A Case Study for Partitioned Modelling of a Control System

Ilmenau Technical University, Germany
Where is Ilmenau?
Topics

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Supported by the German Research Council (DFG) under SFB 622.
1. Introduction

Model-Based Design:

- Software design or hardware-software codesign based on formal models
- Checking the model by analysis and simulation
- Avoiding some errors, optimizing the design

- Some kind of **partitioning** occurs (mapping of elements to partitions)
Common Partitions

- **Implementation:**
  System intended to be implemented into hardware and software

- **Environment:**
  Embedding components, including controlled process and its context

- **Instrumentation:**
  Elements for simulation/analysis only
  (e.g. stimuli, logs, interactions, etc.)

**Case study:**
Refine this concept.
Use hierarchical approach.
Evaluate within real project.
2. Known Approaches

- Top level blocks:
  - Interfaces between blocks easily visible
  - Many connections routed through several levels, many ports needed
  - Functional structure hidden
Known Approaches

- Textual reference:
  - Less ports and connections
  - No connections between partitions
  - No graphical representation of relationships
  - Functional structure hidden
3. This Approach: Individual Assignment

- Individual assignment:
  - Functional structure visible
  - Less ports and connections
  - Good graphical representation of relationships
  - Hierarchical concept needed
  - Tool support needed
Refined Partition Set

- **None**
  - Blocks that are not yet assigned

- **Implementation** (*Impl*)
  - Blocks intended to be implemented into HW and SW

- **Environment** (*Env*)
  - Blocks constituting the embedding environment

- **Instrumentation** (*Inst*)
  - Blocks for simulation and analysis only

- **Miscellaneous** (*Misc*)
  - Blocks to be assigned automatically
Hierarchical Mapping Rules

- Initial mapping value of a new block
  - New block refines a block with value other than Misc: Inherit this value
  - Otherwise: Get value None

- Downlevel propagation of a changed value
  - Current value is None: Inherit value propagated
  - Otherwise: No change
  - Values None and Misc do not propagate
Steps for Extracting a Target System

(1) Collect leaves with value None:
   If any: Stop. Partitioning is not complete.

(2) Collect leaves with value Misc:
   Automatically generate temporary assignment to one partition out of Impl, Env, Inst.
   (Minimizing cross-partition connections).

(3) Collect leaves with value Impl:
   Blocks constitute target system.

(4) Collect ports at leaves with value Impl that are connected to blocks with value Env:
   Ports constitute interface of target system.

(5) Stop.
4. Case Study

- **Project:**
  - HW and SW design for a DSP system that controls a high precision measuring machine

- **Modelling infrastructure:**
  - Available modelling tool
  - External program (for value propagation and target extraction)

- **Representation of mapping value:**
  - Block parameter (enumeration type)
  - Background colour of block
Modelling Environment

Modelling tool used:

MLDesigner® from MLDesign Technologies, Inc.

MLDesigner: Copyright (c) 2004 MLDesign Technologies, Inc. All rights reserved.  www.mldesigner.com

- Hierarchical multi domain modelling framework
- Capabilities for simulation, design check, export
- Derived from well-known Ptolemy tool (University of Berkeley)
- No generic support for partitioning
Principle of Scanning Probe Microscope

(From a project team at Ilmenau Technical University)
Example Model: Top Level

Screenshot from MLDesigner. *Italic words inserted manually.*
Example Model: Refined Block

Screenshot from MLDesigner. *Italic words inserted manually.*
5. Results and Conclusion

- **Case study:**
  - First validation of method
  - Demonstration with nontrivial models from real project
  - Experimental tool support

- **Further work:**
  - Improvement of tool support
  - Integration into design processes
  - Generalisation towards extensible partition set
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