

Beyond Unit Testing

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About Us

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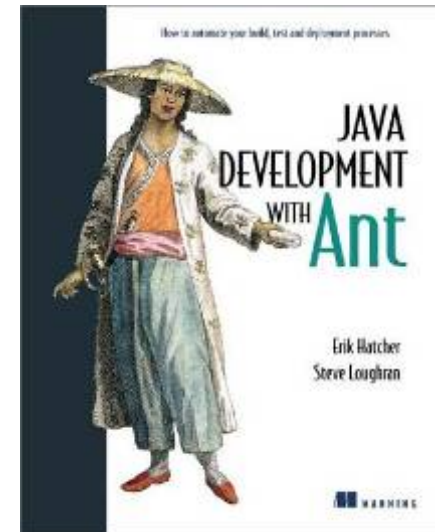
Research scientist at HP Laboratories on
Grid-Scale Deployment

Apache Ant & Axis committer

Co-author of

Java Development with Ant

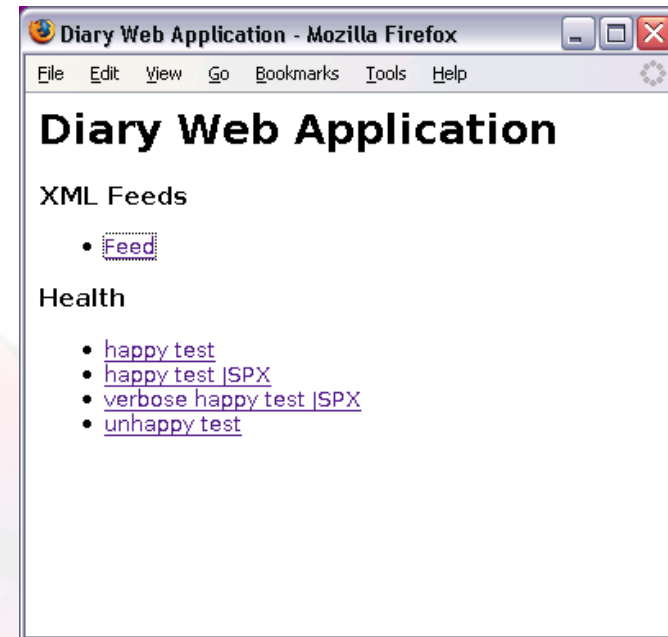
Behind schedule on the 2nd edition



two different distributed systems



CERN Large Hadron Collider



Multi-tier webapp

How do you show it works?



- Europe's high-end server farms
- Years of simulations
- Nobel Prize winners, Computer Scientists and physics PhD students
- An old laptop nobody wants
- Any spare time before you ship
- You

Classic unit tests

- Run in a test harness
- Don't stress the system
- Don't run on real servers
- Don't run with real data



A modest proposal

Write less Unit Tests!

Apply Formal Methods!

- Integrating *Formal Methods* with XP development.
- How to use *axiomatic theorem proofs* to verify correctness in a large-scale distributed system.
- How Milner's *π -calculus* is the underpinnings for the BPEL workflow language.
- *Continuations vs. bisimilar state machines* -which is better for correctness proofs?
- How relaxing your *concurrency constraints* results in higher throughput.



Or:
System Testing

System Tests



- Deploy the app
- Add a real dataset
- Use the app server
- Remotely test from other sites/hosts
- Test in the client
- Are big, complex and distributed

How to test big systems

- Simulate the production system.
- Automate deployment
- Write functional tests
- Remote test from clients

