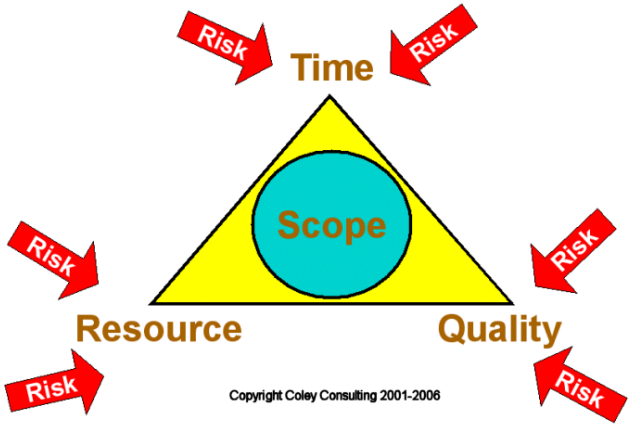
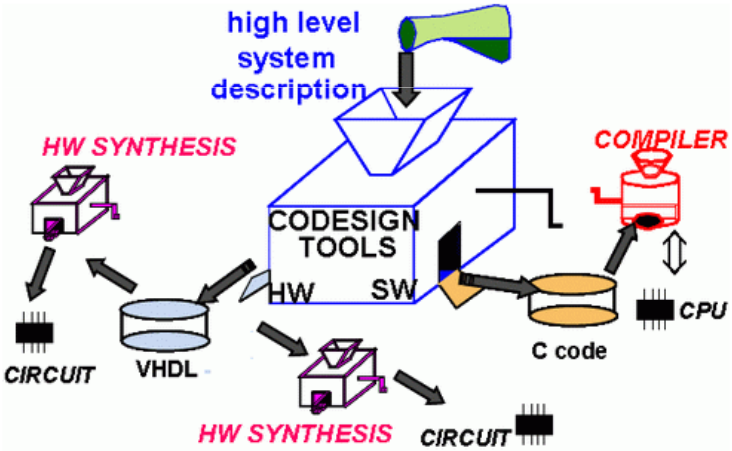
Introduction

Project in

Hardware-Software Co-design (TIPHSC)

Introduction





Source: Micaela Serra, University of Victoria
http://webhome.cs.uvic.ca/~mserra/HScodesign.html

Teacher

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- Lokale 421a

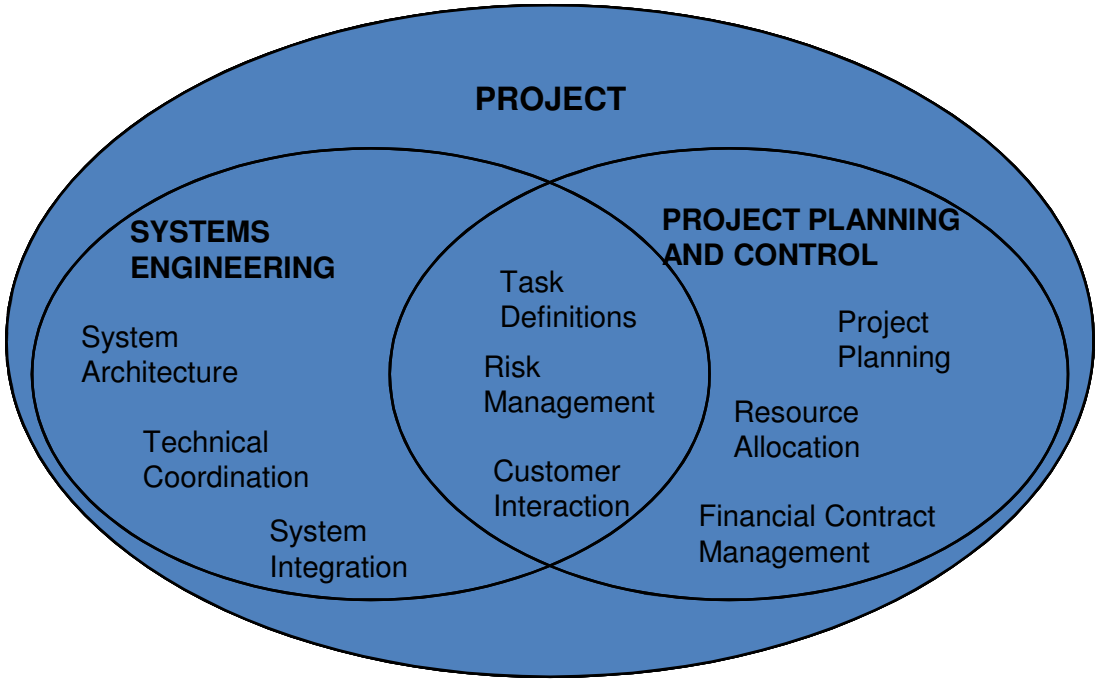
http://dk.linkedin.com/pub/kim-bjerge/6/192/983

