Performance Evaluation of UML Software Systems

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Overview of the presentation

- Motivation: Performance evaluation at the Software Architecture level
- Modeling Performances with UML
- Mobility Modeling with UML
- Future Works
Performance Evaluation at the Architectural Level

- 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

Software Architecture

Software Model

Performance Model

Performance Results

Perf. Model Evaluation

Feedback

UML-Ψ
Modeling Performances with UML

- Combine **Use Case, Activity and Deployment diagrams**
  - Use Case diagrams → Workloads
  - Activity diagrams → Processing Steps
  - Deployment diagrams → Resources
- Process-oriented simulation model, implemented with a custom C++ simulation library
- Computed results:
  - Utilization/Throughput of resources
  - Mean execution time of actions
Annotations: Use Case Diagram

<<ClosedWorkload>>

Request Video

PApopulation = 10
PAextDelay = ["assm", "dist", ["exponential", 10.0]]

Paprob = 1.0
Annotations: Activity Diagram
Annotations: Deployment Diagram

- **ClientWorkstation**:
  - **PAschedPolicy**: "FIFO"
  - **PARate**: 5.0
  - **PActxSwT**: ["msr", "dist", ["constant", 0.05]]

- **WebServerNode**:
  - **PAschedPolicy**: "PS"
  - **PARate**: 2.0

- **VideoServerNode**:
  - **PAschedPolicy**: "FIFO"
  - **PARate**: 5.0
  - **PActxSwT**: ["msr", "dist", ["constant", 0.05]]
Problem of *notation*. Different proposals for high-level UML mobility modeling:

- V. Grassi and R. Mirandola, “*UML Modeling and Performance Analysis of Mobile Software Architectures*”
- Baumeister et al., “*Extending Activity Diagrams to Model Mobile Systems*”
- P. Kosiuczenko, “*Sequence Diagrams for Mobility*”
- Others...
Our proposal

- Unified UML notation for mobility AND performance modeling
  - **Deployment Diagrams**
    - Represent the configuration of physical resources available in the system.
  - **Activity Diagrams**
    - Represent the computations performed on the system
    - Describe how the physical configuration of the system changes as the result of mobility (both physical and logical)
  - **Use Case Diagrams**
    - Represent workloads
The approach / 1
Each workload (user class) is modeled as an **Actor**.

Each behavior executed by actors is represented by a **Use Case**.

Use Cases are expanded into **top-level Activity Diagrams**. Each action represents a possible system configuration.

Top-level Activity Diagrams are detailed with the actions performed while the system is in that configuration.

**Deployment Diagrams** represent resources.
Conclusions

- We proposed a unified approach to mobility and performance modeling of software systems
- The approach is based on standard UML notation
  - We defined a UML profile based on (a subsef of) OMG's “UML Profile for Schedulability, Performance and Time Specification”
- We have built a performance evaluation tool UML-ψ to show the approach in practice.
  - The performance model is a process-oriented simulation model.
Current Status & Future Research

- What we have:
  - A UML-based approach for performance evaluation of software architectures at the SA level.
  - A prototype tool to implement the approach
  - An extension of the approach to mobile systems

- What we are working on
  - Extend the approach with more features
  - Integrate our approach into a general framework
  - Extend the approach to reliability
More Informations

- Our papers on UML performance modeling are available online at:
  http://www.dsi.unive.it/~marzolla