SAMPLE CHAPTER

SPRING IN ACTION

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MANNING

Spring in Action

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Sample Chapter 1

brief contents

1 A Spring jump start

This chapter covers

- Creating simpler J2EE applications using Spring
- Decoupling components with inversion of control
- Managing cross-cutting concerns with aspect-oriented programming
- Comparing the features of Spring and EJB

It all started with a bean.

In 1996 the Java programming language was still a young, exciting, up-and-coming platform. Many developers flocked to the language because they had seen how to create rich and dynamic web applications using applets. But they soon learned that there was more to this strange new language than animated juggling cartoon characters. Unlike any language before it, Java made it possible to write complex applications made up of discrete parts. They came for the applets, but they stayed for the components.

It was in December of that year that Sun Microsystems published the JavaBeans 1.00-A specification. JavaBeans defined a software component model for Java. This specification defined a set of coding policies that enabled simple Java objects to be reusable and easily composed into more complex applications. Although JavaBeans were intended as a general-purpose means of defining reusable application components, they have been primarily used as a model for building user interface widgets. They seemed too simple to be capable of any "real" work. Enterprise developers wanted more.

Sophisticated applications often require services such as transaction support, security, and distributed computing—services not directly provided by the JavaBeans specification. Therefore, in March 1998, Sun published the 1.0 version of the Enterprise JavaBeans (EJB) specification. This specification extended the notion of Java components to the server side, providing the much-needed enterprise services, but failed to continue the simplicity of the original JavaBeans specification. In fact, except in name, EJB bears very little resemblance to the original JavaBeans specification.

Despite the fact that many successful applications have been built based on EJB, EJB never really achieved its intended purpose: to simplify enterprise application development. Every version of the EJB specification contains the following statement: "Enterprise JavaBeans will make it easy to write applications." It is true that EJB's declarative programming model simplifies many infrastructural aspects of development, such as transactions and security. But EJBs are complicated in a different way by mandating deployment descriptors and plumbing code (home and remote/local interfaces). Over time many developers became disenchanted with EJB. As a result, its popularity has started to wane in recent years, leaving many developers looking for an easier way.

Now Java component development is coming full circle. New programming techniques, including aspect-oriented programming (AOP) and inversion of control (IoC), are giving JavaBeans much of the power of EJB. These techniques furnish JavaBeans with a declarative programming model reminiscent of EJB, but

without all of EJB's complexity. No longer must you resort to writing an unwieldy EJB component when a simple JavaBean will suffice.

And that's where Spring steps into the picture.

1.1 Why Spring?

If you are reading this book, you probably want to know why Spring would be good for you. After all, the Java landscape is full of frameworks. What makes Spring any different? To put it simply, Spring makes developing enterprise applications easier. We don't expect that to convince you at face value, so first let's take a look at life without Spring.

1.1.1 A day in the life of a J2EE developer

Alex is a Java developer who has just started on his first enterprise application. Like many Java 2 Enterprise Edition (J2EE) applications, it is a web application that serves many users and accesses an enterprise database. In this case, it is a customer management application that will be used by other employees at his company.

Eager to get to work, Alex fires up his favorite integrated development environment (IDE) and starts to crank out his first component, the `CustomerManager` component. In the EJB world, to develop this component Alex actually has to write several classes—the home interface, the local interface, and the bean itself. In addition, he has to create a deployment descriptor for this bean.

Seeing that creating each of these files for *every* bean seems like a lot of effort, Alex incorporates XDoclet into his project. XDoclet is a code generation tool that can generate all of the necessary EJB files from a single source file. Although this adds another step to Alex's development cycle, his coding life is now much simpler.

With XDoclet now handling a lot of the grunt work for him, Alex turns his attention to his real problem—what exactly should the `CustomerManager` component do? He jumps in with its first method, `getPreferredCustomer()`. There are several business rules that define exactly what a preferred customer is, and Alex dutifully codes them into his `CustomerManager` bean.

Wanting to confirm that his logic is correct, Alex now wants to write some tests to validate his code. But then it occurs to him: the code he is testing will be running within the EJB container. Therefore, his tests need to execute within the container as well. To easily accomplish this, he concocts a servlet that will be responsible for executing these tests. Since all J2EE containers support servlets, this will allow him to execute his tests in the same container as his EJB. Problem solved!

So Alex fires up his J2EE container and runs his tests. His tests fail. Alex sees his coding error, fixes it, and runs the tests again. His tests fail again. He sees another error and fixes it. He fires up the container and runs the tests again. As Alex is going through this cycle, he notices something. The fact that he has to start the J2EE container for each batch of testing really slows down his development cycle. The development cycle should go code, test, code, test. This pattern has now been replaced with code, wait, test, code, wait, test, code, wait, get increasingly frustrated…

While waiting for the container to start during another test run, Alex thinks, "Why am I using EJB in the first place?" The answer, of course, is because of the services it provides. But Alex isn't using entity beans, so he is not using persistence services. Alex is also not using the remoting or security services. In fact, the only EJB service Alex is going to use is transaction management. This leads Alex to another question: "Is there an easier way?"

1.1.2 Spring's pledge

The above story was a dramatization based on the current state of J2EE—specifically EJB. In its current state, EJB is complicated. It isn't complicated just to be complicated. It is complicated because EJBs were created to solve complicated things, such as distributed objects and remote transactions.

Unfortunately, a good number of enterprise projects do not have this level of complexity but still take on EJB's burden of multiple Java files and deployment descriptors and heavyweight containers. With EJB, application complexity is high, regardless of the complexity of the problem being solved—even simple applications are unduly complex. With Spring, the complexity of your application is proportional to the complexity of the problem being solved.

However, Spring recognizes that EJB does offer developers valuable services. So Spring strives to deliver these same services while simplifying the programming model. In doing so, it adopts a simple philosophy: J2EE *should* be easy to use. In keeping with this philosophy, Spring was designed with the following beliefs:

- Good design is more important than the underlying technology.
- JavaBeans loosely coupled through interfaces is a good model.
- Code should be easy to test.

Okay. So how does Spring help you apply this philosophy to your applications?

Good design is more important than the underlying technology

As a developer, you should always be seeking the best design for your application, regardless of the implementation you choose. Sometimes the complexity of EJB is warranted because of the requirements of the application. Often, this is not the case. Many applications require few, if any, of the services provided by EJB yet are still implemented using this technology for technology's sake. If an application does not require distribution or declarative transaction support, it is unlikely that EJB is the best technology candidate. Yet many Java developers feel compelled to use EJB for every Java enterprise application.

The idea behind Spring is that you can keep your code as simple as it needs to be. If what you want are some plain-vanilla Java objects to perform some services supported by transparent transactions, you've got it. And you don't need an EJB container, and you don't have to implement special interfaces. You just have to write your code.

JavaBeans loosely coupled through interfaces is a good model

If you are relying on EJBs to provide your application services, your components do not just depend on the EJB business interface. They are also responsible for retrieving these EJB objects from a directory, which entails a Java Naming and Directory Interface (JNDI) lookup and communicating with the bean's `EJBHome` interface. This is not creating a decoupled application. This is tightly coupling your application to a specific implementation, namely EJB.

With Spring, your beans depend on collaborators through interfaces. Since there are no implementation-specific dependencies, Spring applications are very decoupled, testable, and easier to maintain. And because the Spring container is responsible for resolving the dependencies, the active service lookup that is involved in EJB is now out of the picture and the cost of programming to interfaces is minimized. All you need to do is create classes that communicate with each other through interfaces, and Spring takes care of the rest.

Code should be easy to test

Testing J2EE applications can be difficult. If you are testing EJBs within a container, you have to start up a container to execute even the most trivial of test cases. Since starting and stopping a container is expensive, developers may be tempted to skip testing all of their components. Avoiding tests because of the rigidness of a framework is not a good excuse.

Because you develop Spring applications with JavaBeans, testing is cheap. There is no J2EE container to be started since you will be testing a POJO. And

since Spring makes coding to interfaces easy, your objects will be loosely coupled, making testing even easier. A thorough battery of tests should be present in all of your applications; Spring will help you accomplish this.

1.2 What is Spring?

Spring is an open-source framework, created by Rod Johnson and described in his book *Expert One-on-One: J2EE Design and Development*.[1] It was created to address the complexity of enterprise application development. Spring makes it possible to use plain-vanilla JavaBeans to achieve things that were previously only possible with EJBs. However, Spring's usefulness isn't limited to server-side development. Any Java application can benefit from Spring in terms of simplicity, testability, and loose coupling.