Introduction to Project in Hardware/Software Co-design

Contents

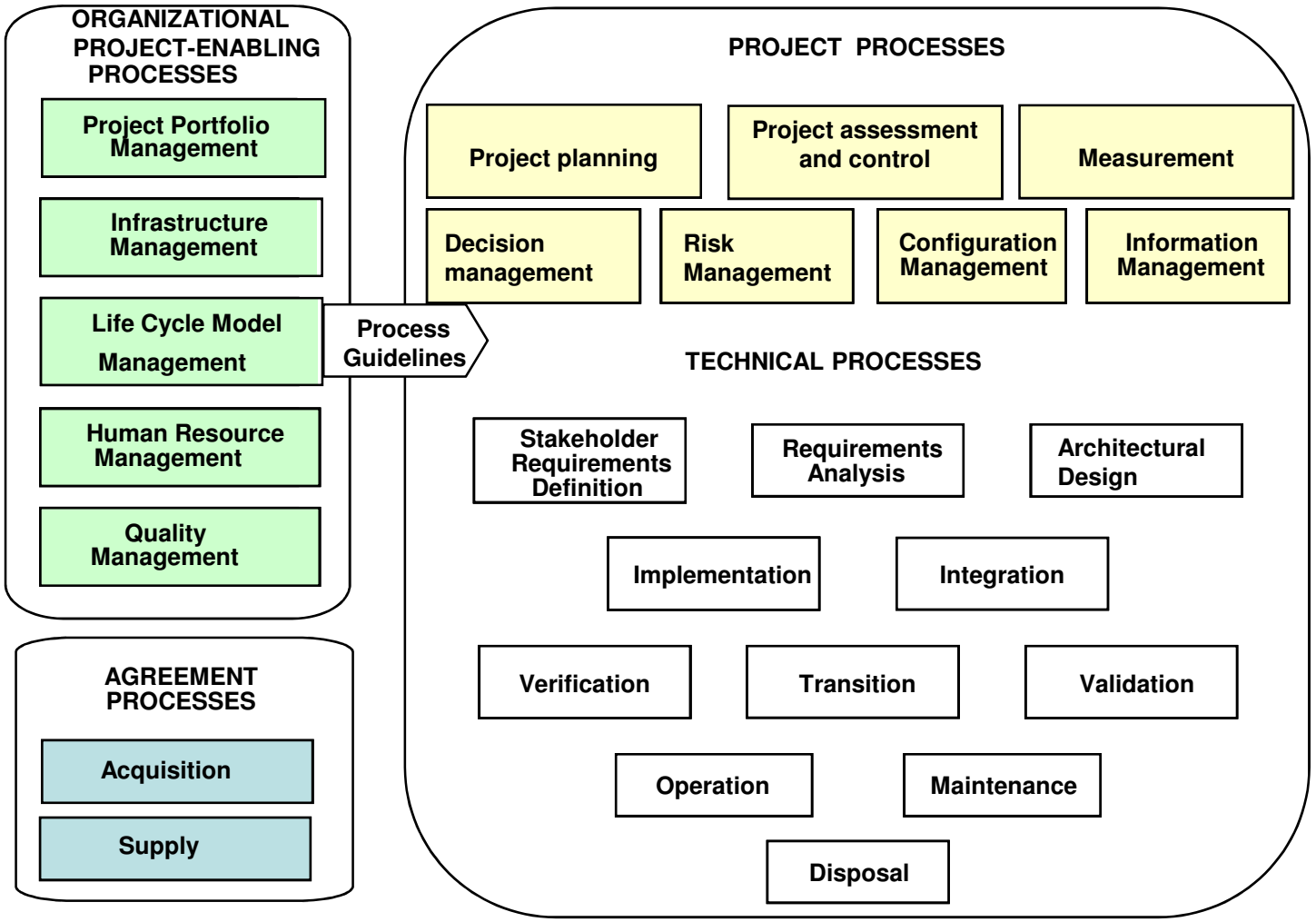
- Summary
  - System Engineering and HW/SW Co-design
- Course overview
- Learning objectives and exam
- Report, Projects and groups

