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FNSNF

Addressing safety-criticality in optimal deployment of data-flow applications onto many-core platforms

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Motivation

Safety-critical systems

Increasing processing demand → Multi-/Many-Cores

Estimating Worst-Case Execution Times (WCET) of parallel executing tasks *is challenging*:

- Interferences due to accessing shared resources

WCET

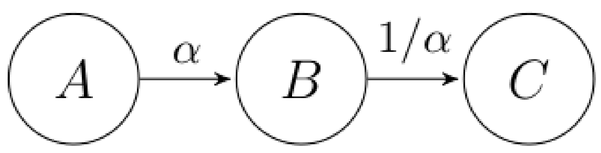
- Affected by scheduling, mapping and buffer sizes
- Safe, optimal scheduling requires knowledge of WCET

Vicious cycle → *Safe and optimal deployment is hard!*

Background

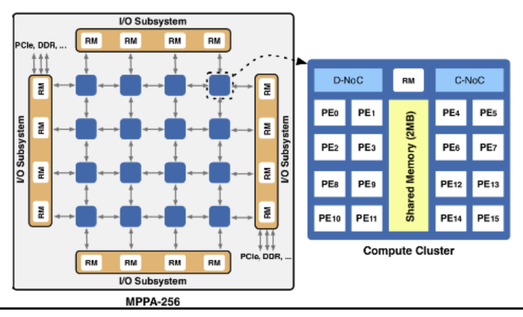
Application Model

+ Dataflow applications as SDF with known guarantees
+ High degree of data and task parallelism
+ Known Worst-Case Computation (WCCT) time in isolation



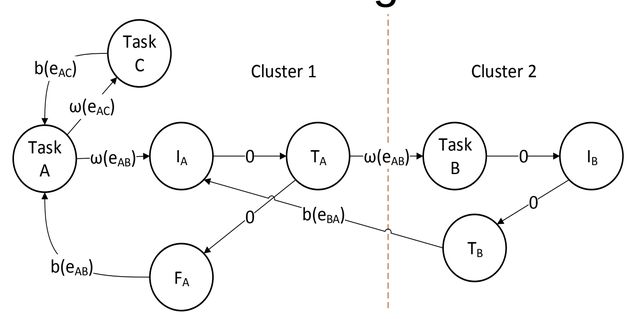
Architecture Model

+ Large number of cores (>100) organised in clusters
+ Intra-cluster communication via NoC
+ Efficient for Dataflow applications



Unified System Model

+ Derived from Application and Architecture model
+ Models both computation and communication system behavior
+ Basis for deriving WCET

