Using Dynamic Workflows for Coordinating Self-adaptation of Software Systems

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Agenda

- Introduction
- Background
- Workflow generation
  - Applied to architectural reconfiguration
- Case study
- Conclusions

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Introduction

Motivation

- Self-adaptive systems should be able to define adaptation plans at run-time
  - Deal with variability
  - E.g., Web-based systems

Our approach

- Dynamic workflows for managing self-adaptation
  - Workflows for representing adaptation plans
  - Dynamic workflow generation

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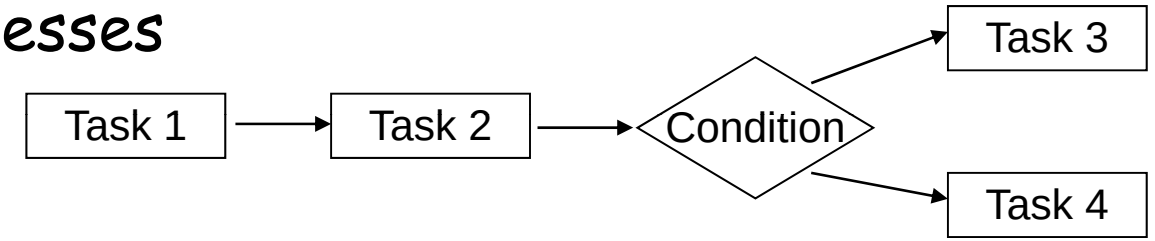
Background

Workflow management technology

- Coordination of the flow of work and information of business processes
- Workflows



- Significant maturity level
  - Heterogeneous environments/technologies, modelling languages, etc ...
  - Applied in several domains
    - Including self-adaptive systems [Valetto] [Shrivastava]

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Dynamic Workflow

- Modification of workflows
  - Restructuring of workflows
  - Flexible composition
  - Flexible deployment

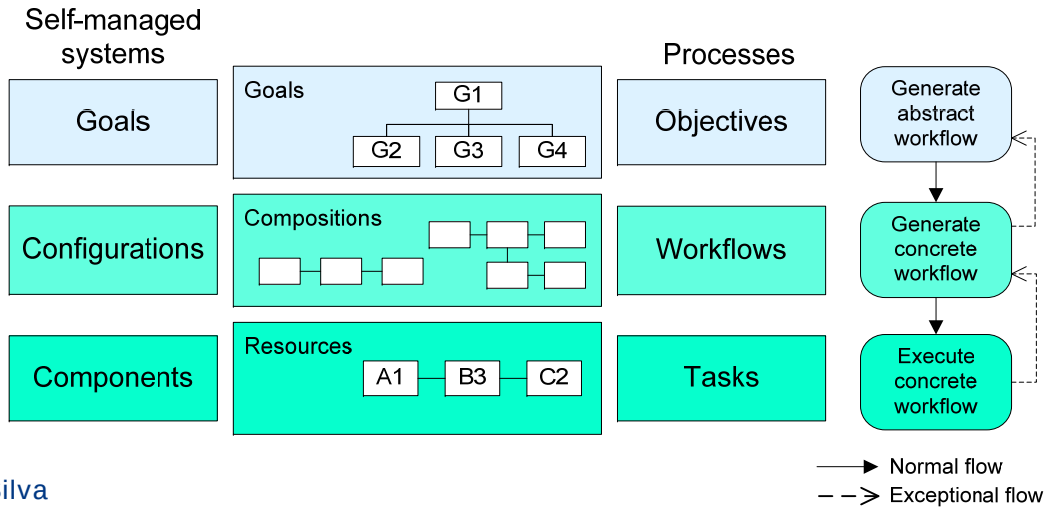
Workflow generation

- Composition process
  - Tasks
  - Interconnection of tasks
  - For achieving an objective
    - From a particular state

