1. Introduction to Spring Framework

Spring Framework is a Java platform that provides comprehensive infrastructure support for developing Java applications. Spring handles the infrastructure so you can focus on your application.

Spring enables you to build applications from “plain old Java objects” (POJOs) and to apply enterprise services non-invasively to POJOs. This capability applies to the Java SE programming model and to full and partial Java EE.

Examples of how you, as an application developer, can use the Spring platform advantage:

- Make a Java method execute in a database transaction without having to deal with transaction APIs.
- Make a local Java method a remote procedure without having to deal with remote APIs.
- Make a local Java method a management operation without having to deal with JMX APIs.
- Make a local Java method a message handler without having to deal with JMS APIs.

1.1 Dependency Injection and Inversion of Control

Background

“*The question is, what aspect of control are [they] inverting?*” Martin Fowler posed this question about Inversion of Control (IoC) on his site in 2004. Fowler suggested renaming the principle to make it more self-explanatory and came up with *Dependency Injection*.

For insight into IoC and DI, refer to Fowler's article at http://martinfowler.com/articles/injection.html.

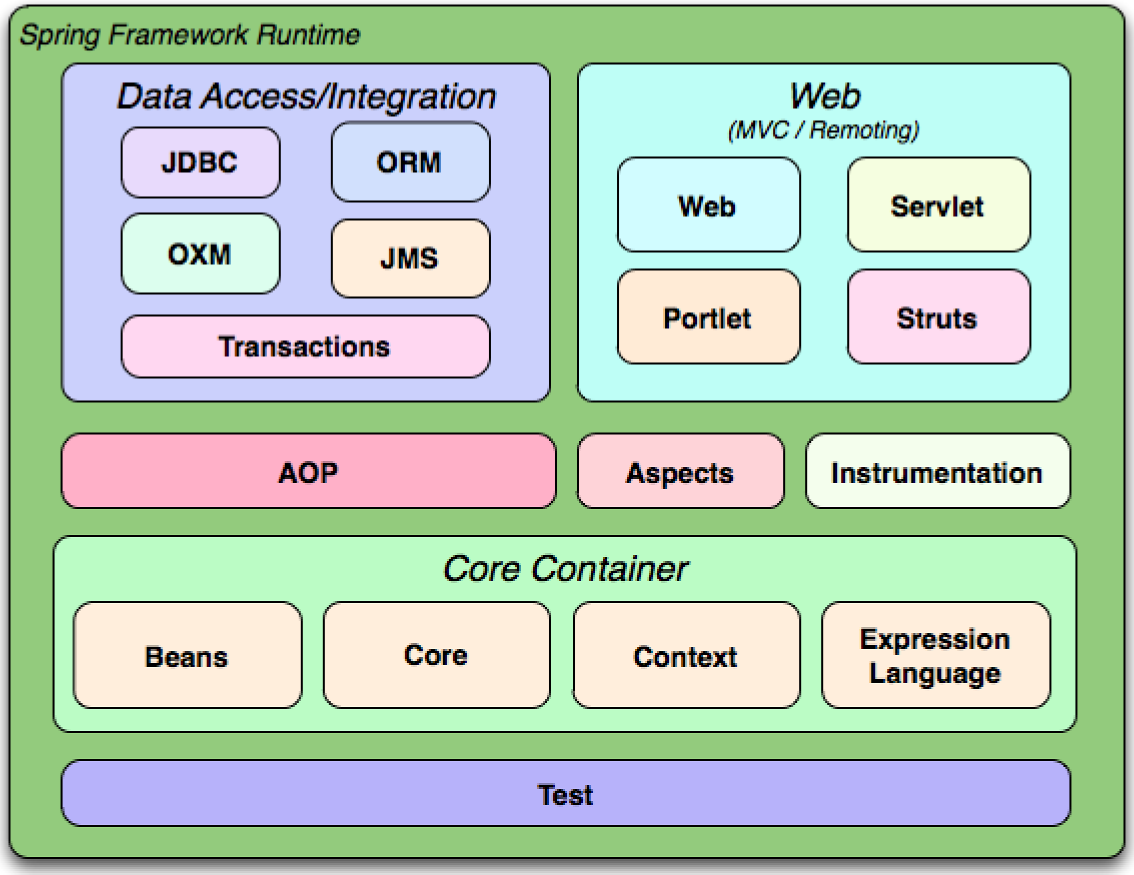
Java applications -- a loose term that runs the gamut from constrained applets to n-tier server-side enterprise applications -- typically consist of objects that collaborate to form the application proper. Thus the objects in an application have *dependencies* on each other.

Although the Java platform provides a wealth of application development functionality, it lacks the means to organize the basic building blocks into a coherent whole, leaving that task to architects and developers. True, you can use design patterns such as *Factory*, *Abstract Factory*, *Builder*, *Decorator*, and *Service Locator* to compose the various classes and object instances that make up an application. However, these patterns are simply that: best practices given a name, with a description of what the pattern does, where to apply it, the problems it addresses, and so forth. Patterns are formalized best practices that *you must implement yourself* in your application.

The Spring Framework *Inversion of Control* (IoC) component addresses this concern by providing a formalized means of composing disparate components into a fully working application ready for use. The Spring Framework codifies formalized design patterns as first-class objects that you can integrate into your own application(s). Numerous organizations and institutions use the Spring Framework in this manner to engineer robust, *maintainable* applications.

