Minimalist Testing Techniques for Enterprise Java Technology-based Applications

Chris Richardson
Author of POJOs in Action
Chris Richardson Consulting, Inc

www.chrisrichardson.net

TS-4439

What You Will Learn…

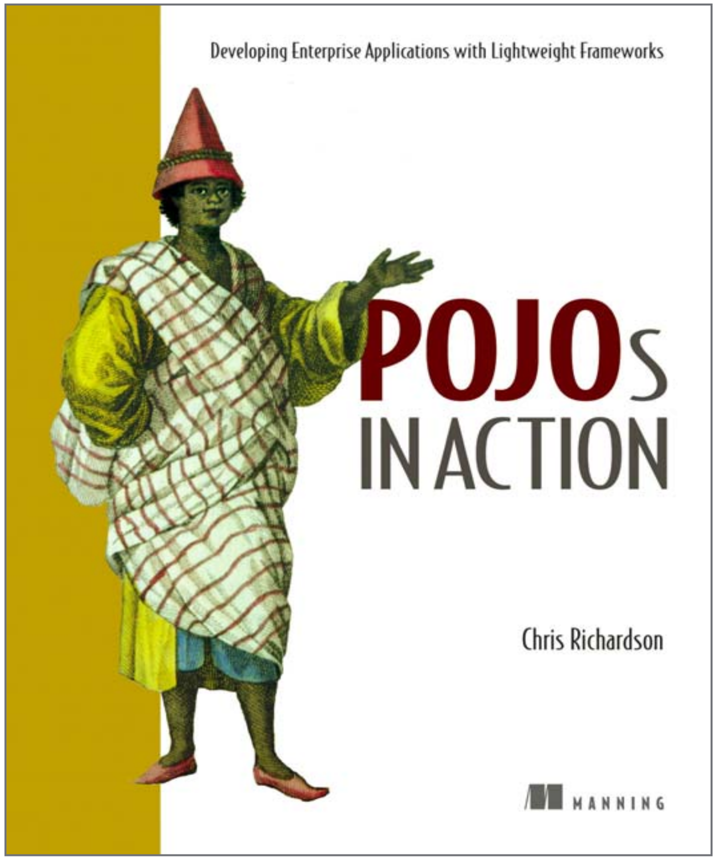
Nasty things can happen to you when you don’t write tests

BUT

It isn’t too difficult to write a few fast running tests

About Chris

- Grew up in England
- Live in Oakland, CA
- 21 years of software development experience
    - OO development since 1986
    - Java™ platform since 1996
    - Java Platform, Enterprise Edition (Java EE) since 1999
- Author of *POJOs in Action*
- Speaker at the JavaOne℠ conference, JavaPolis, NFJS, SD West, JUGs…
- Chair of the eBIG Java SIG in Oakland (www.ebig.org)
- Run a consulting and training company that helps organizations build better software faster


Developing Enterprise Applications with Lightweight Frameworks
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Agenda

When Developers Write Tests

Fast Feedback Is Essential

Business Tier Tests

Persistence Tier Tests

Web Tier Tests

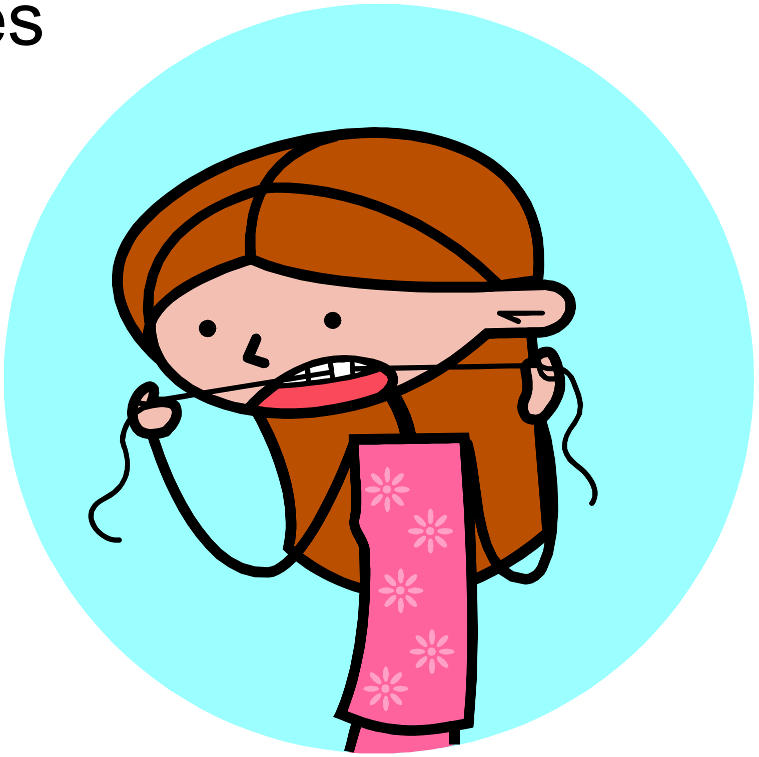
Getting Started

The State of Developer Testing

- (Almost) Everybody agrees that automated tests are good idea

BUT TYPICALLY

- Developers don't write tests
- QA does (manual) testing



Obstacles to Developer Testing

- Cultural obstacles to testing
  - Perceived as extra work that is QA’s responsibility
  - Unnecessary—“My code always works”
  - Not always rewarded—paradox of excellence?
  - Something new to learn
- Technical obstacles to testing
  - Spaghetti code
  - Some frameworks make testing difficult
  - Framework developers must consider testability

Edit and Pray Development

- You can perhaps live with few tests at the start of a project
- But very quickly you need to change existing code, and development slows down
  - No tests—make changes very carefully
  - Lots of manual testing
- More bugs → Long nights, stress…
- Your application decays
  - No one has confidence or time to refactor code
  - Even slower progress
  - Eventually you need to throw it away and start over