Workflow generation model

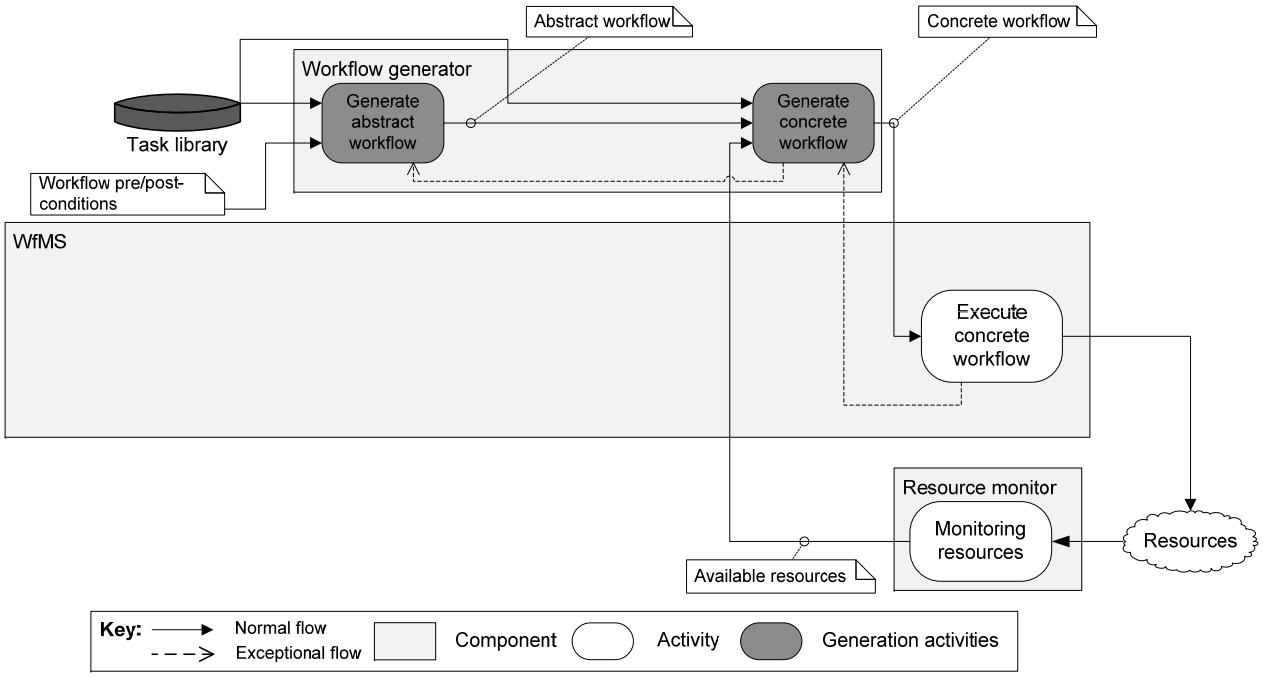
Basis for workflow generation model

- 3 layers reference model for self-managed systems
  - Feedback between the layers
- Workflow techniques from different domains
  - Grid computing/Web service composition/Pervasive systems
    - Abstract/concrete workflows



Workflow generation model

- Generate abstract workflows
  - Pre/post-conditions of task templates/workflow
- Generate concrete workflows
  - Populate abstract workflows with actual resources



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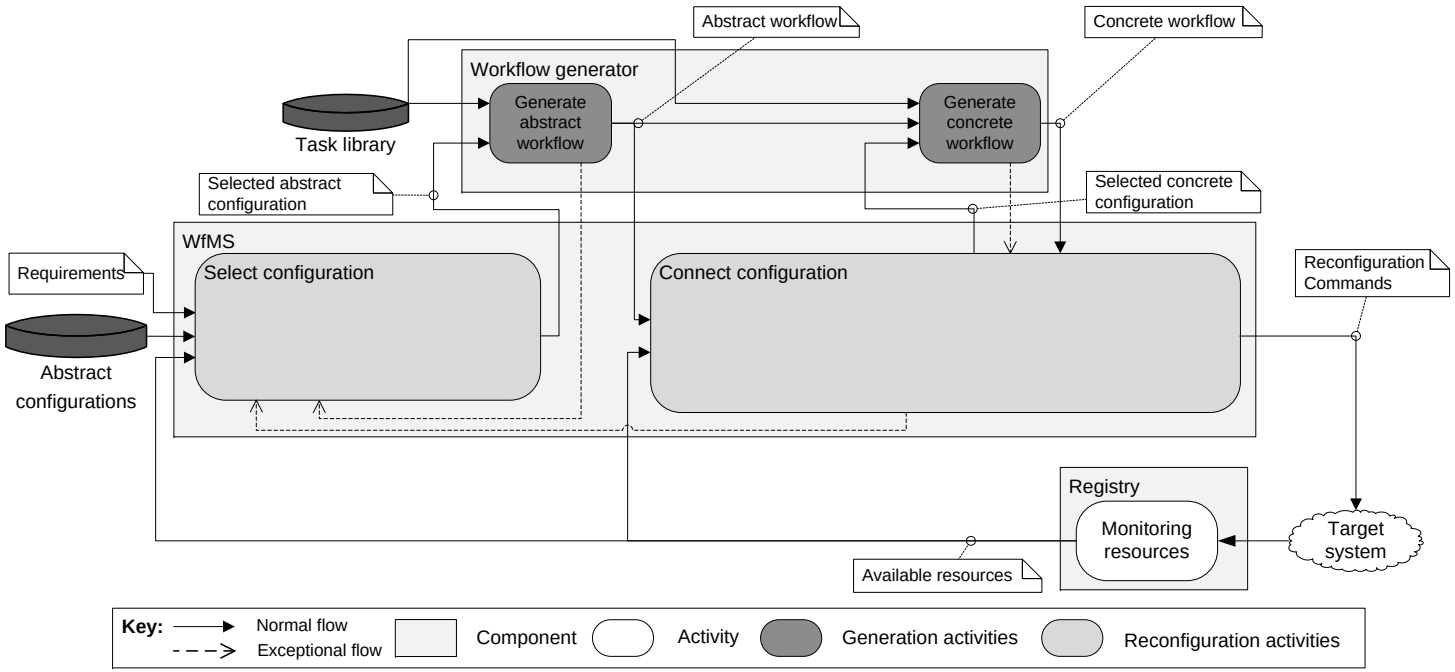
Applied to architectural reconfiguration

