

Nizhni Novgorod State University

HPC Competency Center Based on Microsoft Technologies



Paralab

**A Visual Way to the World of Parallel
Computations**

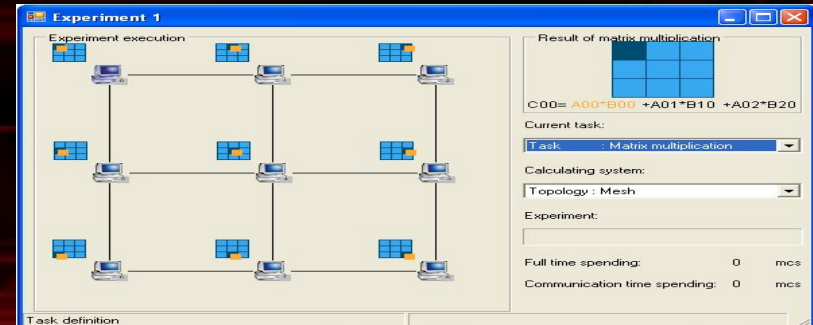
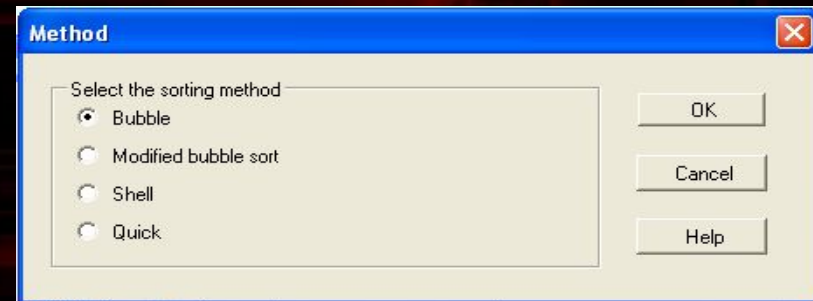
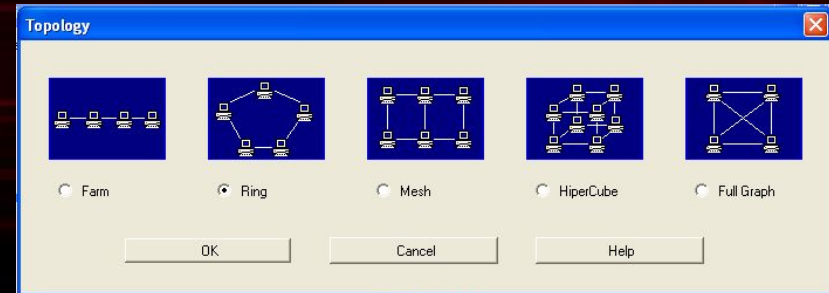
ParaLab Objective

- Intensive use of research and education software systems for modeling computations on various multiprocessor systems and visualization of parallel computation processes:
 - The system **Parallel Laboratory (ParaLab)** – the software system for studying and investigations parallel methods for solving time-consuming problems



ParaLab Overview...

- Modeling a parallel computing system
- Choosing a studied problem and a method to solve it
- Carrying out computational experiments with visualization of parallel calculations
- Information gathering and analyzing the results ("experiment log")
- Data archiving



ParaLab Overview...

- Modeling a parallel computing system

The image displays a screenshot of the ParaLab software interface, which is used for modeling parallel computing systems. The main window, titled "Topology", shows three network configurations: "Farm" (a linear chain of four nodes), "Ring" (a circular arrangement of six nodes), and a third configuration with three nodes connected in a vertical line. Below these diagrams are radio buttons for "Farm" and "Ring", with "Ring" selected. An "OK" button is visible at the bottom of the main window.

Overlaid on the main window are three smaller configuration windows:

- Number of processors:** A window with a title bar and a close button. It contains the text "Ring can be derived from the farm by connecting first and last processors" and five icons representing different processor counts: a single square, two squares connected by a line, three squares in a triangle, a circle with "10", and a circle with "20".
- Net characteristics:** A window with a title bar and a close button. It features a "Network latency" slider set to "10 microseconds" and a "Bandwidth" slider set to "100 MBit/second". It includes "Cancel" and "Help" buttons at the bottom.
- Data passing routing:** A window with a title bar and a close button. It has two radio buttons: "Store-and-forward routing" (selected) and "Cut-through routing". Under "Cut-through routing", there are sliders for "Packet header size" (set to "10 byte") and "Packet size" (set to "500 byte"). It includes "OK", "Cancel", and "Help" buttons at the bottom.

