Technology Compatibility Kit Reference Guide for JSR 349: Bean Validation

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Preface

This guide describes how to download, install, configure, and run the Technology Compatibility Kit (TCK) used to verify the compatibility of an implementation of JSR 349: Bean Validation 1.1.

The Bean Validation TCK is built atop *Arquillian* [http://www.jboss.org/arquillian.html], a portable and configurable automated test suite for authoring unit and integration tests in a Java EE environment.

The Bean Validation TCK is provided under the *Apache Public License 2.0* [http://www.apache.org/licenses/LICENSE-2.0].

1. Who Should Use This Guide

This guide is for implementors of the Bean Validation specification to assist in running the test suite that verifies the compatibility of their implementation.

2. Before You Read This Guide

The Bean Validation TCK is based on the Bean Validation specification 1.1 (JSR 349). Information about the specification can be found on the *JSR-349 JCP page* [http://jcp.org/en/jsr/detail?id=303].

3. How This Guide Is Organized - TODO!

If you are running the Bean Validation TCK for the first time, read *Chapter 1, Introduction* completely for the necessary background information about the TCK. Once you have reviewed that material, perform the steps outlined in the remaining chapters.

- *Chapter 1, Introduction* gives an overview of the principles that apply generally to all Technology Compatibility Kits (TCKs), outlines the appeals process and describes the Bean Validation TCK architecture and components.
- *Chapter 2, Appeals Process* explains the process to be followed by an implementor should they wish to challenge any test in the TCK.
- *Chapter 3, Installation* explains where to obtain the required software for the Bean Validation TCK and how to install it.
- *Chapter 5, Configuration* details the configuration of the test harness, how to create a TCK runner for the TCK test suite and the mechanics of how an in-container test is conducted.
- *Chapter 4, Reports* explains the test reports that are generated by the TCK test suite and introduces the TCK audit report as a tool for measuring the completeness of the TCK in testing the JSR 349 specification and in understanding how test cases relate to the specification.
- *???* documents how the TCK test suite is executed. It covers both modes supported by the TCK, standalone and in-container, and shows how to dump the generated test artifacts to disk

Introduction

This chapter explains the purpose of a TCK and identifies the foundation elements of the Bean Validation TCK.

1.1. TCK Primer

A TCK, or Technology Compatibility Kit, is one of the three required pieces for any JSR (the other two being the specification document and the reference implementation). The TCK is a set of tools and tests to verify that an implementation of the technology conforms to the specification. The tests are the primary component, but the tools serve an equally critical role of providing a framework and/or set of SPIs for executing the tests.

The tests in the TCK are derived from assertions in the written specification document. The assertions are itemized in an XML document (`tck-audit.xml`), where they each get assigned a unique identifier, and materialize as a suite of automated tests that collectively validate whether an implementation complies with the aforementioned assertions, and in turn the specification. For a particular implementation to be certified, all of the required tests must pass (meaning the provided test suite must be run unmodified).

A TCK is entirely implementation agnostic. It should validate assertions by consulting the specification's public API.

1.2. Compatibility Testing

The goal of any specification is to eliminate portability problems so long as the program which uses the implementation also conforms to the rules laid out in the specification.

Executing the TCK is a form of compatibility testing. It's important to understand that compatibility testing is distinctly different from product testing. The TCK is not concerned with robustness, performance or ease of use, and therefore cannot vouch for how well an implementation meets these criteria. What a TCK can do is to ensure the exactness of an implementation as it relates to the specification.

Compatibility testing of any feature relies on both a complete specification and a complete reference implementation. The reference implementation demonstrates how each test can be passed and provides additional context to the implementor during development for the corresponding assertion.

1.2.1. Why Compatibility Is Important

Java platform compatibility is important to different groups involved with Java technologies for different reasons:

- Compatibility testing is the means by which the JCP ensures that the Java platform does not become fragmented as it is ported to different operating systems and hardware.

- Compatibility testing benefits developers working in the Java programming language, enabling them to write applications once and deploy them across heterogeneous computing environments without porting.
- Compatibility testing enables application users to obtain applications from disparate sources and deploy them with confidence.
- Conformance testing benefits Java platform implementors by ensuring the same extent of reliability for all Java platform ports.

The Bean Validation specification goes to great lengths to ensure that programs written for Java EE are compatible and the TCK is rigorous about enforcing the rules the specification lays down.

1.3. About the Bean Validation TCK

The Bean Validation TCK is designed as a portable, configurable and automated test suite for verifying the compatibility of an implementation of JSR 349. The test suite is built atop TestNG and provides a series of extensions that allow runtime packaging and deployment of JEE artifacts for in-container testing (Arquillian).

Each test class in the suite acts as a deployable unit. The deployable units, or artifacts, are defined in a declarative way using annotations.

The declarative approach allows many of the tests to be executed in a standalone implementation of Bean Validation, accounting for a boost in developer productivity. However, an implementation is only valid if all tests pass using the in-container execution mode. The standalone mode is merely a developer convenience.

Note

TODO - explain the reason for this - BV part of EE

1.3.1. TCK Specifications and Requirements

This section lists the applicable requirements and specifications for the Bean Validation TCK.

