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ВИБІР СТРУКТУРИ МЕРЕЖІ ПЕРЕДАВАННЯ МУЛЬТИМЕДІЙНОЇ ІНФОРМАЦІЇ

При передаванні мультимедійної інформації по мережам зв'язку завжди виникає питання багатьох критеріїв її оцінки. Існування багатьох критеріїв зручно кваліфікувати як невизначеність цілей і підходити до цього з єдиних позицій аналізу саме невизначеності.

Метою роботи є розгляд конкретних принципів вибору структури мережі, а також вирішення проблеми формування системи аксіом і властивостей. які відповідають принципам вибору.

При дослідженні задач з багатьма критеріями необхідно визначити спосіб завдання та обліку визначальних елементів вибору структури мережі. До визначальних елементів такого вибору відносяться поняття нормалізації, згортки і пріоритету. Для вирішення цього питання необхідно сформулювати систему аксіом і властивостей, яким повинні відповідати принципи такого вибору.

Спочатку розглянуто поняття нормалізації і класифіковано можливі її способи. Далі вказані дії з показниками, що утворюють повний простір, тобто враховують всі залежності при формуванні цільової згортки.

Поняття пріоритету базується на порівнянні цільових показників. При розгляді пріоритету, із-за відсутності точного розрізнення важливості, значущості та ефективності при заданні багатоцільових структур, можливо використовувати лише один з варіантів задання пріоритету. Показано, що відношення пріоритету може бути також визначено у фор-

ми більш складних відношень порядку, які породжуються початковими бінарними порядками. При цьому необхідно враховувати узгоджене завдання пріоритету.

Формування відношення порядку, при якому проведений вибір нормалізації, згортки та пріоритету віднесено до принципу вибору. Задання принципу вибору дає можливість визначити, як розуміється рішення задачі багатоцільової оптимізації та визначити множину оптимальних елементів.

Встановлено, що задача прийняття рішення в умовах природної невизначеності може бути зведена до задачі прийняття рішення в умовах невизначеності цілей.

Наведено приклад отримання додаткової інформації про ситуацію, що веде до усунення конфлікту.

Ключові слова: *згортка, мультимедійна інформація, невизначеність цілей, нормалізація, пріоритет, конфлікт, критерій.*

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SELECTING THE STRUCTURE OF A MULTIMEDIA INFORMATION TRANSMISSION NETWORK

When transmitting multimedia information over communication networks, the question of multi-criteria evaluation always arises. It is convenient to qualify multi-criteria as the uncertainty of goals and to approach it from the only positions of analysis of uncertainty itself.

The purpose of the work is to consider the specific principles of choosing a network structure, as well as to solve the problem of forming a system of axioms and properties. which correspond to the principles of selection.

When studying multi-criteria problems, it is necessary to determine the method of the task and accounting for the determining elements of choosing the network structure. The article shows that the defining elements of such

a choice include the concepts of normalization, convolution, and priority. To solve this issue, it is necessary to formulate a system of axioms and properties that must correspond to the principles of such a choice.

First, the concept of normalization is considered and its possible methods are classified. Next, actions with indicators that form a complete space are indicated, that is, all dependencies are taken into account when forming the target convolution. The concept of priority is based on the comparison of target indicators. When considering the priority, due to the lack of a clear distinction between importance, significance and efficiency when setting multi-purpose structures, it is possible to use only one of the options for setting the priority. It is shown that the priority relation can also be defined in the form of more complex order relations, which are generated by the initial binary orders. At the same time, it is necessary to take into account the agreed priority task. The formation of the order relation in which the selection of normalization, convolution, and priority is carried out is attributed to the principle of selection. Setting the principle of choice makes it possible to determine how the solution of the multi-objective optimization problem is understood and to determine the set of optimal elements.

It is established that the task of decision-making in conditions of natural uncertainty can be reduced to the task of decision-making in conditions of uncertainty of goals.

An example of obtaining additional information about the situation, which leads to the resolution of the conflict, is given.

Keywords: *convolution, multimedia information, uncertainty of goals, normalization, priority, conflict, criteria.*

Problem statement. Multimedia production is a special object, both in terms of its structure and composition. Along with the requirements for promptness, stability, and continuity of operation, multimedia content distribution networks are subject to the requirements of confidentiality, integrity, availability, and observability of processes related to the use of content. Multimedia content transmission networks are characterized by the existence of many criteria for their evaluation. It is convenient to qualify the existence of many criteria as uncertainty of goals and to approach it from the standpoint of analysis of uncertainty itself [1, 2].

