Hardware-Software Codesign

0. Organization

Lothar Thiele
Overview

- Introduction and motivation
- Course synopsis
- Administrativa
What is HW-SW Codesign?

... integrated design of systems that consist of hardware- and software-components

- Analysis of HW/SW boundaries and interfaces
- Evaluation of design alternatives
Review: Target Architectures

general-purpose processors

microcontrollers
digital signal processors

field-programmable gate arrays

systems on a chip
**Hardware/Software Boundaries**

- **General purpose systems** (PC, workstation)
  - processor design:
    - processor ↔ compiler, operating system

- **Embedded systems** (cell phone, automotive electronics)
  - design of specialized processors:
    - processor ↔ compiler, operating system
  - system design:
    - processors ↔ dedicated hardware devices
Why Codesign? (1)

- Modern embedded systems require "design" optimization
  - many functions, great variability, high flexibility
  - heterogeneous target systems
    - processors, ASICs, FPGAs, systems-on-chip, ...
  - many design goals
    - performance, cost, power consumption, reliability, ...

- Advances in formal / automated design methods
  - automation on the system level becomes possible
  - reduction of cost and time-to-market
Why Codesign? (2)

- Optimization of the “design process”

**classic design**

```
hw
sw
```

**co-design**

```
hw
  sw
hw
  sw
```
System Design

Specification

System Synthesis

SW-Compilation

Instruction Set

HW-Synthesis

Estimation

Intellectual Prop. Code

Machine Code

Net lists

Intellectual Prop. Block
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Course Synopsis

- Specification and Models of Computation (Section 2)
  - State-Charts
  - Kahn Process Networks

- Design Space Exploration (Section 7)
  - Mapping (Section 3)
  - Partitioning (Section 4)
  - Multi-Criteria Optimization (Section 5)

- Performance Estimation (Section 8)
  - Simulation-based Methods (Section 6)
  - Worst-Case Execution Time Analysis (Section 9)
  - Performance Analysis of Distributed Systems (Section 10)
  - Thermal-aware Design (Section 11)
Benefits ? Learn about …

- … challenges and approaches in modern system design
- … useful optimization methods
- … performance estimation of distributed systems
- … a current research area
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Organization (1)

- **Lecture**: Wednesday, 10 - 12, ETZ E8
- **Exercises**: Wednesday, 15 - 17, ETZ E8 or D96
- **Team**:
  - Lecture: Lothar Thiele, ETZ G87, thiele@ethz.ch
    Pratyush Kumar, ETZ G76, pratyush.kumar@tik.ee.ethz.ch
  - Exercises: Pratyush Kumar, ETZ G76, pratyush.kumar@tik.ee.ethz.ch
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    Pengcheng Huang, ETZ G77, pengcheng.huang@tik.ee.ethz.ch
- **Web page**: www.tik.ee.ethz.ch/tik/education/lectures/hscd
Organization (2)

► Course materials:
  ▪ slide copies, exercise sheets, papers
  ▪ the slides contain material from Marco Platzner, Peter Marwedel, Ryan Kastner, and others

► References:

► Recommendation: submit/participate 9 out of 11 exercises, participate in the practical simulation exercises.

► Exam: oral, German or English