But if You Write Tests…

- Fewer bugs that impact customers **and** development
- Write new code more easily
  - Automates what we are doing already—right!?
  - Run fast unit tests instead of slower web application
  - Use TDD to incrementally solve a problem
- Tests are a safety net
  - Confidently change existing code
  - Easier to refactor code to prevent decay
  - The application has longer, healthier life

POJOs Make Testing Easier

- A Plain Old Java Object
  - Does not implement any special interfaces
  - Does not call infrastructure APIs
  - Decouples business logic from infrastructure
- Dependency injection wires components together
  - Simplifies code
  - Promotes loose coupling between components
  - Makes it easy to pass in mocks for testing
- Aspects handle cross-cutting concerns
  - Simplifies code that implements business logic
  - Decouples it from infrastructure

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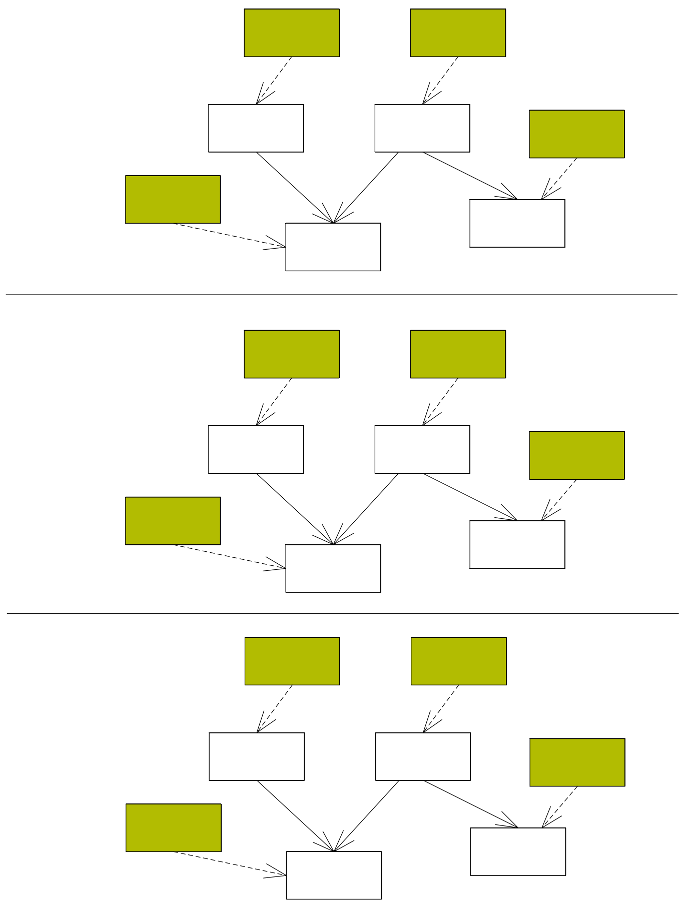
Fast Feedback Is Essential

- You change a complex interest calculation
- When do you want to find out whether it works?
  - 15 minutes later after run web tests?
  - 10 seconds later after running a hundred unit tests?
- Write unit tests at every level
  - Fast running
  - Easy to relate test failure with cause

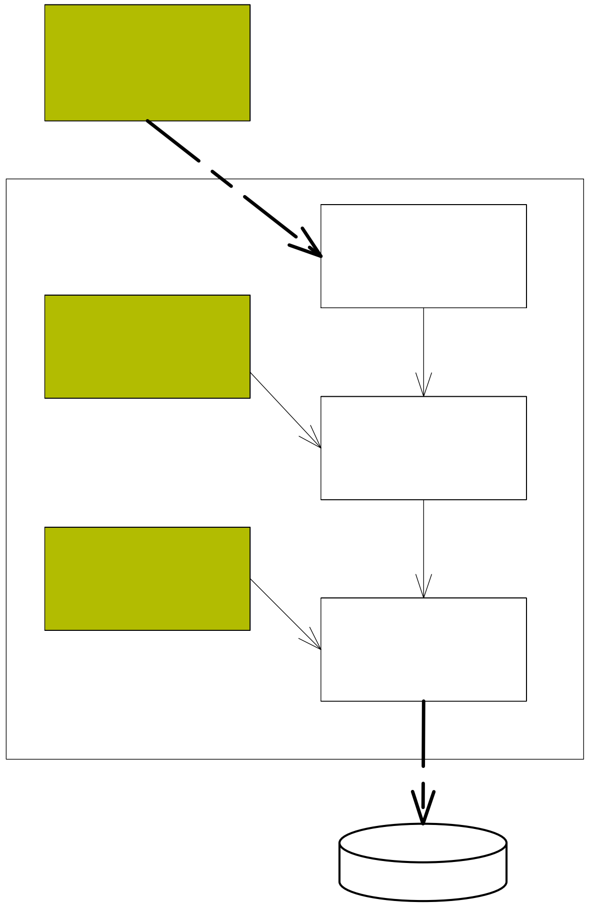


Fast Builds Are Also Essential

- If you are good at writing tests → lots of tests
- Unit tests run very quickly but lots of functional tests can take a long time to run
- Building and testing an application can be slow
  - On some past projects it took 30–50 minutes
  - Yet this had to be done prior to check-in
- Consequences
  - Check-in was a big deal → rarely done
  - Developers didn't run tests → broken builds

One Reason for Slow Tests = Going Outside of the Virtual Machine for the Java Platform (JVM™ Interface)

- Tests that cross JVM interface boundaries are generally slow
- Databases are slow
  - Testing at every layer → hit the database over and over again
- Web tests tend to be slow
  - JavaServer Pages™ (JSP™) technology compilation time
  - Networking



The terms “Java Virtual Machine” and “JVM” mean a Virtual Machine for the Java™ platform

