ibm.com/redbooks

Configuring and Deploying Open Source with IBM WebSphere Application Server Liberty Profile

Rufus Credle

Shao Jan Ding

Miho Hachitani

Jagdish Komakula

Catalin Mierlea

Pete Neergaard

Alexander Poga

Grzegorz Smolko

Sebastian Thomschke

Marek Zajac

WebSphere

International Technical Support Organization

Configuring and Deploying Open Source with IBM WebSphere Application Server Liberty Profile

July 2015

SG24-8194-01

Note: Before using this information and the product it supports, read the information in “Notices” on page v.

Second Edition (July 2015)

This edition applies to IBM WebSphere® Application Server V8.5.5.6.

Contents

Notices

Trademarks

Preface

This IBM® Redbooks® publication explains the capabilities of IBM WebSphere® Application Server Liberty profile (Liberty profile), which is lightweight, easy to install, and fast to use. Liberty profile provides a convenient and capable platform for developing and testing your web and OSGi applications. The Liberty profile server is built by using OSGi technology and concepts. The fit-for-purpose nature of the run time relies on the dynamic behavior that is inherent in the OSGi framework and service registry. As bundles are installed or uninstalled from the framework, their services are automatically added or removed from the service registry. The result is a dynamic, composable run time that can be provisioned with only what your application requires and responds dynamically to configuration changes as your application evolves.

This book can help you install, customize, and configure several popular open source technologies that can be deployed effectively with the Liberty profile server.

The following popular open source toolkits for the Liberty profile server were selected for this book based on the significant enhancements they provide to the web application development process:

- Apache Maven
- Spring Framework
- Hibernate
- Jenkins
- Opscode Chef
- Arquillian
- MongoDB

In this book, the *Todo* sample demonstrates the use of multiple open source frameworks or toolkits with the Liberty profile server, including Maven, MongoDB, Spring, JPA, Arquillian, Wicket, and others. The Todo sample is a simple application that can be used to create, update, and delete todo items and todo lists, and put the todo items into a related todo list.

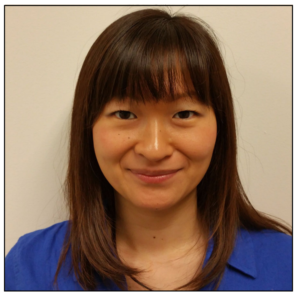
Authors

This book was produced by a team of specialists from around the world working at the International Technical Support Organization, Raleigh Center.

Rufus Credle is a Certified Consulting IT Specialist at the ITSO Research Triangle Park NC Center. In his role as Project Leader, he conducts residencies and develops IBM Redbooks publications and IBM Redpapers™ publications with a team of IBM subject matter experts (SMEs), IBM Business Partners, and clients around the globe on the subjects of network operating systems, enterprise resource planning (ERP) solutions, voice technology, high availability, clustering solutions, web application servers, pervasive computing, IBM and OEM e-business applications, WebSphere Commerce, IBM industry technology, the IBM Customer Information Control System (IBM CICS®) family of application servers and connectors, System x, and IBM BladeCenter.

Rufus has held various positions during his IBM career, including assignments in administration and asset management, systems engineering, sales and marketing, and IT services. He has a Bachelor of Science degree in Business Management from Saint Augustine's College. Rufus has been employed at IBM for 33 years.

Shao Jan Ding is a Software developer for the IBM WebSphere Application Server Development organization. She is based at the Beijing, China Software Development Laboratory. She has over 10 years of experience in the IT industry and focuses primarily on Java and Java Platform, Enterprise Edition technologies.



Miho Hachitani is an advisory specialist with the technical support team for WebSphere Application Server. She has over 13 years of experience at the WebSphere Application Server support organization in IBM, including the design of topologies, scalability, high availability, performance, and administration.

She has delivered customer projects that adopt the Liberty profile, and tested many cases of Liberty profile, including Liberty collective.

Jagdish Komakula is a Senior Staff Software Engineer and has over nine years of IT experience in WebSphere administration, Java, Java Platform, Enterprise Edition, XML, service-oriented architecture (SOA), and related technologies. He holds a master's degree in Information Systems and is part of the Worldwide Competitive Migration Team. He was a Technical Leader for SIBus Test Team and Project Leader for WebSphere Application Server Functional Verification Test Team at IBM Software Labs, Bangalore, India. Jagdish is focused and enjoys delivering measurable business value by interacting with WebSphere customers. He is an IBM Certified WebSphere V8.5 Network Deployment Administrator and coauthored *WebSphere Application Server V7 Migration Guide*, REDP-4635. Jagdish has presented many technical articles at various conferences, such as RTLE, APQSE, and WTC.

Catalin Mierlea is Middleware Software Specialist at Technical Support Services of Global Technologies Services, IBM Romania. Catalin joined IBM in March 2012 and has 10 years experience with IBM middleware software. His areas of expertise include WebSphere products, SOA, and software architecture. He specializes in WebSphere Application Server, WebSphere Portal Server, and WebSphere Business Process Manager. Catalin has a Bachelor of Science degree in Automation Control and Computers, a Master of Science degree in Integrated Informatics Systems, IBM WebSphere products certifications, and competencies in different Oracle and Microsoft technologies. He has extensive industry knowledge and hands-on project experience in the banking and public sectors.

Pete Neergaard is a Certified IT Specialist working as a Course Developer and Instructor in the WebSphere Application Server area. He has been at IBM for 18 years, working for the WebSphere Education team with a focus on WebSphere Application Server, Intelligent Management, Security, and Mobile. Previously, he worked at Carnegie Mellon University as a Research Systems Programmer. He holds a bachelor's degree in Computer Science and Applied Math from Carnegie Mellon University. He lives and works in Pittsburgh, Pennsylvania.

Alexander Poga is a Software Engineer with the IBM Australian Development Lab, which is based in Perth, Western Australia. He works on the development team for the Fault Analyzer for IBM z/OS® product, which is part of the Problem Determination Tools suite for z/OS mainframes. His areas of expertise include Java, C, and JavaScript programming for IBM z Systems™ mainframes, Eclipse plug-ins, web services, and front-end applications.

Grzegorz Smolko is a Certified IT Specialist at IBM Poland in Warsaw, Poland. Grzegorz has been working for IBM for more than 12 years, mostly in IBM Software Services for WebSphere. He is a member of the World Wide WebSphere Competitive Migration Team, helping customer to migrate their applications from various platforms to WebSphere Application Server and WebSphere Liberty profile. Before joining IBM, he worked for software house companies in Poland as a Java developer and architect. His areas of expertise include Java, Java Platform, Enterprise Edition, and WebSphere. He holds certifications from Oracle and IBM in Java and WebSphere technologies. He has a master's degree in Computer Science from the Warsaw University of Technology, Poland.

Sebastian Thomschke is a Senior IT Consultant and CEO at Vegard IT GmbH, a Berlin-based IT consulting company and IBM Business Partner. This company's main focus is on the IBM WebSphere technology stack. He has over 17 years of experience in the IT industry, where he successfully fulfilled roles as Application Developer, IT Architect, Trainer, and IT Consultant. For the last eight years, he has been primarily engaged in WebSphere Application Server and Portal Server development and deployment projects. Sebastian has a degree in Business Administration from the Berufsakademie of Berlin, Germany.

Marek Zajac is a Software Architect with the IBM Krakow Lab, which is based in Krakow, Poland. He works with the WW BP Technical Professional team and is responsible for delivering WebSphere technical support and enablement to IBM Business Partners in Central and Eastern Europe (CEE) and Middle East Africa (MEA). He has 13 years of experience in the IT industry and for the last seven years has focused on Java and Java Platform, Enterprise Edition. His specialities are WebSphere Application Server, IBM Business Process Manager (IBM BPM), and WebSphere Message Broker.

This project was led by:

Margaret Ticknor an IBM Redbooks Project Leader at the Raleigh Center. She primarily leads projects about WebSphere products and IBM PureApplication® System. Before joining the ITSO, Margaret worked as an IT specialist in Endicott, NY. Margaret attended the Computer Science program at State University of New York at Binghamton.

Thanks to the following people for their contributions to this project:

Paul W Bennett
IBM Systems, Middleware, WebSphere Development, IBM US

Kihup Boo
IBM Systems, Middleware, IBM Canada

Robert Haimowitz
DST Poughkeepsie, Enablement for IBM z™ Systems and z/OS

Alex Mulholland
STSM WebSphere Application Server Liberty Runtime Architect, IBM US

Alasdair Nottingham
WebSphere Application Server Liberty profile Development Lead IBM Hursley

Gary R. Picher
Software Engineer, WebSphere for z/OS, IBM US

Preethi R Sulkunte
IBM Systems, Middleware, IBM India Pvt Ltd

Thanks to the following people for their support of this project:

Deana Coble
IBM Redbooks Technical Writer

Lindamay Patterson
IBM Redbooks Technical Writer

Tamikia Lee
IBM Redbooks Residency Administrator

Suresh K Kalathody
IBM Redbooks Graphics Editor

Wade Wallace
IBM Redbooks Editor

.Now you can become a published author, too!

Here’s an opportunity to spotlight your skills, grow your career, and become a published author—all at the same time! Join an ITSO residency project and help write a book in your area of expertise, while honing your experience using leading-edge technologies. Your efforts will help to increase product acceptance and customer satisfaction, as you expand your network of technical contacts and relationships. Residencies run from two to six weeks in length, and you can participate either in person or as a remote resident working from your home base.

Find out more about the residency program, browse the residency index, and apply online at:

ibm.com/redbooks/residencies.html

Comments welcome

Your comments are important to us!

We want our books to be as helpful as possible. Send us your comments about this book or other IBM Redbooks publications in one of the following ways:

- Use the online **Contact us** review Redbooks form found at:

  ibm.com/redbooks

- Send your comments in an email to:

  redbooks@us.ibm.com

- Mail your comments to:

  IBM Corporation, International Technical Support Organization
  Dept. HYTD Mail Station P099
  2455 South Road
  Poughkeepsie, NY 12601-5400

Stay connected to IBM Redbooks

- Find us on Facebook:

  http://www.facebook.com/IBMRedbooks

- Follow us on Twitter:

  http://twitter.com/ibmredbooks

- Look for us on LinkedIn:

  http://www.linkedin.com/groups?home=&gid=2130806

- Explore new Redbooks publications, residencies, and workshops with the IBM Redbooks weekly newsletter:

  https://www.redbooks.ibm.com/Redbooks.nsf/subscribe?OpenForm

- Stay current on recent Redbooks publications with RSS Feeds:

  http://www.redbooks.ibm.com/rss.html

1 IBM WebSphere Application Server Liberty profile

Along with the development of the IT industry, new challenges have occurred for application servers:

- Application servers require readily deployable artifacts. They require a test-driven development methodology and the development must be under a continuous integration mode. The application server must support rapid application development and deployment.
- Software should be modularized and should be more easily assembled, which leads to the requirements for composable, dynamic, and fast application server run time.
- Modern programming models, such as NoSQL database, RESTful web services, and responsive UI are more popular. Application servers must be fast and open to adopt these new programming models.
- Open source is becoming more useful. Application servers must work seamlessly with different open source frameworks.

The WebSphere Application Server Liberty profile is lightweight, easy to install, and fast to use. It provides a convenient and capable platform for developing and testing your web, enterprise, and OSGi applications. The *Liberty profile server* (short name) is built by using OSGi technology and concepts. The fit-for-purpose nature of the run time relies on the dynamic behavior that is inherent in the OSGi framework and service registry. As bundles are installed or uninstalled from the framework, their services are automatically added or removed from the service registry. The result is a dynamic, composable run time that can be provisioned with only what your application requires and responds dynamically to configuration changes as your application evolves.

This book uses multiple samples to demonstrate how WebSphere Application Server Liberty profile can be used to address these challenges. This chapter has an overview of WebSphere Application Server Liberty profile and its strength.

This chapter covers the following topics:

- Overview of Liberty profile server
- Strengths of Liberty profile server

1.1 Overview of Liberty profile server

The Liberty profile server is a simple, lightweight development and application runtime environment that offers these benefits:

- Simple to configure: Configuration is read from a single XML file with text-editor syntax.
- Dynamic and flexible: The run time loads only what your application needs and constructs the run time in response to configuration changes.
- Fast: The server starts in under five seconds with a basic web application.
- Extensible: The server supports user and product extensions, which can use system programming interfaces (SPIs) to extend the run time.

The Liberty profile server is available in all editions of the WebSphere Application Server product. It is the only profile in the low-end Liberty Core edition of the product; all other editions contain both the Liberty profile and the full (traditional) profile of the WebSphere Application Server.

1.2 Strengths of Liberty profile server

The WebSphere Application Server Liberty profile offers great advantages when used as both a development and production run time. The Liberty profile server is both lightweight and capable, particularly when considering the ability of third parties to extend and enhance the available features. Creating a configurable run time with a custom application that can be running in seconds becomes easy and time-efficient. The learning curve to understand the new product can be short because the configuration is kept in a single file and all parameters are organized in a concise way.

1.2.1 Simple configuration

The server configuration, from the user perspective, is only a single `server.xml` file that contains all the needed information. This WebSphere Application Server Liberty Core V8.5.5 configuration file has many optional parameters that are used for specific scenarios. You can find them in the following IBM Knowledge Center at the following website:

http://www-01.ibm.com/support/knowledgecenter/SSD28V_8.5.5/com.ibm.websphere.wlp.core.doc/autodita/rwlp_metatype_core.html?cp=SSD28V_8.5.5%2F1-1-1-0

Users can easily configure the server manually by editing the `server.xml` file or by using the Eclipse and the WebSphere Application Server Developer Tools. It provides the graphical tool to manage the server properties and deploy applications. For the production environment, having a set of resources that allow tuning the run time properly and also doing the troubleshooting when needed is important. For instructions about how to tune the Liberty profile server, go to the following website:

http://www-01.ibm.com/support/knowledgecenter/SSD28V_8.5.5/com.ibm.websphere.wlp.core.doc/ae/twlp_tun.html

1.2.2 Runtime composition with features and services

The composable nature of the Liberty profile server is based on the concept of features. A *feature* is a unit of functionality. Features can overlap, and they can include other features.

The Liberty profile server process consists of a single JVM, the Liberty kernel, and any number of optional features. The feature code and most of the kernel code runs as OSGi bundles within an OSGi framework. Features provide the programming models and services that are required by applications. You can choose which optional features should be enabled according to your application requirements.

For a list of the main Liberty features, go to the following website:

http://www-01.ibm.com/support/knowledgecenter/SSAW57_8.5.5/com.ibm.websphere.wlp.nd.multiplatform.doc/ae/rwlp_feat.html?cp=SSAW57_8.5.5%2F3-0-2-2-0

1.2.3 Developer first focus

With Liberty profile server, you can do rapid development and deployment to meet with the agile development trend. Liberty profile server is an open source software alternative with WebSphere quality of service (QoS).

Fast and no-cost download for developer's desktop

Liberty profile server is for fast and no-cost developer desktop use. It can be downloaded and installed from http://www.eclipse.org or http://www.WASdev.net. To download from WASdev.net, go to this address:

http://wasdev.net/downloads

The WebSphere Application Server Developer Tools for Eclipse are also available. The WebSphere Application Server Developer Tools product is available through the Eclipse Marketplace. You can also use IBM Rational® Application Developer for your development. For more information about WebSphere Application Server Developer Tools and access to the tool, see the following website:

https://www.ibmdw.net/wasdev/

Rapid development and deployment

You deploy an application in Liberty profile server by either dropping the application into the server's `dropins` directory, or by adding an application entry to the server configuration (`server.xml`) file.

By default, the `dropins` directory is automatically monitored. If you drop an application into this directory, the application is automatically deployed on the server. Similarly, if the application is deleted from the directory, the application is automatically removed from the server. For applications that are not in the `dropins` directory, you specify the location by using an application entry in the server configuration file. The location can be on the file system or at a URL.

Although there is no distinction between installing and starting an application, installed applications can be stopped and restarted. By default, the Liberty profile server monitors deployed applications for changes. Updates to static files (HTML, CSS, or JavaScript) or JSP files are detected and served immediately. Changes to servlet classes cause an automatic restart of the application. So, in your development time, updating your application is quick and you do not need to redeploy the application. The server can monitor and restart the application, if needed, to retrieve your new changes.

