Mock Object Creation for Test Factoring

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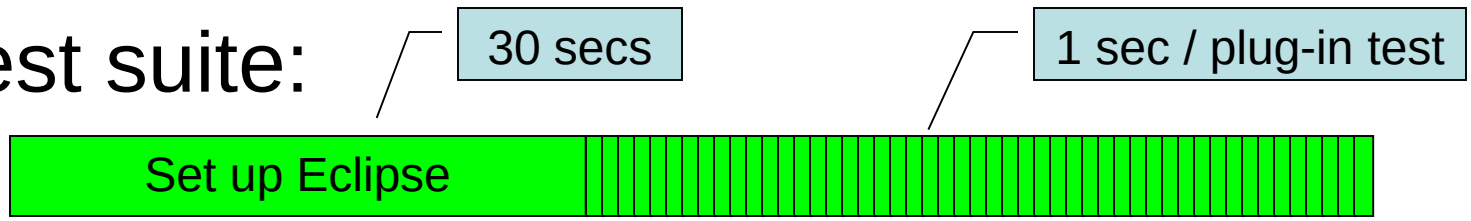
Motivation

- Continuous testing plug-in for the Eclipse IDE*
- Test suite:



- Problem: find out about errors faster
- Solution: *mock objects* to replace Eclipse framework

* Saff, Ernst, ETX 2004: Continuous testing in Eclipse

Outline

- Mock objects introduced
- Test factoring introduced
- Mock object creation for test factoring
- Conclusion