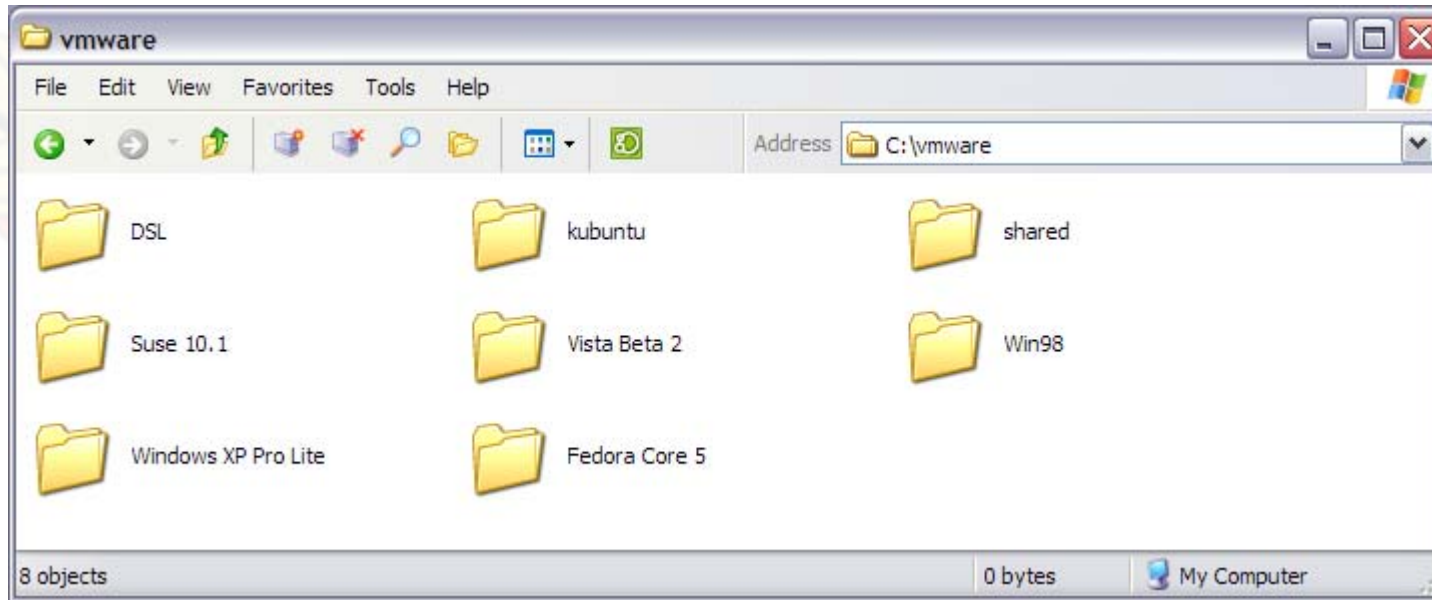
Simulate the production system
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Remote test from clients

Embrace Virtualization

- VMWare player free; workstation for \$£€
- Create VM images that resemble production configurations.
- Deploy and test into virtual machines
- Host continuous integration server in VMs
- Simulate complex/broken networks



...and become a cluster admin



- PXE System Installers: linuxcoe.sf.net
- Auto-rollback images during test *and* production
- Isolate insecure platforms on virtual network

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Automate app deployment

- RPM/APT/.msi packages pushed out to hosts
- *SmartFrog*: <http://smartfrog.org/>
- *Cargo*: <http://cargo.codehaus.org>
- Shell Scripts
- Ant build files using scp, ssh

Database setup

- Data setup is too time consuming to do every test
- Use the same DB that production will have.
- Automated set up of the database
- keep this DB snapshot and revert to it after a run.
(or the entire virtual machine image)

```
<mysql-admin>  
  CREATE DATABASE diary;  
  GRANT ALL PRIVILEGES ON diary.*  
    TO 'diary'@'localhost';  
  SET PASSWORD FOR 'diary'@'localhost' =  
    PASSWORD('${mysql.diary.pass}');  
</mysql-admin>
```

