Simulation Modeling of UML Software Architectures

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Performance Evaluation of SA

• Early identification of performance problems in Software Architectures is very useful
  – Costs of changing the design increases as the software development process proceeds

• Performances of SA can be evaluated with
  – Measurement-based approach (requires a running system)
  – Model-based approach (can be done at early stages of the software development process)
Model-based approach/1

- Develop a model of the system
- Translate the model into a performance model
- Evaluate the performance model
- Report feedback into the original system.
Model-based approach/2

Software Architecture

Software Model

Performance Model

Performance Results

Perf. Model Evaluation

Feedback
Simulation for Software Performance Evaluation

- Simulation not considered a solution technique for other performance models, but a performance model itself

- Advantages
  - Mapping between Software Model and Performance Model should be immediate
  - No constraints on the Software Model
  - Easy to report feedback into the Software Model
Proposed approach/1

- Annotated UML Use Case, Activity and Deployment diagrams as SA description model
- Performance model based on UML Profile for Schedulability, Performance and Time Specification
- Process-oriented simulation model
  - Model is implemented as a C++ simulation program, using home-made simulation library
Proposed approach/2

UML Model
- Use Case Diagrams
- Activity Diagrams
- Deployment Diagrams
- Tagged Values

Performance Model
- Workloads
- Processing Steps
- Resources
- Model Parameters
Proposed approach/3

- User annotates the UML diagrams according to (a subset of) the UML Performance Profile
- UML model is exported in XMI format
- We built a tool which parses the XMI file and builds the simulation model
- Model is executed according to user-supplied parameters
- Simulation results are put back into the UML diagrams as tag values
The Simulation Library/1

- Layered structure (classes):
  - Layer 0: Coroutines
  - Layer 1: Simulation Processes, Simula-like SQS
  - Layer 2: Random Variate Generators, Basic Statistics
Simulation Library Core

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The Performance Model
Example: Web Video Application

• User accesses with a browser the Web Server and requests a video
• The Web Server initializes the Video Server
• Video Server sends the frames through the Internet
• Video Server sends termination frame
• User workstation terminates the video player
Example/1
Example/2

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Example/3
Work in progress

- Extend the performance model to include passive resources
- Compute more performance measures
- Validate the methodology
- Apply the methodology to a real-life case study
  - Including mobility?
- Integrate the methodology into a more general framework