Minimizing Test Times

- Solutions
  - Write lots of fast running tests, i.e., unit tests
  - Run different tests at different times
- Developers should run mainly fast tests
  - During development run mostly unit tests
  - Before check-in run some functional tests
- Continuous integration server
  - Runs slower but more thorough tests
  - But getting fast feedback is also important
  - Consider multiple levels of CI server testing
  - Use a parallelized build server

Avoid the Boiled Frog Problem

- More development → more tests → longer test times
- Suddenly, the tests take too long
- But you don't know how to fix it
- Be vigilant! Invest in reducing the build time when necessary

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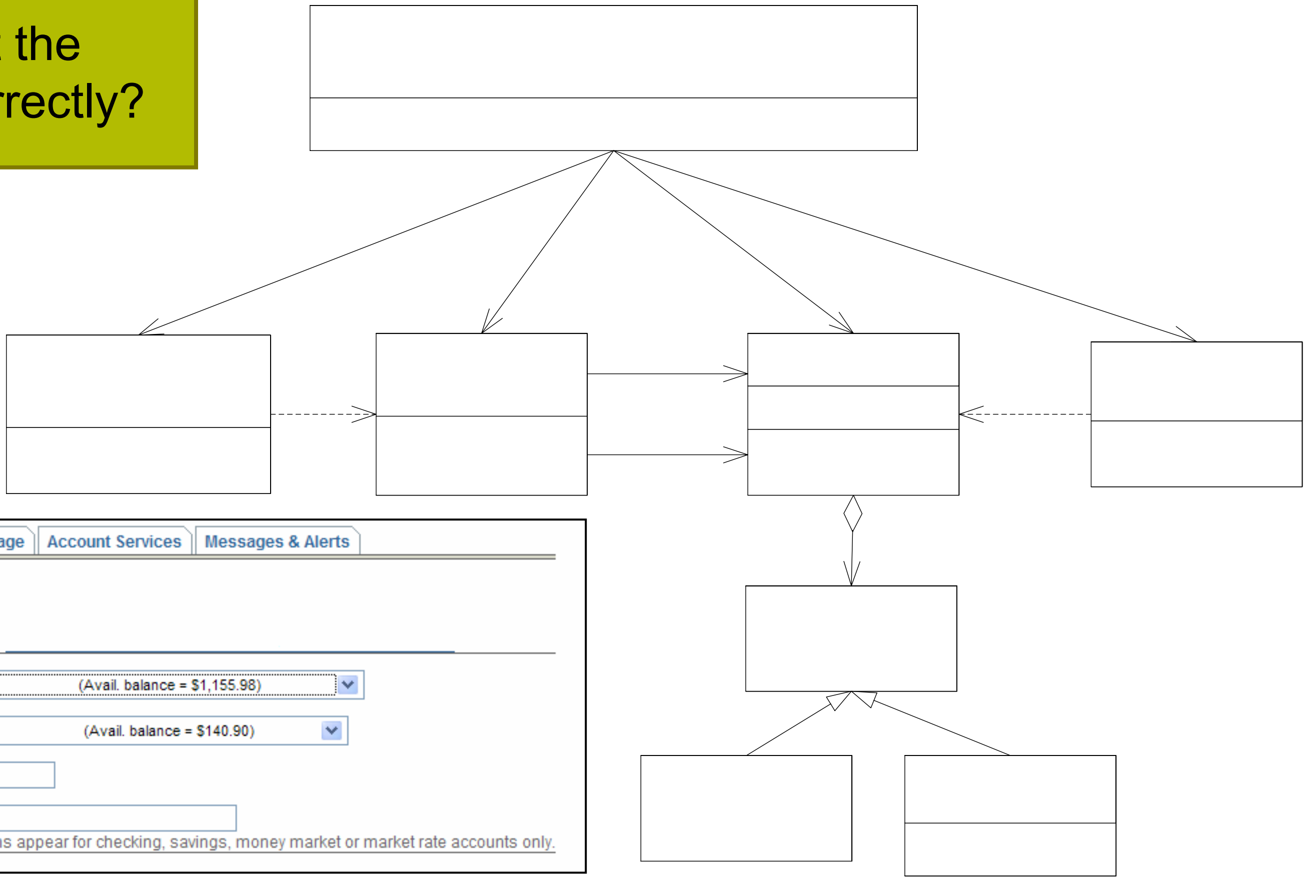
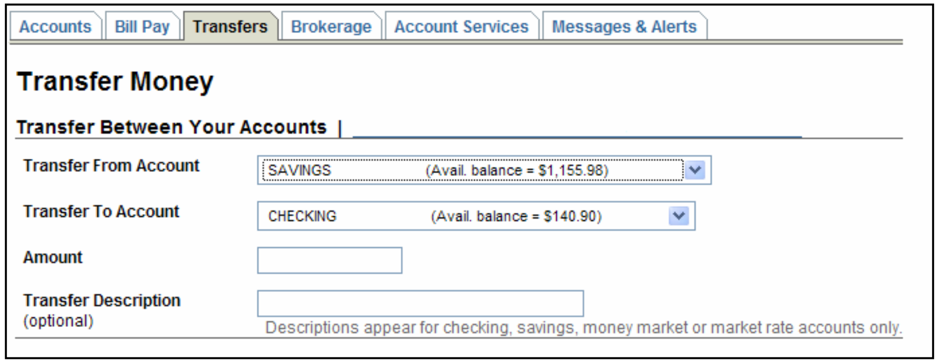
The Example Business Logic

Does it implement the business rules correctly?





Transfer Money

Transfer Between Your Accounts |

Transfer From Account	SAVINGS (Avail. balance = $1,155.98)
Transfer To Account	CHECKING (Avail. balance = $140.90)
Amount	
Transfer Description (optional)	

Descriptions appear for checking, savings, money market or market rate accounts only.