Architectural reconfiguration based on dynamic workflows

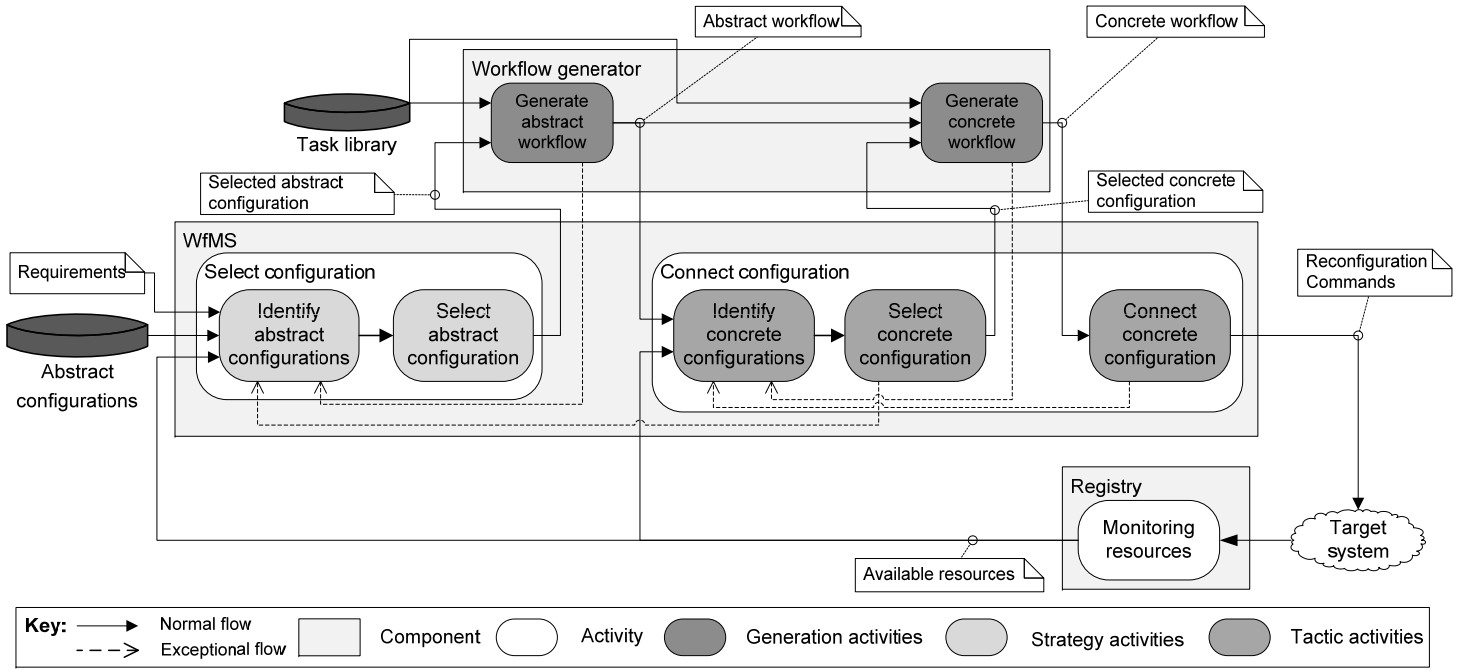
- Strategy
  - Abstract configuration
- Tactics
  - Concrete configuration