Analysis of recent research and publications. When studying multi-criteria problems, it is necessary to determine the method of the task and accounting for the determining elements of choosing the network structure. The defining elements of such a choice include the concepts of normalization, convolution, and priority. In order to understand this issue, it is necessary to consider the system of axioms and properties to which the principles of such a choice must correspond.

The work of many scientists has been devoted to the development of these issues [3-6]. However, today there is no unified approach to the complete solution of the problems of choosing the network structure for the transmission of multimedia content. This is due, on the one hand, to the complexity of the network structure, and on the other hand, to insufficient awareness of the emerging tasks.

The purpose of the article. For networks of transmission of multimedia information, which are qualified as systems with uncertainty of goals, to specify specific principles of network structure selection, as well as to explore ways of creating some system of axioms and properties that describe these principles. An additional goal of the work is to correct some errors, inaccuracies and markings that exist in this field of activity.

Presentation of the main research material.

First, let's consider the concept of *normalization*. Let's mark F is the space of target functionals f_i. The method of normalization means unambiguous mapping $f_i \rightarrow F$, whic—h turns its target functionality into another element of space F. Table 1 provides possible methods of normalization [3].

Table 1. Methods of normalization

Normalization	Mathematical representation
Reduction to dimensionless quantities	$f_i(x)/\rho[f_i(x)]$
Change of ingredient	$-f_i(x),\ 1/f_i(x)$
Natural	$\lambda_f = \dfrac{f_i(x), -\min\limits_x f_i(x)}{\max\limits_x f_i(x) - \min\limits_x f_i(x)}$
Comparison	$f_i(x) / \max\limits_x f_i(x)$
Savage	$\max\limits_x f_i(x) - f_i(x)$
Averaging	$f_i(x) / \sum\limits_i f_i(x)$

Source: [3]

Another defining element is the concept of convolution. Convolution of the component of the multi-purpose indicator $f_i(x) \in F$ is called reflection $q \in \{F \in R^1\}$, which transforms the set of components f_i into a scalar target $q[f_i(x)]$.

Convolutions are usually divided into the following main types [3]:

1. Summary of indicators f_i with their weighting factors α_i, or the so-called «economical» method:

$$q[f_i(x)] = \sum_i a_i f_i(x) \quad (1)$$

2. On the basis of minimization:

$$q[f_i(x)] = \min_x [a_i f_i(x) + \beta_i]. \quad (2)$$

3. Using the Cobb-Douglas function:

$$q[f_i(x)] = \prod_i [a_i f_i(x)]^i \quad (3)$$

4. Breakdown of vectors $\{f_i\}$ into satisfactory and unsatisfactory (transition to qualitative indicators).

Vectors are considered satisfactory $\{f_i\}$, for which $f_i \geq f_i^0$. Then the convolution has the form

$$q[f_i(x)] = 1, \textit{ if perfomed } (1),$$
$$q[f_i(x)] = 0, \textit{ if not perfomed } (1). \quad (4)$$

Selection of vectors f_i^0 very not simple, therefore there is always freedom of choice f_i^0 a decision-maker.

The convolution (4) can be expanded for a more accurate description of qualitative processes. Forinstead of two convolution values of 0 or 1, you can enter some basic scale of values for $A \in [0, 1]$ and the function of belonging to the «fuzzy» set

$$M_A(f_i^0) : (f_i^0) \rightarrow A. \quad (5)$$

Then the conditions $f_i \geq f_i^0$ will look like this

$$f_i \geq f_i^0 M_A(f_i^0) , \quad (6)$$

and accordingly convolution

$$q[f_i(x)] = \min_x M_A(f_i^0) \tag{7}$$

The basic scale shows the assessment of the process by the person making the decision and is a reflection of the space of indicators on the set A. Note that the scale of the scale can be any, including also negative values.

