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THE TASK OF REDESIGNING LARGE DISTRIBUTED CORPORATE SYSTEM

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1. Introduction. Modern global information networks are extremely complex structures that are constantly changing, which is associated with the appearance and removal of certain servers, the commissioning of new communication channels and the dismantling of outdated and unreliable communications [1,3]. All this affects of the information flows routing in the network. This is NP-complete problem [6]. There are many ways to solve it at the lower levels of the open systems interconnection reference model, but for the application level it is important to have its own methods of forming routes with a specific understanding of the applied problems characteristics and their requirements for managing information flow routes. This is especially important for systems B2B, B2C [3,4]. In [5], the author proposed a set of M-models for finding rational structures of global networks and systems, which is solved at the stage of complex systems conceptual design. This paper proposes new mathematical models, integral channel weighting index and a criterion for optimizing information flows.

2. The proposed mathematical models and optimization criterion. The network under study will be represented as an undirected edge-weighted graph with a set of vertices (nodes) $V = \{v_1, v_2, ..., v_n\}$ that can be sources $O = \{o_1, o_2, ..., o_{ns}\}$ or receivers $D = \{d_1, d_2, ..., d_{np}\}$ of information flows, where. $ns \le n,\ \ np \le n$.

Each source o_k can generate many directed information flows $W_k = \{w_{k1}, w_{k2}, ..., w_{kl}\}$. Each information flow is described by a four:

$$\left\langle OD_{kj},\ b_{kj},\ \lambda_{kj},\ X_{kj} \right\rangle,$$

where $OD_{kj} = (o_k, d_j)$ - is the OD-pair or Origin-Destination pair, indicating the source o_k and receiver d_j of the information flow;

b_{kj} - the average volume of an information message generated by a source o_k that creates a flow $w_{kj} = b_{kj} \times \lambda_{kj}$ (bit / s) with an average intensity λ_{kj} ;each source can generate several streams, which differ in the following elements: d_j, b_{kj} (additional characteristics);

$X_{kj} = \{K_{kj}^{w}, T_{kj}^{\text{ded}}, K_{kj}^{\text{dis}}\}$ - vector of additional flow w_{kj} characteristics: K_{kj}^{w}, $0 < K_{kj}^{w} \le 1$ - coefficient that characterizes the "weight" or "importance" of the flow, we will calculate it as $K_{kj}^{w} = \frac{w_{kj}}{\sum_{j=1}^{l} w_{kj}}$, T_{kj}^{ded} - the time limit for the delivery of information b_{kj} to a piece, K_{kj}^{dis} $(0 \le K_{kj}^{\text{dis}} < 1)$ - coefficient of permissible distortion (loss) of information in a message during its transmission.

Obviously, each source can generate one or more streams for one or more different receivers. Receivers can receive multiple streams from one or more sources.

For the analysis and synthesis of the information structure of the network and the optimal redistribution of information flows (route changes), we introduce additional concepts: **link** and **route**.

A **link** is a bi-directional (duplex) information meta-channel that links two nodes with an information flow. In the meta-model, a set of **links** is defined like this:

$$L^0 = \{l_j\},\ j = \overline{1, N_L},\ N_L = \left|L^0\right|,$$

$$l_j = \{(v_{j1}, v_{j2}), \bar{W}_j, Y_j\},$$

where (v_{j1}, v_{j2}) are the nodes (vertices) connected by the meta-channel or **link** j;

- $\bar{W}_j = \{\bar{w}_{j1}, \bar{w}_{j2}, ..., \bar{w}_{jk}\}$ a set of streams of routes that pass along the j-th link in two directions;

- $Y_j = \{\overleftarrow{C}_j^{\text{lim}}, \vec{C}_j^{\text{lim}}, K_j^{\text{av-k}}\}$ many additional characteristics associated with the features of its possible technical implementation;

