dipartimentoinformatica
Università degli Studi dell'Aquila

Software Architecture-based Regression Testing

Henry Muccini
Software Engineering and Architecture Group
Università degli Studi dell'Aquila
I-67100 L'Aquila, Italy
muccini@di.univaq.it

Marcio Dias
Department of Computer Science and
e-Science Research Institute,
University of Durham, UK

Debra J. Richardson
Donald Bren School of Information
and Computer Sciences,
University of California Irvine, USA

My main research areas: Analysis

» **SEA Group**

- Software Engineering and Architecture Group

» **Software Architecture Analysis:**

- Model-Checking SAs (the CHARMY framework)
- SA-based Testing
- SA-based Regression Testing (the SARTE project)
- Model-checking driven Testing (the ModTest approach)

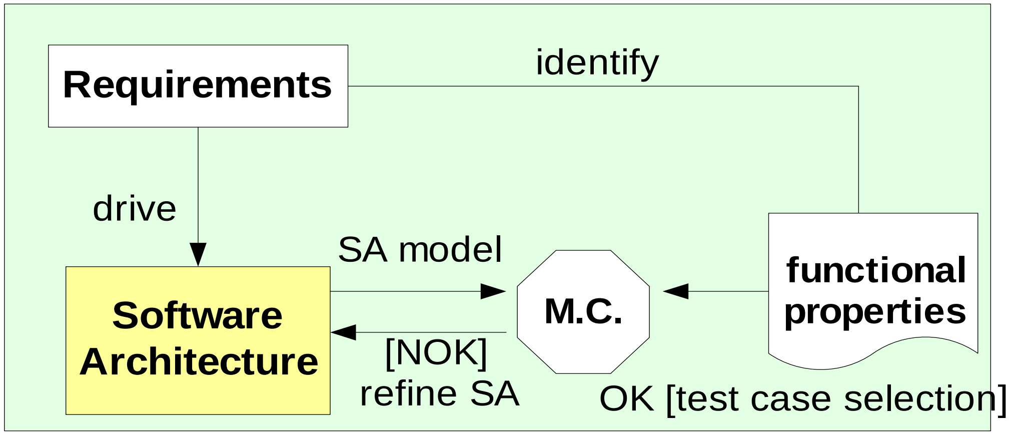
» **Product Line:**

- Modeling Product Line Architecture
- Testing and Model Checking of Product Line

Our Experience on SA-based analysis

SA conformance to requirements through MC

Model Checking

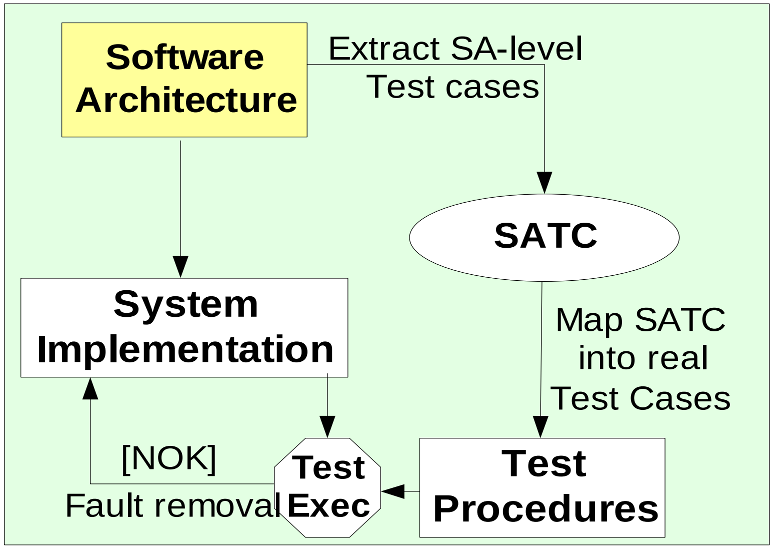


validate the SA model conformance
with respect to selected functional properties

Charmy Project

[www.di.univaq.it/charmy]

Testing



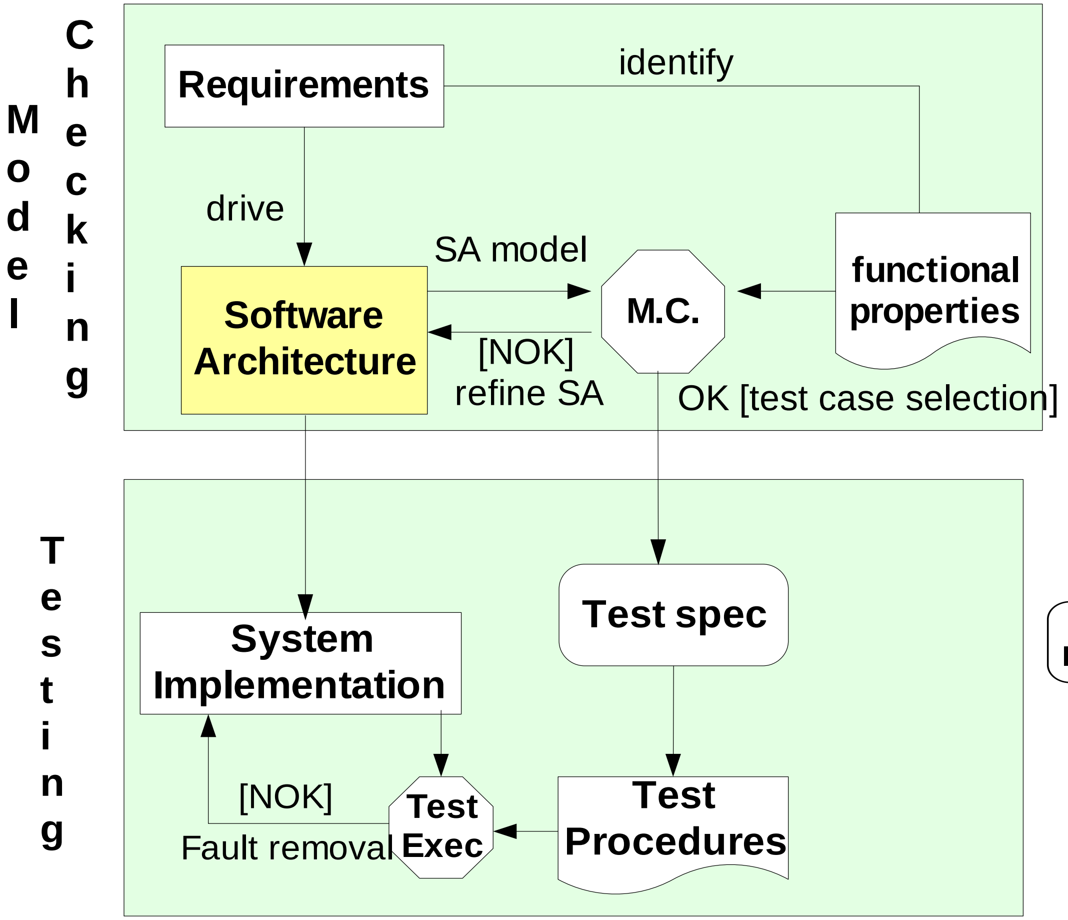
provide confidence on the implementation
fulfillment to its architectural spec