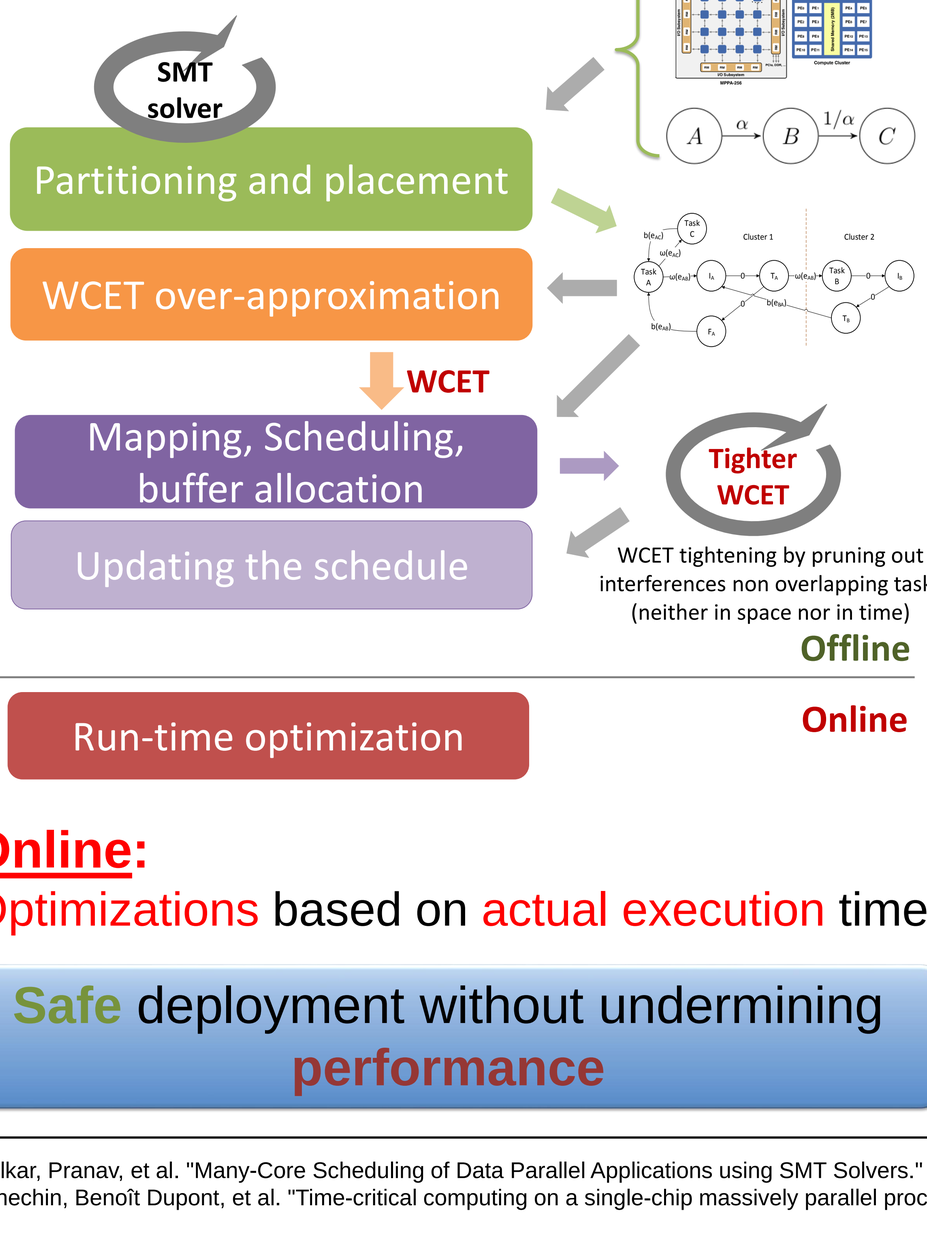


Safe optimal deployment

Hybrid approach:

Offline:

1. WCET = WCCT+ Interferences
2. WCET-based optimization, providing real-time guarantees



Online:

Optimizations based on actual execution times

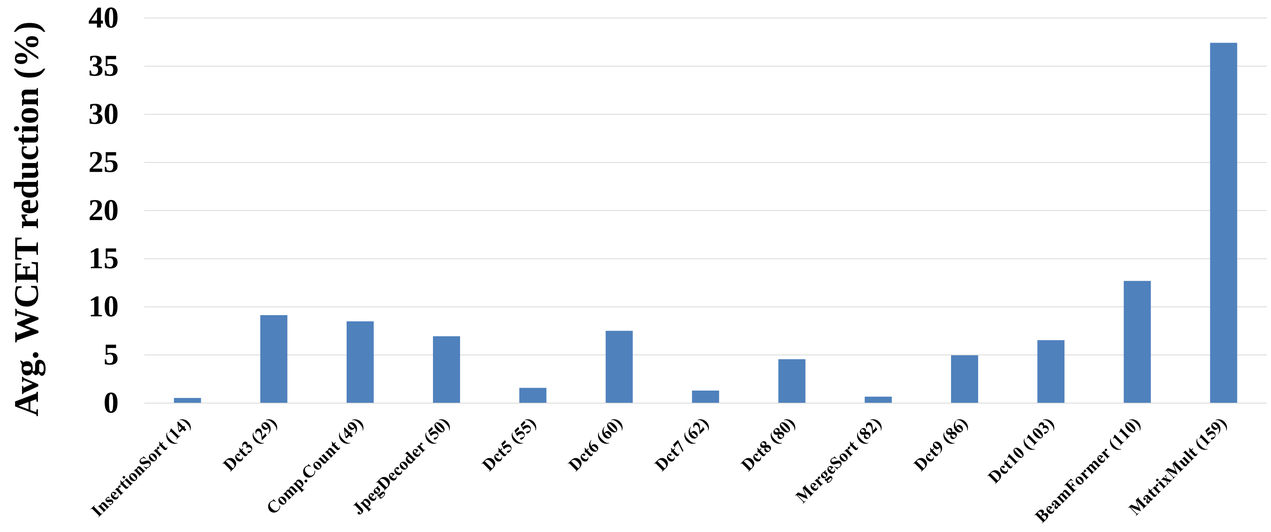
Safe deployment without undermining **performance**

