A Case Study for Partitioned Modelling of a Control System

Ilmenau Technical University, Germany

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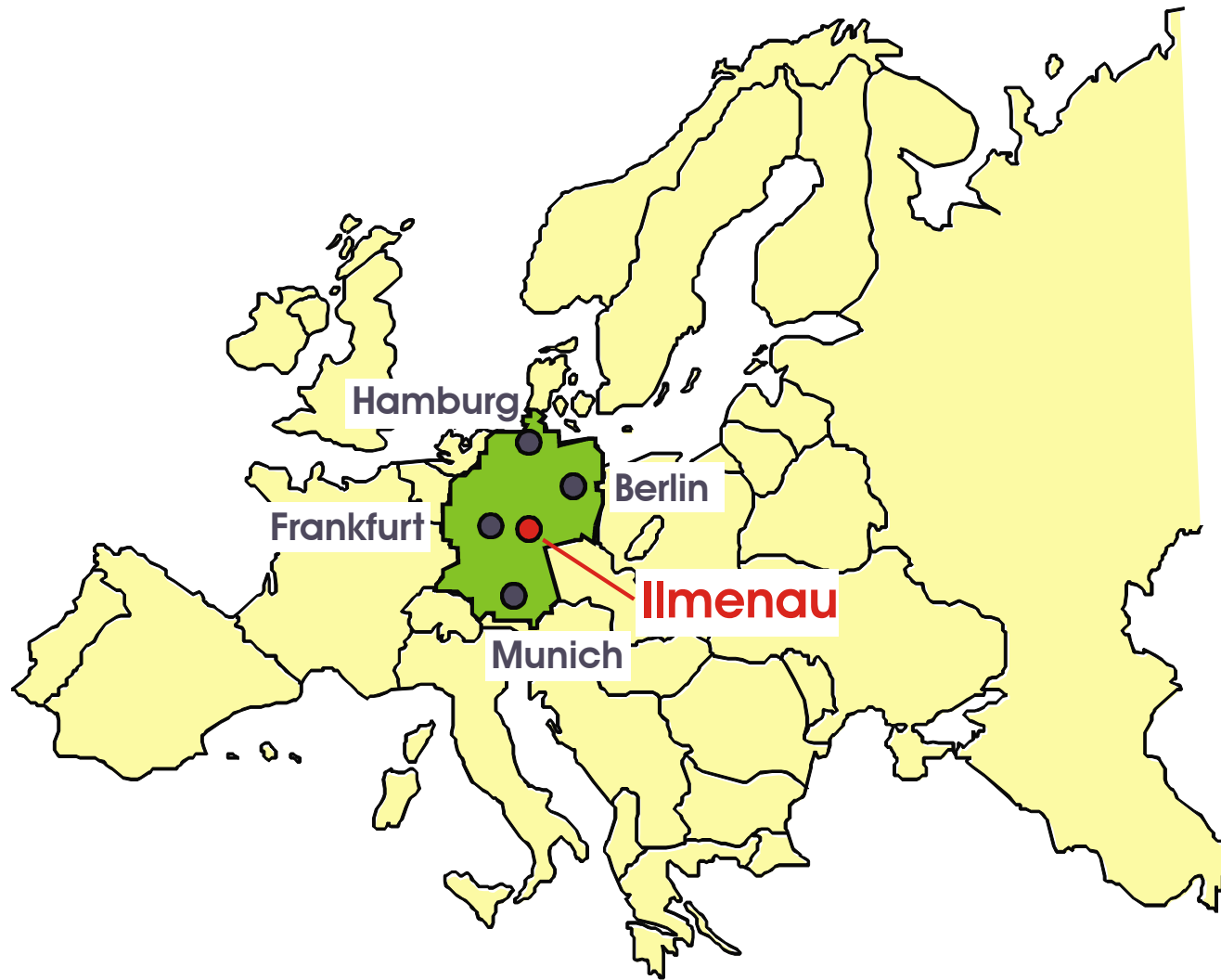
Topics

