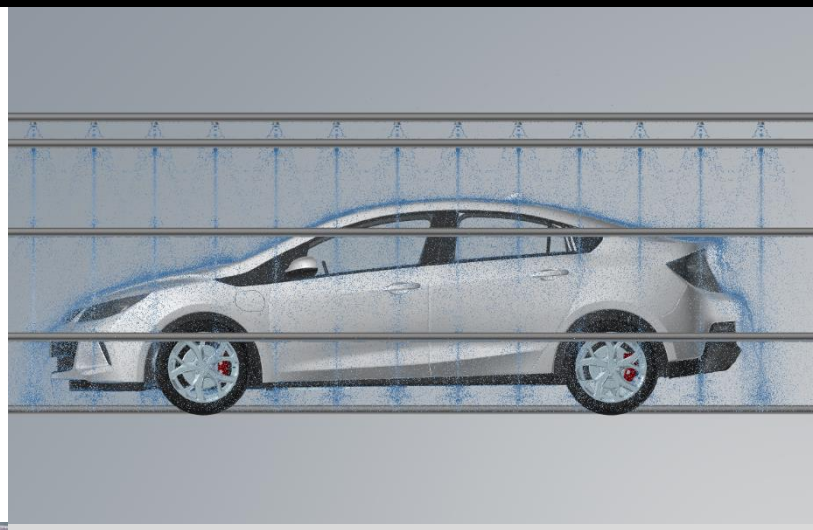
MPI Benchmark – Raining

Model description and setup

Raining simulation.

Number of Nozzles:	143
Flow rate per nozzle:	80 mL/s
Simulation resolution:	2 mm
Fluid particle number:	0 to ~ 4.5 million
Physical time:	30 s

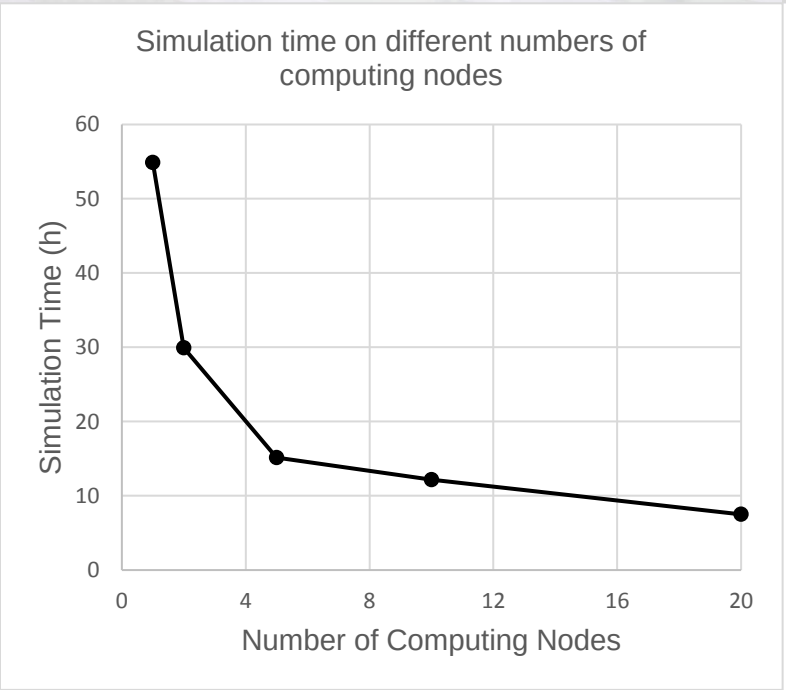


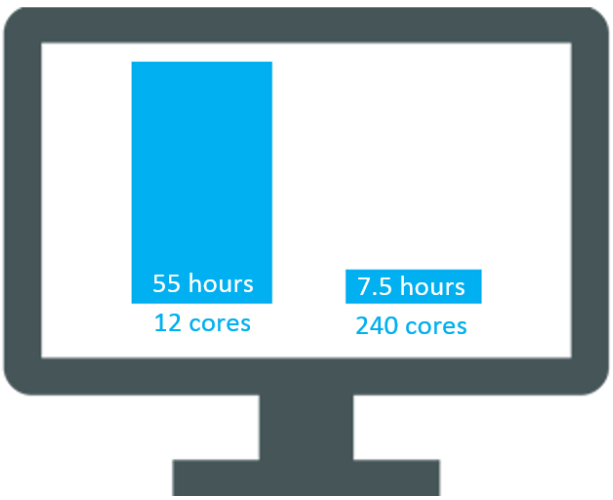
Hardware specification

HLRS High Performance Computing Center Stuttgart
www.hlrs.de/systems/nec-cluster-laki-laki2

LAKI2 Cluster node specification:

SandyBridge (E5-2670)
12 physical cores
64GB RAM
Infiniband





With PreonLab on an HPC cluster, the simulation time can be reduced significantly.
By using the power of a cluster with 240 cores, the computation time is cut down by 86% compared to the simulation on 12 cores.