Systems Engineering and Project Management

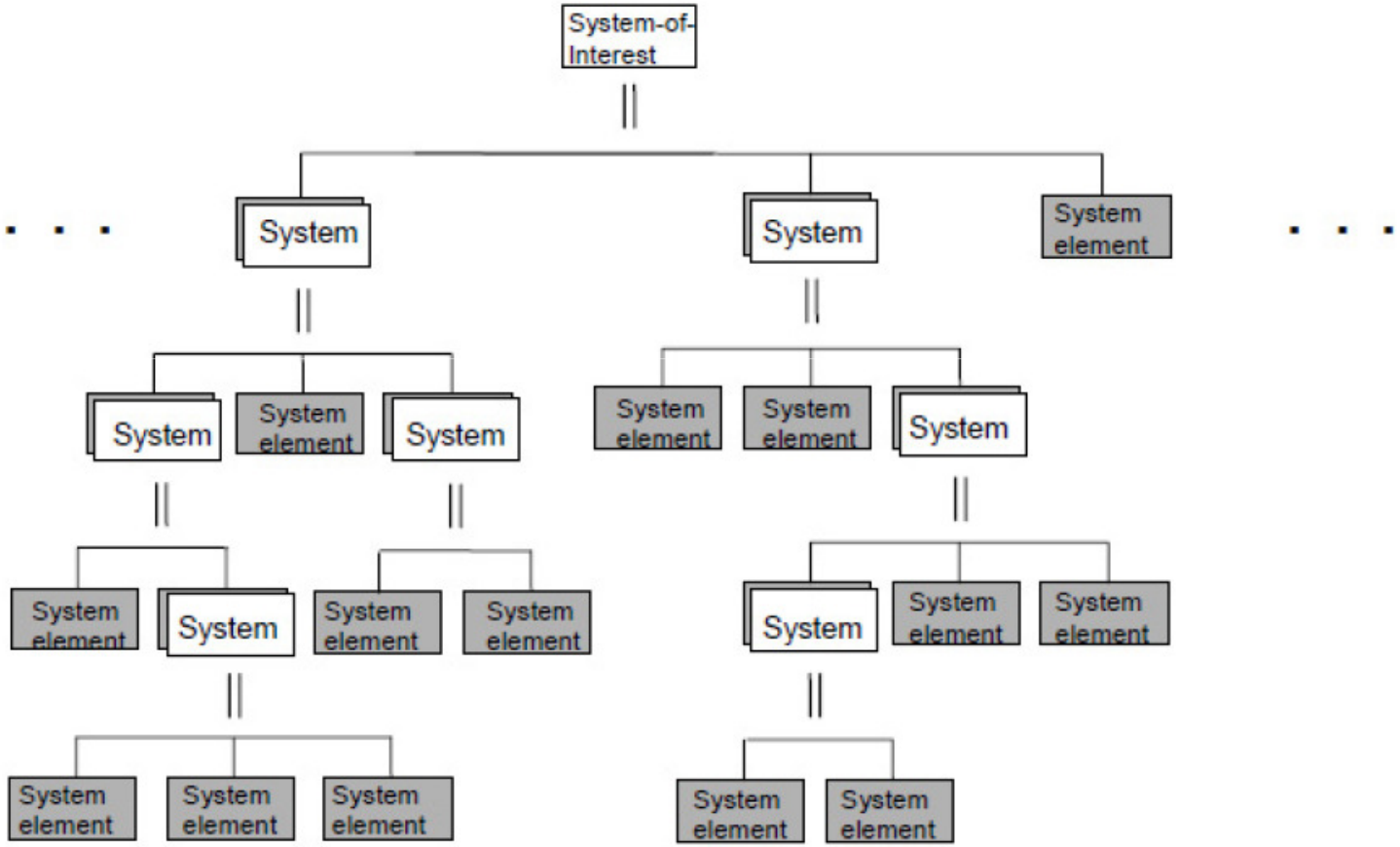


- Systems engineers continually interact