Testing a POJO Domain Object

```
public class Account {

private String accountId;
private double balance;
private OverdraftPolicy
        overdraftPolicy;

public double getBalance() {
  return balance;
}

public void debit(double amount)
{ … }

public void credit(double
       amount) { … }
```

Relatively easy to write tests that run blindingly fast

```
public class AccountTests
          extends TestCase {

private Account account;

public void setUp() {
  account = AccountMother
              .makeAccount(10.0);
}

public void test_normal() {
  assertMoneyEquals(10.0,
               account.getBalance());
  account.debit(5);
  assertMoneyEquals(5.0,
               account.getBalance());
  account.credit(10);
  assertMoneyEquals(15.0,
               account.getBalance());
}

…
```

But How to Test a Service?

```
public class MoneyTransferServiceImpl implements MoneyTransferService {

  private final AccountRepository accountRepository;
  private final BankingTransactionRepository bankingTransactionRepository;

  public MoneyTransferServiceImpl(AccountRepository accountRepository,
      BankingTransactionRepository bankingTransactionRepository) {
    this.accountRepository = accountRepository;
    this.bankingTransactionRepository = bankingTransactionRepository;
  }

  public BankingTransaction transfer(String fromAccountId,
      String toAccountId, double amount) throws MoneyTransferException {
    Account fromAccount = accountRepository.findAccount(fromAccountId);
    Account toAccount = accountRepository.findAccount(toAccountId);
    fromAccount.debit(amount);
    toAccount.credit(amount);
    TransferTransaction txn = new TransferTransaction(fromAccount,
        toAccount, amount, new Date());
    bankingTransactionRepository.addTransaction(txn);
    return txn;
}

…
```

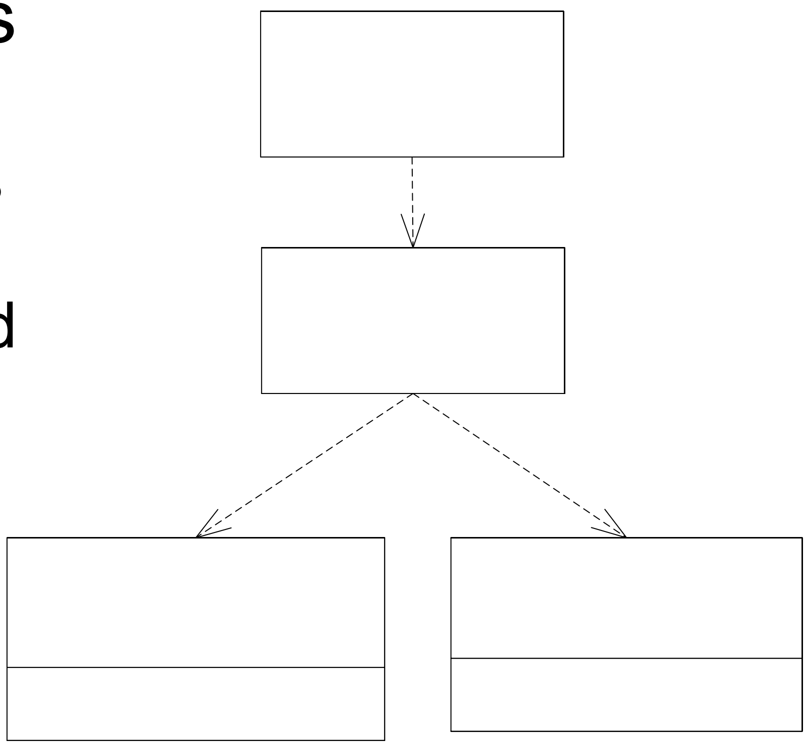
Database access

The Slow Way: Write Integration Tests

- Each test
  - Initializes the database
  - Calls the service
  - Verifies state of database
- But lots of database accesses → slow test
- Require lots of setup
  - Setting up the database
  - Initializing the database
  - …
- Integration tests are valuable but…

Faster Testing With Mock Objects

- A mock object simulates the real object
  - Returns values or throws exceptions
  - Verifies that the expected methods are called
- Using mocks
  - Simplifies tests
  - Speeds up tests
  - Enables an object to be tested in isolation
  - Enables top-down development



Creating Mocks

- Write your own mocks
  - Simple for interfaces but it becomes tedious
  - How to mock concrete classes?
- Use a mock object framework
  - jMOCK, EasyMock
- Create and configure mock object
  - Specify expected method and arguments
  - Define method behavior: return value or throw exception

Mock Objects Example: Part 1

```
public class MoneyTransferServiceTests extends TestCase {

protected void setUp() throws Exception {
    super.setUp();
    accountRepository = createMock(AccountRepository.class);
    bankingTransactionRepository =
         createMock(BankingTransactionRepository.class);

    service = new MoneyTransferServiceImpl(accountRepository,
        bankingTransactionRepository);

    fromAccount = AccountMother.makeAccount(100);
    toAccount = AccountMother.makeAccount(200);
    fromAccountId = fromAccount.getAccountId();
    toAccountId = toAccount.getAccountId();

}
```

Create service with mocks

Mock Objects Example: Part 2

```
public class MoneyTransferServiceTests extends TestCase {

  public void testTransfer_normal() {

    expect(accountRepository.findAccount(fromAccountId)).andReturn(fromAccount);
    expect(accountRepository.findAccount(toAccountId)).andReturn(toAccount);

    bankingTransactionRepository.addTransaction(isA(BankingTransaction.class));

    replay(accountRepository, bankingTransactionRepository);

    BankingTransaction result = service.transfer(fromAccountId, toAccountId, 50);

    assertNotNull(result);

    assertMoneyEquals(50.0, fromAccount.getBalance());
    assertMoneyEquals(250.0, toAccount.getBalance());

    verify(accountRepository, bankingTransactionRepository);

  }
```

Downsides of Mocks

- Testing the collaboration of objects = white box testing
- Tests can be brittle
  - Change design without changing what it does → failing tests
  - Discourages developers from writing tests
- Fortunately, many collaborations are stable
  - e.g., between services and repositories
- Mock selectively!