SA-based Testing

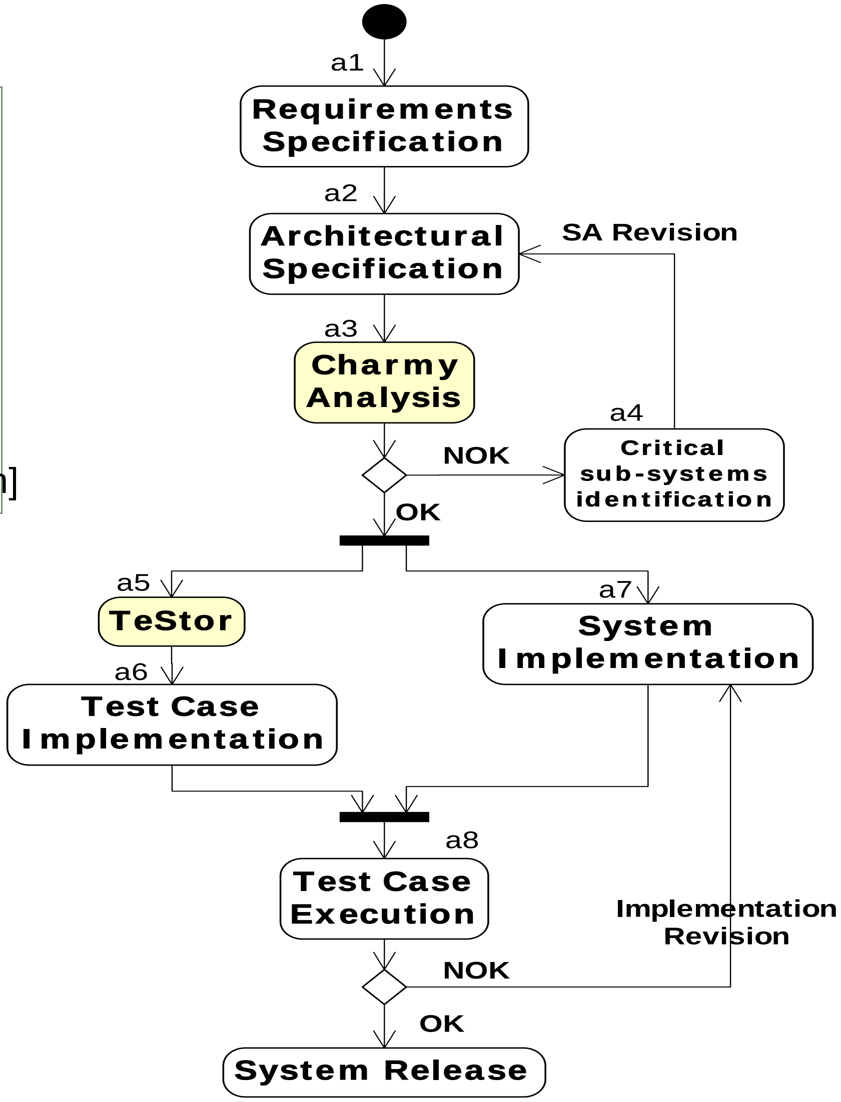
Implementation conformance to SA through Testing

ModTest: Model-Checking driven Testing

SA conformance to requirements through MC



Implementation conformance to SA through Testing



Our Recent experience in SA-based Analysis

» Industrial Experience

- PSTDA Italy [ICSE00,ICSE01]
- Telcordia
- Marconi [FME 03]
- Siemens [ITM 04]

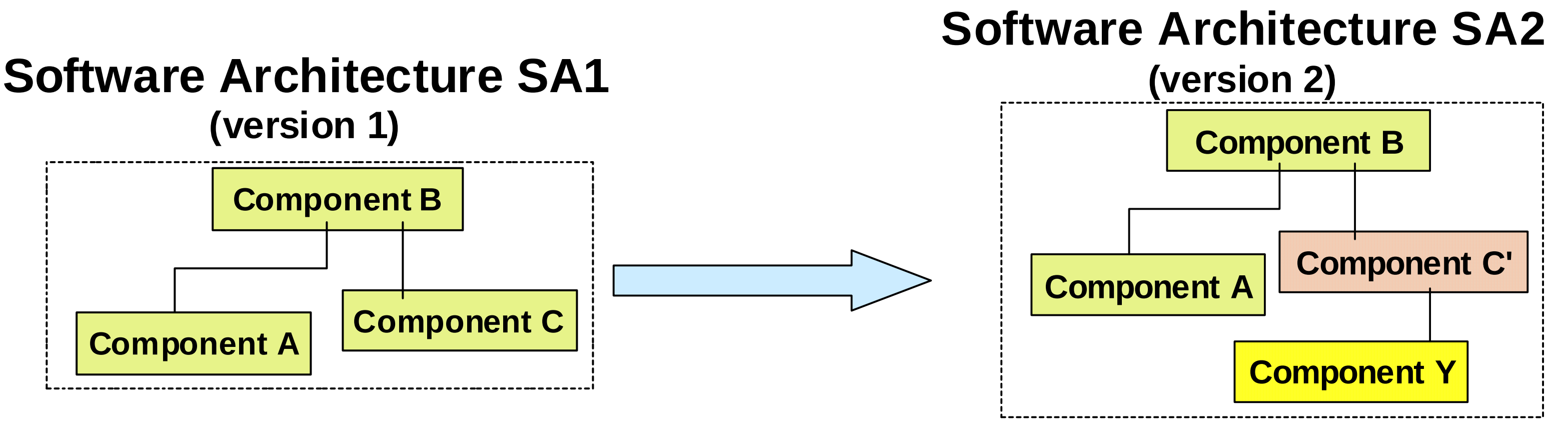
» Academic Experience

- [FASE 04][IEEE TSE04]
- [CBSE 05][COMPSAC05]

