VOLVO

Unit Testing and Test Driven Development (TDD)

Training provided from DRS

Volvo Information Technology

Outline of the course

- Session 1 & 2:
  - Background: Unit Testing
  - Junit : Basics
  - Junit : Advanced topics
  - Test Driven Development
  - Breaking dependencies: Moquito
  - Background: Integration Testing
  - Integration testing
- Session 3 (& 4):
  - Refactoring
  - Requirements driving the test

Training material - Java

- These slides in pdf
- Online resources
  - www.junit.org
  - code.google.com/p/mockito/
  - www.dbunit.org
  - strutstestcase.sourceforge.net
- Source code to exercises

Then, What about tests …

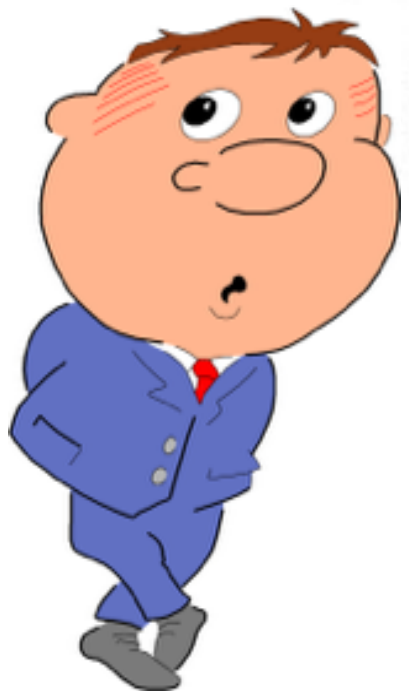
Everybody knows they should, but few actually do

- "Why isn't this tested before"?
  - Because it has been too expensive, difficult, cumbersome to test
  - Because we have been too busy
  - Because things have changed

Discussion: In case the application

you currently work on lacks tests;

- In your opinion; what's the main reason for this?



Quality Assurance precedes Quality Assessment

- Testing is about Quality Assurance, not just Quality Assessment
- Quality Assessment only indirectly affect quality
- Testing *reveals information*
- Testing helps *focus project activity*

Test Automation Goals

Tests should be S.M.A.R.T !

- Self Checking
- Maintainable
- Act as documentation
- Repeatable and Robust
- To the point – provide ”defect triangulation”

Manual Tests are …

- Repetitive
- Error-prone
- Difficult to test other units than the User Interface

- yet …

- a (Manual) Test Process must be present in order to automate it!

Critical Success Factors for Automated Tests

- **Repeatability and Consistency**
  - Once the test is complete, it should pass repeatedly, whether it executes by itself or within a test suite.
  - When a completed test fails, we need to quickly and accurately pinpoint the cause: did the test uncover a bug in the system, or is the test itself faulty?
- **Readability**
  - The tests are the definitive reference for the system requirements.
- **Maintainability**
  - Iterative, test-first development yields as much (or more) test code than system code
  - Thus we have to be as concerned (or more) with the maintenance costs of test code as compared to system code.

Testability

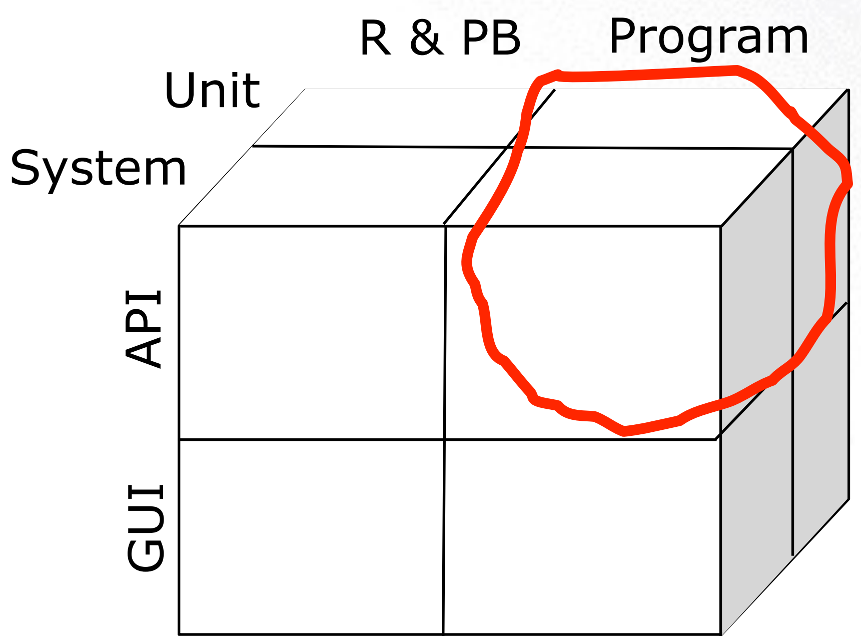
- Testability consists of two fundamental characteristics:
  - **Visibility** – the tester can see (and understand) what happens within the system (i.e. can observe important aspects of the internal state of the system)
  - **Control** – the tester can force interesting things to happen within the system (i.e. can control its behavior)

Testability doesn't just happen. It must be designed and built into a system.