When you finish development, if you want to distribute the final result to users, you can package the Liberty profile server from the command line. Then, you can store this package, distribute it to colleagues, use it to deploy the installation to a different location or to another machine, or embed the installation in a product distribution. For information about how to package and distribute your Liberty profile server and application, go to the following website:

`http://www-01.ibm.com/support/knowledgecenter/SSAW57_8.5.5/com.ibm.websphere.wlp.nd.multiplatform.doc/ae/rwlp_feat.html?cp=SSAW57_8.5.5%2F3-0-2-2-0`

1.2.4 Multiple programming model support

The Liberty profile server is certified for the Java Platform, Enterprise Edition (Java EE) standard. You can create web applications for the Java EE Web Profile by using the Liberty Core edition, and Java enterprise applications for the full platform standard in all other product editions.

The Liberty profile server supports a subset of the Java EE 6 stack and the full Java EE 7 stack. It also supports, for example, web services technologies, enterprise application technologies, and more.

The Liberty profile server supports OSGi applications in all editions. The following technologies are supported for OSGi applications (with a reference to the specification where appropriate):

- Web Application Bundles (OSGi R4.2 Enterprise, Chapter 128)
- Blueprint Container (OSGi R4.2 Enterprise, Chapter 121)
- Blueprint Transactions
- Blueprint Managed JPA
- JNDI (OSGi R4.2 Enterprise, Chapter 126)
- OSGi application of Java EE technologies that are supported by the profile

A complete list of the technologies that are supported by the Liberty profile server are at the following IBM Knowledge Center website:

`http://www-01.ibm.com/support/knowledgecenter/SSAW57_8.5.5/com.ibm.websphere.wlp.nd.doc/ae/rwlp_prog_model_support.html?cp=SSAW57_8.5.5%2F1-0-2-0-0`

1.2.5 Easy extensibility for custom features and third-party components

The Liberty profile server supports direct extension of the run time by using product extensions. A product extension allows custom content to be added to a Liberty installation in a way that avoids conflicts with the base content of the product and with other product extensions. A product extension is defined by using a simple properties file (`<extensionName>.properties`) in the following directory:

```
${wlp.install.dir}/etc/extensions/
```

This naming convention helps to ensure that each product extension has a unique name. The unique name, in turn, is used as a prefix to avoid collisions when specifying extension-provided features and configuration in the `server.xml` file.

1.2.6 Easy access

The Liberty profile server is a small download file that you can extract to install. The download size for web profile support is only 60 MB and the installed size is approximately 67 MB. The installation time on the developer system is under ten seconds.

You can also first install WebSphere Application Server Developer Tools for Eclipse and then use this tool to download the WebSphere Application Server Liberty profile. This installation option is complete in only three minutes.

Liberty profile server supports a broad list of operating systems: IBM AIX®, HP, IBM i, Linux, Solaris, Windows, and z/OS. The Liberty profile server is also supported for development on Mac OSX.

The Liberty profile server runs on Java 6, 7, or 8 regardless of the vendor that provides it. All Java EE 7 features require the use of Java 7 or Java 8.

1.2.7 Fast and small footprint

The Liberty profile server start is fast. It can be started in approximately three seconds, and even in debug mode it can be started within five seconds.

The Liberty profile server memory footprint is small at about 60 MB for the TradeLite benchmark.

1.2.8 Compatibility with WebSphere Application Server full profile

The WebSphere Application Server Liberty profile shares all core technologies, except the JAX-WS implementation, with the WebSphere Application Server *full profile* server. Most Java EE 6 applications move easily from Liberty profile servers to the WebSphere Application Server full profile server, although the reverse is not necessarily true. The Liberty profile feature architecture and continuous delivery model allow for faster delivery of new JSR specifications on Liberty profile, so keep this in mind if you are developing applications on Liberty profile that are destined for deployment onto WebSphere Application Server full profile. For support details, go to the IBM Knowledge Center at the following website:

http://www-01.ibm.com/support/knowledgecenter/SSAW57_8.5.5/com.ibm.websphere.wlp.nd.doc/ae/rwlp_prog_model_support.html?cp=SSAW57_8.5.5%2F1-0-2-0-0

Other differences also exist between profiles in terms of configuration, including parameter names and their default values. The following list summarizes the primary areas that differ between the WebSphere Application Server full profile and the Liberty profile server:

- Time values

  In the WebSphere Application Server Liberty profile, most properties are represented by units of time. In the WebSphere Application Server full profile, they are stored as units of seconds, milliseconds, or minutes depending on the setting.

- Class loading

  The main difference is that the WebSphere Application Server full profile uses and exposes many open source libraries to applications running on the server. For example, classes under the `org.apache.*` location are visible in the application. The following open source packages are available to applications on the WebSphere Application Server:

  - commonj
  - org.apache.axiom
  - org.apache.axis2
  - org.apache.bval
  - org.apache.http
  - org.apache.wink

  - org.apache.xerces
  - org.apache.commons.[beanutils | codec | collections | digester | discovery | el | fileupload | httpclient | io | jxpath | lang | lang3 | logging | pool]

  You might encounter problems when your application uses the same libraries at different versions that are deployed within your application. To fix this issue, you must change the class loader from parent first to parent last. WebSphere Application Server Liberty profile exposes only the specification API and IBM APIs to applications, by default. This means you do not have to change the class loader policy. But, you must remember the default action when migrating your application from the Liberty profile server to the full profile.

- Server properties

  If you are familiar with the WebSphere Application Server full profile, you already know that there are many parameters, for example, data sources, web container properties, thread pools, and others. Usually, you configure the server by using the web-based admin console or **`wsadmin`** command-line tool. The WebSphere Application Server Liberty profile has only one single configuration XML file that contains all the server settings instead of many XML files that contain parameters in the WebSphere Application Server full profile. An important aspect to mention here is that the name of those parameters and their default values might differ among the various WebSphere Application Server profiles. Be aware of this difference when you plan to switch from Liberty profile server to WebSphere Application Server full profile.

  To learn about server parameters, their descriptions, and default values for WebSphere Application Server Liberty profile, see the IBM Knowledge Center at the following website:

  `http://www-01.ibm.com/support/knowledgecenter/SSAW57_8.5.5/com.ibm.websphere.wlp.nd.doc/autodita/rwlp_metatype_4ic.html?cp=SSAW57_8.5.5%2F1-0-2-1-0`

When you are planning to switch from the WebSphere Application Server full profile to Liberty profile server, consider the following differences:

- Liberty profile server supports only EJB 3.x beans.
- JNDI lookups that use the `ejblocal` name space are not supported. Instead, the ejb-ref bindings must be specified by using the `java:global`, `java:app`, or `java:module` name. The simple-binding-name and interface binding-name elements are ignored in the `ibm-ejb-jar-bnd.xml` file.
- Security differences exist between WebSphere Application Server Liberty profile and WebSphere Application Server full profile. To learn more, go to the following website:

  `http://www-01.ibm.com/support/knowledgecenter/SSAW57_8.5.5/com.ibm.websphere.wlp.nd.doc/ae/cwlp_sec.html`
- Web Services Security in WebSphere Application Server Liberty profile is configured within the WSDL file in applications. In WebSphere Application Server, the same can be configured by applying policy sets.
- Bean validation is not supported in the Liberty profile server when deployed in OSGi applications.
- In the WebSphere Application Server full profile, when you want to expose an EJB3.x through web services, a web archive (WAR) Router web project is generated. This is not needed in WebSphere Application Server Liberty profile, where you can directly expose EJB by using `@WebService` annotation.

2

Open source frameworks and toolkits selection

This chapter introduces several popular open source technologies that can be deployed effectively with the WebSphere Application Server Liberty profile.

The following list represents a selection of popular open source toolkits for the Liberty profile server. Each product was selected based on the significant potential enhancements they provide to the web application development process.

- Apache Maven
- Spring Framework
- Hibernate
- Jenkins
- Opscode Chef
- Arquillian
- MongoDB

2.1 Apache Maven

Apache Maven is an open source software project management tool that can streamline the software development lifecycle. Although it is primarily focused on Java based software projects, Maven can be configured to work with other languages, such as C#, Ruby, and Scala.

Through configuration of a Project Object Model (POM) XML configuration file, Maven can automate several common tasks, including the following tasks:

- Building project source files
- Managing dependencies on external modules and components, such as Java libraries
- Running unit tests and reporting test code coverage
- Generating documentation and project information reports, including change logs
- Managing release distribution and mailing lists

In addition, the capabilities of Maven can be enhanced to meet further requirements through its extensible plug-in architecture.

Maven build lifecycles consist of a list of ordered phases. Figure 2-1 shows how build lifecycles and Maven plug-ins are organized.

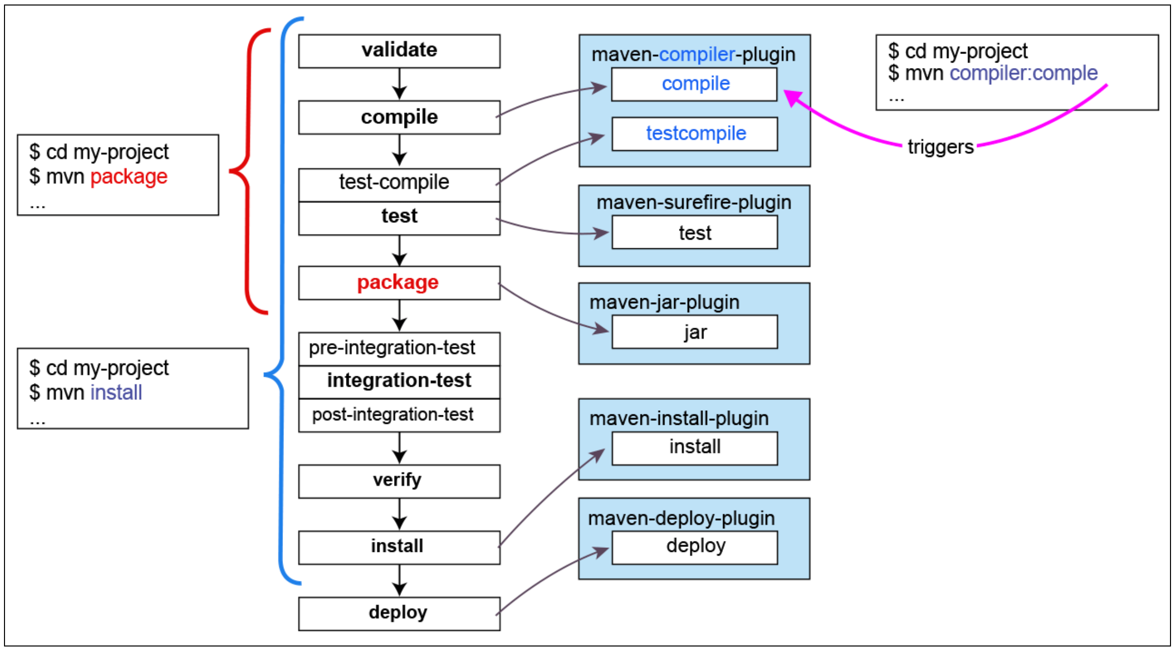


Figure 2-1 Default Maven lifecycle plug-in bindings

The Liberty profile server provides a Maven plug-in that can be used for automating Liberty profile server-specific tasks. After adding the Liberty profile server Maven plug-in from the WebSphere Application Server Developer Community (WASdev) to your POM XML file, the following “goals” are available:

- liberty:create-server
- liberty:start-server
- liberty:package-server
- liberty:stop-server
- liberty:undeploy
- liberty:install-apps

2.2 Spring Framework

The Spring Framework is a modular Java development platform that provides several features to support the enterprise application development process. Spring uses a model of dependency injection or *Inversion of Control* (IoC) where Java components can be created and wired together by declaring relationships that use XML and annotations. This model enables an application developer to focus on the business logic by using “plain old Java objects” (POJOs), leaving the infrastructure management to Spring.

As an example, each of the following operations can be performed by using local Java methods without needing to interact directly with their respective environment APIs:

- Running database transactions
- Performing remote procedures
- Performing management operations by using the Java Management Extensions (JMX)
- Handling messages by using the Java Message Service (JMS)

2.2.1 Spring Framework modules

The Spring Framework modules are organized into the categories: core container, data access and integration, web, aspect-oriented programming, and testing.

Core container

This category provides the fundamental components of the framework by using IoC and dependency injection for configuration, context, and lifecycle management of Java objects. In addition, the Expression Language module provides various utility functions that include support for querying and manipulating objects at run time.

Data access/integration

This category facilitates integration with numerous popular data access frameworks to support JDBC, Object Relational Mapping (ORM), Object/XML Mapping (OXM), JMS, and transaction management. Supported frameworks include JDBC, Hibernate, JPA, JDO, and iBatis for ORM, and also JAXB, Castor, XMLBeans, JiBX, and XStream for OXM.

Web

This category includes several useful web components and utilities, including request parameter parsing, multi-part request handling (as used in uploading files) the remote access framework, and a model view controller (MVC) framework for web applications.

Aspect-oriented programming and instrumentation

Aspect-oriented programming (AOP) is a technique to alleviate issues with cross-cutting concerns by encapsulating behaviors between multiple classes into reusable modules. Cross-cutting concerns are parts of a program that rely on or affect many other components in a software system, which cannot be cleanly implemented in object-oriented or procedural programming. An example might be an application-wide logging or caching system that requires code duplication or complicated dependency linkages between components.

Testing

This category includes modules to support the testing of Spring components by providing component-mocking utilities and also consistent loading and caching of Spring ApplicationContexts.

2.3 Hibernate

Hibernate is an Object Relational Mapping (ORM) library for Java applications. By using a lightweight persistence framework, Hibernate handles the mapping of Java objects to tables in a traditional relational database.

To provide this functionality, the Hibernate data query and retrieval facilities abstract away from the selected database SQL calls and result set handling. This allows the developer to focus on the features of an application without having to worry about interacting with a database when the developer must store or find objects.

Hibernate can use Java annotations or XML mapping documents to describe the following mappings:

- Java objects to relational database tables
- One-to-many and many-to-many relationships between objects
- Reflexive one-to-many relationships between an object and other instances of its own type
- Java object types to SQL types (when overriding the default mappings)
- Java Enum types to columns
- Single properties to multiple columns

2.4 Jenkins

Jenkins is an open source continuous integration platform that runs under a Java web servlet container (such as the Liberty profile server).

Continuous integration is the practice of frequently building and testing software projects during development. The aim of this process is to discover defects and regressions early by automating the process of running unit and integration tests. These automated build and test cycles typically happen on a regular schedule (such as every night) or even after each change is delivered.

Jenkins can integrate with a large variety of frameworks and toolkits by using its extensive library of available plug-ins, including the following items:

- Source code management and version control platforms, including CVS, Subversion, Git, Mercurial, Perforce, IBM ClearCase®, and IBM Rational Team Concert™.
- Build automation tools, such as Apache Ant and Maven, and also standard operating system batch and script files
- Testing frameworks, such as JUnit and TestNG
- RSS, email, and instant messenger clients for reporting results in real time
- Artifact uploaders and deployers for several integration platforms

2.5 Opscode Chef

Opscode Chef is an application and server configuration framework that is designed to automate the process of provisioning and deploying resources. Chef provides a way to model infrastructure and processes in code so that they become testable, versioned, and repeatable.

The *chef-client* uses abstract reusable definitions of system configurations that are named *cookbooks* and *recipes*. These configuration files describe how each part of the server infrastructure should be built and managed, whether it is in a physical, internal, or cloud-based server environment. When new hardware is added, the chef-client needs to know only which cookbooks and recipes to apply. For example, a cookbook might define everything that is required to install, configure, and manage the Liberty profile server on a node.

Through integration with frameworks such as Jenkins, Chef also enables a model of *continuous delivery*, where updates can automatically be deployed into production after completing the continuous integration testing and approval process.

In a traditional client/server configuration, the Chef framework consists of three main components:

- A single Chef server
- A chef-client installed on each node (a physical, virtual, or cloud server)
- One or more workstations to be used for administration and development

In addition, Chef can also be run by using a limited *chef-solo* configuration that runs without a server. However, this setup does require that a cookbook and any dependencies are available on the same physical disk as the node.

2.6 Arquillian

Integration-testing a modern Java web application can be difficult and time consuming because of the necessity of re-creating a realistic web container environment. Managing a simulated environment is achieved by using mocking or extensive environment initialization and teardown between tests. Arquillian is a testing framework that aims to simplify this process by automatically handling container management, deployment, and framework initialization. With this design, developers can focus on the testing of business logic with what Arquillian describes as “real tests.”

By handling the environment configuration for the tester, Arquillian allows test cases to be run against several various platforms. This is helpful when various web containers are used between development and production (such as using the Liberty profile server for development of a WebSphere Application Server full profile application).