NOTE To avoid ambiguity, we'll use the term "EJB" when referring to Enterprise JavaBeans. When referring to the original JavaBean, we'll call it "JavaBean," or "bean" for short. Some other terms we may throw around are "POJO" (which stands for "plain old Java object") or "POJI" (which means "plain old Java interface").

Put simply, Spring is a lightweight inversion of control and aspect-oriented container framework. Okay, that's not so simple a description. But it does summarize what Spring does. To make more sense of Spring, let's break this description down:

- *Lightweight*—Spring is lightweight in terms of both size and overhead. The entire Spring framework can be distributed in a single JAR file that weighs in at just over 1 MB. And the processing overhead required by Spring is negligible. What's more, Spring is nonintrusive: objects in a Spring-enabled application typically have no dependencies on Spring-specific classes.
- *Inversion of control*—Spring promotes loose coupling through a technique known as inversion of control (IoC). When IoC is applied, objects are passively given their dependencies instead of creating or looking for dependent objects for themselves. You can think of IoC as JNDI in reverse—instead of an object looking up dependencies from a container, the container gives the dependencies to the object at instantiation without waiting to be asked.

[1] In this book, Spring was originally called "interface21."

- *Aspect-oriented*—Spring comes with rich support for aspect-oriented programming that enables cohesive development by separating application business logic from system services (such as auditing and transaction management). Application objects do what they're supposed to do—perform business logic—and nothing more. They are not responsible for (or even aware of) other system concerns, such as logging or transactional support.
- *Container*—Spring is a container in the sense that it contains and manages the life cycle and configuration of application objects. You can configure how your each of your beans should be created—either create one single instance of your bean or produce a new instance every time one is needed based on a configurable prototype—and how they should be associated with each other. Spring should not, however, be confused with traditionally heavyweight EJB containers, which are often large and cumbersome to work with.
- *Framework*—Spring makes it possible to configure and compose complex applications from simpler components. In Spring, application objects are composed declaratively, typically in an XML file. Spring also provides much infrastructure functionality (transaction management, persistence framework integration, etc.), leaving the development of application logic to you.

All of these attributes of Spring enable you to write code that is cleaner, more manageable, and easier to test. They also set the stage for a variety of subframeworks within the greater Spring framework.

1.2.1 Spring modules

The Spring framework is made up of seven well-defined modules (figure 1.1). When taken as a whole, these modules give you everything you need to develop enterprise-ready applications. But you do not have to base your application fully on the Spring framework. You are free to pick and choose the modules that suit your application and ignore the rest.

As you can see, all of Spring's modules are built on top of the core container. The container defines how beans are created, configured, and managed—more of the nuts-and-bolts of Spring. You will implicitly use these classes when you configure your application. But as a developer, you will most likely be interested in the other modules that leverage the services provided by the container. These modules will provide the frameworks with which you will build your application's services, such as AOP and persistence.

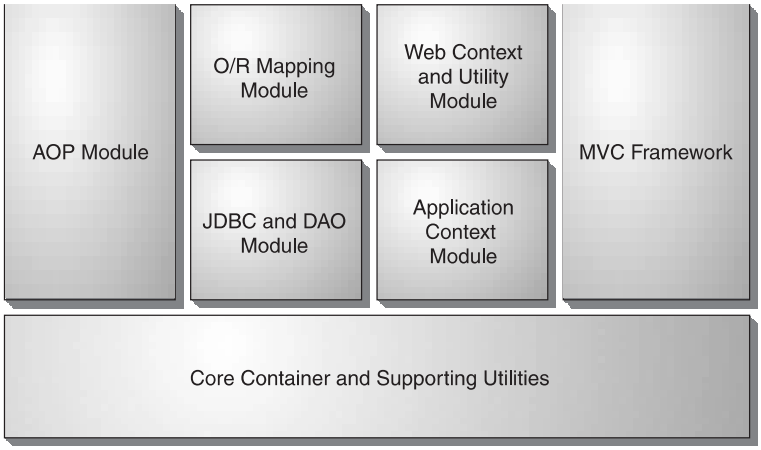

Figure 1.1 The Spring framework is composed of several well-defined modules.

The core container

Spring's core container provides the fundamental functionality of the Spring framework. In this module you'll find Spring's `BeanFactory`, the heart of any Spring-based application. A `BeanFactory` is an implementation of the factory pattern that applies IoC to separate your application's configuration and dependency specifications from the actual application code.

We'll be discussing the core module (the center of any Spring application) throughout this book, starting in chapter 2, when we cover bean wiring using IoC.

Application context module

The core module's `BeanFactory` makes Spring a container, but the context module is what makes it a framework. This module extends the concept of `BeanFactory`, adding support for internationalization (I18N) messages, application life cycle events, and validation.

In addition, this module supplies many enterprise services such as e-mail, JNDI access, EJB integration, remoting, and scheduling. Also included is support for integration with templating frameworks such as Velocity and FreeMarker.

Spring's AOP module

Spring provides rich support for aspect-oriented programming in its AOP module. This module serves as the basis for developing your own aspects for your Spring-enabled application.

To ensure interoperability between Spring and other AOP frameworks, much of Spring's AOP support is based on the API defined by the AOP Alliance. The

AOP Alliance is an open-source project whose goal is to promote adoption of AOP and interoperability among different AOP implementations by defining a common set of interfaces and components. You can find out more about the AOP Alliance by visiting their website at http://aopalliance.sourceforge.net.

The Spring AOP module also introduces metadata programming to Spring. Using Spring's metadata support, you are able to add annotations to your source code that instruct Spring on where and how to apply aspects.

JDBC abstraction and the DAO module

Working with JDBC often results in a lot of boilerplate code that gets a connection, creates a statement, processes a result set, and then closes the connection. Spring's JDBC and Data Access Objects (DAO) module abstracts away the boilerplate code so that you can keep your database code clean and simple, and prevents problems that result from a failure to close database resources. This module also builds a layer of meaningful exceptions on top of the error messages given by several database servers. No more trying to decipher cryptic and proprietary SQL error messages!

In addition, this module uses Spring's AOP module to provide transaction management services for objects in a Spring application.

Object/relational mapping integration module

For those who prefer using an object/relational mapping (ORM) tool over straight JDBC, Spring provides the ORM module. Spring doesn't attempt to implement its own ORM solution, but does provide hooks into several popular ORM frameworks, including Hibernate, JDO, and iBATIS SQL Maps. Spring's transaction management supports each of these ORM frameworks as well as JDBC.

Spring's web module

The web context module builds on the application context module, providing a context that is appropriate for web-based applications. In addition, this module contains support for several web-oriented tasks such as transparently handling multipart requests for file uploads and programmatic binding of request parameters to your business objects. It also cotains integration support with Jakarta Struts.

The Spring MVC framework

Spring comes with a full-featured Model/View/Controller (MVC) framework for building web applications. Although Spring can easily be integrated with other MVC frameworks, such as Struts, Spring's MVC framework uses IoC to provide for a clean separation of controller logic from business objects. It also allows you to

declaratively bind request parameters to your business objects, What's more, Spring's MVC framework can take advantage of any of Spring's other services, such as I18N messaging and validation.

Now that you know what Spring is all about, let's jump right into writing Spring applications, starting with the simplest possible example that we could come up with.

1.3 Spring jump start

In the grand tradition of programming books, we'll start by showing you how Spring works with the proverbial "Hello World" example. Unlike the original Hello World program, however, our example will be modified a bit to demonstrate the basics of Spring.

NOTE To find out how to download Spring and plug it into your project's build routine, refer to appendix A.

Spring-enabled applications are like any Java application. They are made up of several classes, each performing a specific purpose within the application. What makes Spring-enabled applications different, however, is how these classes are configured and introduced to each other. Typically, a Spring application has an XML file that describes how to configure the classes, known as the Spring configuration file.

The first class that our Springified Hello World example needs is a service class whose purpose is to print the infamous greeting. Listing 1.1 shows GreetingService.java, an interface that defines the contract for our service class.

Listing 1.1 The `GreetingService` interface separates the service's implementation from its interface.

```
package com.springinaction.chapter01.hello;

public interface GreetingService {
  public void sayGreeting();
}
```

GreetingServiceImpl.java (listing 1.2) implements the `GreetingService` interface. Although it's not necessary to hide the implementation behind an interface, it's highly recommended as a way to separate the implementation from its contract.