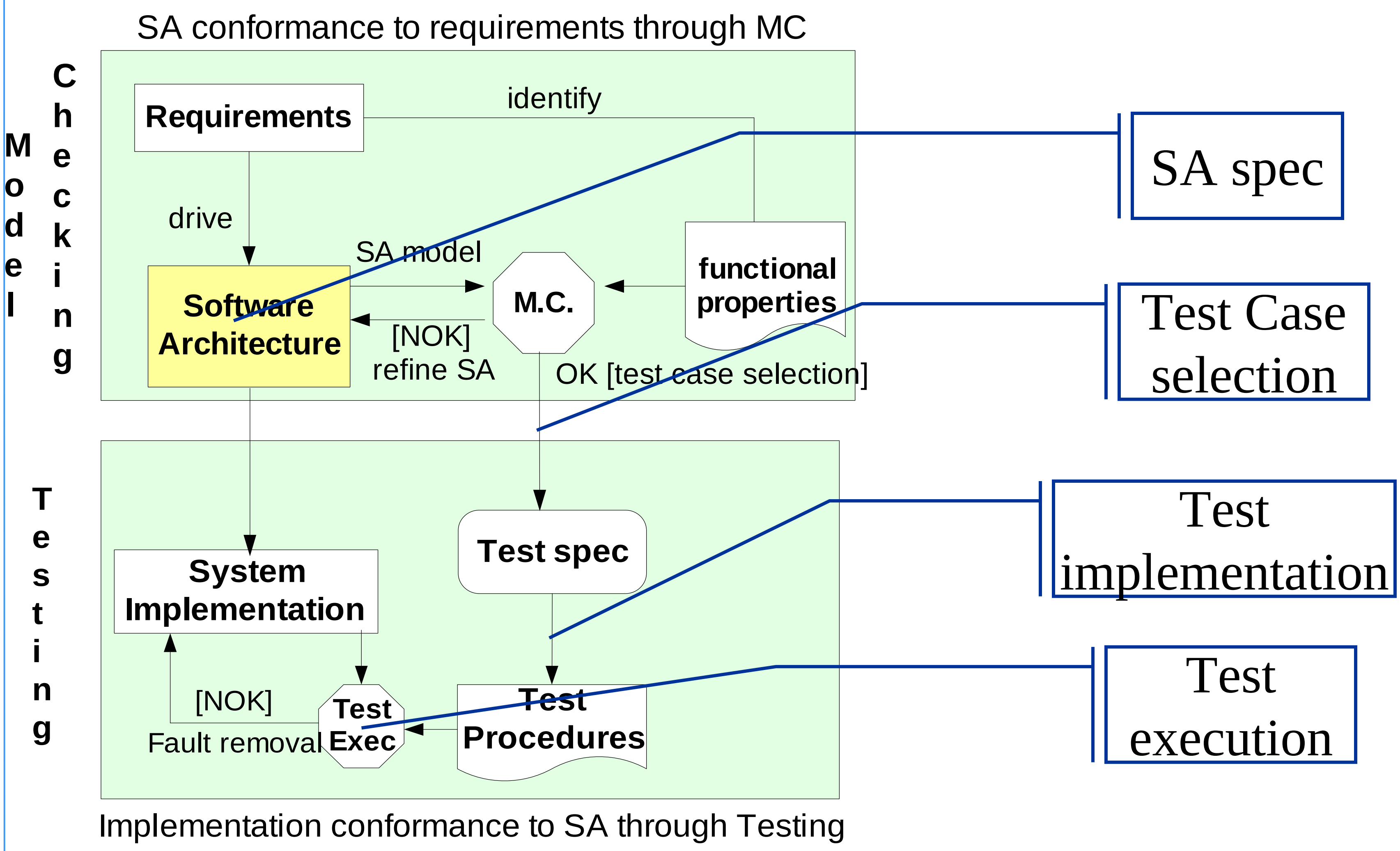
Considerations

» What happens if the (architectural) model changes?

- Usually, we need to remake analysis from scratch



How changes affect ModTest



SA conformance to requirements through MC

Model Checking

Requirements

identify

drive

SA model

Software Architecture

M.C.

functional properties

[NOK] refine SA

OK [test case selection]

Testing

System Implementation

Test spec

[NOK]

