Design-Space Exploration of High-tech Embedded Systems

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Acknowledgements

• ESI, TU Eindhoven, Océ, Radboud Universiteit

Xiaochen Chen, Marc Geilen, Roelof Hamberg, Fred Houben, Georgeta Igna, Venkatesh Kannan, Frans Reckers, Sebastian de Smet, Lou Somers, Frits Vaandrager, Jacques Verriet, Marc Voorhoeve, Yang Yang, Sander van Zuidam

• Octopus project

• Funding: SenterNovem

Design-space exploration: an example

• Use-cases to be mapped onto a professional printer
  – Copying (black&white, color, various paper sizes, zoom factors, …)
  – Printing
  – Scanning
  – Simultaneous printing and scanning

• How many CPUs, GPUs ?
• Processor speeds ?
• How to achieve X images/min ?
• Double resolution ?

Observation

Many high-tech industries face very similar design-space exploration problems
Objective

Design-space exploration support for high-tech embedded systems

- Flexible set of tools
- Support for formal analysis
- Support for (semi-)automatic exploration
- Prototype for professional printers
- Retargetable to other systems

The Y-chart

The toolset architecture
Benefits

- Intuitive domain-specific modeling environments
- One UI, access to multiple analysis tools
- Hides complexity of formal methods and models
- Reduces modeling effort
- Provides consistency between different analyses
- Flexible, extensible toolset
- Reuse potential between different industries
- Potential to support the DSE process
  - Model storage and versioning
  - Decision tracking and decision support
  - Code generation and synthesis

Other initiatives

- Domain- and/or tool specific
  - e.g., Autosar/AADL, Deadalus, Mescal, Metropolis, Scade
- Generic, but without well-defined kernel
  - e.g., Opt4J, PISA

None of these targets the combination of
- support for the entire DSE process
- across application domains, and
- formal analysis by different tools

The current toolset

- Domain-specific scenario editor
  - for professional printers
- For static scenarios and fixed architectures
- The kernel
  - Central engine
  - Intermediate representation
  - Default analyses
- Analysis
  - CPN Tools
- Diagnostics & visualization
  - Gantt charts
  - Metric values

The current toolset diagram: [Image]
The envisioned toolset

**The kernel**
- Central engine
- Intermediate representation
- Default analyses

**Domain-specific scenario editor**
- UI for the system designer
- Specification of design alternatives
- Specification of experiments, metrics

**Analysis**
- Point analysis tools
- Automated exploration

**The kernel**
- Central engine
- Intermediate representation
- Default analyses

**Diagnostics & visualization**
- Gantt charts
- Metric values, trade offs
- Bottlenecks, trends
The envisioned toolset

- **Domain-specific scenario editor**
  - UI for the system designer
  - Specification of design alternatives
  - Specification of experiments, metrics

- **The kernel**
  - Central engine
  - Intermediate representation
  - Default analyses

- **Diagnostics & visualization**
  - Gantt charts
  - Metric values, trade offs
  - Bottlenecks, trends

- **Analysis**
  - Point analysis tools
  - Automated exploration

- **Scientific challenges**
  - Computational modeling, analysis, synthesis
  - Intermediate representation
    - Expressive
    - Conceptually simple
  - Translations to different modeling formalisms
  - (Semi-)automatic DSE
  - Diagnostics and back-annotation

Thank you

Questions?

- **Domain-specific scenario editor**
  - UI for the system designer
  - Specification of design alternatives
  - Specification of experiments, metrics

- **The kernel**
  - Central engine
  - Intermediate representation
  - Default analyses

- **Diagnostics & visualization**
  - Gantt charts
  - Metric values, trade offs
  - Bottlenecks, trends

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