1. Introduction

2. Known Approaches

3. This Approach: Individual Assignment

4. Case Study

5. Results and Conclusion

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
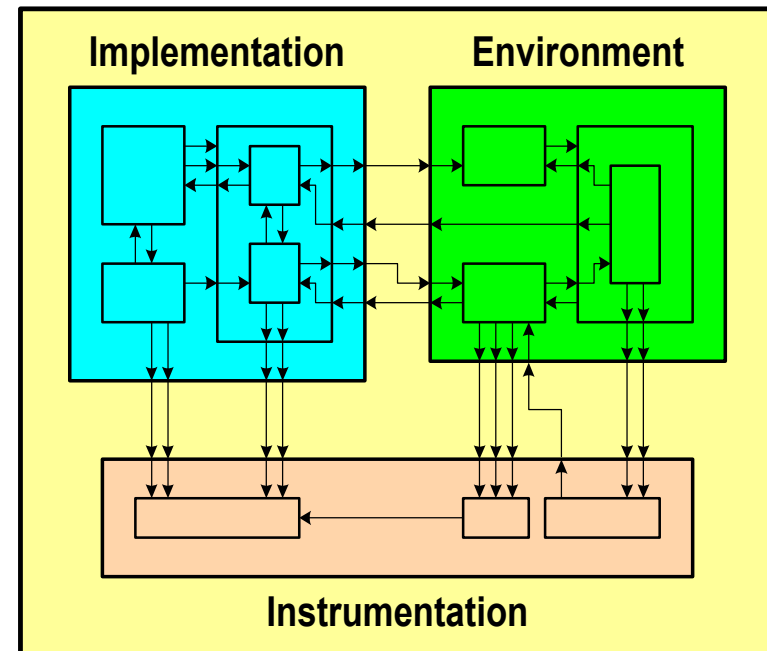
Known Approaches

- Textual reference:

  – Less ports and connections

  – No connections between partitions

  – No graphical representation of relationships

  – Functional structure hidden
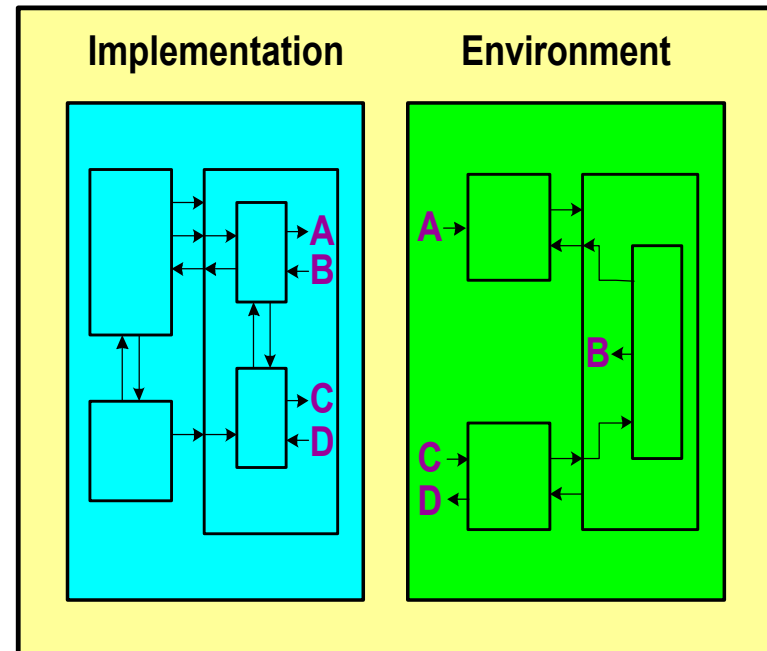
3. This Approach: Individual Assignment