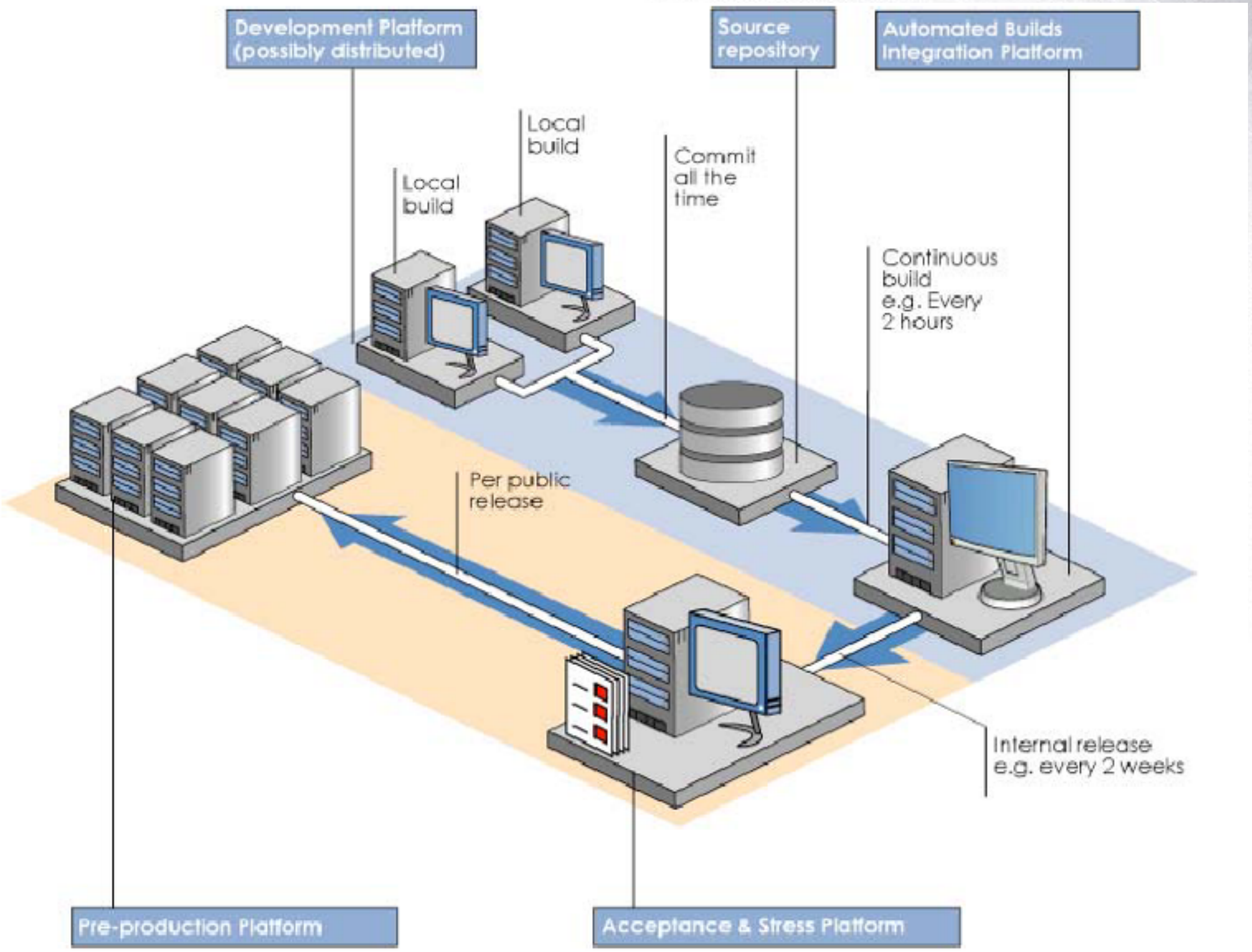
Writing tests before designing and building the system (a.k.a. Test-First or Test-Driven Development) is a great way of achieving good testability.

Classifying Automated Tests

- **Granularity**
  - Entire system
  - Individual units
- **Point of Contact**
  - Existing User Interface
  - Testability API
- **Test Case Production**
  - Record & Play Back
  - Hand Written (programmatic)



Test (and build) automation


Development Platform (possibly distributed)
Source repository
Automated Builds Integration Platform
Local build
Local build
Commit all the time
Continuous build e.g. Every 2 hours
Per public release
Internal release e.g. every 2 weeks
Pre-production Platform
Acceptance & Stress Platform

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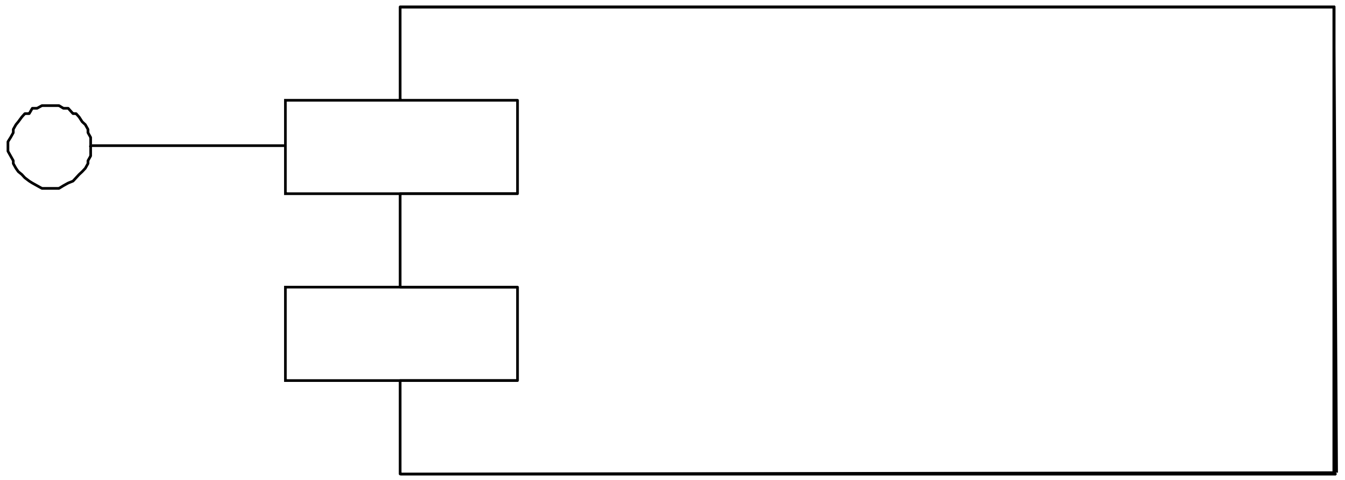
Introduction to
Unit Testing with JUnit and Eclipse

