

## Technical characteristics of MLIS and MNIS GAO 2.2

The names of the proposed software products are: **Multilingual local instrumental system of goal achievement optimization**, version 2.2 (MLIS GAO 2.2), and **Multilingual network instrumental system of goal achievement optimization**, version 2.2/upc (MNIS GAO 2.2/upc).

### 1. General characteristics of the products

#### 1.1. Business benefits

Allowing any interested users to operatively solve tasks of finding *optimal compromise* between cost and time to achieve the set goal by performing a given network graph of arbitrary structure (including hierarchical), comprising a lot of ordinary and nested chains of linked operations with various options of executing each of them. Such tasks can be solved as for the new network graph, which has not yet been optimized, and in the process of practical realization of the existing graph, the calculated optimal parameters of which have been found earlier, but in practice changed.

#### 1.2. Products positioning

Markets of software and network computing services to solve tasks of network planning optimization.

#### 1.3. Information about users

Potential users of MLIS GAO 2.2 and MNIS GAO 2.2/upc (further - MLIS/MNIS GAO 2.2) are: design and construction organizations, enterprises for production of serial production, and businessmen.

### 2. Products overview

Programs **MLIS/MNIS GAO 2.2** are intended to find optimal compromise between cost and time of performing a network graph that consists of chains of linked operations (ordinary and nested) and aimed at achieving the set goal. Each of these operations is characterized by various options of values of cost and net time of its execution inherent to respective individual resources, some of which may be temporarily unavailable. MLIS/MNIS allow to minimize the cost (or time) of performing the network graph at a given restriction on the time (cost) of its performance, which is achieved by finding the optimal options of executing all its operations. There is also provided a mode of realization accompaniment for the existing network graph. It follows that MLIS/MNIS possess all features for solving tasks of project management, where a plan of project creation is presented in the form of a network graph of arbitrary structure.

MLIS/MNIS GAO 2.2 are multilingual programs. Alternative languages of their interfaces are stored in separate files, called *language shells*. These programs include two such shells: Russian and English, as well as a special program of version 1.0 called "**Генератор языковых оболочек (ГЯО 1.0)** (Generator of language shells (GLS 1.0))", that allows users themselves to create such shells for any languages in which they usually communicate.

MLIS is a offline program, designed for a particular user (the lite version of this program is free).

MNIS is purposed to provide network services to many users. This system consists of two parts: one remote module of optimization (MO), which is a part of the Universal processing center (UPC) 9 MNIS 1.0 (that is why the suffix "/upc" is indicated in the name of this MNIS), and numerous automated work places (AWPs) targeted at specific MNIS users. Each such AWP is designed to prepare by a separate user the input data of the tasks to be solved and to output the calculation results, and the synthesis of optimal strategies of executing network graphs takes place in the MO. Information link between AWP and MO can be carried out via the Internet, over the local network or even on the computer bus of a single user of AWP. In the first and second cases MO is located on the network server, and in the third - on the computer of the indicated user. At that, there is ensured the operativeness and full automation of the AWP interaction with this module.

MLIS/MNIS GAO 2.2 are created on the basis of a new science-intensive information technology of automation of control of discrete technological and information processes (IT AC DTIP), having many uses, the founder of which is the author of these multilingual programs. A set of lite version of MLIS GAO 2.2 can be downloaded from any of two websites of the author: "Promotion center of IT AC DTIP" (<http://dtip-burlakov.com/en>) and "Implementation center of IT AC DTIP" (<http://dtip-optim.com/en/main>). There also the user can solve remotely up to 10 test tasks in MNIS GAO 2.2/upc.

Areas of possible use MLIS/MNIS GAO 2.2 are **designing, construction, industrial production and business**.

Year of release MLIS/MNIS GAO 2.2 - 2016 (year of MNIS update to version 2.2/upc - 2018). Place of development - Kiev (Ukraine).

### 3. Products functions

MLIS/MNIS GAO 2.2 allow to solve the tasks of finding such strategies of performing network graphs in which achieved one of the two:

- minimum **cost** of executing the graph under given restriction on its execution *time*;
- minimum **time** of executing the graph under given restriction on its execution *cost*.

#### Input data of a task to be solved:

- 1) minimized parameter: cost or time of executing the network graph (NG);
- 2) total number of chains of operations in NG, and number of nested chains in it;
- 3) while minimizing the cost of performing NG - possible mode of use temporarily unavailable resources (TUR) among individual resources for executing the graph operations;
- 4) in the absence of TUR - possible mode of NG decomposition by selecting nested network subgraphs (NNSGs), as well as a manual or automatic mode of their numbering;
- 5) in the presence of TUR - a set of their categories, each of which is characterized by time intervals of availability of resources of this category;
- 6) mode of automatic conversion (in order to solve the task) of some usual operations in the crucial ones (see below);
- 7) number of operations in each chain, as well as coordinates of its ends in the graph;
- 8) a set of operations options, each of which is characterized by three parameters: category of used resource (if TUR), as well as the cost and time of executing the operation;
- 9) one of the three:
  - up to ten possible thresholds of restricting *time* of executing NG in solving the task of minimizing cost of its execution;
  - up to ten possible thresholds of restricting *cost* of executing NG in minimizing time of its execution, if the resulting part of the graph (after its decomposition) will consist of a single chain of operations.
  - one threshold of restricting *cost* of executing NG in minimizing time of its execution, if the resulting part of the graph will consist of two or more chains of operations.

As a result of solving the task, presented in a tabular form, is a set of optimal options of executing all NG operations for each specified threshold of its execution time or cost. In particular, for each operation of the graph are specified all its parameters, including the time range within which can vary the start of its execution.