1.2 Modules

The Spring Framework consists of features organized into about 20 modules. These modules are grouped into Core Container, Data Access/Integration, Web, AOP (Aspect Oriented Programming), Instrumentation, and Test, as shown in the following diagram.



Overview of the Spring Framework

1.2.1 Core Container

The *Core Container* consists of the Core, Beans, Context, and Expression Language modules.

The *Core and Beans* modules provide the fundamental parts of the framework, including the IoC and Dependency Injection features. The `BeanFactory` is a sophisticated implementation of the factory pattern. It removes the need for programmatic singletons and allows you to decouple the configuration and specification of dependencies from your actual program logic.

The *Context* module builds on the solid base provided by the *Core and Beans* modules: it is a means to access objects in a framework-style manner that is similar to a JNDI registry. The Context module inherits its features from the Beans module and adds support for internationalization (using, for example, resource bundles), event-propagation, resource-loading, and the transparent creation of contexts by, for example, a servlet container. The Context module also supports Java EE features such as EJB, JMX ,and basic remoting. The `ApplicationContext` interface is the focal point of the Context module.

The *Expression Language* module provides a powerful expression language for querying and manipulating an object graph at runtime. It is an extension of the unified expression language (unified EL) as specified in the JSP 2.1 specification. The language supports setting and getting property values, property assignment, method invocation, accessing the context of arrays, collections and indexers, logical and arithmetic operators, named variables, and retrieval of objects by name from Spring's IoC container. It also supports list projection and selection as well as common list aggregations.

1.2.2 Data Access/Integration

The *Data Access/Integration* layer consists of the JDBC, ORM, OXM, JMS and Transaction modules.

The JDBC module provides a JDBC-abstraction layer that removes the need to do tedious JDBC coding and parsing of database-vendor specific error codes.

The *ORM* module provides integration layers for popular object-relational mapping APIs, including JPA, JDO, Hibernate, and iBatis. Using the ORM package you can use all of these O/R-mapping frameworks in combination with all of the other features Spring offers, such as the simple declarative transaction management feature mentioned previously.

The OXM module provides an abstraction layer that supports Object/XML mapping implementations for JAXB, Castor, XMLBeans, JiBX and XStream.

The Java Messaging Service (JMS) module contains features for producing and consuming messages.

The Transaction module supports programmatic and declarative transaction management for classes that implement special interfaces and for *all your POJOs (plain old Java objects)*.

1.2.3 Web

The *Web* layer consists of the Web, Web-Servlet, Web-Struts, and Web-Portlet modules.

Spring's *Web* module provides basic web-oriented integration features such as multipart file-upload functionality and the initialization of the IoC container using servlet listeners and a web-oriented application context. It also contains the web-related parts of Spring's remoting support.

The *Web-Servlet* module contains Spring's model-view-controller (*MVC*) implementation for web applications. Spring's MVC framework provides a clean separation between domain model code and web forms, and integrates with all the other features of the Spring Framework.

The *Web-Struts* module contains the support classes for integrating a classic Struts web tier within a Spring application. Note that this support is now deprecated as of Spring 3.0. Consider migrating your application to Struts 2.0 and its Spring integration or to a Spring MVC solution.

The *Web-Portlet* module provides the MVC implementation to be used in a portlet environment and mirrors the functionality of Web-Servlet module.

1.2.4 AOP and Instrumentation

Spring's *AOP* module provides an *AOP Alliance*-compliant aspect-oriented programming implementation allowing you to define, for example, method-interceptors and pointcuts to cleanly decouple code that implements functionality that should be separated. Using source-level metadata functionality, you can also incorporate behavioral information into your code, in a manner similar to that of .NET attributes.

The separate *Aspects* module provides integration with AspectJ.

