

Software Architecture-Based Reliability Prediction Techniques: an Overview

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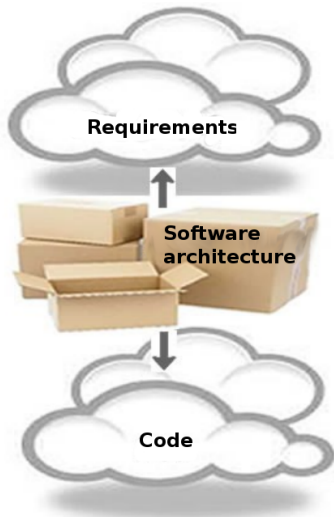
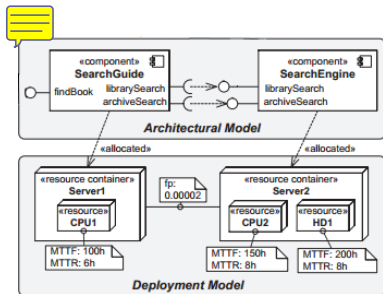
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- Motivation for software architecture reliability prediction
- Overview of main techniques
- Example of real tool
- Current and future research

Software Architecture in General

Software architecture

- Modules
- Connectors
- Deployment on hardware resources



Definition of Reliability

- Dependability vs. reliability

Meanings of reliability:

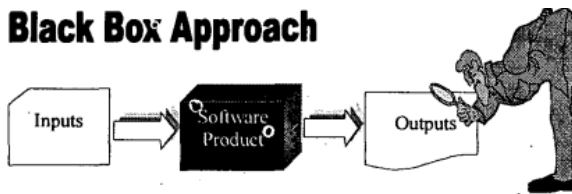
- *Probability of a failure-free operation* (information systems)
- *Failure intensity during specified time interval* (embedded systems)

- Residual failure rate
- Architectural design decisions
- Identification of critical components
- Resource allocation planning

Reliability Analysis Approaches

- Black-box
- White-box

Black Box Approach



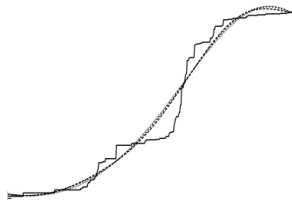
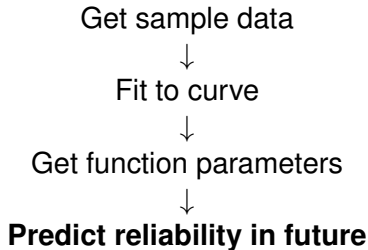
White Box Approach



Black-box approach

- Interactions with external environment
- Failures + downtimes
- Statistical testing → later stages
- **SRGM**

SRGM (Software Reliability Growth Models)



Real-world example

- Railway interlocking software system (Australia, 2011)
- Data set = 199 records

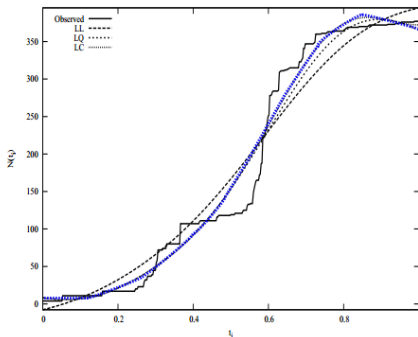


Figure 3. Data set 2: Curve fitting using LL , LQ , LC estimators with $h_n = 0.17$

How to...

- ensure consistency of tests?
- get source of failures?
- determine reusability of system?

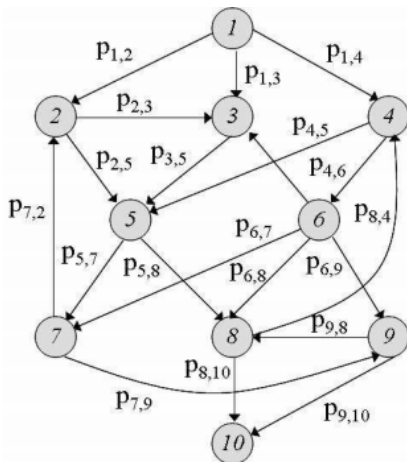
White-box approach

- Reliabilities of components, connectors
- Various information resources
- Early stages of lifecycle
- Identify critical components

