Simulation models for multicore microprocessors research

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Abstract

The paper describes one approach to modern microprocessors research. It is developed with application of a simulation modeling method and allows investigating operation of the central processors cores, as well as the processors in general. As an example the bi-core processor is considered. The sets of input and output data are given. The samples of the simulation model screen form are shown. When developing models a choice of the basic elements structure, their parameters level and the models adequacy assessment problems were solved.

Keywords: computer; processor; core; simulation modeling

1. Introduction

Modern computers and systems are characterized by the complex architectures and sophisticated operating modes [1, 2]. Methods of the computing systems theory are applied to research the systems specifics. The most reliable results might be obtained by the experiments on the computing systems functioning under the real or close to real conditions. High complexity of the real computer architectures makes the research process very hard [2, 3].

2. The object of the study

Object of research is the modern multicore processor. Its structure and mode are considered on the example of bi-core architecture. The processor effective functioning is ensured due to parallel branches of one program or several programs performance on each core. The branches sizes (parallel programs) and their performance duration can be different. It was decided to model the parallel mode where the main and background program are processed. For comparison it is expedient to investigate the mode without overlapping. In this case only one processor core is used, and the others stand idle.

The most important processors and computing systems characteristics are temporary. They allow estimating overall these systems performance.

3. Methods

The most perspective methods of modeling are the methods which are based on the functional specification of the system presented in the form of algorithm called as simulation (algorithmical) model [4]. The program contains the procedures that imitate the states of the system and the processes for evaluation of the system requirements. Simulation models reproduce the work of the system according to the foregone properties of the elements which models in their turn are also combined into corresponding structure. Scalability is one of the most important properties of simulation modelling. Proposed approach allows research the systems of any complexity considering the impacts of different factors and reproducing the most typical situations. Simulation models give the chance to the experimenter and the developer to form ideas of properties and, studying system through its model, to make reasonable design decisions. Important feature of the described method is use the animation which provides presentation and confirm reliability of modelling experiments.

The correct choice of parameters and attributes which should be used to describe the structure and the possible states of the objects inside the model is the core problem of its development. The chosen attributes should provide the basic properties of computers' functioning on the one hand and to reduce the number of secondary factors which complicate the perception of the model on the other hand.

The number of problems had been solved while developing models:

1) Choosing the basic elements of the system which have to be displayed in the model;
2) Definition the specification level of the object parameters;
3) Assessment of the model adequacy.

During for the solution of the first problem as the research objects were chosen:

a) The simplified structures of the most widespread processors type – superscalar, two cores;
b) The main central processors part – core as pipeline.

It was necessary to display the basic elements of the systems which define the features of their functioning. For example, the pipelining principle is widely used [1]. So simulation model contained the one pipeline per core were developed.

The choice of the objects parameters was the other problem in developing models. They have to provide explanation of the main functioning features of modern processors. Thus, it is necessary to reject the minor factors complicating perception.

Described approach led to use of the simplified models of systems. Models contain minimum quantity of elements which is enough for the object work explanation.

The described approach is realized in simulation model software for the modern central processors research. The software allows research the features of the multicore processors organization. It provides an assessment of temporary characteristics. The program is developed on C# in the Visual Studio 2015 environment for use on the IBM PC platform under control of Microsoft Windows Vista/7/8/10 and so on. The software includes toolkits for research the following standard elements:

1) Two cores (pipes);
2) Instructions cash memory.

The modelled program is submitted as an instructions sequence. It may contain parallel processed branches.

The model allows investigating the following processor modes:

- consecutive at which the program is entirely carried out by one core (pipe);
- parallel with blocks of the modelled program which are sent to a free core;
- parallel with slow blocks at which performance time of separate blocks can differ.

At the parallel mode it is considered that the main program and background tasks are processed at the same time. For its imitation in the model after each block pipe during 20 steps are processed background tasks. Thus, all 20 steps work unproductively, serve background tasks.

Input data for modelling are

a) Total number of the instructions in the modelled program;
b) Instructions blocks size;
c) Number of slow blocks.

Modelling results are following:

a) each core useful time;
b) total two cores useful time per program;
c) each core background tasks time;
d) total background tasks time;
e) total modelling time.