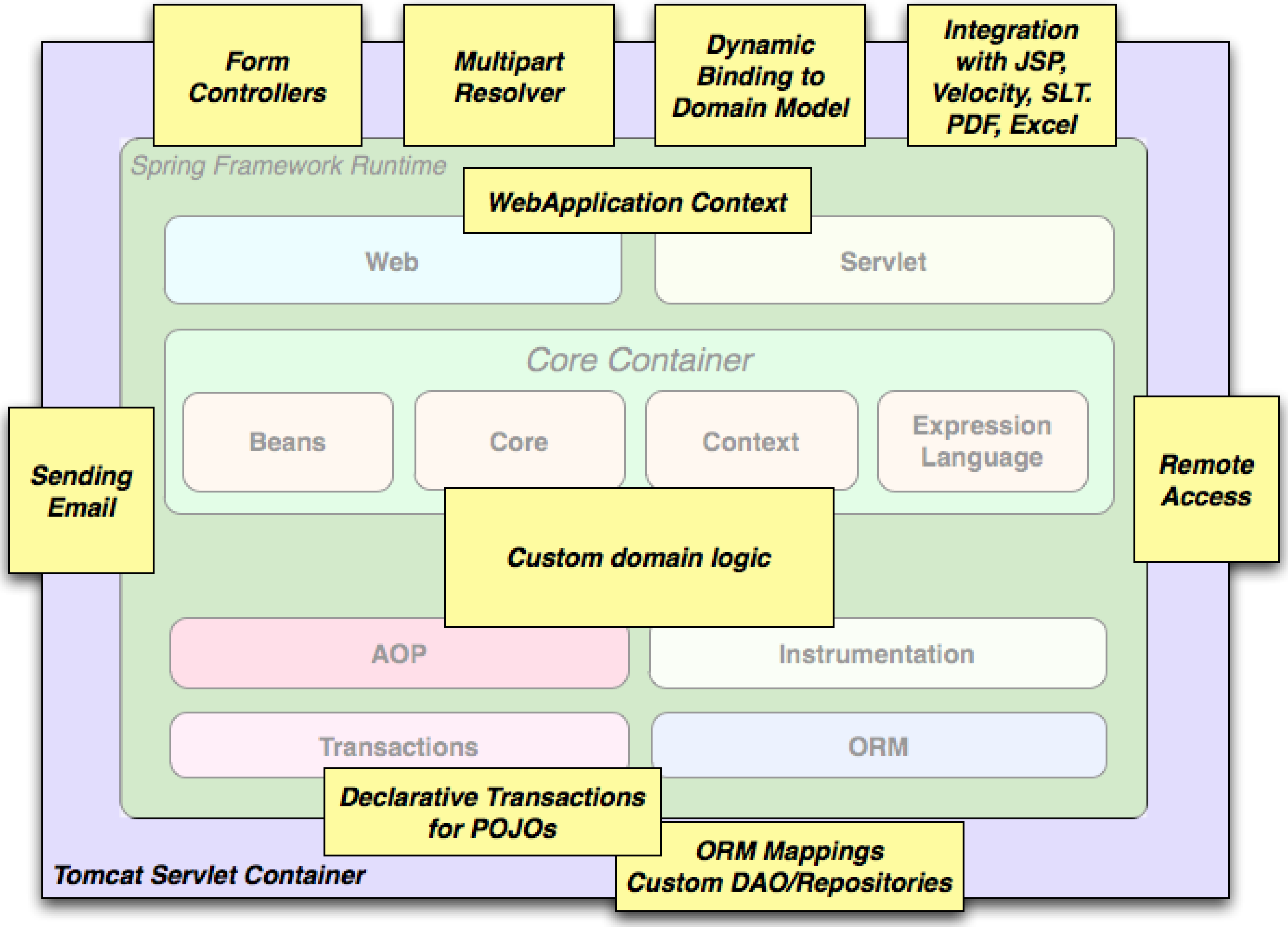
The *Instrumentation* module provides class instrumentation support and classloader implementations to be used in certain application servers.

1.2.5 Test

The *Test* module supports the testing of Spring components with JUnit or TestNG. It provides consistent loading of Spring ApplicationContexts and caching of those contexts. It also provides mock objects that you can use to test your code in isolation.