with project management

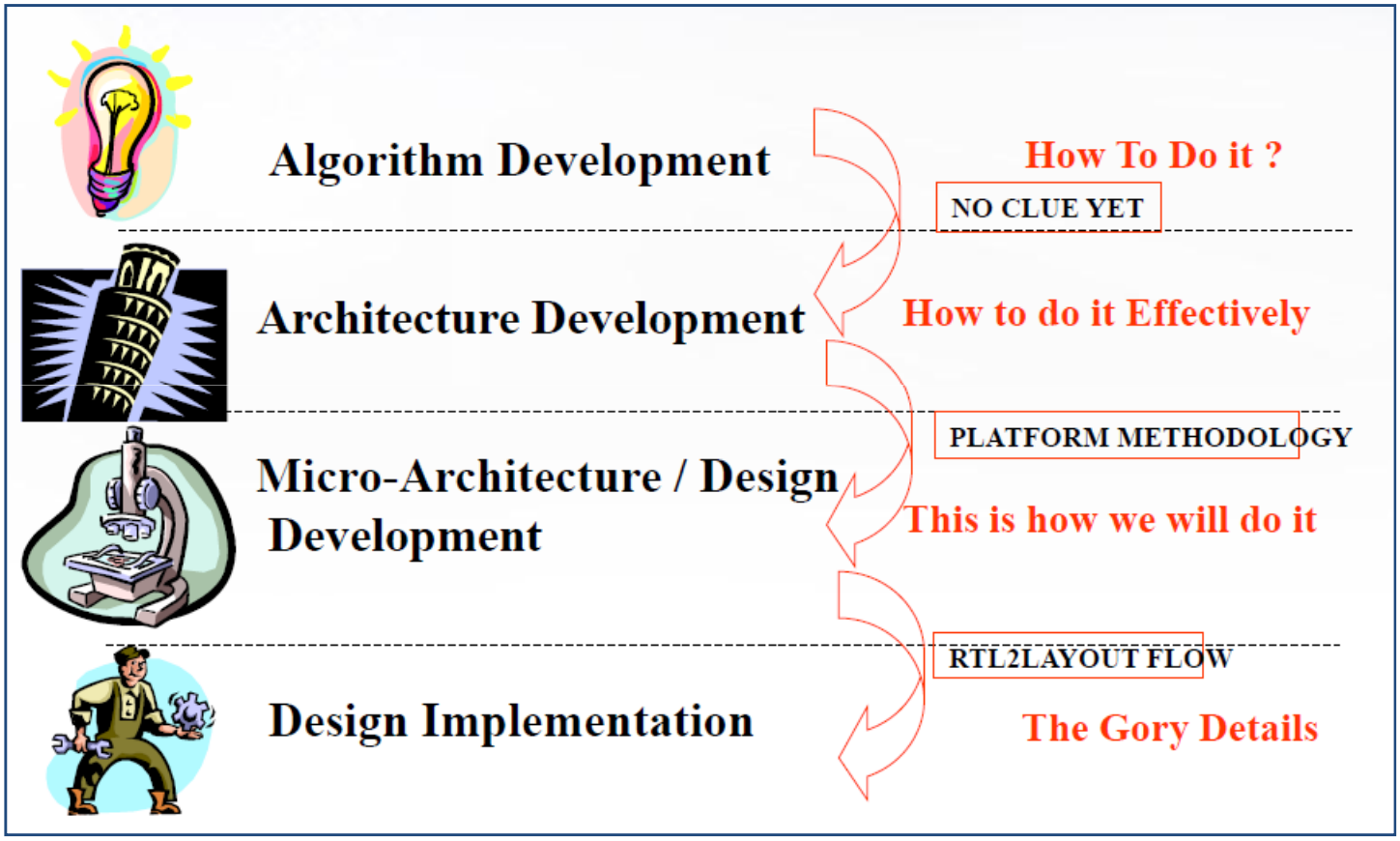
System Life Cycle Processes Overview per ISO/IEC 15288



