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JTREG TUTORIAL

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Table of Contents

Section I: Getting started

1. Introduction

1. Introduction

- The primary purpose of jtreg tool is for developing unit tests
    - It can also be used for writing functional tests.
- The jtreg tool can be used for developing and running tests for java APIs, compilers, VM and GUI components.
- The jtreg tool use JavaTest harness which is a set of tools designed to execute test programs. http://jtharness.java.net/.
- Information about jtreg is available at
    - http://openjdk.java.net/jtreg/
    - http://openjdk.java.net/projects/code-tools/

Section I: Getting started

1. Introduction
2. Nuts and Bolts

2. Nuts and Bolts (1/4)

- A test case is a
  - java program with usual static main method (main test)
  - an applet (applet test)
  - a shell script (shell test)
- A test case should define Pass-Fail criteria.
  - if the test fails, it should throw an exception.
  - if it succeeds, it should return normally.
  - Not recommended to catch general exceptions such as Throwable, Exception, or Error.

2. Nuts and Bolts (2/4)

- A test case is distinguished and controlled by tags
  - **@test** tag identifies a source file that defines a test. This is a mandatory tag. This must be the first tag in a comment block
  - **@run** tag tells the harness how to perform the test.
  - **@summary** tag is used to provide brief description of the test case.
  - **@library** tag is used to reference library source files.
  - **@build** tag is used to compile dependent classes or libraries before running the tests
  - **@compile** tag is used to compile a class. It is useful for writing compiler tests
- More tags and options are available in
  - doc/jtreg/tag-spec.txt in jtreg bundle
  - jtreg -onlineHelp

2. Nuts and Bolts(3/4)

- @run tag is optional for automated tests
  - This tag can be used to run tests with non-default options.
- Manual tests use /manual option with @run tag
  - @run applet/manual
  - @run main/manual
  - @run shell/manual
- Negative test is marked with /fail option
  - @run main/fail
  - @compile/fail

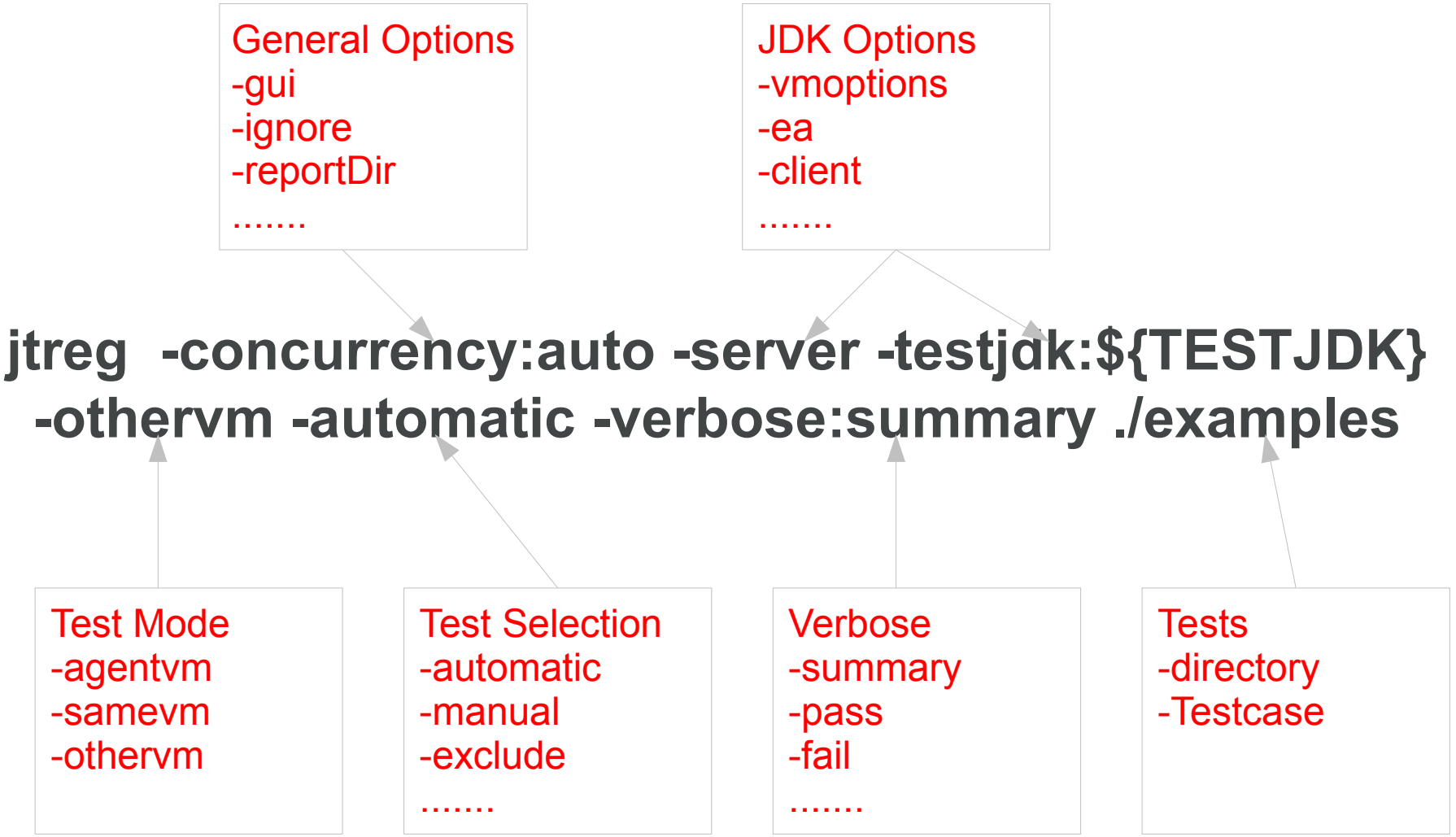
2. Nuts and Bolts (4/4)