Listing 1.2 GreetingServiceImpl.java: Responsible for printing the greeting

```
package com.springinaction.chapter01.hello;

public class GreetingServiceImpl implements GreetingService {
  private String greeting;

  public GreetingServiceImpl() {}

  public GreetingServiceImpl(String greeting) {
    this.greeting = greeting;
  }

  public void sayGreeting() {
    System.out.println(greeting);
  }

  public void setGreeting(String greeting) {
    this.greeting = greeting;
  }
}
```

The `GreetingServiceImpl` class has a single property: the `greeting` property. This property is simply a `String` that holds the text that is the message that will be printed when the `sayGreeting()` method is called. You may have noticed that the `greeting` can be set in two different ways: by the constructor or by the property's setter method.

What's not apparent just yet is who will make the call to either the constructor or the `setGreeting()` method to set the property. As it turns out, we're going to let the Spring container set the `greeting` property. The Spring configuration file (hello.xml) in listing 1.3 tells the container how to configure the greeting service.

Listing 1.3 Configuring Hello World in Spring

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE beans PUBLIC "-//SPRING//DTD BEAN//EN"
    "http://www.springframework.org/dtd/spring-beans.dtd">

<beans>
  <bean id="greetingService"
      class="com.springinaction.chapter01.hello.GreetingServiceImpl">
    <property name="greeting">
      <value>Buenos Dias!</value>
    </property>
  </bean>
</beans>
```

The XML file in listing 1.3 declares an instance of a `GreetingServiceImpl` in the Spring container and configures its `greeting` property with a value of "Buenos Dias!" Let's dig into the details of this XML file a bit to understand how it works.

At the root of this simple XML file is the `<beans>` element, which is the root element of any Spring configuration file. The `<bean>` element is used to tell the Spring container about a class and how it should be configured. Here, the `id` attribute is used to name the bean `greetingService` and the `class` attribute specifies the bean's fully qualified class name.

Within the `<bean>` element, the `<property>` element is used to set a property, in this case the `greeting` property. By using `<property>`, we're telling the Spring container to call `setGreeting()` when setting the property.

The value of the greeting is defined within the `<value>` element. Here we've given the example a Spanish flair by choosing "Buenos Dias" instead of the traditional "Hello World."

The following snippet of code illustrates roughly what the container does when instantiating the greeting service based on the XML definition in listing 1.3:[2]

```
GreetingServiceImpl greetingService = new GreetingServiceImpl();
greetingService.setGreeting("Buenos Dias!");
```

Similarly, we may choose to have Spring set the `greeting` property through `GreetingServiceImpl`'s single argument constructor. For example:

```
<bean id="greetingService"
    class="com.springinaction.chapter01.hello.GreetingServiceImpl">
  <constructor-arg>
    <value>Buenos Dias!</value>
  </constructor-arg>
</bean>
```

The following code illustrates how the container will instantiate the greeting service when using the `<constructor-arg>` element:

```
GreetingServiceImpl greetingService =
    new GreetingServiceImpl("Buenos Dias");
```

The last piece of the puzzle is the class that loads the Spring container and uses it to retrieve the greeting service. Listing 1.4 shows this class.

---

[2] The container actually performs other activities involving the life cycle of the bean. But for illustrative purposes, these two lines are sufficient.

Listing 1.4 The Hello World main class

```
package com.springinaction.chapter01.hello;

import java.io.FileInputStream;
import org.springframework.beans.factory.BeanFactory;
import org.springframework.beans.factory.xml.XmlBeanFactory;

public class HelloApp {
  public static void main(String[] args) throws Exception {
    BeanFactory factory =
        new XmlBeanFactory(new FileInputStream("hello.xml"));

    GreetingService greetingService =
        (GreetingService) factory.getBean("greetingService");

    greetingService.sayGreeting();
  }
}
```

The `BeanFactory` class used here is the Spring container. After loading the hello.xml file into the container, the `main()` method calls the `getBean()` method on the `BeanFactory` to retrieve a reference to the greeting service. With this reference in hand, it finally calls the `sayGreeting()` method. When we run the Hello application, it prints (not surprisingly)

```
Buenos Dias!
```

This is about as simple a Spring-enabled application as we can come up with. But it does illustrate the basics of configuring and using a class in Spring. Unfortunately, it is perhaps too simple because it only illustrates how to configure a bean by injecting a `String` value into a property. The real power of Spring lies in how beans can be injected into other beans using IoC.

1.4 Understanding inversion of control

Inversion of control is at the heart of the Spring framework. It may sound a bit intimidating, conjuring up notions of a complex programming technique or design pattern. But as it turns out, IoC is not nearly as complex as it sounds. In fact, by applying IoC in your projects, you'll find that your code will become significantly simpler, easier to understand, and easier to test.

But what does "inversion of control" mean?

1.4.1 Injecting dependencies

In an article written in early 2004, Martin Fowler asked what aspect of control is being inverted. He concluded that it is the acquisition of dependent objects that is being inverted. Based on that revelation, he coined a better name for inversion of control: dependency injection.[3]

Any nontrivial application (pretty much anything more complex than HelloWorld.java) is made up of two or more classes that collaborate with each other to perform some business logic. Traditionally, each object is responsible for obtaining its own references to the objects it collaborates with (its dependencies). As you'll see, this can lead to highly coupled and hard-to-test code.

Applying IoC, objects are given their dependencies at creation time by some external entity that coordinates each object in the system. That is, dependencies are *injected* into objects. So, IoC means an inversion of responsibility with regard to how an object obtains references to collaborating objects.

1.4.2 IoC in action

If you're like us, then you're probably anxious to see how this works in code. We aim to please, so without further delay…

Suppose that your company's crack marketing team culled together the results of their expert market analysis and research and determined that what your customers need is a knight. That is, they need a Java class that represents a knight. After probing them for requirements, you learn that what they specifically want is for you to implement a class that represents an Arthurian knight of the Round Table that embarks on brave and noble quests to find the Holy Grail.

This is an odd request, but you've become accustomed to the strange notions and whims of the marketing team. So, without hesitation, you fire up your favorite IDE and bang out the class in listing 1.5.

Listing 1.5 KnightOfTheRoundTable.java

```
package com.springinaction.chapter01.knight;

public class KnightOfTheRoundTable {
  private String name;
  private HolyGrailQuest quest;
```

[3] Although we agree that "dependency injection" is a more accurate name than "inversion of control," we're likely to use both terms interchangeably in this book.

```
  public KnightOfTheRoundTable(String name) {
    this.name = name;
    quest = new HolyGrailQuest();    <-- A knight gets its own quest
  }

  public HolyGrail embarkOnQuest()
      throws GrailNotFoundException {
    return quest.embark();
  }
}
```

In listing 1.5 the knight is given a name as a parameter of its constructor. Its constructor sets the knight's quest by instantiating a `HolyGrailQuest`. The implementation of `HolyGrailQuest` is fairly trivial, as shown in listing 1.6.

Listing 1.6 HolyGrailQuest.java

```
package com.springinaction.chapter01.knight;
public class HolyGrailQuest {
  public HolyGrailQuest() {}

  public HolyGrail embark() throws GrailNotFoundException {
    HolyGrail grail = null;
    // Look for grail
    …
    return grail;
  }
}
```

Satisfied with your work, you proudly check the code into version control. You want to show it to the marketing team, but deep down something doesn't feel right. You almost dismiss it as the burrito you had for lunch when you realize the problem: you haven't written any unit tests.

Knightly testing

Unit testing is an important part of development. It not only ensures that each individual unit functions as expected, but it also serves to document each unit in the most accurate way possible. Seeking to rectify your failure to write unit tests, you put together the test case (listing 1.7) for your knight class.

Listing 1.7 Testing the KnightOfTheRoundTable