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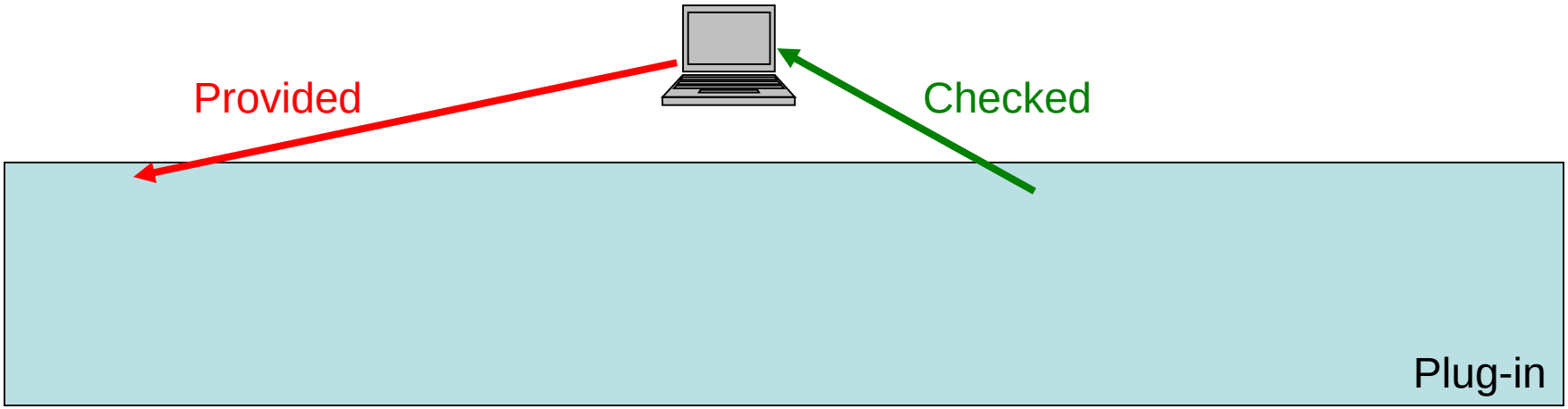
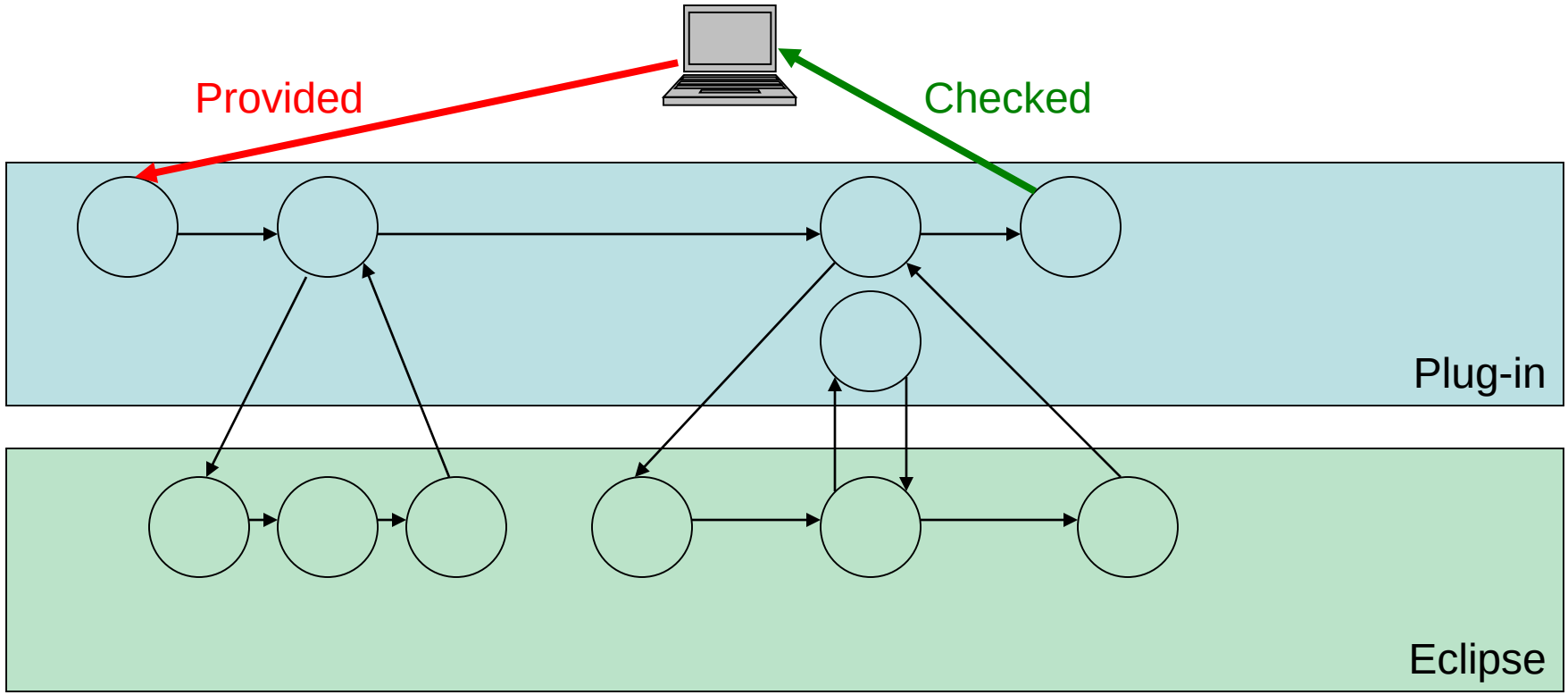
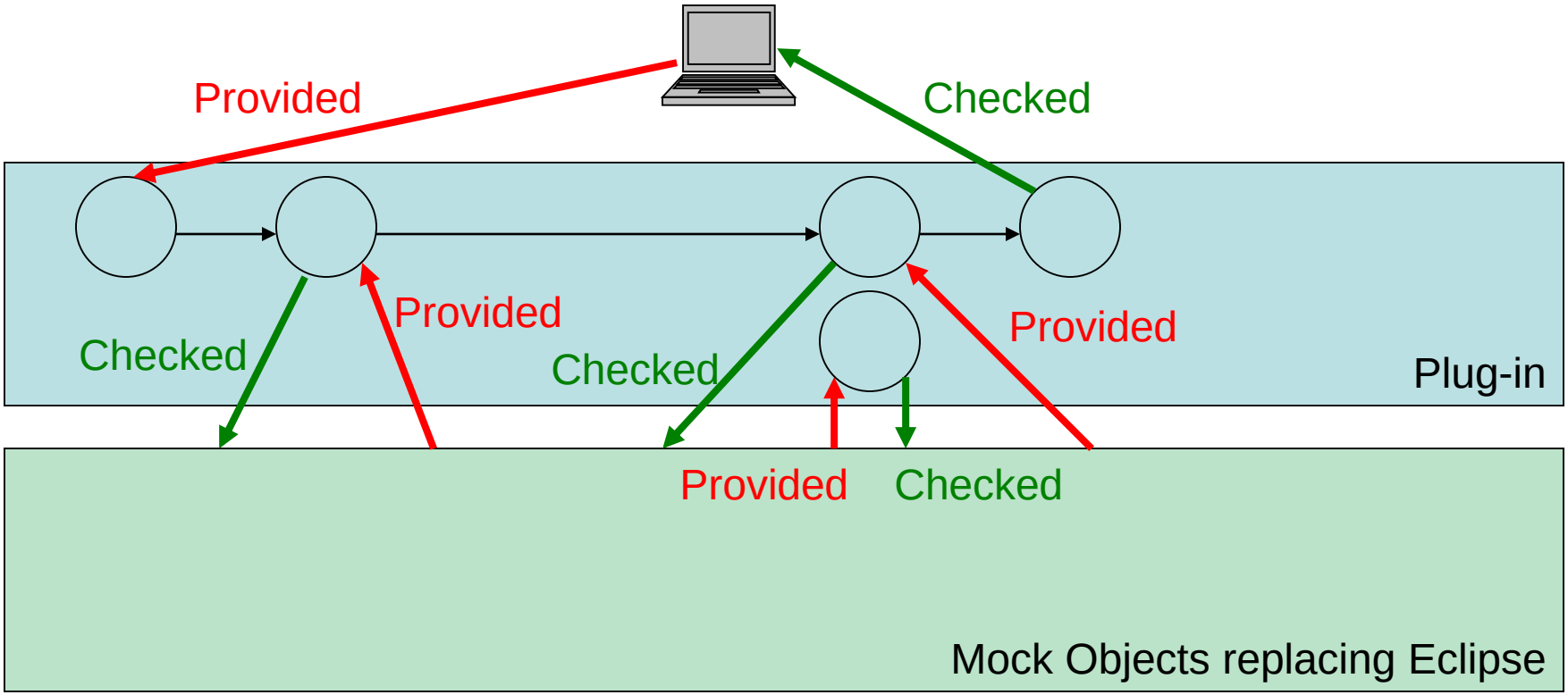
Unit test for plug-in



System Test for plug-in



Unit Test with Mock Object



A mock object:

- provides *part* of the functionality of the original object(s)
- is focused on allowing the test to proceed

Mock objects for our example

- Using a debugger, determined:
  - 147 static calls from plug-in to framework
    - Defined on 49 classes
  - 8 callbacks from framework to plug-in
- Substantial work to define mock objects.
- How well can we automate this process without additional manual effort?

