Dynamic Analysis for Model-Driven Software Modernization

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March 01, 2011 @ MDSM Workshop, Oldenburg

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Kiel — “the City by the Sea” [Kie]

Oldenburg (Oldb)

Kiel
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Photo: http://www.port-of-kiel.de/
Overview of Project Topic

DynaMod
Dynamic Analysis for Model-Driven Software Modernization

Motivation

- Long-lived software systems require continuous modernization
- System behavior & usage important for modernization decisions
- MDSD techniques promise high degree of automation
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- Combining static and dynamic analysis for model reconstruction
- Model enrichment supporting reverse and forward engineering
- Architectural transformation from outdated to modernized system
- Generating code & tests employing mature MDSD techniques

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André van Hoorn (Univ. Kiel) et al.
DynaMod Project — [http://kosse-sh.de/dynamod/](http://kosse-sh.de/dynamod/)
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Expected Results
- Developing resuable methods, techniques, and tools for MDM
- Evaluation by 3 representative case studies
- Sustainable value of models for MDSD-based evolution & operation

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Project Consortium & Funding

Project Consortium:

1. **b+m Informatik AG**
   
   *(Development partner, consortium leader)*
   
   - Comprehensive MDSD know-how
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   - Provides ICT services for public/tax administrations

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Data: 
- [b+m Informatik AG](http://www.bmiag.de/)
- [Software Engineering Group, Univ. Kiel](http://se.informatik.uni-kiel.de/)
- [Dataport](http://www.dataport.de/)

[André van Hoorn](http://kosse-sh.de/dynamod/) et al.

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4. **HSH Nordbank AG**
   - *(Associated partner)*
   - Leading bank for corporate and private clients in northern Germany
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Funding:

- BMBF “KMU-innovativ”
- 2 years (01/11–12/12)
The horseshoe model — “A visual metaphor of the integration of code-level and architectural reengineering views of the world” [KWC98]
Working Packages & Involved Technologies

Working Packages:

WP 1: Static Analysis
WP 2: Dynamic Analysis
WP 3: Definition of Transformations
WP 4: Code Generation
WP 5: Model-Based Testing
WP 6: Evaluation

Involved Technologies:

- Eclipse Modeling Framework/Project (EMF [SBPM09], EMP [ecl10]) for meta-modeling and tooling
- DSLs based on OMG’s ADM meta-models (KDM [Obj09a], SMM [Obj09b] et al.)
- Kieker [vHRH09] for dynamic analysis (monitoring, reconstruction, visualization etc.)
- Apache JMeter [Apa] & Markov4JMeter [vHRH08] for model-based testing
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- Legacy technology (VB6, Natural etc.) subject to modernization (next slides)
Case Study Scenarios

1. AIDA-SH (Dataport)

- Information management and retrieval system for inventory data of historical archives
- Client/server architecture
- Technologies
  - Visual Basic 6
  - MS SQL Server (7.0, 2000, 2003) and MSDE
- Impulse for modernization
  - Outdated technology
- Representative of many modernization projects
Nordic Analytics (HSH Nordbank AG)

- Function library for assessment and risk control of finance products
- Deployments
  1. Desktop installations (Excel front-end)
  2. Trading systems
  3. Batch processing systems
- C# implementation
- Impulse for modernization
  - Architectural restructuring
Case Study Scenarios (cont’d)

3 Permis-B (Dataport)

- System for managing health care allowance
- Complex and critical
- Technologies
  - z/OS (mainframe OS)
  - Adabas-C (DBMS)
  - Natural (online) & COBOL (batch)
  - EskerTun/HOBLink (terminal emulation)
  - ApplinX (web GUI)
- Impulses for modernization
  - Outdated technology
  - Eroded architecture
**Core Characteristics [vHRH⁺ 09]**

- **Flexible architecture** (custom *probes, readers, writers, analysis plug-ins*)
- **Integrated & extensible record type model** for monitoring & analysis
- **Logging, reconstruction, analysis/visualization of (distributed) traces**
- **Low overhead** (designed for continuous operation in multi-user systems)
- **Evaluated in industry case studies**

http://kieker.sourceforge.net
Kieker Framework for Dynamic Analysis

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Kieker.Monitoring
- Monitoring Probe
- Monitoring Controller
- Monitoring Log Writer

Kieker.Analysis
- Analysis Plug-In
- Analysis Controller
- Monitoring Log Reader

Monitoring log
- e.g., AOP-based method call interception
- e.g., trace information, workload, response times, resource utilization, loop counts
- e.g., architecture reconstruction, performance evaluation, online adaptation control, failure diagnosis
- e.g., file system, database, message-oriented middleware

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Sequence Diagrams
Visualization Examples

(a) Assembly-level view

(b) Deployment-level view

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(a) **Assembly-level component** dependency graph

(b) **Deployment-level operation** dependency graph
Dynamic Call Trees
Visualization Examples (cont’d)

(a) Dynamic call tree (single trace)

(b) Aggregated deployment-level call tree
Kieker.TraceAnalysis Tool

System Model Repository

Message Trace Sink Plug-Ins

Execution Trace Sink Plug-Ins

Sequence diagrams, Dependency graphs, Dynamic call trees, System model (html), ...

Kieker.Analysis

Execution Filter

Trace Reconstruction Filter

...
Instrumentation of Visual Basic 6 Code

Uninstrumented VB 6 code

```vbnet
Public Sub searchBook()

    Call catalog.getBook(False)

    Call crm().getOffers

End Sub
```
Instrumentation of Visual Basic 6 Code

Manually instrumented VB 6 code (Kieker.VB6)
VB 6 code instrumentation by annotation
Call catalog.getBook(False)
Static analysis

Call catalog.getBook(False)
catalog.getBook(False)
Model-Driven Instrumentation & Analysis

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Model-Driven Instrumentation & Analysis

Dim tin As Variant
Dim tout As Variant
Dim r As OperationExecutionRecord

' 1.) Calls the Catalog component's getBook() method and logs its entry and exit timestamp using Kieker
Set r = New OperationExecutionRecord
tin = monitoringCtrl.currentTimeNanos
Call catalog.getBook(False)
tout = monitoringCtrl.currentTimeNanos
Call r.initField("Catalog", "getBook", index, tin, tout, 1, 1)
Call monitoringCtrl.writeRecord(r)
Call catalog.getBook(False)

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Additional Information:

- [http://kosse-sh.de/dynamod](http://kosse-sh.de/dynamod) (in German)
Apache Software Foundation.
Apache JMeter – homepage.

Eclipse Modeling Project.

Kiel — A City Portrait.
http://www.kiel.de/Aemter_01_bis_20/06/Stadtpartrait_English/cityportrt1.htm.

Requirements for integrating software architecture and reengineering models: CORUM II.

Object Management Group, Inc.

Object Management Group, Inc.

David Steinberg, Frank Budinsky, Marcelo Paternostro, and Ed Merks.
EMF: Eclipse Modeling Framework.

Thomas Stahl and Markus Völter.

DynaMod project: Dynamic analysis for model-driven software modernization.
Invited paper.

André van Hoorn, Matthias Rohr, and Wilhelm Hasselbring.

Markov4JMeter: Generating probabilistic workload for web-based applications.
In *30th International Conference on Software Engineering (ICSE ’08)*, 2008.
rejected.

André van Hoorn, Matthias Rohr, Wilhelm Hasselbring, Jan Waller, Jens Ehlers, Sören Frey, and Dennis Kieselhorst.

Continuous monitoring of software services: Design and application of the Kieker framework.
Technical Report TR-0921, Department of Computer Science, University of Kiel, Germany, November 2009.