- **Bean Validation API** - The Java API defined in the Bean Validation specification and provided by the reference implementation.
- **Arquillian** - The Bean Validation TCK requires Arquillian version 1.0.0.Final. The Harness is based on *TestNG 5.x* [http://testng.org].
- **TCK Audit Tool** - An itemization of the assertions in the specification documents which are cross referenced by the individual tests. Describes how well the TCK covers the specification.
- **Reference runtime** - The designated reference runtimes for compatibility testing of the Bean Validation specification is the Sun Java Platform, Enterprise Edition (Java EE) 7 reference

implementation (RI). See details at *Java EE 7* [http://java.sun.com/javaee/6/docs/api/] (todo - check link)

1.3.2. TCK Components

The Bean Validation TCK includes the following components:

- **The test suite**, which is a collection of TestNG tests, the TestNG test suite descriptor and supplemental resources that configure Bean Validation and other software components.
- **The TCK audit** (`tck-audit.xml`) is used to list out the assertions identified in the Bean Validation specification. It matches the assertions to test cases in the test suite by unique identifier and produces a coverage report.

  The audit document is provided along with the TCK. Each assertion is defined with a reference to a chapter, section and paragraph from the specification document, making it easy for the implementor to locate the language in the specification document that supports the feature being tested.
- **TCK documentation** accompanied by release notes identifying updates between versions.

Appeals Process

While the Bean Validation TCK is rigourous about enforcing an implementation's conformance to the JSR 349 specification, it's reasonable to assume that an implementor may discover new and/or better ways to validate the assertions. This chapter covers the appeals process, defined by the Specification Lead, Red Hat Middleware LLC., which allows implementors of the JSR 349 specification to challenge one or more tests defined by the Bean Validation TCK.

The appeals process identifies who can make challenges to the TCK, what challenges to the TCK may be submitted, how these challenges are submitted, how and by whom challenges are addressed and how accepted challenges to the TCK are managed.

Following the recent adoption of transparency in the JCP, implementors are encouraged to make their appeals public, which this process facilitates. The JCP community should recognize that issue reports are a central aspect of any good software and it's only natural to point out shortcomings and strive to make improvements. Despite this good faith, not all implementors will be comfortable with a public appeals process. Instructions about how to make a private appeal are therefore provided.

2.1. Who can make challenges to the TCK?

Any implementor may submit an appeal to challenge one or more tests in the Bean Validation TCK. In fact, members of the JSR 349 Expert Group (EG) encourage this level of participation.

2.2. What challenges to the TCK may be submitted?

Any test case (e.g. `@Test` method), test case configuration (e.g. @Deployment, validation.xml), test entities, annotations and other resources may be challenged by an appeal.

What is generally not challengeable are the assertions made by the specification. The specification document is controlled by a separate process and challenges to it should be handled through the JSR 349 EG by sending an e-mail to *jsr349-comments@jcp.org* [mailto:jsr349-comments@jcp.org]. (todo verify email)

2.3. How these challenges are submitted?

To submit a challenge, a new issue of type Bug should be created against *BVTCK* [https://hibernate.onjira.com/browse/BVTCK] in the Hibernate JIRA instance. The appellant should complete the Summary, Component (TCK Appeal), Environment and Description Field only. Any communication regarding the issue should be added in the comments of the issue for accurate record.

To submit an issue in the Hibernate JIRA, you must have a (free) Jira member account. You can create a member account using the *on-line registration* [https://hibernate.onjira.com/secure/Signup!default.jspa].

If you wish to make a private challenge, you should follow the above procedure, setting the Security Level to Private. Only the issue reporter, TCK Project Lead and designates will be able to view the issue.

2.4. How and by whom challenges are addressed?

The challenges will be addressed in a timely fashion by the Bean Validation TCK Project Lead, as designated by Specification Lead, Red Hat Inc. or his/her designate. The appellant can also monitor the process by watching the issue filed against *BVTCK* [https://hibernate.onjira.com/browse/BVTCK].

The current TCK Project Lead is listed on the *BVTCK Project Summary Page* [https://hibernate.onjira.com/browse/BVTCK].

2.5. How accepted challenges to the TCK are managed?

Accepted challenges will be acknowledged via the filed issue's comment section. Communication between the Bean Validation TCK Project Lead and the appellant will take place via the issue comments. The issue's status will be set to "Resolved" when the TCK project lead believes the issue to be resolved. The appellant should, within 30 days, either close the issue if they agree, or reopen the issue if they do not believe the issue to be resolved.

Resolved issue not addressed for 30 days will be closed by the TCK Project Lead. If the TCK Project Lead and appellant are unable to agree on the issue resolution, it will be referred to the JSR 349 specification lead or his/her designate.

Installation

This chapter explains how to obtain the TCK and supporting software and provides recommendations for how to install/extract it on your system.

3.1. Obtaining the Software

You can obtain a release of the Bean Validation TCK project from the from the *download page* [http://www.hibernate.org/subprojects/validator/download] on the Hibernate Validator website. The Bean Validation TCK is distributed as a ZIP file, which contains the TCK artifacts (the test suite binary and source, the test suite descriptor, the audit source and report), the TCK library dependencies in `/lib` and documentation in `/doc`. The contents should look like (todo - verify against final dist bundle):

```
artifacts/
changelog.txt
docs/
lib/
license.txt
src/
```

You can also download the source code from GitHub - *https://github.com/beanvalidation/beanvalidation-tck*.

The JSR 349 reference implementation (RI) project is named Hibernate Validator. You can obtain the Hibernate Validator release used as reference implementation from the Hibernate Validator *download page* [http://www.hibernate.org/subprojects/validator/download].

Note

Hibernate Validator is not required for running the Bean Validation TCK, but it can be used as a reference for familiarizing yourself with the TCK before testing your own Bean Validation implementation.

