

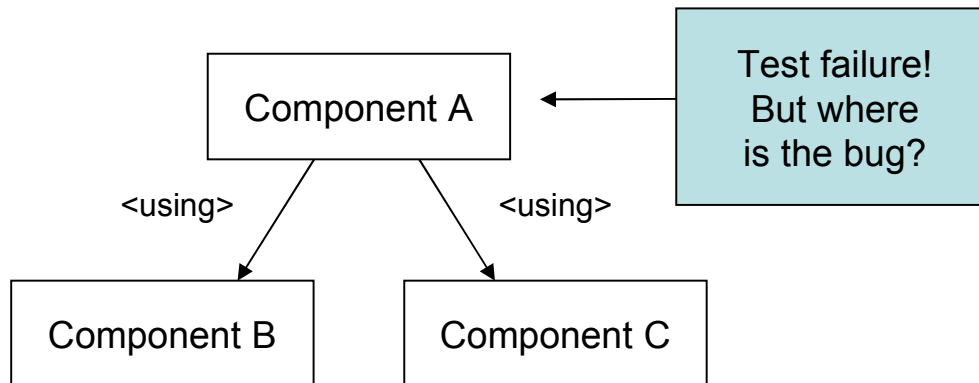
Unit Testing

and

JUnit

Problem area

- Code components must be tested!
 - Confirms that your code works
- Components must be tested in isolation
 - A functional test can tell you that a bug exists in the implementation
 - A unit test tells you where the bug is located



Example: The Calculator

```
public interface Calculator
{
    int add( int number1, int number2 );

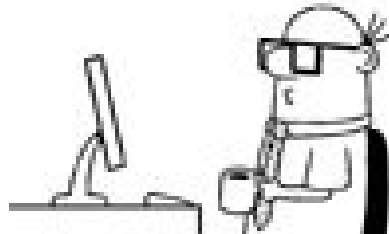
    int multiply( int number1, int number2 );
}
```

```
public class DefaultCalculator
    implements Calculator
{
    public int add( int number1, int number2 )
    {
        return number1 + number2;
    }

    public int multiply( int number1, int number2 )
    {
        return number1 * number2;
    }
}
```

Approaches to unit testing

- Write a small command-line program, enter values, and verify output
 - Involves your ability to type numbers
 - Requires skills in mental calculation
 - Doesn't verify your code when its released



Approaches to unit testing

- Write a simple test program
 - Objective and preserves testing efforts
 - Requires you to monitor the screen for error messages
 - Inflexible when more tests are needed

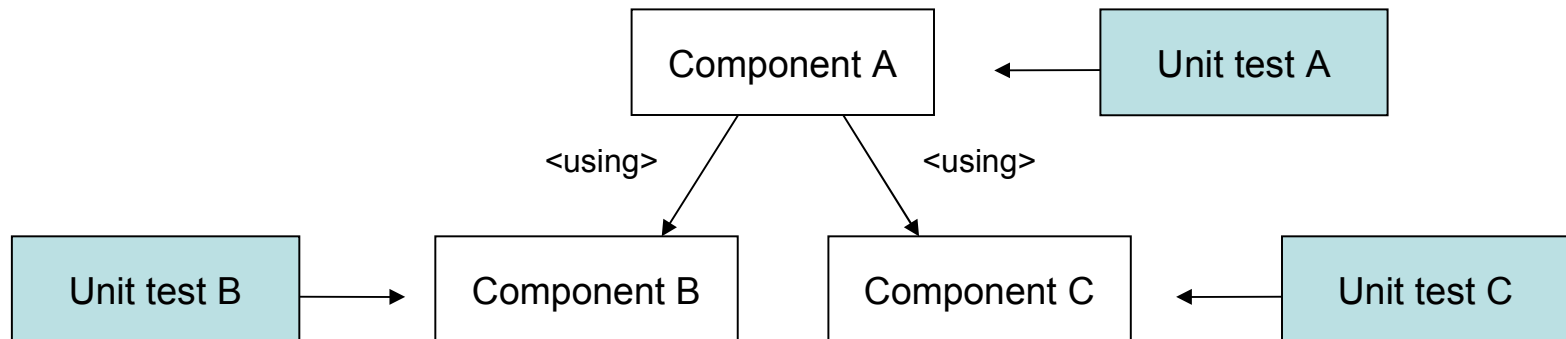
```
public class TestCalculator
{
    public static void main( String[] args )
    {
        Calculator calculator = new DefaultCalculator();

        int result = calculator.add( 8, 7 );

        if ( result != 15 )
        {
            System.out.println( "Wrong result: " + result );
        }
    }
}
```