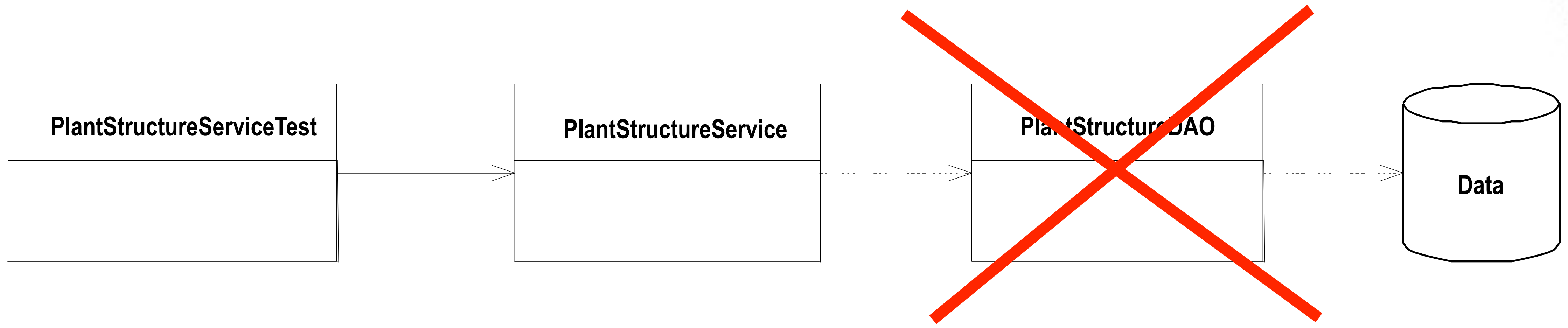
Unit Tests

- Black-box or White-box test of a *logical unit*, which verifies that the logical unit behaves correctly – *honors its contract*.



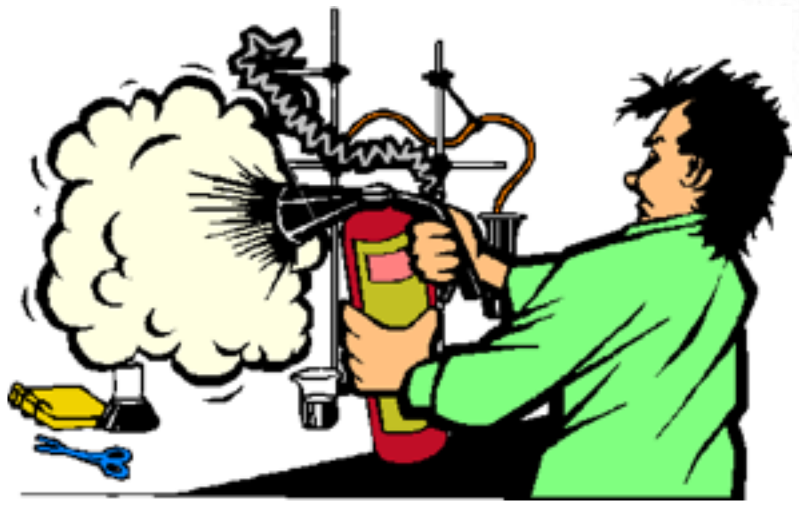
What exactly is a Unit Test?

- A self-contained software module (in OO languages typically a Class) containing one or more test scenarios which tests a Unit Under Test in isolation.
- Each test scenario is autonomous, and tests a separate aspect of the Unit Under Test.



Smoke Tests

- A set of Unit Tests (which tests a set of logical units) executed as a whole provides a way to perform a *Smoke Test*: Turn it on, and make sure that it doesn't come smoke out of it!
- A relatively cheap way to see that the units "seems to be working and fit together", even though there are no guarantees for its overall function (which requires functional testing)



Developer testing vs Acceptance testing

- Unit Tests are written by developers, for developers.
- Unit Tests do not address formal validation and verification of correctness (even though it has indirect impact on it!) - Unit Tests prove that some code does what we intended it to do
- Unit Tests complements Acceptance Tests (it does not replace it)

Why should I (as a Developer) bother?