Applied to architectural reconfiguration

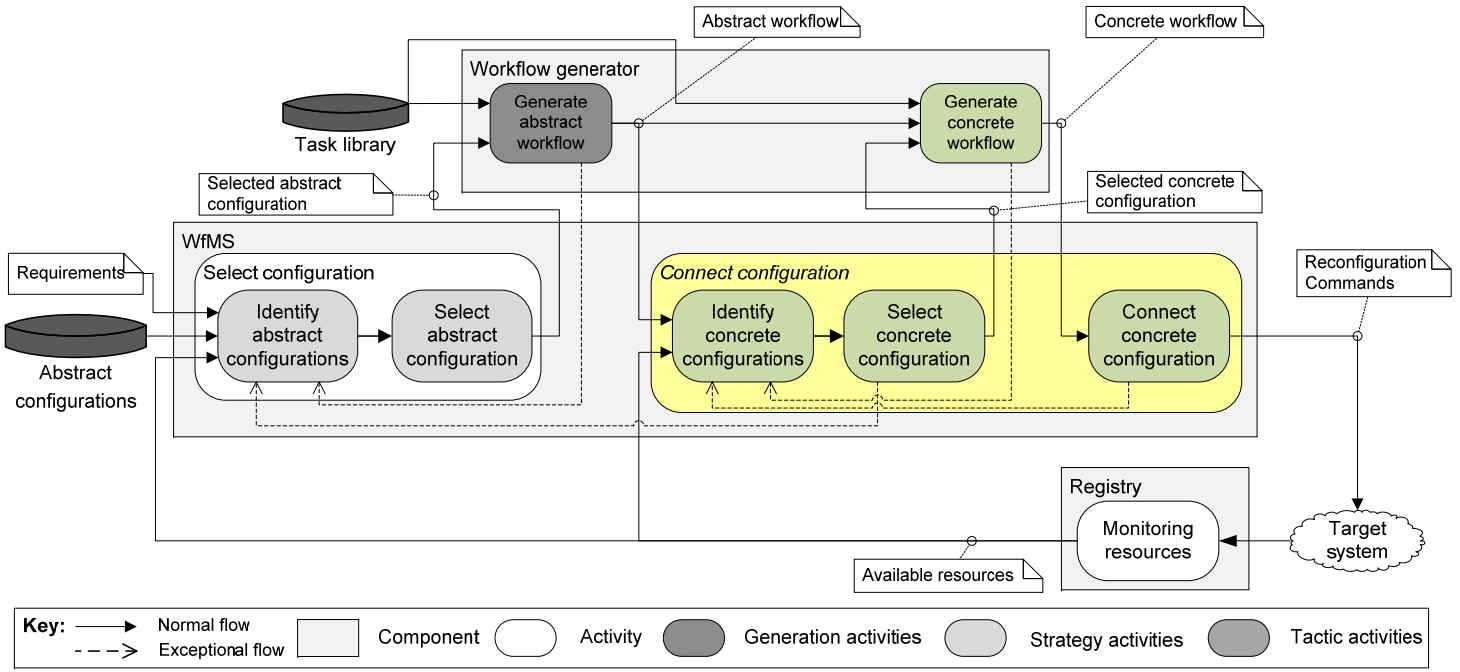
Architectural reconfiguration based on dynamic workflows

- Detailed workflow for reconfiguration
  - Control generation process

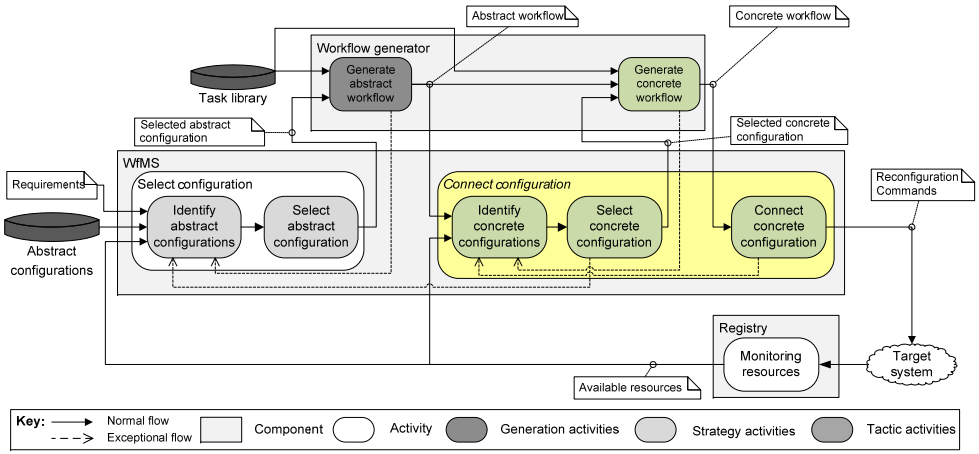


Example of reconfiguration workflow

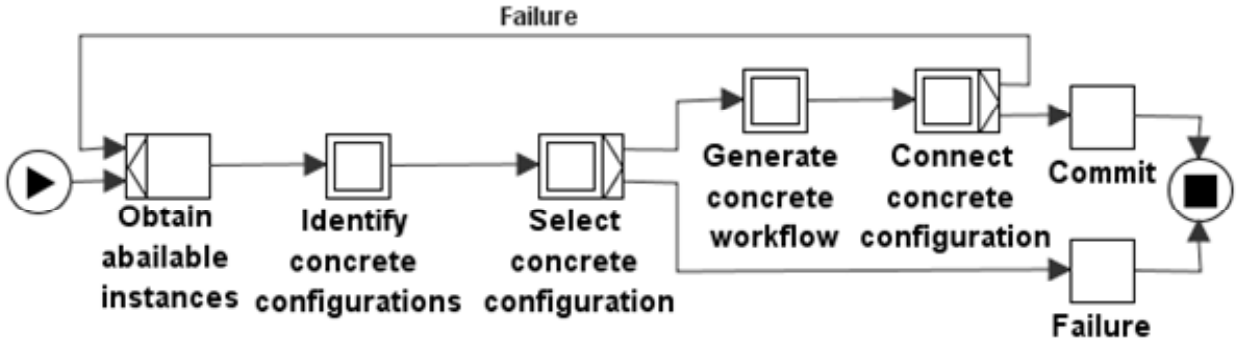
- Tactics level *(Connect configuration)*
  - Concrete configuration