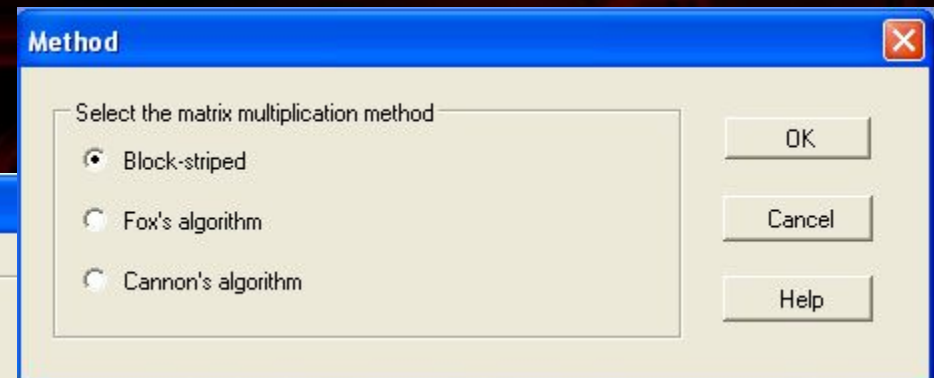
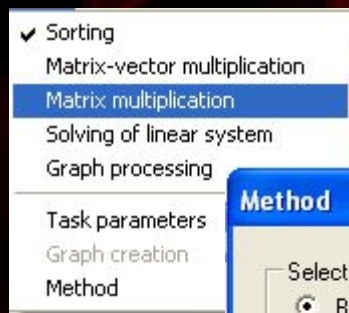
ParaLab Overview...

- Choosing a studied problem and a method to solve it...
 - Sorting,
 - Matrix calculations,
 - Systems of linear equations,
 - Graph processing,
 - Optimization,
 - Solving differential equations in partial derivatives



ParaLab Overview...

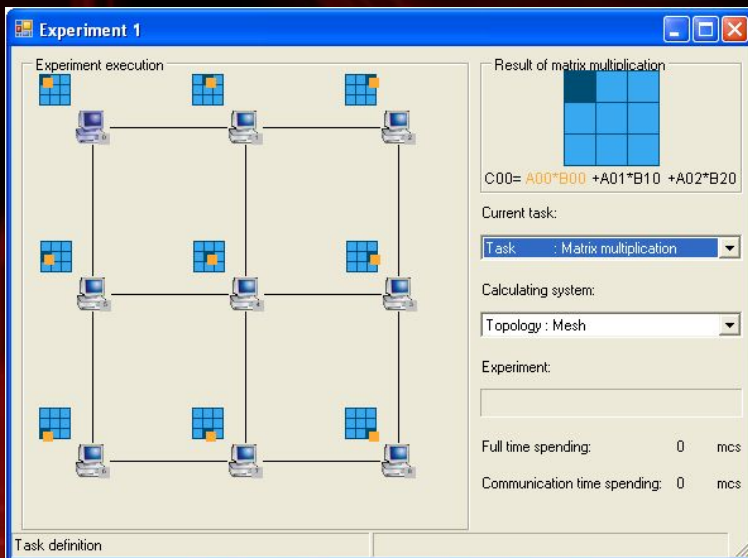
- Choosing a studied problem and a method to solve it...



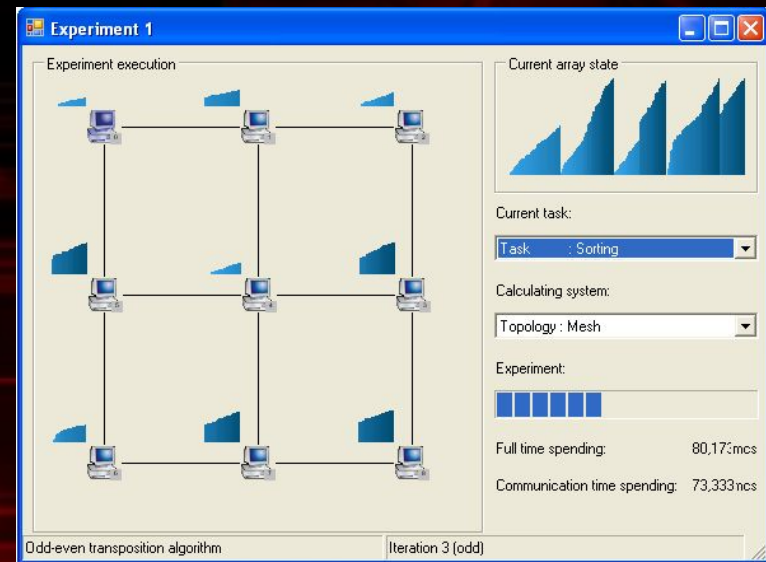
ParaLab Overview...

- Computational experiments and visualization of parallel calculations

Matrix computations



Sorting



ParaLab Overview...