5. Method of sequential achievement of partial goals.

The start of the next operation begins only when the absolute maximums of the operation efficiency indicators are reached

$$q[f_i(x)] = f_i(x) - \sum_i f_i(x). \tag{8}$$

Practically, this indicator is implemented when there is confidence in reaching the upper limit of the indicator of each previous operation. For example, this indicator successfully describes the successive expansion of the network without changing its topological structure in terms of the degree of capacity maximization.

6. Logical combination of indicators.

This convolution is used for the qualitative type indicators, which take the value 0 or 1. In this case, two options are possible:

the overall goal is to fulfill all partial indicators (conjunctions):

$$q[f_i(x)] = \prod_i f_i(x); \tag{9}$$

the overall goal is to fulfill at least one of the partial indicators (disjunctions):

$$q[f_i(x)] = 1 - \prod_i [1 - f_i(x)]. \tag{10}$$

Similarly to point 4, instead of two values of 0, 1, an increased number of values with membership functions $M_A[f_i(x)]$ and the corresponding base scale can be considered. Then the convolutions will be written in the form:

$$q[f_i(x)] = \prod_i f_i(x)\, M_A(f_i), \tag{11}$$

$$q[f_i(x)] = 1 - \prod_i [1 - f_i(x)]\, M_A(f_i). \tag{12}$$

The specified actions with indicators form a complete space, that is, they take into account all of them dependencies in the formation of the target convolution [4].

The following concept of priority is based on the comparison of target indicators. On unfortunately, until now there are no precise definitions of priority, corresponding to the awareness of the essence of the multi-objective approach in the theory of optimization, based on a clear distinction between the importance, superiority and effectiveness of target indicators. Of course, when considering the priority, due to the lack of a precise distinction between importance, significance and efficiency when setting multi-purpose structures, it is possible to use only one of the options for setting the priority. One approach is that the precedence relation can be defined as a binary order relation R, equalization of space elements F in the sense that one of the conditions is met [3, 5, 6]:

1) f_i better f_k by $R;$ $(f_i R f_k)$;

2) f_k better f_i by $R;$ $(f_k R f_i)$;

3) f_i equivalently f_k by $R;$ $(f_i R f_k \wedge f_k R f_i)$;

4) f_i no better f_k by $R;$ $(f_i \overline{R} f_k)$;

5) f_k no better f_i by $R;$ $(f_k \overline{R} f_i)$;

6) f_i not worse f_k by $R;$ $[f_i R f_k \vee (f_i R f_k \wedge f_k R f_i)]$;

7) f_k not worse f_i by $R;$ $[f_k R f_i \vee (f_k R f_i \wedge f_i R f_k)]$;

8) $[(f_i R f_k) \wedge f_k R f_i) \wedge (f_i R f_k \wedge f_k R f_i)]$.

The priority relationship can also be defined in a more complex form order relations generated by initial binary orders. At the same time, it is necessary to take into account the agreed priority task.

The formation of the order relation in which the selection of normalization, convolution, and priority is made refers to the principle of selection. Setting the principle of choice makes it possible to determine how the solution of the multi-objective optimization problem is understood and to determine the set of optimal elements. The main principles of selection are given in Table 2 [7].

Selection principles do not solve the problem of setting and prioritizing. Solving the problem is possible only under the condition of building a clear, consistent system of axioms of the principles of choice. The main axiom systems were formulated by Arrow [8], Sen [9], Nash [10], Milnor [11], Arrow-Hurwicz [12]:

Table 2. The principle of choice

Name	Optimality condition
Dominance R^{dom}	$F_i(x_0) \geq f_i(x), \forall x \in x, \forall i \in [1,n]$
Partial dominance	$\exists k_1,...,k_q \in [1,n]: fk_i(x_o) \geq fk_i(x), \forall x \in x, \forall k_i, 1 < n$
Pareto $\hat{R}^{dom}$	$\bar{\exists} x \in X: \{f_i(x) \geq f_i(x_0), \forall i\} \cap \{\exists j: f_j(x) > f_j(x_0)\}$
Slater	$\bar{\exists} x \in X: f_i(x) > f_i(x_0), \forall i \in [1,n]$
Jeffrey's effectiveness actually	$\bar{\exists} x: f_i(x) > f_i(x_0), \forall i$ $\exists \mu > 0: \dfrac{f_i(x) - f_i(x_0)}{f_j(x_0) - f_j(x)} \leq \mu$ $\forall i, \forall x \in \{x: f_i(x) > f_i(x_0)\} \exists j \in \{f_j(x) < f_j(x_0)\}$
Not exactly Jeffrey's effectiveness	$\bar{\exists} x: f_i(x) > f_i(x_0), \forall i, \quad \exists \mu > 0,$ $\exists k, \exists x \in \{x: f_i(x) > f_i(x_0)\} \dfrac{f_k(x) - f_k(x_0)}{f_i(x_0) - f_i(x)} \leq \mu,$ $\forall j: \{f_j(x) < f_j(x_0)\}$
Equality	$f_i(x_0) = f_k(x_0), \forall i, k$