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What is a factored test?

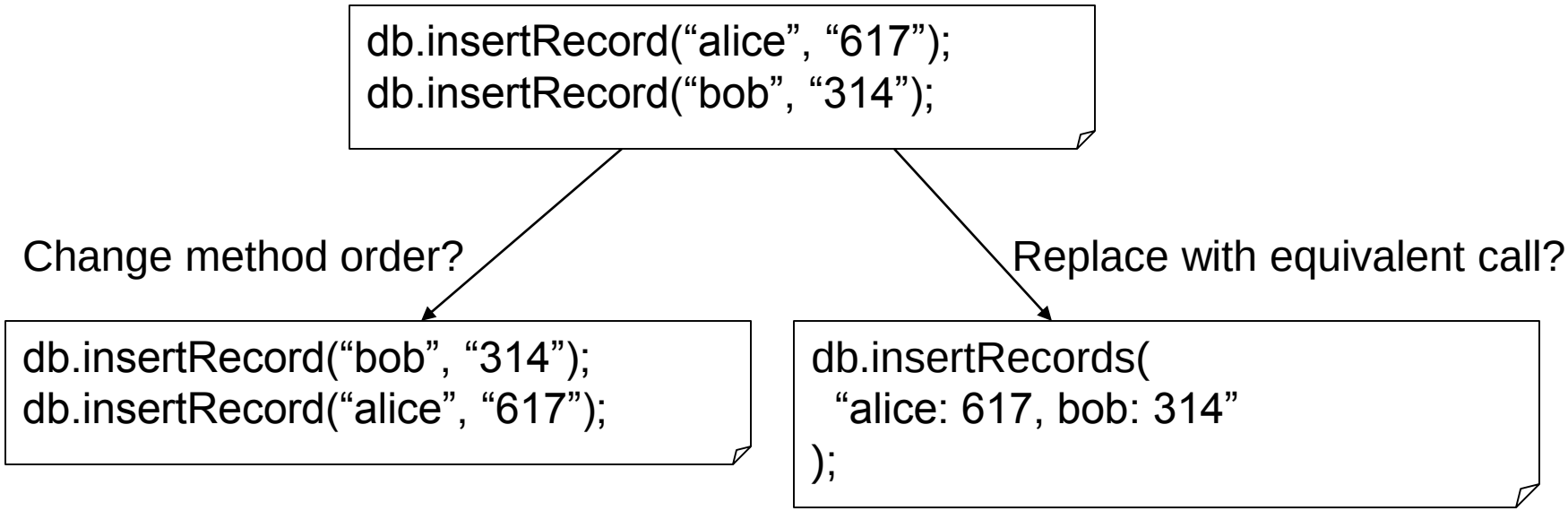
- Split a system test into several smaller *factored* tests that
  - exercise less code than system test
  - can be added to the suite and prioritized
    - Find out about errors faster
  - embody assumptions about future code changes

Pros and cons of factored tests

- **Pro**: factored test should be faster if system test
  - is slow
  - requires an expensive resource or human interaction
- **Pro**: isolates bugs in subsystems
- **Con**: if assumptions about how developer will change the code are violated, can lead to:
  - false negatives: OK, some delay
  - false positives: bad, distract developer

Change language

Change language: the set of tolerated changes

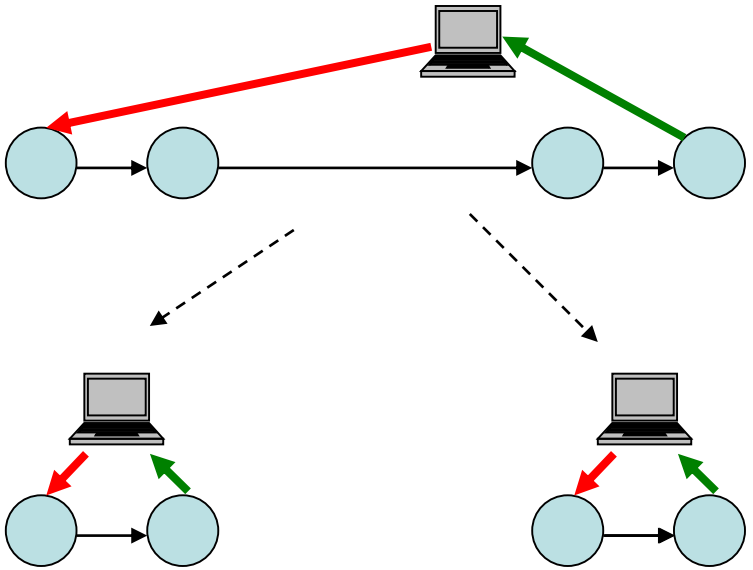


- When change language is violated, factored test must be discarded and re-created
  - Can detect violation through analysis, or incorrect result.