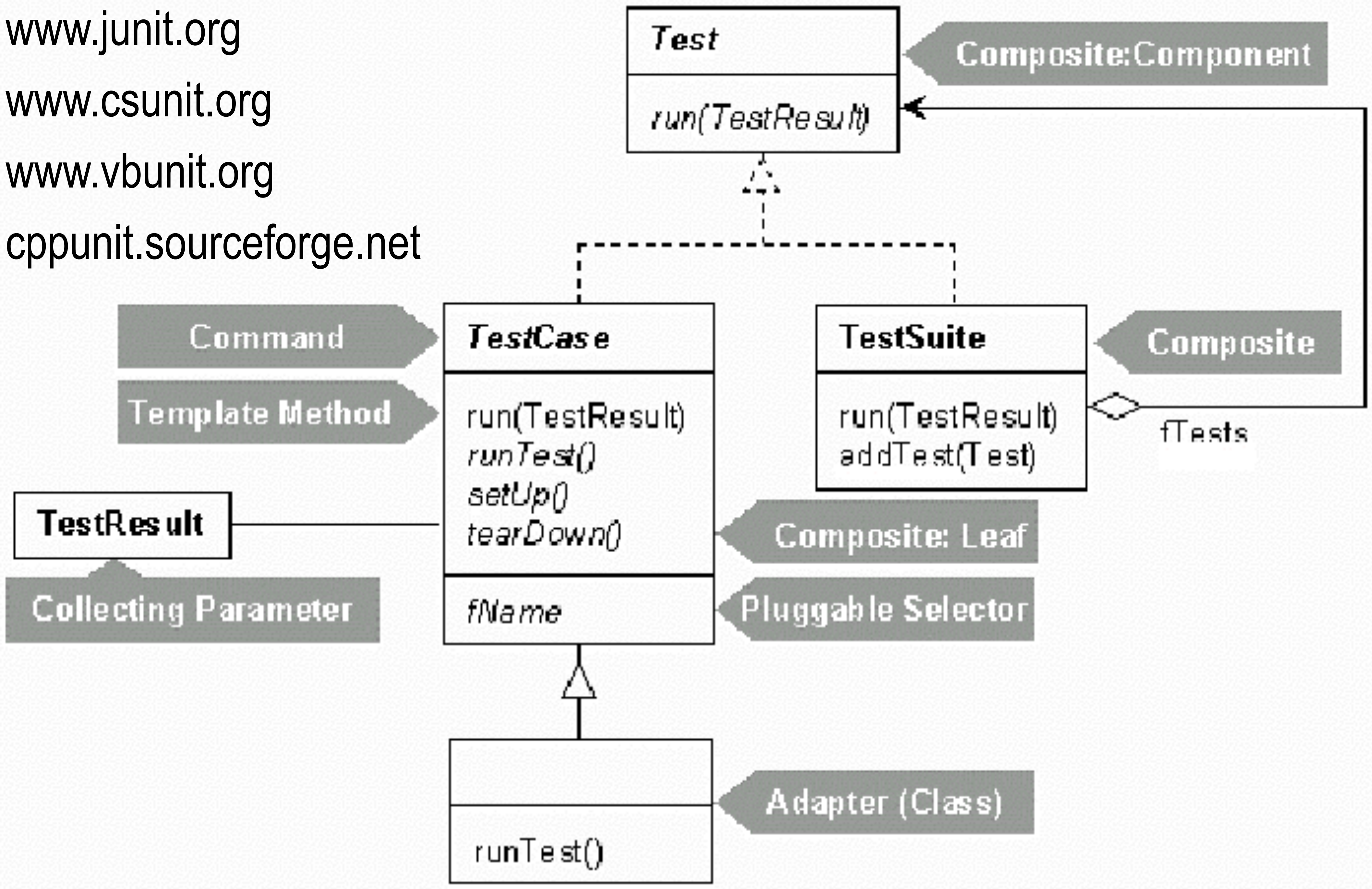
- Well-tested code works better. Customers like it better.
- Tests support refactoring. Since we want to ship useful function early and often, we know that we'll be evolving the design with refactoring.
- Tests give us confidence. We're able to work with less stress, and we're not afraid to experiment as we go.
- Hence Unit Testing will make my life easier
  - It will make my design better
  - It will give me the confidence needed to refactor when necessary
  - It will dramatically reduce the time I spend with the debugger
  - It will make me sleep better when deadlines are closing in

Requirements on Unit Tests

- Easy to write a test class
- Easy to find test classes
- Easy to test different aspects of a contract
- Easy to maintain tests
- Easy to run tests