By using special Java annotations to integrate seamlessly with familiar testing frameworks (such as JUnit and TestNG), Arquillian tests can be run from a developer’s integrated development environment (IDE) or build system without any extra plug-ins by using tools such as Ant and Maven.

2.7 MongoDB

MongoDB is an open source, cross-platform, and document-oriented database system. Based on the concept of a dynamic NoSQL structure, MongoDB differs from a traditional relational database because of its ability to store documents in a format similar to JavaScript Object Notation (JSON). This data format allows for greater flexibility of the types of information that is stored (including regular files that use GridFS) by eschewing the limitations of a strict schema. Example 2-1 shows two samples of documents that have different attribute structures.

Example 2-1 Two example MongoDB documents with differing attribute structures

```
{
   firstName: “John”,
   secondName: “Smith”,
   age: “20”
}

{
   firstName: “Mary”,
   secondName: “Smith”,
   hobby: “painting”,
   favouriteColor: “blue”
}
```

To support efficient query resolution, MongoDB uses an indexing system for each document. Any field can be selected for use as the document index. Secondary indexes are also supported.

MongoDB offers several features to support large workloads and storage requirements. By using a *replica set*, groups of MongoDB daemon processes can maintain the same data set in multiple physical locations. Data can be mirrored by establishing a “master/subordinate” relationship between environments where the subordinate maintains a copy of the master database for reading and backup purposes. This configuration has the advantage that a new master source can be selected if the current master becomes unavailable. In addition, MongoDB also supports sharding, where one large set of data is split into ranges that are distributed across multiple servers.

3 Implementing and testing back-end services on Liberty profile server

In this book, the *Todo* sample application is used to demonstrate the use of multiple open source frameworks or toolkits with Liberty profile server, including Maven, MongoDB, Spring, JPA, Arquillian, Wicket, and others. The Todo sample is a simple application that can be used to create, update, and delete to-do items and to-do lists. It also provides a query function that gets the to-do items in one specific to-do list, or gets all to-do lists. Later, in the `todo-service-api` project, you can find all the available APIs.

This chapter guides you from setting up the development environment through the integration testing by using Arquillian. It mainly focuses on the back-end service implementation and on how to do an integration test with Liberty profile server automatically. For an extended set of sample applications that incorporate graphical user interfaces (GUIs), see Chapter 5, "Front-end development on the Liberty profile server" on page 53.

This chapter covers the following topics:

- Setting up the development environment
- Project outline of the Todo list sample application
- Docker Hub support

3.1 Setting up the development environment

Preparing the development environment for our sample application requires the following steps:

1. Install JDK 7 and update your system `JAVA_HOME` environment variable to reference the installation directory.
2. Download and install Eclipse and the WebSphere Application Server Developer Tools from the following website:

   https://developer.ibm.com/wasdev/docs/developing-applications-wdt-liberty-profile//
3. Download and install Apache Maven for command-line console-based builds from the following website:

   http://maven.apache.org/download.cgi#Installation_Instructions
4. Download and install the `m2eclipse` plug-in into Eclipse from the following website:

   http://www.eclipse.org/m2e/
5. Download and install Subclipse 1.8.x (*not* the 1.10.x) plug-in from the following website:

   http://subclipse.tigris.org/servlets/ProjectProcess?pageID=p4wYuA
6. Get all Todo sample-related source files for this book (see Appendix A, “Additional material” on page 99) and save them in to your local directory.
7. Open Eclipse to set the JDK home by clicking **Window** → **Preferences** → **Java** → **Installed JREs** and then selecting **JDK 7 home**.

8. In Eclipse, click **File** → **Import** → **Maven** → **Existing Maven Projects**, as shown in Figure 3-1. Click **Next**.

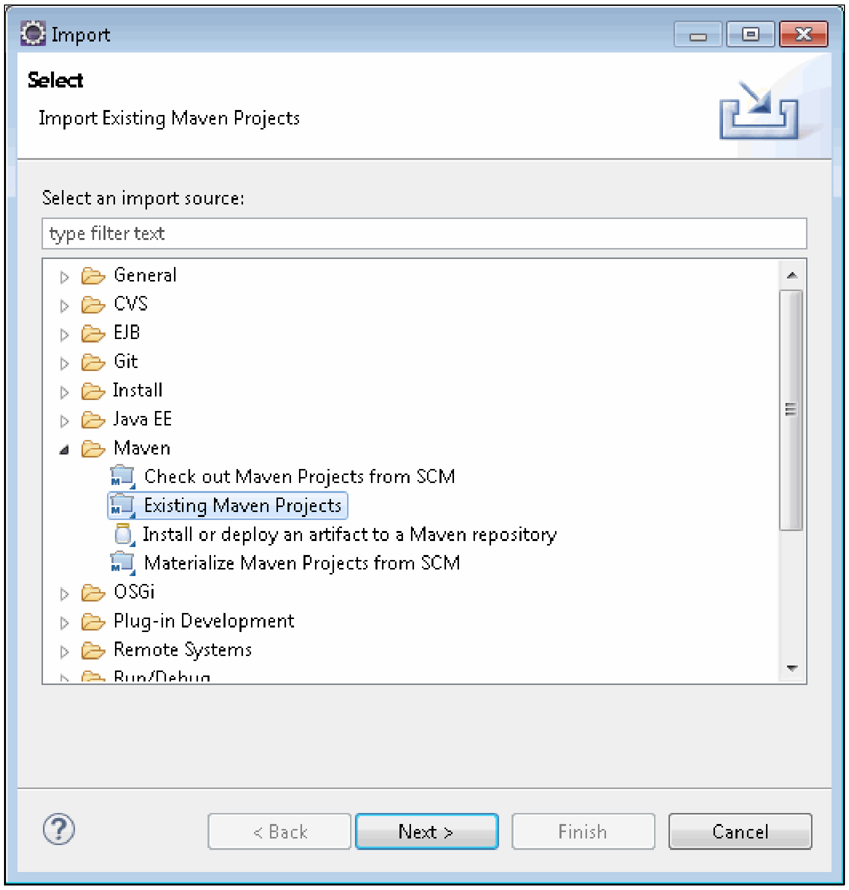
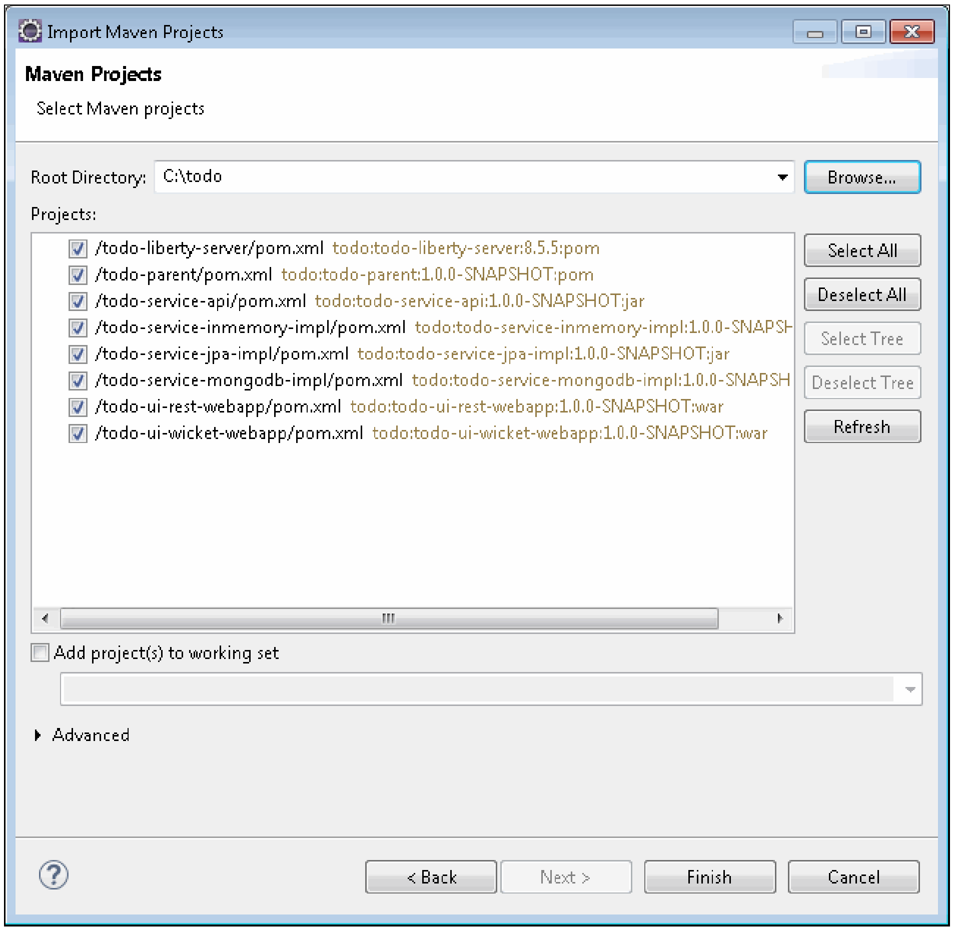


Figure 3-1 Import existing Maven projects

9. Open the directory where you saved the Todo sample. Ensure that all projects are selected and click **Finish**, as shown in Figure 3-2.


Import Maven Projects

Maven Projects

Select Maven projects

Root Directory: C:\todo

Projects:

- [✓] /todo-liberty-server/pom.xml todo:todo-liberty-server:8.5.5:pom
- [✓] /todo-parent/pom.xml todo:todo-parent:1.0.0-SNAPSHOT:pom
- [✓] /todo-service-api/pom.xml todo:todo-service-api:1.0.0-SNAPSHOT:jar
- [✓] /todo-service-inmemory-impl/pom.xml todo:todo-service-inmemory-impl:1.0.0-SNAPSH
- [✓] /todo-service-jpa-impl/pom.xml todo:todo-service-jpa-impl:1.0.0-SNAPSHOT:jar
- [✓] /todo-service-mongodb-impl/pom.xml todo:todo-service-mongodb-impl:1.0.0-SNAPSH
- [✓] /todo-ui-rest-webapp/pom.xml todo:todo-ui-rest-webapp:1.0.0-SNAPSHOT:war
- [✓] /todo-ui-wicket-webapp/pom.xml todo:todo-ui-wicket-webapp:1.0.0-SNAPSHOT:war

[ ] Add project(s) to working set

Figure 3-2 Select all projects to import

Wait a few seconds. Your projects are then listed, without errors, in the Project Explorer (Figure 3-3); `m2eclipse` has already taken care of cross-references between projects and configured the projects.

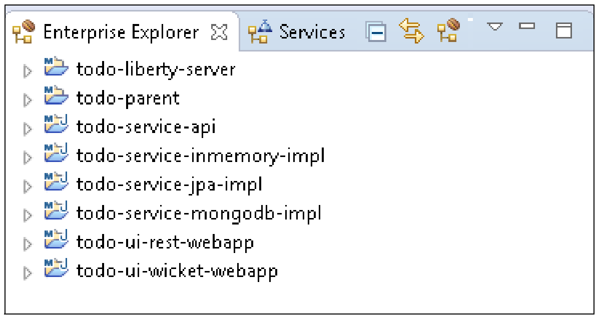


Figure 3-3 Projects that are listed after they are imported into Eclipse

Note: We are presenting a sample application that uses only specific versions of the Liberty profile, WebSphere Application Server Developer Tools, and open source frameworks. If you also plan to use these technologies, make sure that the versions you have are compatible with each other.

3.2 Project outline of the Todo list sample application

Table 3-1 explains the structure of the sample application.

Table 3-1 The Todo sample application project structure

Project name	**Basic description**
`todo-parent`	Holds the shared Maven configuration for all projects
`todo-service-api`	Contains the model and service API
`todo-liberty-server`	Contains the Liberty profile server binary file
`todo-service-inmemory-impl`	Contains an example in-memory implementation of the todo-service
`todo-service-jpa-impl`	Contains an example JPA implementation of the todo-service
`todo-service-mongodb-impl`	Contains an example MongoDB implementation of the todo-service
`todo-ui-rest-webapp`	Contains an example RESTful web service API and Dojo Toolkit based front end
`todo-ui-wicket-webapp`	Contains an example Wicket front-end UI of the todo-service

The relationship between each project is shown in Figure 3-4.

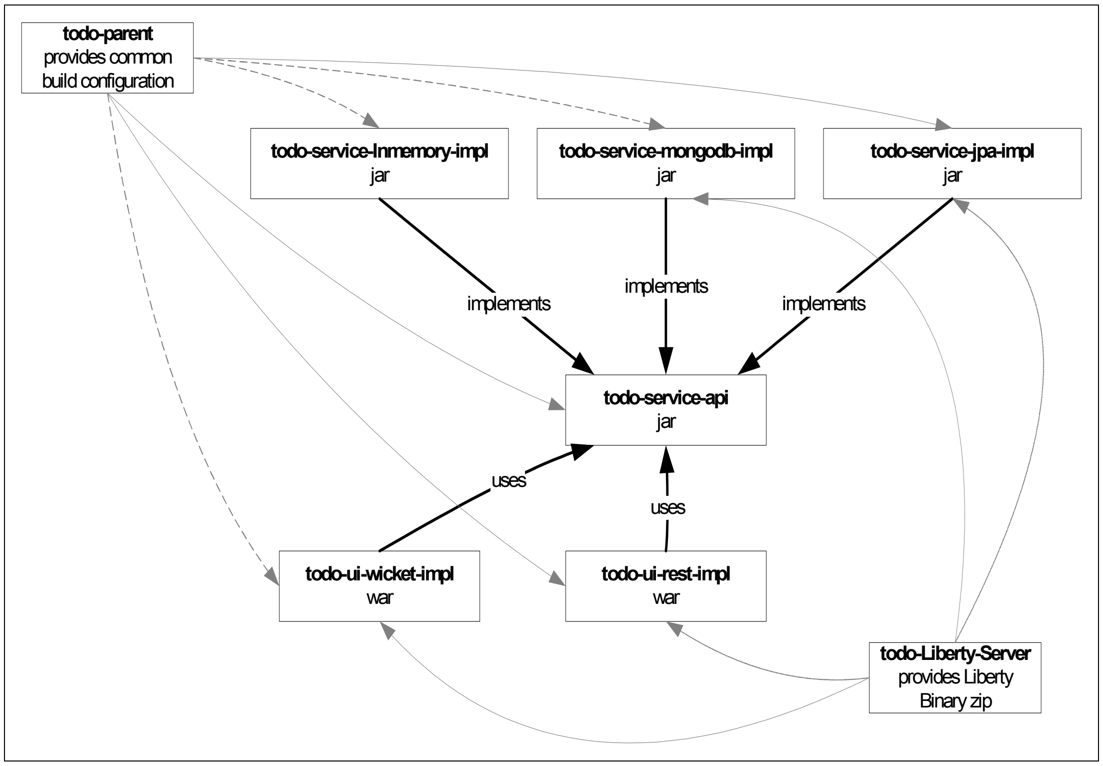


Figure 3-4 The Todo sample projects relationships

3.2.1 The simple todo-parent project

The sample Todo list application configuration begins in the Maven `todo-parent` parent component. Maven supports configuration inheritance, which means a Maven project can define another project as its parent project by using the `<parent>` XML node and inherits its configuration. Dependencies that are declared in a parent project are automatically declared as dependencies in child projects. Using the `<dependencyManagement>` and `<pluginManagement>` sections in a parent project, preconfigurations of artifact versions and plug-in configurations can be made.

This means that in all child projects, you can use the Liberty `assemblyArtifact` in the local Maven repository to create a Liberty profile server, as shown in the `todo-parent` component `pom.xml` sample file (Figure 3-5 on page 19).

```
<pluginManagement>
   <!-- plugin configurations listed here apply to all child modules, which
explicitly list these plugins in there <build><plugins>...</plugins></build>
section -->
   <plugins>
      <plugin>
         <groupId>com.ibm.websphere.wlp.maven.plugins</groupId>
         <artifactId>liberty-maven-plugin</artifactId>
         <version>1.1</version>
         <configuration>
            <assemblyArtifact>
               <!-- instruct the liberty maven plugin to use the liberty server
binary files that are provided by this artifact -->
               <groupId>todo</groupId>
               <artifactId>todo-liberty-server</artifactId>
               <version>8.5.5</version>
               <type>zip</type>
            </assemblyArtifact>
         </configuration>
      </plugin>
   </plugins>
</pluginManagement>
```

Figure 3-5 Liberty Maven plug-in definition in the pom.xml file

This simplifies the configuration process by providing a single location for specifying settings, such as the Java compiler version and any common dependencies. However, these settings become effective only when that same dependency or plug-in is directly declared in the `pom.xml` file of the child project.