- Applet test requires an HTML file which should contain an applet tag with any necessary parameters.
  - Extension should be .html
- Shell tests should
  - have extension .sh
  - use Bourne shell syntax
- Test fails if tests take longer than 120 seconds
  - It can be controlled by /timeout option e.g. @run main/timeout=100

Section I: Getting started

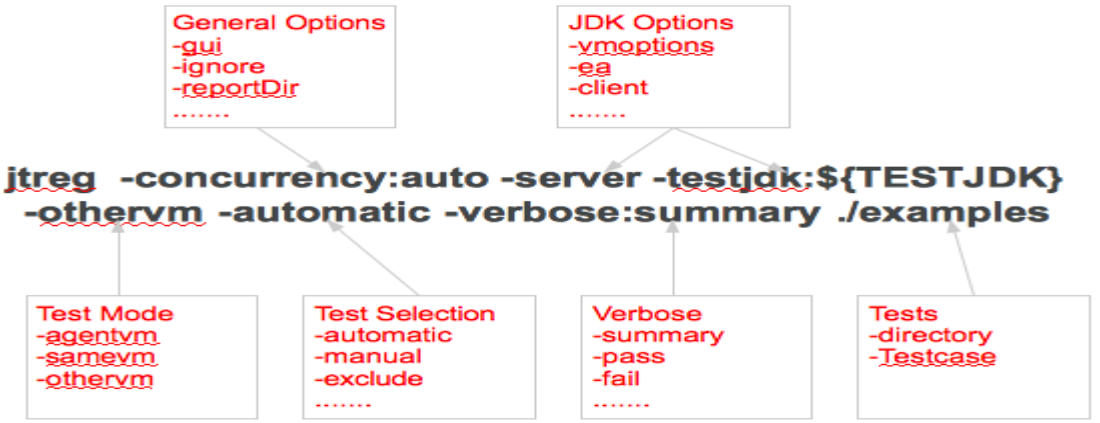
1. Introduction
2. Nuts and Bolts
3. Test Execution

