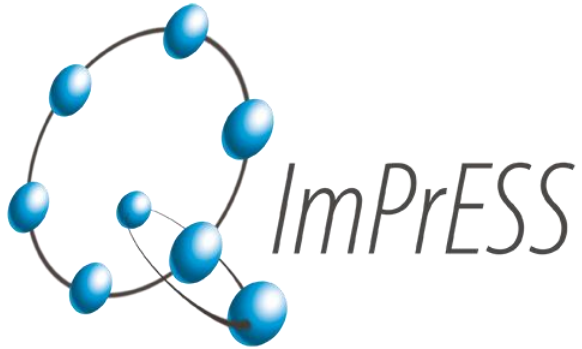




Parameter Dependencies for Component Reliability Specifications

Heiko Koziolk (ABB Corporate Research)
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Heiko Koziolk: Parameter Dependencies for Component Reliability Specifications

Software Reliability

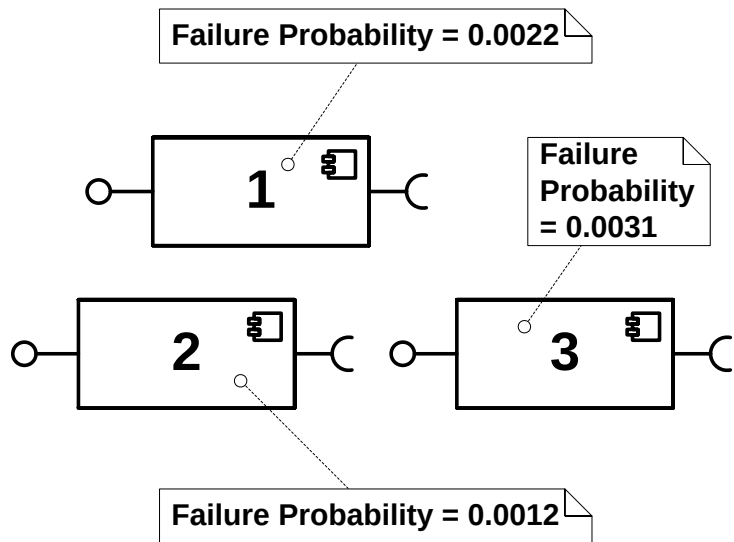
“The probability of failure-free operation of a program for a specified period of time in a specified environment.”

[Musa1987]

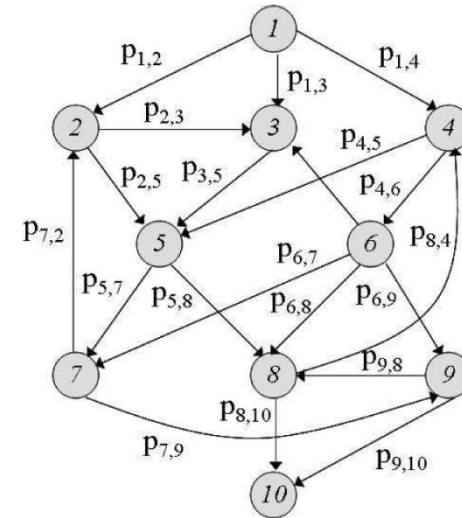


99%

Architecture-based Reliability Analysis



Component Architecture



Markov Model



$$R = \prod_{i=1}^{10} \left(R_i^{\nu_i} + \frac{1}{2} R_i^{\nu_i} (\log R_i)^2 \sigma_i^2 \right)$$

Markov Model Solution



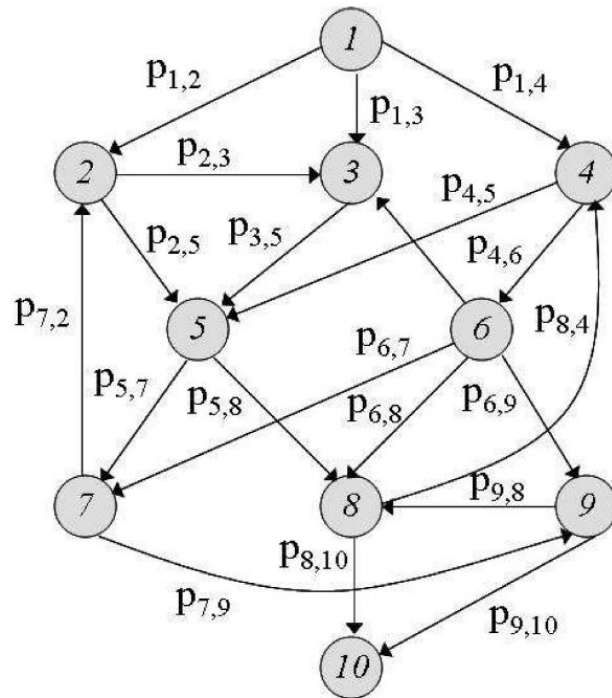
R = 0.9223

Expected Reliability

[Trivedi2001]