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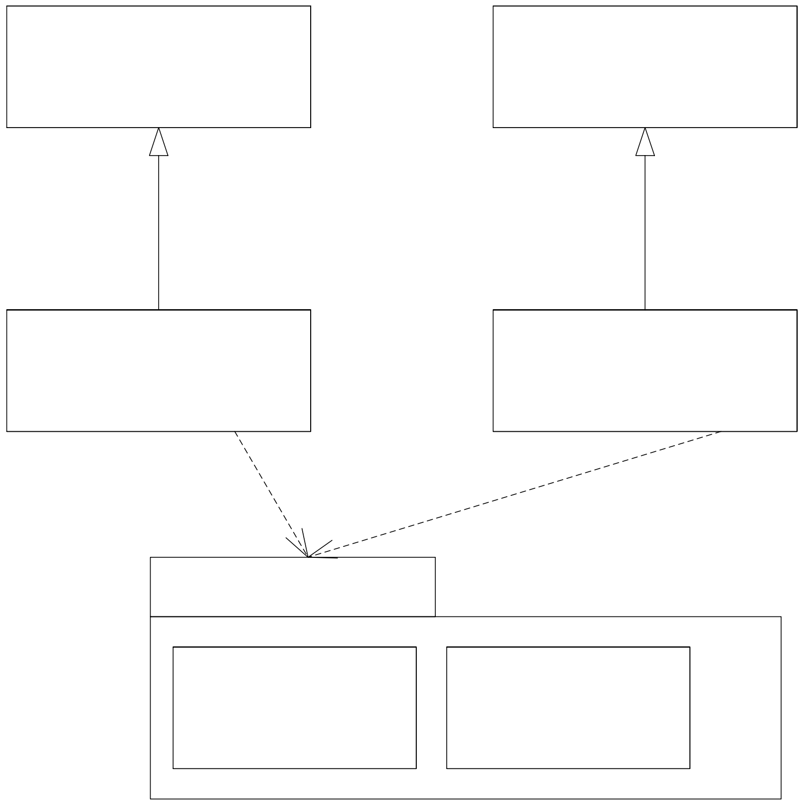
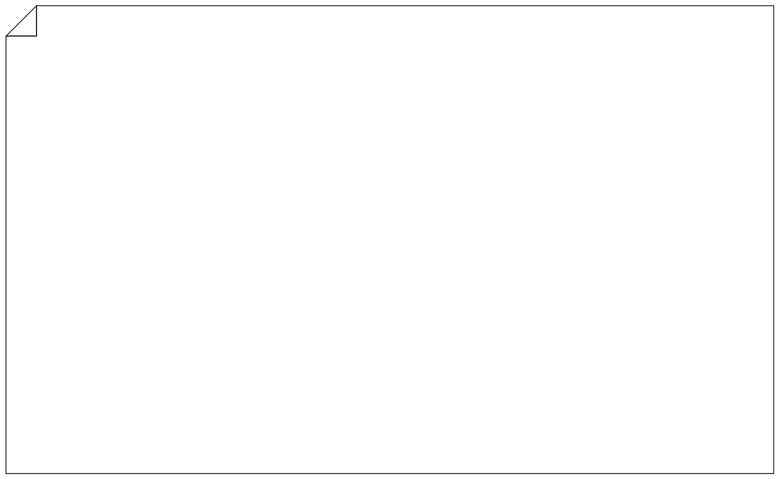
Persistence Tier Components



Can my application create, find, update and delete persistent objects?

Does the data end up in the correct table/column?

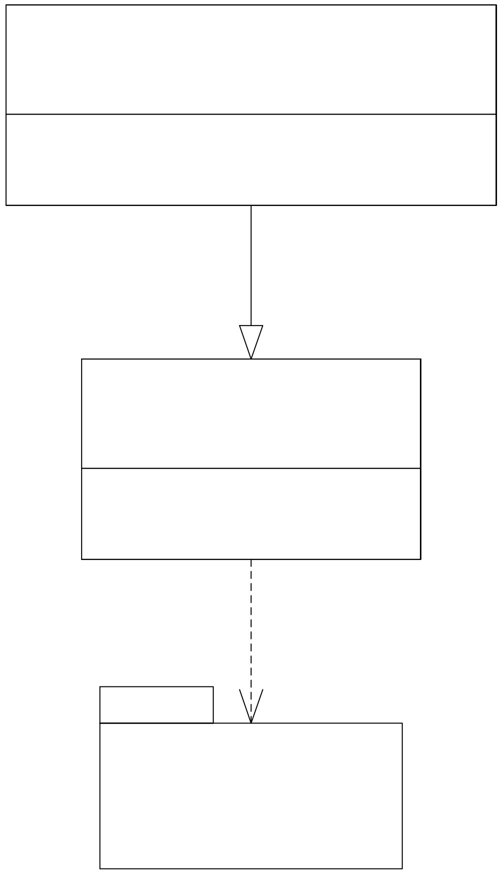


The Slow Way to Test

- Write lots of tests that bang against the database
  - Initialize the database
  - Load an object
  - Save an object
  - Verify the state of the database
- Drawbacks
  - Lots of database access → slow
  - Need to initialize the database → difficult to write
- We still need some tests like this but we can do better…

Avoid the DB #1: Mock the ORM Framework

- Problem
  - Bugs in the logic of the DAOs
  - Testing against the database is slow
- Solution
  - Mock the ORM framework APIs



Avoid the DB #2: Test the O/R Mapping

- Problem
  - Incorrectly defined mapping,
  - e.g., forgetting to map a field is a common bug
  - But tests that save objects and check the contents of the DB are slow to execute and tedious to write
- Solution
  - Read XML O/RM and make assertions about it
  - ORMUnit framework makes this easy to do

```
class BankingMappingTests extends HibernateMappingTests {

 public void testAccount() {
   assertClassMapping(Account.class, "BANK_ACCOUNT");
   assertAllFieldsMapped();
 }
…
```