The preferred solution

- Use a unit testing framework like *JUnit*
- A *unit* is the smallest testable component in an application
- A unit is in most cases a *method*
- A unit does not depend on other components which are *not unit tested themselves*
- Focus on whether a method is following its *API contract*



JUnit

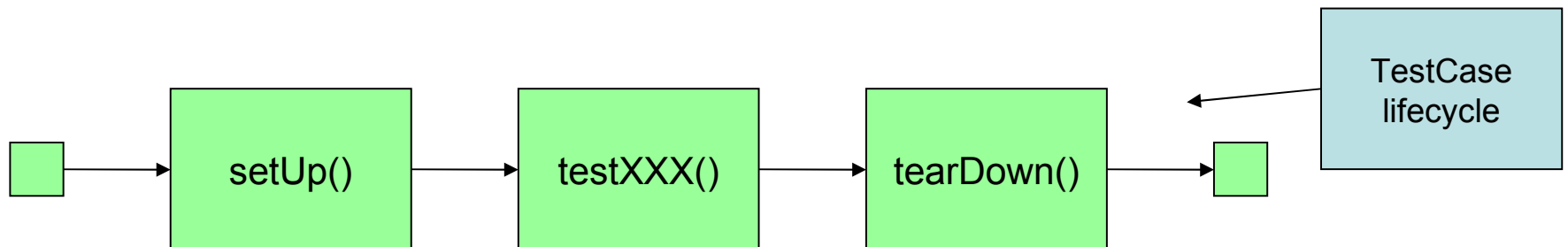
- *De facto* standard for developing unit tests in Java
 - One of the most important Java libraries ever developed
 - Made unit testing easy and popular among developers
 - Driven by annotations
 - Spring provides integration with JUnit

Using Junit annotations

- No need to follow naming conventions
 - Tests identified by the `@Test` annotation
 - Fixture methods identified by `@Before` and `@After` annotations
- Class-scoped fixture
 - Identified by the `@BeforeClass` and `@AfterClass` annotations
 - Useful for setting up expensive resources, but be careful...
- Ignored tests
 - Identified by the `@Ignore` annotation
 - Useful for slow tests and tests failing for reasons beyond you
- Timed tests
 - Identified by providing a parameter `@Test(timeout=500)`
 - Useful for benchmarking, network, deadlock testing

Test fixtures

- Tests may require common resources to be set up
 - Complex data structures
 - Database connections
- A *fixture* is a set of common needed resources
- A fixture can be created by overriding the *setUp* and *tearDown* methods from `TestCase`
- *setUp* is invoked before each test, *tearDown* after



JUnit Calculator test

Static import of Assert

Fixture

Fixture

Use assertEquals to
verify output

```
import static junit.framework.Assert.*;

public class CalculatorTest
{
    Calculator calculator;

    @Before
    public void before()
    {
        calculator = new DefaultCalculator();
    }

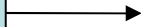
    @Test
    public void addTest()
    {
        int sum = calculator.add( 8, 7 );

        assertEquals( sum, 15 );
    }

    @Test
    public void deleteTest()
    {
    }
}
```

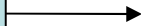
Example: The EventDAO

Event object



```
public class Event()  
{  
    private int id;  
    private String title;  
    private Date date;  
  
    // constructors  
    // get and set methods  
}
```

EventDAO interface



```
public interface EventDAO  
{  
    int saveEvent( Event event );  
  
    Event getEvent( int id );  
  
    void deleteEvent( Event event );  
}
```

EventDAOTest

Assert imported statically

Fixture method identified by the `@Before` annotation

Test identified by the `@Test` annotation. Test signature is equal to method signature.