Systems of Systems

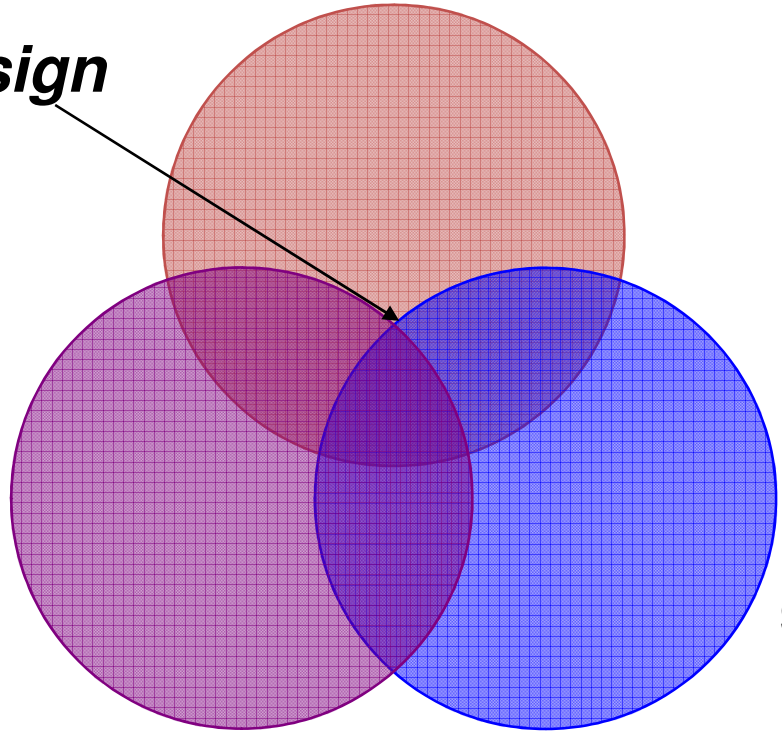


Design Methodology



Software
Real-Time
Embedded Systems

HW/SW Co-design



Hardware
Digital Design
ASIC, FPGA

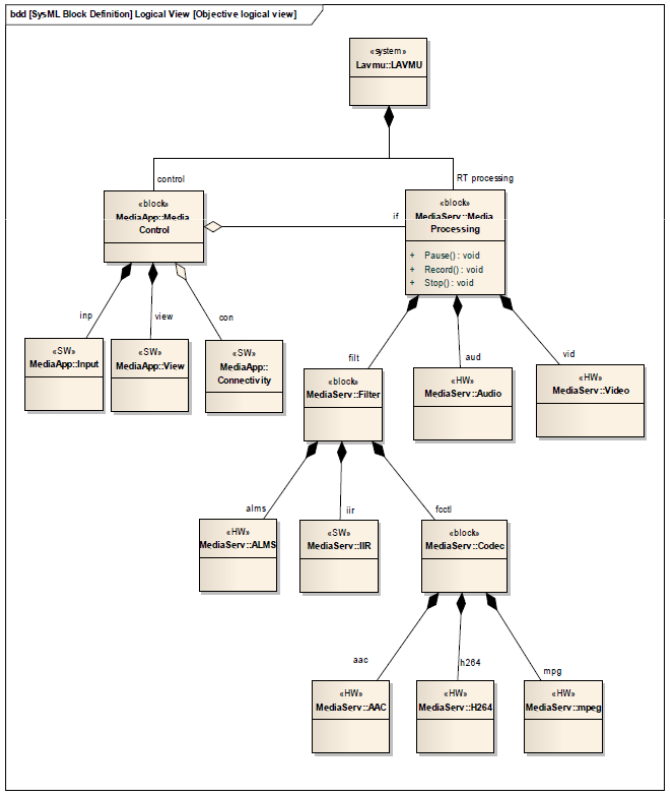
Domains
Signal Processing
Communication
Control Systems
SoC/MPSoC design

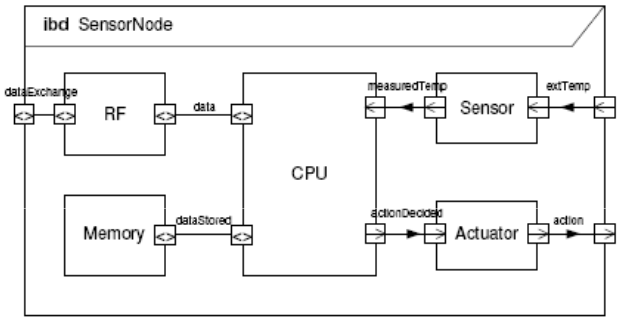
HW/SW Co-design disciplines

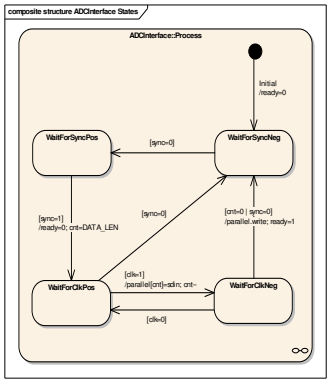
- **Specification - Executable**
  - Use cases and non-functional requirements
- **System Modeling and Abstractions**
  - Model of Computation (State and data flow, PSM)
  - UML/SysML profiles and SystemC (TLM+CAM)
- **Partitioning and DSE** (Design Space Exploration)
  - Mapping, Platform, Load Balancing, Pareto optimal designs
  - Metrics: Performance, Cost, Security, Power, Size
- **Performance Estimation and Analysis**
  - Profiling, Timing, Scheduling, Event arrival analysis
- **Validation, Verification and Test**
  - Simulation and formel verification
  - Simulation verification through refinement (Gajski)

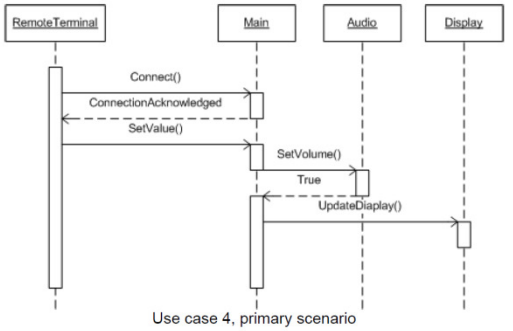
UML and SysML models with different purpose and views