3.2. The TCK Environment

The TCK requires the following two Java runtime environments:

- Java 6 or better
- Java EE 7 or better (e.g., JBoss AS 7.x)

You should refer to vendor instructions for how to install the runtime.

The rest of the TCK software can simply be extracted. It's recommended that you create a dedicated folder to hold all of the jsr349-related artifacts. This guide assumes the folder is called `jsr349`. Extract the `src` folder of the TCK distribution into a sub-folder named `tck` or use the following git commands to

```
git clone git://github.com/beanvalidation/beanvalidation-tck tck
git checkout 1.1.0.Final // TODO - add right version number
```

You can also check out the full Hibernate Validator source into a subfolder ri. This will allow you to run the TCK against Hibernate Validator.

```
git clone git://github.com/hibernate/hibernate-validator.git ri
git checkout 4.2.0.Final // TODO - add right version number
```

The resulting folder structure is shown here:

```
jsr349/
   ri/
   tck/
```

Now lets have a look at one concrete test of the TCK, namely `ConstraintInheritanceTest` (found in `tck/tck/src/main/java/org/hibernate/beanvalidation/tck/tests/constraints/inheritance/ConstraintInheritanceTest.java`):

```
package org.hibernate.beanvalidation.tck.tests.constraints.inheritance;

import java.lang.annotation.Annotation;
import javax.validation.Validator;
import javax.validation.constraints.NotNull;
import javax.validation.metadata.BeanDescriptor;
import javax.validation.metadata.PropertyDescriptor;

import org.jboss.arquillian.container.test.api.Deployment;
import org.jboss.arquillian.testng.Arquillian;
import org.jboss.shrinkwrap.api.spec.WebArchive;
import org.jboss.test.audit.annotations.SpecAssertion;
import org.jboss.test.audit.annotations.SpecAssertions;
import org.testng.annotations.Test;

import org.hibernate.beanvalidation.tck.util.TestUtil;
import org.hibernate.beanvalidation.tck.util.shrinkwrap.WebArchiveBuilder;

import static org.testng.Assert.assertTrue;

public class ConstraintInheritanceTest extends Arquillian {

    @Deployment
```

```
    public static WebArchive createTestArchive() {
        return new WebArchiveBuilder()
                .withTestClassPackage( ConstraintInheritanceTest.class )
                .build();
    }

    @Test
    @SpecAssertion(section = "3.3", id = "b")
    public void testConstraintsOnSuperClassAreInherited() {
        Validator validator = TestUtil.getValidatorUnderTest();
        BeanDescriptor beanDescriptor = validator.getConstraintsForClass( Bar.class );

        String propertyName = "foo";
        assertTrue( beanDescriptor.getConstraintsForProperty( propertyName ) != null );
                                                PropertyDescriptor      propDescriptor      =
 beanDescriptor.getConstraintsForProperty( propertyName );

        // cast is required for JDK 5 - at least on Mac OS X
       Annotation constraintAnnotation = (Annotation) propDescriptor.getConstraintDescriptors()
                .iterator()
                .next().getAnnotation();
        assertTrue( constraintAnnotation.annotationType() == NotNull.class );
    }

    @Test
    @SpecAssertions({
            @SpecAssertion(section = "3.3", id = "a"),
            @SpecAssertion(section = "3.3", id = "b")
    })
    public void testConstraintsOnInterfaceAreInherited() {
        Validator validator = TestUtil.getValidatorUnderTest();
        BeanDescriptor beanDescriptor = validator.getConstraintsForClass( Bar.class );

        String propertyName = "fubar";
        assertTrue( beanDescriptor.getConstraintsForProperty( propertyName ) != null );
                                                PropertyDescriptor      propDescriptor      =
 beanDescriptor.getConstraintsForProperty( propertyName );

        // cast is required for JDK 5 - at least on Mac OS X
       Annotation constraintAnnotation = (Annotation) propDescriptor.getConstraintDescriptors()
                .iterator()
                .next().getAnnotation();
        assertTrue( constraintAnnotation.annotationType() == NotNull.class );
    }
}
```

Each test class is treated as an individual artifact (hence the `@Deployment` annotation on the class). In most tests the created artifact is a standard *Web application Archive* [http://en.wikipedia.org/wiki/WAR_file_format_%28Sun%29] build via `WebArchiveBuilder` which in turn is a helper class of the TCK itself alleviating the creation of of the artifact. All methods annotated with `@Test` are actual tests which are getting run. Last but not least we see the use of the `@SpecAssertion` annotation which creates the link between the tck-audit.xml document and the actual test (see *Section 1.1, “TCK Primer”*).

Running the TCK against the Bean Validation RI (Hibernate Validator) and JBoss AS 7

- Install Maven. You can find documentation on how to install Maven 2 in the *Maven: The Definitive Guide* [http://www.sonatype.com/books/maven-book/reference/installation-sect-maven-install.html] book published by Sonatype.
- Change to the `ri/hibernate-validator-tck-runner` directory.
- Next, instruct Maven to run the TCK:

```
mvn test -Dincontainer
```

- TestNG will report, via Maven, the outcome of the run, and report any failures on the console. Details can be found in `target/surefire-reports/TestSuite.txt`.

Reports

This chapter covers the two types of reports that can be generated from the TCK, an assertion coverage report and the test execution results.

4.1. Bean Validation TCK Coverage Report

A specification can be distilled into a collection of assertions that define the behavior of the software. This section introduces the Bean Validation TCK coverage report, which documents the relationship between the assertions that have been identified in the JSR 349 specification document and the tests in the TCK test suite.

The structure of this report is controlled by the assertion document, so we'll start there.