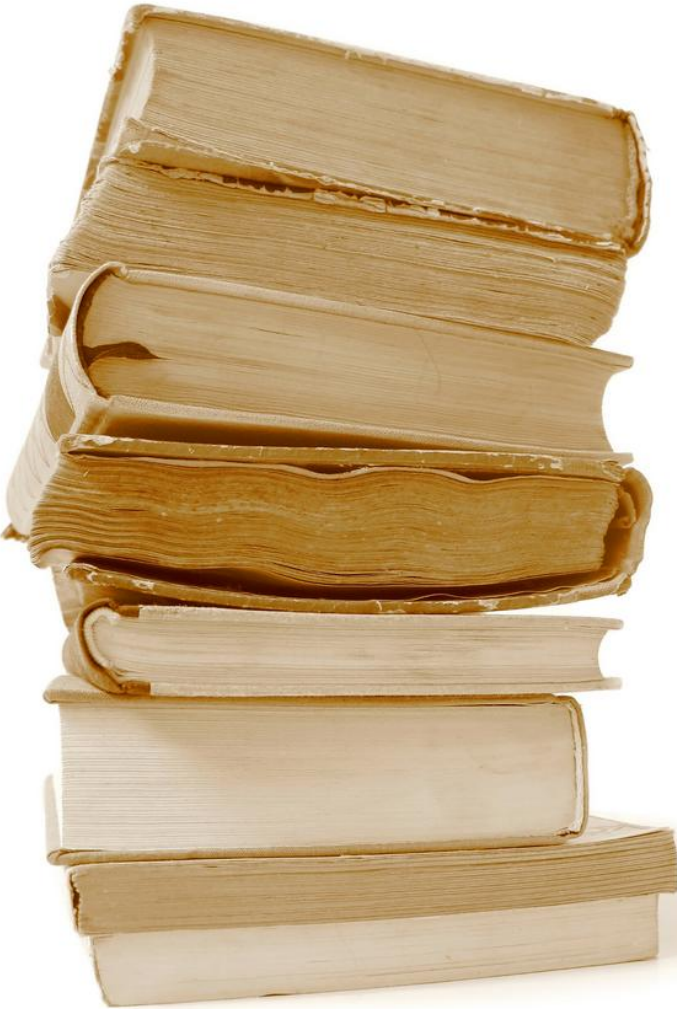


Problem



How to determine the transition probabilities?

Literature: Existing Approaches



R. Cheung 1980 (IEEE TSE)

- Transition probabilities via measurements



Hamlet 2001 (ICSE)

- Transition probabilities via measurements



Reussner 2003 (JSS Vol. 66 No.3)

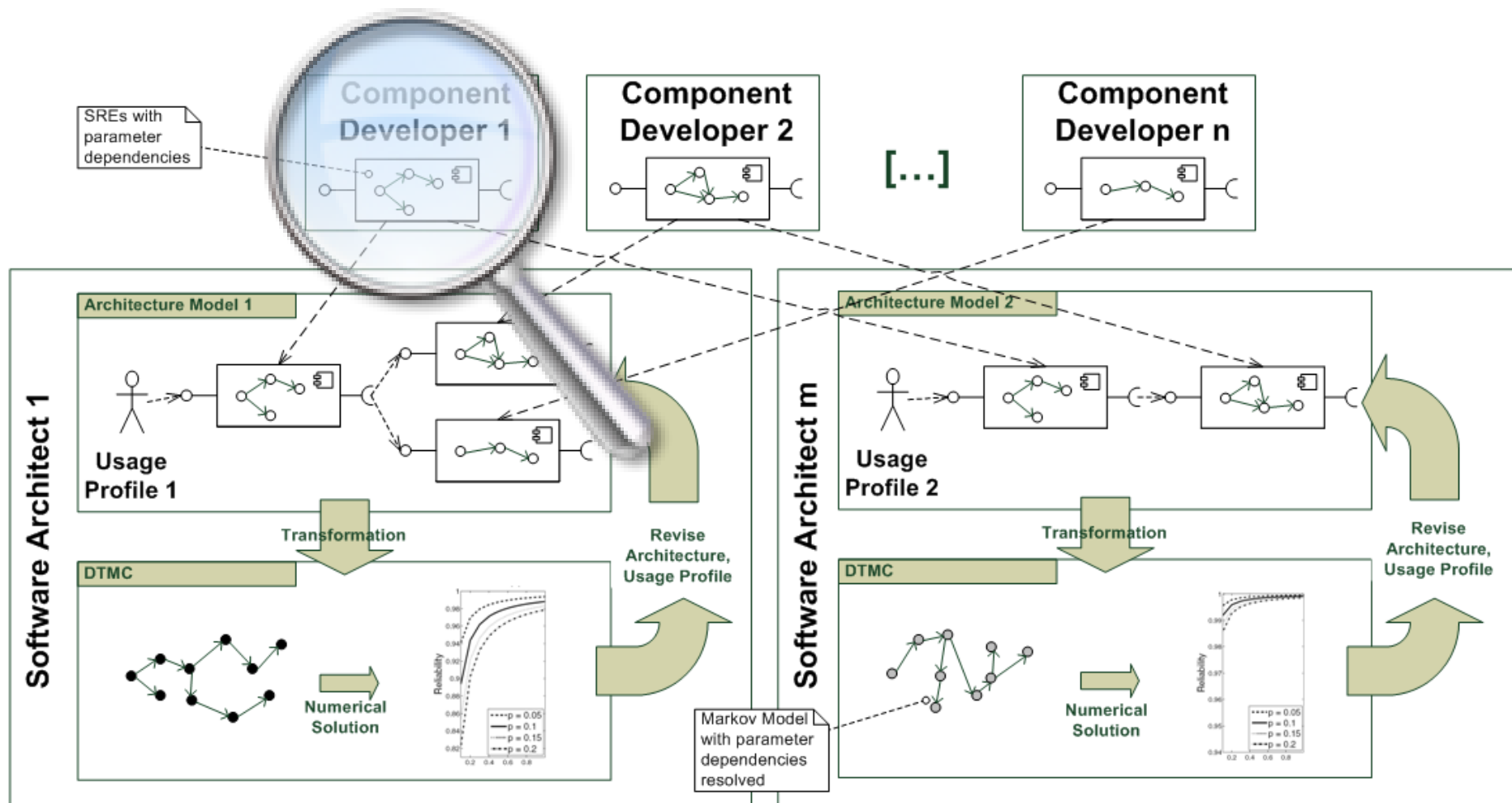
- Assumes transition probabilities as given



