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Research paper

Methods of Protecting the Distributed Computation in Multi-Agent System

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Abstract

Currently, there are many different approaches for organization of the distributed calculations in computer network technology grid, metacomputing (BOINC, PVM, and others). The main drawback of most existing approaches is that they are designed to create centralized distributed computing systems. In this article we propose to organize the solution of such problems as multivariate modeling, through the creation of distributed computations in computer networks based on decentralized multi-agent system. When used as a computing environment a computer network on a large scale can cause threats to the security of distributed computing from the intruders. One of these threats is getting the calculation about the result by the attacker. A false result can leads in the modeling process to adopt is not optimal or wrong decisions. We developed a method of protecting distributed computing from the threat of receiving false result.

Keywords: *distributed computing; multi-agent system; protection of results of calculations.*

1. Introduction

Currently, many tasks require a large amount of computation. These include modeling problems.
In practice, modeling problems require the choice of the best solutions to not one, but multiple criteria (multiobjective optimization problem), which bring additional and not always solvable difficulties. If the object and its parameters are variable, time-dependent, in this case using more complex strategies for solving modeling tasks [1,2].
Choosing one of the many variants can require too much of the huge options that are not available even for the fastest computers. It is estimated, for example, that the problem of distribution of the 20 criteria at 10 sites, the number of possible options is 108. Even if the calculation of each option would require only 10 arithmetic operations, and then the total number of payment transactions will reach a billion that cannot be done by computers in a reasonable timeframe.
The most popular solution to this problem at present is the use of distributed computing.

2. Statement of the Problem

The main tasks of the authors:

- create a method to minimize the preparatory stages for the solution of any task multi-variant modeling;
- to use as computing centers to solve specific computational unit parts of a typical scalable computer network;
- to optimize the task execution time by optimizing the processing load of the computer according to its computational resources.

The system must be operable at any set of computers, quantity and performance, have a high survivability - not to lose efficiency and perform the solution for the allotted task time resources when dynamically changing computing environment [2,3].
Currently, there are many different approaches for organization of the distributed calculations in computer network technology grid, metacomputing (BOINC, PVM, and others) [4]. The main drawback of most existing approaches is that they are designed to create centralized distributed computing systems. As the most promising way of organizing distributed computations in computer networks you have chosen a decentralized multi-agent system.
Under a multi-agent system is a set of agents, each of which represents a software module hosted on a separate computer. All agents form a peer-to-peer set and work on the same algorithm. The agent takes control of your computer and its operation is not dependent on other computers. The agent manages the execution of the processing load on your computer, initiates data exchange with other agents executes a processing received from the other agents information and based on it make decisions.
For the realization and protection of distributed computations in computer networks developed by the algorithm of multi-agent agent system. Running the algorithm, the agents organize a distributed computing system based on the nodes of computer network [5].

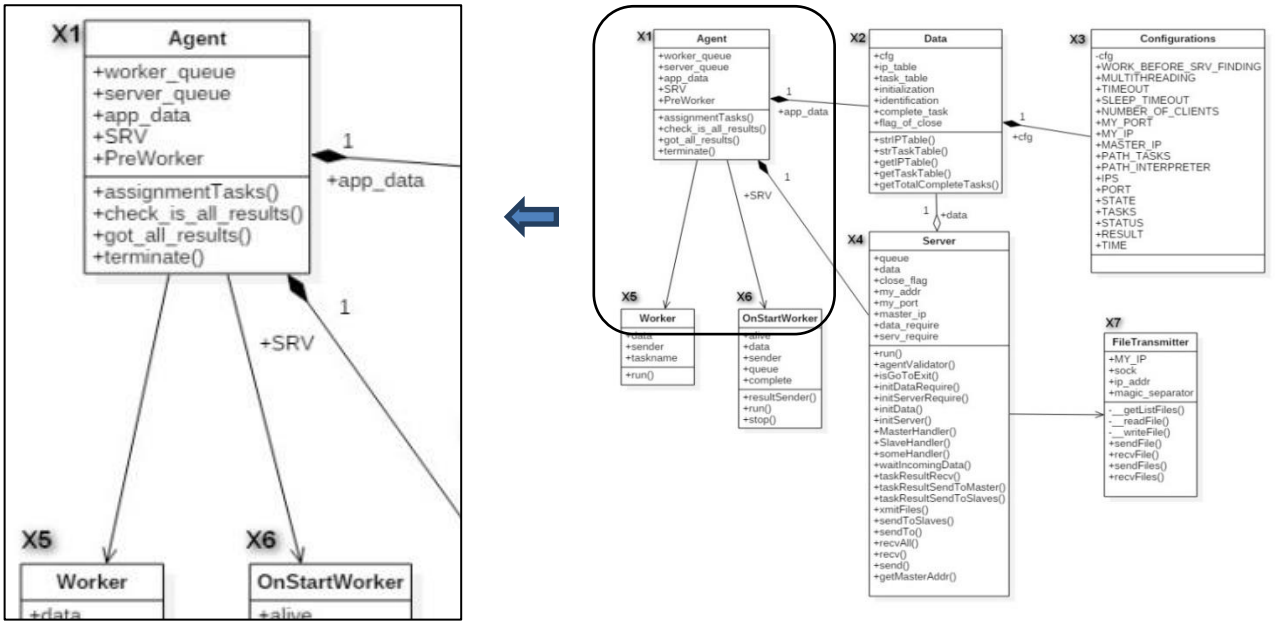

Fig.1: Structure of agent programs multi-agent system

3. Implementation of Multi-Agent System

Let's formulate requirements to the algorithm of the system. The system should be decentralized — each agent should have equal rights and be able to exchange messages with other agents:

- the agent must monitor the computing processes performed on the managed computer;
- agents must share the computational load;
- each agent needs to store all the results of the execution of a large task;
- multi-agent system must ensure the security of distributed computing against threats from intruders.

