Parallel programming techniques for engineering problems  
SS 2018 (Lv.-Nr. 6221807)  
Prof. Dr. Markus Uhlmann  
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1 Time and location

Time: Wednesday 11:30 – 13 h  
Start date: 18.4.2018  
Location: HS 93, Bldg. 10.81

2 Contact

Office: Room 122, Bldg. 10.81  
Hours: by appointment  
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3 Scope of this course

• To convey the basic knowledge about parallel computing possibilities and its limitations.  
• To enable the students to analyze a given problem from CFD (and beyond) and assess the potential for an efficient solution using parallel computing techniques.  
• To transmit the scope, syntax and practical application of the message passing paradigm, using the standard "MPI".

4 Course material

Will be made available under ILIAS Please subscribe to this course under the following URL:  
https://ilias.studium.kit.edu/goto_produktiv_crs_814553.html

5 Prerequisites

• MANDATORY: good programming skills in either Fortran, C or C++  
• successful participation in Module “Numerical Fluid Mechanics” or equivalent  
• if possible, please bring your own laptop (install: compiler, MPI libraries)

6 Exam

Written exam with a duration of 60 minutes (date to be announced).
7 Planning and content of the course

Lecture 1 (18.4.): General introduction to parallel programming
Background on hardware; software paradigms; measuring efficiency; network topologies.

Lecture 2 (25.4.): General introduction to MPI (Message passing interface)
“hello world!”

Lecture 3 (2.5.): MPI point-to-point communication
“send/recv”

Lecture 4 (9.5.): Case study – parallel search problem
“search”

Lecture 5 (16.5.): MPI collective communication
“pi”

Lecture 6 (30.5.,6.6.): Case study – 2D Poisson solver
“Jacobi”

Lecture 7 (13.6.): Non-contiguous data & mixed datatypes
“search”

Lecture 8 (27.6.): Virtual topologies & Communication subsets
“search”

Lecture 9 (4.7.,11.7.): Use of linear algebra libraries – dense linear system solver
“scaex”

Lecture 10 (18.7.): Some examples of parallel applications – Navier-Stokes solvers
Parallel wavelet transform; spectral methods for DNS of single-phase flow; finite-difference method for particulate flow DNS.

8 Further Ressources

- NCSA online courses on parallel programming and MPI:
  http://www.citutor.org/users/index.php (choose “Introduction to MPI”)
- A complete reference of the MPI library standard is available at NETLIB:
- A useful short summary of the syntax and use of each MPI command can be accessed at the following URL:
  http://www-cfd.ifh.uni-karlsruhe.de/uhlmann/mpi2/www/index.html
- The user guides for SCALAPACK and BLACS are also available at NETLIB:
  http://www.netlib.org/scalapack

References