4.1.1. Bean Validation TCK Assertions

The Bean Validation TCK developers have analyzed the JSR 349 specification document and identified the assertions that are present in each chapter. Here's an example of one such assertion found in section 2.1: “Every constraint annotation must define a message element of type String”

The assertions are listed in the XML file `tck-audit.xml` in the Bean Validation TCK distribution. Each assertion is identified by the section of the specification document in which it resides and assigned a unique paragraph identifier to narrow down the location of the assertion further. To continue with the example, the assertion shown above is listed in the `tck-audit.xml` file using this XML fragment:

```
<section id="2.1.1" title="Constraint definition properties">
  ...
   <assertion id="c">
      <text>Every constraint annotation must define a message element of type String</text>
   </assertion>
  ...
</section>
```

The strategy of the Bean Validation TCK is to write a test which validates this assertion when run against an implementation. A test case (a method annotated with `@Test`) is correlated with an assertion using the `@org.jboss.test.audit.annotations.SpecAssertion` annotation as follows:

```
@Test
@SpecAssertion(section = "2.1.1", id = "c")
public void testConstraintDefinitionWithoutMessageParameter() {
   try {
       Validator validator = TestUtil.getValidatorUnderTest();
       validator.validate( new DummyEntityNoMessage() );
        fail( "The used constraint does not define a message parameter. The validation should
 have failed." );
```

```
    }
    catch ( ConstraintDefinitionException e ) {
        // success
}
```

To help evaluate the distribution of coverage for these assertions, the TCK provides a detailed coverage report. This report is also useful to help implementors match tests with the language in the specification that supports the behavior being tested.

4.1.2. The Coverage Report

The coverage report is an HTML report generated as part of the TCK project build. Specifically, it is generated by an annotation processor that attaches to the compilation of the classes in the TCK test suite.

Tip

You can find the source code for this processor in the GitHub repository *https://github.com/jboss/jboss-test-audit*

The report is written to the file `target/coverage-report/coverage-beanvalidation.html`. The report itself has five sections:

1. **Chapter Summary** - List the chapters (that contain assertions) in the specification document along with total assertions, tests and coverage percentage.
2. **Section Summary** - Lists the sections (that contain assertions) in the specification document along with total assertions, tests and coverage percentage.
3. **Coverage Detail** - Each assertion and the test that covers it, if any.
4. **Unmatched Tests** - A list of tests for which there is no matching assertion (useful during TCK development).
5. **Unversioned Tests** - A list of tests for which there is no `@SpecVersion` annotation on the test class (useful during TCK development).

The coverage report is color coded to indicate the status of an assertion, or group of assertions. The status codes are as follows:

- **Covered** - a test exists for this assertion
- **Not covered** - no test exists for this assertion
- **Unimplemented** - a test exists, but is unimplemented

- **Untestable** - the assertion has been deemed untestable, a note, explaining why, is normally provided

For reasons provided in the `tck-audit.xml` document and presented in the coverage report, some assertions are not testable.

The coverage report does not give any indication as to whether the tests are passing. That's where the TestNG reports come in.

4.2. The TestNG Report

As you by now know, the Bean Validation TCK test suite is really just a TestNG test suite. That means an execution of the Bean Validation TCK test suite produces all the same reports that TestNG produces. This section will go over those reports and show you were to go to find each of them.

4.2.1. Maven 2, Surefire and TestNG

When the Bean Validation TCK test suite is executed during the Maven 2 test phase of the TCK runner project, TestNG is invoked indirectly through the Maven Surefire plugin. Surefire is a test execution abstraction layer capable of executing a mix of tests written for JUnit, TestNG, and other supported test frameworks.

Why is this relevant? It means two things. First, it means that you are going to get a summary of the test run on the commandline. Here's the output generated when the tests are run using standalone mode.

```
-------------------------------------------------------
 T E S T S
-------------------------------------------------------
Running TestSuite
Tests run: 258, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 11.062 sec

Results :

Tests run: 258, Failures: 0, Errors: 0, Skipped: 0
```

Note

The number of tests executed, the execution time, and the output will differ when you run the tests using in-container mode as the Bean Validation TCK requires.

If the Maven reporting plugin that compliments Surefire is configured properly, Maven will also generate a generic HTML test result report. That report is written to the file test-report.html in the `target/surefire-reports` directory of the TCK runner project. It shows how many tests were run, how many failed and the success rate of the test run.

Configuration

This chapter lays out how to configure the TCK harness by specifying the `DeployableContainer`, selecting the container interaction style and setting various other switches. Maven 2 is used in the configuration examples, mainly because it is the de facto standard build tool at the time of writing. However, the test harness is not dependent on a specific build tool and any other tool, for example Ant or Gradle, work as well.

If you have not made yourself familiar with the *Arquillian documentation* [https://docs.jboss.org/author/display/ARQ/Reference+Guide] by now, this is a good time to do it. It will give you a deeper understanding of the different parts described in the following sections.

Tip

If you followed all the steps of *Chapter 3, Installation* you find the full `pom.xml` used in the following examples in the directory `jsr349/ri/tck-runner`.

5.1. Configuring TestNG to execute the TCK

The Bean Validation test harness is built atop TestNG, and it is TestNG that is responsible for selecting the tests to execute, the order of execution, and reporting the results. Detailed TestNG documentation can be found at *testng.org* [http://testng.org/doc/documentation-main.html].