3. Test Execution



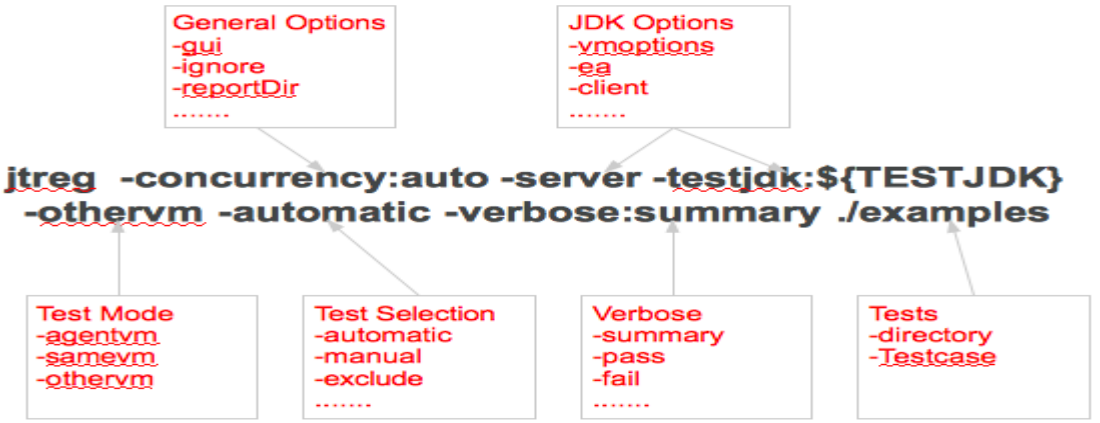
- Online help: jtreg -onlineHelp

3. Test Execution (1/4)



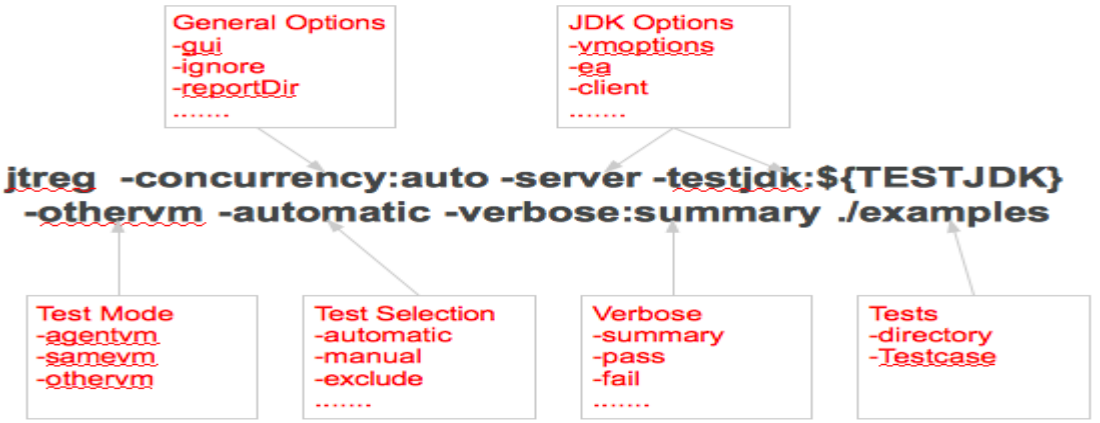
- Verbose options
  - amount of output written to the console while running tests.
  - -verbose:summary, -verbose:fail,error, ..
- Test selection options
  - -a | -automatic can be used to run automatic tests
  - -m | -manual can be used to run manual tests
  - -k:<keywordExpr> can be used to run only tests with <keywordExpr> which is a simple boolean expression containing keywords
  - -bug:<bugid> can be used to run only tests with <bugid>
  - All tests run by default

3.Test Execution (2/4)



- Test Mode
  - -othervm : Run every test in its own JVM; maximum isolation between tests; maximum overhead
  - -samevm : Run each test in the same JVM as the JavaTest harness; minimum overhead; minimum isolation between tests; one bad test can cause problems for all subsequent tests
  - -agentvm : Run tests using a pool of reusable JVMs; reuse vm if it can be reset to a clean state after a test; cannot be enforced in a test
  - Test mode can also be specified in a test source file e.g. @run main/agentvm, @run main/othervm/timeout=300
- Tests can be run concurrently using -conc:*N* | -concurrency:*N* option
  - This option can not be used with -samevm option
  - Not suitable for GUI tests e.g. a test require mouse interaction

3.Test Execution (3/4)



- JDK options
  - -vmoption can be used to pass all applicable JVM options
  - Most common JVM options, e.g. -server, -d64, -client etc. are supported directly
- Test JDK
  - -testjdk can be used to pass JDK version for testing
  - JDK version used for running 'jtreg' harness is tested by default
- Excluding testcases
  - ProblemList.txt can contain known failing tests.
  - -exclude:ProblemList.txt excludes tests present in the files from executing.

3. Test Execution (4/4)

- Test log is written to a text file with .jtr extension.
  - Contains the command used to execute tests
  - Contains diagnostic message included in exception
  - Contains output of System.out and System.err
- Report and log files are written to JTreport and JTwork directory, by default
  - JTwork directory contains .jtr files and .class files.
  - JTreport directory contains html summary report and summary.txt
  - -r and -w options can be used to specify non-default work and report directory
- -xml option can be used to produce test log files in xml format
  - Log files with .jtr.xml extension are found in JTwork directory

Section I: Getting started

1. Introduction
2. Nuts and Bolts
3. Test Execution
4. An Example

4. An Example (1/5)

```
/* @test
   @summary Example1 - a simple testcase
   @run main Example1
*/
import javax.swing.*;
import javax.accessibility.*;

public class Example1 {
   public static void main(String[] args) throws Exception {
        JLayer l = new JLayer();
        AccessibleContext acc = l.getAccessibleContext();
        if (acc == null) {
            throw new RuntimeException("JLayer's AccessibleContext is null");
        }
    }
}
```

Indicates source is a test

4. An Example (2/5)

```
 /* @test
   @summary Example1 - a simple testcase
   @run main Example1
*/
import javax.swing.*;
import javax.accessibility.*;

public class Example1 {
   public static void main(String[] args) throws Exception {
        JLayer l = new JLayer();
        AccessibleContext acc = l.getAccessibleContext();
        if (acc == null) {
            throw new RuntimeException("JLayer's AccessibleContext is null");
        }
    }
}
```

- **Brief description of the test.**
- **Appear in output .jtr file**

4. An Example (3/5)

```
 /* @test
   @summary Example1 - a simple testcase
   @run main Example1
*/
import javax.swing.*;
import javax.accessibility.*;

public class Example1 {
   public static void main(String[] args) throws Exception {
        JLayer l = new JLayer();
        AccessibleContext acc = l.getAccessibleContext();
        if (acc == null) {
            throw new RuntimeException("JLayer's AccessibleContext is null");
        }
    }
}
```

- **It means invoke main method of Example1 class**
- **The line is optional for default execution.**

4. An Example (4/5)

```
 /* @test
   @summary Example1 - a simple testcase
   @run main Example1
*/
import javax.swing.*;
import javax.accessibility.*;

public class Example1 {
   public static void main(String[] args) throws Exception {
       JLayer l = new JLayer();
       AccessibleContext acc = l.getAccessibleContext();
       if (acc == null) {
          throw new RuntimeException("JLayer's AccessibleContext is null");
       }
    }
}
```

- **Throw an exception to indicate test failure.**
- **Test should exit normally to indicate PASS.**

4. Running an Example (5/5)

- jtreg -verbose:summary -testjdk:{TESTJDK} Example1.java
  - An empty file TEST.ROOT should exist at the root directory of the test.
  - Creates JTwork and JTreport directory, if the directory is not present.
- JTreport/html/report.html contains the overall results summary
- JTreport/text/summary.txt contains the results summary in text format
- JTwork/Example1.jtr contains test log file