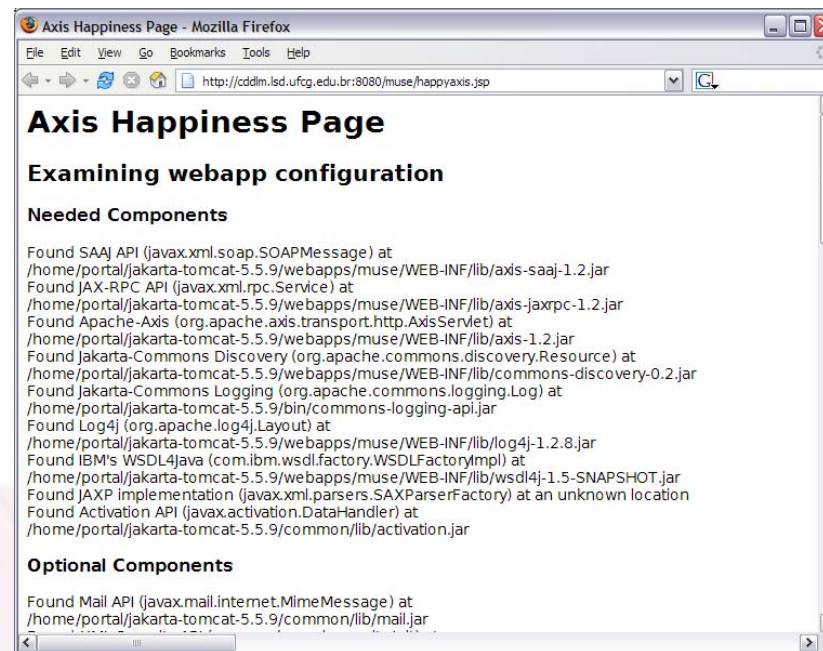
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What to test?

- system health tests
- In-container unit tests
- Remote web service/HTML tests
- In-browser GUI testing
- Load tests
- Network failure simulations
- ...

Health Test: “happy pages”

```
<%@ taglib uri="/WEB-INF/diary.tld"
  prefix="h" %>
<body>
<ha:happy
  classMustExist="org.jdom.JDOMException"
  errorText="JDom missing"/>
We are happy
</body>
</html>
```