End of the table 1

Name	Optimality condition
Total efficiency	$\sum_i f_i(x_0) \geq \sum_i f(x), \forall x$
Nash's	$\prod_i f_i(x_0) \geq \prod_i f_i(x), \forall x$
Compromise	$\exists \alpha_i : \sum_i \alpha_i f_i(x_0) = \max_x \sum_i \alpha_i f_i(x)$
Dominant result	$\max_i f_i(x_0) \geq \max_i f_i(x), \forall x$
Guaranteed result	$\min_i f_i(x_0) \geq \min_i f_i(x), \forall x$
The smallest deviation	$\left\| f(x_0) - f^* \right\| \leq \left\| f(x) - f^* \right\|, \forall x, f^* = \{f_i^*\}, f_i^* = \max_x f_i(x), \forall i$
λ – criterion	$x_0 \in x\lambda_0 : \lambda_0 = \max_{0 \leq \lambda \leq 1} (\lambda : x_\lambda \neq \varnothing), x_\lambda = \{x : \lambda_i(x, \lambda) \geq \lambda, \forall i\}$
α – Hurwicz's criterion	$x_0 : \alpha \min_i \lambda_f(x_0, i) + (1-\alpha) \max_i \lambda_f(x_0, i) \geq$ $\geq \alpha \min_i \lambda_f(x, i) + (1-\alpha) \max_i \lambda_f(x, i), \forall x$
The maximum of the uncertainty function	$x_0 : H[f(x_0)] \geq H[f(x)]$

Source: [3]

Arrow's system of axioms is five natural axioms that make up the so-called Arrow's paradox, the content of which is that there is no order R, which satisfies these five axioms [8].

There has always been a desire to change the formulation of these axioms in such a way as to find an order relation R, which would satisfy these conditions. A change in the axioms proposed by Sen led to the fact that the system holds for the choice principle if and only if it is trivial, that is, when it is a dominance principle [9]. Thus, since a negative answer was received to the question of the existence of the principle of choice (different from dominance) in the class of relations, which satisfies the system of Sen's axioms, attempts were made to develop new systems of axioms and principles of choice.

Nash's axiomatics contains four axioms and satisfies his choice principle. Milnor's axiomatics consists of three axioms [11]. The principle of choice satisfies this axiom system

$$R(f) = \min_i f_i(x). \quad (13)$$

At the same time, one of the axioms is, in fact, a condition that the elements dominate and do not belong to the set of optimal ones according to the principle of selection $R(f)$ elements.

The Arrow- Hurwicz axiom system contains four axioms [12]. This system satisfies the principle of a guaranteed result.

The Sen, Nash, Milnor, Arrow-Hurwicz axiom systems are aimed at solving the Arrow paradox. This can be done at the cost of a significant departure from Arrow's original axiomatics. One of the approaches consists in comparing the orders for the selection principles [12].

Definition 1. Order relation R_i, for a fuzzy set $F(\mu)$ for $\mu \in [0,1]$ stronger than the order relation R_2 ($R_1 \triangleright R_2$), if the intersection of sets is not empty,

$$F_1(\mu) = \{f_0 \in F(\mu): f_0 R_1 f, \forall f \in F(\mu), \forall \mu \in [0,1]\}, \quad (14)$$

$$F_2(\mu) = \{f_0 \in F(\mu): f_0 R_2 f, \forall f \in F(\mu), \forall \mu \in [0,1]\}, \quad (15)$$

and if

$$F_1(\mu) \le F_2(\mu), \forall \mu \in [0,1] \quad (16)$$

$$R_1 \triangleright R_2 \rightarrow \{ F_1(\mu) \cap F_2(\mu) \ne \varnothing, \forall \mu \in [0,1] \cap (F_1(\mu) \le F_2(\mu), \forall \mu \in [0,1])\} \quad (17)$$