```
package com.springinaction.chapter01.knight;

import junit.framework.TestCase;

public class KnightOfTheRoundTableTest extends TestCase {

  public void testEmbarkOnQuest() {
    KnightOfTheRoundTable knight =
        new KnightOfTheRoundTable("Bedivere");

    try {
      HolyGrail grail = knight.embarkOnQuest();

      assertNotNull(grail);

      assertTrue(grail.isHoly());
    } catch (GrailNotFoundException e) {
      fail();
    }
  }
}
```

After writing this test case, you set out to write a test case for `HolyGrailQuest`. But before you even get started, you realize that the `KnightOfTheRoundTableTest` test case indirectly tests `HolyGrailQuest`. You also wonder if you are testing all contingencies. What would happen if `HolyGrailQuest`'s `embark()` method returned `null`? Or what if it were to throw a `GrailNotFoundException`?

Who's calling who?

The main problem so far with `KnightOfTheRoundTable` is with how it obtains a `HolyGrailQuest`. Whether it is instantiating a new `HolyGrail` instance or obtaining one via JNDI, each knight is responsible for getting its own quest (as shown in figure 1.2). Therefore, there is no way to test the knight class in isolation. As it

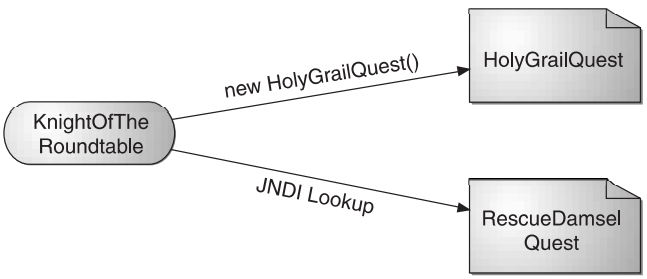

Figure 1.2 A knight is responsible for getting its own quest, through instantiation or some other means.

stands, every time you test `KnightOfTheRoundTable`, you will also indirectly test `HolyGrailQuest`.

What's more, you have no way of telling `HolyGrailQuest` to behave differently (e.g., return `null` or throw a `GrailNotFoundException`) for different tests. What would help is if you could create a mock implementation of `HolyGrailQuest` that lets you decide how it behaves. But even if you were to create a mock implementation, `KnightOfTheRoundTable` still retrieves its own `HolyGrailQuest`, meaning you would have to make a change to `KnightOfTheRoundTable` to retrieve the mock quest for testing purposes (and then change it back for production).

Decoupling with interfaces

The problem, in a word, is *coupling*. At this point, `KnightOfTheRoundTable` is statically coupled to `HolyGrailQuest`. They're handcuffed together in such a way that you can't have a `KnightOfTheRoundTable` without also having a `HolyGrailQuest`.

Coupling is a two-headed beast. On one hand, tightly coupled code is difficult to test, difficult to reuse, difficult to understand, and typically exhibits "whack-a-mole" bugs (i.e., fixing one bug results in the creation of one or more new bugs). On the other hand, completely uncoupled code doesn't do anything. In order to do anything useful, classes need to know about each other somehow. Coupling is necessary, but it should be managed very carefully.

A common technique used to reduce coupling is to hide implementation details behind interfaces so that the actual implementation class can be swapped out without impacting the client class. For example, suppose you were to create a `Quest` interface:

```
package com.springinaction.chapter01.knight;

public interface Quest {
  public abstract Object embark() throws QuestException;
}
```

Then, you change `HolyGrailQuest` to implement this interface. Also, notice that embark now returns an Object and throws a QuestException.

```
package com.springinaction.chapter01.knight;

public class HolyGrailQuest implements Quest {
  public HolyGrailQuest() {}

  public Object embark() throws QuestException {
    // Do whatever it means to embark on a quest
    return new HolyGrail();
  }
}
```

Also, the following method must also change in KnightOfTheRoundTable to be compatible with these Quest types:

```
private Quest quest;
…
public Object embarkOnQuest() throws QuestException {
  return quest.embark();
}
```

Likewise, you could also have `KnightOfTheRoundTable` implement the following `Knight` interface:

```
public interface Knight {
  public Object embarkOnQuest() throws QuestException;
}
```

Hiding your class's implementation behind interfaces is certainly a step in the right direction. But where many developers fall short is in how they retrieve a `Quest` instance. For example, consider this possible change to `KnightOfTheRoundTable`:

```
public class KnightOfTheRoundTable implements Knight {

  private Quest quest;
  …

  public KnightOfTheRoundTable(String name) {
    quest = new HolyGrailQuest();
  …
  }

  public Object embarkOnQuest() throws QuestException {
    return quest.embark();
  }
}
```

Here the `KnightOfTheRoundTable` class embarks on a quest through the `Quest` interface. But, the knight still retrieves a specific type of `Quest` (here a `HolyGrailQuest`). This isn't much better than before. A `KnightOfTheRoundTable` is stuck going only on quests for the Holy Grail and no other types of quest.

Giving and taking

The question you should be asking at this point is whether or not a knight should be responsible for obtaining a quest. Or, should a knight be given a quest to embark upon?

Consider the following change to `KnightOfTheRoundTable`:

```
public class KnightOfTheRoundTable implements Knight {
  private Quest quest;
  …

  public KnightOfTheRoundTable(String name) {
    …
  }

  public HolyGrail embarkOnQuest() throws QuestException {
    …
    return quest.embark();
  }

  public void setQuest(Quest quest) {
    this.quest = quest;
  }
}
```

Notice the difference? Compare figure 1.3 with figure 1.2 to see the difference in how a knight obtains its quest. Now the knight is *given* a quest instead of retrieving one itself. `KnightOfTheRoundTable` is no longer responsible for retrieving its own quests. And because it only knows about a quest through the `Quest` interface, you could give a knight any implementation of `Quest` you want. In a production system, maybe you would give it a `HolyGrailQuest`, but in a test case you would give it a mock implementation of `Quest`.

In a nutshell, that is what inversion of control is all about: the responsibility of coordinating collaboration between dependent objects is transferred away from the objects themselves. And that's where lightweight container frameworks, such as Spring, come into play.

Assigning a quest to a knight

Now that you've written your `KnightOfTheRoundTable` class to be given any arbitrary `Quest` object, how can you specify which `Quest` it should be given?

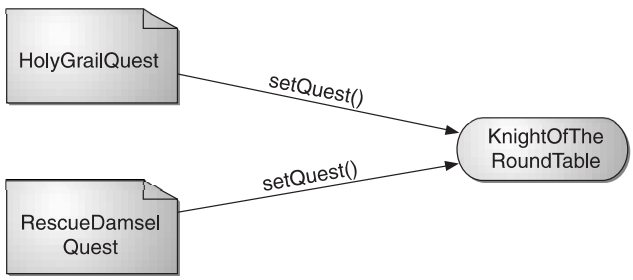

Figure 1.3
A knight is given a quest through its `setQuest()` method.

The act of creating associations between application components is referred to as *wiring*. In Spring, there are many ways to wire components together, but the most common approach is via XML. Listing 1.8 shows a simple Spring configuration file, knight.xml, that gives a quest (specifically, a `HolyGrailQuest`) to a `KnightOfTheRoundTable`.

Listing 1.8 Wiring a quest to a knight in knight.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE beans PUBLIC "-//SPRING//DTD BEAN//EN"
    "http://www.springframework.org/dtd/spring-beans.dtd">

<beans>                                                    Define a quest
  <bean id="quest"
      class="com.springinaction.chapter01.knight.HolyGrailQuest"/>

  <bean id="knight"
      class="com.springinaction.chapter01.knight.KnightOfTheRoundTable">
                                                           Define a knight
    <constructor-arg>
      <value>Bedivere</value>    <-- Set the knight's name
    </constructor-arg>
    <property name="quest">
      <ref bean="quest"/>    <-- Give the knight a quest
    </property>

  </bean>
</beans>
```

This is just a simple approach to wiring beans. Don't worry too much about the details of it right now. In chapter 2 we'll explain more about what is going on here, as well as show you even more ways you can wire your beans in Spring.

Now that we've declared the relationship between a knight and a quest, we need to load up the XML file and kick off the application.

Seeing it work

In a Spring application, a `BeanFactory` loads the bean definitions and wires the beans together. Because the beans in the knight example are declared in an XML file, an `XmlBeanFactory` is the appropriate factory for this example. The `main()` method in listing 1.9 uses an `XmlBeanFactory` to load `knight.xml` and to get a reference to the "knight" object.