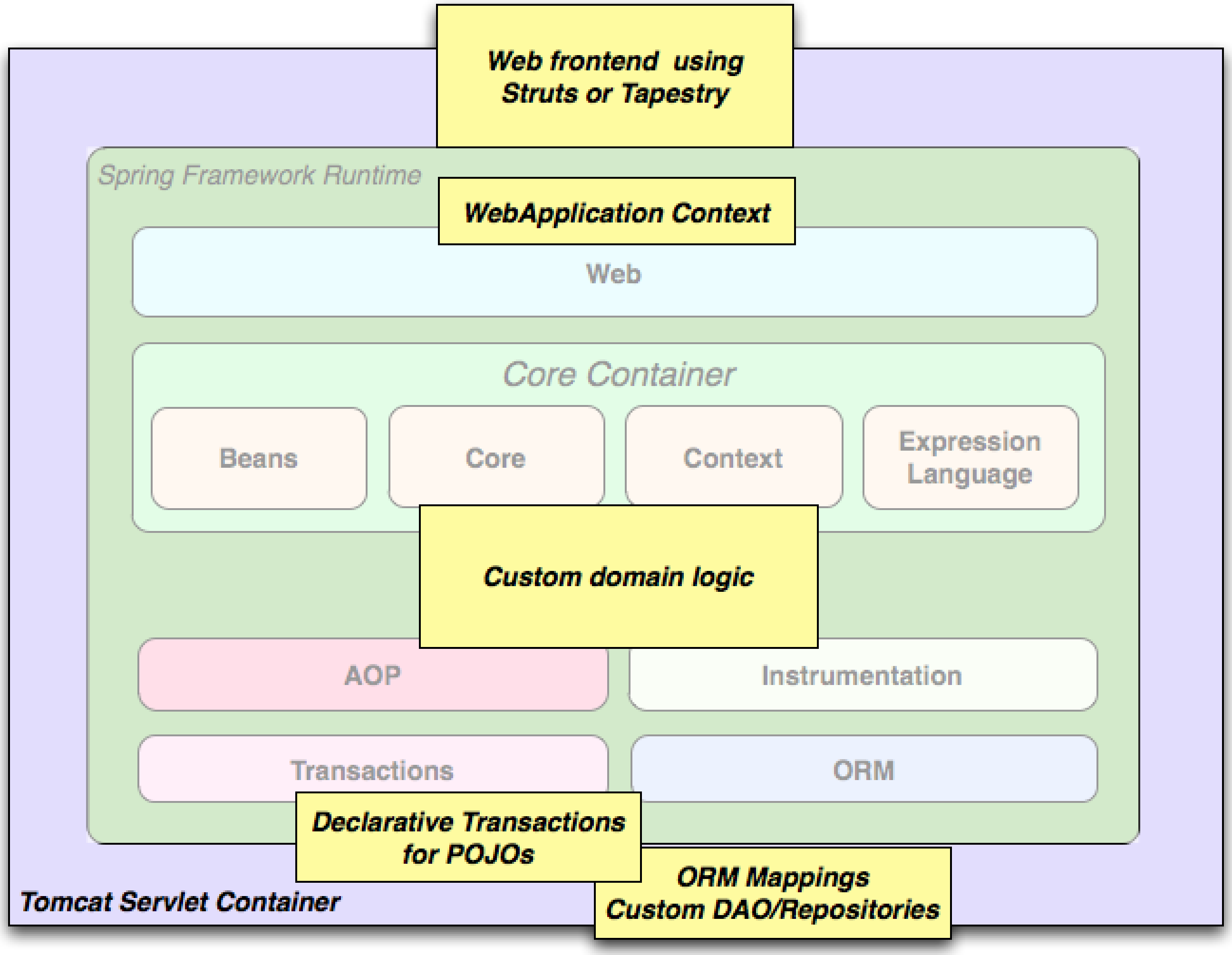
1.3 Usage scenarios

The building blocks described previously make Spring a logical choice in many scenarios, from applets to full-fledged enterprise applications that use Spring's transaction management functionality and web framework integration.



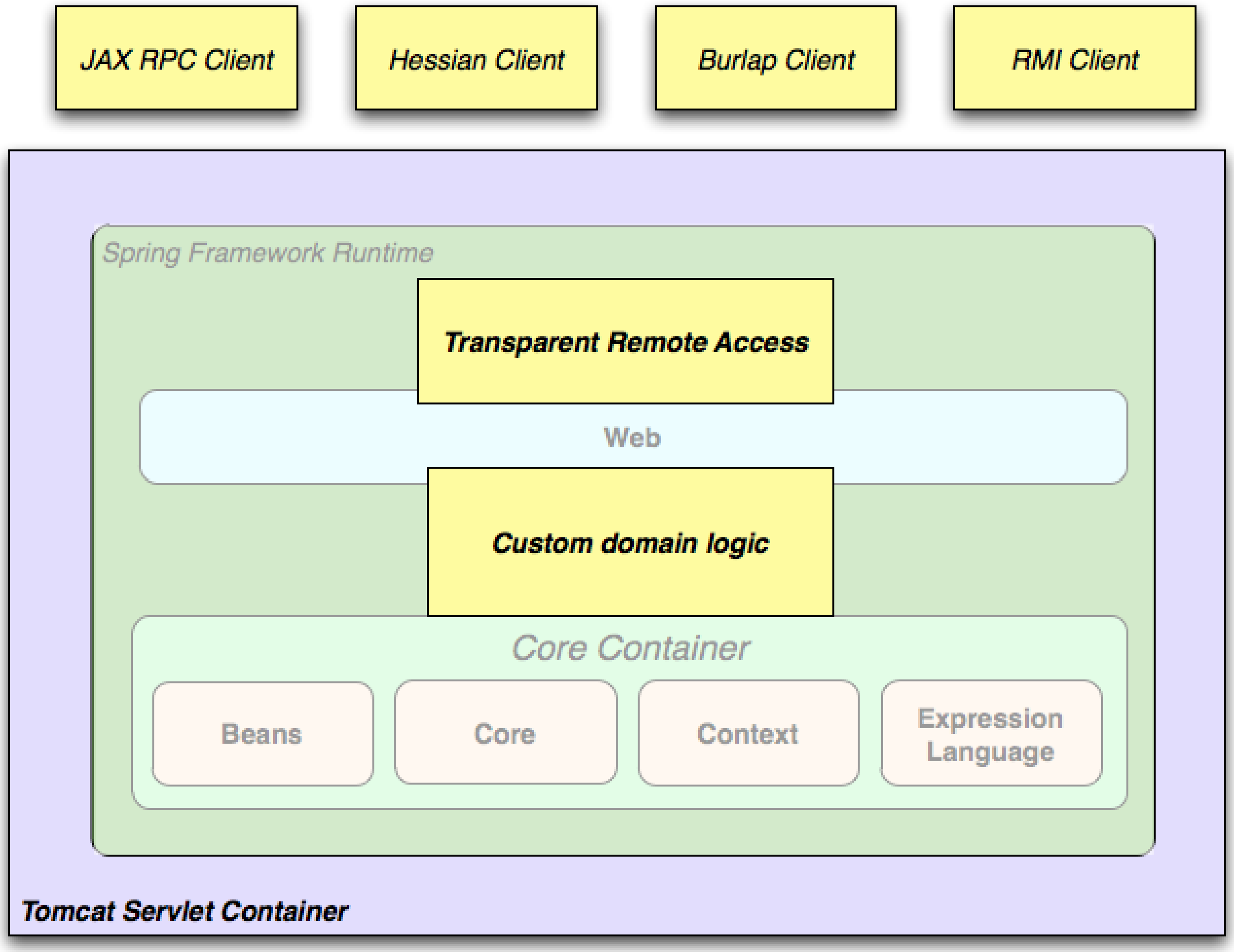
Typical full-fledged Spring web application

Spring's declarative transaction management features make the web application fully transactional, just as it would be if you used EJB container-managed transactions. All your custom business logic can be implemented with simple POJOs and managed by Spring's IoC container. Additional services include support for sending email and validation that is independent of the web layer, which lets you choose where to execute validation rules. Spring's ORM support is integrated with JPA, Hibernate, JDO and iBatis; for example, when using Hibernate, you can continue to use your existing mapping files and standard Hibernate `SessionFactory` configuration. Form controllers seamlessly integrate the web-layer with the domain model, removing the need for `ActionForms` or other classes that transform HTTP parameters to values for your domain model.