Definition 2. Order relation R stronger than the ratio of each order $R_k (k = 1, ..., n)$ for an odd set if

$$\{ R_1 \triangleright R_k \} \wedge \{ F_0(\mu) \cap F_k(\mu)\} \ne \varnothing \quad (18)$$

i.e.

$$F_0(\mu) \le F_k(\mu), \forall \mu \in [0,1]), \quad (19)$$

where

$$F_0(\mu) = \{f_0 \in F(\mu) : f_0 R f,\ \forall f \in F(\mu),\ \forall \mu \in [0,1]\}, \quad (20)$$

$$F_k(\mu) = \{f_0 \in F(\mu) : f_0 R_k f,\ \forall f \in F(\mu),\ \forall \mu \in [0,1]\}. \quad (21)$$

Definition 3. Order relation R stronger than the totality $R_k (k = 1, ..., n)$ for a fuzzy set $F(\mu)$, if

$$\{R_1 \triangleright R_k\} \wedge F_0(\mu) \cap \{\cap_k F_k(\mu)\} \neq \varnothing, \quad (22)$$

$$F_0(\mu) \leq \cap_k F_k(\mu),\ \forall k,\ \forall \mu \in [0,1]. \quad (23)$$

The problem of choosing a multi-objective indicator arises because, as a rule, the set is empty

$$F_0(\mu) = \{f_0 \in F(\mu) : f_0 R^{dom} f,\ \forall f \in F(\mu),\ \forall \mu \in [0,1]\}. \quad (24)$$

the best by R^{dom} elements.

However, close to R^{dom} order relation $R^{dom} / \hat{R}^{dom}$ is common, since it is assumed that the multi-objective optimization problem is non-degenerate, that is, a set of Pareto-optimal elements f_0 not empty, but elements $f_0 \in F(\mu)$ best are the in $R^{dom} / \hat{R}^{dom}$, and the problem of choosing the optimal element based on the multi-objective indicator arises due to the fact that the set is sufficiently represented.

Introduction of the concept $\triangleright$ on order relations R allows comparison of selection principles $R(f, \mu)$ that is, to determine whether they exist for a given selection principle $R(f, \mu)$ other principles of choice in which the order relations corresponding to them are stronger $R(f, \mu)$. In addition, for specific pairs of choices, it is possible to determine which of them is stronger.

In the presence of natural uncertainty, the parameters of the process are set $x(t)$ and the objective function f, but they are specified incorrectly – they contain an undefined parameter $\hat{\alpha}$:

$$x \to x(t, \hat{\alpha}), \quad (25)$$

$$f \to f(x, t, \hat{\alpha}), \quad (26)$$

If there is no information about $\hat{\alpha}$, then the optimization result is free. Natural uncertainties arise due to the following factors:

- uncertainty associated with not knowing specific values of random variables or functions for which statistical and probabilistic properties are known with one or another degree of detail (distribution laws, correlation functions, etc.), or a given area of change $\hat{\alpha} \in A$;
- uncertainty associated with not knowing the type of some deterministic functions that describe processes, which leads to the need for approximations;
- uncertainty associated with ignorance of some factors of the process, which leads to incomplete models;
- uncertainty associated with the technical impossibility of accurately taking into account all the factors that affect the process, but these factors are reliably known;
- uncertainty associated with instability and bifurcations of systems;
- uncertainty associated with new phenomena;
- uncertainty associated with the unknown actions of the other party, which leads to conflicts.

The given list can be developed and clarified.

One of the basic principles of natural uncertainty is its guaranteed outcome. It consists in the following. As for anyone x

$$\min_{\hat{\alpha}} f(x, \hat{\alpha}) \le f(x, \hat{\alpha}) \tag{27}$$

and for anyone $\hat{\alpha}$

$$f_0 = \max_x \min_{\hat{\alpha}} f(x, \hat{\alpha}) \le \max_x f(x, \hat{\alpha}) \tag{28}$$

Numeric f_0 – a guaranteed assessment, and an appropriate decision x_0 is a guarantee strategy, in the sense that whatever the value of the parameter $\hat{\alpha}$, choice x_0 guarantees that the value of the objective function will be no less than f_0.