Fault removal

Test Exec

Test Procedures

Implementation conformance to SA through Testing

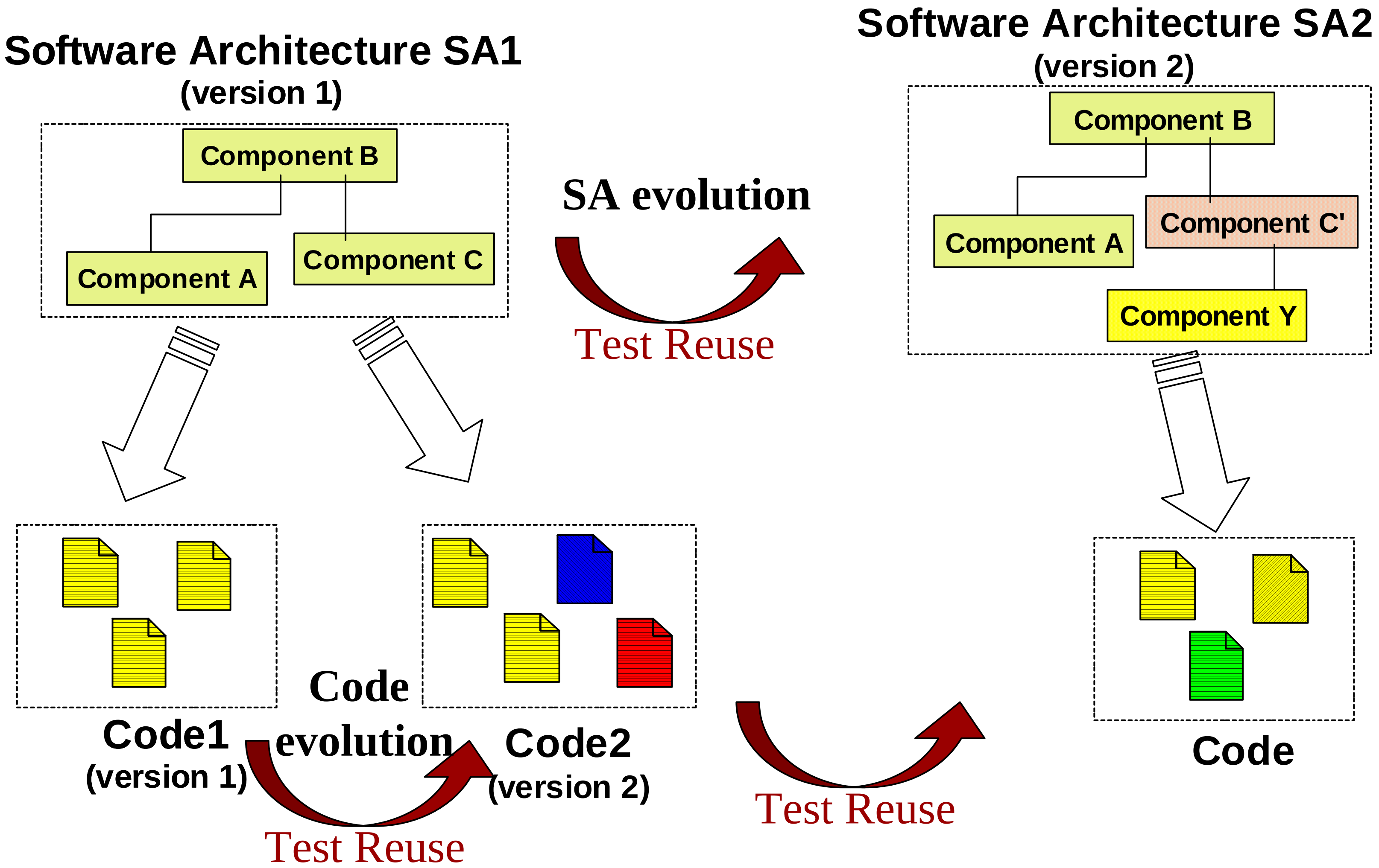
SA spec

Test Case selection

Test implementation

Test execution

SA-based Regression Testing [WADS05] [COMPSAC05]



SEA Group

© 2005 by H. Muccini, WADS 2005

Traditional Regression Testing

- Test modified software to provide a certain confidence that no new errors are introduced into previously tested code.

- Two key phases:

  i) *testing* the program P with respect to a specified test suite T, and

  ii) when a new version P' is released, *regression testing* of the modified version P' versus a test suite T'

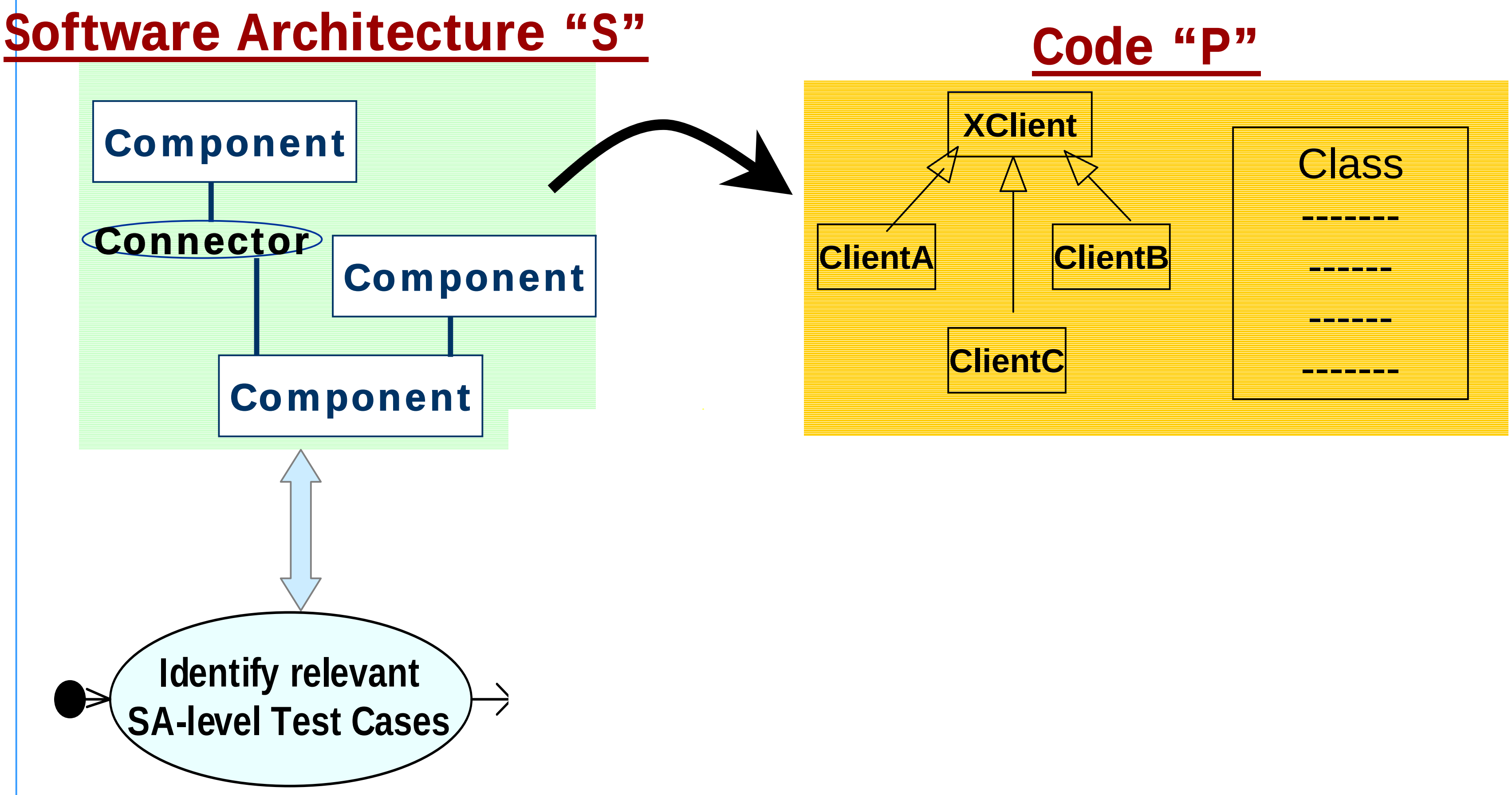
- Selective RT:

  - Goal: selecting T' as a “relevant” subset of T

    > t1 in T is included in T ' if there is the potential that it could produce different results on P' than it did on P