Listing 1.9 Running the knight example

```
import org.springframework.beans.factory.BeanFactory;
import org.springframework.beans.factory.xml.XmlBeanFactory;

public class KnightApp {
  public static void main(String[] args) throws Exception {
    BeanFactory factory =
        new XmlBeanFactory(new FileInputStream("knight.xml"));

    KnightOfTheRoundTable knight =
        (KnightOfTheRoundTable) factory.getBean("knight");

    knight.embarkOnQuest();
  }
}
```

Load the XML beans file

Retrieve a knight from the factory

Send knight on its quest

Once the application has a reference to the `KnightOfTheRoundTable` object, it simply calls the `embarkOnQuest()` method to kick off the knight's adventure. Notice that this class knows nothing about the quest the knight will take. Again, the only thing that knows which type of quest will be given to the knight is the `knight.xml` file.

It's been a lot of fun sending knights on quests using inversion of control, but now let's see how you can use IoC in your real-world enterprise applications.[4]

1.4.3 IoC in enterprise applications

Suppose that you've been tasked with writing an online shopping application. Included in the application is an `OrderServiceBean`, implemented as a stateless session bean. Now you want to have a class that creates an `Order` object from user input (likely an HTML form) and call the `createOrder()` method on your `OrderServiceBean`, as shown in listing 1.10.

Listing 1.10 Creating an order using EJB

```
...
private OrderService orderService;

public void doRequest(HttpServletRequest request) {
  Order order = createOrder(request);
  OrderService orderService = getOrderService();
  orderService.createOrder(order);
}
```

[4] This assumes that your real-world applications do not involve knights and quests. In the event that your current project does involve knights and quests, you may disregard the next section.

```
private OrderService getOrderService() throws CreateException {
  if (orderService == null) {
    Context initial = new InitialContext();
    Context myEnv = (Context) initial.lookup("java:comp/env");
    Object ref = myEnv.lookup("ejb/OrderServiceHome");
    OrderServiceHome home = (OrderServiceHome)
          PortableRemoteObject.narrow(ref, OrderService.class);
    orderService = home.create();
  }
  return orderService;
}
...
```

Get the JNDI Context

Retrieve an EJB Home from JNDI

Get the Remote object from the Home object

Notice that it took five lines of code *just* to get your `OrderService` object. Now imagine having to do this everywhere you need an `OrderService` object. Now imagine you have ten other EJBs in your application. That is a lot of code! But duplicating this code everywhere would be ridiculous, so a `ServiceLocator` is typically used instead. A `ServiceLocator` acts as a central point for obtaining and caching EJB-Home references:

```
private OrderService getOrderService() {
  OrderServiceHome home =
    ServiceLocator.locate(OrderServiceHome);
  OrderService orderService = home.create();
}
```

While this removes the need to duplicate the lookup code everywhere in the application, one problem still remains: we always have to explicitly look up our services in our code.

Now let's see how this would be implemented in Spring:

```
private OrderService orderService;

public void doRequest(HttpServletRequest request) {
  Order order = createOrder(request);
  orderService.createOrder(order);
}

public void setOrderService(OrderService orderService) {
  this.orderService = orderService;
}
```

No lookup code! The reference to `OrderService` is given to our class by the Spring container through the `setOrderService()` method. With Spring, we never have to trouble ourselves with fetching our dependencies. Instead, our code can focus on the task at hand.

But inversion of control is only one of the techniques that Spring offers to JavaBeans. There's another side to Spring that makes it a viable framework for enterprise development. Let's take a quick look at Spring's support for aspect-oriented programming.

1.5 Applying aspect-oriented programming

While inversion of control makes it possible to tie software components together loosely, aspect-oriented programming enables you to capture functionality that is used throughout your application in reusable components.

1.5.1 Introducing AOP

Aspect-oriented programming is often defined as a programming technique that promotes separation of concerns within a software system. Systems are composed of several components, each responsible for a specific piece of functionality. Often, however, these components also carry additional responsibility beyond their core functionality. System services such as logging, transaction management, and security often find their way into components whose core responsibility is something else. These system services are commonly referred to as *cross-cutting concerns* because they tend to cut across multiple components in a system.

By spreading these concerns across multiple components, you introduce two levels of complexity to your code:

- The code that implements the systemwide concerns is duplicated across multiple components. This means that if you need to change how those concerns work, you'll need to visit multiple components. Even if you've abstracted the concern to a separate module so that the impact to your components is a single method call, that single method call is duplicated in multiple places.
- Your components are littered with code that isn't aligned with their core functionality. A method to add an entry to an address book should only be concerned with how to add the address and not with whether it is secure or transactional.

Figure 1.4 illustrates this complexity. The business objects on the left are too intimately involved with the system services. Not only does each object know that it is being logged, secured, and involved in a transactional context, but also each object is responsible for performing those services for itself.

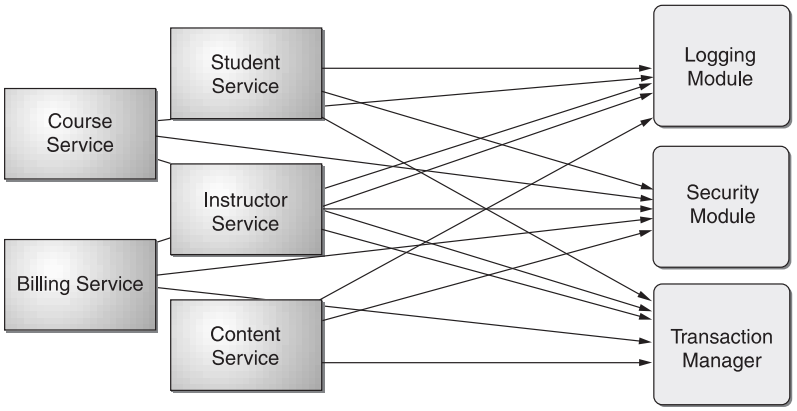

Figure 1.4 Calls to system-wide concerns such as logging and security are often scattered about in modules where those concerns are not their primary concern.

AOP makes it possible to modularize these services and then apply them declaratively to the components that they should affect. This results in components that are more cohesive and that focus on their own specific concerns, completely ignorant of any system services that may be involved.

As shown in figure 1.5, it may help to think of aspects as blankets that cover many components of an application. At its core, an application is comprised of modules that implement the business functionality. With AOP, you can then cover

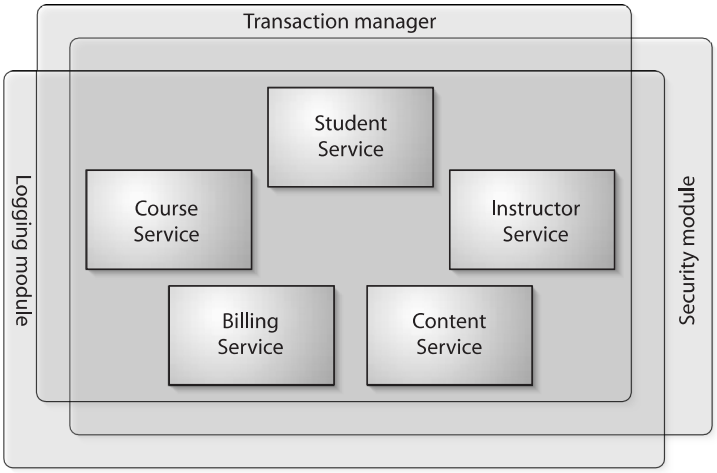

Figure 1.5 Using AOP, systemwide concerns blanket the components that they impact.

your core application with layers of functionality. These layers can declaratively be applied throughout your application in a flexible manner without your core application even knowing they exist. This is a very powerful concept.

1.5.2 AOP in action

Let's revisit our knight example to see how AOP works with Spring. Suppose that after showing your progress to marketing, they came back with an additional requirement. In this new requirement, a minstrel must accompany each knight, chronicling the actions and deeds of the knight in song.[5]

To start, you create a `Minstrel` class:

```
package com.springinaction.chapter01.knight;

import org.apache.log4j.Logger;

public class Minstrel {
  Logger song = Logger.getLogger(KnightOfTheRoundTable.class);
  public Minstrel() {}

  public void compose(String name, String message) {
    song.debug("Fa la la! Brave " + name + " did " + message + "!");
  }
}
```

In keeping with the IoC way of doing things, you alter `KnightOfTheRoundTable` to be given an instance of `Minstrel`:

```
public class KnightOfTheRoundTable {
…
  private Minstrel minstrel;
  public void setMinstrel(Minstrel minstrel) {
    this.minstrel = minstrel;
  }

…

  public HolyGrail embarkOnQuest() throws QuestException {
    minstrel.compose(name, "embark on a quest");
    return quest.embark();
  }
}
```

[5] Think of minstrels as musically inclined logging systems of medieval times.