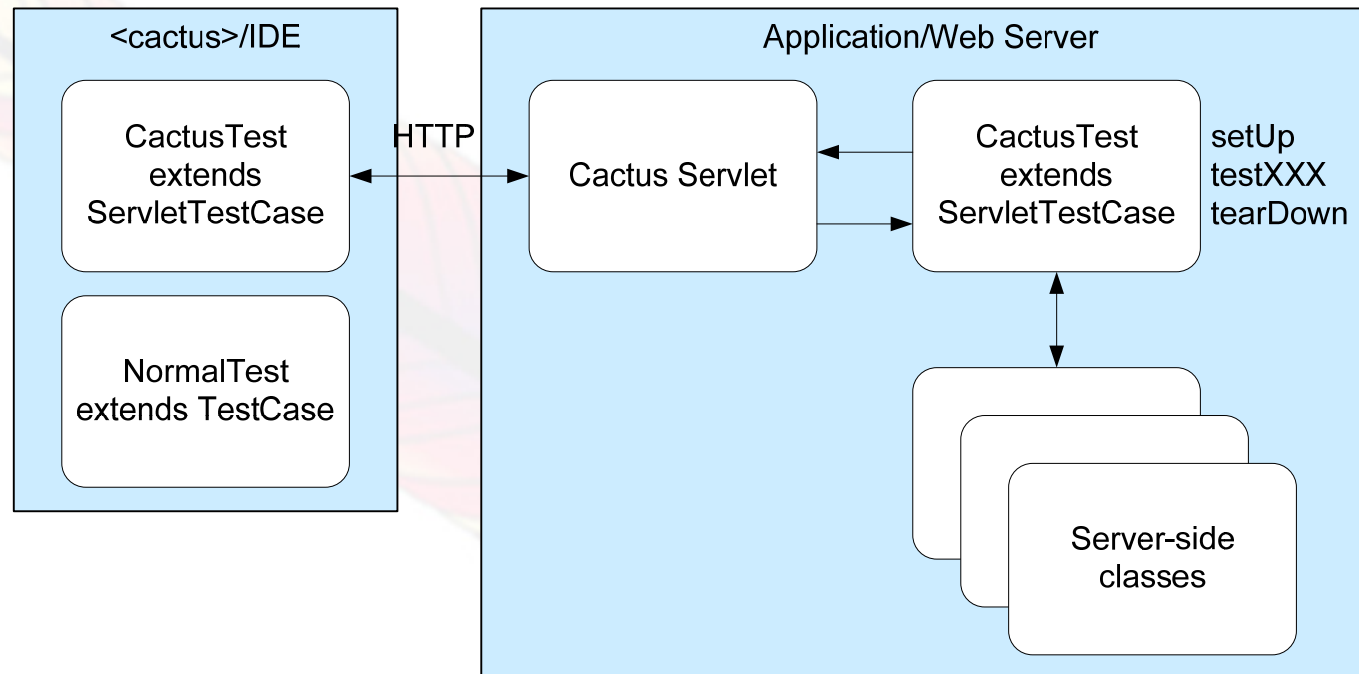


Delegate to machines:

```
<waitfor maxwait="30" maxwaitunit="second"
  timeoutproperty="unhappy">
  <http url="http://server/happyaxis.jsp"/>
</waitfor>
<fail if="unhappy"/>
```


Test in-container with cactus

Simulate the production system
Automate deployment
Write functional tests
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Cactus Test Case

```
public class CactusPersistTest extends ServletTestCase {
    private static int counter = 0;
    private SessionFactory factory;

    public void testPersist() throws Exception {
        Event event = createTestEvent();
        Session session = factory.openSession();
        try {
            session.persist(event);
        } finally {
            session.close();
        }
        assertEventIsInDB(event);
    }
}
```

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<cactus> task *choreographs*

```
<cactus:cactus warfile="${cactus.war}"
  errorProperty="cactus.failed" failureProperty="cactus.failed">
  <containerset>
    <generic name="server" port="8080">
      <startup>
        <copy file="${cactus.war}" tofile="${cactus.destfile}"
          overwrite="true"/>
      </startup>
      <shutdown>
        <delete file="${cactus.destfile}"/>
      </shutdown>
    </generic>
  </containerset>
  <classpath><path refid="test.classpath"/></classpath>
  <formatter type="xml"/>
  <batchtest todir="${test.data.dir}">
    <fileset dir="test" includes="**/*Test.java">
  </batchtest>
</cactus:cactus>
```

Cactus Demo

```
C:\WINDOWS\system32\cmd.exe
[junit] at org.hibernate.hql.antlr.HqlBaseParser.queryRule(HqlBaseParser
.java:708)
[junit] at org.hibernate.hql.antlr.HqlBaseParser.selectStatement(HqlBase
Parser.java:296)
[junit] at org.hibernate.hql.antlr.HqlBaseParser.statement(HqlBaseParser
.java:159)
[junit] at org.hibernate.hql.ast.QueryTranslatorImpl.parse(QueryTranslat
orImpl.java:236)
[junit] at org.hibernate.hql.ast.QueryTranslatorImpl.doCompile(QueryTran
slatorImpl.java:153)

[junit] Test dl.webapp.test.cactus.GroupEventsTest FAILED
[junit] Testsuite: dl.webapp.test.cactus.StubTest
[junit] Tests run: 1, Failures: 0, Errors: 0, Time elapsed: 0.19 sec

[echo] shutdown finished
[junitreport] Transform time: 1301ms

BUILD FAILED
C:\Personal\examples\diary\persist-webapp\webapp-chapter-14.xml:657: Tests faile
d. Check C:\Personal\examples\diary\persist-webapp\build\test\reports

Total time: 12 seconds
C:\Personal\examples\diary\persist-webapp>
```