It is possible to improve the guaranteed assessment if decisions related to the defined risk are made. At the same time, two situations arise: the choice is made multiple times and the choice is one-time. In the first case, it is necessary to specify some probability distribution of a random variable $\hat{\alpha}$, in the second – to use fuzzy sets.

The problem of decision-making under conditions of natural uncertainty can be reduced to the problem of decision-making under conditions of uncertainty of goals. Really target condition

$$f(x, \hat{\alpha}) \rightarrow \max_x \quad \hat{\alpha} \in A \tag{29}$$

is equivalent to an infinite number of criteria:

$$f(x, \hat{\alpha}_1) \rightarrow \max_x \quad \hat{\alpha}_1 \in A$$

$$f(x, \hat{\alpha}_2) \rightarrow \max_x \quad \hat{\alpha}_2 \in A$$

$$f(x, \hat{\alpha}_n) \rightarrow \max_x \quad \hat{\alpha}_n \in A$$

You can limit yourself with some credibility n criteria and solve the optimization problem for specific values $\hat{\alpha}$, choosing normalization, convolution, priority, or constructing a Pareto optimal region.

Conflict occupies a special place in the task of decision-making. With the functioning of communication networks and the probabilistic nature of information flows, conflicts in nodes are inevitable, and the quality of network functioning depends on how successfully these conflicts are resolved and how successfully the routing of information flows is performed.

Let's introduce the concept of intensity of interaction of information flows Target criterion of one party that controls the information flow U_1 let's define $f_1(x_1, f_2)$, the target criterion of the second party with the flow $U_2 - f_2(x_2, f_1)$. At the same time:

$$x_1 = \delta f_1(x_1, f_2) / \ \delta f_2 ;$$

$$x_2 = \delta f_2(x_2, f_1) / \ \delta f_1 . \tag{30}$$

Thus, for x_1 efficiency f_1 is a functional of a function $f_2(x_2)$, and for x_2 efficiency f_2 – functional from $f_1(x_1)$.

Under the influence of interaction, the effectiveness of the parties changes, which is the basis of conflict classification [3, 13].

For multi-objective systems, classification by criteria is complicated, because for some purposes the systems can be mutually acting, for others - opposing.

The resolution of the conflict involves the resolution of such basic issues [3, 13].

1. How would the conflict take place if the parties were fully aware?
2. How realistically, that is, taking into account the limitations of technical, time, or priority resources, can efficiency behave f_{12}?
3. How he can behave realistically f_{22}?

4. How would the conflict occur if for f_1 there would be full information about the situation, and for f_2 – incomplete?

5. How would the conflict develop if for f_2 there would be full information about the situation, and for f_1 – incomplete?

Based on the results of solving these issues, the value (relevance) of information is determined and the need for such redistribution by the parties of their resources, during which part of them is spent on obtaining additional information about the situation, which leads to the elimination of the conflict.

For multimedia data transmission network must first be defined by its topology, for example, which is described by a graph G. Let us also assume the given matrix of information flows between each pair of network nodes

$$\Lambda = \| \Lambda_{ij} \|, \tag{31}$$

and a matrix of channel rental costs

$$C = \| C_{ij} \|. \tag{32}$$

It is necessary to determine the number and type of transmission channels n_{rh} in each connection $(r; h)$ with transmission speed V_{rh},

$$N = \| n_{rh} \|. \tag{33}$$

and flow rates in each connection (r, h)

$$F = \| f_{rh} \|. \tag{34}$$

At the same time, the conditions must be met

$$f_1\,(n_{rh}) = \sum_r \sum_h c_{rh} c_{rh} \rightarrow \min \tag{35}$$

$$f_1\,(n_{rh}) = \sum_r \sum_h V_{rh} n_{rh} \rightarrow \max \tag{36}$$

for the following restrictions:

$$\sum_r \sum_h f_{rh} = \sum_i \sum_j \Lambda_{ij}\,, \tag{37}$$

$$T_{ij} \le \tau_{kr}\,, \tag{38}$$

$$f_{rh} \le V_{rh}\, n_{rh} \;. \qquad (39)$$

In such a formulation, the problem is multi-criteria, and in order to be clear in what sense the solution to the problem is understood, it is necessary to formulate the target structure, namely to define the principle of selection for criteria (35), (36). Note that these criteria conflict, with the same priority. Therefore, selection principles based on dominance are not suitable. For conflicting criteria, the principles of Pareto, Nash, guaranteed result or compromise are acceptable [10]. The conflict described above is not antagonistic, ithis can be qualified as a loose confrontation. Therefore, the principle of Nash choice, which determines the equilibrium situation for antagonistic criteria, and the principle of guaranteed result, which is also used in conditions of antagonism and provides a bottom-up assessment of possible optimal solutions, are also not suitable. The principle of Pareto choice and the principle of trade-off remain. According to definitions 1–3, the Pareto selection principle gives a stronger order relation on the set of all possible connections *(r, h)* han the principle of compromise. Therefore, it is defined as the principle of choice.

To find the Pareto optimal solution, consider the criterion space $E^2_{f_0}$. In this space, it is necessary to create a multiplicity of reach G_f, which is a reflection of the set of possible connections n_{rh}. Otherwise for each point n_{rh}, in the space of connections relations

$$f_1 = f_1(n_{rh}),\, f_2 = f_2(n_{rh}) \qquad (40)$$

correspond to some point of the criterion space

$$f = G_f \;. \qquad (41)$$

Plural G_f is called the reachability set. For this task G_f limited since the value C_{rh} and V_{rh} are limited, and the number n_{rh} can change at finite intervals $[a_{rh},\ b_{rh}]$ Depending on the linearity of conditions (35) – (37), (39) is a set G_f polyhedral [14] and, accordingly, convex and closed. Vertices of the polygon G_f there can be only those points of the criterion space whose coordinates correspond to the values $n_{rh} = a_{rh}$, $n_{rh} = b_{rh}$.

Let's mark through P_f a set of points that are Pareto optimal. It consists of a subset of the boundary points of the set G_f and is ribbed. To form the Pareto set, we fix some permissible values of the criteria f_1 i f_2, belonging to G_f:

$$f_1 = c_1, \quad f_2 = c_2. \tag{42}$$

At the same time, two optimization problems must be solved:

1. $f_1(n_{rh}) \rightarrow \min,\ f_2(n_{rh}) = c_2,\ \sum_r \sum_h f_{rh} = \sum_i \sum_j \Lambda_{ij'} f_{rh} \leq V_{rh}\, n_{rh}$

2. $f_1(n_{rh}) \rightarrow c_1,\ f_2(n_{rh}) = \max,\ \sum_r \sum_h f_{rh} = \sum_i \sum_j \Lambda_{ij'} f_{rh} \leq V_{rh}\, n_{rh}$

As a result of solving these problems, you can determine the points G_f^{01} та G_f^{02}. For reference points F_1 = {min f_1 c_2} and F_2 = {c_1 max f_2} it is necessary to take the leftmost point of the polygon G_f and its highest point (Fig. 1).

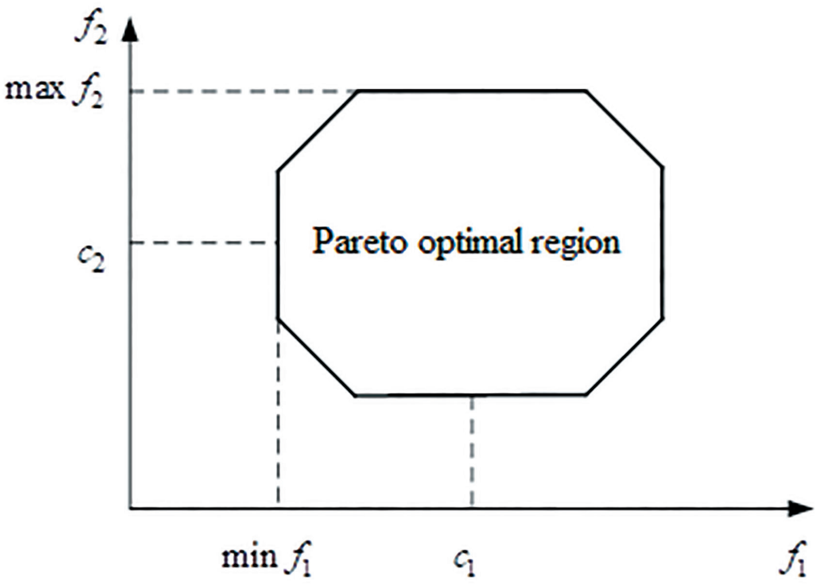

Fig. 1. View of the reachability set G_f
Source: [3]

If the points G_f^{01} and G_f^{02} satisfy these requirements, you can take them as reference. Connecting the dots G_f^{01} and G_f^{02} we get the first approximation of the Pareto set with a straight line (Fig. 2).