There's only one problem. As it is, each knight must stop and tell the minstrel to compose a song before the knight can continue with his quest (as in figure 1.6). Ideally a minstrel would automatically compose songs without being explicitly told to do so. A knight shouldn't know (or really even care) that their deeds are being written into song. After all, you can't have your knight being late for quests because of a lazy minstrel.

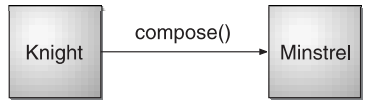

Figure 1.6 Without AOP, a knight must tell his minstrel to compose songs.

In short, the services of a minstrel transcend the duties of a knight. Another way of stating this is to say that a minstrel's services (song writing) are orthogonal to a knight's duties (embarking on quests). Therefore, it makes sense to implement a minstrel as an aspect that adds its song-writing services to a knight. Probably the simplest way to create an aspect-oriented minstrel is to change the minstrel class to be an implementation of `MethodBeforeAdvice`, as shown in listing 1.11.

Listing 1.11 An aspect-oriented minstrel

```
package com.springinaction.chapter01.knight;

import java.lang.reflect.Method;
import org.apache.log4j.Logger;
import org.springframework.aop.MethodBeforeAdvice;

public class MinstrelAdvice
    implements MethodBeforeAdvice {
  public MinstrelAdvice() {}

  public void before(Method method, Object[] args,
      Object target) throws Throwable {

    Knight knight = (Knight) target;

    Logger song =
        Logger.getLogger(target.getClass());

    song.debug("Brave " + knight.getName() +
        " did " + method.getName());
  }
}
```

Advise method before call

Get the advised class's logger

As a subclass of `MethodBeforeAdvice`, the `MinstrelAdvice` class will intercept calls to the target object's methods, giving the `before()` method an opportunity to do something before the target method gets called. In this case, `MinstrelAdvice` naively assumes that the target object is a `KnightOfTheRoundTable` and uses log4j as its mechanism for chronicling the knight's actions. As illustrated in figure 1.7, the knight needn't worry about how he is being sung about or even that the minstrel is writing the song.

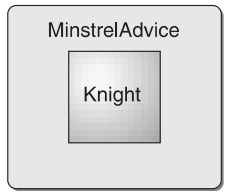

Figure 1.7
An aspect-oriented minstrel covers a knight, chronicling the knight's activities without the knight's knowledge of the minstrel.

The knight no longer needs to tell this new aspect-oriented minstrel to sing about the knight's activities. In fact, the knight doesn't even need to know that the minstrel exists. But how does `MinstrelAdvice` know that it is supposed to intercept calls to a `Knight`?

Weaving the aspect

Notice that there's nothing about `MinstrelAdvice` that tells the `Minstrel` what object it should sing about. Instead, a `Minstrel`'s services are applied to a `Knight` declaratively. Applying advice to an object is known as *weaving*. In Spring, aspects are woven into objects in the Spring XML file, much in the same way that beans are wired together. Listing 1.12 shows the new knight.xml, modified to weave `MinstrelAdvice` into a `KnightOfTheRoundTable`.

Listing 1.12 Weaving MinstrelAdvice into a knight

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE beans PUBLIC "-//SPRING//DTD BEAN//EN"
    "http://www.springframework.org/dtd/spring-beans.dtd">

<beans>
  <bean id="quest"
      class="com.springinaction.chapter01.knight.HolyGrailQuest"/>

  <bean id="knightTarget"
      class="com.springinaction.chapter01.knight.KnightOfTheRoundTable">
    <constructor-arg><value>Bedivere</value></constructor-arg>

    <property name="quest"><ref bean="quest"/></property>
  </bean>

  <bean id="minstrel"
      class="com.springinaction.chapter01.knight.MinstrelAdvice"/>
```

Create a minstrel instance

```
  <bean id="knight"
      class="org.springframework.aop.framework.ProxyFactoryBean">
    <property name="proxyInterfaces">
      <list>
        <value>com.springinaction.chapter01.knight.Knight</value>
      </list>
    </property>
    <property name="interceptorNames">
      <list>
        <value>minstrel</value>
      </list>
    </property>
    <property name="target"><ref bean="knightTarget"/></property>
  </bean>
</beans>
```

Intercept calls to the knight

Let minstrel handle call first

Then let the knight handle the call

Notice that the `id` of `KnightOfTheRoundTable` has changed from `knight` to `knightTarget` and now `knight` points to a Spring class called `ProxyFactoryBean`. What this means is that when the container is asked for a `knight` object, it will return an object that intercepts calls to the target `KnightOfTheRoundTable` object, giving `MinstrelAdvice` a shot at handling method calls first. Once `MinstrelAdvice` is finished, control is returned to `KnightOfTheRoundTable` to perform the knightly task.

Don't worry if this doesn't make sense yet. We'll explain Spring's AOP support in more detail in chapter 3. For now, suffice it to say that even though a knight's every move is being observed by a minstrel, the knight's activities are in no way hampered because of the minstrel's presence.

But Spring's AOP can be used for even more practical things than composing ageless sonnets about knights. As you'll see, AOP can be used to provide enterprise services such as declarative transactions and security.

1.5.3 AOP in the enterprise

Enterprise applications often require certain services such as security and transactional support. One way of applying these services is to code support for them directly into the classes that use them. For example, to handle transactions, you may place the following snippet throughout your code:

```
UserTransaction transaction = null;
try {
  transaction = ... {retrieve transaction}

  transaction.begin();

  ... do stuff...
```

```
    transaction.commit();
  } catch (Exception e) {
    if (transaction != null) transaction.rollback();
  }
```

The problem with handling transactions this way is that you may repeat the same transaction handling code several times—once for each time you need a transactional context. What's more, your application code is responsible for more than its core functionality.

EJB simplifies things by making it possible to declare these services and their policies in the EJB deployment descriptor. With EJB it is possible to write components that are ignorant of the fact that they are in a transactional context or being secured and then declare the transactional and security policies for those components in the EJB deployment descriptor. For example, to ensure that a method is transactional in EJB, you simply place the following in the deployment descriptor:

```
<container-transaction>
  <method>
    <ejb-name>Foo</ejb-name>
    <method-intf>Remote</method-inf>
    <method-name>doSomething</method-name>
  </method>
  <trans-attribute>RequiresNew</trans-attribute>
</container-transaction>
```

EJB has hung its hat on how it simplifies infrastructure logic such as transactions and security. But as we discussed in the introduction to this chapter, EJB has complicated matters in other ways.

Although Spring's AOP support can be used to separate cross-cutting concerns from your application's core logic, its primary job is as the basis for Spring's support for declarative transactions. Spring comes with several aspects that make it possible to declare transaction policies for JavaBeans. And the Acegi Security System (another open-source project associated with Spring) provides declarative security to JavaBeans. As with all Spring configuration, the transactional and security policies are prescribed in a Spring configuration file.

NOTE Although the Spring framework comes packed with several frameworks and support for several enterprise-level services, it does not come with much to assist you with security. The Acegi security system uses Spring's AOP support as the foundation of a framework that adds declarative security to Spring-enabled applications. You will learn more about Acegi in chapter 11.

For example, suppose that instead of a knight your application handles student registration for training courses. Perhaps you have a bean called `StudentServiceImpl` that implements the following interface:

```
public StudentService {
  public void registerForCourse(Student student, Course course);
}
```

This bean may be registered in the Spring bean XML file as follows:

```
<bean id="studentServiceTarget"
    class="com.springinaction.training.StudentServiceImpl"/>
```

`StudentService`'s `registerForCourse()` method should perform the following actions:

1. Verify that there is an available seat in the course.
2. Add the student to the course's roster.
3. Decrement the course's available seat count by 1.
4. Notify the student by e-mail of a successful registration.

All of these actions should happen atomically. If anything goes bad, then all should be rolled back as if nothing happened. Now imagine if instead of a minstrel providing musical logging to this class, you were to apply one of Spring's transaction manager aspects. Applying transactional support to `StudentServiceImpl` might be as simple as adding the lines shown in listing 1.13 to the bean XML file.

Listing 1.13 Declaring StudentService to be transactional