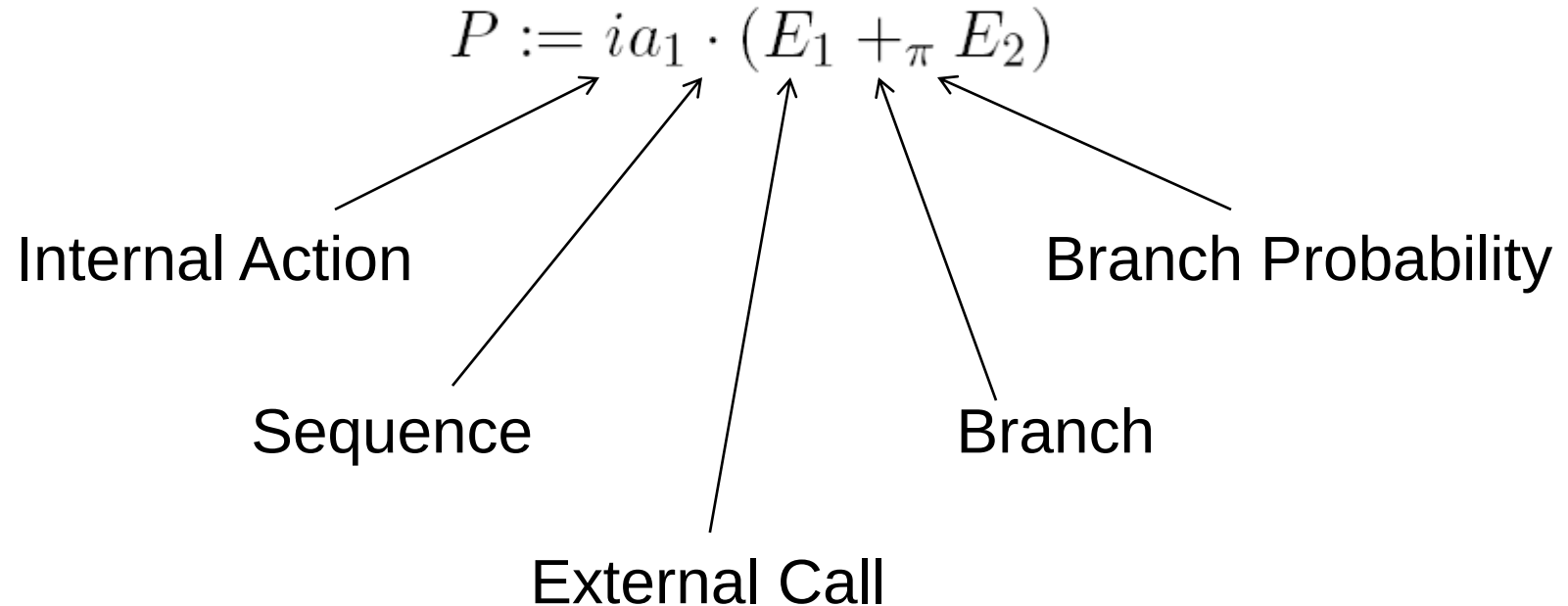
L. Cheung 2008 (ICSE)