Faster Tests #1: Use an In-Memory DB

- For example: HSQLDB
- Typically much faster than a traditional DB
  - Committing transactions
  - Recreating the schema
- No install—it's just a Java Archive (JAR) file
- O/RM = DB portability → makes this easy
- Issues
  - Difficult to do if using hand-coded SQL
  - Some incompatibilities: e.g., time precision

Faster Tests #2: Rollback Transactions

- Execute entire test in a transaction, which is rolled back
- Tests run faster
- Leaves the database unchanged
- Issues to consider
  - Single transaction → Single Session/EntityManager → potentially very different behavior
  - Commit-time constraints not checked
  - Code in a different JVM interface can’t see the changes

DEMO

Walkthrough Persistence Tests Code

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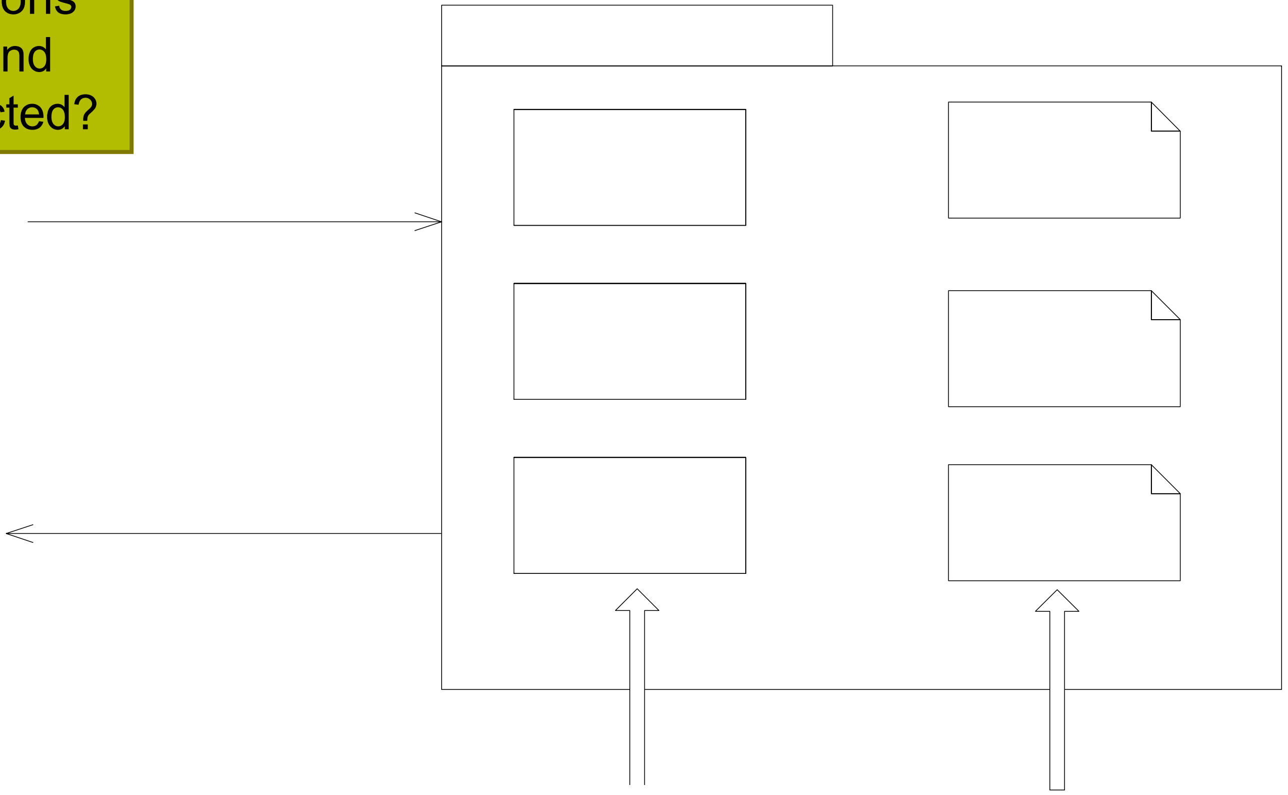
Web Tier Design

Do the links, buttons and fields exist and behave as expected?



Unit Test Web Components

- Simulate HTTP request
  - Request parameters
  - Cookies
  - Session state
  - …
- Use mocks for services
- Verify
  - Service invocation
  - View selection
  - Data passed to view

Web Application Testing

- Simulate a user clicking and typing in a browser
- Superficial tests
  - Test happy paths
  - Easy way to test basic functionality
- More thorough tests
  - Test lots of different scenarios
  - Lots of work

Web Testing With Selenium

- Selenium
  - Open source web application testing tool
  - Tests run in a real browser (IE/Firefox/…)
- Three components
  - Core = JavaScript™ technology library that runs in the browser
  - IDE = Firefox plug-in for recording and executing tests
  - Remote Control (RC) = framework for writing automated tests in Java/.NET/Ruby/…

Selenium RC—Code Example

```
public WebTest extends … {

  public void setUp() throws Exception {
    …
    selServer = new SeleniumServer();
    selServer.start();

    selenium = new DefaultSelenium("localhost", selServer.getPort(),
                                   "*iexplore",
                                   "http://localhost:8080");
    selenium.start();
  }

  public void testCreateProject(Selenium selenium) {
    selenium.open("/ptrack/acegilogin.jsp");
    selenium.type("j_username", "proj_mgr");
    selenium.type("j_password", "faces");
    selenium.click("Login");
    …
  }
```

Starting and Stopping the Web Container

- Testing with an embedded web container
  - e.g., Jetty
  - Avoids having to build a WAR
  - Typically starts up faster
- Testing with a web container in a separate JVM interface
  - Typically slower
  - Requires a WAR to be built
- Use the Cargo open-source framework
  - Installs/starts/stops web containers
  - Deploys/un-deploys web applications
  - Java API, Maven Plug-in, Ant tasks, IDE plug-ins