- Information gathering and analyzing the results ("experiment log")

The screenshot displays the ParaLab software interface with several windows open:

- Compare experiment results:** A table showing the results of calculating experiments.

№	Date	Time	Experiment	Task	Method	Size of initial data	Topology	Number of p
5	10.11.2005	1:04	Emulation	Sorting	Bubble	500	Full Graph (Clique)	5
6	10.11.2005	1:05	Emulation	Sorting	Bubble	3666	Full Graph (Clique)	5
7	10.11.2005	1:05	Emulation	Sorting	Bubble	6833	Full Graph (Clique)	5
8	10.11.2005	1:05	Emulation	Sorting	Bubble	10000	Full Graph (Clique)	5

Below the table is a line graph showing the time spent on different experiments as a function of the number of processors. The x-axis is labeled "Количество процессоров" (Number of processors) and ranges from 2 to 18. The y-axis is labeled "Время" (Time) and ranges from 0 to 50000. The legend indicates several experiments with different time values: Experiment 1 (1:05), Experiment 1 (1:04), and Experiment 1 (1:02).

- Experiment 1:** A window showing the "Result of matrix multiplication" with a 5x5 grid and the equation $C00 = A00*B00 + A01*B10 + A02*B20$. It also displays the "Current task" as "Matrix multiplication", the "Calculating system" as "Topology: Mesh", and the "Experiment" name. It shows "Full time spending: 0 mcs" and "Communication time spending: 0 mcs".
- Current array state:** A window showing a bar chart representing the current array state. It displays the "Current task" as "Sorting", the "Calculating system" as "Topology: Mesh", and the "Experiment" name. It shows "Full time spending: 80,17:mcs" and "Communication time spending: 73,333:mcs".
- Odd-even transposition algorithm:** A window showing the algorithm's progress, currently at "Iteration 3 (odd)".



ParaLab Overview...

- Carrying out an experiment...

Experiment Execution Area

Result of Problem Solving

The screenshot displays the ParaLab software interface. The main window shows a network topology with 10 nodes (A1-A10) and 10 links (B1-B10) arranged in a ring. A window titled "Demonstration of processor activity" is open, showing the actions of the processor for 9 iterations. The actions are represented by matrix multiplication symbols (A x B = C) for each iteration. The results panel on the right shows the "Result of matrix multiplication" as a blue matrix. Below the matrix, the "Current Problem" is "Matrix multiplication", the "Computer system" is "Topology: Ring", and the "Experiment" progress bar is shown. The "Total Time" is 147.4 mcs and the "Communication Time" is 28 mcs. The status bar at the bottom indicates "Iteration 4 of 10".

Execution Progress Bar



ParaLab Overview...

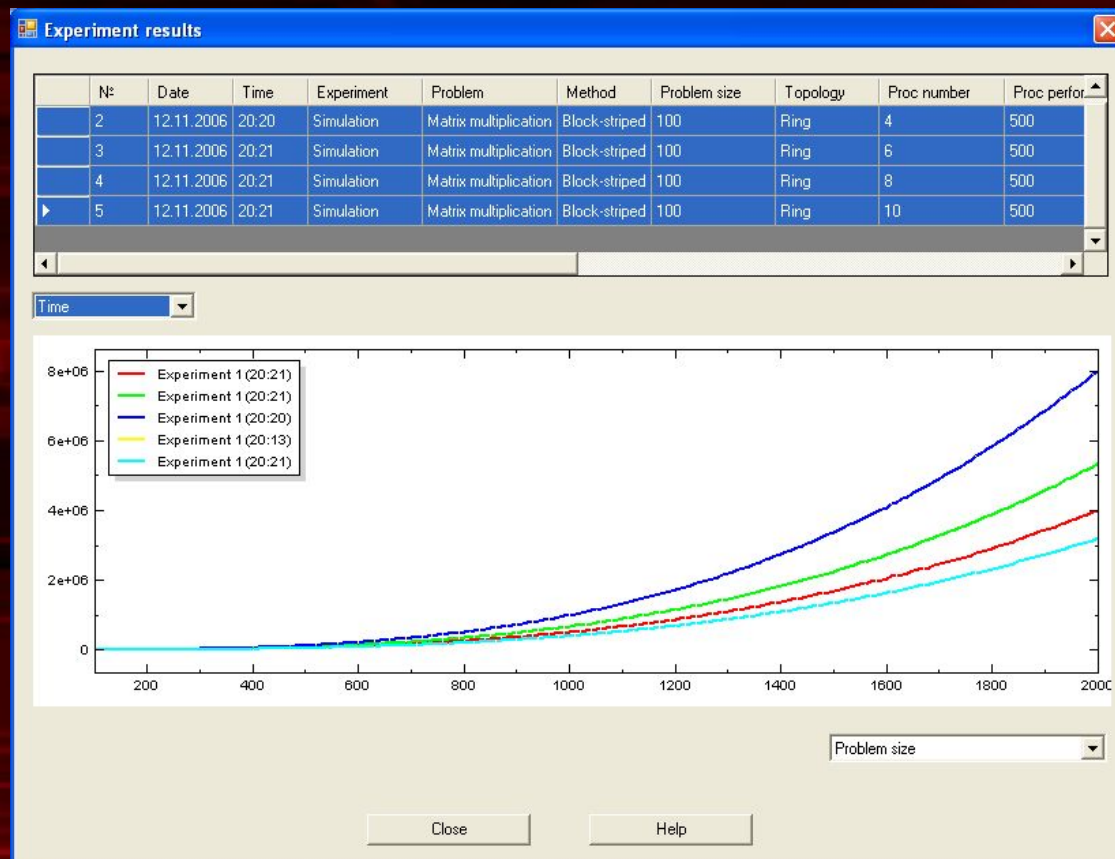
- Carrying out an experiment:
 - Simulation mode,
 - Remote access to a cluster