- Assumes no control flow propagation

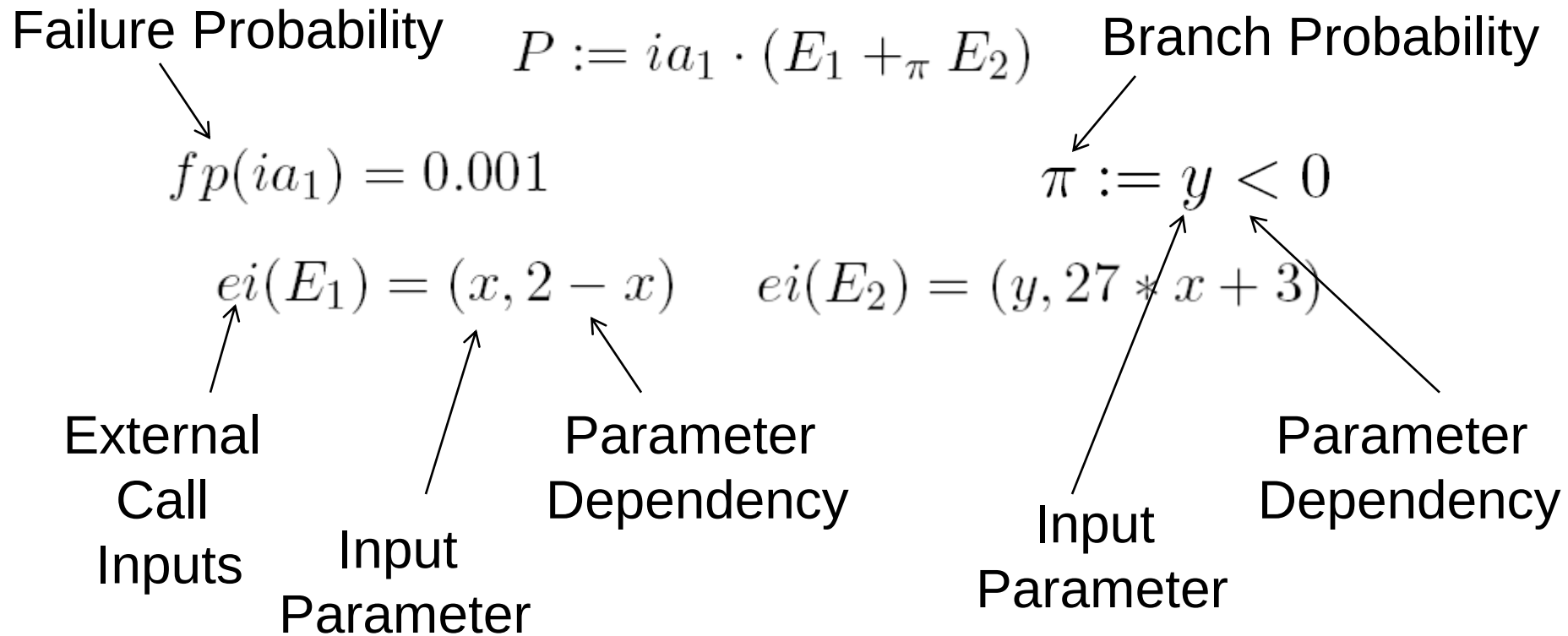
Our Solution



Our Solution: Model



Our Solution: Model



Our Solution: Model

$$P := ia_1 \cdot (E_1 +_{\pi} E_2)$$

$$fp(ia_1) = 0.001$$

$$\pi := y < 0$$

$$ei(E_1) = (x, 2 - x) \quad ei(E_2) = (y, 27 * x + 3)$$

$$P_2 := (ia_1)^v \leftarrow$$

$$fp(ia_1) = 0.0001$$

$$v = x + 2 \leftarrow$$

Loop

$$P_3 := ia_1$$

$$fp(ia_1) = 0.0002$$

Number of Iterations

$$UsageProfile = \{(x, 1), (P(y = -2) = 0.3), (P(y = 4) = 0.7)\}$$

Our Solution: Model