Cargo Example

```
public WebTest extends … {

  public void setUp() throws Exception {
     ZipURLInstaller installer = new ZipURLInstaller(
        new URL("http://apache.tradebit.com/.../jakarta-tomcat-5.0.28.zip"),
        new File(tempDir, "tomcat-install"));
    installer.install();

    Tomcat5xStandaloneLocalConfiguration config = new
                   Tomcat5xStandaloneLocalConfiguration(
                                   new File(tempDir, "tomcat-deploy"));
    config.setProperty(ServletPropertySet.PORT, "8080"));

    WAR war = new WAR(locateWAR("webapp/target/ptrack.war"));
    config.addDeployable(war);

    container = new Tomcat5xInstalledLocalContainer(config);
    File home = installer.getHome();
    container.setHome(home);

    container.start();
    …
  }
```

DEMO

Review and Run Selenium/Cargo Test Code

Speeding Up Web Tests

- Web tests can be slow
  - Lots of inter-process communication
  - Database access
  - JSP technology page compilation
- Minimize start and stops of browser and web application
  - JUnit Decorator that starts browser/server once for a set of tests
  - TestNG @BeforeClass
- Don’t run all the web tests on developer’s desktop, e.g.,
  - Only run embedded web container tests
  - Only run a subset of the tests

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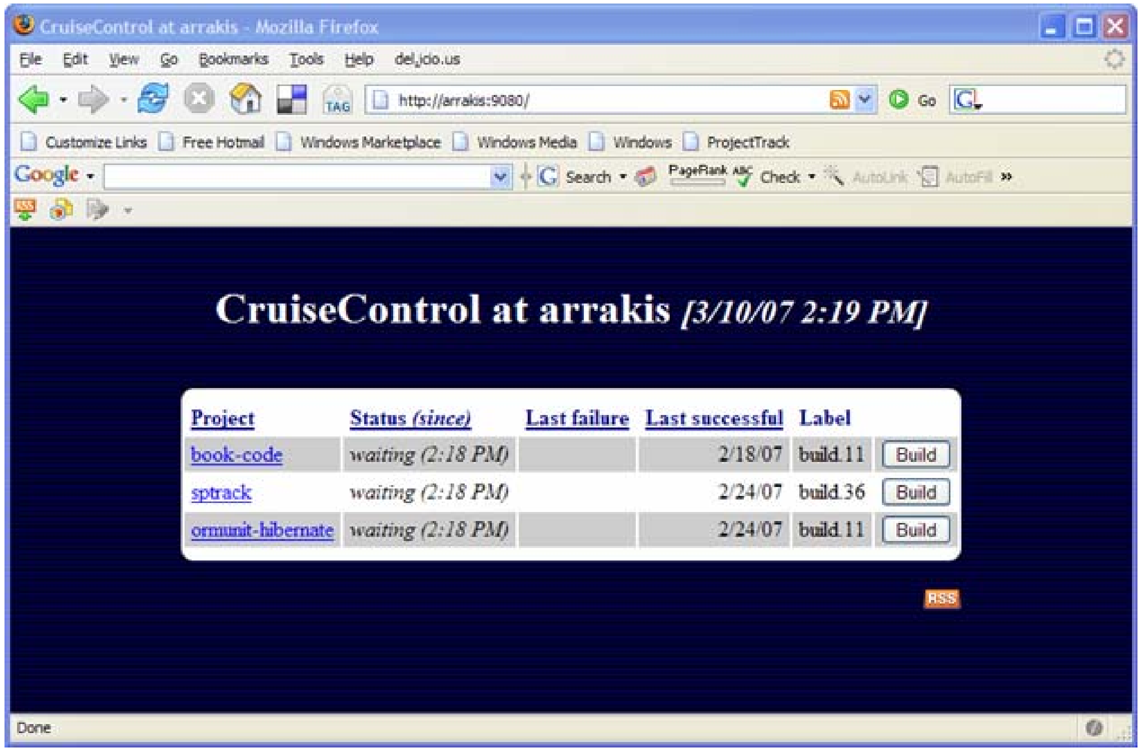
Getting Started Incrementally

- Existing application = lots of code
- Impractical to stop and create tests for everything
- Need an incremental strategy

Install Continuous Integration Server (If You Haven't Already)

e.g., CruiseControl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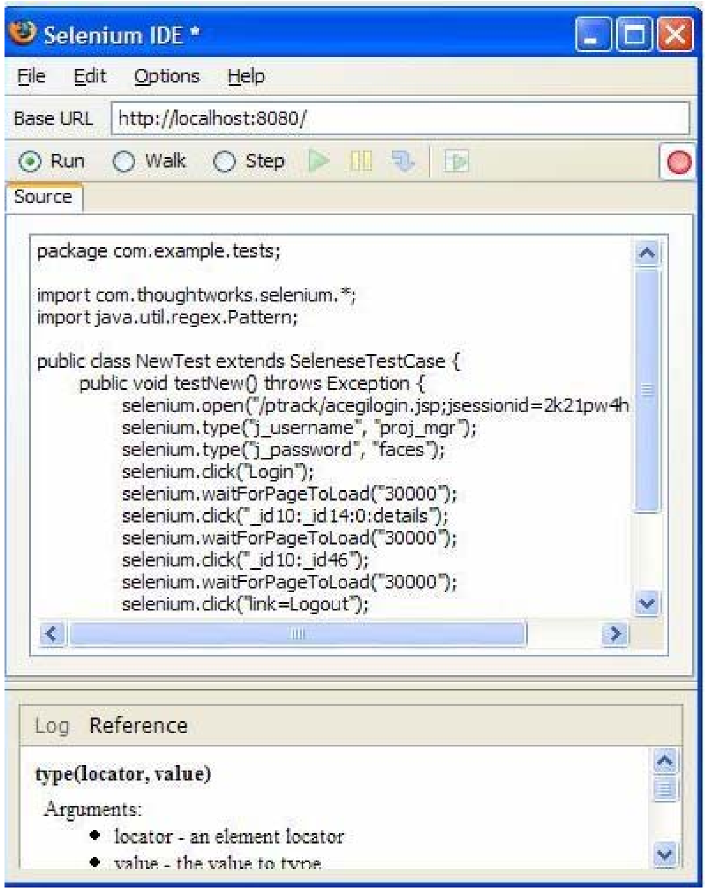
Project	Status *(since)*	Last failure	Last successful	Label	
book-code	*waiting (2:18 PM)*		2/18/07	build.11	Build
sptrack	*waiting (2:18 PM)*		2/24/07	build.36	Build
ormunit-hibernate	*waiting (2:18 PM)*		2/24/07	build.11	Build

