Universiteit Antwerpen
Faculteit Wetenschappen

Multi-Paradigm Modeling Techniques

Thimoty Smet

What's on the menu

- A Few Definitions
- Problem Scenario
- Heterogeneity
  - Issues
- MPM domain
  - What is it?
  - Difficulties
- MPM Techniques

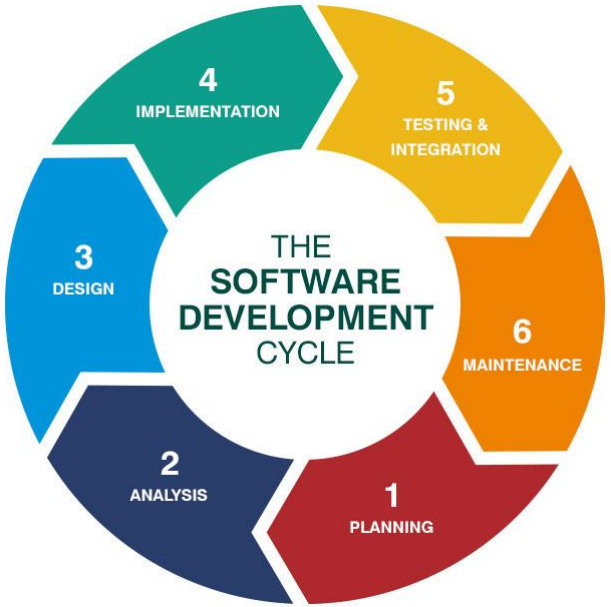
Introduction

A Few Definitions

- **Modeling language**
  - Abstract Syntax
  - Semantics
  - Concrete Syntax
- **Formalism**
  - Formal syntax and semantics
  - Precisely and unambiguously defined
- **Modelling Paradigm**
  - Mindset
    - Implemented by several languages or formalisms

Scenario

- **Designing a big system is tedious**
  - Multiple technical domains required
- **Multiple stages in development cycle**
  - Domain
  - Abstraction
  - Activity
  - View



Problem

- **Each stage requires change of modeling technique**
  - Best technique that fits the goal
- **Changes are unavoidable and essential**
- **→System is described by collection of models**
  - Expressed in different languages

Heterogeneity

- **Heterogenous models of the same system**
  - Do not form global model
- **Global model is needed**
  - Study of global properties
- **Manual integration is tedious and error prone**

Heterogeneity – Levels of Difficulty

	Identical Paradigms	Different Paradigms
Identical Languages	Homogenous	Heterogenous (2)
Different Languages	Heterogenous (1)	Heterogenous (3)

Multi-Paradigm Modeling Domain

Multi-Paradigm Modeling Domain

- **Address issues**
- **Easing joint use**
- **Automation of different actions**
  - Transformation
  - Composition
  - Co-execution
  - Etc.

4 sources of difficulties of MPM

1. Composition of models from different domains
2. Abstraction/refinement relationship
3. Joint use of multiple views
4. Related models of a system for several activities

Composition of Models from Different Domains

- **Issues:**
  - Can models be composed?
  - Will composition yield expected result?
- **Why?**
  - Semantic differences
  - → Comparative analysis
- **How do we realize the composition?**
- **How to verify and preserve semantics of composition?**

Abstraction/Refinement Relationship

- **Conformance relationship**
  - Preservation constraints on properties
- **Issues**
  - Refinement process
    - Obtained refined model = refinement of source model
  - Automation of abstraction/refinement through model transformations
  - Composition of models and different abstraction levels

Joint Use of Multiple Heterogeneous Views

- **Views linked by common elements**
  - Influence observation
- **Issues**
  - Consistency
    - Detection of inconsistencies
    - Derivation process to build consistent views
  - Changes in design of system
    - Impact multiple views
  - Merging overlapping views
    - Identification of overlapping

Use of Related Models for Different Activities

- **Different models for different design activities**
- **Issue**
  - Different theoretical foundation
    - Different formalisms
    - Difficult consistency

Multi-Paradigm Modeling Techniques

Addressing Capture of Modeling Languages

- **Capture syntax and semantics of modeling languages**
- **Techniques:**
  - Kermeta
  - Semantic Units & Anchoring
  - Models of Computation

Translation of Models

- **From different language to identical language**
- **Possibilities:**
  - Model as target
  - Different modeling language as target
  - Composition
- **Techniques:**
  - ATOM3
  - HETS
  - Rosetta

Composition of Modeling Languages

- **Techniques:**
  - Composition of meta-models
  - Semantic Units

Composition of Models

- **Coherent coupling of models**
- **Based on MoC**
- **Techniques:**
  - Ptomely II
  - ModHel’X
  - ’42’
  - Rosetta

Joint Use of Modeling Tools

- **Performance and accuracy of tools**
- **Build bridges**
- **Techniques:**
  - High Level Architecture
  - Co-Simulation Bus

Unifying Semantics

- **Semantic support to describe models**
- **Techniques:**
  - Metropolis
  - Inframodels

Other Approaches

- **Component Based Approaches**
  - Compatibility checking
  - Component Adaptation
- **Heterogenous Interactions**
  - BIP
  - Architectural Interaction Diagrams
- **Megamodels**

Conclusion

- Many techniques for a model
- No single type of technique that solves all categories of problems
- Different modeling goals for different problems
- A lot of new formalisms introduced
- Definitely useful for MDE, see ATOMPM