



# Application of HPX to tiled GEMM and QR: A benchmark

September 24, 2019 | Thomas Miethlinger | Jülich Supercomputing Centre

# Part I: Introduction

# About me

(Thomas Miethlinger)

- Study: Master Physics
- Johannes Kepler University of Linz
- Institute for Theoretical Physics  
Department Many Particle Systems
- Research:
  - Quantum fluids
  - Complex fluids
  - Non-equilibrium statistical mechanics

# About the GSP

- Supervisor: Dr. Edoardo Di Napoli
- Co-Supervisor: Dr. Xinzhe Wu
- SimLab Quantum Materials
- Research:
  - Development and maintenance of numerical libraries
  - Design and implementation of high-performance algorithms
  - Development of new mathematical and computational models within a methodological frameworkin the scope of computational materials science and quantum materials.

## Part II: Introduction to HPX

# Current situation in high performance computing (HPC)

Currently, speed-up in computing does not stem from higher CPU frequency, but increased parallelism. However, we already face the following challenges in HPC:

- Ease of programming
- Inability to handle dynamically changing workloads
- Scalability
- Efficient utilization of system resources

⇒ a need for a new execution model: ParalleX, which is implemented by HPX

# ParalleX

ParalleX is a new parallel execution model that offers an alternative to the conventional computation models(e.g. message passing):

- Split-phase transaction model
- Message-driven
- Distributed shared memory
- Multi-threaded
- Futures synchronization
- Local Control Objects (LCOs)
- ...

ParalleX focusses on latency hiding instead of latency avoidance.

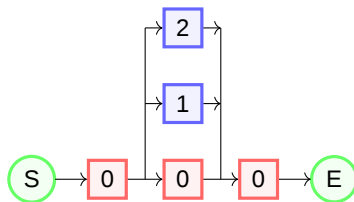
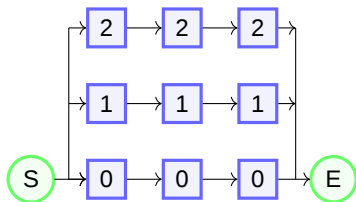
# About HPX

- High Performance ParallelX (HPX) is the first runtime system implementation of the ParallelX execution model.
- Development: STE||AR group  
Louisiana State University  
LSU Center for Computation and Technology
- Released as open source under the Boost Software License
- Aims to be a **C++ standards conforming implementation** of the Parallelism and Concurrency proposals for C++ 17/20/23/...
- This means: HPX is a C++ library that supports **dynamic adaptive resource management** and **lightweight task programming and scheduling** within the context of a **global address space**.



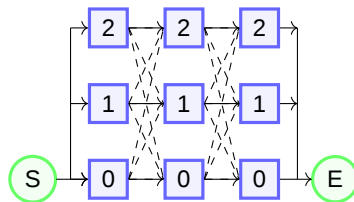
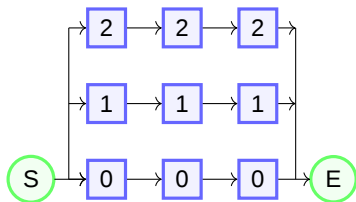
# Comparison of HPX and OpenMP

HPX	OpenMP
C++ library Core language: <code>hpx::C++</code> Task-based parallelism AGAS (active global address space)	Compiler extension to C and Fortran <code>#pragma omp directives</code> Parallel regions (fork-join model) shared memory



# Comparison of HPX and MPI

HPX	MPI
C++ library Core language: <code>hpx::C++</code> Task-based parallelism AGAS (active global address space)	Interface specification for C and Fortran Core language: <code>MPI_C</code> , <code>MPI_F08</code> Single program, multiple data (SPMD) Explicit message passing



## Part III: Overview of numerical linear algebra and its applications

## Part IV: GEMM

## Part V: QR



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