The main emphasis in model is put on the visualization of transfer instructions from a cache memory to core and their performance. The animation principles are for this purpose used.

Screen forms examples for various research modes are given in figures 1 – 3. During modeling in a cache the following instruction which will come to the core is noted green. The figure over a core designates number of the processed block. The next instruction passes into what core red arrow is shown. At service by a core usual instructions are filled in the yellow color, slow – pink, and background - white. Updating a cache memory happens to the speed of the slow block instructions selection.

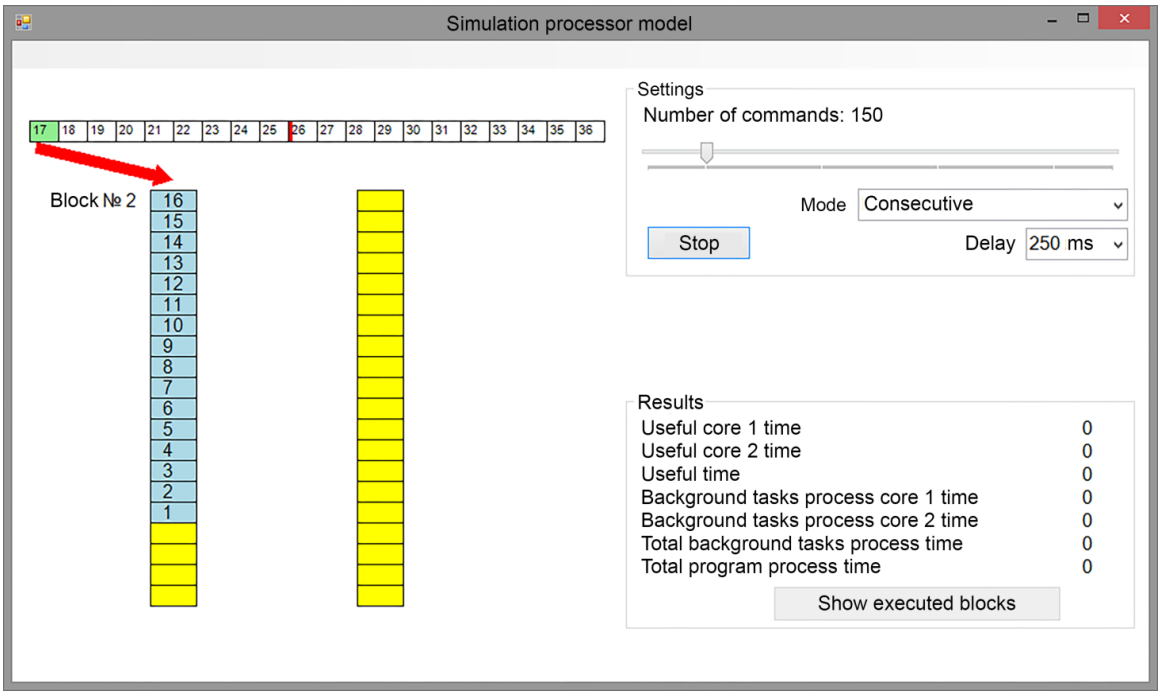

Fig 1. Example of consecutive modeling mode screen form.

