1 An Eclipse-based Framework for Modelling and Design Space Exploration of Embedded Systems: The COMPLEX approach

F.Herrera
Microelectronics Engineering Group
University of Cantabria (Spain)
2 Overview

- UC/GIM
- The problem of DSE
- The COMPLEX approach
- Conclusions
4 GIM/UC

- (10,500 + 2400) students
- >36M€ Research

- Hardware Design
- Specification and Design Languages
- Embedded Systems
- Electronic System-Level (ESL) Design

- European Projects:
  - Pharaon, COMPLEX, SATURN, ANDRES, …
5 Motivation: Challenges in the Design of Embedded Systems

- Complexity vs Constraints & Expectations
  - More and more functionality
    - GSM Audio, SMS, Internet, GPS navigation, games, etc
  - Performance
    - Time, Power Consumption, Weight, Volume, etc

- Considering SW and HW!

- Short time to Market
  - Successful Design ≠ Successful Product
6 Motivation: The problem for the System Designer

- Fast Decision!
  - Successful Design ≠ Successful Product

- Which is the best solution?
  - Application Architecture
  - Platform Architecture
  - Mapping
  - Cache Size,
  - Flash Size, DDRAM size,
  - ...
7 Motivation: DSE in the Implementation Loop

- Model
  - Implementation Solution
  - Application Architecture
  - Platform Architecture
  - Parameters

- Slow DSE loop

- Implementation
  - Functional Validation
  - Performance Metrics

- Exploration
  - Performance Constraints
  - Performance Goals

- Model
  - Compilation
  - Synthesis
  - Integration
8 Motivation: DSE relying on Executable Models

- Model
  - Implementation Solution
  - Application Architecture
  - Platform Architecture
  - Parameters

- Generation
- Exploration
  - Performance Metrics
  - Performance Constraints
  - Performance Goals

- VIRTUAL PLATFORM
  - Executable Performance Model
  - Functional Validation

DSE loop
9 The COMPLEX Consortium

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10 The COMPLEX Solution (General)
11 The COMPLEX Solution

- Abstract, but sufficiently Accurate
- Exploration Space
  - (a single representation for multiple solutions)
- Performance Constraints
- A Single & Automated Generation
  - Implementation Solution
  - Configurable&Executable
    - Functional Validation
    - Fast Simulation
    - No Recompilation!
  - Exploration Tool
    - Automated Search
    - Representation

DSE loop

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12 The COMPLEX Solution

- Abstract, but sufficiently Accurate
- Exploration Space
  - (a single representation for multiple solutions)
- Performance Constraints
- A Single & Automated Generation

Model

COMPLEX Eclipse Plug-In

Configurable & Executable

DSE loop

Exploration Tool

- Functional Validation
- Fast Simulation
- No Recompilation!

- Performance Metrics
- Automated Search
- Representation

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The COMPLEX Consortium and the UML-based side

- C/ C++
- Application
- Mapping
- HW/SW platform
- DSE parameters and rules
- Model-to-text Transformations

- CFAM
- xml
- Mak.
- Stimuli
- cross-toolkit
- .elf
- Mak.
- IP-XACT
- TCL generator
- SNPS VP
- Abstract SystemC PDM
- MOST
- script

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SCoPE+

www.teisa.unican.es/scope

Performance Estimation of MPSoC with NoC
  Native Source Simulation
  Beyond manual workloads, automating calculation & annotation of:
    Actual Computation Code
    communication (from mapping, data width, bandwidth, …)

Input:
  Application, HW/SW architecture, MPSoC with NoC, output metrics

Output:
  Performance Figures: Time, Power, CPU usage, Temperature, …

FAST:
  Time estimation speed-up = 5 vs Virtualization / 100 vs ISS
  Power estimation speed-up = NA vs Virtualization / 500 vs ISS
MOST

- Objective Functions
- Intelligent Search
- Representation of Results
16 Modelling Methodology

- Data view
- Functional view
- C&C view
- Platform view
- Architectural view
17 An Eclipse-based solution

- Modelling
  - PapyrusMDT
  - Profiles:

- Complex Eclipse Plugin
  - Checkers
  - Configuration
  - DSE trigger

- Generation plugins (AcceleoMTL - 3.1)
  - Marte2CFAM
  - Marte2xml
  - Marte2IPXACT (Martix)
  - Marte2SC

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Flavour of Papyrus capture
19 Flavor of Papyrus capture
20 Flavor of Papyrus capture
22 COMPLEX Configuration (Current)
23 Work in progress

- Possible Migration to Indigo
- Improvement of Model Capture
  - Papyrus Palette adaptation to Views
  - Automation iMARTE&COMPLEX stereotyping
- Automation (Integration of tools)
  - Generation of MOST scripts
- Tool Configuration
  - Behavior of Transformators
- Scalability
  - Integration of user code
- DSE configuration (objectives constrains):
  - Advanced vs Novel user
24 Conclusions

A Eclipse-based Framework for DSE
- Key tooling for Embedded System Design
- Relying on a powerful performance estimation (SCoPE+) and Exploration (MOST) tooling

A First flavour available in COMPLEX update site
- COMPLEX site: http://complex.offis.de
- COMPLEX Eclipse Plugin Update Site: http://complex.offis.de/eclipse/update/release

Still work in progress and nice features to come!
Thank you

Questions?

Further Information:
- http://complex.offis.de
- www.teisa.unican.es/gim
- {fherrera, evillar}@teisa.unican.es

Demo: 15:30-17:00 (P. Peñil, F. Herrera University of Cantabria)
- UML/MARTE COMPLEX model
- Automated Code Generation
- User code, generated executable and configurable
- Automated Exploration