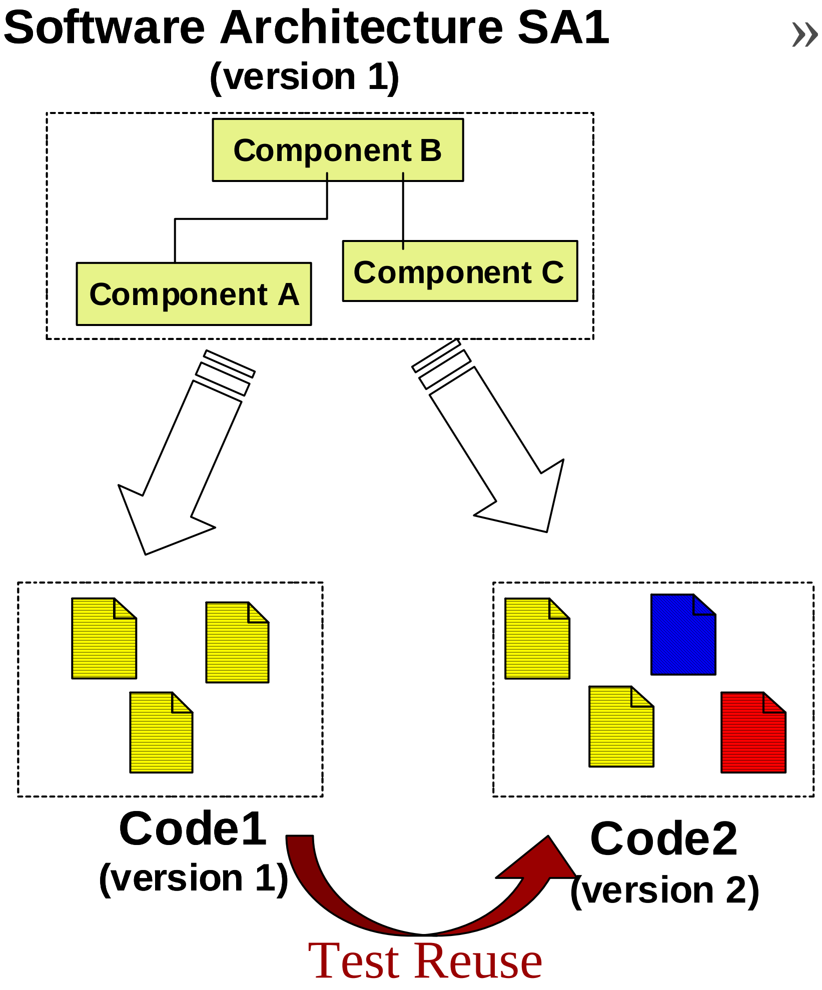
First phase: SA-based Code Testing

» The code conformance to the SA has been already tested



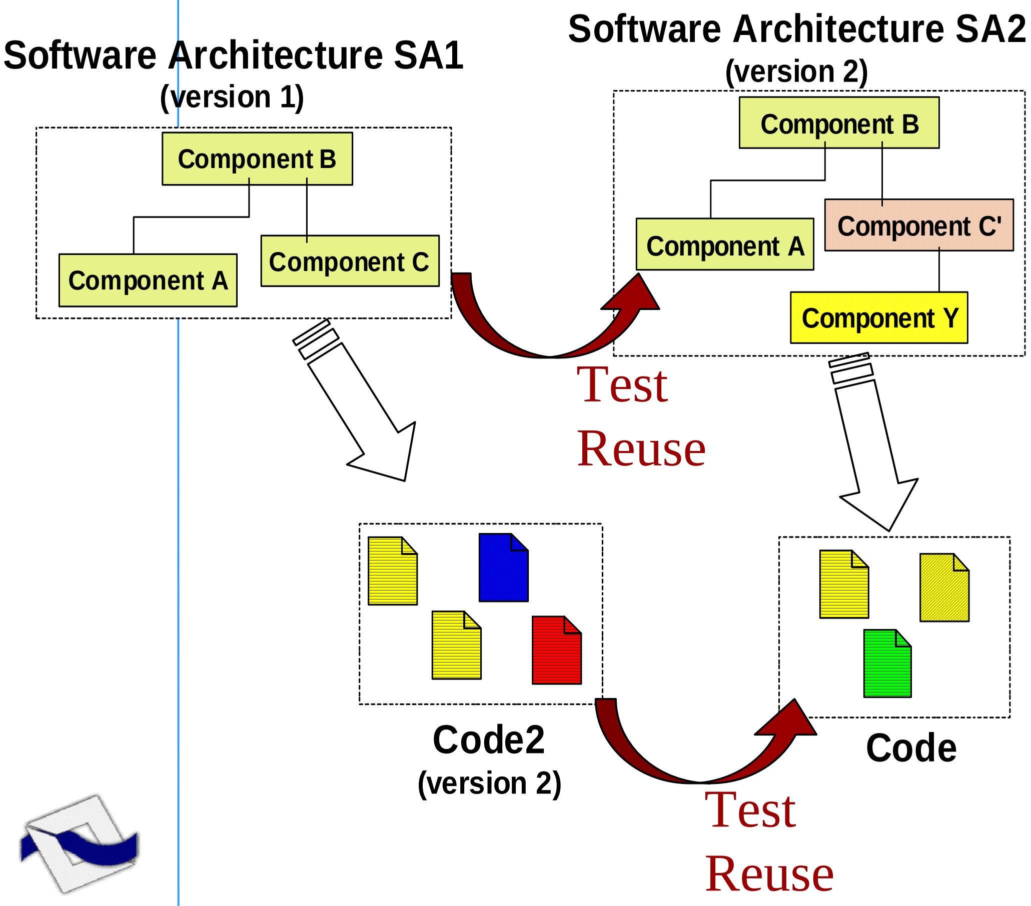
Steps 0 - 2

SArTe - Goal 1 (code evolution)



- Test Conformance of a Modified Implementation P' to the initial SA
  - **Context:**
    - P correctly implements the SA S
    - P' modifies P: some objects are modified, and/or some new objects are introduced.
  - **Goal:** Test the conformance of P' with respect to S,
    - while reusing previous test information for selective regression testing, thereby reducing the test cases that must be retested.
  - To handle **Architectural Drift**

SArTe - Goal 2 (SA evolution)