- Structure, Behavior, Interaction



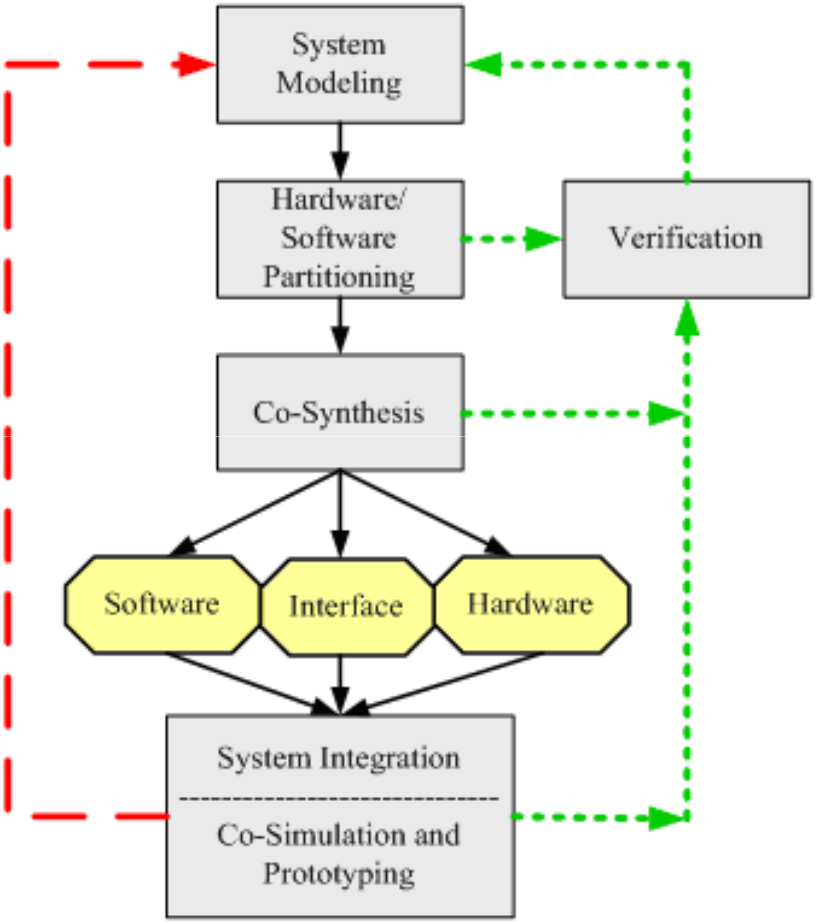






Intergrated Co-Design

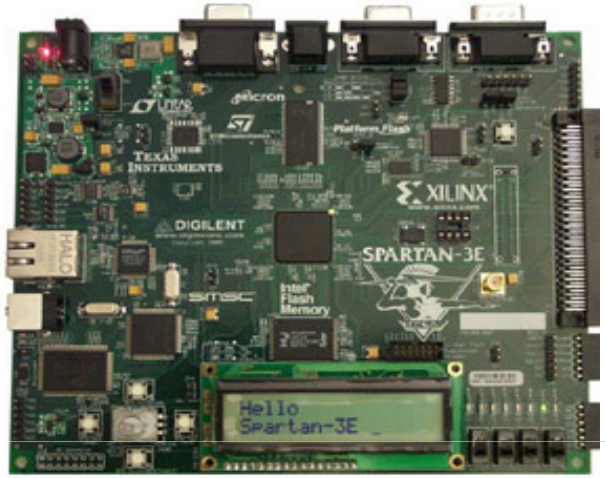
- Modelling
- Partitioning
- Platform
- Co-Simulation
- Co-Synthesis