RSS

Create Some Web UI Tests

- Use Selenium IDE to create basic tests
  - Push buttons
  - Click links
  - …
- Run
  - Before check-in
  - With CruiseControl



Base URL http://localhost:8080/

```
package com.example.tests;

import com.thoughtworks.selenium.*;
import java.util.regex.Pattern;

public class NewTest extends SeleneseTestCase {
	public void testNew() throws Exception {
		selenium.open("/ptrack/acegilogin.jsp;jsessionid=2k21pw4h
		selenium.type("j_username", "proj_mgr");
		selenium.type("j_password", "faces");
		selenium.click("Login");
		selenium.waitForPageToLoad("30000");
		selenium.click("_id10:_id14:0:details");
		selenium.waitForPageToLoad("30000");
		selenium.click("_id10:_id46");
		selenium.waitForPageToLoad("30000");
		selenium.click("link=Logout");
```

type(locator, value)

Arguments:
- locator - an element locator
- value - the value to type

DEMO

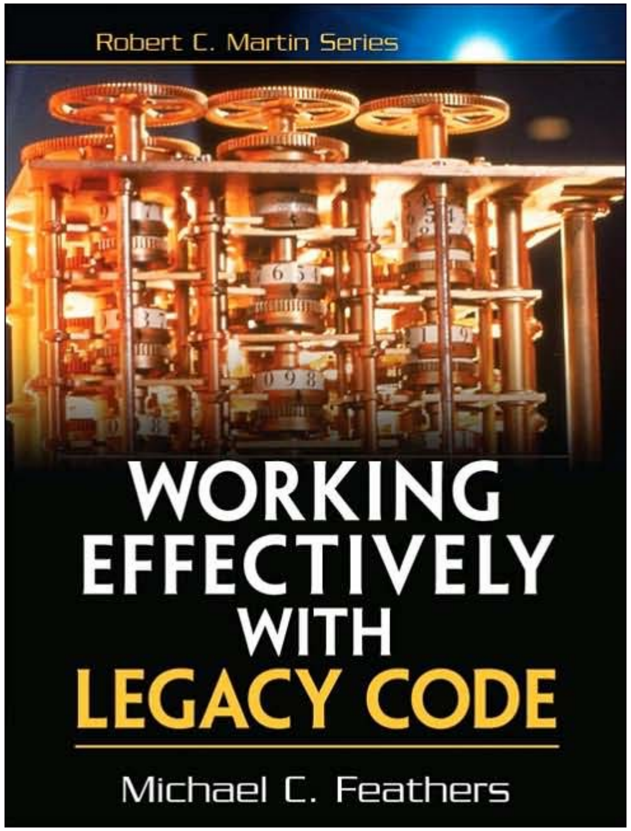
Recording a Web Test With Selenium IDE

Write More Tests When…

- Fixing a bug
  - Write a functional web UI test
  - Write a low-level unit test
- Working on a component
  - Write characterization tests for existing behavior
  - Write some tests for the new behavior
  - Make the tests pass

If Your Code = Big Ball of Mud

- This won’t stop you writing functional tests
- But it’s difficult to write unit tests

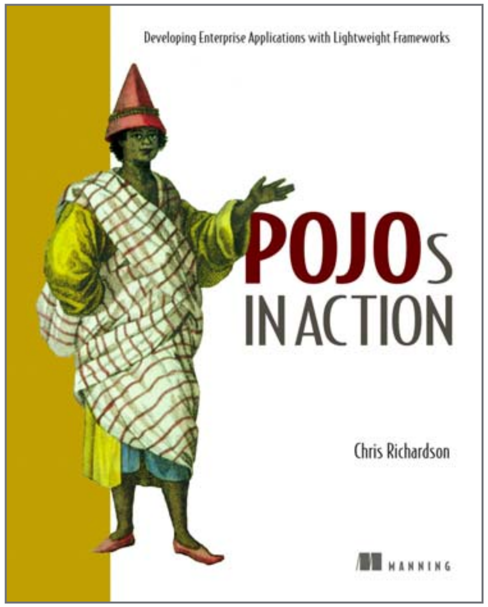


Summary

- Bad things can happen without tests
  - Development slows down
  - The application decays
  - It can be a downward spiral
- Writing some basic tests isn’t that difficult
  - Write tests for the POJO business logic
  - Test the OR/M mapping metadata
  - Use Selenium for web testing
  - Incrementally write tests for existing code

  - Just do it!

For More Information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  - chris@chrisrichardson.net
- ORMUnit website
  - http://code.google.com/p/ormunit/
- ProjectTrack Sample Code
  - http://code.google.com/p/projecttrack/
- My website for other resources
  - www.chrisrichardson.net
- Other sessions
  - TS-7082—Building JavaServer Faces Applications with Spring and Hibernate
  - BOF-7846—The Long-Tail Treasure Trove
  - BOF-6825—Testing Web 2.0 Features, Using Real-World Applications
  - TS-4588—Advanced Enterprise Debugging Techniques

Q&A

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Chris Richardson
Author of POJOs in Action
Chris Richardson Consulting, Inc.

www.chrisrichardson.net

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