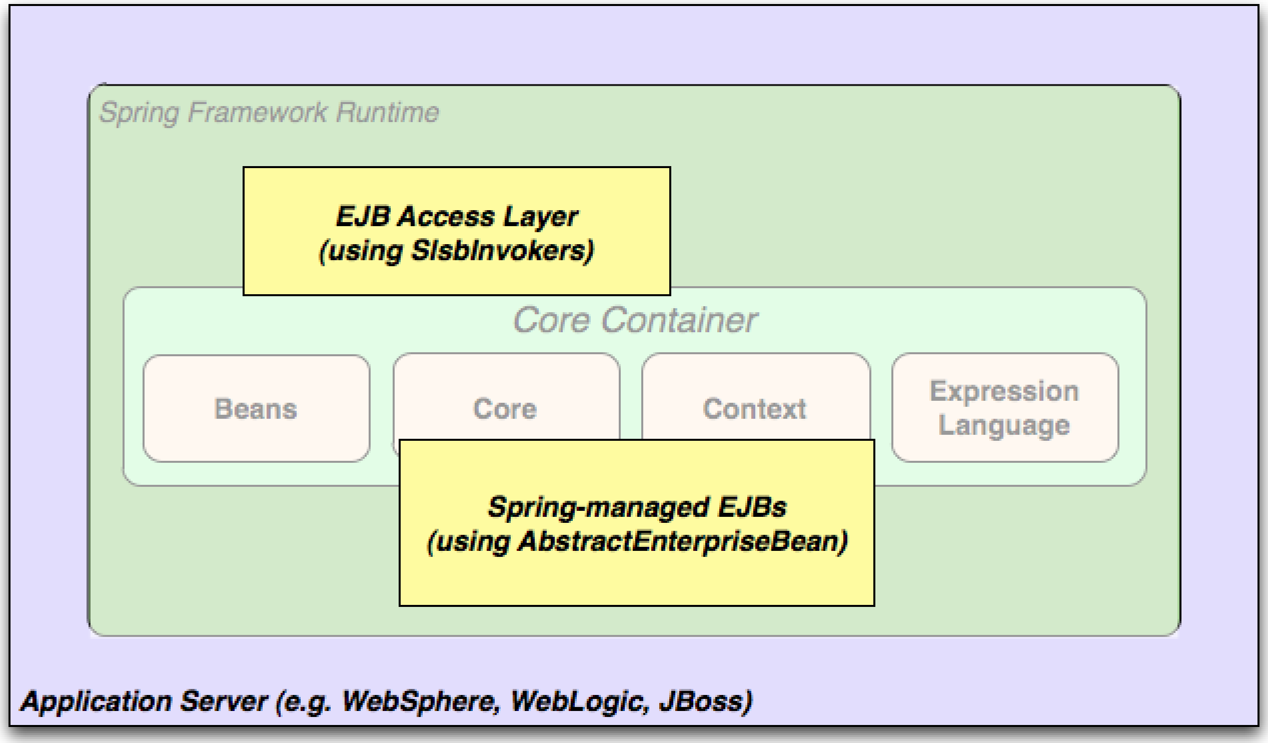
Spring middle-tier using a third-party web framework

Sometimes circumstances do not allow you to completely switch to a different framework. The Spring Framework does *not* force you to use everything within it; it is not an *all-or-nothing* solution. Existing front-ends built with WebWork, Struts, Tapestry, or other UI frameworks can be integrated with a Spring-based middle-tier, which allows you to use Spring transaction features. You simply need to wire up your business logic using an `ApplicationContext` and use a `WebApplicationContext` to integrate your web layer.



Remoting usage scenario

When you need to access existing code through web services, you can use Spring's `Hessian-`, `Burlap-`, `Rmi-` or `JaxRpcProxyFactory` classes. Enabling remote access to existing applications is not difficult.


Spring Framework Runtime
EJB Access Layer (using SlsbInvokers)
Core Container
Beans
Core
Context
Expression Language
Spring-managed EJBs (using AbstractEnterpriseBean)
Application Server (e.g. WebSphere, WebLogic, JBoss)

EJBs - Wrapping existing POJOs

The Spring Framework also provides an access and abstraction layer for Enterprise JavaBeans, enabling you to reuse your existing POJOs and wrap them in stateless session beans for use in scalable, fail-safe web applications that might need declarative security.

1.3.1 Dependency Management and Naming Conventions

Dependency management and dependency injection are different things. To get those nice features of Spring into your application (like dependency injection) you need to assemble all the libraries needed (jar files) and get them onto your classpath at runtime, and possibly at compile time. These dependencies are not virtual components that are injected, but physical resources in a file system (typically). The process of dependency management involves locating those resources, storing them and adding them to classpaths. Dependencies can be direct (e.g. my application depends on Spring at runtime), or indirect (e.g. my application depends on `commons-dbcp` which depends on `commons-pool`). The indirect dependencies are also known as "transitive" and it is those dependencies that are hardest to identify and manage.

If you are going to use Spring you need to get a copy of the jar libraries that comprise the pieces of Spring that you need. To make this easier Spring is packaged as a set of modules that separate the dependencies as much as possible, so for example if you don't want to write a web application you don't need the spring-web modules. To refer to Spring library modules in this guide we use a shorthand naming convention `spring-*` or `spring-*.jar,` where "*" represents the short name for the module (e.g. `spring-core`, `spring-webmvc`, `spring-jms`, etc.). The actual jar file name that you use may be in this form (see below) or it may not, and normally it also has a version number in the file name (e.g. `spring-core-3.0.0.RELEASE.jar`).