Example of reconfiguration workflow

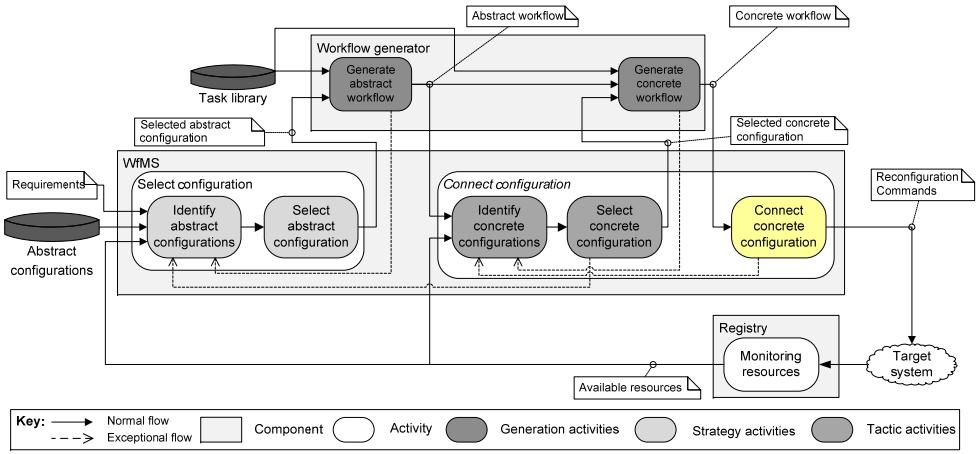


- *Connect configuration*

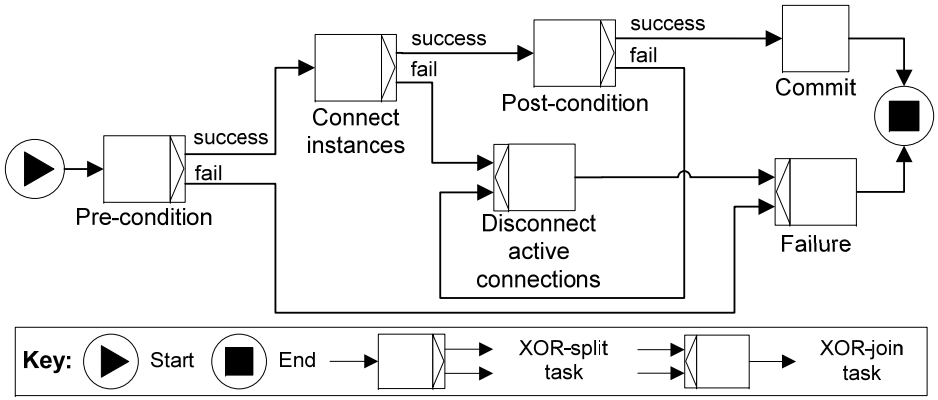


Applied to architectural reconfiguration

Example of reconfiguration workflow



- *Connect concrete configuration (stateless)*



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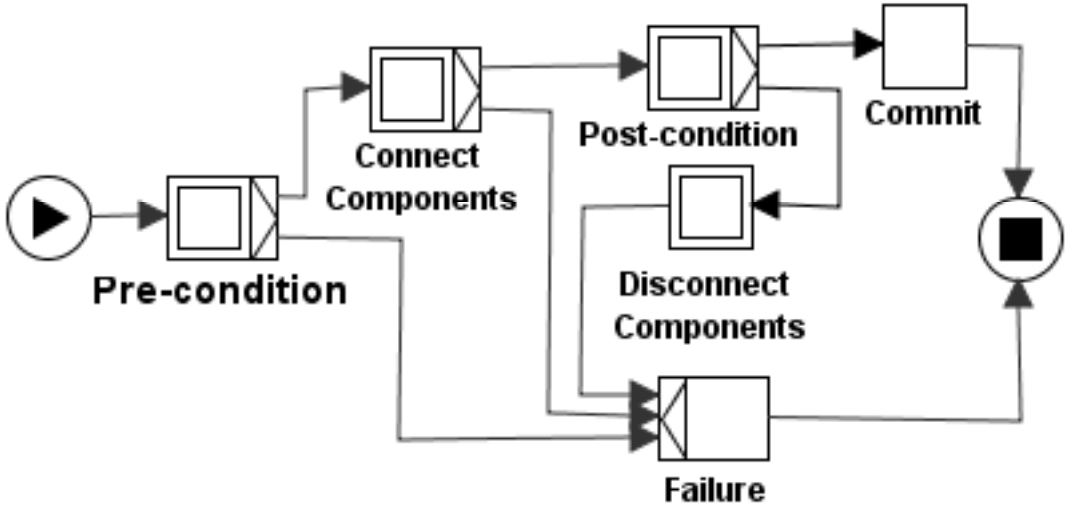
Task template