$$P := ia_1 \cdot (E_1 +_{\pi} E_2)$$

$$fp(ia_1) = 0.001$$

$$\pi := 0.3$$

$$ei(E_1) = (x, 1) \quad ei(E_2) = (y, 27 * x + 3)$$

$$P_2 := (ia_1)^v$$

$$fp(ia_1) = 0.0001$$

$$v = 3$$

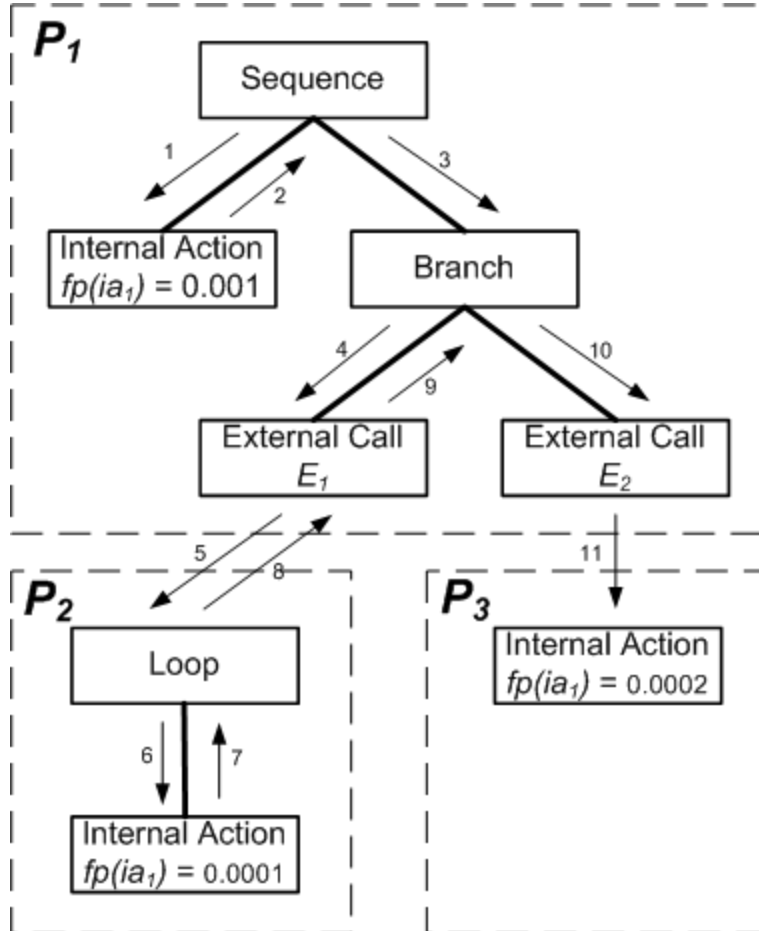
$$P_3 := ia_1$$

$$fp(ia_1) = 0.0002$$

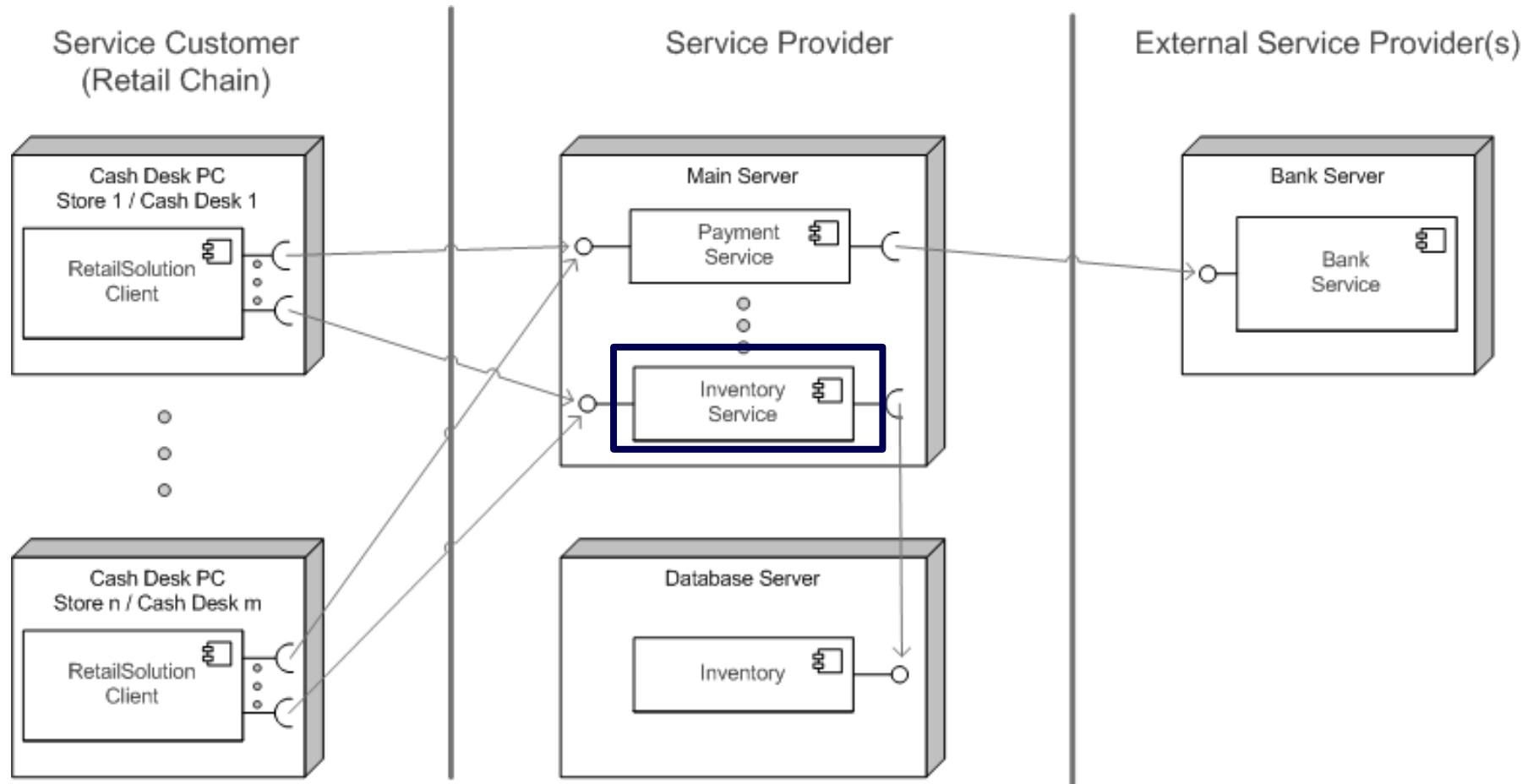
$$UsageProfile = \{(x, 1), (P(y = -2) = 0.3), (P(y = 4) = 0.7)\}$$



Our Solution: Transformation



Case Study: Retail Management System



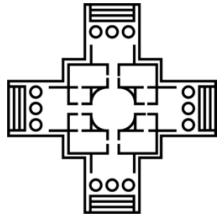
Case Study: Inventory Service - Book Sale