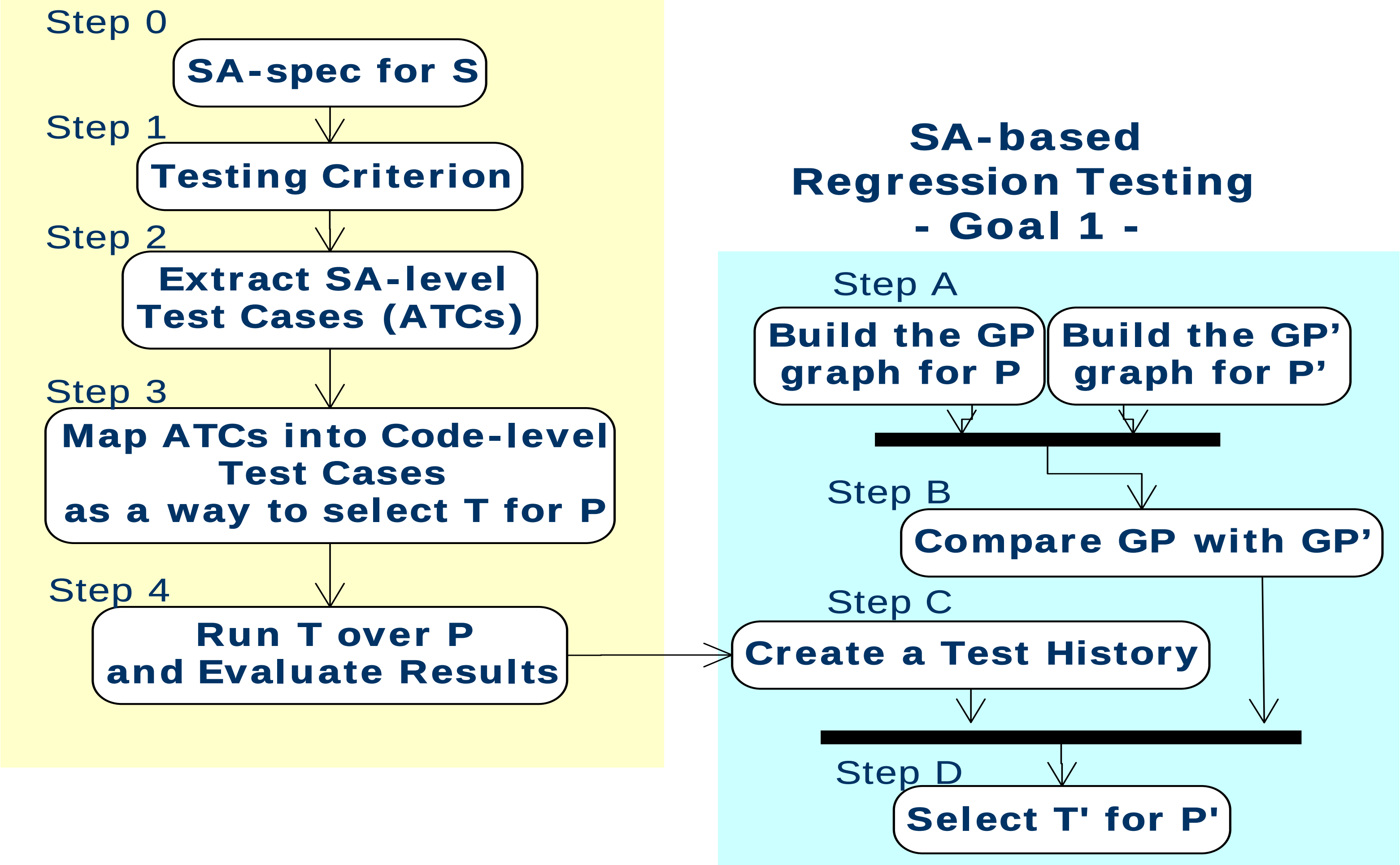
» Test Conformance of an Evolved Software Architecture

- **Context:**
  - P correctly implements the SA S
  - S’ modifies S, adding or removing components
  - A modified implementation P' may have been also developed.
- **Goal:** Test the conformance of P’ with respect to S',
  - while reusing previous test information for selective RT, thereby reducing the test cases that must be retested.

Goal 1: P changes

SA-based Code Testing

SA-based
Regression Testing
- Goal 1 -



Considerations

» **Differences** with respect to traditional code-based selective RT techniques:

- code-level test cases are always selected starting from a well formalized architectural specification.
- the oracle in SA-based RT is the software architecture specification itself.

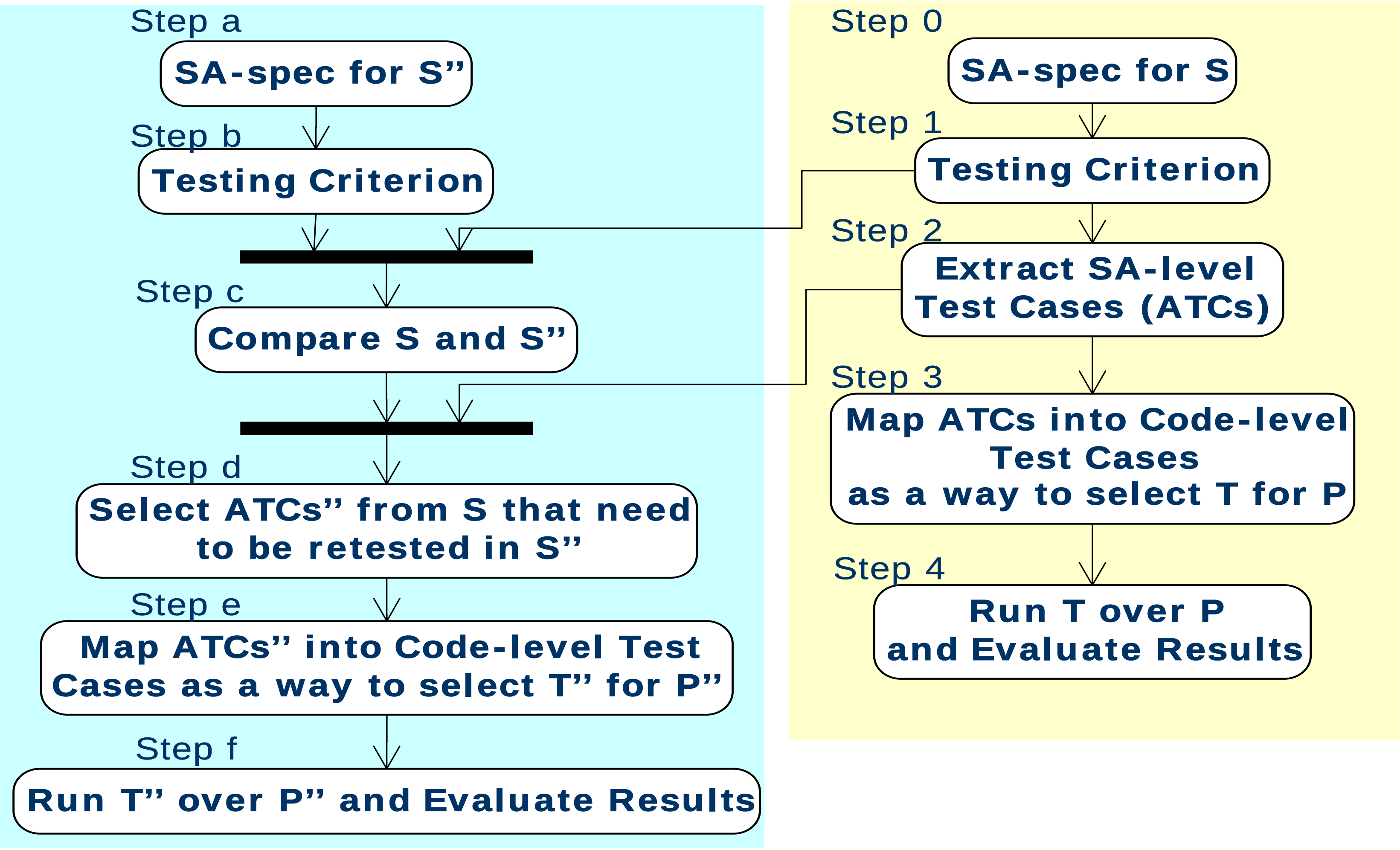
» **Advantages**:

- as in traditional RT, we reduce the size of the test suite for P', eliminating all those tests which do not need to be reapplied to P', and
- when conformance faults are detected, we can gather information on how to adjust the initial architecture.

