MuCoSim Seminar SS2022

Prof. Gerhard Wellein / Dr.-Ing. Jan Eitzinger

About us `https://hpc.fau.de`

- Professorship for High Performance Computing
- NHR@FAU
- HPC group at RRZE

Some facts

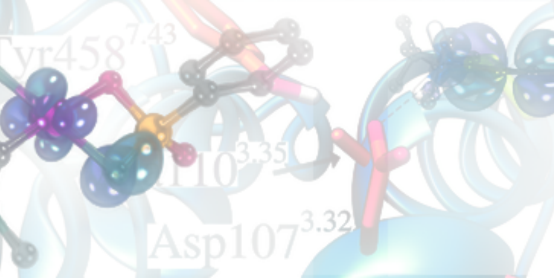
2 Professors
22 staff members
6 PHD students

Operate multiple HPC clusters:
  1650 compute nodes
  220 GPUs

Teaching and training

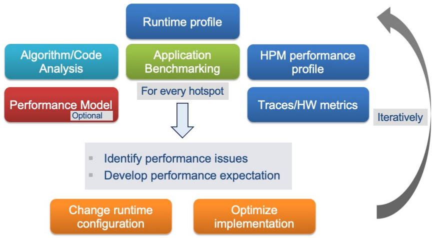
Research

Develop Open-Source tools



Research focus

- Performance Engineering



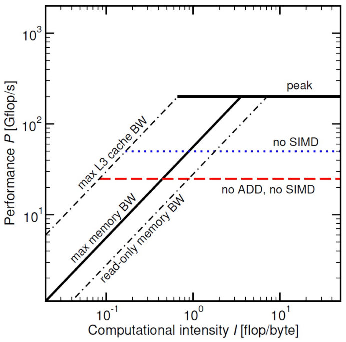
- Performance Tools

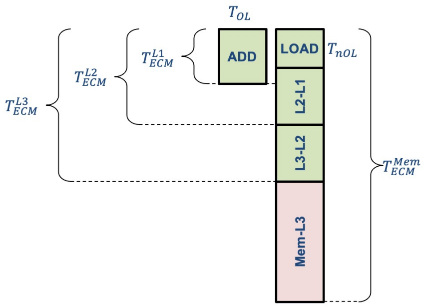
LIKWID TOOLS

OSACA

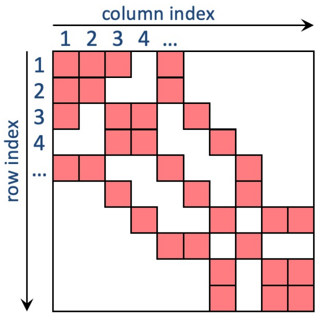
ClusterCockpit

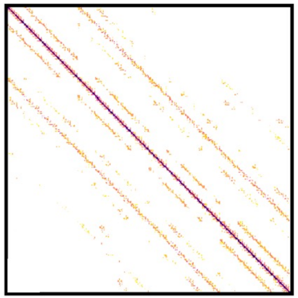
- Performance Modeling





- Hardware-Aware Building Blocks for Sparse Linear Algebra





Topic of Seminar

- Seven Dwarfs:
  - numerical methods that are important for science and engineering
  - defined by similarity in computation and data movement
- Mini-Apps / Proxy Apps
  - Self-contained code that is simple to build and run
  - Simple to understand and maintain
  - Still mimics the performance behavior of critical kernels from real applications

The Landscape of Parallel Computing Research: A View from Berkeley

Krste Asanovic
Ras Bodik
Bryan Christopher Catanzaro
Joseph James Gebis
Parry Husbands
Kurt Keutzer
David A. Patterson
William Lester Plishker
John Shalf
Samuel Webb Williams
Katherine A. Yelick

Electrical Engineering and Computer Sciences
University of California at Berkeley

Technical Report No. UCB/EECS-2006-183
http://www.eecs.berkeley.edu/Pubs/TechRpts/2006/EECS-2006-183.html

December 18, 2006

Your task

- Pick one of the Mini-apps representing a Dwarf
- Decide if you want to look at CPU or GPU platform
- You will document all your steps and results in a Markdown Performance Logbook (we will provide a template)

Phase 1

- Learn about the Dwarf background and applications
- Get familiar with the Mini-App and build it
- Perform extensive application benchmarking
- Create a runtime profile

Your task cont.

Phase 2

- Instrument the hotspots of the Mini-App using LIKWID markers
- Perform hardware performance profiling with likwid-perfctr
- Document and analyse the results
- In the ideal case you come up with a sound explanation what aspect of the hardware limits the performance
- Investigate what ideal performance you would expect

- You have to give a **short talk about Phase 1** till the end of the year
- A **second talk** in the second semester half with results from Phase 2
- Finally you have to prepare a **report** (8-12 pages)

Overview seven Dwarfs

1. Dense Linear Algebra (BLAS, ScaLAPACK)
2. Sparse Linear Algebra (SpMV, SuperLU)
3. Spectral Methods (FFT)
4. N-Body Methods (MD)
5. Structured Grids (PDE Stencil solver)
6. Unstructured Grids (FEM or FVM on Tetraeder mesh)
7. Monte Carlo (Quantum Monte Carlo)

Possible Mini-Apps

- **Cloverleaf**: Structured stencil code implemented in Fortran (OpenMP and CUDA versions available)
- **HPCCG**: Sparse Linear Algebra code implemented in C++ (OpenMP version)
- **MD-Bench/MiniMD/CoMD**: Molecular dynamics implemented in C (OpenMP and CUDA versions)
- **MiniFE**: Unstructured Grids implemented in C++
- **SWFFT**: HACC FFT implemented in C++ (MPI)
- **Quicksilver**: Monte Carlo Particle Transport implemented in C++ (OpenMP and CUDA versions)

Preliminary Schedule

- 25.04. Intro
- 02.05. Selection of topics
- 09.05./16.05. LIKWID Intro + Presentation of Tealeaf (T. Gruber)
- 23.05. Lecture on Roofline model (tbd)