In general, Spring publishes its artifacts to four different places:

- On the community download site http://www.springsource.org/download/community. Here you find all the Spring jars bundled together into a zip file for easy download. The names of the jars here since version 3.0 are in the form `org.springframework.*-<version>.jar`.
- Maven Central, which is the default repository that Maven queries, and does not require any special configuration to use. Many of the common libraries that Spring depends on also are available from Maven Central and a large section of the Spring community uses Maven for dependency management, so this is convenient for them. The names of the jars here are in the form `spring-*-<version>.jar` and the Maven groupId is `org.springframework`.
- The Enterprise Bundle Repository (EBR), which is run by SpringSource and also hosts all the libraries that integrate with Spring. Both Maven and Ivy repositories are available here for all Spring jars and their dependencies, plus a large number of other common libraries that people use in applications with Spring. Both full releases and also milestones and development snapshots are deployed here. The names of the jar files are in the same form as the community download (`org.springframework.*-<version>.jar`), and the dependencies are also in this "long" form, with external libraries (not from SpringSource) having the prefix `com.springsource`. See the FAQ for more information.
- In a public Maven repository hosted on Amazon S3 for development snapshots and milestone releases (a copy of the final releases is also held here). The jar file names are in the same form as Maven Central, so this is a useful place to get development versions of Spring to use with other libraries deployed in Maven Central.

So the first thing you need to decide is how to manage your dependencies: most people use an automated system like Maven or Ivy, but you can also do it manually by downloading all the jars yourself. When obtaining Spring with Maven or Ivy you have then to decide which place you'll get it from. In general, if you care about OSGi, use the EBR, since it houses OSGi compatible artifacts for all of Spring's dependencies, such as Hibernate and Freemarker. If OSGi does not matter to you, either place works, though there are some pros and cons between them. In general, pick one place or the other for your project; do not mix them. This is particularly important since EBR artifacts necessarily use a different naming convention than Maven Central artifacts.

Table 1.1. Comparison of Maven Central and SpringSource EBR Repositories

Feature	Maven Central	EBR
OSGi Compatible	Not explicit	Yes
Number of Artifacts	Tens of thousands; all kinds	Hundreds; those that Spring integrates with
Consistent Naming Conventions	No	Yes
Naming Convention: GroupId	Varies. Newer artifacts often use domain name, e.g. org.slf4j. Older ones often just use the artifact name, e.g. log4j.	Domain name of origin or main package root, e.g. org.springframework
Naming Convention: ArtifactId	Varies. Generally the project or module name, using a hyphen "-" separator, e.g. spring-core, logj4.	Bundle Symbolic Name, derived from the main package root, e.g. org.springframework.beans. If the jar had to be patched to ensure OSGi compliance then com.springsource is appended, e.g. com.springsource.org.apache.log4j

Feature	Maven Central	EBR
Naming Convention: Version	Varies. Many new artifacts use m.m.m or m.m.m.X (with m=digit, X=text). Older ones use m.m. Some neither. Ordering is defined but not often relied on, so not strictly reliable.	OSGi version number m.m.m.X, e.g. 3.0.0.RC3. The text qualifier imposes alphabetic ordering on versions with the same numeric values.
Publishing	Usually automatic via rsync or source control updates. Project authors can upload individual jars to JIRA.	Manual (JIRA processed by SpringSource)
Quality Assurance	By policy. Accuracy is responsibility of authors.	Extensive for OSGi manifest, Maven POM and Ivy metadata. QA performed by Spring team.
Hosting	Contegix. Funded by Sonatype with several mirrors.	S3 funded by SpringSource.
Search Utilities	Various	http://www.springsource.com/repository
Integration with SpringSource Tools	Integration through STS with Maven dependency management	Extensive integration through STS with Maven, Roo, CloudFoundry

Spring Dependencies and Depending on Spring

Although Spring provides integration and support for a huge range of enterprise and other external tools, it intentionally keeps its mandatory dependencies to an absolute minimum: you shouldn't have to locate and download (even automatically) a large number of jar libraries in order to use Spring for simple use cases. For basic dependency injection there is only one mandatory external dependency, and that is for logging (see below for a more detailed description of logging options).

Next we outline the basic steps needed to configure an application that depends on Spring, first with Maven and then with Ivy. In all cases, if anything is unclear, refer to the documentation of your dependency management system, or look at some sample code - Spring itself uses Ivy to manage dependencies when it is building, and our samples mostly use Maven.

Maven Dependency Management

If you are using Maven for dependency management you don't even need to supply the logging dependency explicitly. For example, to create an application context and use dependency injection to configure an application, your Maven dependencies will look like this:

```
<dependencies>
   <dependency>
      <groupId>org.springframework</groupId>
      <artifactId>spring-context</artifactId>
      <version>3.0.0.RELEASE</version>
      <scope>runtime</scope>
   </dependency>
</dependencies>
```

That's it. Note the scope can be declared as runtime if you don't need to compile against Spring APIs, which is typically the case for basic dependency injection use cases.