$$P_{bookSale} := E_2(ia_1 + \gamma(E_3 + \pi E_4))^v E_5.$$

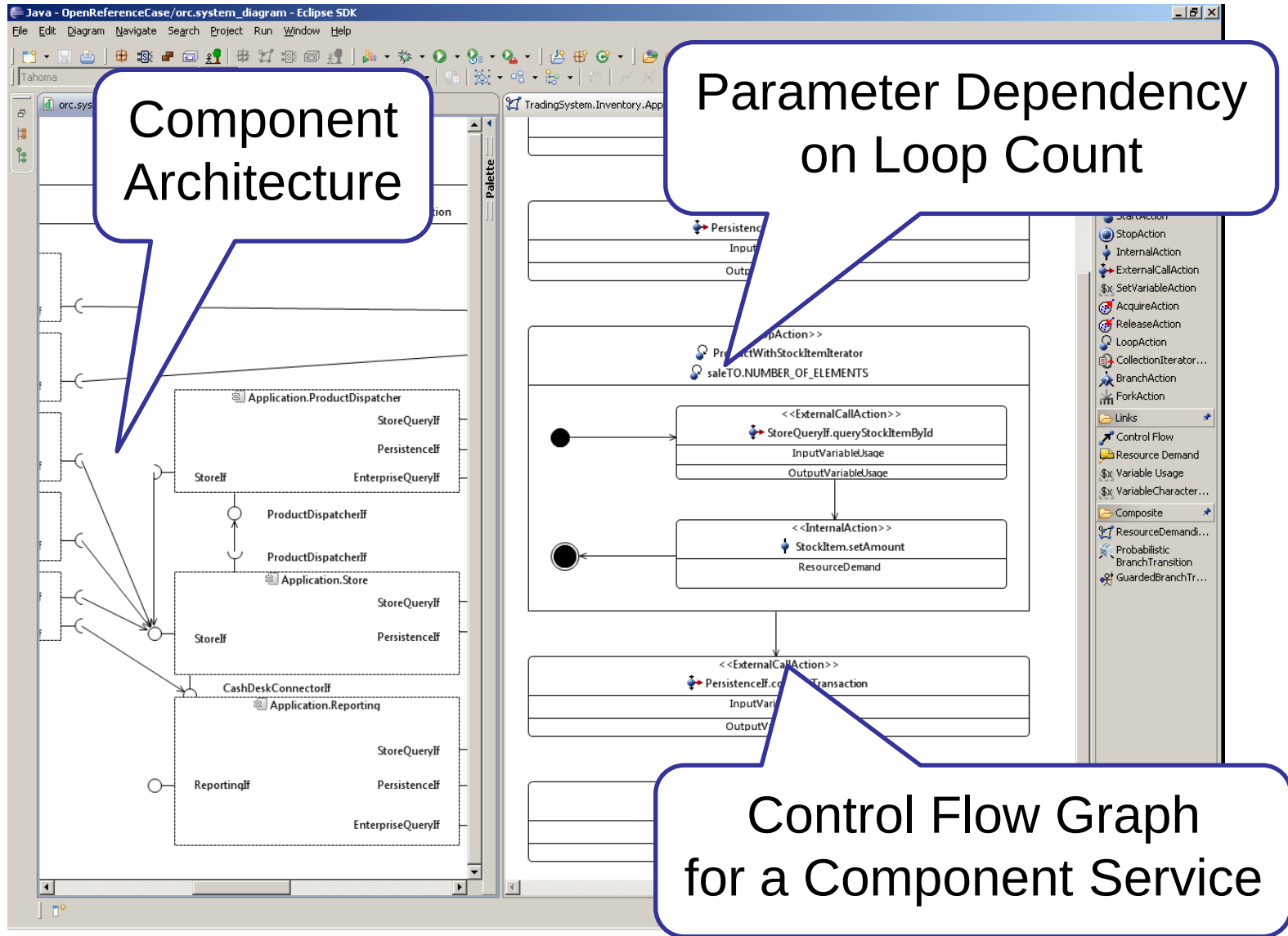
$$v := x, \quad \gamma := (y = 0), \quad \pi := (z = 0)$$