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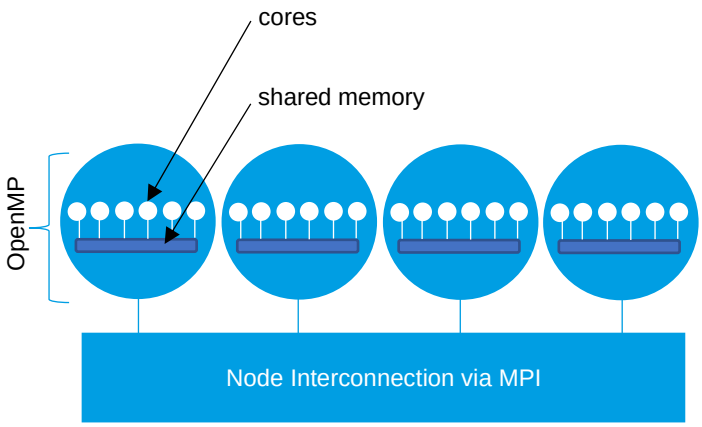
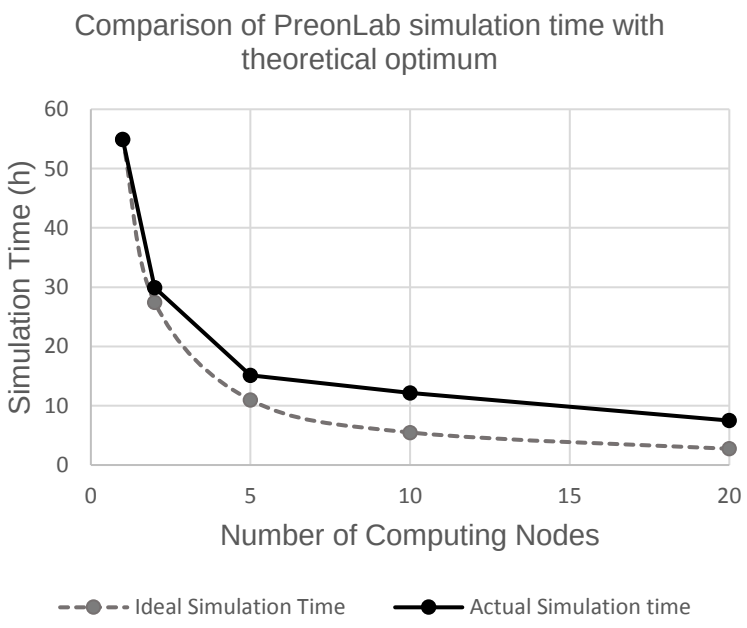
Implementation Details

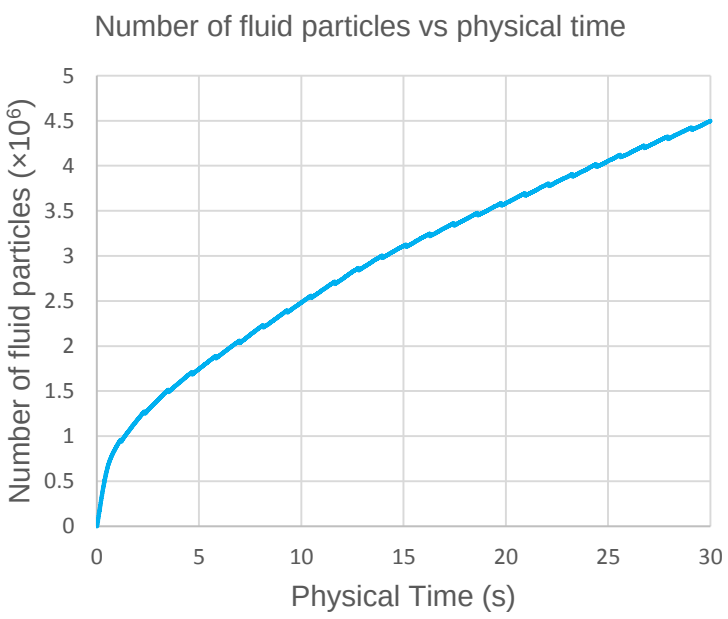
PreonLab implements state-of-the-art hybrid MPI and OpenMP parallel programming. This means:

- MPI between the nodes
- OpenMP shared memory programming inside of each SMP node

The motivation of this implementation is to use the fastest programming model for each available part of the HPC cluster, which is OpenMP for the workload on a single SMP node and MPI for the interaction between the nodes.







Theoretical performance

Ideally, doubling the number of cores reduces the simulation time by half. However, as given by Amdahl's law, a small fraction of serial code or waiting times can already reduce the possible speed-up significantly.

The hybrid parallel programming model implemented in PreonLab uses an automatic load balancer which minimizes waiting times between nodes and yields high cache-hit rates per node. This enables high scalability in dynamic scenarios like raining, in which the optimal load balancing strategy needs to be adapted constantly. As long as there are at least 10,000 particles per core, PreonLab will scale well on your HPC hardware. With an increase in the number of simulated particles, the share of parallel code rises and scalability will improve further.

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