The `tck-tests.xml` artifact provided in the TCK distribution must be run by TestNG (described by the TestNG documentation as "with a `testng.xml` file") unmodified for an implementation to pass the TCK. For testing purposes it is of course ok to modify the file.

```
<suite name="JSR-349-TCK" verbose="1">
    <test name="JSR-349-TCK">

        <method-selectors>
            <method-selector>
                                                                                <selector-class
 name="org.hibernate.beanvalidation.tck.util.IntegrationTestsMethodSelector"/>
            </method-selector>
        </method-selectors>

        <packages>
            <package name="org.hibernate.beanvalidation.tck.tests"/>
        </packages>
    </test>
</suite>
```

TestNG provides extensive reporting information. Depending on the build tool or IDE you use, the reporting will take a different format. Please consult the TestNG documentation and the tool documentation for more information.

Tip

In the example below the *maven-dependency-plugin* is used to extract the `tck-tests.xml` from the artifact jar file to make it available for the surefire configuration.

5.2. Selecting the `ValidationProvider`

The most important configuration you have make in order to run the Bean Validation TCK is to specify your `ValidationProvider` you want to run your tests against. To do so you need to set the Java system property validation.provider to the fully specified class name of your `ValidationProvider`. In the examples below this is done via the *systemProperties* configuration of the *maven-surefire-plugin*. This property will be picked up by `org.hibernate.beanvalidation.tck.util.TestUtil` which will instantiate the `Validator` under test. This means the test harness does not rely on the service provider mechanism to instantiate the Bean Validation provider under test, partly because this selection mechanism is under test as well.

```
<project xmlns="http://maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
          xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/maven-
v4_0_0.xsd">
    <modelVersion>4.0.0</modelVersion>

    <parent>
        <artifactId>hibernate-validator-parent</artifactId>
        <groupId>org.hibernate</groupId>
        <version>5.0.0-SNAPSHOT</version>
        <relativePath>../pom.xml</relativePath>
    </parent>

    <artifactId>hibernate-validator-tck-runner</artifactId>

    <name>Hibernate Validator TCK Runner</name>

    <properties>
        <tck.version>1.1.0-SNAPSHOT</tck.version>
          <tck.suite.file>${project.build.directory}/dependency/beanvalidation-tck-suite.xml</
tck.suite.file>
        <arquillian.version>1.0.0.Final</arquillian.version>
        <validation.provider>org.hibernate.validator.HibernateValidator</validation.provider>
        <remote.debug/>
    </properties>

    <dependencies>
        <dependency>
            <groupId>javax.validation</groupId>
            <artifactId>validation-api</artifactId>
        </dependency>
        <dependency>
            <groupId>org.hibernate</groupId>
            <artifactId>hibernate-validator</artifactId>
```

```
        </dependency>
        <dependency>
            <groupId>org.testng</groupId>
            <artifactId>testng</artifactId>
        </dependency>
        <dependency>
            <groupId>org.hibernate.beanvalidation.tck</groupId>
            <artifactId>beanvalidation-tck</artifactId>
            <version>${tck.version}</version>
        </dependency>
        <dependency>
            <groupId>org.hibernate.javax.persistence</groupId>
            <artifactId>hibernate-jpa-2.0-api</artifactId>
            <scope>test</scope>
        </dependency>
        <dependency>
            <groupId>org.jboss.arquillian.testng</groupId>
            <artifactId>arquillian-testng-container</artifactId>
            <version>${arquillian.version}</version>
            <scope>test</scope>
        </dependency>
        <dependency>
            <groupId>org.jboss.arquillian.protocol</groupId>
            <artifactId>arquillian-protocol-servlet</artifactId>
            <version>${arquillian.version}</version>
            <scope>test</scope>
        </dependency>
    </dependencies>

    <build>
        <testResources>
            <testResource>
                <filtering>true</filtering>
                <directory>src/test/resources</directory>
            </testResource>
        </testResources>
        <plugins>
           <plugin>
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-dependency-plugin</artifactId>
                <executions>
                    <execution>
                        <id>copy-tck-test-suite-file</id>
                        <phase>generate-test-sources</phase>
                        <goals>
                            <goal>copy</goal>
                        </goals>
                        <configuration>
                            <stripVersion>true</stripVersion>
                            <artifactItems>
                                <artifactItem>
                                    <groupId>org.hibernate.beanvalidation.tck</groupId>
                                    <artifactId>beanvalidation-tck</artifactId>
                                    <type>xml</type>
                                    <classifier>suite</classifier>
                                    <overWrite>false</overWrite>
                                </artifactItem>
                            </artifactItems>
                        </configuration>
```

```
                    </execution>
                </executions>
            </plugin>
            <plugin>
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-surefire-plugin</artifactId>
                <configuration>
                    <suiteXmlFiles>
                        <suiteXmlFile>${tck.suite.file}</suiteXmlFile>
                    </suiteXmlFiles>
                    <argLine>-Xmx128m</argLine>
                    <forkMode>once</forkMode>
                    <systemProperties>
                        <property>
                            <name>validation.provider</name>
                            <value>${validation.provider}</value>
                        </property>
                    </systemProperties>
                </configuration>
            </plugin>
            <plugin>
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-surefire-report-plugin</artifactId>
                <executions>
                    <execution>
                        <id>generate-test-report</id>
                        <phase>test</phase>
                        <goals>
                            <goal>report-only</goal>
                        </goals>
                    </execution>
                </executions>
                <configuration>
                 <outputDirectory>${project.build.directory}/surefire-reports</outputDirectory>
                    <outputName>test-report</outputName>
                </configuration>
            </plugin>
        </plugins>
    </build>
</project>
```

5.3. Selecting the `DeployableContainer`

After setting the `ValidationProvider` you have to make a choice on the right `DeployableContainer`. Arquillian picks which container it is going to use to deploy the test archive and negotiate test execution using Java's service provider mechanism. Concretely Arquillian is looking for an implementation of the `DeployableContainer` SPI is on the classpath. In the following examples this choice is made through the use of Maven profiles adding the appropriate test dependencies.