Configurations that are defined directly in a `pom.xml` file override similar settings that are defined in parent projects. If child projects are registered as modules in a parent project, then they are built as part of the parent project's build process. Running the mvn package on a parent project also triggers execution of this lifecycle phase in all declared modules. Child projects that are not registered as modules are independent from the parent project's build process and must be built separately.

3.2.2 The todo-service-api project

The `todo-service-api` project sits in the middle of the back-end implementation and front-end UI. All available APIs for users are defined in this project. In this way, switching the back-end implementation and front-end UI, based on our requirements, is easy.

`AbstractTodoListServiceTest.java` is defined to perform functional tests against the TodoListService interface. In the MongoDB and JPA back-end implementation, `AbstractTodoListServiceTest.java` does not need to write its functional tests, but extend the abstract test class and ensure that the specific implementation complies with the test case. To make this happen, the AbstractTodoListServiceTest is packaged into the `test.jar` file (`test.jar` is a dependency) so that it can be available for all the back-end service implementation projects: in-memory, MongoDB, and JPA because *by default* test sources are not packaged.

Figure 3-6 shows a snippet of this part in the todo-service-api project pom.xml file.

```
<build>
   <plugins>
      <plugin>
         <!-- create a JAR file containing the test cases, so the test cases can
be referenced and reused in other projects -->
         <groupId>org.apache.maven.plugins</groupId>
         <artifactId>maven-jar-plugin</artifactId>
         <version>2.2</version>
         <executions>
            <execution>
               <phase>package</phase>
               <goals>
                  <goal>test-jar</goal>
               </goals>
            </execution>
         </executions>
      </plugin>
   </plugins>
</build>
```

Figure 3-6 Test resources exposure in pom.xml

3.2.3 The todo-liberty-server project

The Liberty V8.5.5 binary file is included in this project. This project installs the Liberty profile server `assemblyArtifact` in to your local Maven repository. In other projects, you can use the Liberty Maven plug-in to create the server that is based on this `assemblyArtifact` in a local Maven repository, as described in the `pom.xml` file in the `todo-parent` project.

You can also run the **`mvn -Pregenerate-server-xsd generate-sources`** command to generate the Liberty profile server configurations schema. The generated schema is installed into the local Maven repository. Therefore, in other projects, you can reference this schema file to facilitate your editing of `server.xml` file. The snippet for this part is in the `pom.xml` file of `todo-liberty-server` (see Figure 3-7 on page 21).

```
<profiles>
   <profile>
      <!-- activate this profile to regenerate the server.xsd for the liberty
server -->
      <id>regenerate-server-xsd</id>
      <build>
         <plugins>
            <plugin>
               <groupId>org.codehaus.mojo</groupId>
               <artifactId>exec-maven-plugin</artifactId>
               <version>1.2.1</version>
               <executions>
                  <execution>
                     <phase>generate-sources</phase>
                     <goals>
                        <goal>exec</goal>
                     </goals>
                  </execution>
               </executions>
               <configuration>
                  <!--
http://pic.dhe.ibm.com/infocenter/wasinfo/v8r5/topic/com.ibm.websphere.wlp.core
.doc/ae/rwlp_schema_gen.html -->
                  <executable>java</executable>
                  <arguments>
                     <argument>-jar</argument>

<argument>src/main/resources/wlp/bin/tools/ws-schemagen.jar</argument>
                     <argument>src/main/resources/server.xsd</argument>
                     <argument>--locale=en_US</argument>
                  </arguments>
               </configuration>
            </plugin>
         </plugins>
      </build>
   </profile>
</profiles>
```

Figure 3-7 Liberty profile server configuration schema generation in the pom.xml file

3.2.4 The todo-service-inmemory-impl project

The `todo-service-inmemory-impl` project is a simple, in-memory implementation for TodoListService. Orika is used in this project to copy recursively data from the service object to in-memory entity objects or from in-memory entity objects to the service object.In this project, it is added as a dependency in the `pom.xml` file. Orika is a simple and fast bean mapping framework and is available in the Maven central repository. Details about Orika are available at the following website:

https://code.google.com/p/orika/

Because `todo-service-inmemory-impl` implements the TodoListService in `todo-service-api`, the `todo-service-api` project is added as a dependency for it. `Test-jar` is another dependency and is described in 3.2.2, “The todo-service-api project” on page 19.

Figure 3-8 is the dependency snippet for the `todo-service-inmemory-impl` project in the `pom.xml` file.

```
<dependencies>
   <dependency>
      <groupId>${project.groupId}</groupId>
      <artifactId>todo-service-api</artifactId>
      <version>${project.version}</version>
   </dependency>
   <dependency>
      <!--high performance object mapping framework.
         http://code.google.com/p/orika/
         used to convert service objects to entity objects and vice versa -->
      <groupId>ma.glasnost.orika</groupId>
      <artifactId>orika-core</artifactId>
      <version>1.4.3</version>
   </dependency>
   <!-- TEST DEPENDENCIES -->
   <dependency>
      <groupId>${project.groupId}</groupId>
      <artifactId>todo-service-api</artifactId>
      <version>${project.version}</version>
      <type>test-jar</type>
      <scope>test</scope>
   </dependency>
</dependencies>
```

Figure 3-8 Dependency definition in pom.xml

One test, `InMemoryTodoListServiceTest`, is defined. The test extends the class AbstractTodoListServiceTest, which is part of the `todo-service-api` project and performs functional tests against the TodoListService interface. The InMemoryTodoListServiceTest essentially passes only the in-memory implementation of the service to the abstract class. All test logic is defined in AbstractTodoListServiceTest.

You can run this test by right-clicking **InMemoryTodoListServiceTest** and clicking **Run As** → **JUnit Test**. It should finish without errors.

3.2.5 The todo-service-mongodb-impl project

The *todo-service-mongodb-impl* project demonstrates how to use the Liberty built-in mongodb-2.0 feature with CDI to implement the `todo-service`. It also demonstrates how to use Arquillian and embedded MongoDB to do an integration test against the Liberty profile server automatically.

Introduction to the todo-service-mongodb-impl project

The `todo-service-mongodb-impl` project is used by MongoDB to store TodoList and TodoListItem. The Liberty profile server provides configuration support for MongoDB through the mongodb-2.0 feature. This feature enables the use of the MongoDB Java Driver and allows DB instances to be configured in the server configuration, injected into managed components such as EJBs and CDIs, and accessed through JNDI. Applications interact with these DB instances through the MongoDB APIs.

To use the mongodb-2.0 feature that is provided by the Liberty profile server, `mongodb-java-driver` should not be packaged into the application. In this case, set the scope of the MongoDB dependency to `provided` in the `pom.xml` file (Figure 3-9).

```
<dependency>
   <groupId>org.mongodb</groupId>
   <artifactId>mongo-java-driver</artifactId>
   <version>2.11.3</version>
   <scope>provided</scope>
</dependency>
```

Figure 3-9 Scope definition for mongodb-java-driver

The MongoDB implementation (MongoDBTodoListService) is annotated with `@javax.inject.Singleton`, which flags it as a CDI singleton bean. CDI is used here to inject MongoDB instances through JNDI into the Liberty profile server (Figure 3-10).

```
@javax.inject.Singleton
public class MongoDBTodoListService implements TodoListService
{
   public static final String MONGO_DB_JNDI_NAME = "mongo/TODOLIST";

   @Resource(name = MONGO_DB_JNDI_NAME)
   private DB db;
...
```

Figure 3-10 MongoDB injection

An application that uses CDI must have a `beans.xml` file. The file can be empty (it has content only in certain limited situations), but it must be present. For a web application, the `beans.xml` file must be in the `WEB-INF` directory. For EJB modules or JAR files, the `beans.xml` file must be in the `META-INF` directory. In this case, an empty `beans.xml` file is created and put in `src/main/resources/META-INF` and is packaged into the final JAR file. The contents are listed in Figure 3-11.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://java.sun.com/xml/ns/javaee"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:schemaLocation="http://java.sun.com/xml/ns/javaee
http://java.sun.com/xml/ns/javaee/beans_1_0.xsd">

   <!-- marker file to enable CDI processing by the JEE runtime container -->
</beans>
```

Figure 3-11 Contents of the beans.xml file

Using Arquillian to test the MongoDB service implementation against the Liberty profile server

Integration testing of the MongoDB implementation is configured in a self-contained manner. This means that the integration test does not rely on the existence of any external resources, such as a running a preconfigured database or application server. Instead, during the running of the integration tests, a Liberty profile test server is created. An embedded Mongo database is also instantiated within the Liberty profile server and exposed through JNDI data sources.

Toolkit usage

To do integration testing against the Liberty profile server for the MongoDB implementation four our example, we used the following toolkits:

- Arquillian

  With this innovative and highly extensible testing platform for the JVM, developers can easily create automated integration, and functional and acceptance tests for Java middleware. For more information, see the following website:

  `http://arquillian.org/`

- Arquillian WLP Extension

  This Arquillian container adapter (DeployableContainer implementation) can start and stop a local WebSphere Application Server Liberty profile process and run tests on it over a remote protocol (effectively in a different JVM). For more information, see the following website:

  `https://docs.jboss.org/author/display/ARQ/WLP+V8.5+-+Managed`

- Embedded MongoDB

  This toolkit provides a platform-neutral way for running MongoDB in unit tests, and can install and configure MongoDB automatically so that you do not need to install and configure MongoDB before testing. For more information, see the following website:

  `https://github.com/flapdoodle-oss/de.flapdoodle.embed.mongo`

Liberty profile server configuration

Because CDI, JNDI, and MongoDB are used in this back-end sample implementation, these features are enabled in the Liberty profile server. In addition, because Arquillian is used for integration testing, it requires JMX support to control the Liberty profile server container and servlet support to start the test case. These two features must be enabled. So, in the feature snippet (Figure 3-12), the entries are added.

```
<featureManager>
   <feature>localConnector-1.0</feature>
   <feature>servlet-3.0</feature>
   <feature>cdi-1.0</feature>
   <feature>mongodb-2.0</feature>
   <feature>jndi-1.0</feature>
</featureManager>
```

Figure 3-12 Feature list in the server.xml file

The `dropins` deployment feature is enabled and `mbean` is used as an updateTrigger (Figure 3-13 on page 25). This is required by the Arquillian WLP extension.

```
<applicationMonitor dropinsEnabled="true" updateTrigger="mbean" />
```

Figure 3-13 dropinsEnabled in the server.xml file

Note: The `dropins` deployment feature is enabled by default in the Liberty profile server, so you can also remove the `dropinsEnabled="true"` statement part.

A `mongoDB` entry is configured for the JNDI name `mongo/TODOLIST`, which assumes that the `mongoDB` instance is available at `localhost:9991`. The entry references the global shared library that contains the MongoDB Java driver. See Figure 3-14.

Note: We cannot use a separate shared library in our example because Arquillian installs the test WAR file by using the `dropins` feature. Installation that uses the `dropins` feature does not support the attachment of specific shared libraries to WAR files that are deployed that way. Therefore, we put the MongoDB Java driver in the global shared library, and its classes are automatically made available to all WAR files.

```
<mongoDB jndiName="mongo/TODOLIST" databaseName="todolistTest">
   <mongo id="mongoTestDb" libraryRef="global">
   <hostNames>localhost</hostNames>
   <ports>9991</ports>
   </mongo>
</mongoDB>
```

Figure 3-14 The MongoDB configuration in the server.xml file

Arquillian WLP container configuration for integration testing

According to the requirements of Arquillian, put the `arquillian.xml` file into `src/test/resources`. This file defines the Arquillian WLP container configuration (Figure 3-15), including the target webcontainer port, Liberty binary location, and Liberty profile server profile name.

```
<engine>
   <property name="deploymentExportPath">target/</property>
</engine>
<container qualifier="wlp-managed-85" default="true">
   <configuration>
      <property name="wlpHome">target/liberty/wlp</property>
      <property name="serverName">defaultServer</property>
      <property name="httpPort">9080</property>
      <property name="appDeployTimeout">20</property>
      <property name="appUndeployTimeout">20</property>
   </configuration>
</container>
```

Figure 3-15 Arquillian WLP container configuration

Maven build lifecycle for integration testing in mongodb-impl project

To do integration testing, you can run the **`mvn verify`** command under the `todo-service-mongodb-impl` project. Figure 3-16 shows what occurs when you run the command.

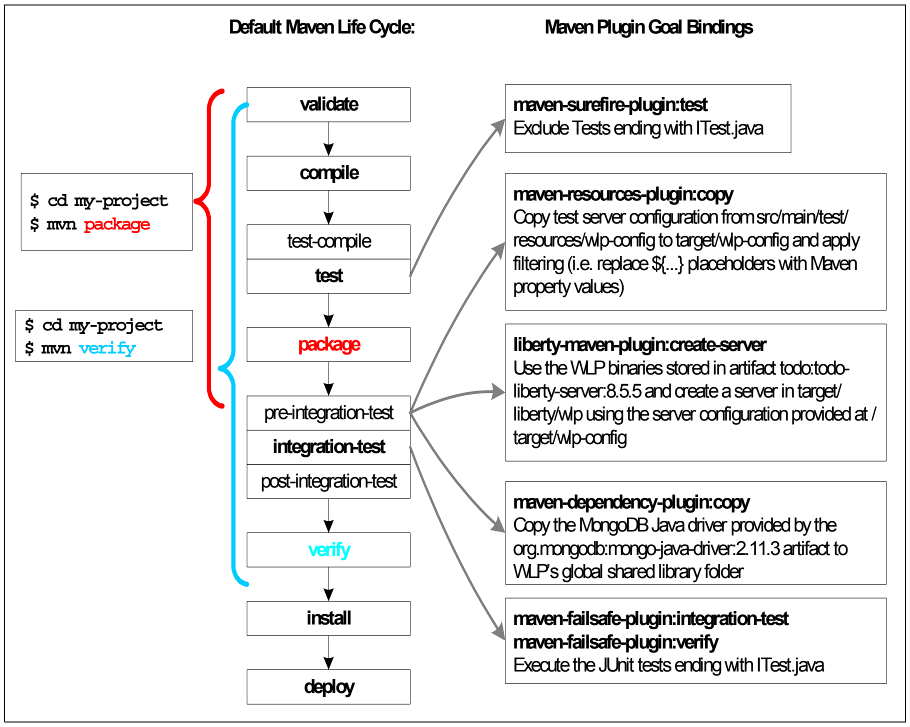

Default Maven Life Cycle:
Maven Plugin Goal Bindings
$ cd my-project
$ mvn package
$ cd my-project
$ mvn verify
validate
compile
test-compile
test
package
pre-integration-test
integration-test
post-integration-test
verify
install
deploy
maven-surefire-plugin:test
Exclude Tests ending with ITest.java
maven-resources-plugin:copy
Copy test server configuration from src/main/test/resources/wlp-config to target/wlp-config and apply filtering (i.e. replace ${...} placeholders with Maven property values)
liberty-maven-plugin:create-server
Use the WLP binaries stored in artifact todo:todo-liberty-server:8.5.5 and create a server in target/liberty/wlp using the server configuration provided at /target/wlp-config
maven-dependency-plugin:copy
Copy the MongoDB Java driver provided by the org.mongodb:mongo-java-driver:2.11.3 artifact to WLP's global shared library folder
maven-failsafe-plugin:integration-test
maven-failsafe-plugin:verify
Execute the JUnit tests ending with ITest.java

Figure 3-16 Maven lifecycle for integration testing in todo-service-mongodb-impl

The integration testing uses various plug-ins that are bound to several Maven build phases to fulfill the MongoDB implementation testing against Liberty and are noted in the following list:

- Test: `maven-surefire-plugin`

  By default, Maven uses `maven-surefire-plugin` during the test phase to run testing. It automatically includes all test classes under `src/test/java` with the following wildcard patterns:

  – Includes all of its subdirectories and all Java file names that start with `Test`:

    `"**/Test*.java"`

  – Includes all of its subdirectories and all Java file names that end with `Test`:

    `"**/*Test.java"`

  – Includes all of its subdirectories and all Java file names that end with `TestCase`:

    `"**/*TestCase.java"`

  In the `mongodb` project, because the MongoDB and Liberty profile server environment is not ready, running tests in this phase successfully is not possible. Therefore, testing is excluded by the snippet in the `pom.xml` file (Figure 3-17 on page 27).