XUnit: A Framework for Unit Tests

- www.junit.org
- www.csunit.org
- www.vbunit.org
- cppunit.sourceforge.net



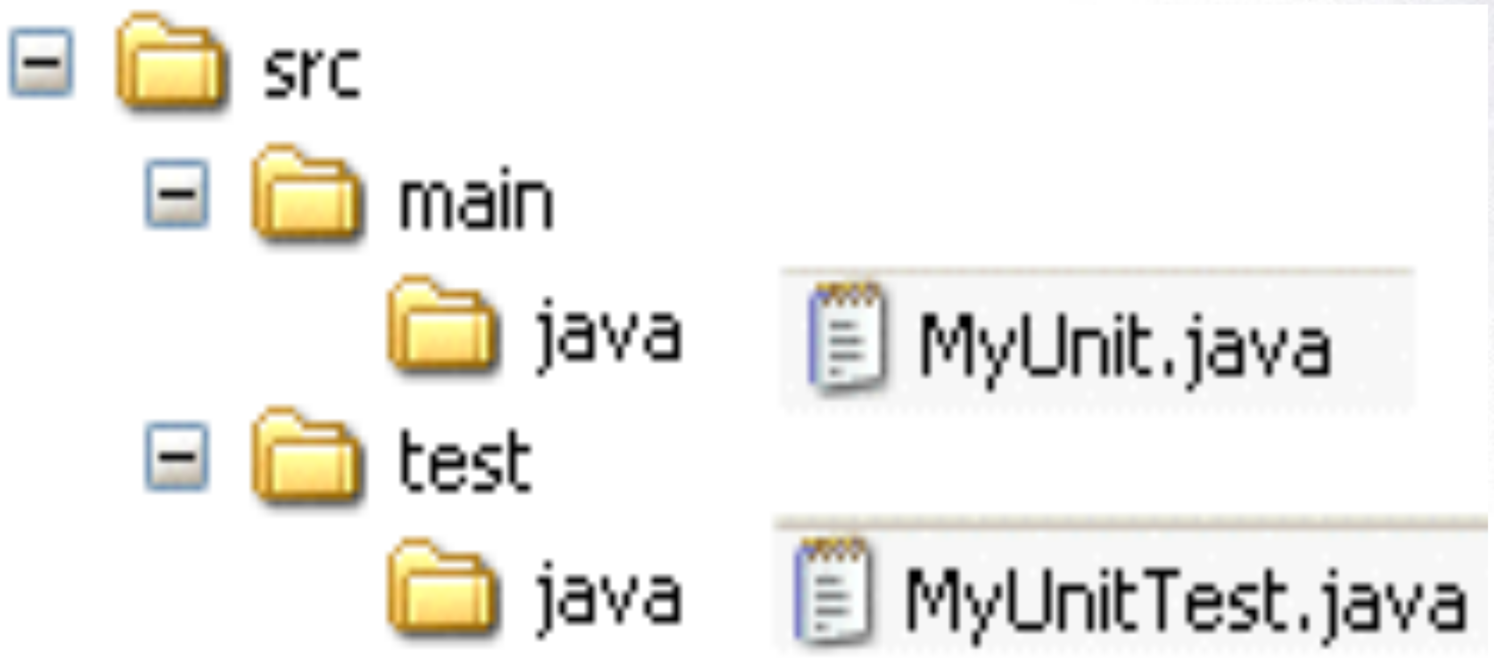
JUnit Test Example

```
public interface Account {
   public void deposit(int amount);
   public void withdraw(int amount) throws AccountException;
   public int getBalance();
      …
}

public class AccountImplTest {
    @Test
    public void testWithdraw() throws AccountException {
        AccountImpl account = new AccountImpl(“1234-9999”, 2000);
        account.withdraw(300);
        Assert.assertEquals(1700, account.getBalance());
     }

    @Test
   public void testWithdrawTooMuch() throws AccountException { … }
     …
}
```

Naming Conventions and Directory Structure

- Unit Tests should be named after the Unit that is tested, with "Test" appended.
  A class usually represents a noun, it is a model of a concept. An instance of one of your tests would be a 'MyUnit test'. In contrast, a method would model some kind of action, like 'test [the] calculate [method]'.

- the MyUnit test --> MyUnitTest
- test the calculate method --> testCalculate()
- JUnit tests should be placed within the same Java package as the Unit under Test, but in a different directory structure.



Test cases and test methods

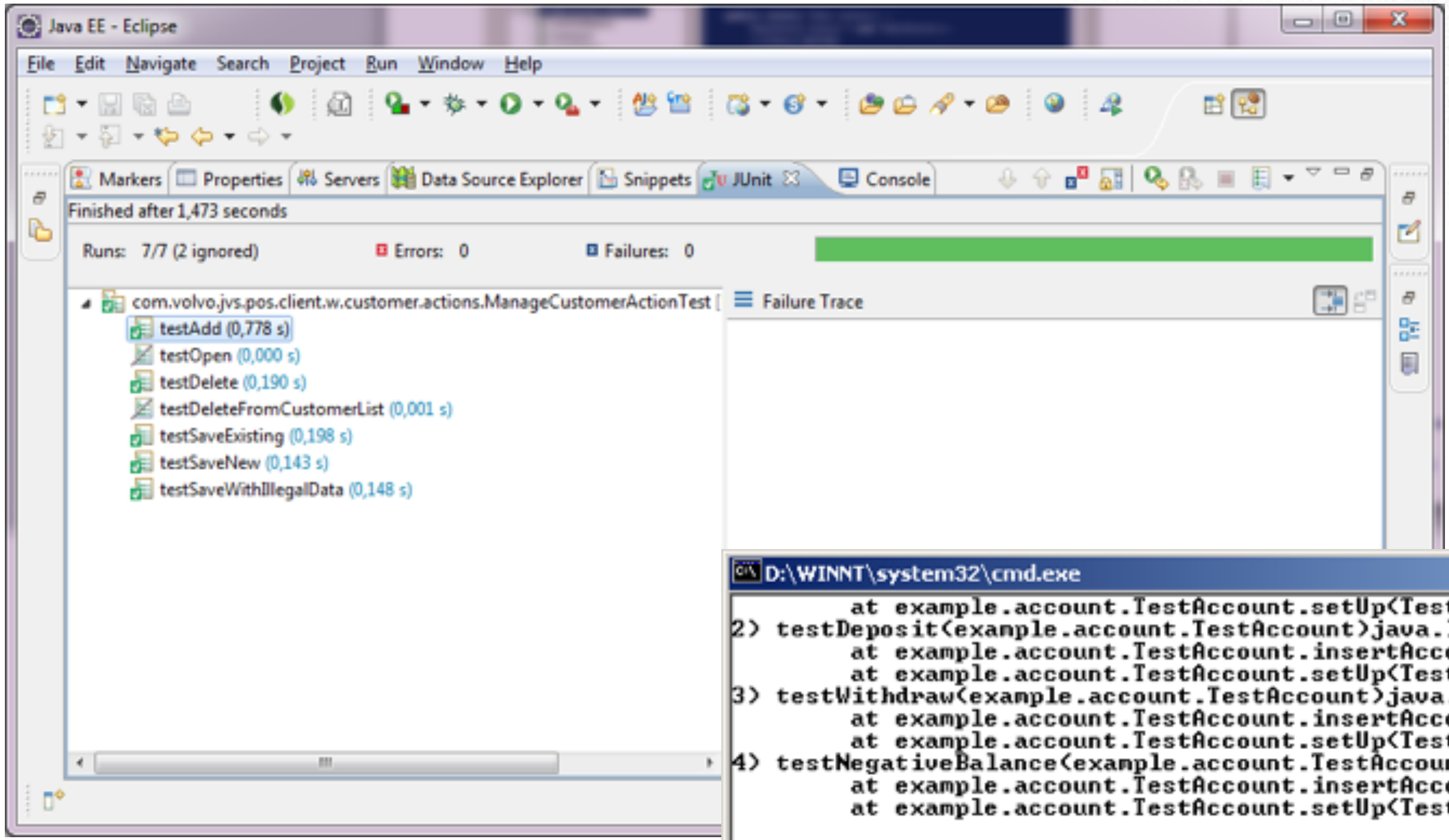
```
import org.junit.Assert;
import org.junit.Before;
import org.junit.Test;

public class AccountImplTest {
    @Test
    public void testWithdraw() throws AccountException {
        AccountImpl account = new AccountImpl(“1234-9999”, 2000);
        account.withdraw(300);
        Assert.assertEquals(1700, account.getBalance());
     }

    @Test
   public void testWithdrawTooMuch() throws AccountException { … }
     …
}
```