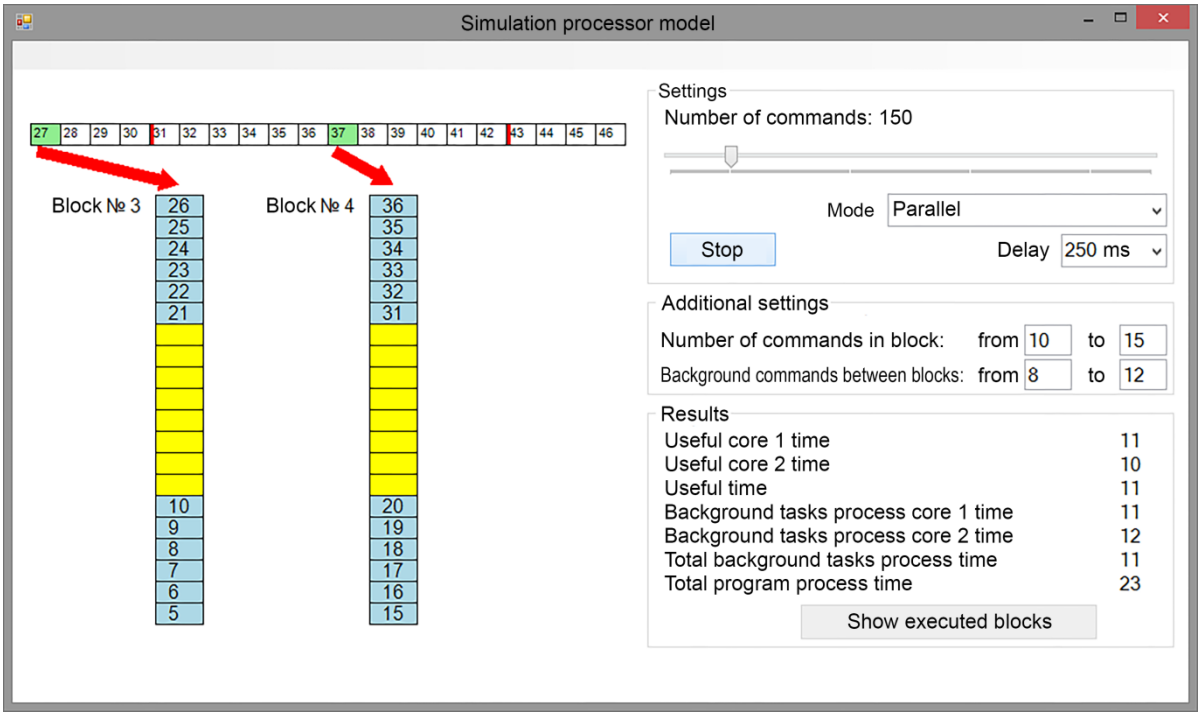

Fig 2. Example of parallel modeling mode screen form.