White-Box Approaches

Path-based

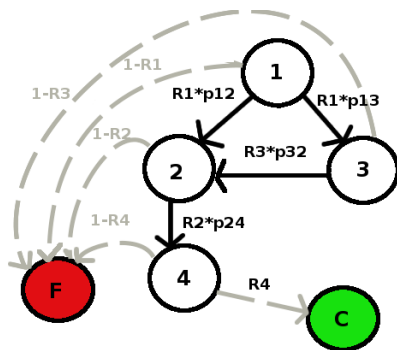
- Execution paths
- No loops



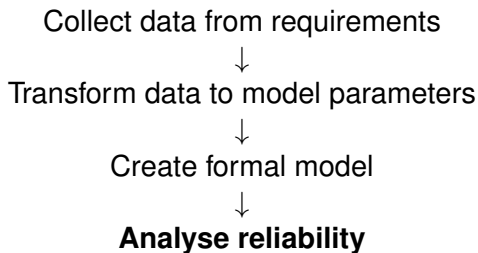
White-Box Approaches

State-based

- Component, action, step of scenario
- Architectural model + failure behavior
- State explosion
- Cheung model



White-Box Reliability Prediction

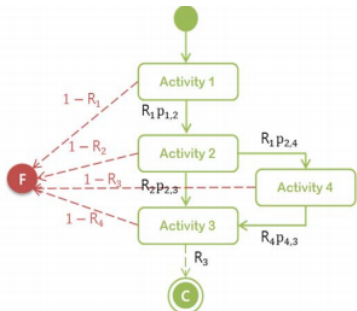


Architectural model:

- Component reliability
- Transition probability
- Operational profile
- Usage profile

Failure behavior model:

- Failure rate
- Time to recover



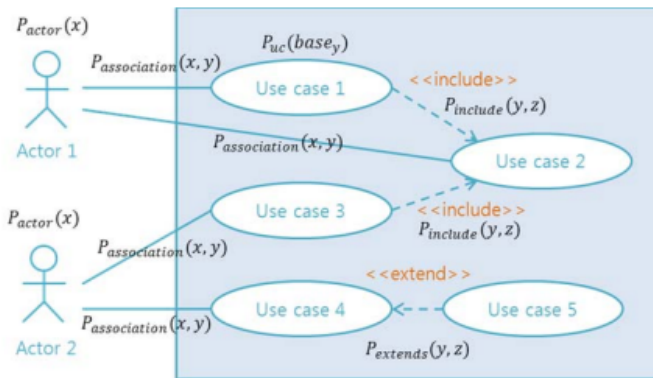
Resources

- Specification
- UML diagrams
- Similar/predecessor projects
- Expert knowledge
- ...

Data Collection – Example

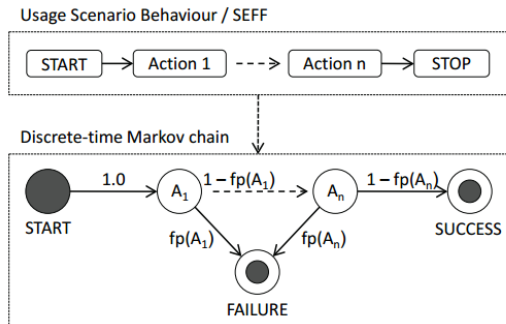
Usage and operational profile

- Use case / activity diagram
- Requirements document



Failure behavior

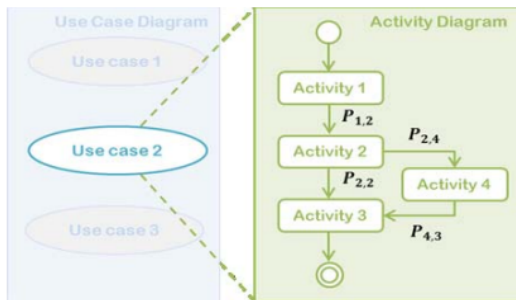
- Activity diagram, fault injection, testing
- Transformation to MC



Data Collection – Example 3

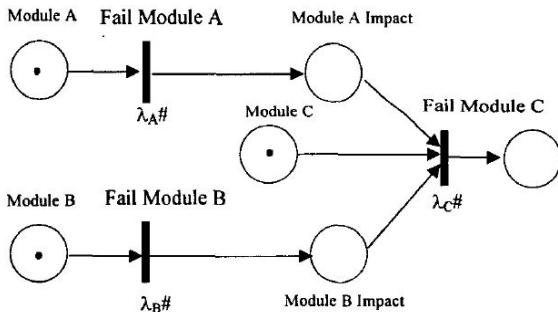
Transition probability

- Profiling
- Requirements document
- Trace data from simulation
- Activity diagram