A small catalog of test factorings

- Like refactorings, test factorings can be catalogued, reasoned about, and automated

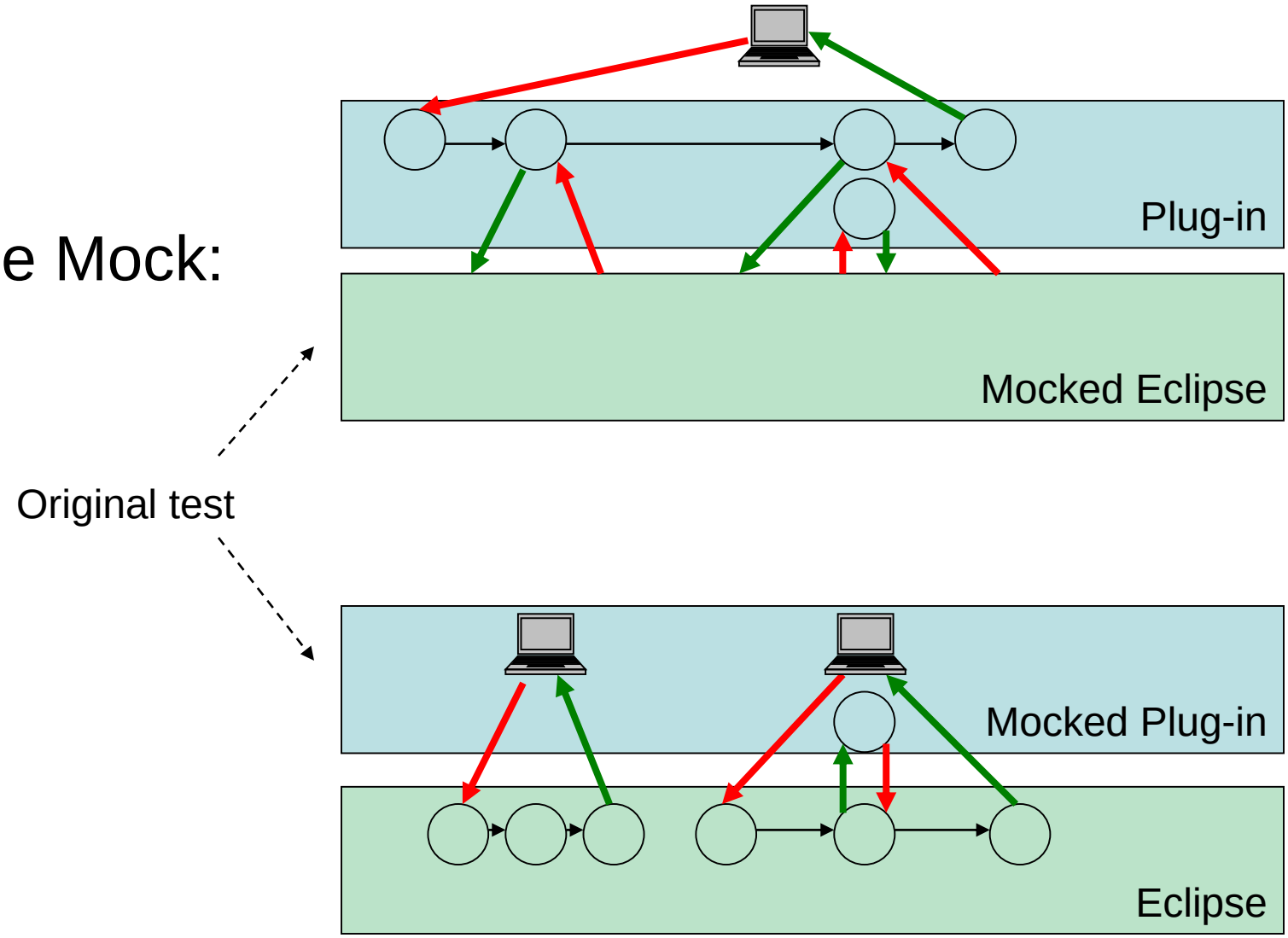
Separate Sequential Code:



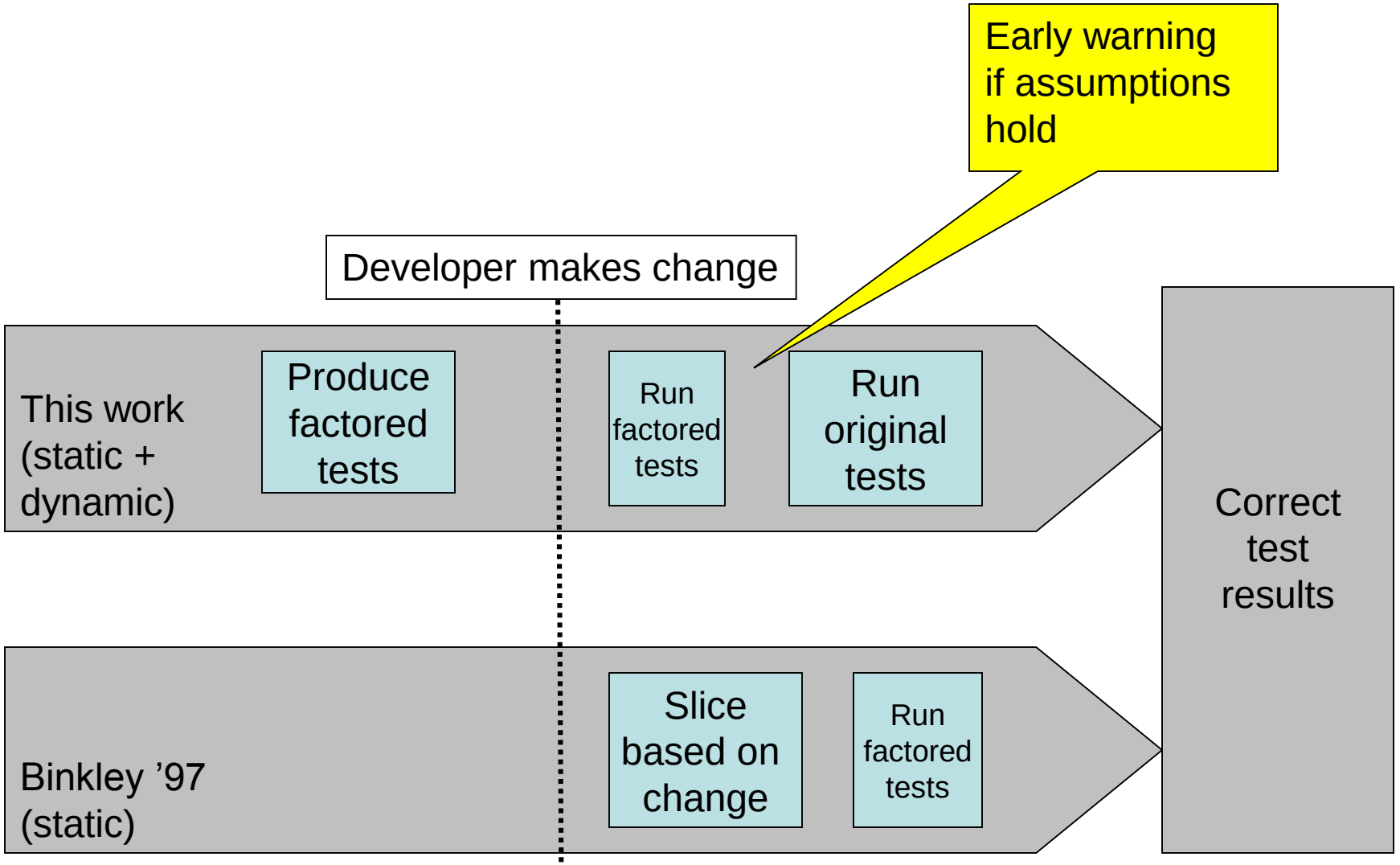
Also “Unroll Loop”, “Inline Method”, etc. to produce sequential code

A small catalog of test factorings

Introduce Mock:



Related work



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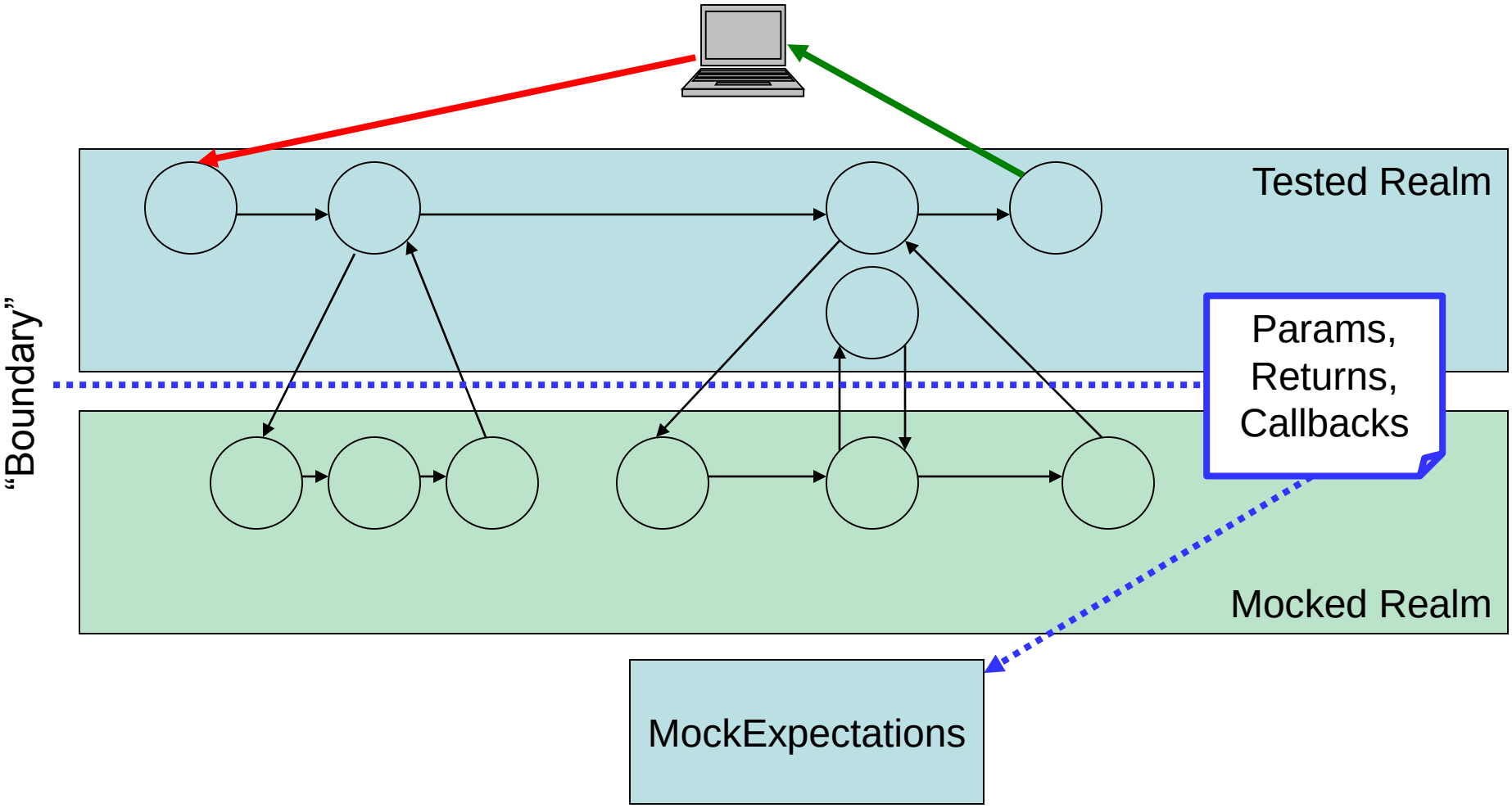
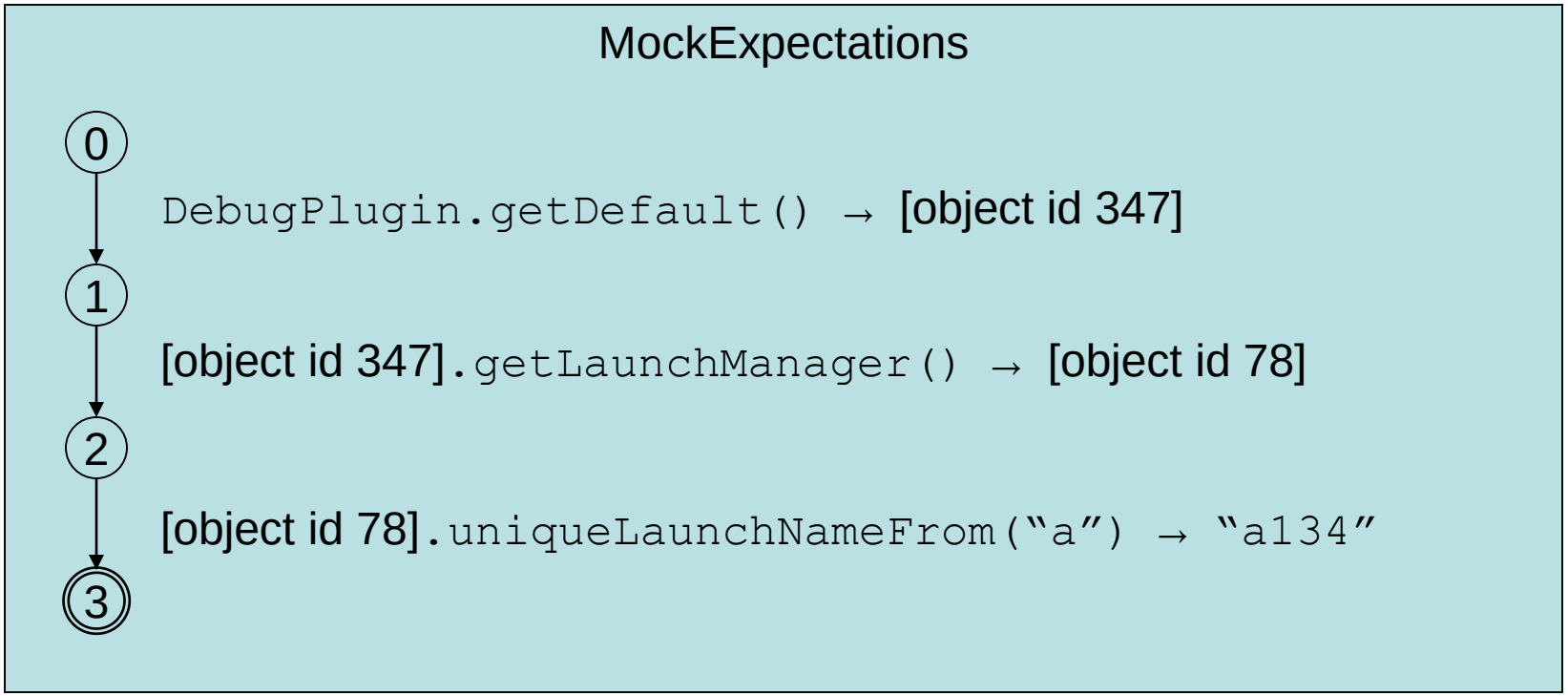
Basic Procedure: Trace Capture



