Laboratory: “Designing Application Specific Embedded Processors”

Dr. Lars Bauer, Hussam Amrouch

(Lehrstuhl Prof. Dr. J. Henkel)

CES - Chair for Embedded Systems

KIT - Karlsruhe Institute of Technology, Germany

ASIPs: efficiency vs. flexibility

src: Henkel "Design and Architectures for Embedded Systems (ESII)"

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Pipeline Processor

src: Muhammad Shaaban “The DLX Architecture”, lecture on ‘Computer Architecture’

Pipelining

Overlapping Execution of multiple Commands with a data dependency

IF	Instruction Fetch
ID	Instruction Decode
EXE	Execute
MEM	Memory Access
WB	Write Back

Goal of ASIP Lab

- Creating new CPUs with new instructions and implementing these new instructions in Hardware and Software with evaluation and testing

- The main goals are:
  - creating new ASIPs for special applications
  - benchmark those ASIPs to find out their benefits and drawbacks
  - and finally to interpret the benchmark results

Profiling on Control-Flow Graph

- Each node is a **Base Block**:
  - The instructions in a Base Block are always executed together
  - ➔ No jumps in a Base Block, except the end
  - ➔ No jump targets in a Base Block, except the beginning

Blowfish with 1 KB input data: Encrypt and Decrypt

Constraints for Designing Custom Instructions

- Number of Input-/Output-Values to Custom Instruction
  - Limited by register file, e.g. 4 read and 2 write ports
- ‘Forbidden Nodes’, e.g. Load/Store
- Convex Graph
- Limited Frequency, Area, Power, and/or Energy Budget
  - An ASIP that consumes more power may consume less energy, if the application terminates much earlier

Tasks in ASIP Lab

- Programming in assembly language
- Implementing new instructions with ASIP Meister (+Simulation, +Hardware)
- Evaluating the results from the new CPU
- designing new instructions for large applications with testing
- Creating different CPU versions

Lab Environments

- dlxsim: Simulator for DLX-Assembler
- ASIP Meister: To create new processor
- CoSy: To compile C-code to assembly code
- ModelSim: simulator for VHDL-Code
- Xilinx ISE: Synthesis of VHDL-Code
- XPower: To estimate power consumption

Important Directories

- /Software/epp:
  - The required programs for the Lab are often used automatically by scripts
- ~asip00/ASIPMeisterProjects/TEMPLATE_PROJECT/
  - New version of Lab scripts
  - Project example with application example
- ~asip00/SessionX: The requirements for each session
  - For instance, you can find the slides and the Lab Script in ~asip00/Session0

Supervisors and the regular meeting

- Dr. Lars Bauer
- Hussam Amrouch
- Regular Meeting:
  what about Tuesday 11:00 ?

Questions??

General Information

- Computer-Accounts (SuSE- und CentOS Clients)
- For the first session, read chapter 3 (dlxsim; without 3.2.2, 3.2.3 & 3.3.2)
- For the second session, read chapter 2 (working environment), 8.3 (using the compiler) and 5 (Modelsim)

- **Now:** Accounts & Linux-Tutorial (chapter 2.2)