Test being ignored

```
import static junit.framework.Assert.assertEquals;
```

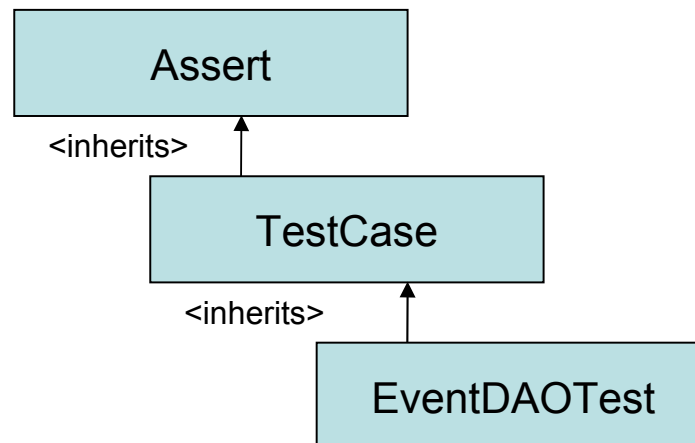
```
@Before  
public void init()  
{  
    eventDAO = new MemoryEventDAO();  
    event = new Event( "U2 concert", date );  
}
```

```
@Test  
public void saveEvent()  
{  
    int id = eventDAO.saveEvent( event );  
  
    event = eventDAO.getEvent( id );  
  
    assertEquals( id, event.getId() );  
}
```

```
@Test @Ignore  
Public void getEvent()  
{  
    // Testing code...  
}
```

The Assert class

- Contains methods for testing whether:
 - Conditions are true or false
 - Objects are equal or not
 - Objects are null or not
- If the test fails, an `AssertionFailedError` is thrown
- All methods have overloads for various parameter types
- Methods available because *TestCase* inherits *Assert*



Assert methods

<i>Method</i>	<i>Description</i>
assertTrue(boolean)	Asserts that a condition is true.
assertFalse(boolean)	Asserts that a condition is false.
assertEquals(Object, Object)	Asserts that two objects are equal.
assertNotNull(Object)	Asserts that an object is <i>not</i> null.
assertNull(Object)	Asserts that an object is null.
assertSame(Object, Object)	Asserts that two references refer to the same object.
assertNotSame(Object, Object)	Asserts that two references do <i>not</i> refer to the same object.
fail(String)	Asserts that a test fails, and prints the given message.

Assert in EventDAOTest

Asserts that the saved object is equal to the retrieved object

Saves and retrieves an Event with the generated identifier

An object is expected

Asserts that null is returned when no object exists

```
@Test
public void testSaveEvent()
{
    int id = eventDAO.saveEvent( event );

    event = eventDAO.getEvent( id );

    assertEquals( id, event.getId() );
    assertEquals( "U2 concert", event.getTitle() );
}

@Test
public void testGetEvent()
{
    int id = eventDAO.saveEvent( event );

    event = eventDAO.getEvent( id );

    assertNotNull( event );

    event = eventDAO.getEvent( -1 );

    assertNull( event );
}
```

Testing Exceptions

- Methods may be required to throw exceptions
- Expected exception can be declared as an annotation
 - `@Test(expected = UnsupportedOperationException.class)`

Annotation declares that an exception of class `UnsupportedOperationException` is supposed to be thrown

```
@Test( expected = UnsupportedOperationException.class )  
public void divideByZero()  
{  
    calculator.divide( 4, 0 );  
}
```