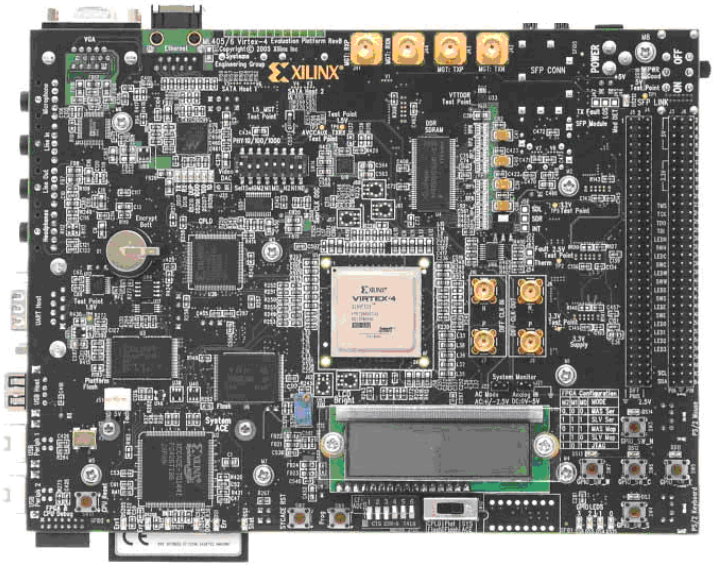


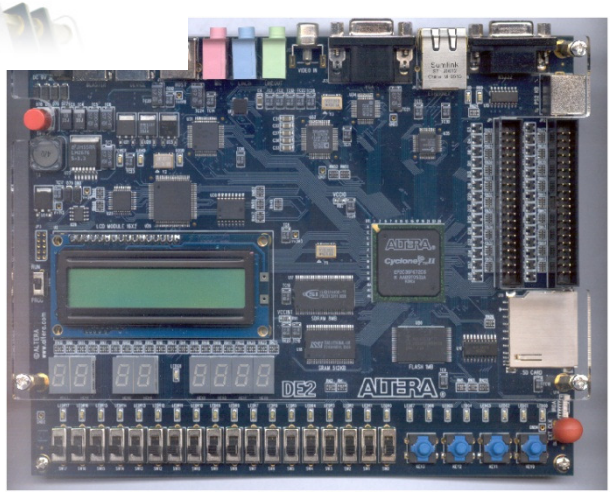
Embedded System Level Design Approaches

- ***Platform-based design***
  - Maps system behavior to predefined architecture
- ***Component-base design*** (Button-up)
  - Assembles existing components to a predefined platform
- ***HW/SW co-design*** (Top-down)
  - Generates the architecture from the specification of the behavior

FPGA development boards (Xilinx/Altera)







Course overview

Day 1

- **Course overview and introduction**
- **Learning objectives and exam**
- **Project definition and objectives**
- **Work in groups to define your project**
  - **Scope, Objectives**
  - **Detailed Specification**
  - **Methodologies and tools**
  - **Working group contract**
  - **Planning**

Day 2

- **Present your project for the class**
  - **Goals, Topics**
  - **Specification**
  - **Feedback from class and teacher**
- **Hand-in project definition and spec.**
  - **Scope, Objectives, Definition**
  - **Goal for learning**
  - **First version of report and specification**
- **Work in Groups**
  - **Architecture, Design and prototype**

Day 3

- **Present your final project**
  - **Project, Process, Method and conclusion**
  - **Each group 30 minutes**
- **Feedback from class and teacher**
  - **Use inputs to refine you final report**
  - **Prepare for exam**
- **Work in Groups**
  - **Design, Prototype, Documentation …**

Learning objectives and exam

Course Learning Objectives

- Anvende teoretisk funderede metoder til systemanalyse og design. (Project/Product report)
- Analysere samspillet mellem hardware og software i en konkret problemstilling i et system. (Project report)
- Anvende metoder til hardware-software co-design på konkrete problemstillinger. (Project report)
- Evaluere forskellige løsningsmetoders fordele og ulemper i en specifik problemstilling. (Project report)
- Kommunikere analyser og implementerede løsningsmetoder klart og utvetydigt. (Product report)

Anvende teoretisk funderede metoder til systemanalyse og design.

- System Engineering
  - Systems of Systems – System Life Cycle Processes
  - Technical process
    - Requirement specification, analysis, architecture, implementation …
  - Project process
    - Planning, assessment & control, risk management ….
- Process and methodology
  - Scrum, ROPES, UP, 4+1 View
  - Modified Unified Process for HW/SW Co-design
  - UML/SysML and profiles
- Models of Computation
  - Process State Machines (PSM, Gajski)
  - State based models and data flow

Analysere samspillet mellem hardware og software i en konkret problemstilling i et system.

- Project definition and specification
  - Select and specify topics and objectives for project
  - Prioritize performance metrics
- Analysis and Design
  - HW/SW Allocation, partitioning, mapping
  - Explore and suggest different platform alternatives
    - Load balancing
  - Design Space Exploration
    - Pareto optimal designs
  - Modeling by Specify-Explore-Refine Design Flow (Gajski)
    - SystemC TLM and CAM models

Anvende metoder til hardware-software co-design på konkrete problemstillinger.