- Needs classpath right for client and server
- cactus servlet is possible security risk

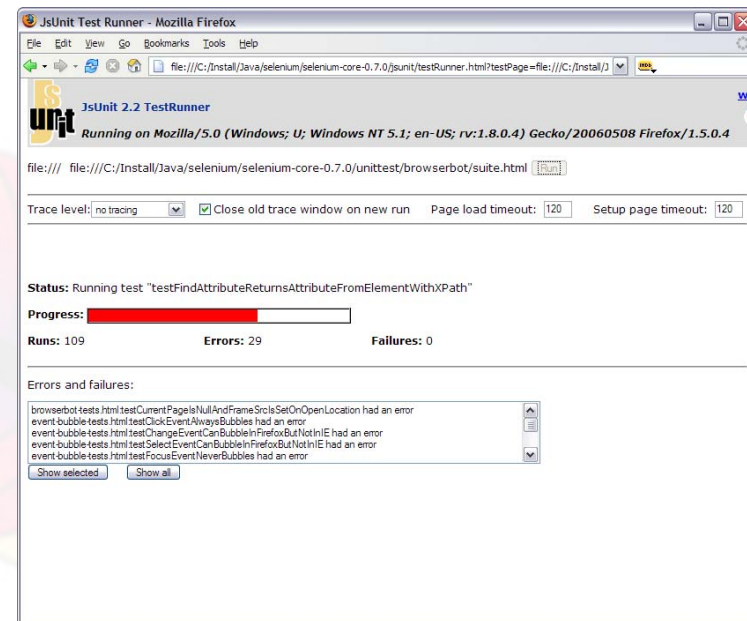
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GUI testing hurts

- Static HTML is the easiest (HttpUnit)
- Swing, DHTML, SWT, Flash hard.
- Most people stop at the “model”
- Whoever does a new GUI -fix this!

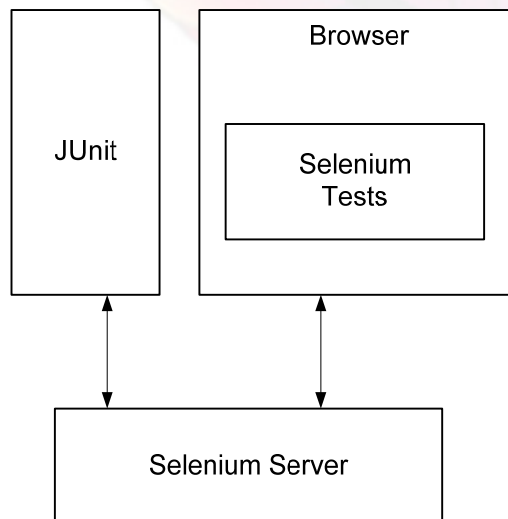
jsUnit is JUnit for JavaScript

```
function test3() {  
  var buffer = top.testManager.documentLoader.buffer();  
  var emps = buffer.document.getElementsByTagName('employee');  
  assert('expected 5 employees, not ' + emps.length,  
    emps.length == 5);  
  var empid = emps[0].getElementsByTagName('employeeId');  
  assert('employeeId[0] was '  
    + empid[0].firstChild.data,  
    empid[0].firstChild.data == 'EMP0001');  
}
```



Selenium: tests in a table

```
<tr>
  <td>verifyTitle</td>
  <td>Click Page Target</td>
  <td>&nbsp;</td>
</tr>
```



The screenshot shows the Selenium Functional Test Runner interface. The main window displays a table of test results for a test suite named 'Test selectWindow'. The table lists various test methods and their outcomes. On the right, there is a 'Selenium TestRunner' control panel with options to 'Run', 'Walk', or 'Step' through tests, and a summary of test results. Below the table, a section titled 'Contrived Application Under Test (AUT)' shows a sample web page with a form and text.