Section I: Getting started

1. Introduction
2. Nuts and Bolts
3. Test Execution
4. An Example
5. Log file

5. Log file (1/3)

```
#Test Results (version 2)
#Tue Nov 20 16:53:27 GMT 2012
#checksum:45cf21a8ef8efa
#-----testdescription-----
$file=/home/jtest/jtregtests/examples/Example1.java
$root=/home/jtest/jtregtests
run=USER_SPECIFIED main Example1\n
source=Example1.java
title=Example1 - a simple testcase

#-----environment-----

#-----testresult-----
description=file\:/home/jtest/jtregtests/examples/Example1.java
elapsed=928 0\:00\:00.928
end=Tue Nov 20 16\:53\:27 GMT 2012
environment=regtest
execStatus=Passed. Execution successful
hostname=testmachine
javatestOS=Linux 2.6.32-100.28.5.el6.x86_64 (amd64)
javatestVersion=4.4
jtregVersion=jtreg 4.1 fcs b04
script=com.sun.javatest.regtest.RegressionScript
sections=script_messages build compile main
start=Tue Nov 20 16\:53\:26 GMT 2012
test=examples/Example1.java
user.name=jtest
work=/home/jtest/jtregtests/JTwork/examples
```

Test information

Log file has an extension .jtr and can be found in sub-directories of JTwork directory

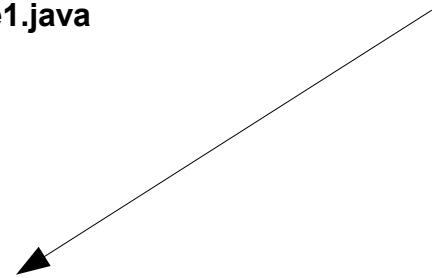
5. Log file (2/3)

```
#Test Results (version 2)
#Tue Nov 20 16:53:27 GMT 2012
#checksum:45cf21a8ef8efa
#-----testdescription-----
$file=/home/jtest/jtregtests/examples/Example1.java
$root=/home/jtest/jtregtests
run=USER_SPECIFIED main Example1\n
source=Example1.java
title=Example1 - a simple testcase

#-----environment-----

#-----testresult-----
description=file\:/home/jtest/jtregtests/examples/Example1.java
elapsed=928 0\:00\:00.928
end=Tue Nov 20 16\:53\:27 GMT 2012
environment=regtest
execStatus=Passed. Execution successful
hostname=testmachine
javatestOS=Linux 2.6.32-100.28.5.el6.x86_64 (amd64)
javatestVersion=4.4
jtregVersion=jtreg 4.1 fcs b04
script=com.sun.javatest.regtest.RegressionScript
sections=script_messages build compile main
start=Tue Nov 20 16\:53\:26 GMT 2012
test=examples/Example1.java
user.name=jtest
work=/home/jtest/jtregtests/JTwork/examples
```

Test result summary



5. Log file (3/3)

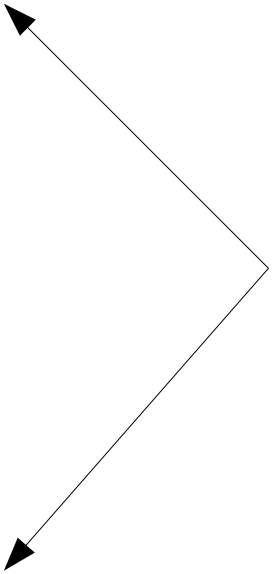
```
#section:script_messages
----------messages:(4/184)----------
JDK under test: (/home/jtest/jdks/jdk1.8.0)
java version "1.8.0-ea"
Java(TM) SE Runtime Environment (build 1.8.0-ea-b59)
Java HotSpot(TM) 64-Bit Server VM (build 25.0-b02, mixed mode)

#section:build
----------messages:(3/93)----------
command: build Example1
reason: Named class compiled on demand
elapsed time (seconds): 0.635
result: Passed. Build successful

#section:compile
----------messages:(3/143)----------
command: compile /home/jtest/jtregtests/examples/Example1.java
reason: .class file out of date or does not exist
elapsed time (seconds): 0.631
----------System.out:(0/0)----------
----------System.err:(0/0)----------
result: Passed. Compilation successful

#section:main
----------messages:(3/102)----------
command: main Example1
reason: User specified action: run main Example1
elapsed time (seconds): 0.22
----------System.out:(0/0)----------
----------System.err:(1/15)----------
STATUS:Passed.
result: Passed. Execution successful


test result: Passed. Execution successful
```



Detail test results broken down into different phases of test execution

Section I: Getting started

1. Introduction
2. Nuts and Bolts
3. Test Execution
4. An Example
5. Log file

Section II: Examples

1. Examples

1. Examples

- Specifying VM Options
- Applet testcase
- Manual testcase
- Shell test
- Defining timeout
- Reusing the testcase to run with different VM/GC options
- Compiler test
- Negative test
- OS/Platform checks