```
<plugin>
   <!-- exclude integration tests from surefire plugin -->
   <artifactId>maven-surefire-plugin</artifactId>
   <version>2.16</version>
   <configuration>
      <excludes>
         <exclude>**/*ITest.java</exclude>
      </excludes>
   </configuration>
</plugin>
```

Figure 3-17 Exclude testing in test phase in pom.xml

- Pre-integration-test: `maven-resources-plugin`

  The `maven-resources-plugin` copies the server configuration template from the `src/test/resources/wlp-config/server.xml` file to the `target/wlp-config/server.xml` file. At the same time, it filters the file, it resolves and replaces property placeholders with property values that are provided by the Maven run time. For more information about the server configuration in the `server.xml` file, see "Liberty profile server configuration" on page 24.

- Pre-integration-test: `liberty-maven-plugin`

  The `liberty-maven-plugin` installs the Liberty profile server binary files from the `todo-liberty-server` artifact to `target/liberty/wlp`. Arquillian expects this location based on how it is defined in `arquillian.xml` in the `src/test/resources`. For more information, see "Arquillian WLP container configuration for integration testing" on page 25. After achieving its goals, the plug-in then creates the `defaultServer` by using the `target/wlp-config/server.xml` configuration file. The `target/wlp-config/server.xml` file is copied in this location through the `maven-resources-plugin`.

- Pre-integration-test: `maven-dependency-plugin`

  The `maven-dependency-plugin` is used to copy the `mongo-java-driver` artifact to `wlp/usr/shared/config/lib/global/`, which is the global shared folder.

  After the pre-integration test phase, a Liberty profile server (`defaultServer`) is created in `target/liberty/wlp/usr/servers/defaultServer`. The server is preconfigured in the `server.xml` file with all the necessary features and settings. A Liberty profile server now is ready for integration testing.

Figure 3-18 shows the snippet for the three plug-ins in the pre-integration-test phase.

```
<plugins>
   <plugin>
      <artifactId>maven-resources-plugin</artifactId>
      <version>2.6</version>
      <executions>
         <execution>
            <phase>pre-integration-test</phase>
            <goals>
               <goal>copy-resources</goal>
            </goals>
...
         </execution>
      </executions>
   </plugin>
...
   <plugin>
      <!-- before the integration test runs create a pre-configured liberty
server -->
      <groupId>com.ibm.websphere.wlp.maven.plugins</groupId>
      <artifactId>liberty-maven-plugin</artifactId>
      <executions>
         <execution>
            <phase>pre-integration-test</phase>
            <goals>
               <goal>create-server</goal>
            </goals>
         </execution>
      </executions>
...
   </plugin>
...
   <plugin>
      <groupId>org.apache.maven.plugins</groupId>
      <artifactId>maven-dependency-plugin</artifactId>
      <version>2.8</version>
      <executions>
         <execution>
            <phase>pre-integration-test</phase>
            <goals>
               <goal>copy</goal>
            </goals>
...
         </execution>
      </executions>
</plugin>
```

Figure 3-18 The plug-ins in the pre-integration-test phase in the pom.xml file

- integration-test: `maven-failsafe-plugin`

  The `maven-failsafe-plugin` is used to run a JUnit test on the `MongoDBTodoListServiceITest` test case.

  `MongoDBTodoListServiceITest` has several JUnit and Arquillian annotations, as noted in the following list:

  – `@RunWith(Arquillian.class)`: This JUnit annotation is used to tell JUnit to run the test case through Arquillian.

  – `@Deployment`: This is an Arquillian annotation and is used to give information about how to build the test WAR file. The test WAR file contains all the compile and test dependencies of the `mongodb-impl maven` project that is achieved through the **`Maven.resolver()`** method. It also contains the `MongoDBTodoListService.class`, `MongoDBTodoListServiceITest.class`, an empty `beans.xml` file to trigger CDI injection, and a `web.xml` file with a `resource-env-ref` definition so that JDNI lookup can work. Figure 3-19 is the snippet for the `web.xml` file in the generated test WAR file.

```
<resource-env-ref>
   <resource-env-ref-name>mongo/TODOLIST</resource-env-ref-name>
   <resource-env-ref-type>com.mongodb.DB</resource-env-ref-type>
</resource-env-ref>
```

Figure 3-19 The resource-env-ref definition in the web.xml file

The process that is associated with running `MongoDBTodoListServiceTest` is described in the following list:

1. Arquillian locates and starts the Liberty profile server based on the information that is provided in the `src/test/resources/arquillian.xml` file.
2. Arquillian deploys the test WAR file through the `dropins` feature and `mbean` trigger.
3. Arquillian triggers JUnit test execution of the `MongoDBTodoListService` from within the running WAR file.
4. Liberty injects the `MongoDBTodoListService` CDI bean implementation into the `todoListService` field of the test class that is annotated with `@Inject`. During instantiation of the `MongoDBTodoListService` instance, Liberty injects a MongoDB JNDI resource reference in the `@Resource` annotated DB field. Because Liberty is all about loading and initialization, it does not note now that no MongoDB instance is running.
5. JUnit runs the **`setupMongoDB()`** method, which is annotated with the `@Before` JUnit annotation. This method downloads, installs, and starts an ad hoc MongoDB instance on `localhost:9991` in a separate process. After this step, the test environment is ready: The test WAR file is running on Liberty Server-defaultServer on port `9080`, and the MongoDB instance is running on `localhost:9991`.
6. JUnit runs the **`testMongoFBTodoListService()`** method, which is annotated with the `@Test` JUnit annotation. It calls the inherited **`testImplementation()`** method and provides a reference to the CDI injected `MongoDBTodoListService` instance. Now, Liberty establishes a connection to the MongoDB instance that is configured in the `server.xml` file, which is running now.
7. After the test case is run, JUnit runs the **`tearDownEmbeddedMongoDB()`** method, which is annotated with the `@After` JUnit annotation to stop the MongoDB instance.
8. Arquillian undeploys the test WAR file, stops the Liberty profile server, and reports back to the `maven-fail-safe` plug-in.

3.2.6 The todo-service-jpa-impl project

The `todo-service-jpa-impl` project demonstrates how to use the Liberty profile server and JPA2 to implement the `todo-service`. It also demonstrates how to use Arquillian and the H2 embedded database to do automatically integration testing against the Liberty profile server.

Introduction to the todo-service-jpa-impl project

The following runtime components are used for the JPA implementation:

- Hibernate-entitymanager as a JPA2 implementation.
- Spring application framework for dependency injection, service discovery, and transaction management.
- Spring Data as a high productivity framework for implementing JPA repositories without boilerplate. For more information, see the following website:

  `http://www.infoq.com/articles/spring-data-intro`
- Orika as mapping framework between JPA entities and service DTOs.

The `JPATodoListService` is implemented as a Spring-managed service (annotated with `@org.springframework.stereotype.Service`). It uses two Spring Data repository beans that provide typical create, retrieve, update, and delete operations on the two entity types (`TodoListEntity` and `TodoListItemEntity`). The repository beans are injected by the Spring framework.

The implementation is packaged as a JAR file. Applications that use this implementation must perform the typical Spring configuration for JPA-based applications.

JPA Service implementation follows a similar lifecycle, as shown in Figure 3-20 on page 31, compared to the other projects that are described in this chapter.

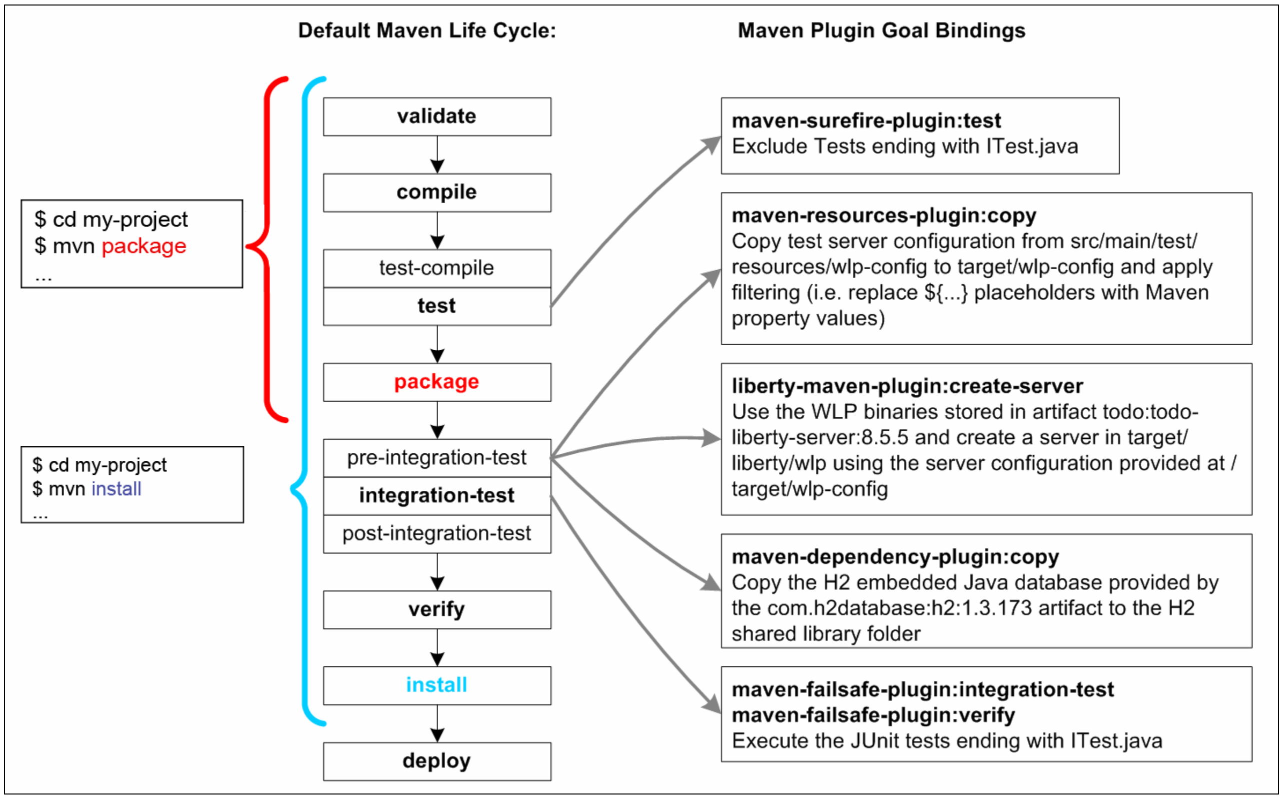

Default Maven Life Cycle:
Maven Plugin Goal Bindings
$ cd my-project
$ mvn package
...
$ cd my-project
$ mvn install
...
validate
compile
test-compile
test
package
pre-integration-test
integration-test
post-integration-test
verify
install
deploy
maven-surefire-plugin:test
Exclude Tests ending with ITest.java
maven-resources-plugin:copy
Copy test server configuration from src/main/test/resources/wlp-config to target/wlp-config and apply filtering (i.e. replace ${...} placeholders with Maven property values)
liberty-maven-plugin:create-server
Use the WLP binaries stored in artifact todo:todo-liberty-server:8.5.5 and create a server in target/liberty/wlp using the server configuration provided at / target/wlp-config
maven-dependency-plugin:copy
Copy the H2 embedded Java database provided by the com.h2database:h2:1.3.173 artifact to the H2 shared library folder
maven-failsafe-plugin:integration-test
maven-failsafe-plugin:verify
Execute the JUnit tests ending with ITest.java

Figure 3-20 Maven lifecycle for integration testing in todo-service-jpa-impl

Using Arquillian to test the JPA Service implementation against Liberty profile server

Similar to the MongoDB implementation, the integration test of the JPA implementation is configured in a self-contained manner, which means that the integration test does not rely on the existence of any external resources, such as a running and preconfigured database or application server. Instead, during the running of the integration tests, a Liberty test server is created, and an in-memory relational database is instantiated within the Liberty profile server and exposed through JNDI data sources.

Integration testing

For our integration testing, we used the following components:

- Arquillian JUnit container
- Arquillian WLP extension, found at the following website:

  `https://docs.jboss.org/author/display/ARQ/WLP+V8.5+-+Managed`
- H2 embedded database, found at the following website:

  `http://www.h2database.com/`

The `src/test/resources/wlp-config/server.xml` test-integration server configuration file is shown in Figure 3-21.

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="Integration Test Server"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="../../../../../todo-liberty-server/src/main/reso
urces/server.xsd">

   <featureManager>
      <!-- JMX and Servlet support - required by Arquillian -->
      <!-- https://docs.jboss.org/author/display/ARQ/WLP+V8.5+-+Managed -->
      <feature>localConnector-1.0</feature>
      <feature>servlet-3.0</feature>

      <!-- JDBC support -->
      <feature>jdbc-4.0</feature>

      <!-- JNDI Support, i.e. @Resource -->
      <feature>jndi-1.0</feature>
   </featureManager>

   <httpEndpoint id="defaultHttpEndpoint" host="localhost" httpPort="9080" />

   <library id="H2Lib">
      <fileset dir="${shared.config.dir}/lib/h2" includes="*.jar" />
   </library>

   <jdbcDriver id="H2Driver" libraryRef="H2Lib"
javax.sql.DataSource="org.h2.jdbcx.JdbcDataSource" />

   <dataSource jndiName="jdbc/TODOLIST" jdbcDriverRef="H2Driver"
type="javax.sql.DataSource">
      <connectionManager maxPoolSize="5" minPoolSize="1"
numConnectionsPerThreadLocal="1" />
      <!-- configure in-memory H2 database instance -->
      <properties URL="jdbc:h2:mem:testdb;DB_CLOSE_DELAY=-1"></properties>
   </dataSource>

   <!-- dropins support and mbean trigger required by Arquillian -->
   <applicationMonitor dropinsEnabled="true" updateTrigger="mbean" />
</server>
```

Figure 3-21 The server.xml file of the todo-service-jpa-impl project

Observe the following information in the `server.xml` file:

- Enabled features:
  - `localConnector-1.0`: This is JMX support, which is required by Arquillian to control the Liberty profile server.
  - `servlet-3.0`: This is servlet support, which is required by Arquillian to start the test case.

  - jdbc-4.0: This is JDBC support.
  - jndi-1.0: This is JNDI support so that injection of JNDI-based resources (@Resource) can work.

- Webcontainer is bound to localhost:9080.
- The dropins deployment feature is enabled and mbean is used as updateTrigger. This is required by the Arquillian WLP extension.
- A shared library containing the binary files of the H2 database is configured.
- A JDBC driver providing access to the H2 JDBC driver is configured.
- An H2 data source is configured by using the special JDBC URL prefix *jdbc:h2:mem*. The H2 JDBC driver is instructed not to connect to an external H2 instance but to start an in-memory H2 instance.

The src/test/resources/arquillian.xml file is the Arquillian WLP container configuration. See Figure 3-22.

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

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

   <container qualifier="wlp-managed-85" default="true">
      <configuration>
         <property name="wlpHome">target/liberty/wlp</property>
         <property name="serverName">defaultServer</property>
         <property name="httpPort">9080</property>
         <property name="appDeployTimeout">20</property>
         <property name="appUndeployTimeout">20</property>
      </configuration>
   </container>
</arquillian>
```

Figure 3-22 The src/test/resources/arquillian.xml file of the todo-service-jpa-impl project

For the integration test to work, a valid and complete Spring configuration is required.

The following list notes important considerations, information, and steps that are associated with the src/test/resources/arquillian-spring-config.xml Spring configuration:

1. Enable annotation-based processing so that Spring creates managed instances of the implementation and the required JPA repositories. See Figure 3-23.

```
<ctx:annotation-config />
<ctx:component-scan base-package="todo.service" />
<tx:annotation-driven transaction-manager="transactionManager" />
<jpa:repositories base-package="todo.service.jpa.repository" />
```

Figure 3-23 The rc/test/resources/arquillian-spring-config.xml file

2. Look up the target (H2) data source that is exposed through the `server.xml` file. See Figure 3-24.

```
<jee:jndi-lookup id="todolistDS" jndi-name="jdbc/TODOLIST" />
```

Figure 3-24 Target (H2) data source in the src/test/resources/arquillian-spring-config.xml file

3. Configure the `entityManagerFactory` bean that references the data source, scans the `todo.service.jpa.model` package for entity classes, and uses Hibernate with the H2 dialect as a JPA implementation. See Figure 3-25.