ParaLab Overview

- Information gathering and analyzing the results

“Experiment Log”



Graphs of Performance Metrics (Time, Speedup,...)

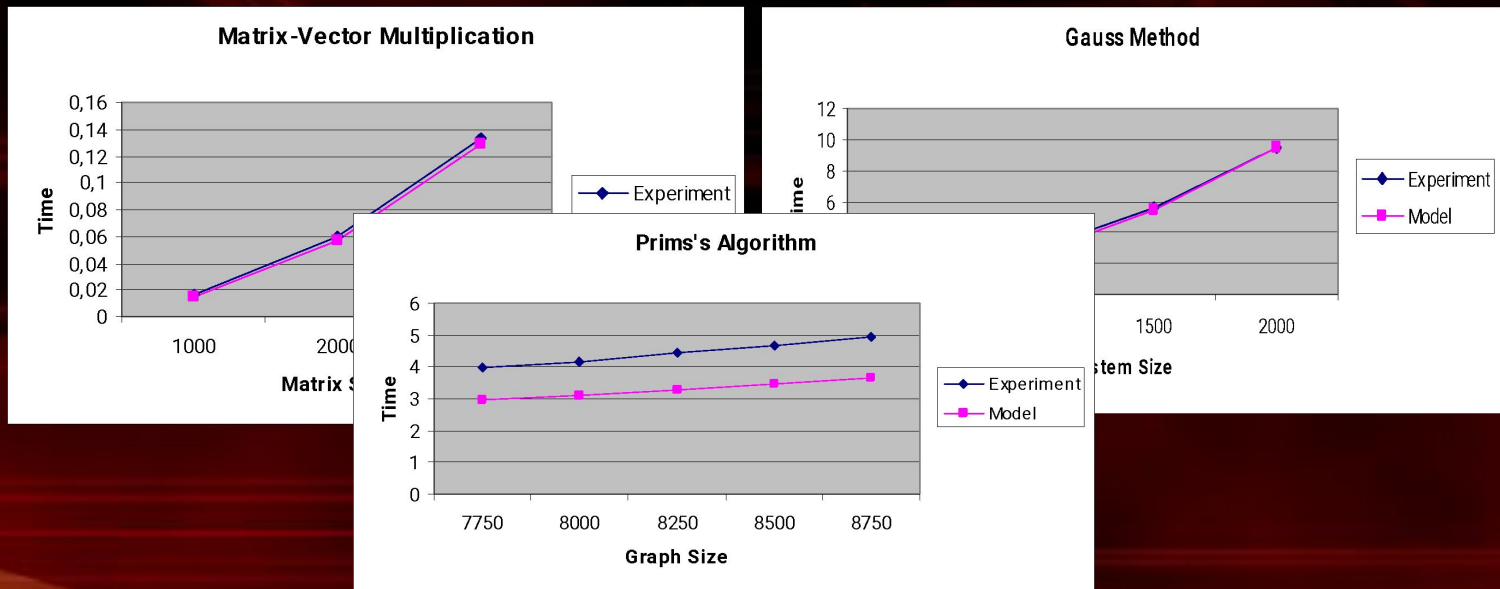


Estimation of Parallel Algorithm Execution Time:

- Hockney's model and its generalizations

$$T(comm) = l \cdot \left(\alpha + \frac{m}{\beta} \right)$$

- Results



ParaLab Requirements:

- Microsoft .NET, C#
- Microsoft Compute Cluster Server 2003



ParaLab may be useful for both novices, who are just starting to learn parallel computing, and experts in this perspective sphere of strategic computer technology



**Take advantage of ParaLab and
the world of parallel computing
will become more evident to you!**



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