1. Examples (1/9): Specifying VM options

```
 /* @test
 * @summary Example 2 - passing VM parameters
 * @run main/othervm -Xms100m -Xmx100m  -XX:+PrintGC -XX:
+UseParallelGC Example2
 */
public class Example2 {
    public static void main(String[] args) throws InterruptedException {
        ……..
         for (GarbageCollectorMXBean collector : collectors) {
            String x = collector.getName();
            if (x.contains("MarkSweep")) {
               long count = collector.getCollectionCount();
                if (count > 0) {
                    throw new RuntimeException("Failed.”);
                }
            }
        }
    }
}
```

- **VM options can be specified with main/othervm**
- **Equivalent to java <vm options> Example2**

1. Examples (2/9) : Applet testcase

```
<html>
<!--
  @test
  @summary - Example3 - running applet
  @run applet Example3.html
  -->
<head>
<title> Example3 </title>
</head>
<body>

<h1>Example3</h1>

<APPLET CODE="Example3.class" WIDTH=200
HEIGHT=200></APPLET>
</body>
</html>
```

- Run the applet specified at <APPLET> tag in Example3.html
- Equivalent to “appletviewer Example3.html”

1. Examples (3/9): Manual testcase

```
<html>
<!--
  @test
  @summary - Example4 - a manual test
  @run applet/manual=yesno Example4.html
  -->
<head>
<title> Example4 - a manual test</title>
</head>
<body>

<h1> Example4 - a manual test</h1>


<APPLET CODE="Example4.class" WIDTH=200
HEIGHT=200></APPLET>
</body>
</html>
```

- **Run the applet specified at <APPLET> tag in Example4.html, but tester need to interact and choose whether test is pass or fail.**
- **NOTE: OpenJDK test workspace provides convenient helper classes to display test instruction.**

1. Examples (4/9): Shell test

```
# @test
# @summary Example5 - shell tests
# @run shell Example5.sh

$TESTJAVA/bin/jar -tf "$TESTJAVA/jre/lib/rt.jar" >
/dev/null 2>&1

if [ $? -ne 0 ]; then
   echo FAILED: rt.jar file corrupt
   exit 1
fi

exit 0
```

- **Invokes the Bourne shell to run Example5.sh**

1. Examples (5/9) : Defining timeout

```
/*
 * @test
 * @summary Example6 - interrupting loop/hang
 * @run main/timeout=1 Example6
 */


public class Example6 {
    public static void main(String[] args) throws
InterruptedException {
        System.out.print("Test Loop .... ");
        for (int i = 0; i < 1000000000; i++) {
            Thread.sleep(10);
        }
        System.out.println("Passed.");
    }
}
```

- **Invoke main method with timeout set in seconds.**
- **Test exit with Error if the execution takes longer than timeout period.**
- **Useful option to avoid test hangs.**

1. Examples (6/9) : Reusing the testcase to run with different VM/GC options

```
/* @test
 * @summary Example7 - run tests with multiple java/vm flags
 * @run main/othervm -client  Example7
 * @run main/othervm -Xint Example7
 * @run main/othervm -server Example7
 */
public class Example7 {
    public static void main(String argv[]) {
        Integer x = new Integer(100);
        Integer y = new Integer(100);

        if ( ! x.equals(y) ) {
            throw new RuntimeException("Failed. x is not equal y");
        }

        if (x.hashCode() != y.hashCode()) {
            throw new RuntimeException("Failed. Hashcode comparison failed.");
        }
    }
}
```

- **Invoke main method multiple times with different VM options.**
- **Generates one output file (.jtr)**
- **Test fails if any one invocation of main method fails.**

1. Examples (7/9) : Compiler test

```
/*
 * @test
 * @summary Example8 - compile test
 * @compile Example8.java
 */

public class Example8 {

    static class Base<E> {}

    static void test(Base<?> je) {
        Object o = (Base<Integer>)je;
    }
}
```

- **Invoke compiler and compiles Example8.java**
- **Test pass if compilation succeeds.**
- **Equivalent to “javac Example8.java”**

1. Examples (8/9) : Negative test

```
/*
 * @test
 * @summary Example9 - test pass if compilation fails
 * @compile/fail Example9.java
 */

public class Example9 {
    void test(Float f, Integer i) {
        boolean b = f == i;
    }
}
```

- **Test pass if compilation fails**
- **The option /fail can be used with main, applet and shell tests as well, but such use is discouraged**
  - **@run main/fail <test>**
  - **@run applet/fail <test>**
  - **@run shell/fail <test>**

1. Examples (9/9) : OS/Platform checks

```
# @test
# @summary Testing OS specific feature
# @run shell Example12.sh

OS=`uname -s`
if [ "$OS" != "Windows_NT" ]; then
    echo "This is a Windows only test"
    exit 0
fi

echo “run a test case”
```

- Write a wrapper shell test
- Check OS name
- Skip the test (pass) if the test is not applicable
- May use 'case' statement if test is applicable to more than one OS.
- NOTE: Such testcase filtering is not allowed if the feature is applicable to all OS/platforms.