Results

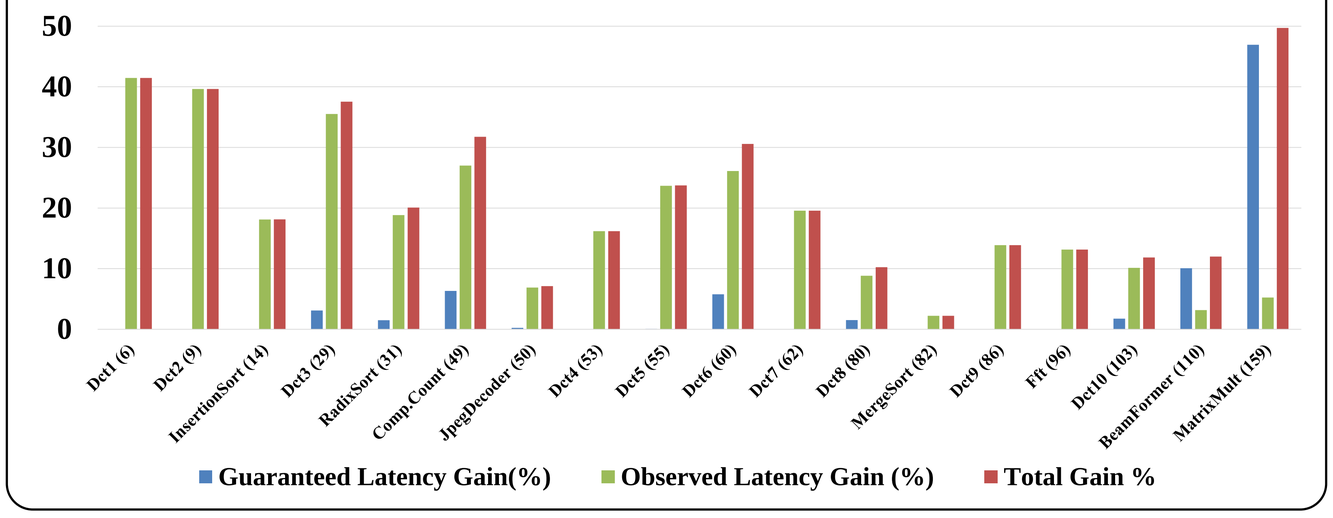
Setup:

- StreamIT: 18 benchmarks with profiled WCCT
- After applying our approach, deployed on Kalray MPPA-256 chip (256 cores @ 400Mhz)

WCET improvement up to 37%



Offline+online latency gain up to: 49%



[1] Tendulkar, Pranav, et al. "Many-Core Scheduling of Data Parallel Applications using SMT Solvers." Digital System Design (DSD), 2014 17th Euromicro Conference on. IEEE, 2014.
[2] De Dinechin, Benoît Dupont, et al. "Time-critical computing on a single-chip massively parallel processor." Design, Automation and Test in Europe Conference and Exhibition (DATE). IEEE, 2014.