

Team Introduction

At FAU Erlangen-Nürnberg high performance computing is treated with high priority and leading research across different fields. Therefore, FAU has been a regular attendee at previous SCC, ISC and ASC competitions. The HPC Team at FAU works closely with the Erlangen National High Performance Computing Center (NHR@FAU), which provides access to several Top500 systems (including "Helma" ranking currently #51) to the team. This year FAU was once again able to assemble a diverse team of ambitious students. Together we hope for a fair and challenging competition, where each team will have a great time and gather many new experiences.



Strengths and Diversity

- **Different perspectives:** our team consists of three computational engineering majors, which focus on computer architecture and engineering applications, and three computer science majors, which have a deeper understanding of the software. Additionally, all six students have completely different minors and therefore a very specialized skill set, which helps to tackle complex challenges from multiple perspectives
- **Experience:** the team advisors and Melanie have all participated in SCCs before and are familiar with possible difficulties
- **Diversity:** we put high efforts in having members of often underrepresented groups in our team. We worked closely with our gender and diversity office and are happy to have a member of the LGBTQIA+ community in our team
- **Skills:** deep understanding of OpenStack environment and Slurm by building own tools for creating elastic Slurm clusters on Jetstream2

Team Preparation and Strategy

- FAU offers a dedicated course for recruiting and training new team members to build a strong cluster competition team
- Skill-based selection process from originally nine team members to the attending six throughout the previous semester
- Preparation with former competition tasks like Seissol and MLPerf on NHR-Clusters
- Performance studies with HPL, PARsec (Cholesky-Factorization) and MPI-Profling
- We split up our team in small subgroups, each one responsible for one of the competition topics
- All members attend the given webinars to gain the best possible insights in the Jetstream2 cluster and the applications we are running
- Each group mainly works independently but constantly shares its progress in weekly meetings with the complete group

Our team and their roles:



Anton Wiede
Team Captain, Cluster Admin, ECE
Major: Computational Engineering
Minor: Thermo- and Fluidynamics
Interests: Classical Music (Violin, Piano), Volleyball, hiking, CE student initiative



Lorenz Löwe
Cluster Admin, SST
Major: Computational Engineering
Minor: Solid Mechanics and Dynamics
Interests: Microcontroller Programming, Playing Guitar, Bikepacking



Malte Fischer
SST
Major: Computer Science
Minor: Political Science
Interests: Backpacking, Volunteering at local youth organization, Boulderling, Hiking



Frederik Janssen
ECE
Major: Computer Science
Minor: Economics
Interests: Boulderling, Backpacking, Playing piano, Hiking, Cycling



Melanie Heckel
Benchmarks testing
Major: Computer Science
Minor: Japanese Studies
Interests: Cycling, Learning Japanese/Chinese, Video game programming



Adrian Lachmann
Benchmarks testing
Major: Computational Engineering
Minor: Mechatronics
Interests: Volunteer fire department, soccer, Playing piano/drums, CE student initiative

Exascale Climate Emulator

- Climate Emulator with very high resolution, reaching a performance of up to 1 Exaflop/s
- ParSEC and DPLASMA: testing and optimizing the builds with different compilers, dependencies and flags
 - Focusing on optimizing Cholesky-Factorization because it uses the most computing resources
 - Tuning parameters for better GPU scalability
 - Using parallel file system to speed up processing of input data

SST-Application

- Simulation Framework, that aims to simulate large HPC Systems in fine detail
- The fundamental bottleneck of the system is the synchronization of the MPI Ranks
 - To achieve the perfect balance between high parallelism and fast synchronization, we analysed SST in depth with MPI-Profilers to fundamentally understand the software and be able to create the best environment for fast simulations
 - Correct partitioning and rank count is key for optimal performance, therefore, we focus on understanding the specific tasks to find the best fit for each challenge. If we encounter intensive IO operations we will use parallel IO options

High-Performance Linpack

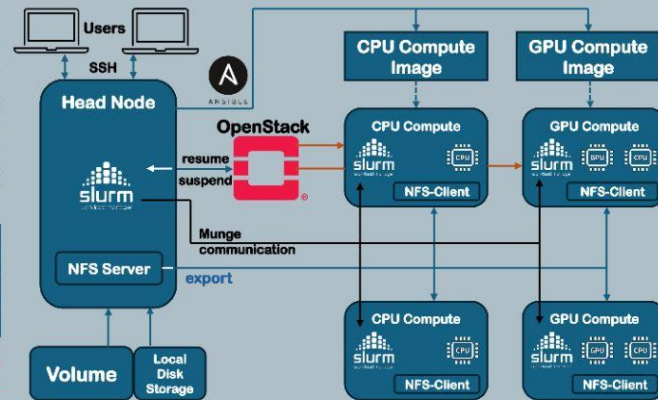
- Tool to measure parallel compute performance by solving a dense system of linear equations
- Use hardware-specific binaries and compilers to leverage modern instruction sets and architecture-specific optimizations
 - Pin processes and threads to specific CPU cores/NUMA domains to reduce cache misses and utilize node topology
 - Use a hybrid approach of distributed-memory (MPI) and shared-memory (OpenMP) parallelism to efficiently utilize all CPU cores across multiple nodes and minimize communication
 - Balance workload across all available nodes to achieve maximum sustained performance and improve scalability

Cluster Design

- Updated Jetstream Virtual Cluster Repo to support Rocky Linux 9
- Use Slurm to manage available resources by spinning up compute instances on demand with the OpenStack CLI
- Create compute node images with Ansible playbooks to automate cluster creation

Cluster Setup	
Scheduler	Slurm
File Systems	Xfs, CephFS
Inter-node Communication	Munge

Jetstream2



Software Stack

Operating System	Rocky Linux 9
Compilers	gcc 11.5.0 / 12.2, aocl 5.1
MPI	openmpi 4.1.5/5.0.5
Cuda	11.8
Python	3.9 / 3.11
iso/v-gnu-toolchain	
LLVM	21.1.3
hdf5	1.14.0
mpiP	3.5.0