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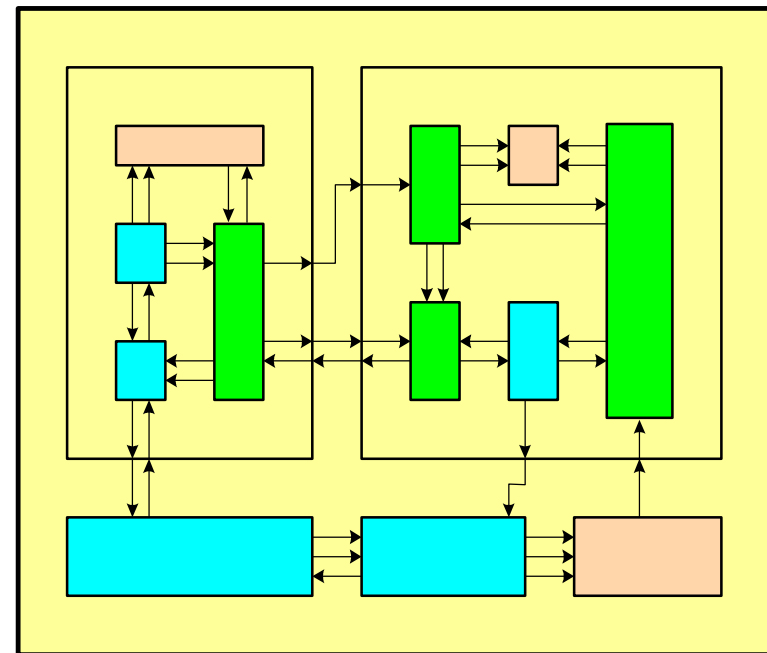
Refined Partition Set

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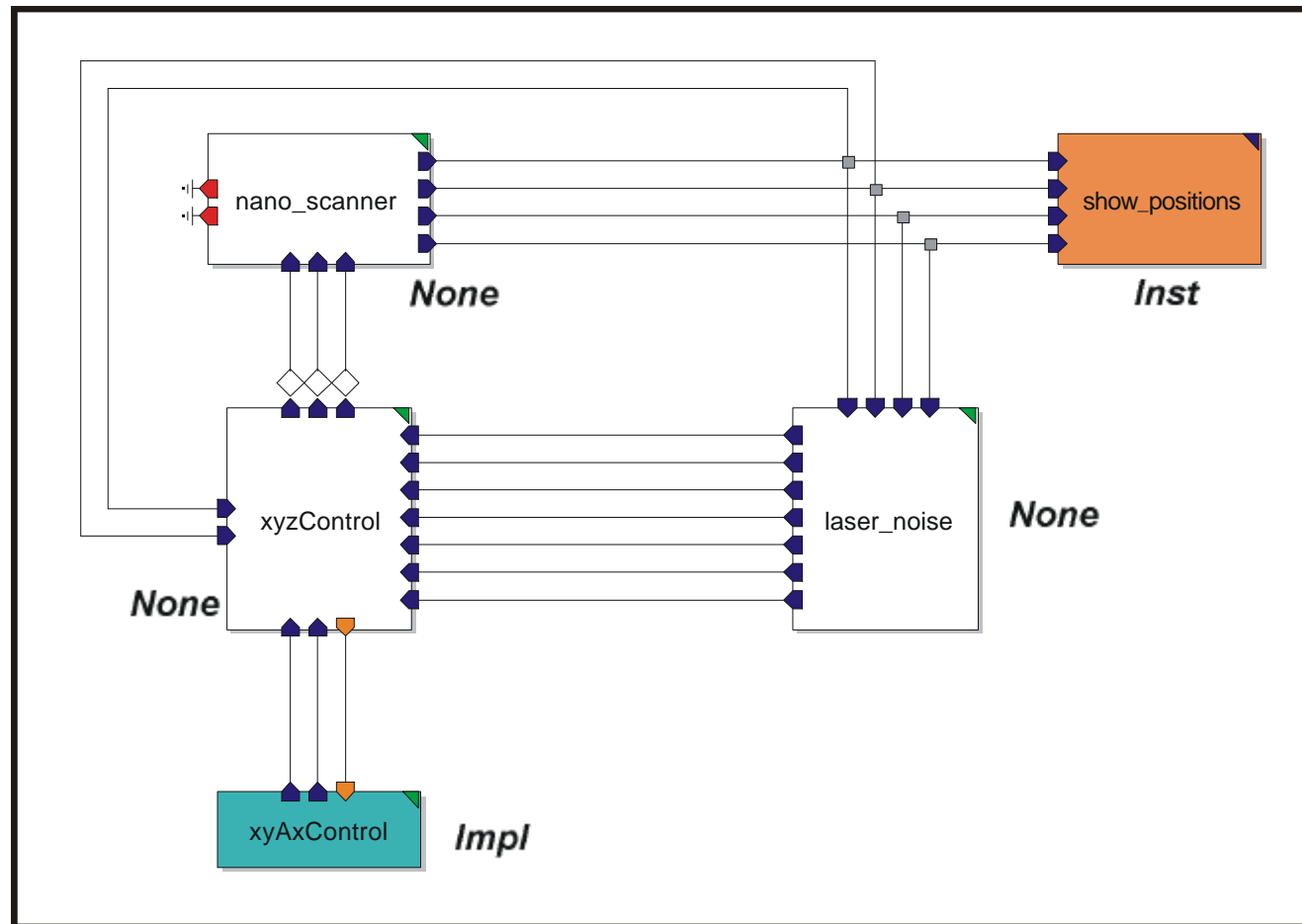
- Hierarchical multi domain modelling framework
- Capabilities for simulation, design check, export
- Derived from well-known **Ptolemy** tool (University of Berkeley)
- No generic support for partitioning