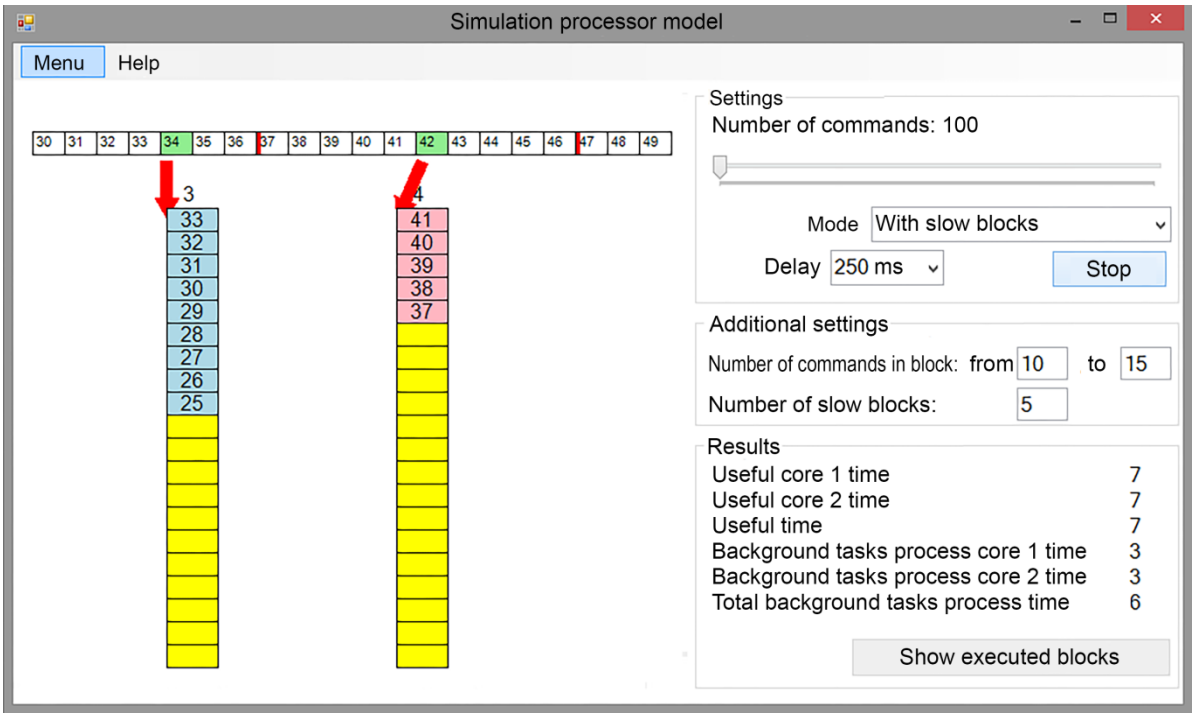

Fig 3. Example of parallel modeling with slow blocks mode screen form.

Modeling process comes to the end either when pressing the Stop button, or after the end of all programs implementation. In the latter case in the corresponding field there are the program implementation results. The results screen form is shown in figure 4.

4. Results and Discussion

The simulation model allows investigating standard structure and modes of the modern multicore processor on the example of bi-core architecture. The program input data are the instructions quantity and the processor mode. As results of modeling the total processed time and each core operating time, and also background tasks time.

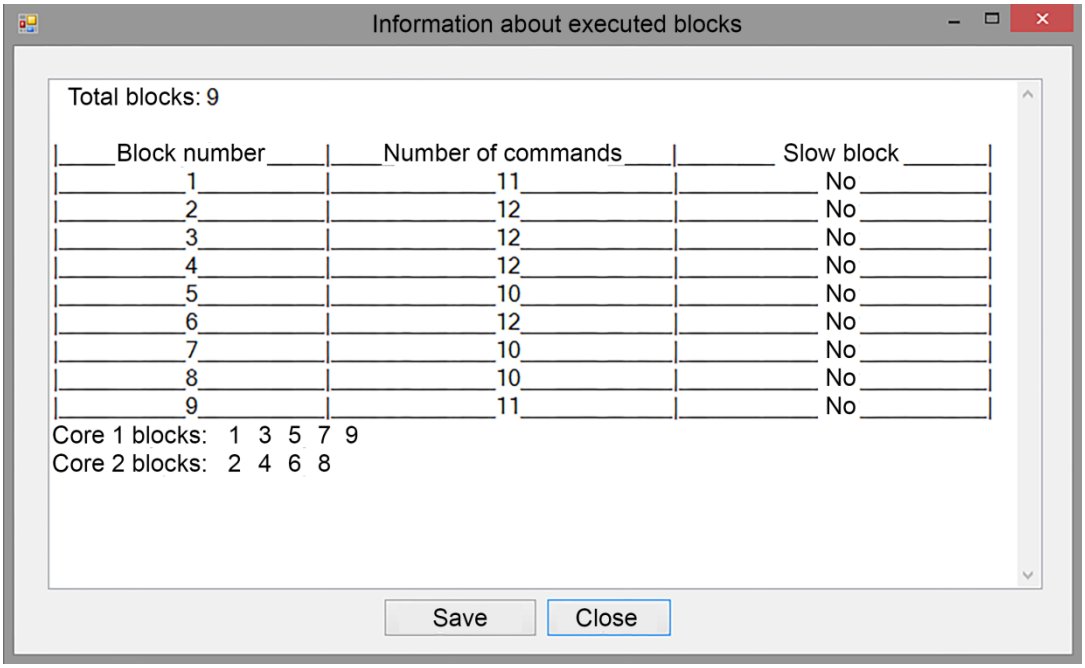

Fig 4. Example of results screen form.

The model is simplified. The follow processor basic elements are presented in it: the instructions cache and pipes imitating core work. For the best explanation of the preceding processes model uses the animation principle.

5. Conclusion

The simulation model of the multicore processor displays function a cache memory and two parallel working cores. In it the sequence instructions processing coming from a cache to cores is reproduced. The model allows investigating the following processor modes:

- consecutive at which the program is entirely carried out by one core (pipe);
- parallel with blocks of the modelled program which are sent to a free core;
- parallel with slow blocks at which performance time of separate blocks can differ.

For descriptive reasons in model the animation principle is widely used.

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