$$P_2 := ia_2, \quad P_3 := ia_3, \quad P_4 := ia_4, \quad P_5 := ia_5$$

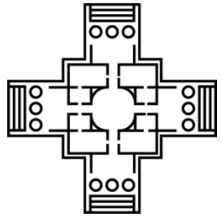
Case Study: Modelling



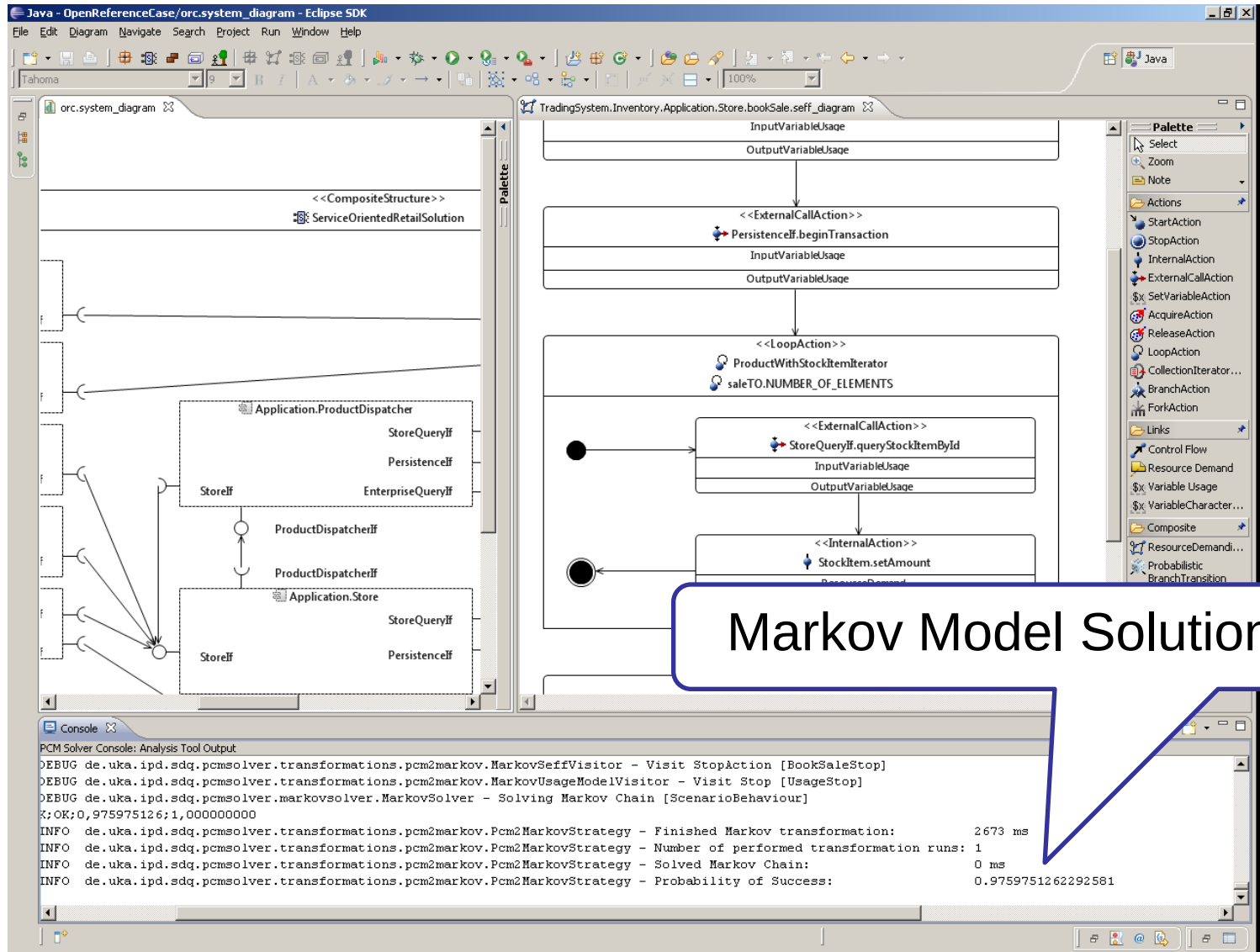
Palladio
Tool



Case Study: Analysis

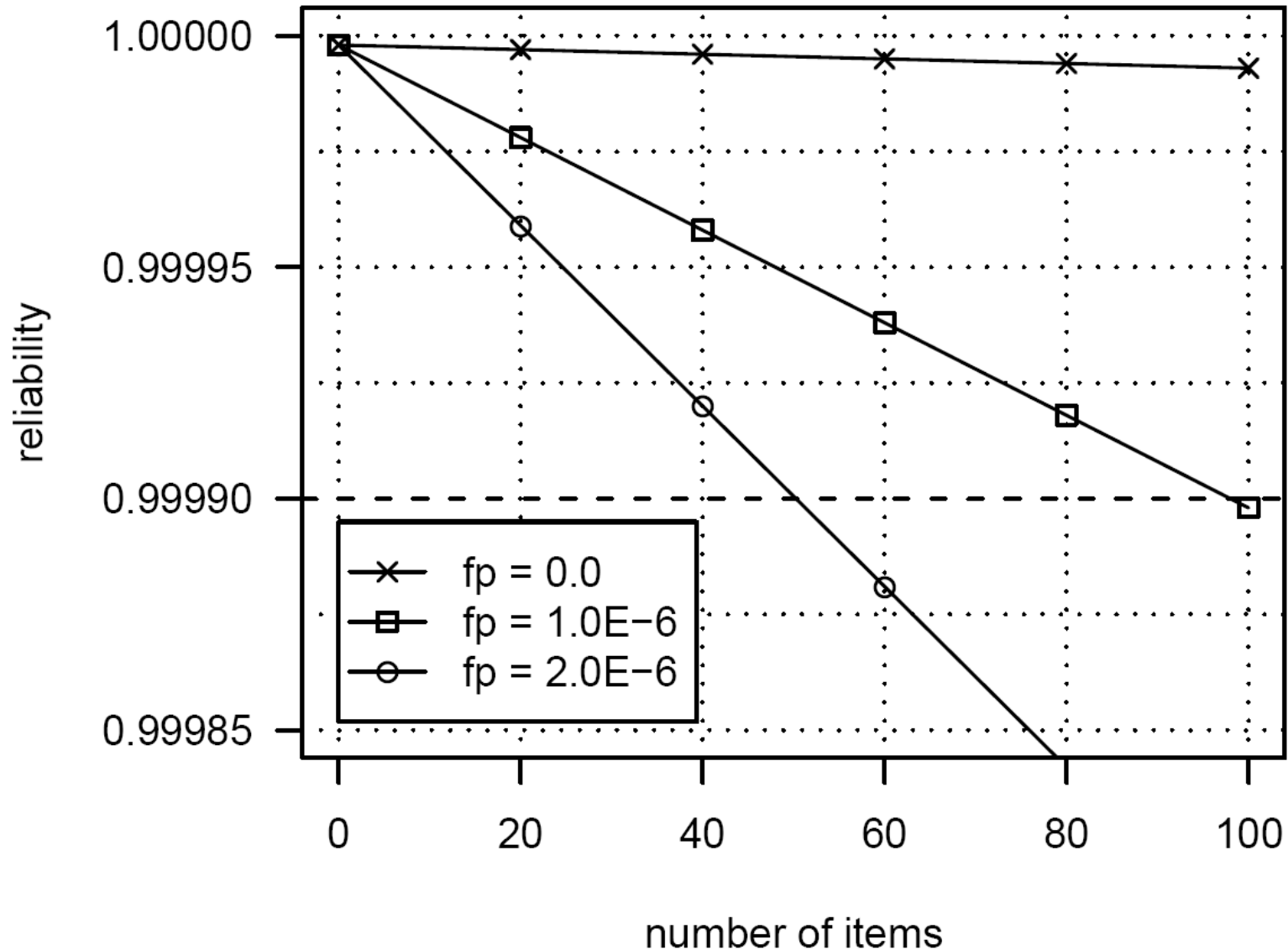


Palladio
Tool

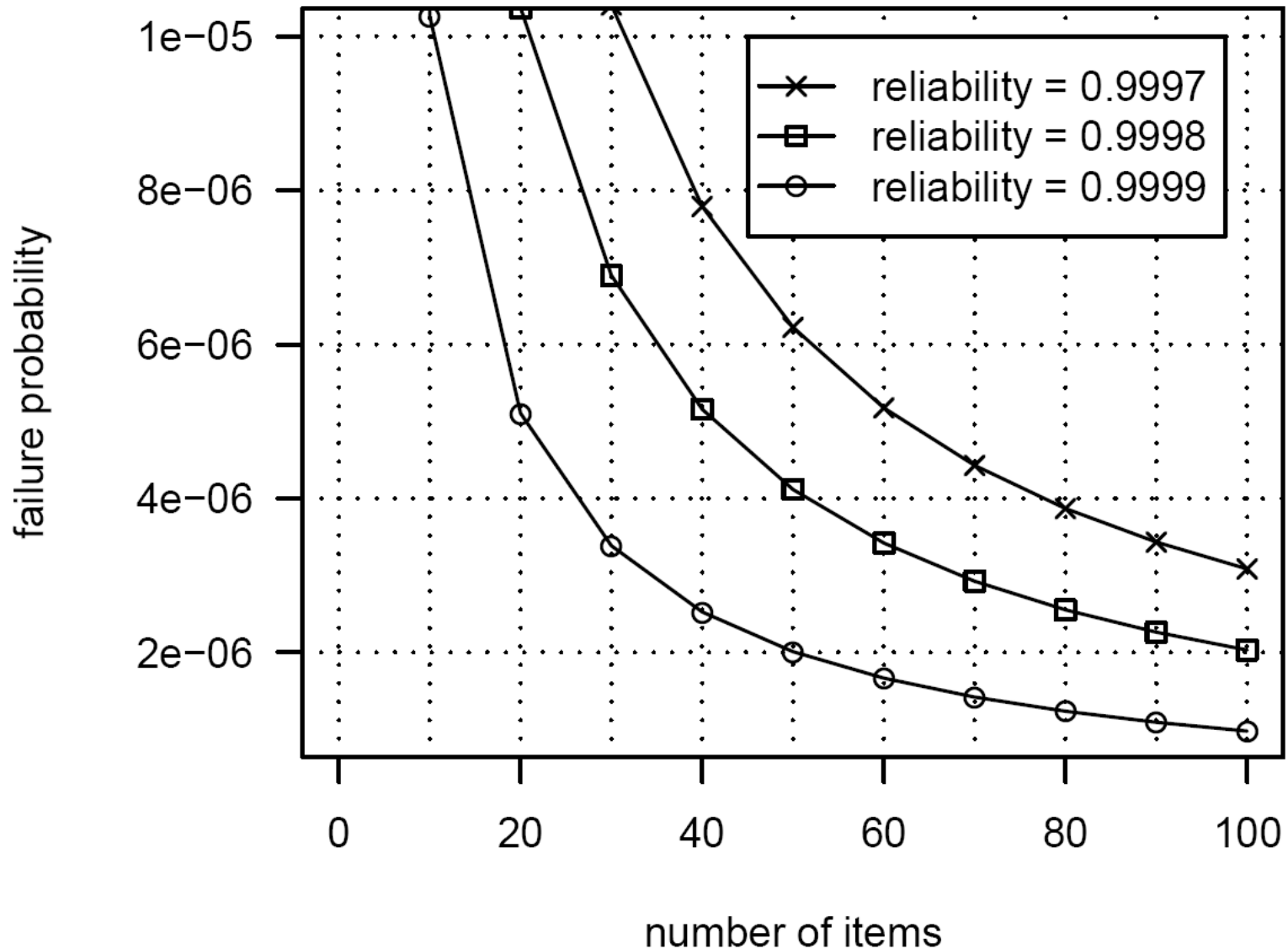


Markov Model Solution

Case Study: Reliability Prediction Results



Case Study: Reliability Prediction Results



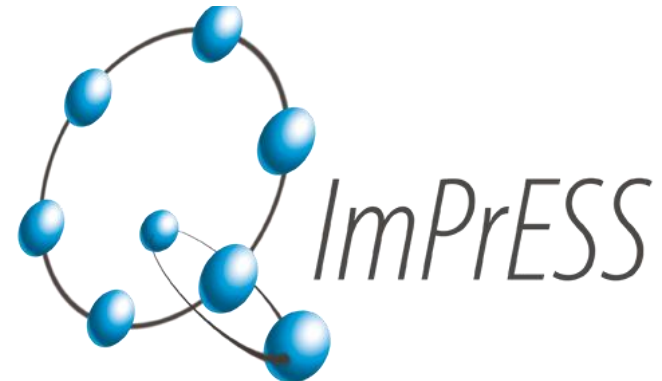
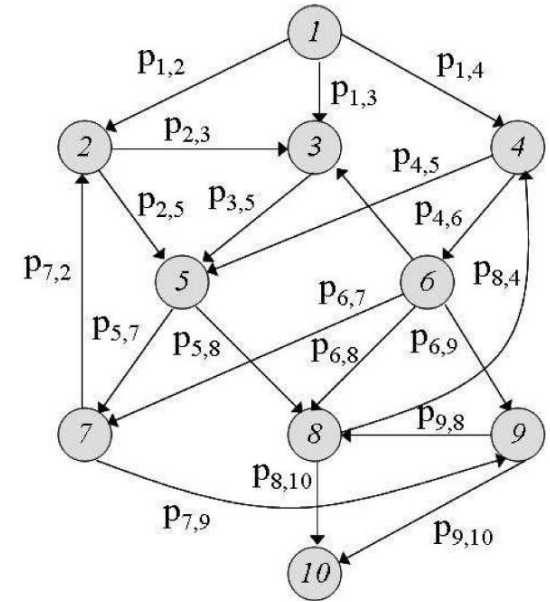
Assumptions & Limitations

- ◆ Obtaining Failure Probabilities
- ◆ Getting Parameter Dependencies
- ◆ No Hardware Failures
- ◆ No Concurrency
- ◆ Stochastically Independent Failure Probabilities
- ◆ Constant Failure Probabilities
- ◆ No Repair



Conclusion

- ◆ Parameter Dependencies for Component Reliability Specifications
 - ◆ Modelling by component developer and software architect
 - ◆ Easy alternation of system-level usage profile
 - ◆ Reusable reliability specifications



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