Principle of Scanning Probe Microscope

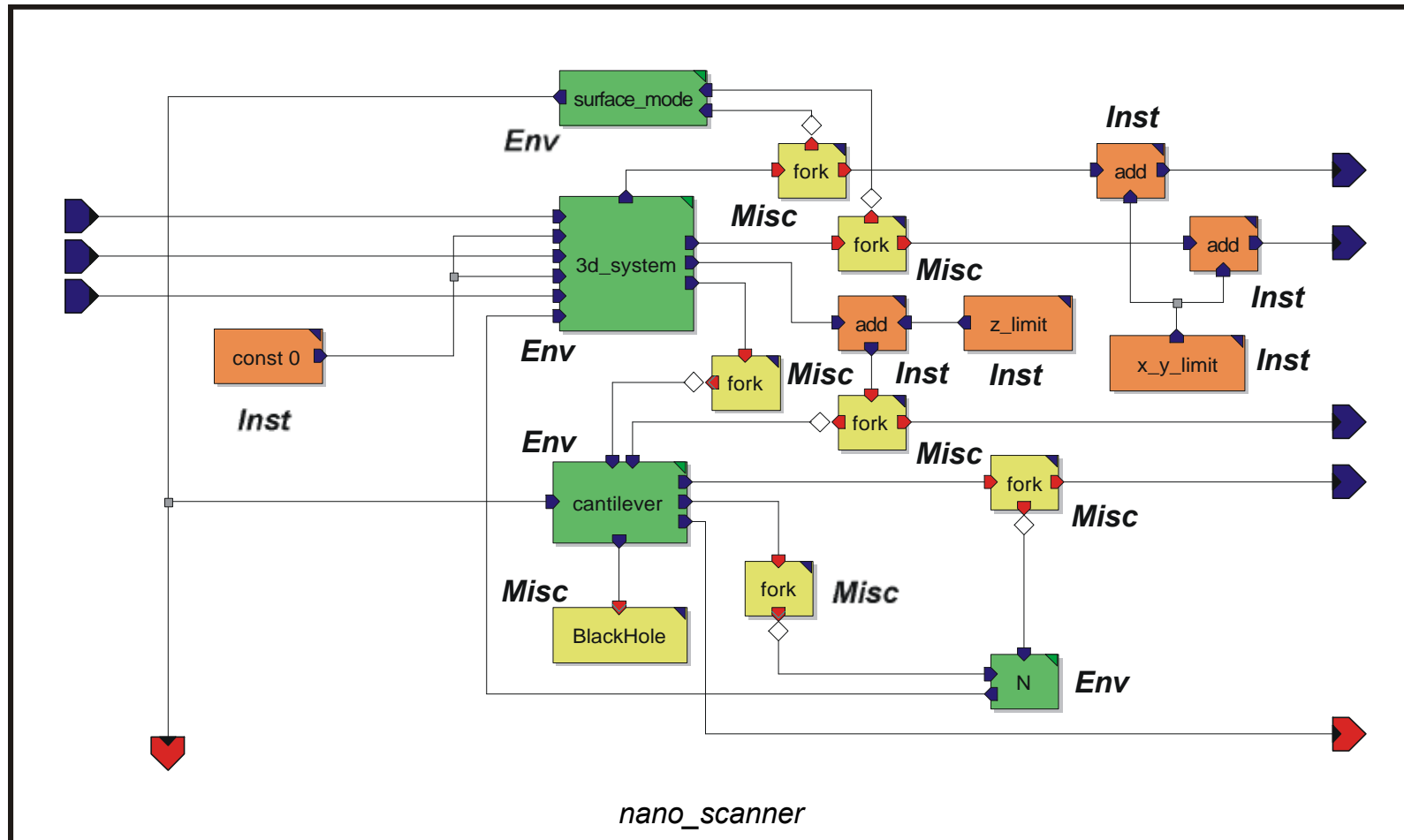(From a project team at Ilmenau Technical University)