All methods annotated with @Test are considered test scenarios

Assert: Support for verifying conditions

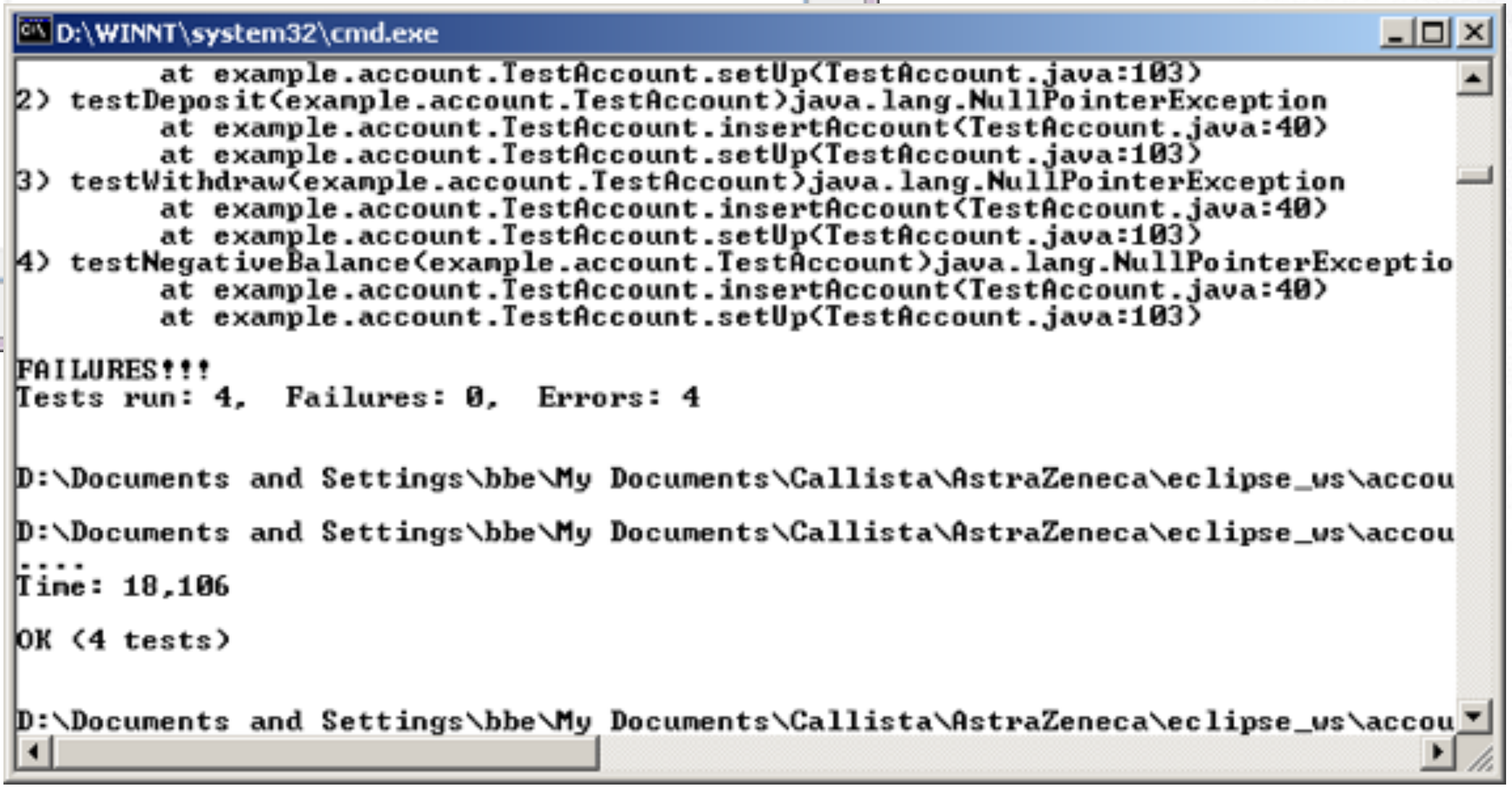
```
static void assertEquals(int expected, int actual);
          // Asserts that two ints are equal.

static void assertEquals(double expected, double actual, double delta);
          // Asserts that two doubles are equal concerning a delta.

static void assertEquals(java.lang.Object expected, java.lang.Object actual);
          // Asserts that two objects are equal.

static void assertFalse(java.lang.String message, boolean condition);
          // Asserts that a condition is false.

static void assertTrue (java.lang.String message, boolean condition);
          // Asserts that a condition is true.

static void assertNull(java.lang.String message, java.lang.Object object);
          // Asserts that an object is null.

static void assertNotNull(java.lang.String message, java.lang.Object object);
          // Asserts that an object isn't null.

// Etc…
```