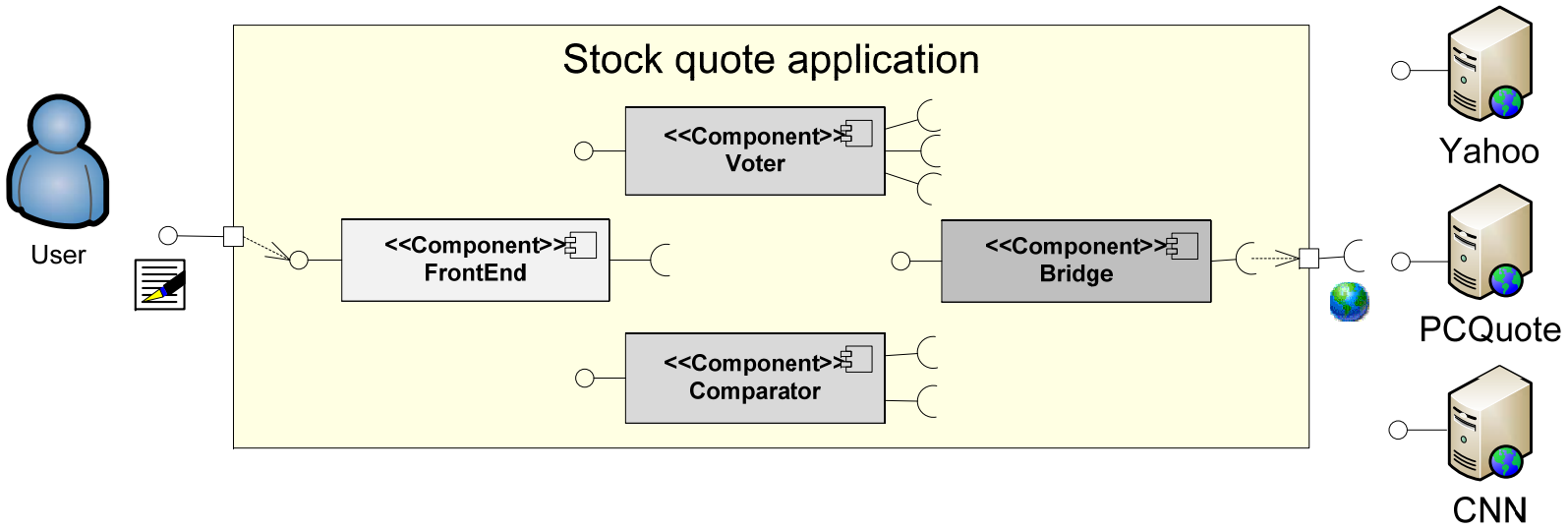
- Instantiation of a structure based on atomic actions
  - For dealing with faults
- Applied to workflows that are generated
- Sub-workflow
  - E.g., *Connect*(Component1, Component2)



Case study

Web-based stock quotes application

- Requirements: dependable stock quotes
- Fault-tolerance techniques: dual and triple module redundancy
- Architectural reconfiguration in the presence of faults



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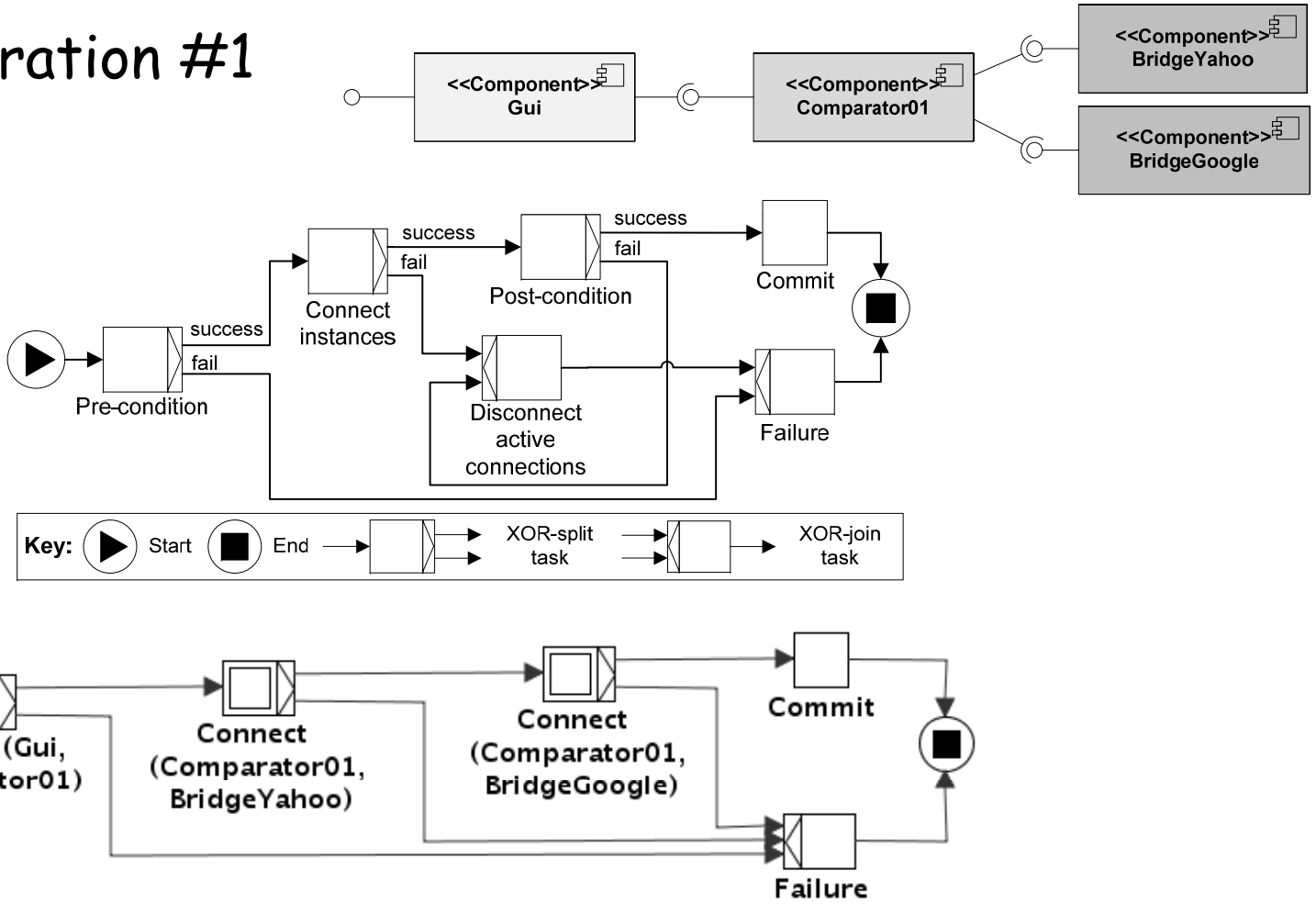
Case study