We used the Maven Central naming conventions in the example above, so that works with Maven Central or the SpringSource S3 Maven repository. To use the S3 Maven repository (e.g. for milestones or developer snapshots), you need to specify the repository location in your Maven configuration. For full releases:

```
<repositories>
   <repository>
      <id>com.springsource.repository.maven.release</id>
      <url>http://repo.springsource.org/release/</url>
      <snapshots><enabled>false</enabled></snapshots>
   </repository>
</repositories>
```

For milestones:

```
<repositories>
   <repository>
      <id>com.springsource.repository.maven.milestone</id>
      <url>http://repo.springsource.org/milestone/</url>
      <snapshots><enabled>false</enabled></snapshots>
   </repository>
</repositories>
```

And for snapshots:

```
<repositories>
   <repository>
      <id>com.springsource.repository.maven.snapshot</id>
      <url>http://repo.springsource.org/snapshot/</url>
      <snapshots><enabled>true</enabled></snapshots>
   </repository>
</repositories>
```

To use the SpringSource EBR you would need to use a different naming convention for the dependencies. The names are usually easy to guess, e.g. in this case it is:

```
<dependencies>
   <dependency>
      <groupId>org.springframework</groupId>
      <artifactId>org.springframework.context</artifactId>
      <version>3.0.0.RELEASE</version>
      <scope>runtime</scope>
```

```
    </dependency>
</dependencies>
```

You also need to declare the location of the repository explicitly (only the URL is important):

```
<repositories>
    <repository>
        <id>com.springsource.repository.bundles.release</id>
        <url>http://repository.springsource.com/maven/bundles/release/</url>
    </repository>
</repositories>
```

If you are managing your dependencies by hand, the URL in the repository declaration above is not browsable, but there is a user interface at http://www.springsource.com/repository that can be used to search for and download dependencies. It also has handy snippets of Maven and Ivy configuration that you can copy and paste if you are using those tools.

Ivy Dependency Management

If you prefer to use Ivy to manage dependencies then there are similar names and configuration options.

To configure Ivy to point to the SpringSource EBR add the following resolvers to your `ivysettings.xml`:

```
<resolvers>

  <url name="com.springsource.repository.bundles.release">

    <ivy pattern="http://repository.springsource.com/ivy/bundles/release/
      [organisation]/[module]/[revision]/[artifact]-[revision].[ext]" />
    <artifact pattern="http://repository.springsource.com/ivy/bundles/release/
      [organisation]/[module]/[revision]/[artifact]-[revision].[ext]" />

  </url>

  <url name="com.springsource.repository.bundles.external">
  <url name="com.springsource.repository.bundles.external">

    <ivy pattern="http://repository.springsource.com/ivy/bundles/external/
       [organisation]/[module]/[revision]/[artifact]-[revision].[ext]" />
    <artifact pattern="http://repository.springsource.com/ivy/bundles/external/
       [organisation]/[module]/[revision]/[artifact]-[revision].[ext]" />

  </url>

</resolvers>
```

The XML above is not valid because the lines are too long - if you copy-paste then remove the extra line endings in the middle of the url patterns.

Once Ivy is configured to look in the EBR adding a dependency is easy. Simply pull up the details page for the bundle in question in the repository browser and you'll find an Ivy snippet ready for you to include in your dependencies section. For example (in `ivy.xml`):

```
<dependency org="org.springframework"
      name="org.springframework.core" rev="3.0.0.RELEASE" conf="compile->runtime"/>
```

1.3.2 Logging

Logging is a very important dependency for Spring because a) it is the only mandatory external dependency, b) everyone likes to see some output from the tools they are using, and c) Spring integrates with lots of other tools all of which have also made a choice of logging dependency. One of the goals of an application developer is often to have unified logging configured in a central place for the whole application, including all external components. This is more difficult than it might have been since there are so many choices of logging framework.

The mandatory logging dependency in Spring is the Jakarta Commons Logging API (JCL). We compile against JCL and we also make JCL `Log` objects visible for classes that extend the Spring Framework. It's important to users that all versions of Spring use the same logging library: migration is easy because backwards compatibility is preserved even with applications that extend

Spring. The way we do this is to make one of the modules in Spring depend explicitly on `commons-logging` (the canonical implementation of JCL), and then make all the other modules depend on that at compile time. If you are using Maven for example, and wondering where you picked up the dependency on `commons-logging`, then it is from Spring and specifically from the central module called `spring-core`.

The nice thing about `commons-logging` is that you don't need anything else to make your application work. It has a runtime discovery algorithm that looks for other logging frameworks in well known places on the classpath and uses one that it thinks is appropriate (or you can tell it which one if you need to). If nothing else is available you get pretty nice looking logs just from the JDK (java.util.logging or JUL for short). You should find that your Spring application works and logs happily to the console out of the box in most situations, and that's important.

Not Using Commons Logging

Unfortunately, the runtime discovery algorithm in `commons-logging`, while convenient for the end-user, is problematic. If we could turn back the clock and start Spring now as a new project it would use a different logging dependency. The first choice would probably be the Simple Logging Facade for Java (SLF4J), which is also used by a lot of other tools that people use with Spring inside their applications.

Switching off `commons-logging` is easy: just make sure it isn't on the classpath at runtime. In Maven terms you exclude the dependency, and because of the way that the Spring dependencies are declared, you only have to do that once.

```
<dependencies>
   <dependency>
      <groupId>org.springframework</groupId>
      <artifactId>spring-context</artifactId>
      <version>3.0.0.RELEASE</version>
      <scope>runtime</scope>
      <exclusions>
         <exclusion>
            <groupId>commons-logging</groupId>
            <artifactId>commons-logging</artifactId>
         </exclusion>
```

```
            </exclusions>
        </dependency>
    </dependencies>
```

Now this application is probably broken because there is no implementation of the JCL API on the classpath, so to fix it a new one has to be provided. In the next section we show you how to provide an alternative implementation of JCL using SLF4J as an example.

