CASH
Compilation and Analysis, Software and Hardware
Analyses, Hardware/Software Compilation, Code Optimization for Complex Dataflow HPC Applications

Compiling and Scheduling Dataflow Programs

Short/Medium-term:
- Unify all kinds of parallelism in a same formal semantic framework
- Express compilation/analysis activities for this model
- Proof of concept, validation on literature examples (video algorithms, neural networks)

Locks:
- Different levels of granularities that do not coexist well
- What’s the boundary between static and dynamic?
- Combination of diverse formal reasoning on programs
- Collaboration with Kalray (Many-Core)

Long-term:
- Find suitable representations to compile from and to (intermediate representation + language)
- Implement a mature compiler infrastructure/toolbox

Sequential Program

Intermediate Parallel Representation

Dataflow Optimization

Simulation

Cost Model

Hardware Compilation for FPGA and Dataflow Optimization

Short/Medium-term:
- Models and algorithms for data movement minimization
- Dataflow optimization for throughput and circuit surface
- Cost models for FPGA and fast simulation algorithms

Locks:
- Energy budget & memory wall
- Classic automatic parallelization does not scale enough
- Dataflow analysis is hindered by dynamic control/data

Added value:
- Cross-fertilization high-level synthesis (HLS) / high-performance compilation
- Technology transfer to Xilim/logic (Inria spin-off)

Long-term:
- Lazy analysis and parametrization for scaling parallelization
- Abstraction and hardware for dynamic control/data

Simulation of Hardware

Short/Medium-term:
- Convergence of approaches (CEA-LIST, Lip6...) 
- Deal with loose information (intervals instead of individual values for physics)
- Application to simulation of data-aware process networks

Locks:
- Heterogeneous simulation (functional + multi-physics, precise/abstract)
- Scale up (→ parallelism)

Added value:
- 15 years of collaboration w/ STMicroelectronics

Long-term:
- Framework for parallel and heterogeneous simulation: simulation backbone and adapters

Scalable Static Analyses for General Programs

Short/Medium-term:
- Rephrase/revisit syntax-based optimizations in the AI framework
- Revisit the polyhedral model optimizations
- Design new low cost analyses

Locks:
- Classic abstract interpretation (AI) is too costly
- How to design optimization-oriented analyses
- Many syntax-based optimizations inside compilers

Added value:
- Experience on design and implementation of scalable analyses
- Cross-fertilization between compilation and abstract interpretation

Long-term:
- Find a theoretical framework (SSA-based?) to design scalable analyses
- Better interfaces for analyses and their optimization clients

http://www.ens-lyon.fr/LIP/CASH/