At the basis of solving the tasks of goal achievement optimization is used a method of numerical optimization of discrete processes of service, as well as a unique scheme to optimize such processes developed by the creator of MLIS/MNIS GAO 2.2.

### 4. Restrictions

- maximum number of chains of operations - **1000** (for lite version of the program MLIS GAO 2.2 - **10**);
- maximum number of operations in each chain - **500** (for lite version of MLIS - **10**);
- maximum total number of options of realizing all operations NG - **64500**;
- allowable number of options of realizing every operation - **20**;
- in the absence of TUR:
  - allowable number of selected NNSGs - **100**;
  - allowable number of nested chains of operations in NG for using *automatic* mode of numbering NNSGs - **10**;
  - maximum number of quantization steps of time of executing NNSG - **20**.
- in the presence of TUR:
  - maximum number of categories of TUR - **100** (for lite version of MLIS - **10**);

- maximum number of resource availability intervals of one category - **10**;
- allowable number of phase states of an optimizable process (it is available for regulation by the user through changing the duration of step of rounding the time or cost parameters) - **1000000** (for lite version of MLIS - **20000**).

### 5. Practical application

MLIS/MNIS GAO 2.2 were put into operation in August 2016 (MNIS was updated to version 2.2/upc in July 2018). Now comes the stage of the search for potential dealers and users of these systems.

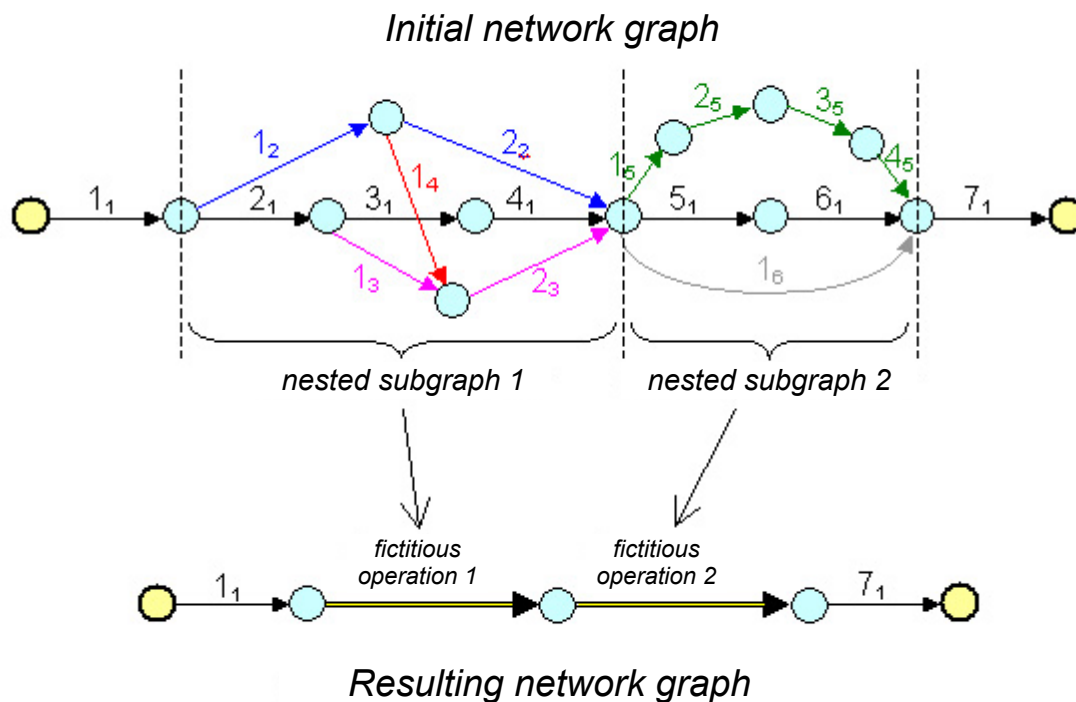
### 6. Description the optimizing object

The optimization object of MLIS/MNIS GAO 2.2 is a network graph of arbitrary structure, including a lot of ordinary and nested chains of operations. All totality of the NG nodes, between which are located its branches (operations), includes two main nodes: initial and final, as well as some intermediate nodes. The graph nodes possess the following properties: from the initial node the chains of operations only come out, to the final node the chains only come in, and any intermediate node connects one or more incoming operations and one outgoing that will be executed if all incoming operations are fulfilled.

NG should have the following general feature: its chains of operations are ordered so that any of them has a common nodes only with the operations of its preceding chains, which defined previously. To optimize performance of any NG that satisfies this property, there is provided the decomposition procedure. Its essence lies in the fact that in the original graph are selected sequentially (either manually or automatically) its separate fragments (they may be nested in each other), linked with the rest part of the graph by its two nodes. Then takes place the optimization of performing each of them throughout the range of its parameters. After that, these fragments are replaced in the resulting graph on the so-called *fictitious operations*, parameters of which are calculated while optimizing the first ones, and then is made a final optimization of the NG.

In order to such optimization of separate parts of the graph was always possible, some of their usual operations are automatically converted to the so-called crucial ones having just one option of realization: with minimum value of its cost or time.

The figure below shows an example of such a decomposition for NG, which was used in two solved demo-tasks (DEME05 and DEME06), included in MLIS/MNIS.



**Figure.** An example of the decomposition of the optimized network graph

Here the original NG consists of one ordinary chain of operations (at first number) and five nested chains (numbers for all chains are shown by subscripts near the operations). To optimize this

graph, we had to select in it two components (nested subgraphs 1 and 2), after which optimization they were replaced by the program on the fictitious operations. In this case the resulting graph presents only one chain of operations, cost or time of its execution can be minimized by specifying up to 10 thresholds of restricting the opposite parameter (time or the cost of its execution).

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