Example of generated workflow (*Connect instances*)

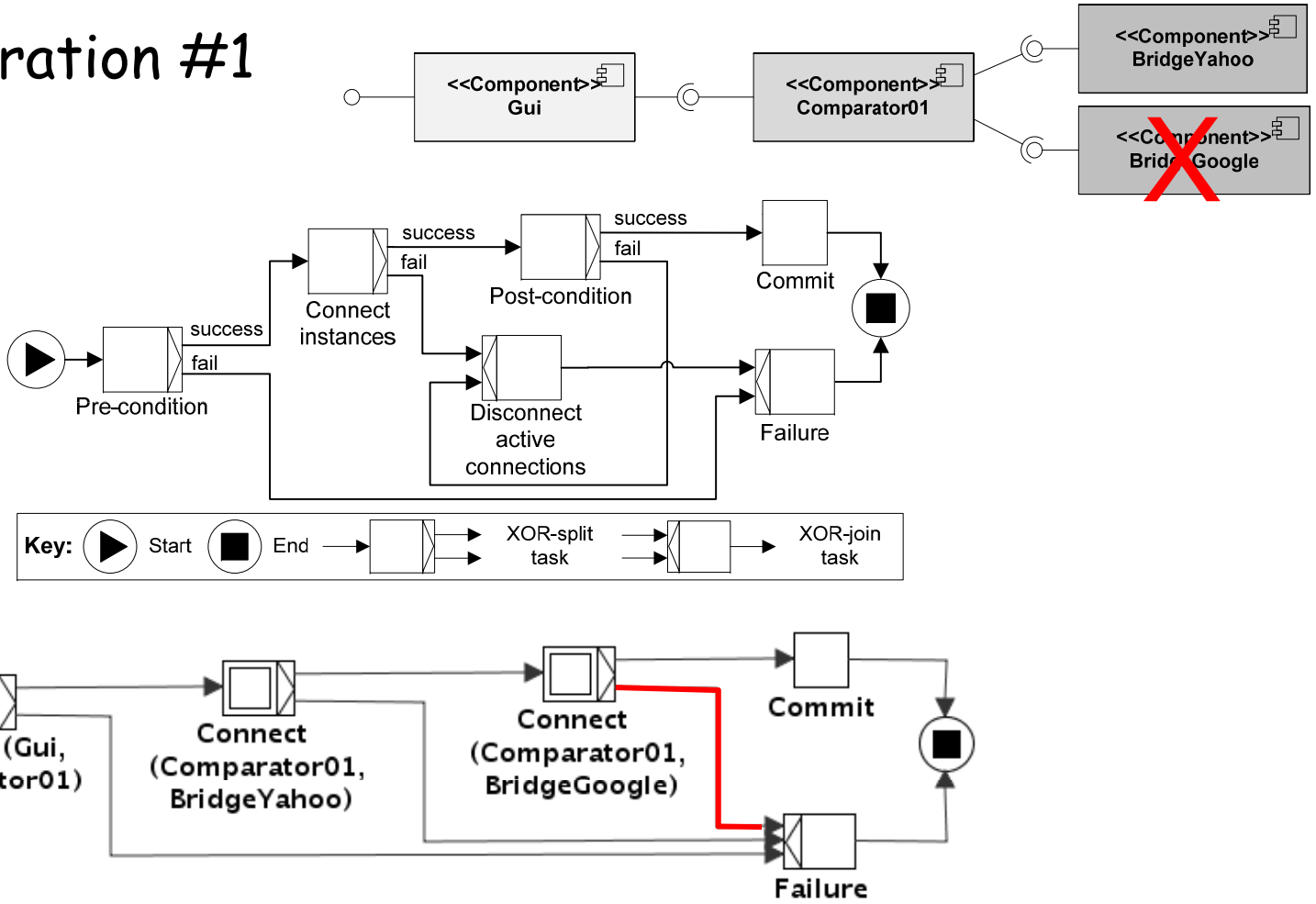
- Configuration #1



Case study

Example of generated workflow (*Connect instances*)