For the organization of distributed computations in computer networks and implementation of the requirements, the algorithm was developed containing a number of rules which should be performed by each agent. At the beginning of the organization of distributed computations in computer networks P to {p1,p2,...,pj} P are managing their work agents {m1, m2, ... , mn} M.

At the initial stage of the organization of distributed computations in computer networks wi W, after the receipt by agent mi M load and General information about the system, mi initiates on your computer p1 computational process for the execution of wi1, performing actions in accordance with rule execution processing load. To test the ability of the organization of distributed calculations in the network was written and debugged the program agent multi-agent system based on Python. The programme structure is shown in figure 1.

4. Security Protection in A Multi-Agent System

The managing agent of a centralized multi-agent system organizes distributed computing and collection of calculation results in a computer network. In such a system, not only failures of the control computer are possible, but also false results from the computing nodes of the network. To protect the results of a centralized distributed computing system, the managing agent must verify all results obtained from the agents. However, because of limited computing resources, it cannot provide reliable protection. The probability of not detecting false results with a large number of agents in a centralized multi-agent system is very high.

In a self-organizing decentralized multi-agent system, any network computers can be used, which can lead to the presence of malicious computers in a multi-agent system.

Providing protection by using computers only from a narrow circle of "trusted" computers imposes severe restrictions on the degree of parallelization of computing processes.

To protect calculations from false results, it is proposed to use a method based on verification of correctness of calculations by all agents. It is proposed to organize distributed calculations so that the result of the solution received by each agent is checked by other agents. This protection increases the load on the multi-agent system. The performance of a distributed computing system will decrease in this case, but the security of computing results will be improved. To implement the proposed method of protection in the new decentralized system, the algorithm for distributing the computational load between agents has been changed. The algorithm ensures control of correctness of the obtained results by repeating the process of computational agents. This allows you to discover about the results obtained from the attackers.

5. The Probability of Not-Detecting A False Result in Centralized and Decentralized Multi-Agent System

Compare the degree of security of distributed computing, organized based on centralized and proposed decentralized multi-agent systems. The probability of not detecting false results is calculated by the formula 1

$$P_{nolr}=1-P_{olr}=1-\frac{\left(\frac{W}{N}\right)!}{m!*\left(\frac{W}{N}-m\right)!}*\left(\frac{1}{N}\right)^{m}*\left(1-\frac{1}{N}\right)^{\frac{W}{N}-m}. \quad (1)$$

The attacker is in a centralized multiagent system with a large number of agents, N (100 to 10 000). The probability of not detecting one, two, three false results in figure 2. Calculations were performed for centralized multi-agent system.

Graph of probability of detection false results P_{nolr} in a decentralized multi-agent system is shown in figure 3. The graph (Fig. 3) was constructed for the number of agents N (5 to 1000). In a decentralized multi-agent system when the number of agents the probability of undetected false results P_{nolr} reduced.

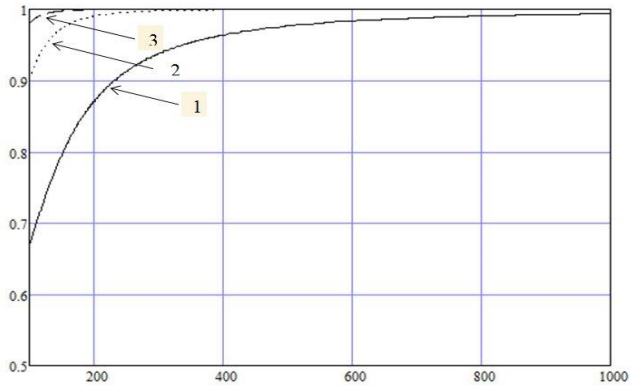

Fig.2: The probability of not detecting 1) one 2) two or 3) three false results in a centralized multiagent system with one managing agent.

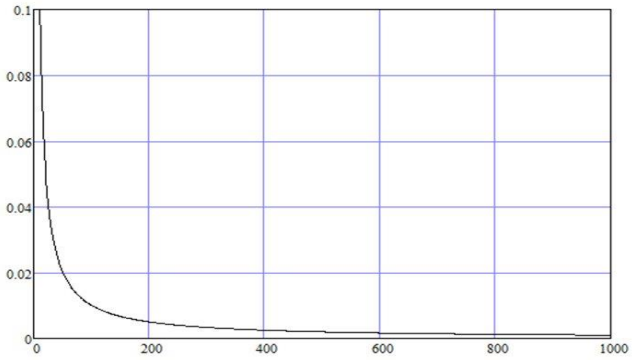

Fig.3: The probability of detection of false results in a decentralized multi-agent system with two attackers depending on the number of agents in the system M.

Comparison of graphs in figures 2 and 3 leads to the conclusion that in a self-organizing decentralized multi-agent system, the probability of not detecting false results with an increase in the number Of agents n decreases, and in a centralized system increases.

6. Conclusion

The algorithm of operation of the agent of a decentralized multi-agent system allows organizing distributed computing in computer networks to reduce the time of solving multi-variant problems.

Each agent works independently of other agents. When organizing a distributed computing system in a computer network, there are threats to the security of computing processes. Obtaining a false result by the computational system instead of the correct one is one of the essential threats. The proposed method of organization of distributed computing on the basis of a decentralized multi-agent system provides a higher efficiency of protection of distributed computing processes than centralized in an unstable computing environment of a computer network. With the number of agents of a multi-agent system N = 200, the probability of not detecting false results in a decentralized system is 40 times less.

Acknowledgement

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