$\overleftarrow{C}_j^{\text{lim}}, \vec{C}_j^{\text{lim}}$ - boundary values of the **link** bandwidth in two directions. Obviously, the constraints must be met:

$$\overleftarrow{C}_j^{\text{lim}} \ge \sum_{w_{ji} \in \bar{W}_j} \overleftarrow{w}_{ji}\ ,\ \vec{C}_j^{\text{lim}} \ge \sum_{w_{ji} \in \bar{W}_j} \vec{w}_{ji}\ ,$$

$K_j^{\text{av-k}}$ $(0 < K_j^{\text{av-k}} \le 1)$ - channel availability factor;

Let's introduce the concept of a "weak" link among meta-channels. To do this, we will use the multiplicative-additive feature: $Q_j = \eta \times K_j^{\text{av-k}} \times \sum_{\forall \bar{w}_{jk} \in \bar{W}_J} K_j^{w_i}$.

Here η is the normalization factor.

A set of **route** $R^0 = \{R_1, R_2, ..., R_{N_R}\}$ is information flows described by the four:

$$R_i = \{O_i, D_i, b_i, \lambda_i, X_i, V_i\} = \{OD_i, \bar{W}_i, X_i, V_i^{(u)}\},$$

where

- $\bar{W}_i = b_i \times \lambda_i$ - information flow (bit / s);
- $V_i^{(u)} = \{u_{i1}, u_{i2}, ..., u_{iN_V}\}$ - a set of transit nodes (does not include an OD-pair), through which the information flow is transmitted; in the original model $V_i^{(u)} = \varnothing$, instead $V_i^{(u)}$ you can use $V_i^{(l)} = \{l_{i1}, l_{i2}, ..., l_{iN_V+1}\}$ - a set of transit links, then in the original model $|V_i^{(l)}| = 1$.

It's obvious $N_R \geq N_L$.

Thus, the complete initial meta-model of the information system can be represented as an undirected edge-weighted graph with directed routes $G = (V, L^0, R^0)$.

It should be noted that if the initial graph is disconnected, then this indicates the presence of autonomous subsystems in the meta-system. In this case, structural optimization is performed for each sub graph.

As a criterion for optimizing the network structure and forming a new route system, it is proposed to use the following criterion: to minimize the increment of the index Q in the network when constructing the minimum spanning graph by removing "weak" channels and redistributing their information flows along other short routes.

So, from the original graph $G = (V, L^0, R^0)$, we must get a graph $G^* = (V, L^*, R^*)$ with $|L^*| \rightarrow |V^*| - 1$ and $\sum_{\forall l_j \in R^*} Q_j - \sum_{\forall l_i \in R^0} Q_i \rightarrow \min$.

4. Discussion. The described criterion for minimizing the increment of the integral additive-multiplicative indicator of the data transmission route can be expanded by including other characteristics of information flows and physical communication channels, which can be the source of the emergence of new interesting and useful for the redesign of B2B and B2C distributed corporate systems.

5. Conclusion. The proposed models and criterion for optimizing information flows can be used in the redesign of large information systems. To obtain optimal structures and new routing schemes, various algorithms can be used, which will be considered in future works.

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THE TASK OF REDESIGNING LARGE DISTRIBUTED CORPORATE SYSTEM

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Abstract. The paper proposes a new problem to be solved in the process of redesigning large distributed corporate systems in which there is an exchange of many information flows through various channels. The variety of information transmission routes often leads to multiple duplication of information flows in physical channels. This increases the likelihood of data corruption on the network. At the same time, in large distributed systems, powerful and weak channels with low bandwidth or low reliability are used, which are often disconnected, and in this case it is necessary to solve the problem of information logistics - redistribution of information flows. The paper proposes the problem of optimizing the redistribution of information flows by the criterion of minimizing the total increment in the volume of transmitted information in the system, which is included in the integral indicator of the characteristics of logical and physical communication channels. The problem is solved at the application level when redesigning a corporate system by removing ineffective channels to obtain a minimum spanning tree structure.

Keywords: redesign of distributed systems, minimization of redundant information flows.