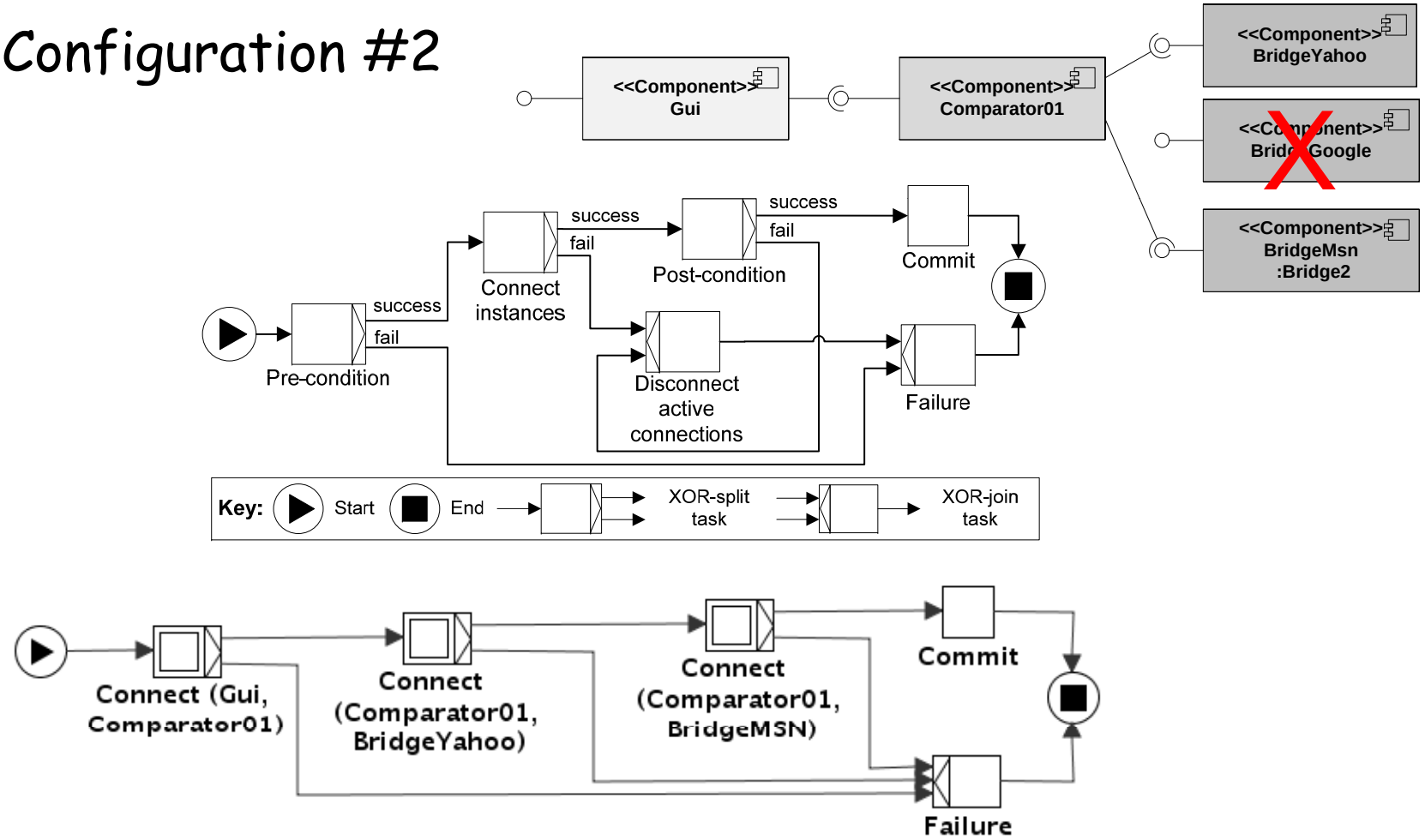
- Configuration #1



Case study

Example of generated workflow (*Connect instances*)

- Configuration #2



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Case study

Prototype

- Web services, xADL 2.0, Yawl workflow management system

Some experiments

- Fault injection on components
  - During application execution
  - During reconfiguration
- Generation of concrete workflows
  - Pre-defined abstract workflows
- Generation of abstract workflows

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Conclusion

We are using workflows for representing adaptation plans

- Dynamic workflow generation (e.g., depending on the resources availability)
  - Based on the pre- and post-conditions of the plan and a library of tasks

Future work

- Refine the generation model/implementation
  - Workflow meta-models
  - Selection of workflows
  - Exception handling and exceptional behaviour of task templates
  - Pre/post-condition representation
- Experiments with more complex scenarios
- Component-based integration testing