Section I: Getting started

1. Introduction
2. Nuts and Bolts
3. Test Execution
4. An Example
5. Log file

Section II: Examples

1. Examples
2. Test Execution

2. Test Execution (1/3)

- VM option from command line
  - jtreg -verbose:summary -testjdk:${TESTJDK} -ea -vmoption:"-XX:+UseParallelGC" Example1.java
- Run all tests present in a directory
  - jtreg -verbose:summary -testjdk:${TESTJDK} ./examples
- Run all manual tests in a directory
  - jtreg -verbose:summary -testjdk:${TESTJDK} -m ./examples
- Run all tests with specific keyword
  - jtreg -verbose:summary -testjdk:${TESTJDK} -a -k:abc ./examples
  - TEST.ROOT file should contain a line “keys abc”

2. Test Execution (2/3)

- Run all automated tests present in a directory
  - jtreg -verbose:summary -testjdk:${TESTJDK} -a ./examples
- Running tests in concurrent mode
  - jtreg -verbose:summary -testjdk:${TESTJDK} -a -concurrency:auto ./examples
  - jtreg -verbose:summary -testjdk:${TESTJDK} -a -concurrency:2 ./examples
  - Tests with /othervm can be run in concurrent mode
- Increase time requirements to run a test
  - jtreg -verbose:summary -testjdk:${TESTJDK} -timeoutFactor:2 Example13.java

2. Test Execution (3/3)

- Excluding tests with known issues
  - jtreg -verbose:summary -testjdk:${TESTJDK} -a -exclude:./ProblemList.txt ./examples
- Re-running only the tests with error status in previous tun
  - jtreg -verbose:summary -testjdk:${TESTJDK} -a -status:error,fail ./examples
- There are many more options. Refer online help.
  - jtreg -h
  - jtreg -onlineHelp