Using SLF4J

SLF4J is a cleaner dependency and more efficient at runtime than `commons-logging` because it uses compile-time bindings instead of runtime discovery of the other logging frameworks it integrates. This also means that you have to be more explicit about what you want to happen at runtime, and declare it or configure it accordingly. SLF4J provides bindings to many common logging frameworks, so you can usually choose one that you already use, and bind to that for configuration and management.

SLF4J provides bindings to many common logging frameworks, including JCL, and it also does the reverse: bridges between other logging frameworks and itself. So to use SLF4J with Spring you need to replace the `commons-logging` dependency with the SLF4J-JCL bridge. Once you have done that then logging calls from within Spring will be translated into logging calls to the SLF4J API, so if other libraries in your application use that API, then you have a single place to configure and manage logging.

A common choice might be to bridge Spring to SLF4J, and then provide explicit binding from SLF4J to Log4J. You need to supply 4 dependencies (and exclude the existing `commons-logging`): the bridge, the SLF4J API, the binding to Log4J, and the Log4J implementation itself. In Maven you would do that like this

```
<dependencies>
       <dependency>
          <groupId>org.springframework</groupId>
          <artifactId>spring-context</artifactId>
          <version>3.0.0.RELEASE</version>
          <scope>runtime</scope>
          <exclusions>
             <exclusion>
```

```
              <groupId>commons-logging</groupId>
              <artifactId>commons-logging</artifactId>
           </exclusion>
        </exclusions>
     </dependency>
     <dependency>
        <groupId>org.slf4j</groupId>
        <artifactId>jcl-over-slf4j</artifactId>
        <version>1.5.8</version>
        <scope>runtime</scope>
     </dependency>
     <dependency>
        <groupId>org.slf4j</groupId>
        <artifactId>slf4j-api</artifactId>
        <version>1.5.8</version>
        <scope>runtime</scope>
     </dependency>
     <dependency>
        <groupId>org.slf4j</groupId>
        <artifactId>slf4j-log4j12</artifactId>
        <version>1.5.8</version>
        <scope>runtime</scope>
     </dependency>
     <dependency>
        <groupId>log4j</groupId>
        <artifactId>log4j</artifactId>
        <version>1.2.14</version>
        <scope>runtime</scope>
     </dependency>
  </dependencies>
```

That might seem like a lot of dependencies just to get some logging. Well it is, but it *is* optional, and it should behave better than the vanilla `commons-logging` with respect to classloader issues, notably if you are in a strict container like an OSGi platform. Allegedly there is also a performance benefit because the bindings are at compile-time not runtime.

A more common choice amongst SLF4J users, which uses fewer steps and generates fewer dependencies, is to bind directly to Logback. This removes the extra binding step because Logback implements SLF4J directly, so you only need to depend on two libraries not four (`jcl-over-slf4j` and `logback`). If you do that you might also need to exclude the slf4j-api dependency from other external dependencies (not Spring), because you only want one version of that API on the classpath.

Using Log4J

Many people use Log4j as a logging framework for configuration and management purposes. It's efficient and well-established, and in fact it's what we use at runtime when we build and test Spring. Spring also provides some utilities for configuring and initializing Log4j, so it has an optional compile-time dependency on Log4j in some modules.

To make Log4j work with the default JCL dependency (`commons-logging`) all you need to do is put Log4j on the classpath, and provide it with a configuration file (`log4j.properties` or `log4j.xml` in the root of the classpath). So for Maven users this is your dependency declaration:

```
<dependencies>
   <dependency>
      <groupId>org.springframework</groupId>
      <artifactId>spring-context</artifactId>
      <version>3.0.0.RELEASE</version>
      <scope>runtime</scope>
   </dependency>
   <dependency>
      <groupId>log4j</groupId>
      <artifactId>log4j</artifactId>
      <version>1.2.14</version>
      <scope>runtime</scope>
   </dependency>
</dependencies>
```

And here's a sample log4j.properties for logging to the console:

```
log4j.rootCategory=INFO, stdout
```

```
log4j.appender.stdout=org.apache.log4j.ConsoleAppender
log4j.appender.stdout.layout=org.apache.log4j.PatternLayout
log4j.appender.stdout.layout.ConversionPattern=%d{ABSOLUTE} %5p %t %c{2}:%L - %m%n

log4j.category.org.springframework.beans.factory=DEBUG
```

Runtime Containers with Native JCL

Many people run their Spring applications in a container that itself provides an implementation of JCL. IBM Websphere Application Server (WAS) is the archetype. This often causes problems, and unfortunately there is no silver bullet solution; simply excluding `commons-logging` from your application is not enough in most situations.

To be clear about this: the problems reported are usually not with JCL per se, or even with `commons-logging`: rather they are to do with binding `commons-logging` to another framework (often Log4J). This can fail because `commons-logging` changed the way they do the runtime discovery in between the older versions (1.0) found in some containers and the modern versions that most people use now (1.1). Spring does not use any unusual parts of the JCL API, so nothing breaks there, but as soon as Spring or your application tries to do any logging you can find that the bindings to Log4J are not working.

In such cases with WAS the easiest thing to do is to invert the class loader hierarchy (IBM calls it "parent last") so that the application controls the JCL dependency, not the container. That option isn't always open, but there are plenty of other suggestions in the public domain for alternative approaches, and your mileage may vary depending on the exact version and feature set of the container.

Prev Up Next

Part I. Overview of Spring Framework Home Part II. What's New in Spring 3