Test Suite	Test	Result
TestOpen	open	../tests/html/test_select_windo
TestClick	click	popupPage
TestClickjavascript-H	waitForPopUp	myPopupWindow
TestType	selectWindow	myPopupWindow
TestSelect	verifyLocation	/tests/html/test_select_windov
TestMultiSelect	verifyTitle	Select Window Popup
TestSubmit	close	
TestCheckUncheck	selectWindow	null
TestSelectWindow	verifyLocation	/tests/html/test_select_windov
TestStore	click	popupPage
TestjavascriptParam	click	popupPage
TestPause	waitForPopUp	myNewWindow
TestWait	waitForPopUp	myNewWindow

Contrived Application Under Test (AUT)
this is the span
Line 1
Line 2
the text value second option
a b
c d

WS Interop Testing

- Use the real client API/classes
- Pass down URLs via system properties

```
protected String getOption(String property,  
    boolean required) {  
    String option = System.getProperty(property);  
    if (required && option== null) {  
        fail("No property " + property);  
    }  
    return option;  
}
```

- Test different endpoints in parallel processes
- Include timeouts; proxy support
- Log for blame assignment

Simulate the production system
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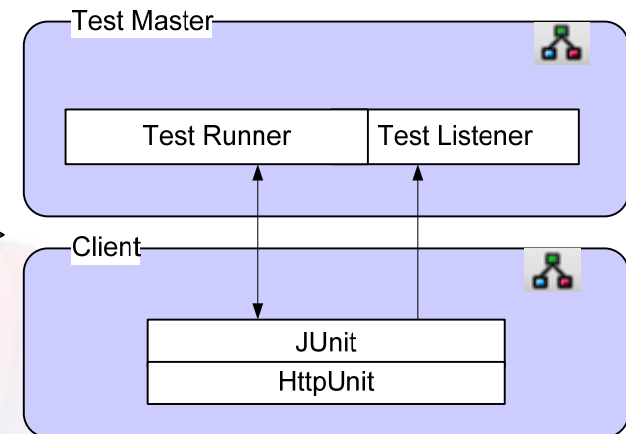
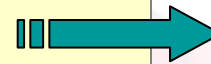
Distributed Testing

- Allocate & configure test systems
- Deploy application across nodes
- Deploy tests on other nodes
- Collect and correlate results
- Try to understand what went wrong