Section I: Getting started

1. Introduction
2. Nuts and Bolts
3. Test Execution
4. An Example
5. Log file

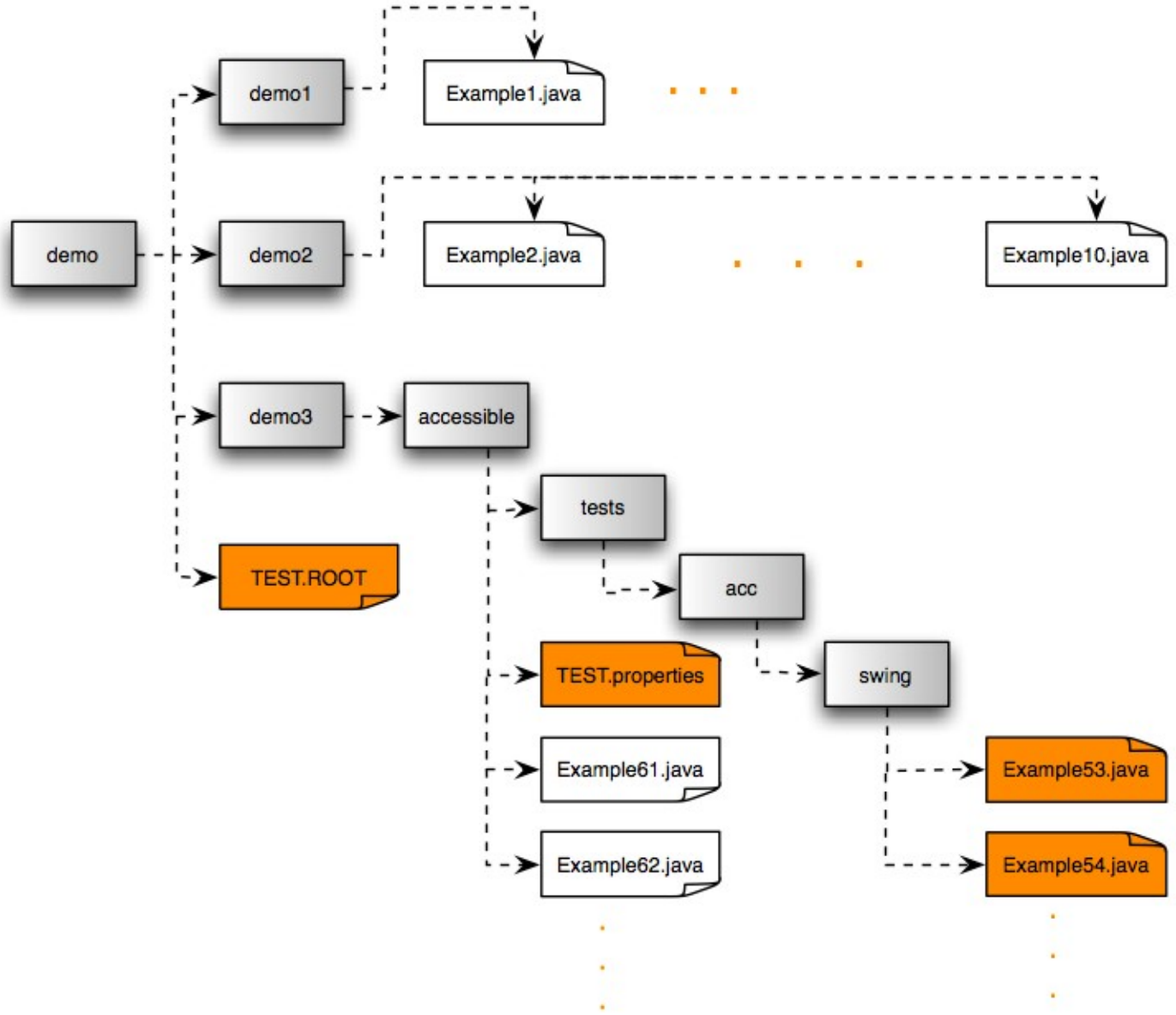
Section II: Examples

1. Examples
2. Test Execution
3. TestNG tests

3. TestNG tests

- JTreg supports TestNG tests in two ways – Type A and Type B
- Type A:
    - Write a testcase using TestNG
    - Add “TestNG.dirs = dir1 dir2” in TEST.properties or TEST.ROOT file, where, dir1 and dir2 represents a package root directory relative test root (TEST.ROOT) directory
    - TEST.properties file, if present, should be present at package root directory
    - While an individual testcase may include jtreg information tags such as @test or @summary, it must not include jtreg action tags such as @run or @compile
- Type B:
    - Write a testcase using TestNG
    - Add jtreg tags (e.g. @test) to the test source
    - Use “@run testng ..” tag instead of “@run main ..” tag

3. TestNG tests – Type A (1/2)



TEST.properties
TestNG.dirs = .

OR

TEST.ROOT
TestNG.dirs = accessible

package tests.acc.swing

3. TestNG tests – Type A (2/2)

tests/acc/swing/Example53.java

```
package tests.acc.swing;
import javax.swing.*;
import javax.accessibility.*;
import org.testng.annotations.Test;

@Test
public class Example53 {
    public void testAccessibleJMenu() throws Exception {
        JMenu l = new JMenu();
        AccessibleContext acc = l.getAccessibleContext();
        if (acc == null) {
            throw new RuntimeException("JMenu's AccessibleContext is null");
        }
    }
    public void testAccessibleJMenuBar() throws Exception {
        JMenuBar l = new JMenuBar();
        AccessibleContext acc = l.getAccessibleContext();

            if (acc == null) {

            throw new RuntimeException("JMenuBar's  AccessibleContext is null");
        }
    }
}
```

tests/acc/swing/Example54.java

```
package tests.acc.swing;
import javax.swing.*;
import javax.accessibility.*;
import org.testng.annotations.Test;

public class Example54 {
    @Test
    public void testAccessibleJMenuItem() throws Exception {
        JMenuItem l = new JMenuItem();
        AccessibleContext acc = l.getAccessibleContext();
        if (acc == null) {
            throw new RuntimeException("JMenuItem's AccessibleContext is null");
        }
    }
    @Test
    public void testAccessibleJFileChooser() throws Exception {
        JFileChooser l = new JFileChooser();
        AccessibleContext acc = l.getAccessibleContext();
        if (acc == null) {
            throw new RuntimeException("JFileChooser's AccessibleContext is
null");
        }
    }
}
```

No jtreg specific tags in the test source files

3. TestNG tests – Type B

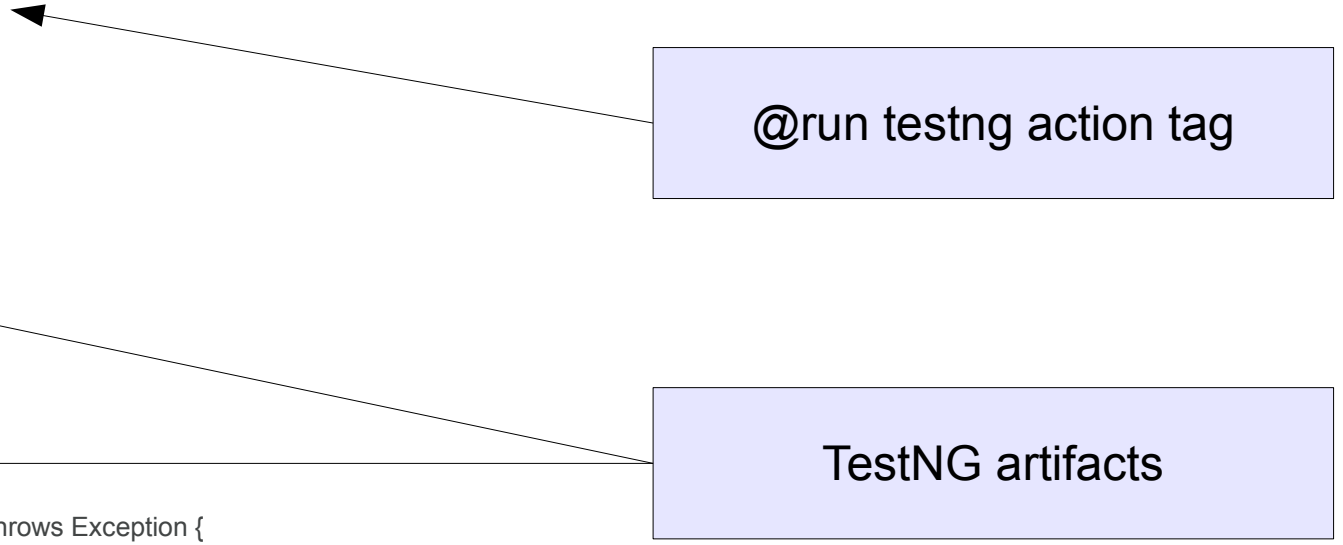
```
/* @test
   @summary Example61 - a simple TestNG testcase that can be run under jtreg
   @run  testng Example61
*/

import javax.swing.*;
import javax.accessibility.*;

import org.testng.annotations.Test;

public class Example61 {

    @Test
    public void testAccessibleContext() throws Exception {
        JLayer l = new JLayer();
        AccessibleContext acc = l.getAccessibleContext();
        if (acc == null) {
            throw new RuntimeException("JLayer's AccessibleContext is null");
        }
    }
}
```