Formal models

- Markov chains
- Petri nets



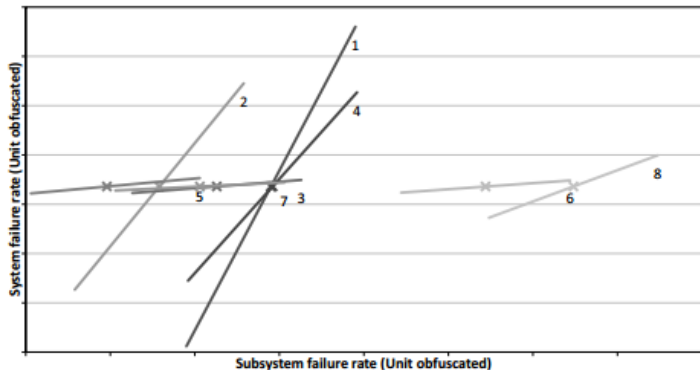
Possible Outputs of Reliability Techniques

- Number $x \in R, x \in \langle 0, 1 \rangle$

Usage Scenario	Reliability Prediction	
	Analysis	Simulation
Sales Manager	0.99673711	0.99691003
Accounting Manager	0.99457976	0.99443006
Administrator	0.99877648	0.99878001

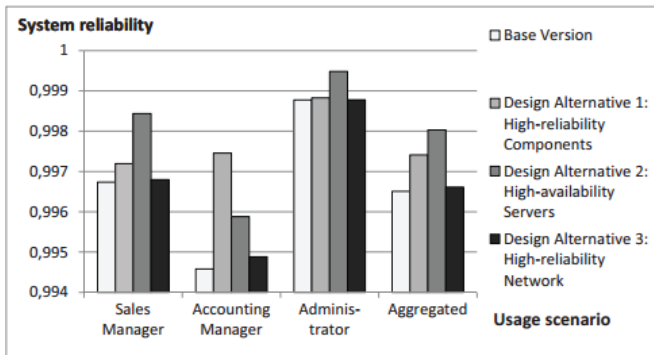
Possible Outputs of Reliability Techniques 2.1

- Sensitivity of system reliability to component reliability



Possible Outputs of Reliability Techniques 3

- Usage profile graph
- Design alternatives



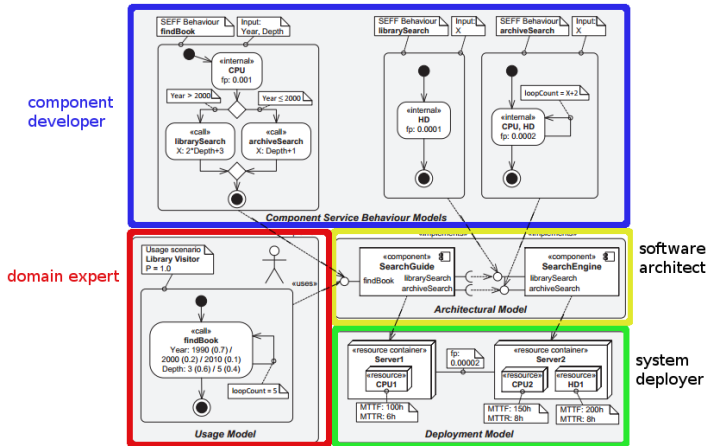
Palladio Component Model

- Reliability prediction tool (Karlsruhe Institute of Technology, cca 2009)
- Extension of Eclipse IDE
- Support for critical business and industrial processes
- Reliability for 4 developer roles

Tool Support for Reliability Prediction 2

Palladio Component Model

- Highly-parametrized UML



Reliability prediction in early stages of lifecycle

- Define categories: goal, model, artifacts, . . .
- Research questions based on categories
- Examine correlation

Possible Directions of Future Research

- **Limitations** of current techniques – no concurrency, distributed processes, failure propagation
- **Usability** of current reliability prediction techniques **in clouds**
- Other types of lifecycle methodics (agile, iterative, . . .)
- Exact **evaluation of contribution** of reliability prediction techniques

LaSArIS (Bühnová)

- Our research – Reliability in software architectures

ParaDiSe (Černá, Barnat)

- *Checking sanity of software requirements*
- *Reliability analysis in component-based development via probabilistic model checking*

- Motivation for software architecture reliability prediction
- Overview of main techniques
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Thank you for your attention.