```
<bean id="transactionManager" class=
    "org.springframework.orm.hibernate.HibernateTransactionManager">
  <property name="sessionFactory">
    <ref bean="sessionFactory"/>
  </property>
</bean>

<bean id="studentService" class=
"org.springframework.transaction.interceptor.
  ➥ TransactionProxyFactoryBean">

  <property name="target">
    <ref bean="studentServiceTarget"/>
  </property>

  <property name="transactionAttributes">
    <props>
```

Declare transaction manager

Apply transactions

```
        <prop key="registerForCourse">                          Declare
            PROPAGATION_REQUIRES_NEW,ISOLATION_DEFAULT          transaction
        </prop>
      </props>
    </property>

    <property name="transactionManager">
        <ref bean="transactionManager"/>    <-- Inject transaction
    </property>
  </bean>
```

Here we make use of Spring's `TransactionProxyFactoryBean`. This is a convenience proxy class that allows us to intercept method calls to an existing class and apply a transaction context. In this case we are creating a proxy to our `StudentServiceImpl` class and applying a transaction to the `registerForCourse()` method. We are also using `HibernateTransactionManager`, the implementation of a transaction manager you would most likely use if your application's persistence layer is based on Hibernate.

Although this example leaves a lot to be explained, it should give you a glimpse of how Spring's AOP support can provide plain-vanilla JavaBeans with declarative services such as transactions and security. We'll dive into more details of Spring's declarative transaction support in chapter 5.

1.6 Spring alternatives

Whew! After that whirlwind introduction of Spring, you have a pretty good idea of what it can do. Now you are probably chomping at the bit to get down into the details so you can see how you can use Spring for your projects. But before we do that, we need to cover what else is out there in the world of J2EE frameworks.

1.6.1 Comparing Spring to EJB

Because Spring comes with rich support for enterprise-level services, it is positioned as a viable alternative to EJB. But EJB, as opposed to Spring, is a well-established platform. Therefore, the decision to choose one over the other is not one to be taken lightly. Also, you do not necessarily have to choose only Spring *or* EJB. Spring can be used to support existing EJBs as well, a topic that will be discussed in detail in chapter 7. With that in mind, it is important to know what these two have in common, what sets them apart, and the implications of choosing either.

EJB is a standard

Before we delve into the technical comparisons between Spring and EJB, there is an important distinction that we need to make. EJB is a *specification* defined by the JCP. Being a standard has some significant implications:

- *Wide industry support*—There is a whole host of vendors that are supporting this technology, including industry heavyweights Sun, IBM, Oracle, and BEA. This means that EJB will be supported and actively developed for many years to come. This is comforting to many companies because they feel that by selecting EJB as their J2EE framework, they are going with a safe choice.
- *Wide adoption*—EJB as a technology is deployed in thousands of companies around the world. As a result, EJB is in the tool bag of most J2EE developers. This means that if a developer knows EJB, they are more likely to find a job. At the same time, companies know that if they adopt EJB, there is an abundance of developers who are capable of developing their applications.
- *Toolability*—The EJB specification is a fixed target, making it easy for vendors to produce tools to help developers create EJB applications more quickly and easily. Dozens of applications are out there that do just that, giving developers a wide range of EJB tool options.

Spring and EJB common ground

As J2EE containers, both Spring and EJB offer the developer powerful features for developing applications. Table 1.1 lists the major features of both frameworks and how the implementations compare.

Table 1.1 Spring and EJB feature comparison

Feature	EJB	Spring
Transaction management	▪ Must use a JTA transaction manager. ▪ Supports transactions that span remote method calls.	▪ Supports multiple transaction environments through its `PlatformTransactionManager` interface, including JTA, Hibernate, JDO, and JDBC. ▪ Does not natively support distributed transactions—it must be used with a JTA transaction manager.

continued on next page

Table 1.1 Spring and EJB feature comparison *(continued)*

Feature	EJB	Spring
Declarative transaction support	▪ Can define transactions declaratively through the deployment descriptor. ▪ Can define transaction behavior per method or per class by using the wild-card character `*`. ▪ Cannot declaratively define rollback behavior—this must be done programmatically.	▪ Can define transactions declaratively through the Spring configuration file or through class metadata. ▪ Can define which methods to apply transaction behavior explicitly or by using regular expressions. ▪ Can declaratively define rollback behavior per method and per exception type.
Persistence	▪ Supports programmatic bean-managed persistence and declarative container managed persistence.	▪ Provides a framework for integrating with several persistence technologies, including JDBC, Hibernate, JDO, and iBATIS.
Declarative security	▪ Supports declarative security through users and roles. The management and implementation of users and roles is container specific. ▪ Declarative security is configured in the deployment descriptor.	▪ No security implementation out-of-the box. ▪ Acegi, an open source security framework built on top of Spring, provides declarative security through the Spring configuration file or class metadata.
Distributed computing	▪ Provides container-managed remote method calls.	▪ Provides proxying for remote calls via RMI, JAX-RPC, and web services.

For *most* J2EE projects, the technology requirements will be met by either Spring or EJB. There are exceptions—your application may need to be able to support remote transaction calls. If that is the case, EJB may seem like the the way to go. Even then, Spring integrates with a Java Transaction API (JTA) transaction providers, so even this scenario is cut-and-dried. But if you are looking for a J2EE framework that provides declarative transaction management and a flexible persistence engine, Spring is a great choice. It lets you choose the features you want without the added complexities of EJB.

The complexities of EJB

So what are the complexities of EJB? Why is there such a shift toward lightweight containers? Here are a few of the complexities of EJB that turn off many developers:

- *Writing an EJB is overly complicated*—To write an EJB, you have to touch *at least* four files: the business interface, the home interface, the bean implementation, and the deployment descriptor. Other classes are likely to be involved as well, such as utility classes and value objects. That's quite a

proliferation of files when all you are looking for is to add some container services to your implementation class. Conversely, Spring lets you define your implementation as a POJO and wire in any additional services needs through injection or AOP.

- *EJB is invasive*—This goes hand in hand with the previous point. In order to use the services provided by the EJB container, you *must* use the `javax.ejb` interfaces. This binds your component code to the EJB technology, making it difficult (if not possible) to use the component outside of an EJB container. With Spring, components are typically not required to implement, extend, or use any Spring-specific classes or interfaces, making it possible to reuse the components anywhere, even in the absence of Spring.
- *Entity EJBs fall short*—Entity EJBs are not as flexible or feature-rich as other ORM tools. Spring recognizes there are some great ORM tools out there, such as Hibernate and JDO, and provides a rich framework for integrating them into your application. And since an entity bean could represent a remote object, the Value Object pattern was introduced to pass data to and from the EJB tier in a course-grained object. But value objects lead to code duplication—you write each persistent property twice: once in the entity bean and once in your value object. Using Spring together with Hibernate or another ORM framework, your application's entity objects are not directly coupled with their persistence mechanism. This makes them light enough to be passed across application tiers.

Again, in most J2EE applications, the features provided by EJB may not be worth the compromises you will have to make. Spring provides nearly all of the services provided by an EJB container while allowing you to develop much simpler code. In other words, for a great number of J2EE applications, Spring makes sense. And now that you know the differences between Spring and EJB, you should have a good idea which framework fits your needs best.

1.6.2 Considering other lightweight containers

Spring is not the only lightweight container available. In the last few years, more and more Java developers have been seeking an alternative to EJB. As a result, several lightweight containers have been developed with different methods for achieving inversion of control.

Table 1.2 lists the types of IoC. These were first described with the nondescript "Type X" convention, but have since shifted to more meaningful names. We will always refer to them by the name.

Table 1.2 Inversion of Control types

Type	Name	Description
Type 1	Interface Dependent	Beans must implement specific interfaces to have their dependencies managed by the container.
Type 2	Setter Injection	Dependencies and properties are configured through a bean's setter methods.
Type 3	Constructor Injection	Dependencies and properties are configured through the bean's constructor.

Although the focus of this book is on Spring, it may be interesting to see how these other containers stack up to Spring. Let's take a quick look at some of the other lightweight containers, starting with PicoContainer.

PicoContainer

PicoContainer is a minimal lightweight container that provides IoC in the form of constructor and setter injection (although it favors constructor injection). We use the word *minimal* to describe PicoContainer because, with it small size (~50k), it has a sparse API. PicoContainer provides the bare essentials to create an IoC container and expects to be extended by other subprojects and applications. By itself, you can only assemble components programmatically through PicoContainer's API. Since this would be a cumbersome approach for anything but the most trivial applications, there is a subproject named NanoContainer that provides support for configuring PicoContainer through XML and various scripting languages. However, at the time of this writing, NanoContainer does not appear to be production-ready.

