**PROJECT GOALS**

Overall charter

A unique, tool-assisted, domain-specific co-design approach for the class of stencil codes

Co-design of application, algorithm, and architecture-aware software:

- to ease application development
- for performance analysis and tuning
- to ensure short turn-around times
- for reasons of portability

Exploitation of domain knowledge at every development phase:

- for application- and platform-specific optimization
- to reach exascale performance

**WORK AREAS**

A: Algorithmic engineering (ACS, LSS)

- A1: Math. classification and model of domain knowledge
- A2: Quantification of run-performance of multigrid components
- A3: Algorithmic techniques for scalability enhancement

B: Domain-specific representation and modeling (CoD)

- B1: Domain capture in a DSL
- B2: Cluster description language
- B3: Compiler and editor support

C: Domain-specific optimization and generation (SPL)

- C1: Internal representation of domain knowledge
- C2: Domain-specific optimization engine
- C3: Optimization rules
- C4: Variance space exploration based on features

D: Polyhedral optimization and code generation (Prog)

- D1: Polyhedral model
- D2: Polyhedral parallelization
- D3: Polyhedral optimization
- D4: Polyhedral search space exploration

E: Platform-specific code optimization and generation (CoD, LSS)

- E1: Domain-specific co-design approach
- E2: Inter-node code generation and optimization
- E3: Performance analysis of target-specific implementations

**DESIGN FLOW**

**SPPEXA RELEVANCE**

SPPEXA topics:

1. programming, 2. computational algorithms, 3. software tools

Exascale deliverables:

- multigrid solver technology
- polyhedral loop optimization technology
- exploitation of domain-specific knowledge
- prototypical applications

Supercomputers used in the first phase:

- SuperMUC, Leibniz Computation Centre (TOP4, June 2012)
- JuQUEEN, Jülich Research Centre (TOP8, June 2012)
- TSUBAME 2.0, Tokyo Institute of Technology (TOP14, June 2012)

Technology transfer in SPPEXA:

- polyhedral, target-specific loop optimization technology
- software product-line technology
- domain-specific optimization technology

**RESEARCH PLAN**

First funding phase:

- exascale multigrid solvers (methods and mathematics for analysis)
- domain-specific language (for application and platform)
- product-line framework (domain assets, generator, optimizer)
- two applications: particle simulation, quantum chemistry

Second funding phase:

- exploitation of stencil-code variability
- power-awareness, error-resilience, dynamicity
- SPPEXA technology transfer