Executing JUnit Tests: Test Runners



Java EE - Eclipse
File Edit Navigate Search Project Run Window Help
Markers Properties Servers Data Source Explorer Snippets JUnit Console
Failure Trace

```
Finished after 1,473 seconds

Runs: 7/7 (2 ignored)        Errors: 0        Failures: 0

com.volvo.jvs.pos.client.w.customer.actions.ManageCustomerActionTest [
    testAdd (0,778 s)
    testOpen (0,000 s)
    testDelete (0,190 s)
    testDeleteFromCustomerList (0,001 s)
    testSaveExisting (0,198 s)
    testSaveNew (0,143 s)
    testSaveWithIllegalData (0,148 s)
```



```
        at example.account.TestAccount.setUp(TestAccount.java:103)
2) testDeposit(example.account.TestAccount)java.lang.NullPointerException
        at example.account.TestAccount.insertAccount(TestAccount.java:40)
        at example.account.TestAccount.setUp(TestAccount.java:103)
3) testWithdraw(example.account.TestAccount)java.lang.NullPointerException
        at example.account.TestAccount.insertAccount(TestAccount.java:40)
        at example.account.TestAccount.setUp(TestAccount.java:103)
4) testNegativeBalance(example.account.TestAccount)java.lang.NullPointerExceptio
        at example.account.TestAccount.insertAccount(TestAccount.java:40)
        at example.account.TestAccount.setUp(TestAccount.java:103)

FAILURES!!!
Tests run: 4,  Failures: 0,  Errors: 4


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....
Time: 18,106

OK (4 tests)


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```
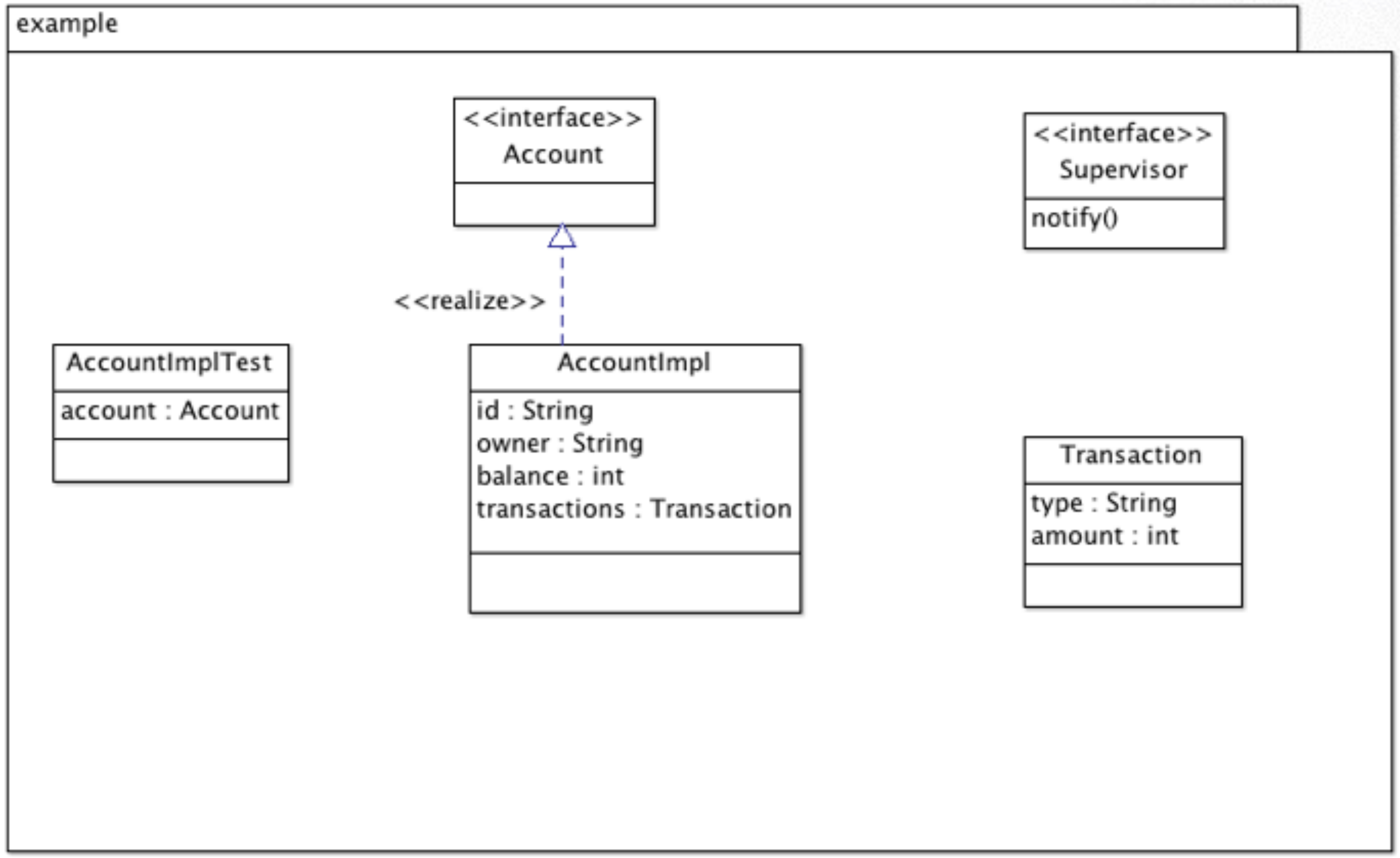

Exercise 1 description



Exercise 1

Sometimes you need to write Unit tests to already existing software when you want to implement a change request e.t.c. In this example we have the source code but no tests, your task is to write them.

- Create an Unit test case which tests the initial balance of an Account (i e. tests the constructor and GetBalance() method of Account).