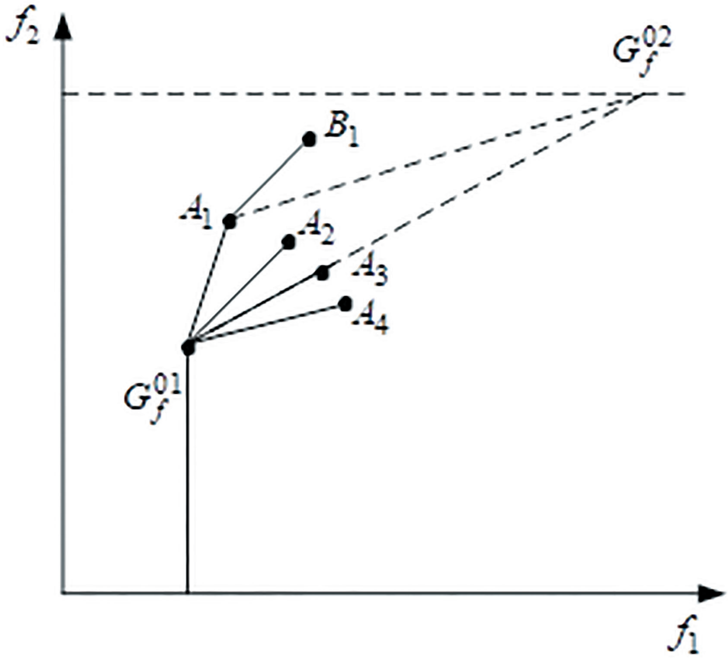

Fig. 2. Approximation of the Pareto set

Source: [3]

The true Pareto set is the broken line that connects the points G_f^{01}, G_f^{02} and which is the border of the region G_f and lies above and to the left of the straight line G_f^{01} and G_f^{02}. The components of the polyline are built starting from the point G_f successively changing and fixing the values of the constants c_1, c_2. The first component of the polyline is chosen from the segments that start from the point G_f^{01}. All these segments belong to the region G_f and are characterized by a change in the value of any one variable. Among the segments that start from the point G_f^{01} choose the one with a straight line G_f^{01}, G_f^{02} makes the largest angle.

Thus, to find the point G_f^{02} it is necessary to solve optimization problems 3, 4, which are similar to problems 1, 2:

3. $f_1(n_{rh}) \to \min, f_2(n_{rh}) = c_3, \sum_r \sum_h f_{rh} = \sum_i \sum_j \Lambda_{ij}, f_{rh} \leq V_{rh} n_{rh}$

4. $f_1(n_{rh}) \to c_4, f_2(n_{rh}) = \max, \sum_r \sum_h f_{rh} = \sum_i \sum_j \Lambda_{ij}, f_{rh} \le V_{rh}\, n_{rh}$

The polyline $G_f^{01} - A_1 - G_f^{02}$ can be considered the second approximation of the Pareto set, in which the segment $G_f^{01} - A_1$ is part of the Pareto set, and the segment $A_1 - G_f^{02}$ needs further clarification according to the same algorithm.

The set of efficient options is determined by the vertices of the polygon, which belong to the Pareto set.

This approach does not provide a single solution, but it allows you to discard ineffective options and significantly narrow the set of possible alternatives, leaving the final one inthe choice of the option by the person who makes the decision.

Conclusions and proposals.

1. Formulated a system of axioms and properties to which the principles of choosing the structure of the multimedia information transmission network must comply.
2. It is shown that the defining elements of choosing a network structure include the concepts of normalization, convolution, and priority.
3. It has been established that the task of decision-making in conditions of natural uncertainty can be reduced to the task of decision-making in conditions of uncertainty of goals.
4. Conflict occupies a special place in the decision-making task. An example of obtaining additional information about the situation, which leads to the resolution of the conflict, is given.

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