```
<bean id="entityManagerFactory"
class="org.springframework.orm.jpa.LocalContainerEntityManagerFactoryBean">
      <property name="dataSource" ref="todolistDS" />
      <property name="packagesToScan" value="todo.service.jpa.model" />
      <property name="jpaVendorAdapter">
         <bean
class="org.springframework.orm.jpa.vendor.HibernateJpaVendorAdapter">
            <property name="generateDdl" value="true" />
            <property name="database" value="H2" />
            <property name="showSql" value="true" />
         </bean>
      </property>
</bean>
```

Figure 3-25 The entityManagerFactory bean in the src/test/resources/arquillian-spring-config.xml file

Note: JPA is configured without the `persistence.xml` file. The key is the *`packagesToScan`* attribute. By specifying this attribute, Spring `EntityManagerFactoryBean` has all the required metadata to bootstrap the JPA implementation.

4. Configure a Transaction Manager. See Figure 3-26.

```
<bean id="transactionManager"
class="org.springframework.orm.jpa.JpaTransactionManager">
   <property name="entityManagerFactory" ref="entityManagerFactory" />
</bean>
```

Figure 3-26 Transaction Manager

Based on the configuration in the `pom.xml` file, the following actions are completed when you run the integration tests with the **`mvn verify`** command:

1. The `maven-resources-plugin` copies the server configuration template from `src/test/resources/wlp-config/server.xml` to `target/wlp-config/server.xml`.

   At the time of copying the file, the plug-in also filters the file and resolves or replaces property placeholders with property values that are provided by the Maven run time.

2. The `liberty-maven-plugin` installs the Liberty profile server binary files from the `todo-liberty-server` artifact to `target/liberty/wlp` (the location where Arquillian expects it) and creates a `defaultServer` based on the `target/wlp-config/server.xml` configuration file.
3. The `maven-dependency-plugin` copies the H2 database artifact to the shared library location that is configured in the `server.xml` file.
4. The `maven-failsafe-plugin` runs JUnit on the `HibernateJPATodoListServiceITest` test case.

   Note: Running of tests matching `*ITest.java` is excluded for the `surefire-plugin` that would run the test case in the wrong phase (test), which is before the Liberty profile server is created.

   a. The test case is annotated with `@RunWith(Arquillian.class)` and therefore JUnit runs the test case through Arquillian.
   b. Arquillian locates the static method in the test case that is annotated with `@Deployment` and uses the information to build a test WAR file. The test WAR file contains these items:
      - All compile and test dependencies of the Maven project that is achieved through the **`Maven.resolver()`** function.
      - All JPA implementation classes from the `todo.service.jpa` package and its subpackages.
      - A `web.xml` file with a `resource-env-ref` definition for JDNI lookup.
      - If `USE_XML_BASED_SPRING_CONFIG` is set to `TRUE` in the test case, then the XML-based Spring configuration file is also included.
      - Implicitly, the test WAR file also contains the `MongoDBTodoListServiceITest.class` file.
   c. Arquillian locates and starts the Liberty profile server based on the information that is provided in the `src/test/resources/arquillian.xml` file.
   d. When the Liberty profile server starts, it configures the H2 data source, which implicitly results in the start of the in-memory H2 database.
   e. Arquillian deploys the test WAR file through the `dropins` feature and `mbean` trigger.
   f. Arquillian triggers JUnit test running of the `HibernateJPATodoListServiceITest` from within the running WAR file.
   g. JUnit runs the `@Before` annotated **`setupSpring()`** method, which bootstraps the Spring framework, depending on the value of `USE_XML_BASED_SPRING_CONFIG`. Spring is configured by using either the XML-based or Java based configuration.
   h. JUnit runs the **`@Test testJPATodoListService()`** method, which calls the inherited test implementation and provides a reference to the Spring-managed `JPATodoListService` instance.
   i. Arquillian undeploys the test WAR file, stops the Liberty profile server, and reports back to the `maven-fail-safe-plugin`.

Integration tests can also be triggered from within Eclipse by clicking **Run As** → **JUnit Test**. However, the Liberty profile server must be created in the `target/liberty/wlp` directory before running the JUnit tests.

Run the **`mvn pre-integration-test`** command, which starts all the plug-in goals that are bound to the pre-integration-test phase, eventually creating the preconfigured Liberty profile server.

Note: If you must follow the above steps, ensure that the Liberty profile version and all the features that are used by you are correct. As some of the features that are used by your Liberty profile version installation might be different from our installation, it is possible that some of these steps might be superseded. Verify the feature list availability by going to the following website:

http://www-01.ibm.com/support/knowledgecenter/SSAW57_8.5.5/com.ibm.websphere.wlp.nd.multiplatform.doc/ae/rwlp_superfeat.html

3.3 Docker Hub support

To test rapidly your applications, as an alternative, you can also use a Docker Hub container with a Liberty profile server image. Docker is an open platform for developers and system administrators to build, ship, and run distributed applications. It provides an IBM WebSphere Application Server for Developers V8.5.5 Liberty profile image along with IBM Java Runtime Environment V7.1 SR1. More information about Docker Hub and Liberty can be found at the following website:

https://registry.hub.docker.com/_/websphere-liberty/

We demonstrate how to test a simple Snoop sample application by deploying it in a Liberty profile server inside a local Docker image. To perform this procedure, complete the following steps:

1. Install Docker by using the instructions that are found at the following website:

   https://docs.docker.com/installation/#installation

2. Start Docker with a specific command for your operating system. In our example, we used the **`sudo service docker start`** command.

3. Prepare your application to run inside Docker by placing the WAR file in to a folder that will be mounted to the `dropins` location of the Liberty profile server. Also, prepare a `server.xml` Liberty profile configuration file that will be used by the Docker Liberty image on top of its default configuration to expose the server HTTP port. This is important because you must access the application by using the Docker Liberty profile server IP and not the default localhost name. The `server.xml` contents are listed in Example 3-1.

   Example 3-1 The server.xml file that is used for the Docker Liberty profile server configuration

```
[catalin@oc4752812068 ~]$ ls /docker/dropins/
snoop.war
[catalin@oc4752812068 ~]$ ls /docker/
dropins  server.xml
[catalin@oc4752812068 ~]$ cat /docker/server.xml
<server description="default servlet engine">
    <!-- Enable features -->
    <featureManager>
        <feature>servlet-3.0</feature>
    </featureManager>
    <httpEndpoint host="*" httpPort="9080" httpsPort="-1"/>
```

```
</server>
[catalin@oc4752812068 ~]$
```

4. Run the application against the Docker Liberty profile server by using a command that mounts the application WAR file to the monitored `dropins` folder (see Example 3-2).

Example 3-2 Deploy the application to a Docker Liberty profile image

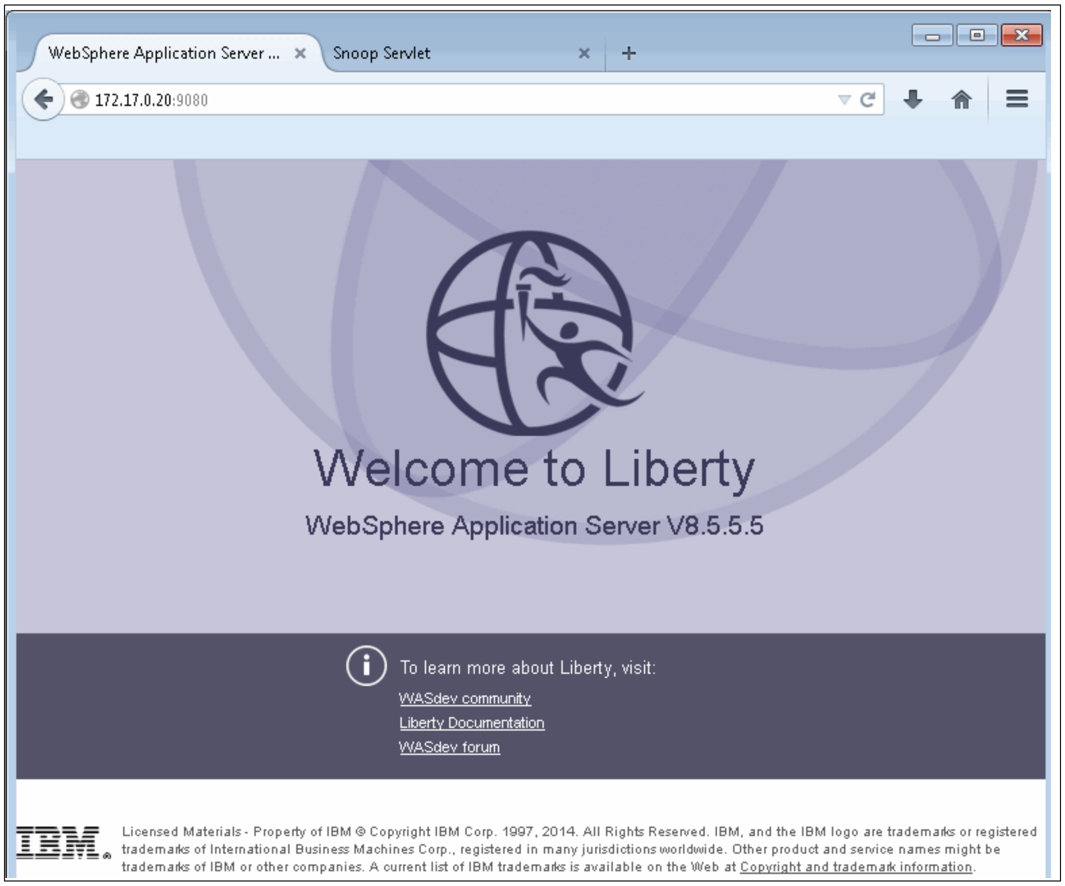
```
catalin@oc4752812068 ~]$ sudo docker run -e LICENSE=accept -d -p 80:9080 -v
/docker/dropins/snoop.war:/opt/ibm/wlp/usr/servers/defaultServer/dropins/snoop.
war websphere-liberty
228280c58cc4521301c89f2784f1323bb236bd4fec87ebc05ecdfe75b40efcdc
[catalin@oc4752812068 ~]$
```

5. Find the IP that is used by the Docker Liberty profile server, as shown in Example 3-3.

Example 3-3 Find the Docker Liberty profile server IP

```
[catalin@oc4752812068 ~]$ sudo docker ps -a
CONTAINER ID        IMAGE                      COMMAND              CREATED
STATUS                            PORTS                            NAMES
228280c58cc4        websphere-liberty:8.5.5   "liberty-run /opt/ib   6 seconds
ago       Up 3 seconds                  9443/tcp, 0.0.0.0:80->9080/tcp
ecstatic_payne
...                                                      insane_hoover
[catalin@oc4752812068 ~]$ sudo docker inspect 228280c58cc4 | grep IPAddress |
cut -d '"' -f 4
172.17.0.20
[catalin@oc4752812068 ~]$
```

6. Using the IP of the Docker Liberty profile server and the port that is configured in the `server.xml` file, you can access the Liberty profile, as shown in Figure 3-27.



Welcome to Liberty

WebSphere Application Server V8.5.5.5

To learn more about Liberty, visit:

WASdev community

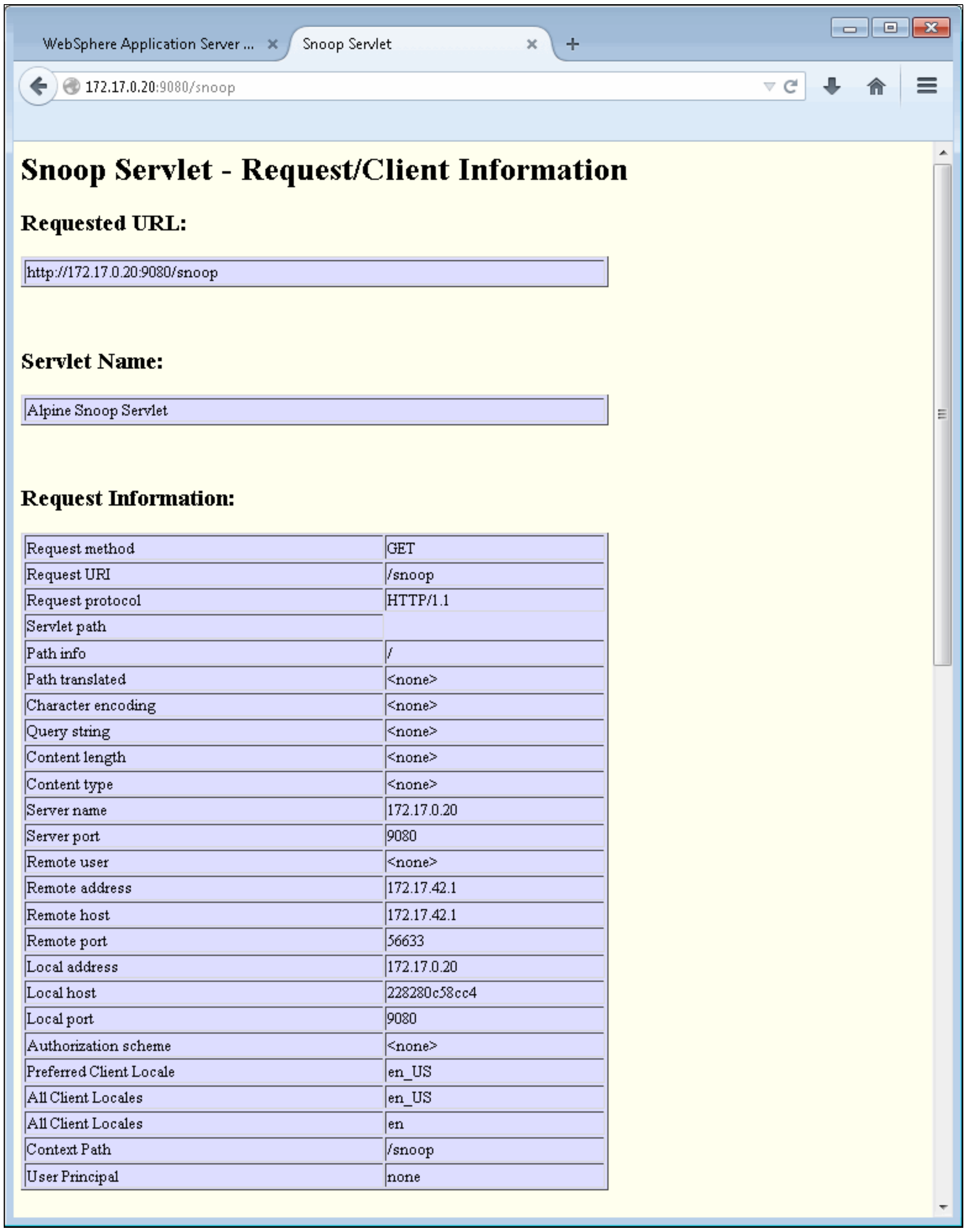
Liberty Documentation

WASdev forum

Licensed Materials - Property of IBM © Copyright IBM Corp. 1997, 2014. All Rights Reserved. IBM, and the IBM logo are trademarks or registered trademarks of International Business Machines Corp., registered in many jurisdictions worldwide. Other product and service names might be trademarks of IBM or other companies. A current list of IBM trademarks is available on the Web at Copyright and trademark information.

Figure 3-27 Access the Docker Liberty profile server

7. Now, you can access and test the application, as shown in Figure 3-28.



Snoop Servlet - Request/Client Information

Requested URL:

http://172.17.0.20:9080/snoop

Servlet Name:

Alpine Snoop Servlet

Request Information:

Request method	GET
Request URI	/snoop
Request protocol	HTTP/1.1
Servlet path	
Path info	/
Path translated	<none>
Character encoding	<none>
Query string	<none>
Content length	<none>
Content type	<none>
Server name	172.17.0.20
Server port	9080
Remote user	<none>
Remote address	172.17.42.1
Remote host	172.17.42.1
Remote port	56633
Local address	172.17.0.20
Local host	228280c58cc4
Local port	9080
Authorization scheme	<none>
Preferred Client Locale	en_US
All Client Locales	en_US
All Client Locales	en
Context Path	/snoop
User Principal	none

Figure 3-28 Accessing the application that is deployed to a Docker Liberty profile server

For more information about the Liberty profile and Docker, go to the following website:

https://developer.ibm.com/wasdev/blog/2015/04/02/websphere-docker-development-production/

4

Continuous integration with Jenkins on Liberty profile server

Continuous integration is a software development practice where members of a team integrate their work frequently, usually at least daily, leading to multiple integrations per day. Each integration is verified by an automated build (including test) to detect integration errors as quickly as possible. Many teams find that this approach leads to reduced integration problems and allows a team to develop cohesive software more rapidly.

Jenkins is one open source tool that performs continuous integration. The basic functions of Jenkins are to monitor a version control system and start and monitor a build system (for example, Apache Ant or Maven) if changes occur. Jenkins monitors the whole build process and provides reports and notifications to alert maintainers about successes or errors.

Jenkins works on all released versions of the Liberty profile server, but it works best with the latest version of WebSphere Application Server V8.5.5. This chapter helps you build a continuous integration environment with Jenkins on Liberty profile V8.5.5.

The chapter includes the following topics:

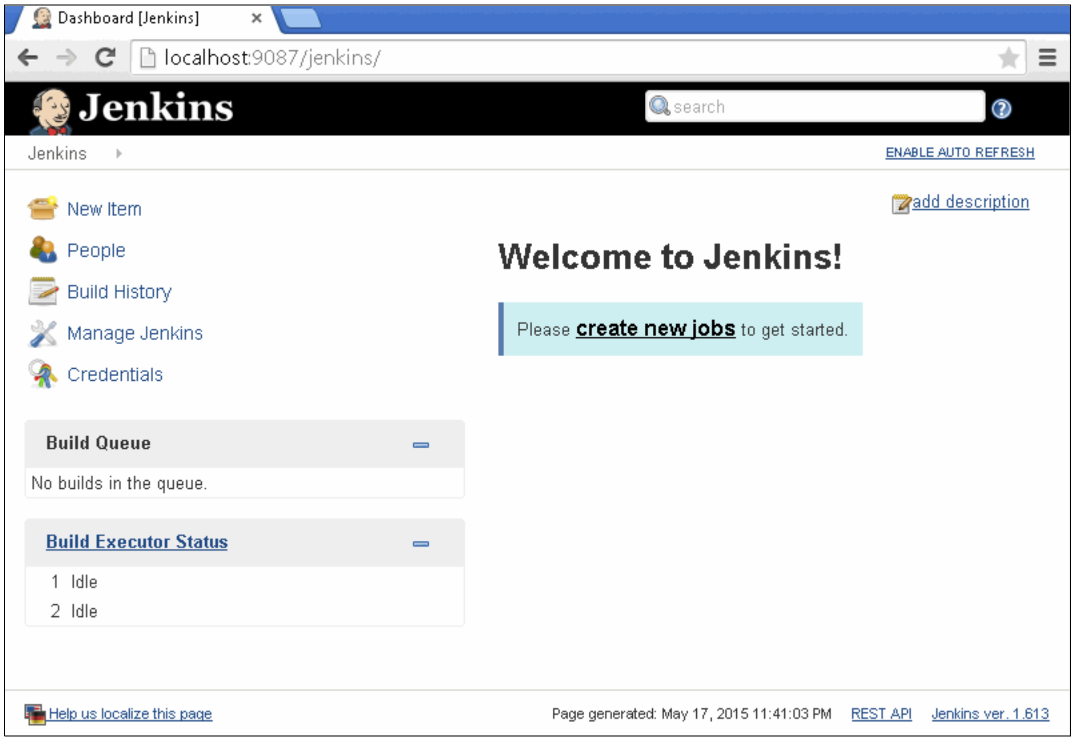
- Installing Jenkins on a Liberty profile server
- Setting up a Jenkins job

4.1 Installing Jenkins on a Liberty profile server

Jenkins is available for download as a native package for different OSes and as a Java web archive (WAR) file. The Java WAR file can be installed on any servlet container that supports Servlet 2.4/JSP 2.0. Jenkins can be deployed on the Liberty profile server in two ways:

- Dropins directory

  To install Jenkins on the Liberty profile server, copy the `jenkins.war` file to `${server.config.dir}/dropins`, and then access `http://yourhost:9087/jenkins` (see Figure 4-1). The host and port that are used here are an example. You must use the host and port of your Liberty profile server configuration.



Welcome to Jenkins!

Please **create new jobs** to get started.

No builds in the queue.

1 Idle
2 Idle

Page generated: May 17, 2015 11:41:03 PM

Figure 4-1 Jenkins home page

- Config directory

  To install Jenkins on the Liberty profile server, copy the `jenkins.war` file to the `${server.config.dir}/apps`. Then, edit the `server.xml` file to add the following text:

  ```
  <webApplication location="jenkins.war" />
  ```

4.1.1 Setting JENKINS_HOME

Before starting the Liberty profile server, create a `${server.config.dir}/jvm.options` file and add the line that is shown in Figure 4-2.

```
-DJENKINS_HOME=/path/to/jenkins_home/
```

Figure 4-2 Set JENKINS_HOME

This file also can be used to increase the heap size by adding the line that is shown in Figure 4-3.

```
-Xmx512m
```

Figure 4-3 Set the JVM heap size parameter

Now, start the Liberty profile server and access Jenkins by accessing the following URL:

`http://yourhost:9087/jenkins/`

4.1.2 Securing Jenkins on a Liberty profile server

To configure the user and group to role mappings in the Liberty profile server, deploy them through the `server.xml` file. Users and groups can be picked up from LDAP, or can be stored in the `server.xml` file. Complete the following steps:

1. Configure security by enabling the appSecurity-2.0 feature, which is done by editing the `server.xml` file and adding the feature, as shown in Figure 4-4.

```
<featureManager>
   <feature>appSecurity-2.0</feature>
</featureManager>
```

Figure 4-4 Add the security feature to the LIberty profile server

Always make sure that you are using the latest Liberty profile server features because they can be superseded by other versions, as described at the following website:

https://www-01.ibm.com/support/knowledgecenter/SSAW57_8.5.5/com.ibm.websphere.wlp.nd.multiplatform.doc/ae/rwlp_superfeat.html

2. Configure the role mapping for the Jenkins application, as shown in Figure 4-5.

```
<webApplication location="jenkins.war">
  <application-bnd>
    <security-role name="admin">
      <user name="jenkins-admin"/>
      <group name="jenkins-admins"/>
    </security-role>
  </application-bnd>
</webApplication>
```

Figure 4-5 Configure the role mapping in the Liberty profile server

3. Optional: Configure the user in the `server.xml` file, as shown in Figure 4-6.

```
<basicRegistry realm="jenkins">
  <user name="jenkins-admin" password="secret"/>
  <group name="jenkins-admins">
    <member name="jenkins-admin">
  </group>
</basicRegistry>
```

Figure 4-6 Configure users in the Liberty profile server

4. The **securityUtility** script in the bin folder can be used to generate a hashed password for this file. To do so, run the command that is shown in Figure 4-7.