Goal 2: SA changes

SA-based Regression Testing - Goal 2 -

SA-based Code Testing



Step a
SA-spec for S''

Step b
Testing Criterion

Step c
Compare S and S''

Step d
Select ATCs'' from S that need to be retested in S''

Step e
Map ATCs'' into Code-level Test Cases as a way to select T'' for P''

Step f
Run T'' over P'' and Evaluate Results

Step 0
SA-spec for S

Step 1
Testing Criterion

Step 2
Extract SA-level Test Cases (ATCs)

Step 3
Map ATCs into Code-level Test Cases as a way to select T for P

Step 4
Run T over P and Evaluate Results

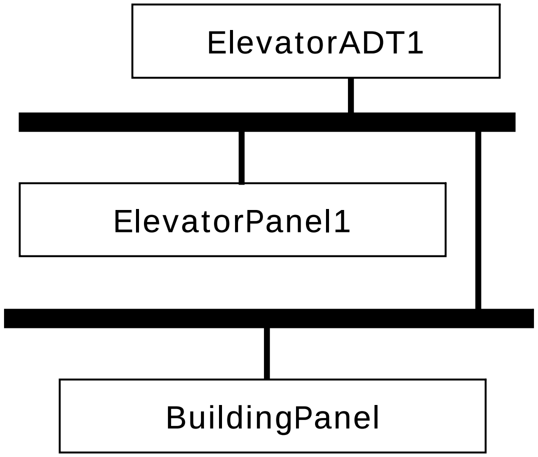
Goal 2 Idea

» Compare the two architectural specifications to identify changed/unchanged portions of the SA.

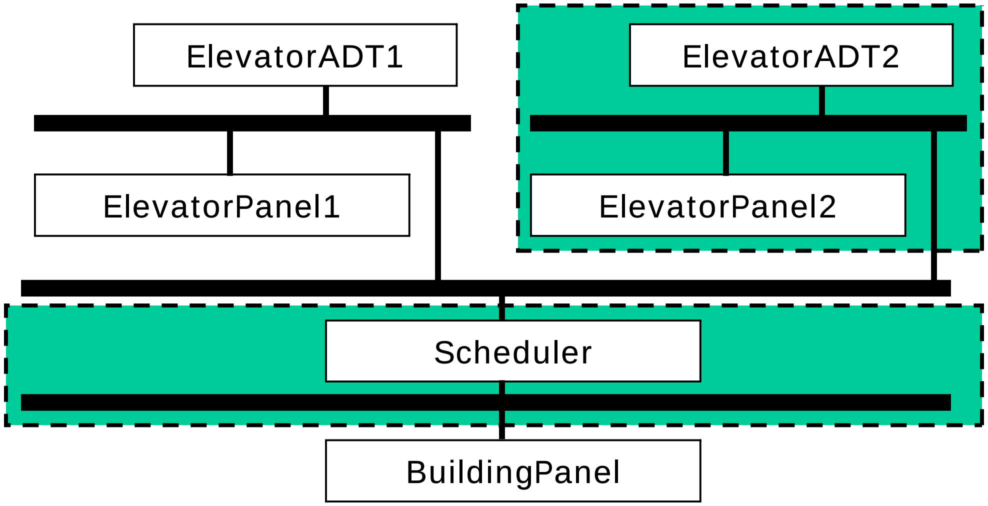
- Both structural and behavioral changes are taken into account
  - > We compare the topology changes (if the SA structure changed)
  - > We compare the behavioral changes (if the SA behavior changed)
- and, in a fashion similar to traditional code-based RT,
  - > ATC needs to be re-run in S'‘, if it traverses a path modified when moving from S to S"