5.3.1. Local test execution via `BeanValidationLocalContainer`

Before trying to run the test harness against a real Java EE container it is recommended to run the test in a local JVM mode. The Bean Validation test harness ships with a `DeployableContainer`

called `BeanValidationLocalContainer` which allows you to do so. All you need is the right dependency:

```
<project xmlns="http://maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
          xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/maven-
v4_0_0.xsd">
    <modelVersion>4.0.0</modelVersion>

   ...

    <profiles>
        <profile>
            <id>local</id>
            <activation>
                <property>
                    <name>incontainer</name>
                    <value>!true</value>
                </property>
            </activation>
            <properties>
                <arquillian.protocol>Local</arquillian.protocol>
            </properties>
            <dependencies>
                <dependency>
                    <groupId>org.hibernate.beanvalidation.tck</groupId>
                    <artifactId>standalone-container-adapter</artifactId>
                    <version>${tck.version}</version>
                </dependency>
            </dependencies>
        </profile>
    </profiles>
</project>
```

As you can see the *local* profile is activated by default. It adds the dependency `org.hibernate.beanvalidation.tck:standalone-container-adapter` which contains the `DeployableContainer BeanValidationLocalContainer`. If the test harness is executed with this dependency on the classpath the tests will run in the local JVM. The purpose of the property arquillian.protocol will be discussed in *Section 5.4, "arquillian.xml"*. Running the test harness is as easy as executing:

```
mvn test
```

Note

The local execution mode is just a convenience for developers. To pass the Bean Validation TCK the test harness has to pass in a Java EE container. The reason for this is that Bean Validation is part of the Java EE specification.

Tip

Arquillian will throw an exception in case it finds more than one `DeployableContainer` implementations on the classpath. If you want to be able to run in local as well as incontainer mode from the same project setup you will need to separate the dependencies. This is the main purpose of the profiles used in this example.

5.3.2. Remote test execution in managed JBoss AS 7

Now let's try to run the tests in a Java EE container, namely JBoss AS 7. For this we defined a new profile incontainer which can be activated via:

```
> mvn test -Dincontainer
```

In this case we are adding the dependency org.jboss.as:jboss-as-arquillian-container-managed which will enable a managed JBoss AS 7 as `DeployableContainer`. AS 7 could be already installed on the system or as in this case be downloaded and unpacked via the *maven-dependency-plugin* prior to the test run.

```
<project xmlns="http://maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
          xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/maven-
v4_0_0.xsd">
    <modelVersion>4.0.0</modelVersion>

   ...

    <profiles>
        <profile>
            <id>local</id>
            <activation>
                <property>
                    <name>incontainer</name>
                    <value>!true</value>
                </property>
            </activation>
            <properties>
                <arquillian.protocol>Local</arquillian.protocol>
            </properties>
            <dependencies>
                <dependency>
                    <groupId>org.hibernate.beanvalidation.tck</groupId>
                    <artifactId>standalone-container-adapter</artifactId>
                    <version>${tck.version}</version>
                </dependency>
            </dependencies>
        </profile>
```

```
        <profile>
            <id>incontainer</id>
            <activation>
                <property>
                    <name>incontainer</name>
                </property>
            </activation>
            <properties>
                <arquillian.protocol>Servlet 3.0</arquillian.protocol>
            </properties>
            <dependencies>
                <dependency>
                    <groupId>org.jboss.as</groupId>
                    <artifactId>jboss-as-arquillian-container-managed</artifactId>
                    <version>${jbossas.version}</version>
                    <scope>test</scope>
                </dependency>
            </dependencies>
            <build>
                <plugins>
                    <plugin>
                        <artifactId>maven-dependency-plugin</artifactId>
                        <executions>
                            <execution>
                                <id>unpack</id>
                                <phase>process-test-resources</phase>
                                <goals>
                                    <goal>unpack</goal>
                                </goals>
                                <configuration>
                                    <artifactItems>
                                        <artifactItem>
                                            <groupId>org.jboss.as</groupId>
                                            <artifactId>jboss-as-dist</artifactId>
                                            <version>${jbossas.version}</version>
                                            <type>zip</type>
                                            <overWrite>false</overWrite>
                                  <outputDirectory>${project.build.directory}</outputDirectory>
                                        </artifactItem>
                                    </artifactItems>
                                </configuration>
                            </execution>
                            <execution>
                                <id>copy-beanvalidation-api</id>
                                <phase>generate-test-sources</phase>
                                <goals>
                                    <goal>copy</goal>
                                </goals>
                                <configuration>
                                    <outputDirectory>
                                       ${project.build.directory}/jboss-as-${jbossas.version}/
modules/javax/validation/api/main
                                    </outputDirectory>
                                    <stripVersion>true</stripVersion>
                                    <artifactItems>
                                        <artifactItem>
                                            <groupId>javax.validation</groupId>
                                            <artifactId>validation-api</artifactId>
                                        </artifactItem>
```

```
                                    </artifactItems>
                                </configuration>
                            </execution>
                        </executions>
                    </plugin>
                    <plugin>
                        <groupId>org.apache.maven.plugins</groupId>
                        <artifactId>maven-surefire-plugin</artifactId>
                        <configuration>
                                                                                <argLine>-Xmx1024m   -
Djava.util.logging.manager=org.jboss.logmanager.LogManager</argLine>
                            <forkMode>once</forkMode>
                            <suiteXmlFiles>
                                <suiteXmlFile>${tck.suite.file}</suiteXmlFile>
                            </suiteXmlFiles>
                            <systemPropertyVariables>
                                <arquillian.launch>incontainer</arquillian.launch>
                              <validation.provider>${validation.provider}</validation.provider>
                                <includeIntegrationTests>true</includeIntegrationTests>
                            </systemPropertyVariables>
                        </configuration>
                    </plugin>
                </plugins>
            </build>
        </profile>
    </profiles>
</project>
```