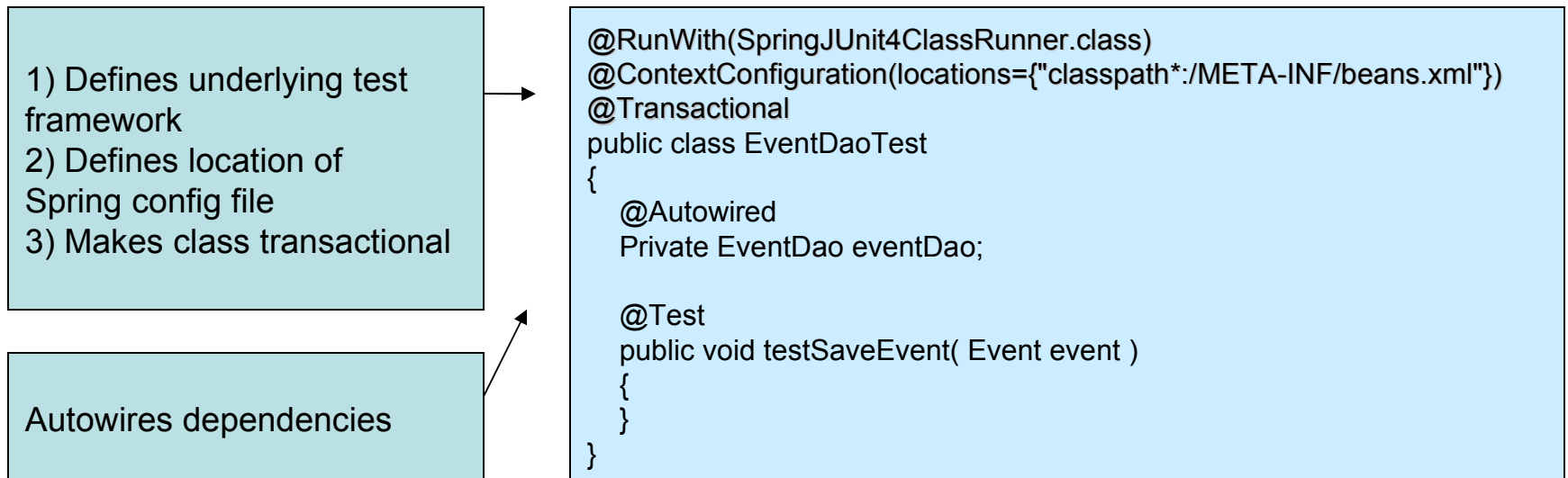

Running JUnit

- Textual test runner
 - Used from the command line
 - Easy to run
- Integrate with Eclipse
 - Convenient, integrated testing within your development environment!
- Integrate with Maven
 - Gets included in the build lifecycle!

Spring test support

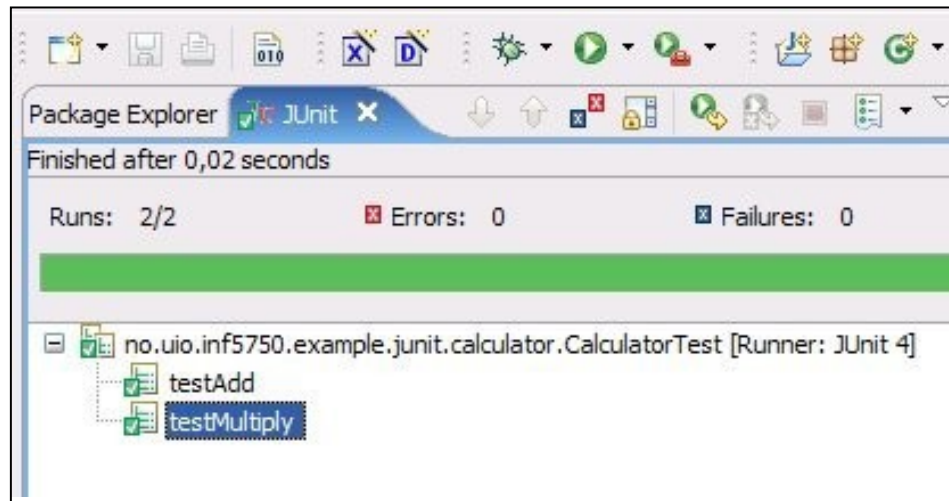
- Spring has excellent test support providing:
 - IoC container caching
 - Dependency injection of test fixture instances / dependencies
 - Transaction management and rollback