Basic Procedure: code generation

- MockExpectations encodes a state machine:

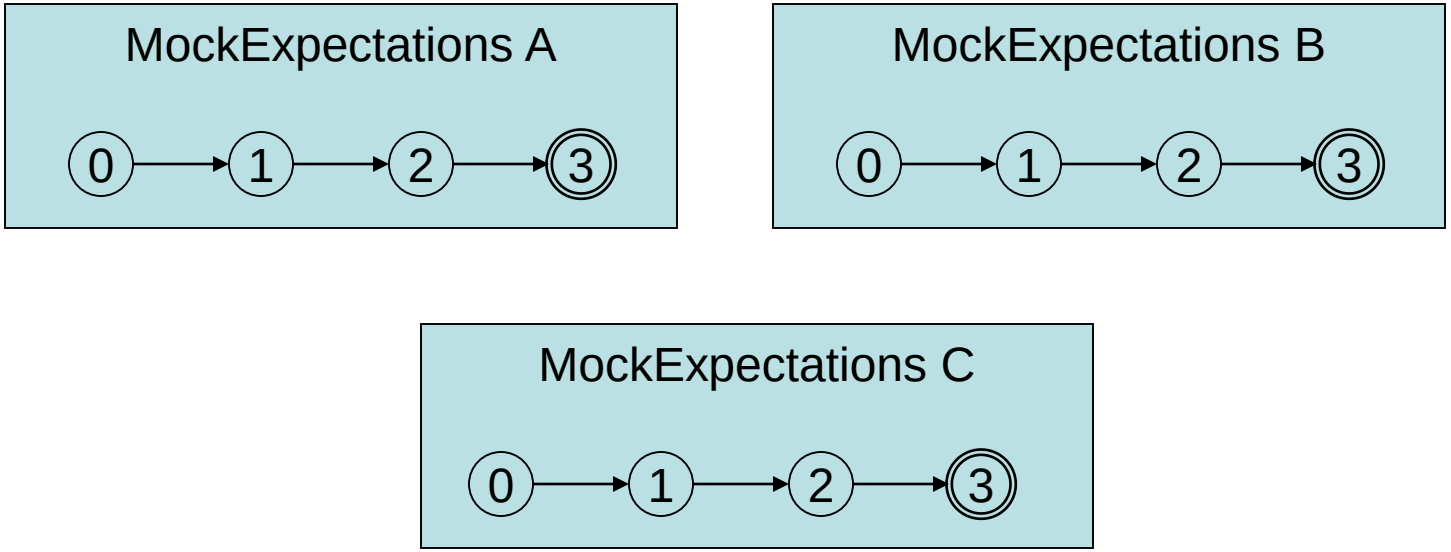


Expanding the change language

- Current tolerated change language includes:
  - Extract method
  - Inline method
- Using static analysis on mocked code, improve the procedure to include:
  - Reorder calls to independent objects
  - Add or remove calls to pure methods