Tip

You find a list of available deployable containers in the Arquillian documentation. Refer to *Container adapters* [https://docs.jboss.org/author/display/ARQ/Container+adapters].

5.3.2.1. Tests annotated with `@IntegrationTest`

Some of the tests can only run within a container (mainly due to the way they are setup). These tests are annotated with @IntegrationTest. Since these tests would fail in local execution mode they can be excluded by setting the system property includeIntegrationTests to `false` (or not specifying it at all). To pass the TCK the property needs to be set to `true` and all integration tests need to run.

Tip

The in- an exclusion of integration tests is handled via a TestNG specific `IMethodSelector`, more concretely *`IntegrationTestsMethodSelector`* [https://github.com/beanvalidation/beanvalidation-tck/tree/master/tests/src/main/java/org/hibernate/beanvalidation/tck/util/IntegrationTestsMethodSelector.java].

5.3.2.2. Debugging remote test executions

The easiest way to debug the tests when they are executes in a remote container is to open a remote debugging session. In order to do so the JVM needs to be started with the right remote debugging options. Again this can be achieved via a profile:

```
<project xmlns="http://maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
          xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/maven-
v4_0_0.xsd">
    <modelVersion>4.0.0</modelVersion>

   ...

    <profiles>
        <profile>
            <id>local</id>
            <activation>
                <property>
                    <name>incontainer</name>
                    <value>!true</value>
                </property>
            </activation>
            <properties>
                <arquillian.protocol>Local</arquillian.protocol>
            </properties>
            <dependencies>
                <dependency>
                    <groupId>org.hibernate.beanvalidation.tck</groupId>
                    <artifactId>standalone-container-adapter</artifactId>
                    <version>${tck.version}</version>
                </dependency>
            </dependencies>
        </profile>

        <profile>
            <id>incontainer-debug</id>
            <activation>
                <property>
                    <name>debug</name>
                </property>
            </activation>
            <properties>
                                    <remote.debug>-Xnoagent  -Djava.compiler=NONE  -Xdebug  -
Xrunjdwp:transport=dt_socket,server=y,suspend=y,address=5005</remote.debug>
            </properties>
        </profile>

        <profile>
            <id>incontainer</id>
            <activation>
                <property>
                    <name>incontainer</name>
                </property>
            </activation>
            <properties>
                <arquillian.protocol>Servlet 3.0</arquillian.protocol>
```

```
            </properties>
            <dependencies>
                <dependency>
                    <groupId>org.jboss.as</groupId>
                    <artifactId>jboss-as-arquillian-container-managed</artifactId>
                    <version>${jbossas.version}</version>
                    <scope>test</scope>
                </dependency>
            </dependencies>
            <build>
                <plugins>
                    <plugin>
                        <artifactId>maven-dependency-plugin</artifactId>
                        <executions>
                            <execution>
                                <id>unpack</id>
                                <phase>process-test-resources</phase>
                                <goals>
                                    <goal>unpack</goal>
                                </goals>
                                <configuration>
                                    <artifactItems>
                                        <artifactItem>
                                            <groupId>org.jboss.as</groupId>
                                            <artifactId>jboss-as-dist</artifactId>
                                            <version>${jbossas.version}</version>
                                            <type>zip</type>
                                            <overWrite>false</overWrite>
                                  <outputDirectory>${project.build.directory}</outputDirectory>
                                        </artifactItem>
                                    </artifactItems>
                                </configuration>
                            </execution>
                            <execution>
                                <id>copy-beanvalidation-api</id>
                                <phase>generate-test-sources</phase>
                                <goals>
                                    <goal>copy</goal>
                                </goals>
                                <configuration>
                                    <outputDirectory>
                                       ${project.build.directory}/jboss-as-${jbossas.version}/
modules/javax/validation/api/main
                                    </outputDirectory>
                                    <stripVersion>true</stripVersion>
                                    <artifactItems>
                                        <artifactItem>
                                            <groupId>javax.validation</groupId>
                                            <artifactId>validation-api</artifactId>
                                        </artifactItem>
                                    </artifactItems>
                                </configuration>
                            </execution>
                        </executions>
                    </plugin>
                    <plugin>
                        <groupId>org.apache.maven.plugins</groupId>
                        <artifactId>maven-surefire-plugin</artifactId>
                        <configuration>
```

```
                                                                    <argLine>-Xmx1024m   -
Djava.util.logging.manager=org.jboss.logmanager.LogManager</argLine>
                            <forkMode>once</forkMode>
                            <suiteXmlFiles>
                                <suiteXmlFile>${tck.suite.file}</suiteXmlFile>
                            </suiteXmlFiles>
                            <systemPropertyVariables>
                                <arquillian.launch>incontainer</arquillian.launch>
                              <validation.provider>${validation.provider}</validation.provider>
                                <includeIntegrationTests>true</includeIntegrationTests>
                            </systemPropertyVariables>
                        </configuration>
                    </plugin>
                </plugins>
            </build>
        </profile>
    </profiles>
</project>
```

In this you would start the tests via (activation order is important):

```
mvn test -Ddebug -Dincontainer
```

The test execution would start but then be suspended until the JVM receives a remote debugging request on port 5005.