Spring (spring-test) integrates nicely with Junit



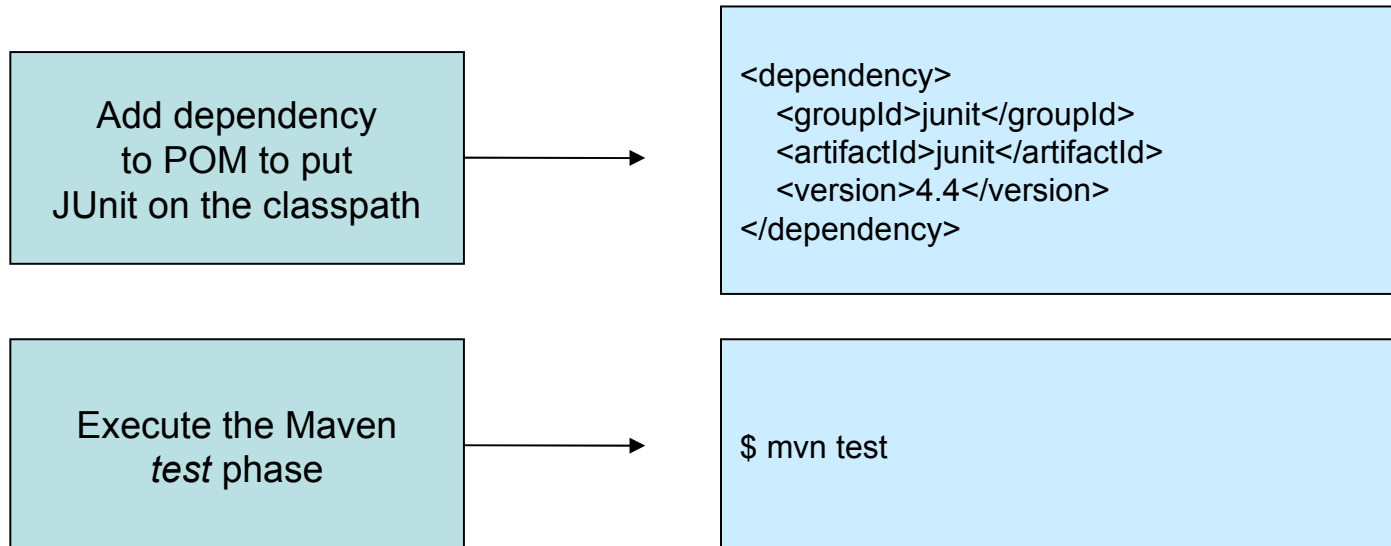
JUnit with Eclipse

- Eclipse features a JUnit view
- Provides an informativ GUI displaying test summaries
- Lets you edit the code, compile and test without leaving the Eclipse environment



JUnit with Maven

- Maven provides support for automated unit testing with JUnit
- Unit testing is included in the build lifecycle
 - Verifies that existing components work when other components are added or changed



JUnit with Maven

- Maven requires all test-class names to contain *Test*
- Standard directory for test classes is `src/test/java`
- The *test* phase is mapped to the *Surefire* plugin
- Surefire will generate reports based on your test runs
- Reports are located in *target/surefire-reports*

```
-----
T E S T S
-----
Running no.uio.inf5750.example.junit.calculator.CalculatorTest
Tests run: 2, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 0.09 sec
Running no.uio.inf5750.example.junit.event.EventDAOTest
Tests run: 3, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 0.03 sec

Results :
Tests run: 5, Failures: 0, Errors: 0, Skipped: 0

[INFO] -----
[INFO] BUILD SUCCESSFUL
[INFO] -----
[INFO] Total time: 2 seconds
[INFO] Finished at: Sun Sep 16 13:40:58 CEST 2007
[INFO] Final Memory: 3M/127M
[INFO] -----
```

Best practises

- One unit test for each tested method
 - Makes debugging easier
 - Easier to maintain
- Choose descriptive test method names
 - TestCase: Use the testXXX naming convention
 - Annotations: Use the method signature of the tested method
- Automate your test execution
 - If you add or change features, the old ones must still work
 - Also called *regression testing*
- Test more than the "happy path"
 - Out-of-domain values
 - Boundary conditions

Advantages of unit testing

- Improves debugging
 - Easy to track down bugs
- Facilitates refactoring
 - Verifies that existing features still work while changing the code structure
- Enables teamwork
 - Lets you deliver tested components without waiting for the whole application to finish
- Promotes object oriented design
 - Requires your code to be divided in small, re-usable units
- Serving as developer documentation
 - Unit tests are samples that demonstrates usage of the API

Resources

- Vincent Massol: *JUnit in Action*
 - Two free sample chapters
 - <http://www.manning.com/massol>
- JUnit home page (www.junit.org)
 - Articles and forum
- Articles
 - <http://www-128.ibm.com/developerworks/java/library/j-junit4.html>
 - <http://www-128.ibm.com/developerworks/opensource/library/os-junit/>
- Spring documentation chapter 9