3. TestNG tests – specifying libraries

- Specifying libraries in “Type 1” tests
  - Add “lib.dirs = dir1 dir2” to the TEST.properties file
  - If path starts with '/', the path is evaluated from the directory containing TEST.ROOT file, else the path is evaluated from the directory containing TEST.properties file
- Specifying libraries in “Type 2” tests
  - Use @library tag <path>, it is same as in other jtreg tests
  - If path starts with '/', the path is evaluated from the directory containing TEST.ROOT file, else the path is evaluated from the directory relative to the testcase

Section I: Getting started

1. Introduction
2. Nuts and Bolts
3. Test Execution
4. An Example
5. Log file

Section II: Examples

1. Examples
2. Test Execution
3. TestNG tests

Section III: Contributing

1. How to contribute?

1. How to Contribute?

- Guidelines
  - http://openjdk.java.net/contribute/
- Subscribe to jtreg-use@openjdk.java.net
  - Ask general questions about jtreg use
- Subscribe to jtreg-dev@openjdk.java.net and
  - Ask tough questions!
  - Send enhancement proposals
- Subscribe to quality-discuss@openjdk.java.net
  - Discuss quality issues
  - Propose test cases, send change sets, send feedback etc.

Section I: Getting started

1. Introduction
2. Nuts and Bolts
3. Test Execution
4. An Example
5. Log file

Section II: Examples

1. Examples
2. Test Execution
3. TestNG tests

Section III: Contributing

1. How to contribute?
2. Recommended Practice

2. Recommended Practice

- Modifying an existing testcase
  - Do not overwrite the test scenarios, unless existing test scenario is obsolete with a new fix
- Test case should run on Windows, Linux, and Solaris.
  - No Exception
  - If testcase is not applicable to a OS/platform, make the testcase PASS.
- Code review
  - Recommend two peer reviews
  - Send email to OpenJDK component mailing list for feedback

Section I: Getting started

1. Introduction
2. Nuts and Bolts
3. Test Execution
4. An Example
5. Log file

Section II: Examples

1. Examples
2. Test Execution
3. TestNG tests

Section III: Contributing

1. How to contribute?
2. Recommended Practice
3. OpenJDK workspace

3. OpenJDK workspace (1/3)

- Cloning OpenJDK workspace
  - $ hg clone http://hg.openjdk.java.net/jdk8/jdk8 localbuild
  - $ cd localbuild
  - $ sh get_source.sh
- Test Root
  - ${localbuild}/jdk/test
  - ${localbuild}/langtools/test
  - ${localbuild}/hotspot/test
- ProblemList.txt present in “Test Root”

3. OpenJDK workspace (2/3)

- A convenient 'Makefile' present in “Test Root”
  - Export environment varaibles
  - make CONCURRENCY=auto <target>
- Environment Variables

```
$ export JT_HOME=<location of jtreg>
$ export JTREG=${JT_HOME}/<linux,solaris,win32>/bin/jtreg
$ export PRODUCT_HOME=<location of test jdk>
$ export ANT_HOME=<location of ant>
$ export PATH=${PATH}:${ANT_HOME}/bin
$ export ALT_OUTPUTDIR=<results home dir>
$ export JPRT_JTREG_HOME=${JT_HOME}     // Required for langtools and hotspot
$ export JPRT_JAVA_HOME=<location of stable jdk>  // Required for langtools
$ export JTREG_TESTDIRS=<location of langtools test> // Required for langtools
$ export TESTDIRS="compiler gc runtime serviceability"     // Required for hotspot
```

3. OpenJDK workspace (3/3)

- Executing langtool and hotspot tests
  - Export environment variables
  - make CONCURRENCY=auto jtreg-tests
- Executing jdk tests
  - Export environment variables
  - make CONCURRENCY=auto jdk_nio1
  - make CONCURRENCY=auto jdk_nio2
  - make CONCURRENCY=auto jdk_lang
  - make CONCURRENCY=auto jdk_net
  - ……..
  - make CONCURRENCY=auto jdk_all // Runs all jdk tests.

Section I: Getting started

1. Introduction
2. Nuts and Bolts
3. Test Execution
4. An Example
5. Log file

Section II: Examples

1. Examples
2. Test Execution
3. TestNG tests

Section III: Contributing

1. How to contribute?
2. Recommended Practice
3. OpenJDK workspace
4. References

References

- http://openjdk.java.net/jtreg/
- http://openjdk.java.net/projects/code-tools/
- http://mail.openjdk.java.net/mailman/listinfo/jtreg-dev
- jtreg-dev@openjdk.java.net
- FAQ included in jtreg bundle
- tag-spec.txt included in jtreg bundle
- jtreg -onlineHelp <word>
- jtreg -help <word>