```
@Test
public void testInitialBalance() { … }
```

- Add tests for the Deposit() method of Account.

```
@Test
public void testDeposit() { … }
```

Typical unit test scenario – The Three A’s

1. Arrange - Instantiate Unit under Test and set up test data
2. Act - Execute one or more methods on the Unit Under Test
3. Assert - Verify the results

```
public interface Account {
   public void deposit(int amount);
   public void withdraw(int amount) throws AccountException;
   public int getBalance();
    …
}
public class AccountImplTest {
    @Test
    public void testWithdraw() throws AccountException {
        AccountImpl account = new AccountImpl(“1234-9999”, 2000);    // ARRANGE
        account.withdraw(300);                                   // ACT
        Assert.assertEquals(1700, account.getBalance());             // ASSERT
     }
    … … …
}
```

General Rules of Thumb

- Create a single test class for each non-trivial application class you have.
- Give a readable, meaningful name to each test method. A good name candidates are to name the test method using the same name as the method that it is testing, with some additional info appended to the name. For instance if testing a method called "***Withdraw***" in an Account class, create a few test methods to test different ways of withdrawal:

```java
@Test
public void testWithdrawTooMuch() throws AccountException {…}
@Test
public void withdrawBigAmount() throws AccountException {…}
@Test
public void withdrawNegativeAmount() throws AccountException {…}
```

- The scope of how much checking to do in a single test case (test method) is a judgment call. It is usually better to test only one scenario (and hence one potential error condition) in each test method. Remember : tests should be “to the point”.

Setup and teardown

- Methods annotated with `@Before` are executed *before every test method.*
- Methods annotated with `@After` are executed *after every test method.*

```
public class AccountImplTest {

     private AccountImpl account;

     @Before
     public void setUp() {
          account = new AccountImpl("1234-9999", 2000);
     }
     @Test
     public void testInitialBalance() {
          int actualBalance = account.getBalance();
          Assert.assertEquals(2000, actualBalance);
     }
     @Test
     public void testWithdraw() throws AccountException {
          account.withdraw(300);
               int actualBalance = account.getBalance();
          Assert.assertEquals(1700, actualBalance);
     }
   …
}
```

Working with Exceptions

- Unexpected exceptions thrown during execution of a test will be caught by the JUnit framework and reported as Errors (i.e. test will fail)
- A Test method must declare that it throws any checked exceptions that the Unit under Test may throw. If there are several checked exceptions that may occur, it is perfectly valid for a test method to declare throwing java.lang.Exception.
- Expected exceptions (exceptions that the test is expecting the Unit under Test should throw in a certain situation) are expressed using the `@Test(expected=ExpectedException.class)` attribute

```
@Test(expected=NastyException.class)
public void doSomethingNastyTest() {
   SomeUnit target = new SomeUnit();
   target.doSomethingNasty();
}
```

Working with Exceptions (Contd.)

- Or using the following idiom:

```
SomeUnit target = new SomeUnit();
try {
  target.doSomethingNasty();
  Assert.fail("NastyException expected");
} catch (NastyException expected) {
  // Expected
}
```

Ignore a Test

- To temporary ignore a test, use the Ignore attribute:

```
@Test
@Ignore("Not right now, but most definitely later")
public void testThatDoesNotWorkYet(){
   SomeUnit target = new SomeUnit();
    target.doSomethingThatDoesNotWork();
    Assert.assertTrue(target.isValid());
}
```

Exercise 2

- Refactor your test data from the last example into a @Before setUp() method
- Add tests for the withdraw() method.

Testing private or protected methods/members

In principle you got four options

- Don't test private methods. (Good or Bad?)
- Give the methods package access. (Good or Bad?)
- Use a nested test class. (Does it work?)
- Use reflection. (Is this good?)

http://stackoverflow.com/questions/34571/whats-the-proper-way-to-test-a-class-with-private-methods-using-junit

Testing private or protected methods/members

The best way to test a private method is via another public method. If this cannot be done, then one of the following conditions is true:

1. The private method is dead code
2. There is a design smell near the class that you are testing
3. The method that you are trying to test should not be private

When I have private methods in a class that is sufficiently complicated that I feel the need to test the private methods directly, that could be a code smell: my class is too complicated.

But, it might also be SDK or Framework code or Security or encryption/decryption code. That type of code also need tests, but no publicity…