An Architecture Framework for an Adaptive Extensible Processor

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An Architecture Framework for an Adaptive Extensible Processor

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[Outline]

- Motivations
- Goal
- An Adaptive Extensible Processor
  - Extensible Processors
  - General Overview of Proposed Architecture
  - Generating Custom Instructions
  - Proposed Reconfigurable Functional Unit
- Evaluation Results

[Motivations (1/2)]

■ Exploding NRE Costs

Keynote @ ASP-DAC 2007

Motivations (2/2)

- Higher design costs due to more complex SoCs
- More complex applications → more computation and power
- SoCs

This has led to the quest for a flexible and reusable embedded processor that still must achieve the required performance and energy efficiency levels.

[Goal]

- Improving the performance and energy efficiency of embedded processors, while maintaining binary compatibility, and flexibility of embedded processors.

[An Adaptive Extensible Processor]

■ Introduction to Extensible Processors

[Custom Instructions]

- Improve performance efficiency
  - Increasing parallelism
  - Reducing the latency of critical path
  - Reducing number of intermediate results written to the register file
  - Reducing cache misses
- Improve energy efficiency
  - Reducing accesses to
    - Instruction cache
    - Register file
    - Decoder
    - ALU
    - Cache misses
  - Reducing execution time (clock energy)

[Proposed Approach]

- An Adaptive Extensible Processor (ADEXOR)
  - Adding and generating custom instructions after fabrication
  - Using a reconfigurable functional unit (RFU) instead of custom functional unit

CFU: Custom Functional Unit

RFU: Reconfigurable Functional Unit

General Overview of the Proposed Architecture

Hot Basic Block

GPP: General Purpose Processor

RFU: Reconfigurable Functional Unit

[Generating Custom Instructions]

- Load, divide, multiply, floating point operations are not supported

BB: Basic Block

Architecture of the RFU

[Evaluation Results]

Issue	1-way
L1- I cache	16K, 2 way, 1 cycle latency for hit, 20 cycles for miss
L1- D cache	16K, 4 way, 1 cycle latency for hit, 20 cycles for miss
Execution units	1 integer unit, 1 floating point unit , 1 divider (8 cycles), 1 multiplier (5 cycles)
Branch predictor	bimodal
Branch prediction table size	256
Extra branch misprediction latency	3
Clock frequency	135 MHz

Performance Evaluation

[Energy Evaluation]

[Area Overhead]

- Base Processor 0.18 μ m (4.5mm²) + Cache (3.2mm²) = 7.7mm²
- Area Overhead: 37%

Conclusions

- An architecture framework for an adaptive extensible processor
- Generating and adding custom instructions after chip-fabrication
- No new compiler, no source code modification and recompiling
- Evaluation
  - Speedup: max. 4.9 and average 1.9
  - Energy saving: max. 67% and 30% in average
  - Area overhead: 36%

Thank you for your attention