5.4. arquillian.xml

The next piece in the configuration puzzle is `arquillian.xml`. This xml file needs to be in the root of the classpath and is used to pass additional options to the selected container. Let's look at an example:

```
<arquillian    xmlns="http://jboss.org/schema/arquillian"    xmlns:xsi="http://www.w3.org/2001/
XMLSchema-instance"
            xsi:schemaLocation="http://jboss.org/schema/arquillian
        http://jboss.org/schema/arquillian/arquillian_1_0.xsd">

     <!-- Need to set the default protocol and use resource filtering, because of https://
issues.jboss.org/browse/ARQ-579 -->
    <defaultProtocol type="${arquillian.protocol}"/>

    <engine>
        <property name="deploymentExportPath">target/artifacts</property>
    </engine>

    <container qualifier="local" default="true">
        <protocol type="Local"/>   <!-- Takes no effect - ARQ-579 -->
    </container>

    <container qualifier="incontainer">
        <protocol type="Servlet 3.0"/> <!-- Takes no effect - ARQ-579 -->
        <configuration>
```

```
            <property name="jbossHome">${jbossTargetDir}</property>
             <property name="javaVmArguments">-Xmx1024m -XX:MaxPermSize=512m ${remote.debug} -
Dvalidation.provider=${validation.provider}</property>
            <property name="allowConnectingToRunningServer">true</property>
        </configuration>
    </container>

</arquillian>
```

In this case we have two *container* nodes, *local* and *incontainer*. The selection of which configuration to chose at runtime is made by setting the system property arquillian.launch. If arquillian.launch is not specify the default is selected which in this case is *local*.

The most important container configuration option is the protocol type which determines how Arquillian communicates with the selected container. The most popular types are *Local* and *Servlet 3.0*. The protocol can be defined per container node, however, due to a bug only the defaultProtocol setting takes effect. This is also the reason for the arquillian.protocol property used in the pom examples. Depending on the chosen profile the appropriate protocol is selected and added to `arquillian.xml` via *resource filtering* [http://maven.apache.org/plugins/maven-resources-plugin/examples/filter.html].

Another interesting property is deploymentExportPath which is optional and instructs Arquillian to dump the test artifacts to the specified directory on disk. Inspection of the deployed artifacts can be very useful when debugging test failures.

Running the Signature Test

One of the requirements of an implementation passing the TCK is for it to pass the Bean Validation signature test. This section describes how the signature file is generated and how to run it against your implementation.

6.1. Obtaining the sigtest tool

You can obtain the Sigtest tool (at the time of writing the TCK uses version 2.1) from the Sigtest home page at *https://sigtest.dev.java.net/*. The user guide can be found at *http://download.oracle.com/javame/test-tools/sigtest/2_1/sigtest2.1_usersguide.pdf*. The downloadable package contains the jar files used in the commands below.

6.2. Creating the signature file

The TCK package contains the files `validation-api-java5.sig`, `validation-api-java6.sig` and `validation-api-java7.sig` and (in the `artifacts` directory) which were created using the following command (using the corresponding Java version):

```
java -jar sigtestdev.jar Setup -classpath $JAVA_HOME/jre/lib/rt.jar:lib/validation-api-1.1.0.Final.jar -package javax.validation -filename validation-api-java6.sig
```

In order to pass the Bean Validation TCK you have to make sure that your API passes the signature tests against `validation-api.sig`.

6.3. Running the signature test

To run the signature test use:

```
java -jar sigtest.jar Test -classpath $JAVA_HOME/jre/lib/rt.jar:lib/validation-api-1.1.0.Final.jar -static -package javax.validation -filename validation-api-java6.sig
```

You have to chose the right version of the signature file depending on your Java version. In order to run against your own Bean Validation API replace validation-api-1.1.0.Final.jar with your own API jar. You should get the message `"STATUS:Passed."`.

6.4. Forcing a signature test failure

Just for fun (and to confirm that the signature test is working correctly), you can try the following:

1) Edit validation-api.sig

2) Modify one of the class signatures - in the following example we change one of the constructors for `ValidationException` - here's the original:

```
CLSS public javax.validation.ValidationException
cons public ValidationException()
cons public ValidationException(java.lang.String)
cons public ValidationException(java.lang.String,java.lang.Throwable)
cons public ValidationException(java.lang.Throwable)
supr java.lang.RuntimeException
```

Let's change the default (empty) constructor parameter to one with a `java.lang.Integer` parameter instead:

```
CLSS public javax.validation.ValidationException
cons public ValidationException(java.lang.Integer)
cons public ValidationException(java.lang.String)
cons public ValidationException(java.lang.String,java.lang.Throwable)
cons public ValidationException(java.lang.Throwable)
supr java.lang.RuntimeException
```

3) Now when we run the signature test using the above command, we should get the following errors:

```
Missing Constructors
--------------------

javax.validation.ValidationException:                              constructor          public
 javax.validation.ValidationException.ValidationException(java.lang.Integer)

Added Constructors
------------------

javax.validation.ValidationException:                              constructor          public
 javax.validation.ValidationException.ValidationException()


STATUS:Failed.2 errors
```