Experiment 1: the Elevator SA

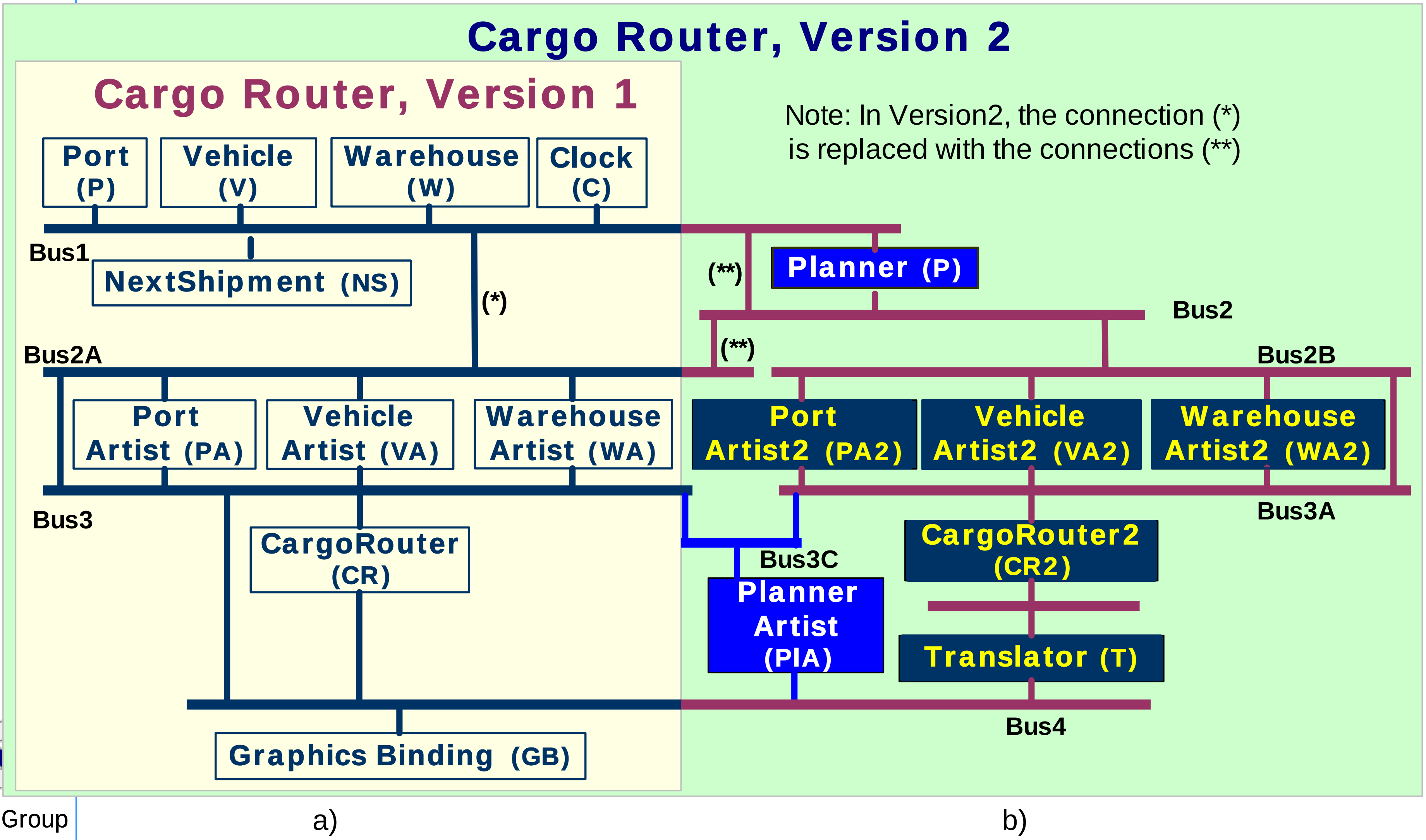
Elevator System Version 1



Elevator System Version 2



Experiment 2: the Cargo Router System



Note: In Version2, the connection (*) is replaced with the connections (**)

Future Work

- To reconstruct the actual architecture when the first goal determines that the code no longer conforms to the initial SA
- Regression Testing of Component-based Software Architectures
- Regression-based Analysis of ModTest
- Apply/refine this approach into real systems (SiemensC.N.X., Terma GmbH)

Contact Information

» **Henry Muccini**

- Dipartimento di Informatica, Universita' dell'Aquila, L'Aquila, Italy
- muccini@di.univaq.it

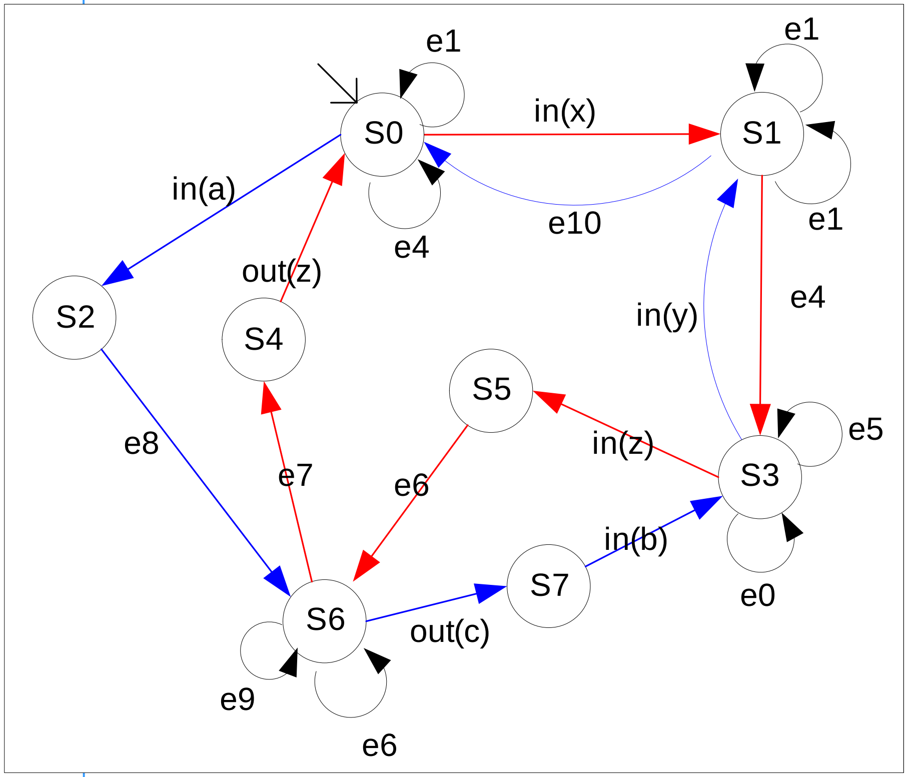
» **Marcio Dias**

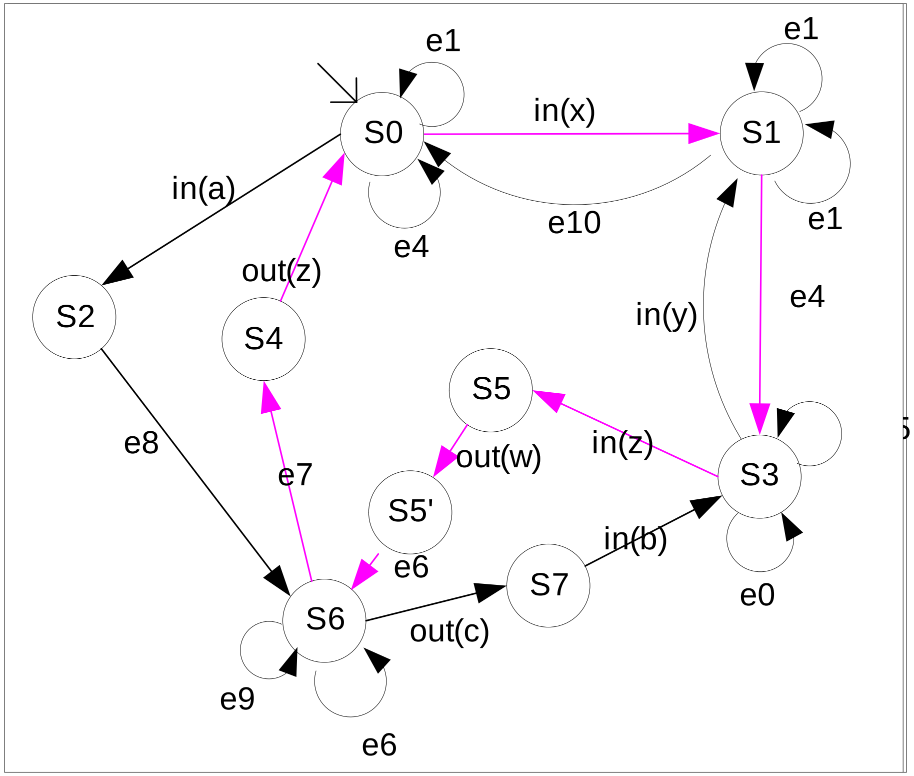
- Department of Computer Science and e-Science Research Institute, University of Durham, UK
- marcio.dias@dur.ac.uk

» **Debra J. Richardson**

- Donald Bren School of Information and Computer Sciences, University of California Irvine, USA
- djr@ics.uci.edu

SA diff





ATC1 in T ATC2 in T

ATC1 in T’