SmartFrog

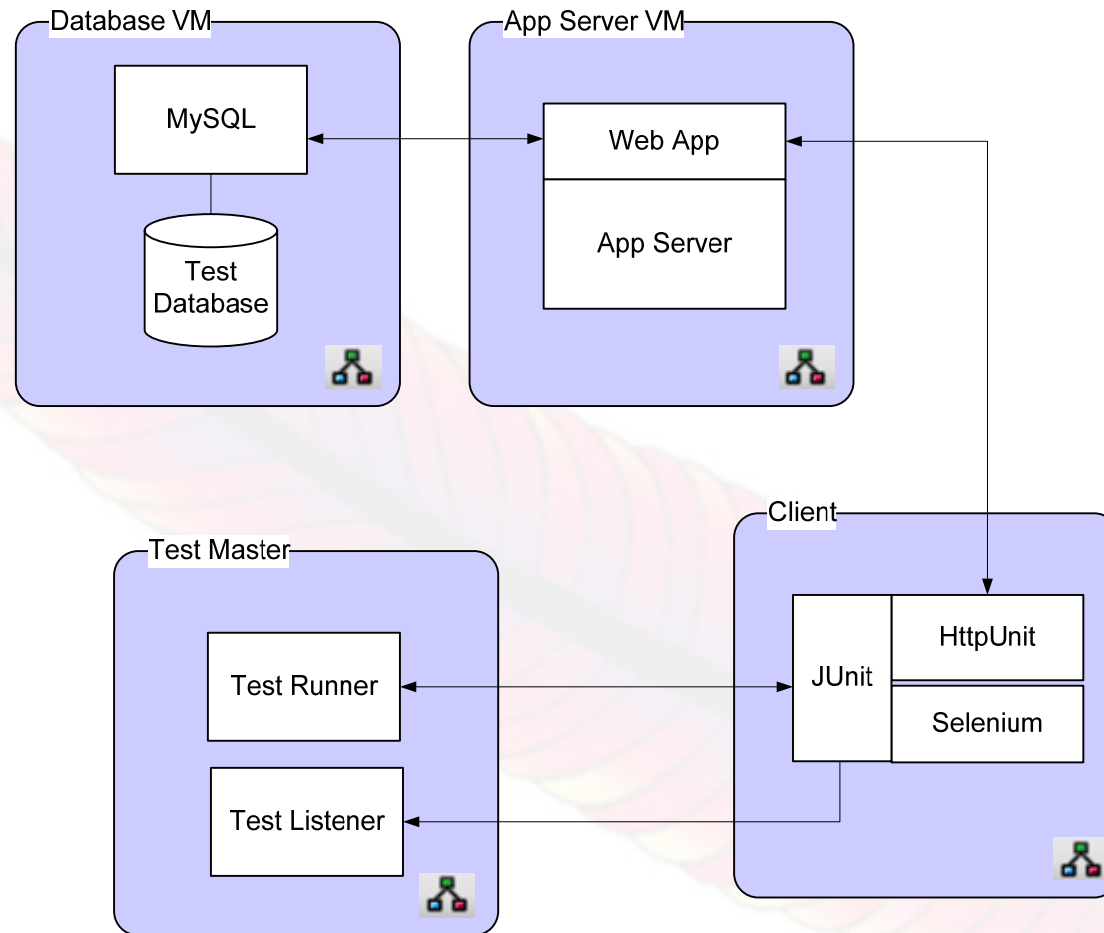
A framework for describing, deploying and managing distributed service components.

```
HttpUnitTests extends JUnit4TestRunner {
    package "d1.webapp.test";
    name "HttpUnitTests";
    server.url TBD;
    sfProcessHost "client";
    properties [
        ["server.url",server.url],
        ["cactus.contextURL",server.url]
    ];
    classes [
        "EventFeedTest",
        "HappyTagTest",
        "IndexTest"
    ];
}
```



 - SmartFrog daemon

Distributed Deployment of App & JUnit



 - SmartFrog daemon

XHTML output of test results

Test suite HttpUnitTests on Zermatt started Thu Jun 29 16:19:30 BST 2006

[summary](#)