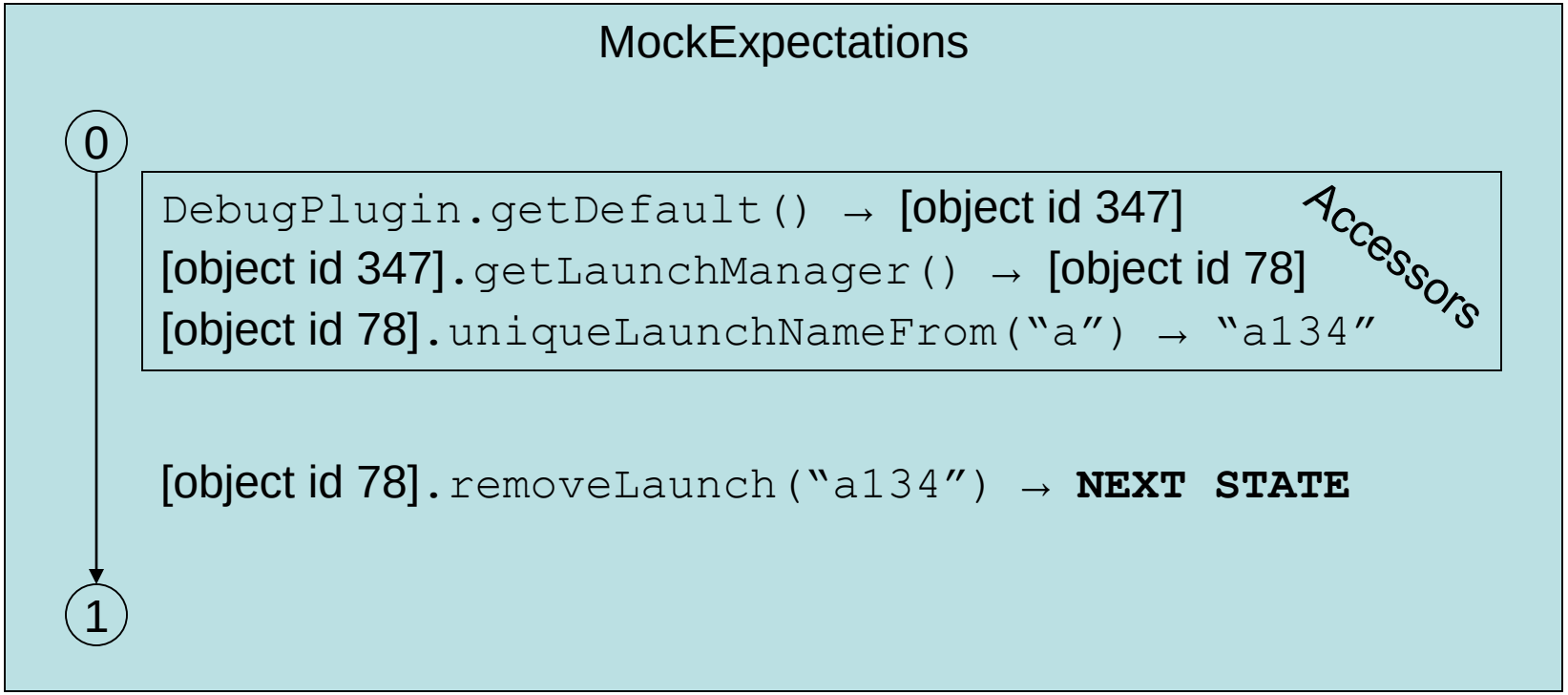
Reorder calls to independent objects

- Group objects that share state into *state sets*
- One MockExpectations per state set:



Add or remove pure method calls

- Allow reordering, addition, removal of calls to pure methods:



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Future work

- Develop a framework for test factoring
- Implement the “Implement Mock” factoring
- Analytic evaluation of framework
  - Capture real-project change data*
  - Measure notification time, false positives
- Case studies of test factoring in practice
  - How do developers feel about the feedback they receive?

* Saff, Ernst, ISSRE 2003: Reducing wasted development time via continuous testing

Conclusion

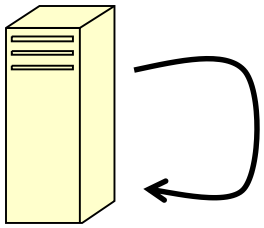
- Test factoring can indicate errors earlier
- “Introduce Mock” is an important test factoring for complicated systems
- We propose:
  - Dynamic analysis for building mock objects
  - Static analysis for increasing the change language
- Mail: saff@mit.edu

A small catalog of test factorings

- Separate Sequential Test:
  - [graphic]
- Unroll Loop:
  - [graphic]
- Introduce Mock:
  - [graphic]

Frequent testing is good:

- Frequent *manual* testing in agile methodologies



- Frequent *automatic* testing in *continuous testing*.

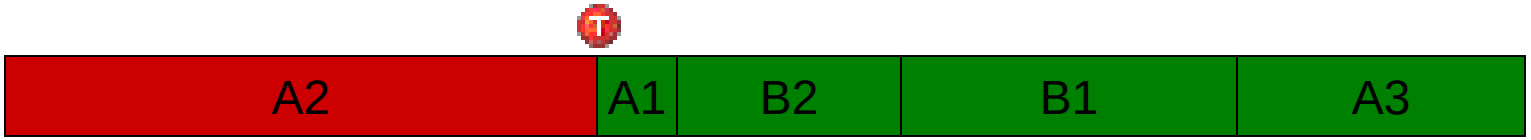
- A testing framework should minimize the cost of frequent testing
  - *Suite* completes rapidly
  - *First failing test* completes rapidly

Getting faster to the first failing test

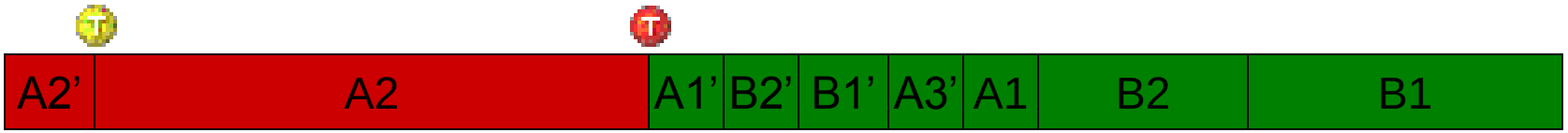
- Default:

- Test selection:

- Test prioritization:



- Test factoring:



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Dynamic, change-independent test factoring

- Dynamic: instrument and run the original test
- Change-independent: factoring happens before any changes are made.
  - Requires a hypothesized *change language*
- Binkley ’97: Static, change-dependent test factoring

Automatic test factoring: change-dependence

- Change-dependent test factoring:
  - After tested code is changed, generate new tests with same result as old tests *for that change*.
- Change-independent test factoring:
  - *Before* tested code is changed, generate new tests that have the same result as old tests for some set of changes.

Better

Automatic test factoring: static vs. dynamic analysis

- Static analysis (Binkley ’97)
  - Analyze code to determine mock object behavior
  - Well-suited for change-dependent factoring
  - May fail
    - without source
    - when dependent on file system or user interaction
  - *Guaranteed* change language may be restrictive
- Dynamic analysis (this work)
  - Instrument and run the original test, gather logs
  - May run original test after factored test fails