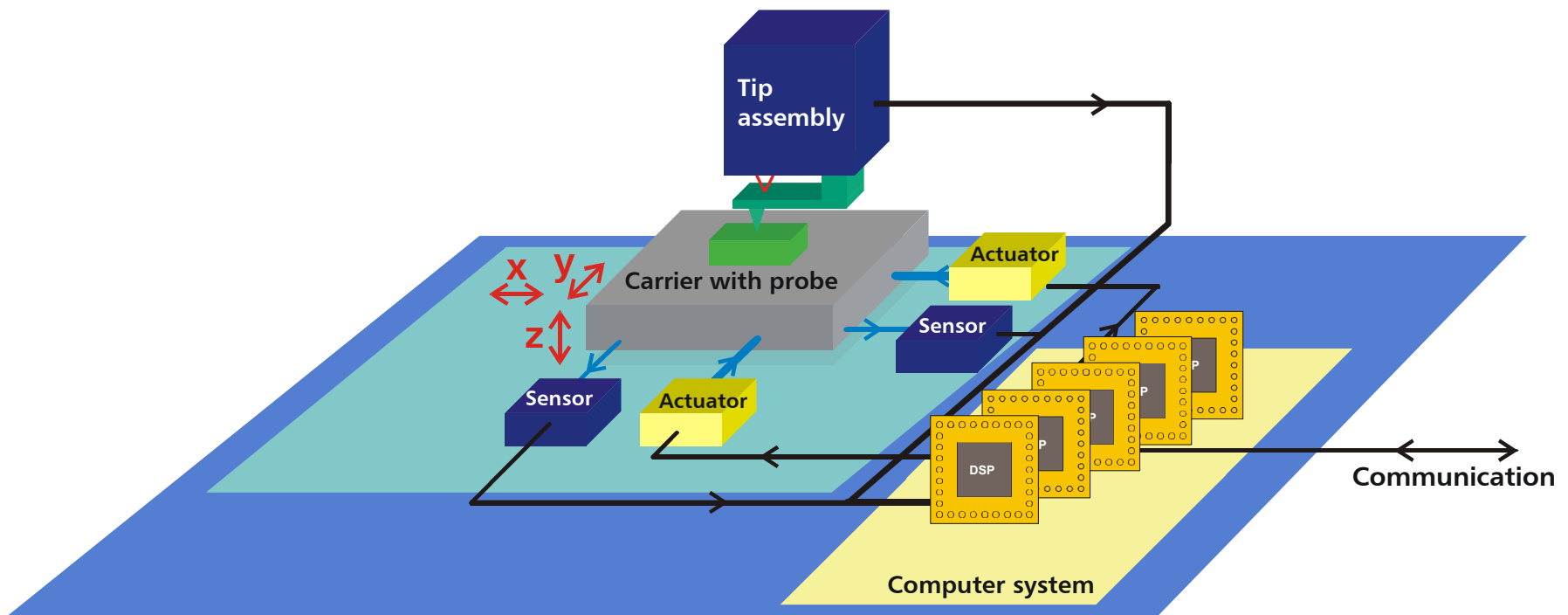
Example Model: Top Level

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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