One of the limitations of PicoContainer is that it allows only one instance of any particular type to be present in its registry. This is could lead to problems if you need more than one instance of the same class, just configured differently. For example, you may want to have two instances of a `javax.sql.DataSource` in your application, each configured for a different database. This would not be possible in PicoContainer.

Also, you should know that PicoContainer is only a container. It does not offer any of the other powerful features that Spring has, such as AOP and third-party framework integration.

HiveMind

HiveMind is a relatively new IoC container. Like PicoContainer, it focuses on wiring and configuring services with support for both constructor and setter injection. HiveMind allows you to define your configuration in an XML file or in HiveMind's Simple Data Language.

HiveMind also provides an AOP-like feature with its *Interceptors*. This allows you to wrap a service with Interceptors to provide additional functionality. However, this is not nearly as powerful as Spring's AOP framework.

Finally, like PicoContainer, HiveMind is *only* a container. It provides a framework for managing components but offers no integration with other technologies.

Avalon

Avalon was one of the first IoC containers developed. As with many early entrants into a market, some mistakes were made in its design. Mainly, Avalon provides interface-dependent IoC. In other words, in order for your objects to be managed by the Avalon container, they must implement Avalon-specific interfaces. This makes Avalon an invasive framework; you must change *your* code in order for it to be usable by the container. This is not desirable because it couples your code to a particular framework for even the simplest of cases.

We believe that if Avalon does not adopt a more flexible means of managing components, it will eventually fade out of the lightweight container market; there are other ways of achieving the same results with much less rigidity.

1.6.3 Web frameworks

Spring comes with its own very capable web framework. It provides features found in most other web frameworks, such as automatic form data binding and validation, multipart request handling, and support for multiple view technologies. We'll talk more about Spring's web framework in chapter 8. But for now, let's take a look at how Spring measures up to some popular web frameworks

Struts

Struts can probably be considered the de facto standard for web MVC frameworks. In has been around for several years, was the first "Model 2" framework to gain wide adoption and has been used in thousands of Java projects. As a result, there is an abundance of resources available on Struts.

The Struts class you will use the most is the `Action` class. It is important to note that this is a class and not an interface. This means all your classes that handle

input will need to subclass `Action`. This in contrast to Spring, which provides a `Controller` interface that you can implement.

Another important difference is how each handles form input. Typically, when a user is submitting a web form, the incoming data maps to an object in your application. In order to handle form submissions, Struts requires you have `ActionForm` classes to handle the incoming parameters. This means you need to create a class solely for mapping form submissions to your domain objects. Spring allows you to map form submissions directly to an object without the need for an intermediary, leading to eaiser maintenance.

Also, Struts comes with built-in support for declarative form validation. This means you can define rules for validating incoming form data in XML. This keeps validation logic out of your code, where it can be cumbersome and messy. Spring does not come with declarative validation. This does not mean you cannot use this within Spring; you will just have to integrate this functionality yourself using a validation framework, such as the Jakarta Commons Validator.

If you already have an investment in Struts or you just prefer it as your web framework, Spring has a package devoted to integrating Struts with Spring.

Furthermore, Struts is a mature framework with a significant following in the Java development community. Much has been written about Struts, including Ted Husted's *Struts in Action* (Manning, 2002).

WebWork

WebWork is another MVC framework. Like Struts and Spring, it supports multiple view technologies. One of the biggest differentiators for WebWork is that it adds another layer of abstraction for handling web requests. The core interface for handling requests is the `Action` interface, which has one method: `execute()`. Notice that this interface is not tied to the web layer in any way. The WebWork designers went out of their way to make the `Action` interface unaware that it could be used in a web context. This is good or bad, depending on your perspective. Most of the time it *will* be used in a web application, so hiding this fact through abstraction does not buy you much.

A feature that WebWork provides that Spring does not (at least, not explicitly) is *action chaining*. This allows you to map a logical request to a series of `Actions`. This means you can create several `Action` objects that all perform discrete tasks and chain them together to execute a single web request.

Tapestry

Tapestry is another open source web framework that is quite different than ones mentioned previously. Tapestry does not provide a framework around the

request-response servlet mechanism, like Struts or WebWork. Instead, it is a framework for creating web applications from reusable components (if you are familiar with Apple's WebObjects, Tapestry was inspired by its design).

The idea behind Tapestry is to relieve the developer from thinking about Session attributes and URLs, and instead think of web applications in terms of components and methods. Tapestry takes on the other responsibilities, such as managing user state and mapping URLs to methods and objects.

Tapestry provides a view mechanism as well. That is, Tapestry is not a framework for using JSPs—it is an alternative to JSPs. Much of Tapestry's power lies in its custom tags that are embedded with HTML documents and used by the Tapestry framework. Needless to say, Tapestry provides a unique web application framework. To learn more about Tapestry, take a look at *Tapestry in Action* (Manning, 2004).

1.6.4 Persistence frameworks

There really isn't a direct comparison between Spring and any persistence framework. As mentioned earlier, Spring does not contain any built-in persistence framework. Instead, Spring's developers recognized there were already several good frameworks for this and felt no need to reinvent the wheel. They created an ORM module that integrates these frameworks with rest of Spring. Spring provides integration points for Hibernate, JDO, OJB, and iBATIS.

Spring also provides a very rich framework for writing JDBC. JDBC requires a lot of boilerplate code (getting resources, executing statements, iterating though query results, exception handling, cleaning up resources). Spring's JDBC module handles this boilerplate, allowing you to focus on writing queries and handling the results.

Spring's JDBC and ORM frameworks work within Spring's transaction management framework. This means you can use declarative transactions with just about any persistence framework you choose.

1.7 Summary

You should now have a pretty good idea of what Spring brings to the table. Spring aims to make J2EE development easier, and central to this is its inversion of control. This enables you to develop enterprise applications using simple Java objects that collaborate with each other through interfaces. These beans will be wired together at runtime by the Spring container. It lets you maintain loosely coupled code with minimal cost.

On top of Spring's inversion control, Spring's container also offers AOP. This allows you place code that would otherwise be scattered throughout you application

in one place—an aspect. When your beans are wired together, these aspects can be woven in at runtime, giving these beans new behavior.

Staying true to aiding enterprise development, Spring offers integration to several persistence technologies. Whether you persist data using JDBC, Hibernate, or JDO, Spring's DAO frameworks ease your development by providing a consistent model for error handling and resource management for each of these persistence frameworks.

Complementing the persistence integration is Spring's transaction support. Through AOP, you can add declarative transaction support to your application without EJB. Spring also supports a variety of transaction scenarios, including integration with JTA transactions for distributed transactions.

Filling out its support for the middle tier, Spring offers integration with other various J2EE services, such as mail, EJBs, web services, and JNDI. With its inversion of control, Spring can easily configure these services and provide your application objects with simpler interfaces.

To help with the presentation tier, Spring supports multiple view technologies. This includes web presentation technologies like Velocity and JSP as well as support for creating Microsoft Excel spreadsheets and Adobe Acrobat Portable Document Format (PDF) files. And on top of the presentation, Spring comes with a built-in MVC framework. This offers an alternative to other web frameworks like Struts and WebWork and more easily integrates with all of the Spring services.

So without further ado, let's move on to chapter 2 to learn more about exactly how Spring's core container works.

JAVA

SPRING IN ACTION

Craig Walls • Ryan Breidenbach

Spring is a fresh breeze blowing over the Java landscape. Based on a design principle called Inversion of Control, Spring is a powerful but lightweight J2EE framework that does not require the use of EJBs. Spring greatly reduces the complexity of using interfaces, and speeds and simplifies your application development. You get the power and robust features of EJB *and* get to keep the simplicity of the non-enterprise JavaBean.

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- Addressing cross-cutting concerns with AOP
- Enterprise applications best practices

Craig Walls is a software developer with over 10 years' experience and co-author of *XDoclet in Action*. He has sucessfully implemented a number of Spring applications. Craig lives in Denton, Texas. An avid supporter of open source Java technologies, **Ryan Breidenbach** has developed Java web applications for the past five years. He lives in Coppell, Texas.

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