DFG SPP 1183 Organic Computing

Formal Modeling, Safety Analysis, and Verification of Organic Computing Applications

SAVE ORCA

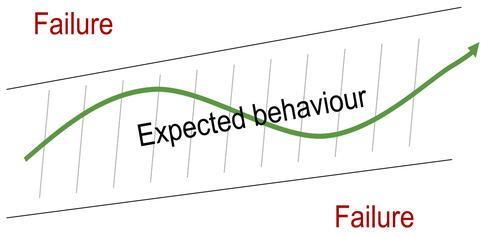
Goal: ➢ Formal framework for ensuring dependability of Organic Computing applications

Scope: ➢ Highly dynamic systems with self-x properties

Challenges: ➢ Formal definitions of self-x
➢ Behavioural guarantees vs. freedom of choice
➢ Smooth integration into software engineering process

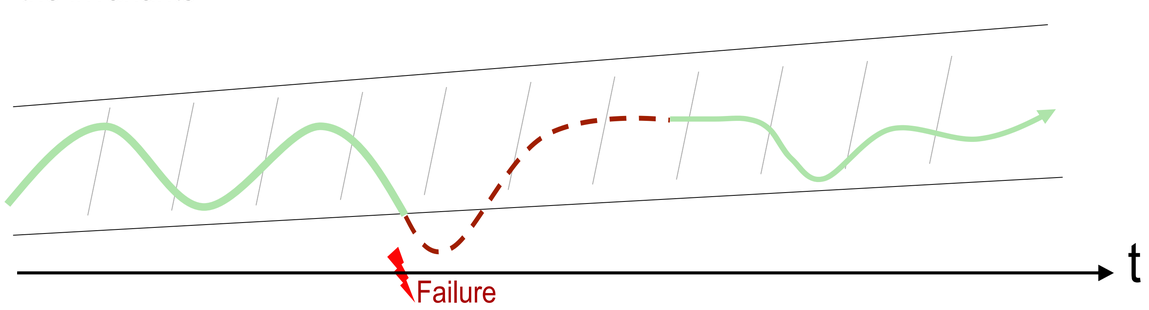
Restore Invariant Approach

1. Behavioural corridors are described by a set of invariants



2. OC system monitors invariants

3. Temporary violation of invariants triggers self-x phase for restoring the invariants



4. OC system preserves invariants as long as possible

5. Sometimes necessary:

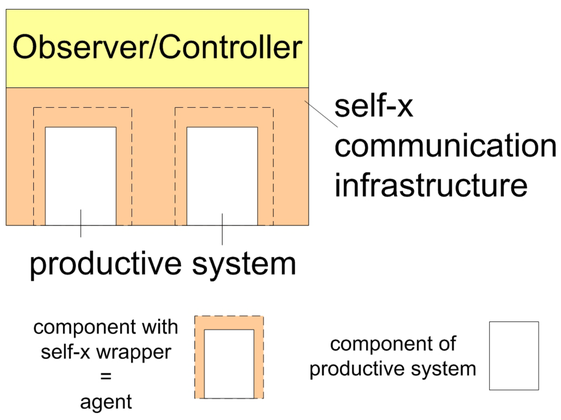
Restoration of all invariants is no longer possible.

Weakening of the invariants (e.g. priority selection)

as restoration of an invariant (Restore Invariant Approach)

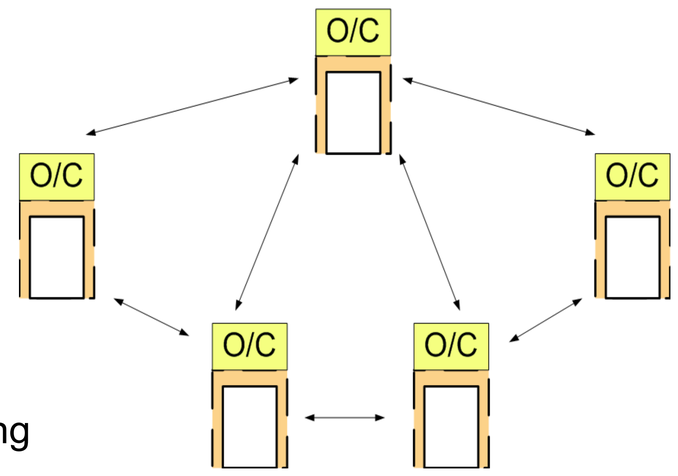
Centralized Approach:
central Observer/Controller calculates new configuration according to the invariants

→ constraint solving
→ planning as modelchecking
→ job shop scheduling



Decentralized Approach:
multiple Observer/Controllers calculating new valid configuration

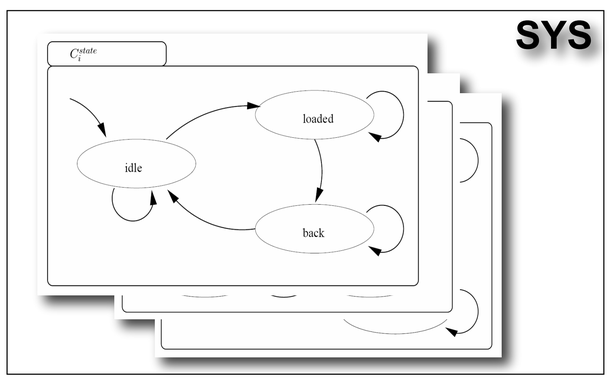
→ leader election
→ global state propagation
→ distributed planning
→ distributed task scheduling



Invariants and formal system model enable formal analysis and verification:

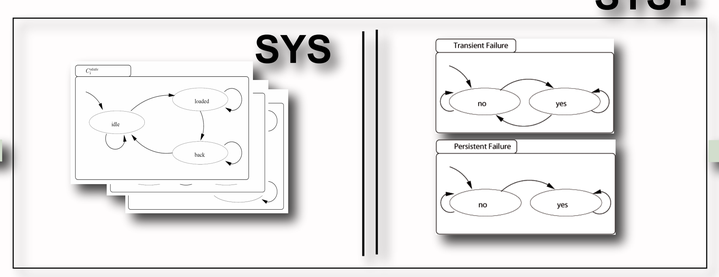
Functional Correctness

→ Interactive verification
→ Model checking



Qualitative Analysis

→ Fault Tree Analysis



→ Adaptive DCCA (ADCCA)

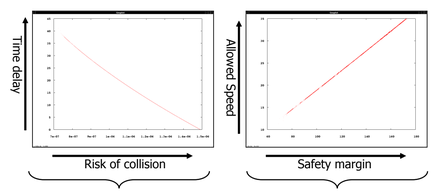
$SYS^{+} \models \mathbf{E}(\neg(\Gamma \setminus \Delta)\ \mathbf{until}\ \mathbf{EG}\ (\neg(\Gamma \setminus \Delta) \wedge H))$

Quantitative Analysis

→ Quantitative ADCCA

$$P \leq \Sigma_{CS \in CSS} \Pi_{fm \in CS} P(fm)$$

→ Multicriteria optimization



→ Probabilistic model checking

Benefits: ➢ **Generic formal framework for specification and development of OC systems**
➢ **Measuring the degree of self-x**
➢ **Behavioural guarantees despite of self-x**

Prof. Dr. Wolfgang Reif
Dr. Frank Ortmeier
Matthias Güdemann
Florian Nafz
Hella Seebach

Department of Software Engineering and Programming Languages
Faculty of Applied Computer Sciences
University of Augsburg

www.informatik.uni-augsburg.de/swt
reif@informatik.uni-augsburg.de

University of Augsburg