d1.webapp.test.HappyTagTest
duration 2.603s
testIndex

d1.webapp.test.HappyTagTest
duration 0.071s
testUnhappy

d1.webapp.test.HappyTagTest
duration 0.04s
testSPX

d1.webapp.test.HappyTagTest
duration 0.02s
testJP

d1.webapp.test.EventFeedTest
duration 1.592s
testFeedDefault

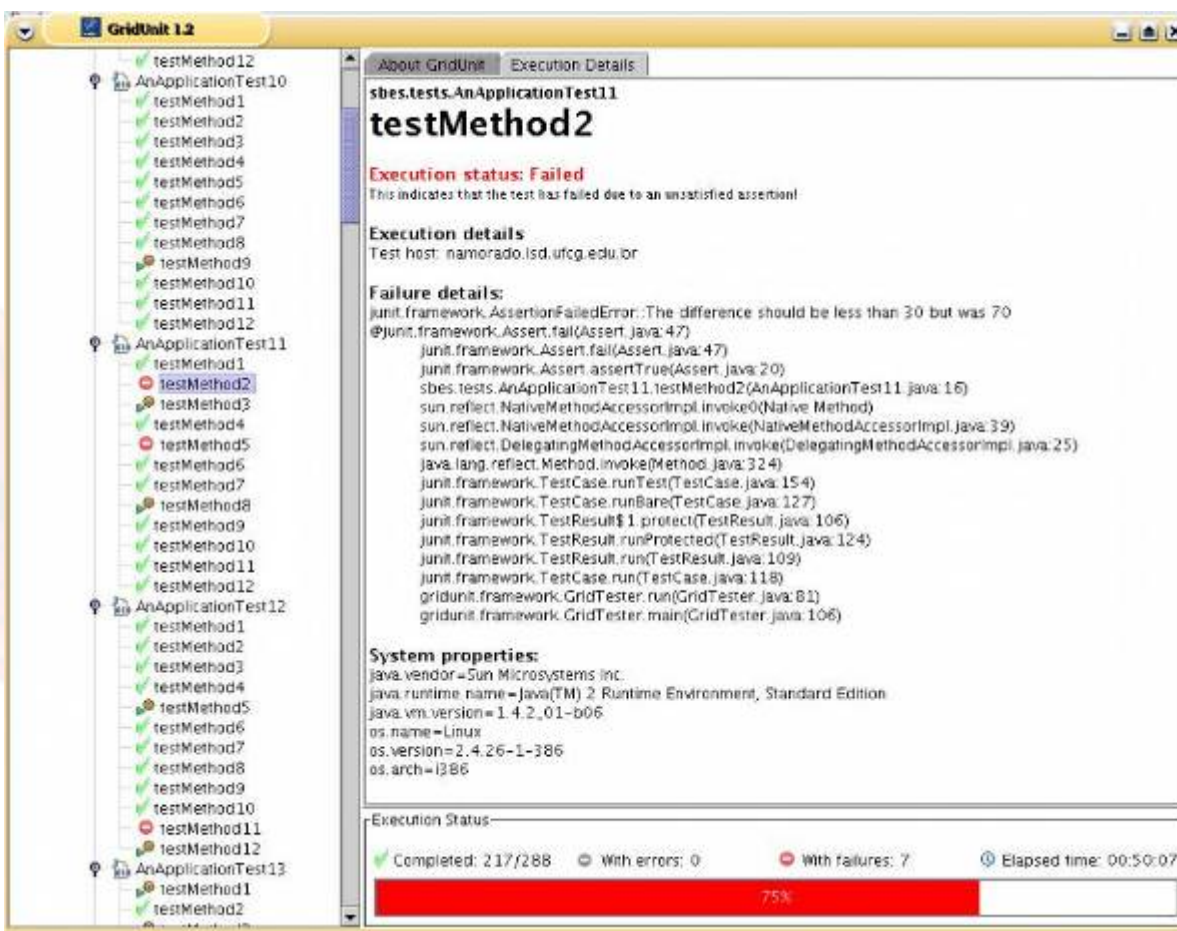
d1.webapp.test.IndexTest
duration 0.14s
testEveryLinkOnThePage

Test Summary	
Tests	6
Successes	6
Percentage Successes	100
Failures	0
Errors	0
Started	Thu Jun 29 16:19:30 BST 2006
Finished	Thu Jun 29 16:19:30 BST 2006
Host	Zermatt

- + ~live output
- + log capture
- no x-system summary
- no merging of logs from different systems
- no notification

Future GUI? GridUnit

- Swing GUI for testing on OurGrid
- Unit test across many different machines
- But not (yet) distributed applications
- Aggregate view of results
- “partial” success
- Common JUnit wire format



Call to Action

- Focus on system tests
- Embrace Virtualization: VMWare, Xen
- Use Cactus for in-container testing
- Use Selenium/jsUnit for browser tests
- Join us in distributed system testing

Junit4?

- Java5 only
- Extension tools not there yet
- Integration with Ant, Maven coming along.
- Ant 1.7 <junit> will work with junit4.jar
- JUnit team plan their own task (Ant team are working with them)