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METHOD OF THE RESERVE RESOURCES DETERMINATION FOR THE DISTRIBUTED COMPUTER SYSTEMS WITH THE NETWORK-CENTRIC RESOURCE CONTROL

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1. Introduction

Nowadays, there are several approaches to Distributed Computer Systems (DCS) resources control, the main of which are centralized, decentralized and hierarchical approaches. Taking into account the scalability of DCS, now it is particularly important the resource control mechanisms based on the decentralized approach. The decentralized approach has the following advantages: fault tolerance, the flexible scalability, high availability. However, the implementation of this approach is a very difficult task, because in this case in the system there is no any central element, which would be store all the information about system resources and performs the resources control. In order to improve the DCS resources control on the decentralized approach it was proposed to implement the module of Resource Management System (RMS) in DCS, the functions of which is based on network-centric control principles [1].

2. The problem statement

In asynchronous mode for the tasks with a high level of parallelization module in RMS module, which is based on the network-centric approach, there was introduced the resources reserve ratio, otherwise for intensive flow of tasks all the DCS resources are distributed between the tasks, and the average time of task execution is significantly increased. We assume that the the parameters of the DCS functioning is significantly dependent on the reserve ratio. It is important to develop a mechanism for reserve ratio control to improve the efficiency of DCS functioning. Since the high reserve ratio will increase DCS resources idle time, it is wisely to take the rate of DCS resource utilization and the average time spent in queuing as parameters which are determining the effectiveness of the DCS functioning

3. Development of a method for determining the required number of DCS resources

Before to get to the development of the method, we consider a tasks model in a parallel form, which is used in this study. The task is presented in MPL-form (multi-layer parallel form). Let the task consist of five levels, on each of which there is a certain number of sub-tasks (subtask, st) of the task.

In [1] the basic concept of DCS resource control based on the network-centric approach is presented. At asynchronous mode for the tasks with a high level of parallelization in the RMS module was introduced the resource reserve ratio, since otherwise for the intensive tasks flow all resources are distributed among the tasks and the average time of one task execution is increased significantly. It is necessary to in order to improve the DCS functioning efficiency.

In order to develop a mechanism for control the number of reserved resources for a distributed system we use the neural network because they are among the most common mechanisms for the image recognition, and in this case they are used for the recognition of the situation, or in other words, the assessment of the situation.

The number of reserved resources is affected by both the task parameters and the DCS parameters, in particular, the performance of the compute nodes. It is desirable to determine the amount of reserve resources for each task separately. The following steps should be performed:

- to formalize the task structure and to define a set of tasks that will be used to learn the neural network;
- to perform simulation of the DCS functioning with RMS module, based on network-centric approach in order to collect data for the neural network learning, with a set of input tasks selected in the previous step, and the tasks in the set must have a different structure;
- to perform the learning of the neural network using the data obtained in the previous step;
-using a neural network to determine the reserve ratio for each next task that will arrive in the DCS, and apply the received ratio to the RMS along with the task.

The parameters of the task that must be submitted to the inputs of the neural network should fully reflect the task structure, so the following parameters are used: the number of levels, the number of subtasks, the average computational complexity of the subtask, the average number of input data streams per subtask (arcsOnStAvg), the level number with the maximum number subtasks (levMaxVol), the maximum number of subtasks at all levels (maxLevVol), the average number of subtasks at the level (stOnLevAvg), the interaction coefficient between the subtasks (interconCoef).

4. Experiments to study the method of determination of the required amount of reserve resources for a task in an asynchronous mode

For the experiment, the it was used the RMS module on the network-centric approach, which was slightly modified. The modification concerned the way to determine the amount of reserve resources for each task [2]. In the original version, the reserve ratio was set with a value of 0.35, and the ration was used to calculate the amount of reserve resources, i.e. the maximum number of subtasks at the level was multiplied by this ratiot. During the experiment, the amount of reserve resources for the task was determined by the data which were obtained as a result of the task parameters was inputed to the neural network.

So, for testing of the method there were generated 5 sets of tasks, and for each of the tasks for all sets the input data for the neural network was generated, next they were fed to the inputs of the neural network and the predicted number of requests for additional DCS resources from the task was obtained. Based on the task parameters and on the number of DCS resource requests, determined by the neural network, the number of reserve resources required for the task was calculated, which, as one of the task parameters, was fed to the input of the simulating system.

For each set of tasks, there were conducted 8 experiments for two different methods of resources reserve ratio determining (with 0.35 reservation ratio and with the proposed method). During the experiments, for each task the waiting time in the queue and the execution time on the DCS resources were recorded. According to the received data, the average waiting time of the task in the queue and the average time of the task execution fixed in quanta were determined.

5. Analysis of experimental results on the method of determination of the required amount of reserve resources for a task in an asynchronous mode

An analysis of the experimental results showed that the average waiting time for the task in the queue was decreased with the application of the suggested method, although the average time for the task was somewhat increased. This is explained by the fact that DCS resources with less computing power have been used more actively, and, consequently, tasks began to be executed longer. However, these time losses completely cover the reduction in the waiting time of the task in the queue, i.e. the total time of the task stay in the DCS also was decreased, which is shown in Fig. 1.

Thus, the decrease in the average waiting time of the task in the queue is from 13.95% to 28.29%, but due to the increase in the average time of the task, which is from 2.15% to 4.81%, the average time of the task stay in the DCS is decreased by at least 8.15% for the third set of tasks and a maximum of 15.25% for the fifth set of tasks.

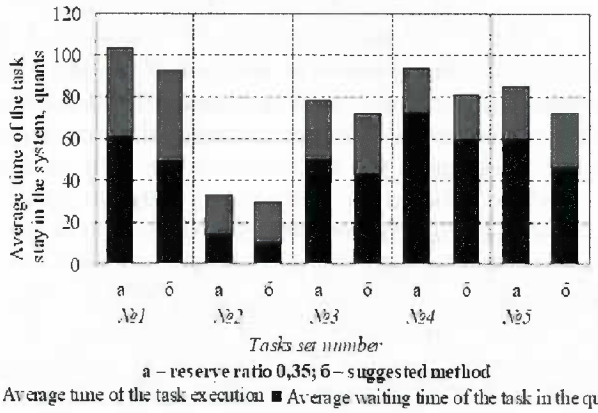

Figure 1. Comparison of the average waiting time of the task in the queue and the average time of the task execution in relation to the average time spent by the task in the DCS for task sets and depending on the method of determining the amount of the resources reserve for the task

6. Conclusions and further research

In this paper is suggested a method for determining the amount of reserve resources for tasks in an asynchronous mode in a distributed computer system with network-centric control. This method is based on the mechanism of neural networks.

The experimental studies have shown the effectiveness of this method, although it should be noted that when using this method it is necessary that the tasks that are put into execution in the DCS should have parameters similar to the parameters of the task set (the number of levels, the number of subtasks at the level, etc.) which were used to learn the neural network. Otherwise, it is necessary to form a new set of data for learning of the neural network and re-learn the neural network on this set.

Keywords: Network-centric approach, resource control, reservation.
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