- Project definition and specification
  - Decide on methods to be used in project
  - Non-functional requirements
  - Prioritization of performance metrics
    - Power, Area, Speed, Cost, Time
- Analysis and design
  - Define in project how to solve the assignment (Method)
  - Model of Computation (PSM and/or SysML)
  - HW/SW Partitioning
  - Design Space Exploration
  - System Level Design Language (SLDL – SystemC)

Evaluere forskellige løsningsmetoders fordele og ulemper i en specifik problemstilling.

- Discussion on work
  - Relate your work and method in relation to problem
  - Comment on the methods you have used and compare to alternatives
  - Use references to papers on similar work
  - Summary of pro and cons on methods and work
  - Identify gaps and limitations

Kommunikere analyser og implementerede løsningsmetoder klart og utvetydigt.

- Report
  - Contents
    - Abstract
    - Introduction
    - Project description
      - Context, Methods, Specification, Analysis, Design, Tools,
      - Results, Discussion, Experience, Excellence, Improvements
    - Conclusion
    - References
  - How to write a good report
    - See guide
- Product documents
  - Requirement specification and analysis
  - Product design document

Exam

- Present your project in groups (15min)
- Individual oral 20 minutes
- External evaluation after the 7-scale
- Present your project with focus on fulfillment of the learning objectives
- Grade based on report and exam
- End March 2011

Report, Tools, Projects and Groups

Report Guides and Examples

- Report guides
  - Guidelines, EIT-projects, templates
- Report examples
  - Exercise 2 (HW/SW Co-Design)
  - Sapien 190 (Embedded Real-time Systems)
  - Pitch detector (Multidisciplinary Project)
  - Evaluation of FPGA based Turbo Coding (AAU)
- Documents found on CampusNet

References and knowledge

- Papers and books from previous courses
- Research on papers relevant for your project
- Incorporate knowledge you already have on related fields
- Remember to have references in your report

Problemord - definitioner

- Emne
  - et afgrænset stofområde
- Problem
  - noget der mangler svar/løsning på inden for stofområdet
- Problemstilling
  - Beskrivelse af den sammenhæng (kontekst) problemet indgår i (der kan være flere problemer i en problemstilling)
- Problemformulering
  - En formulering af ét konkret spørgsmål inden for en problemstilling

Se DGO. eksempel s.127

Gode råd om problemformulering

- Den gode opgave styres af problemformuleringen
- Problemformuler fra begyndelsen så højt på **Blooms taksonomi** som muligt
- Den gode problemformulering lægger op til **kvalitet** i opgaven
  - ved at stille konkrete og præcist formulerede spørgsmål
- Gør det klart hvad der er problemformulerings **hovedspørgsmål** med typografi og layout

Blooms taksonomi over indlæringsmål

- Handling
  - Opstille normer / handleforskrifter - Perspektivere
- Vurdering
  - Bedømme ud fra forskellige kriterier
- Syntese
  - Kombinere dele til helhed - Fortolke
- Analyse
  - Nedbryde i dele, skille – Se system/struktur
- Anvendelse
  - Afprøve, bruge
- Forståelse
  - Forklare med egne ord
- Viden
  - Referere, parafrasere, genkende

Reflections in the Report

What?

How?

Why?

Tools

- UML/SysML tools
  - Enterprise Architect, Artisan Studio, Visio, Papyrus
- Altera Design Suite and DE2 board
- Xilinx Studio and Spartan boards
- ImpulseC – (High level synthesis C -> VHDL)
- SystemC for system level modeling

Projects

- Gas sensor (Danfoss IXA A/S)
  - Type detection of gas (CO2, NH3, H2O..)
- Active Array Loudspeaker (SoundFocus ApS)
  - Directional control of sound
- Emergency Call System (Anders)
  - Elderly support when calling for help
- HW/SW Co-design in education (Klaus, Morten)
  - Robotics at Herning University

Project Groups (TBD)

- Morten Opprud Jakobsen
- Klaus Kolle
- Anders Hvidgaard Poder
- Peter Høgh Mikkelsen
- Kenneth Pihl
- Saiid Shah Alizadeh
- Jørgen Vrou Hansen

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Schedule

- **28.1** Day 1 –– Project startup
  - Hand-in project description (**4.2**)
- **11.2** Day 2 –– Project presentation
  - Hand-in specification (**18.2**)
- **4.3** Day 3 –– Final project presentation
- **16.3** – Hand-in report and project document
- **23-25.3** – Oral Exam

Summary

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  - System Engineering and HW/SW Co-design
- Course overview
- Learning objectives and exam
- Report, Projects and groups