```
${wlp.install.dir}/bin/securityUtility encode --encoding=hash secret
```

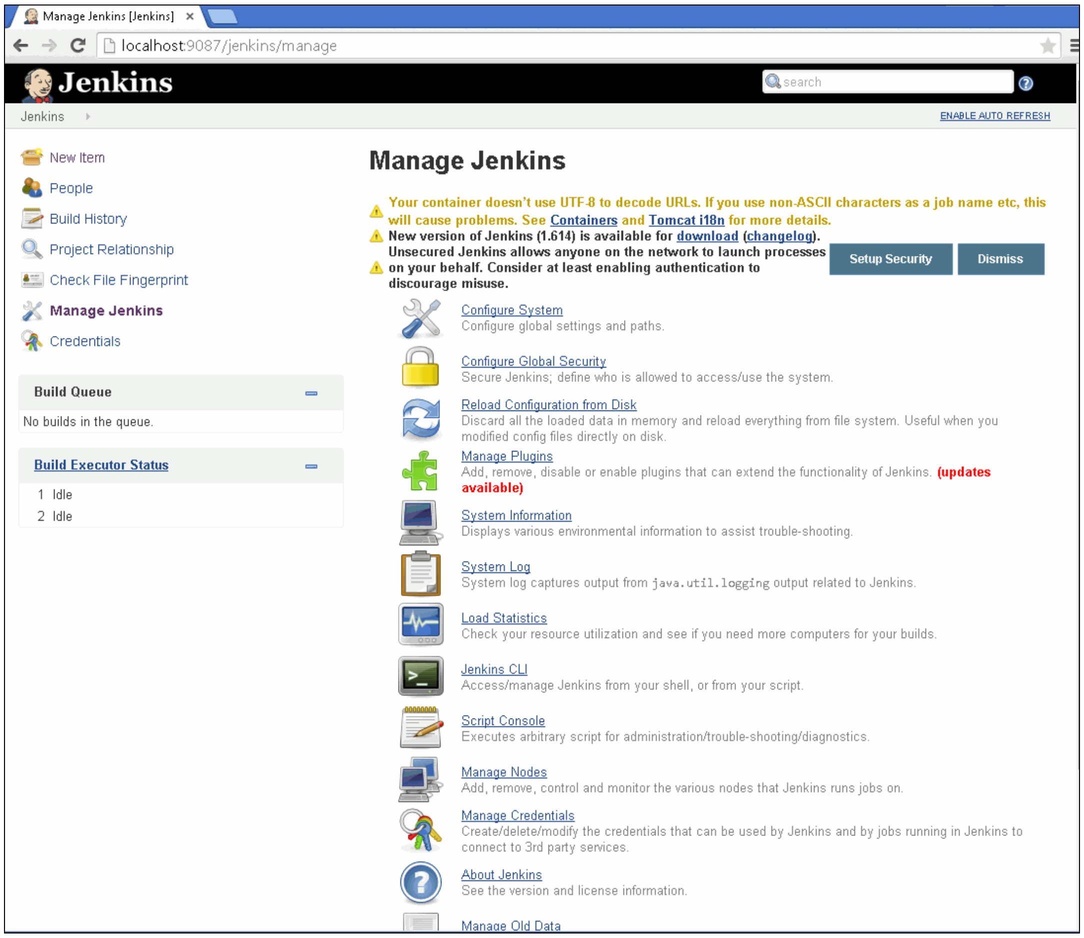
Figure 4-7 securityUtility command

5. Copy the printed hashed password into the password attribute in the server.xml file. If secret is not passed in on the command line, you are prompted for it.

4.1.3 Configuring Jenkins

Jenkins must be configured with JDK and Maven installation paths to run the build system. Complete the following steps:

1. Open Jenkins in a browser and click **Manage Jenkins**, and then click **Configure System**, as shown in Figure 4-8.



Manage Jenkins

Your container doesn't use UTF-8 to decode URLs. If you use non-ASCII characters as a job name etc, this will cause problems. See Containers and Tomcat i18n for more details.

New version of Jenkins (1.614) is available for download (changelog).

Unsecured Jenkins allows anyone on the network to launch processes on your behalf. Consider at least enabling authentication to discourage misuse.

Configure System
Configure global settings and paths.

Configure Global Security
Secure Jenkins; define who is allowed to access/use the system.

Reload Configuration from Disk
Discard all the loaded data in memory and reload everything from file system. Useful when you modified config files directly on disk.

Manage Plugins
Add, remove, disable or enable plugins that can extend the functionality of Jenkins. (updates available)

System Information
Displays various environmental information to assist trouble-shooting.

System Log
System log captures output from java.util.logging output related to Jenkins.

Load Statistics
Check your resource utilization and see if you need more computers for your builds.

Jenkins CLI
Access/manage Jenkins from your shell, or from your script.

Script Console
Executes arbitrary script for administration/trouble-shooting/diagnostics.

Manage Nodes
Add, remove, control and monitor the various nodes that Jenkins runs jobs on.

Manage Credentials
Create/delete/modify the credentials that can be used by Jenkins and by jobs running in Jenkins to connect to 3rd party services.

About Jenkins
See the version and license information.

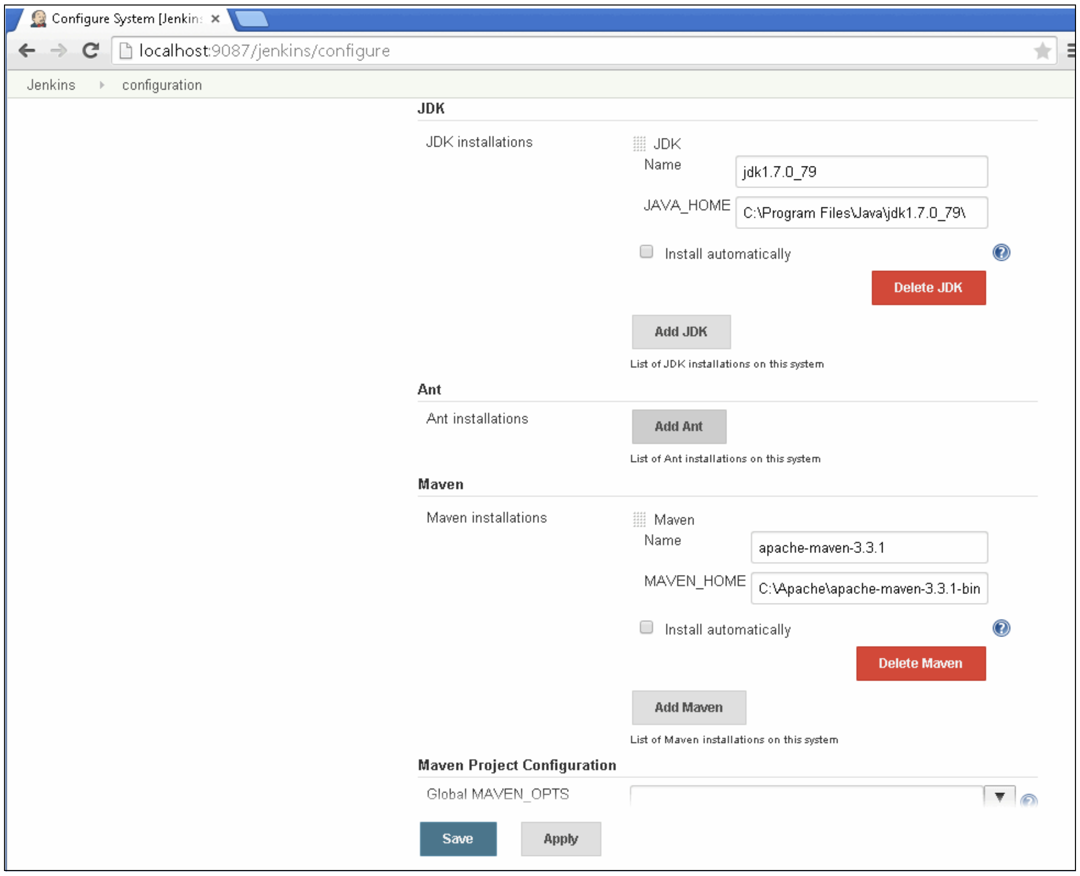
Manage Old Data

No builds in the queue.

1 Idle
2 Idle

Figure 4-8 Manage Jenkins

2. Enter the correct paths to your JDK and Maven installations and click **Save**. Jenkins can also automatically install these paths, as shown in Figure 4-9.



JDK

JDK installations

JDK

Name: jdk1.7.0_79

JAVA_HOME: C:\Program Files\Java\jdk1.7.0_79\

Install automatically

List of JDK installations on this system

Ant

Ant installations

List of Ant installations on this system

Maven

Maven installations

Maven

Name: apache-maven-3.3.1

MAVEN_HOME: C:\Apache\apache-maven-3.3.1-bin

Install automatically

List of Maven installations on this system

Maven Project Configuration

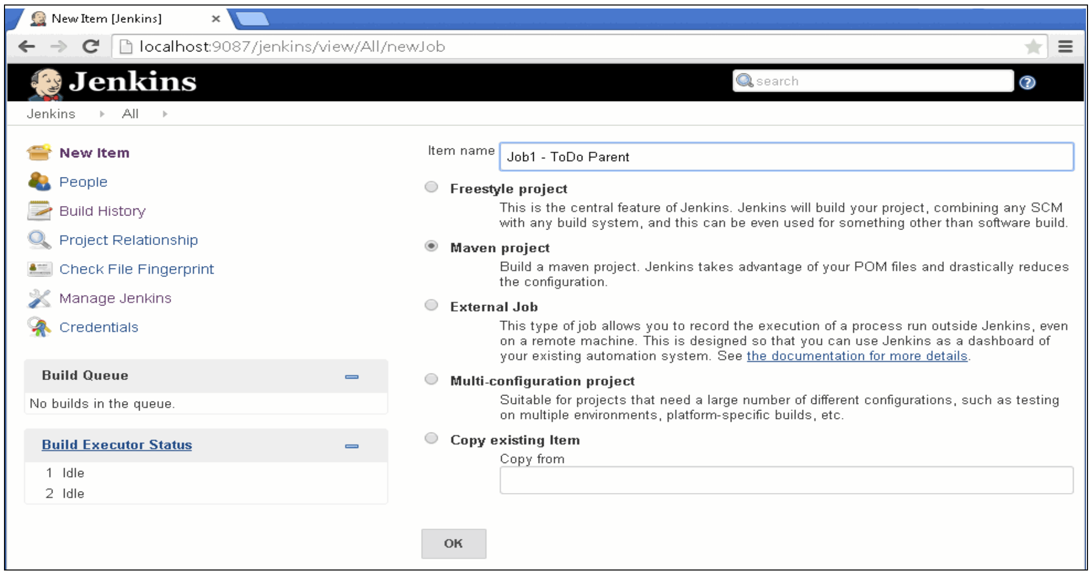
Global MAVEN_OPTS

Figure 4-9 Configure JDK and Maven in Jenkins

4.2 Setting up a Jenkins job

Building a project is handled through jobs in Jenkins. Set up a job for the ToDo Project sample that is built by using Maven by completing the following steps:

1. Click **New Item**, as shown in Figure 4-10.
2. Select **Maven project**.
3. Provide a name for the Job, such as **Job1 - ToDo Parent**.
4. Click **OK**.


New Item [Jenkins]

localhost:9087/jenkins/view/All/newJob

Jenkins

Jenkins ▸ All ▸

New Item
People
Build History
Project Relationship
Check File Fingerprint
Manage Jenkins
Credentials

Build Queue
No builds in the queue.

Build Executor Status
1 Idle
2 Idle

Item name: Job1 - ToDo Parent

○ **Freestyle project**
This is the central feature of Jenkins. Jenkins will build your project, combining any SCM with any build system, and this can be even used for something other than software build.

● **Maven project**
Build a maven project. Jenkins takes advantage of your POM files and drastically reduces the configuration.

○ **External Job**
This type of job allows you to record the execution of a process run outside Jenkins, even on a remote machine. This is designed so that you can use Jenkins as a dashboard of your existing automation system. See the documentation for more details.

○ **Multi-configuration project**
Suitable for projects that need a large number of different configurations, such as testing on multiple environments, platform-specific builds, etc.

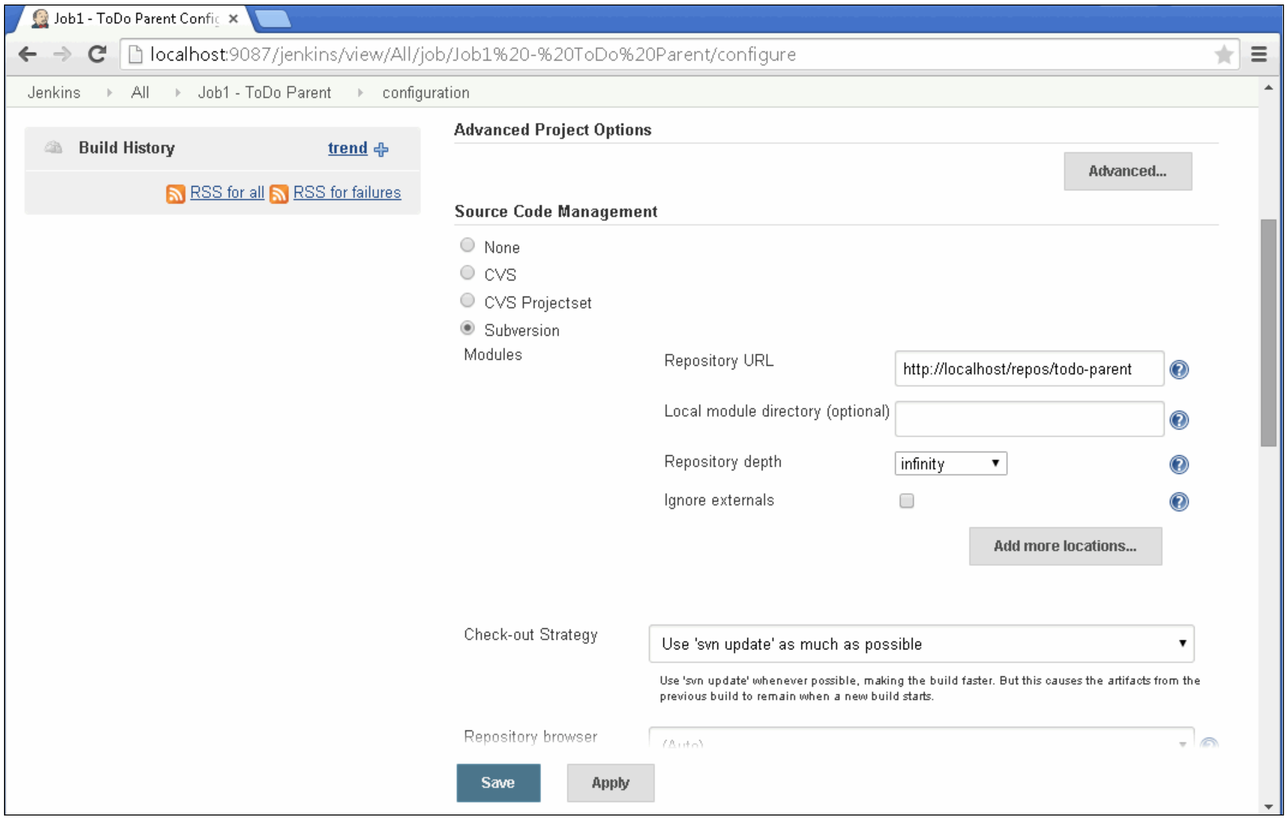
○ **Copy existing Item**
Copy from

OK

Figure 4-10 Create a Jenkins job

Next, configure Jenkins to poll automatically the Apache Subversion repository for changes, and to build when changes are detected. Complete the following steps:

1. Select the **Job1- ToDo Parent** job (created in Figure 4-10) and click **Configure**.
2. Select **Subversion** under the Source Code Management section, as shown in Figure 4-11 on page 47.



Job1 - ToDo Parent Config

localhost:9087/jenkins/view/All/job/Job1%20-%20ToDo%20Parent/configure

Jenkins > All > Job1 - ToDo Parent > configuration

Build History trend

RSS for all RSS for failures

Advanced Project Options

Advanced...

Source Code Management

- None
- CVS
- CVS Projectset
- [✓ Subversion]

Modules

Repository URL: http://localhost/repos/todo-parent

Local module directory (optional):

Repository depth: infinity

Ignore externals: ☐

Add more locations...

Check-out Strategy: Use 'svn update' as much as possible

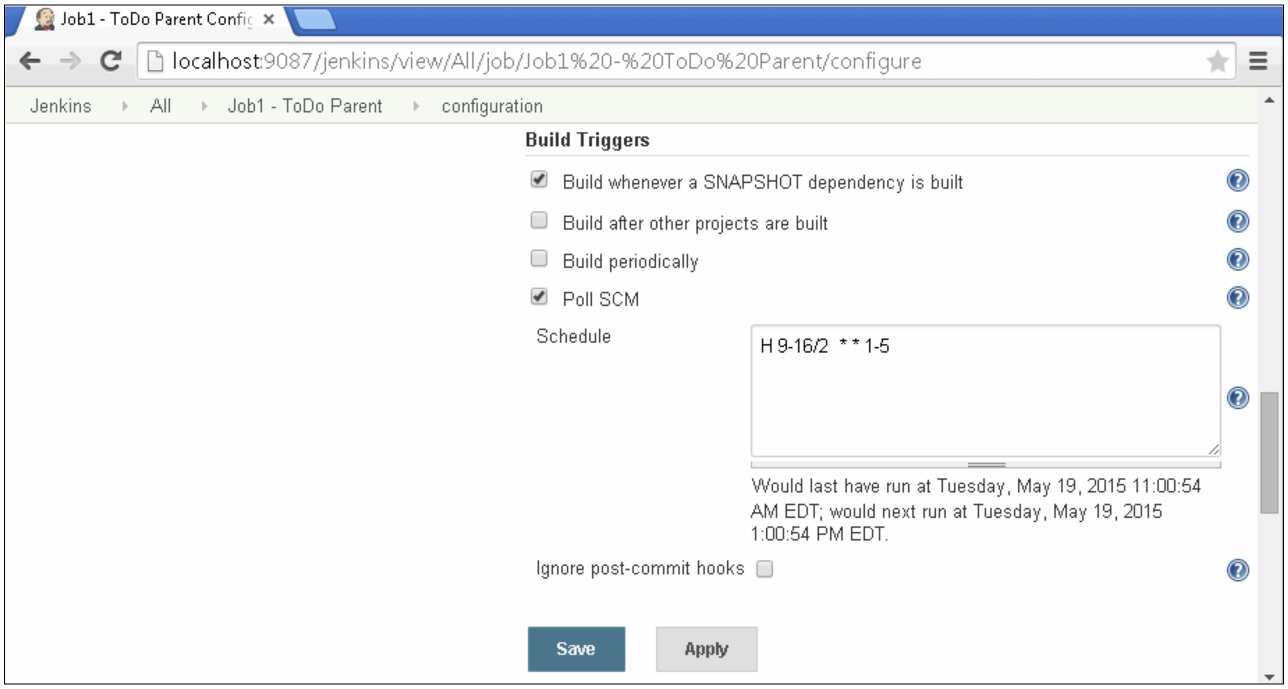
Use 'svn update' whenever possible, making the build faster. But this causes the artifacts from the previous build to remain when a new build starts.

Repository browser: (Auto)

Save Apply

Figure 4-11 Subversion configuration

3. Enter the URL of the Subversion repository you want Jenkins to poll. Click **Apply**.
4. Under Build Triggers (Figure 4-12), select **Poll SCM**. In the Schedule text box, enter how often Jenkins should poll the Subversion repository.



Job1 - ToDo Parent Config

localhost:9087/jenkins/view/All/job/Job1%20-%20ToDo%20Parent/configure

Jenkins > All > Job1 - ToDo Parent > configuration

Build Triggers

- ☑ Build whenever a SNAPSHOT dependency is built
- ☐ Build after other projects are built
- ☐ Build periodically
- ☑ Poll SCM

Schedule: H 9-16/2 * * 1-5

Would last have run at Tuesday, May 19, 2015 11:00:54 AM EDT; would next run at Tuesday, May 19, 2015 1:00:54 PM EDT.

Ignore post-commit hooks ☐

Save Apply

Figure 4-12 Configure Build Triggers

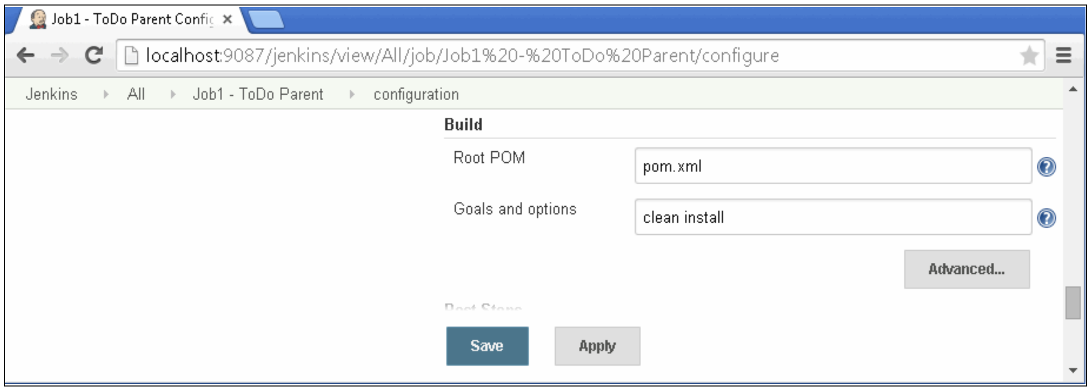
5. Select **Build whenever a SNAPSHOT dependency is built** for automatic build chaining.

   Automatic build chaining from module dependencies: Jenkins reads the dependencies of the project from the POM, and if they are also built on Jenkins, triggers are set up in such a way that a new build in one of those dependencies automatically starts a new build of the project. Jenkins understands all kinds of dependencies in POM:

   - The parent POM
   - The <dependencies> section
   - The <plugins> section
   - The <extensions> section
   - The <reporting> section

   This process accounts for versions; you can have multiple versions or branches of your project on the same Jenkins and it correctly determines dependencies.

6. Under the Build section (Figure 4-13), specify the Root POM as `pom.xml`, and for the Maven goals and options, enter `clean install`.


Job1 - ToDo Parent Config
localhost:9087/jenkins/view/All/job/Job1%20-%20ToDo%20Parent/configure
Jenkins
All
Job1 - ToDo Parent
configuration
Advanced...
Save
Apply

Build

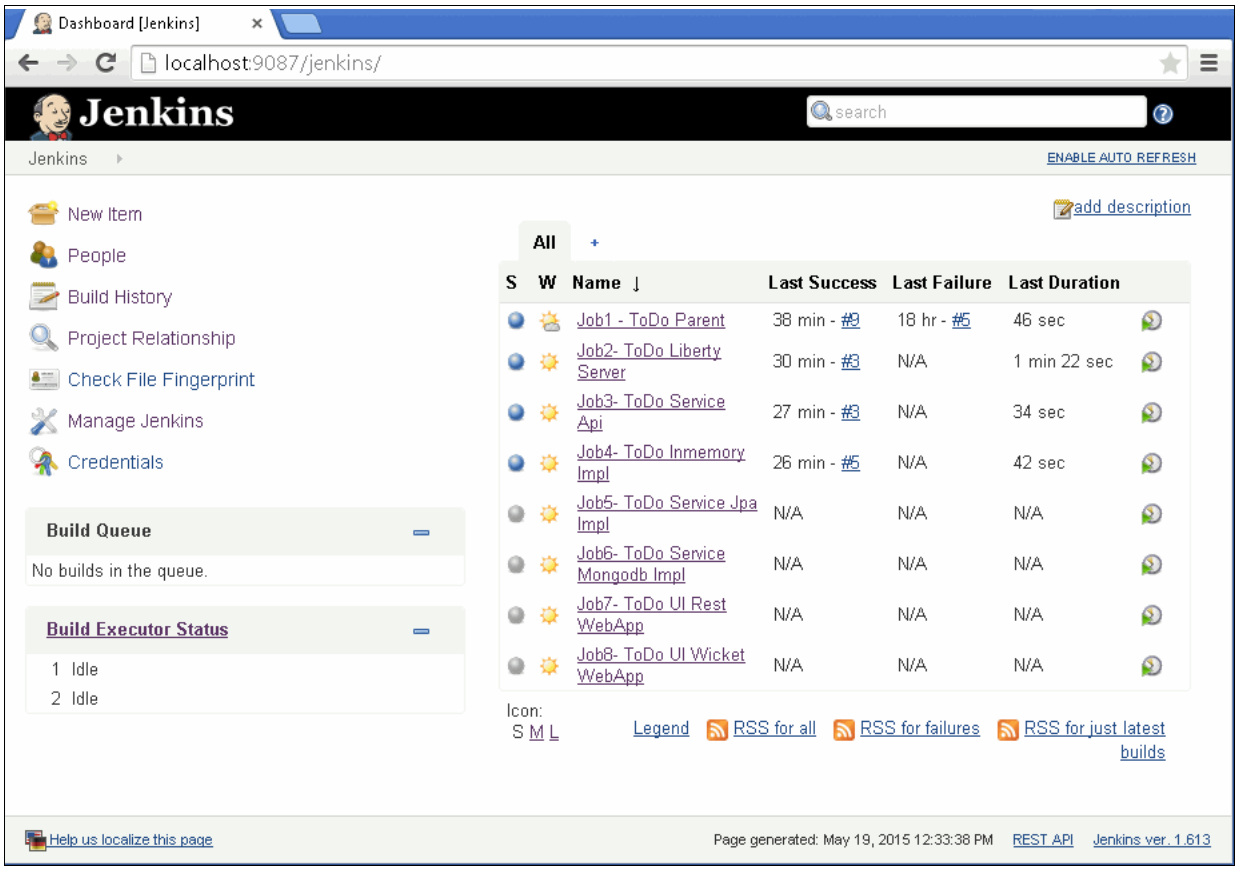
Root POM: pom.xml

Goals and options: clean install

Figure 4-13 Configure Maven Goals

7. Click **Save**.

Then, set up and configure jobs for the remaining modules of the ToDo Project by using the steps above, as shown in Figure 4-14.



Build Queue

No builds in the queue.

Build Executor Status

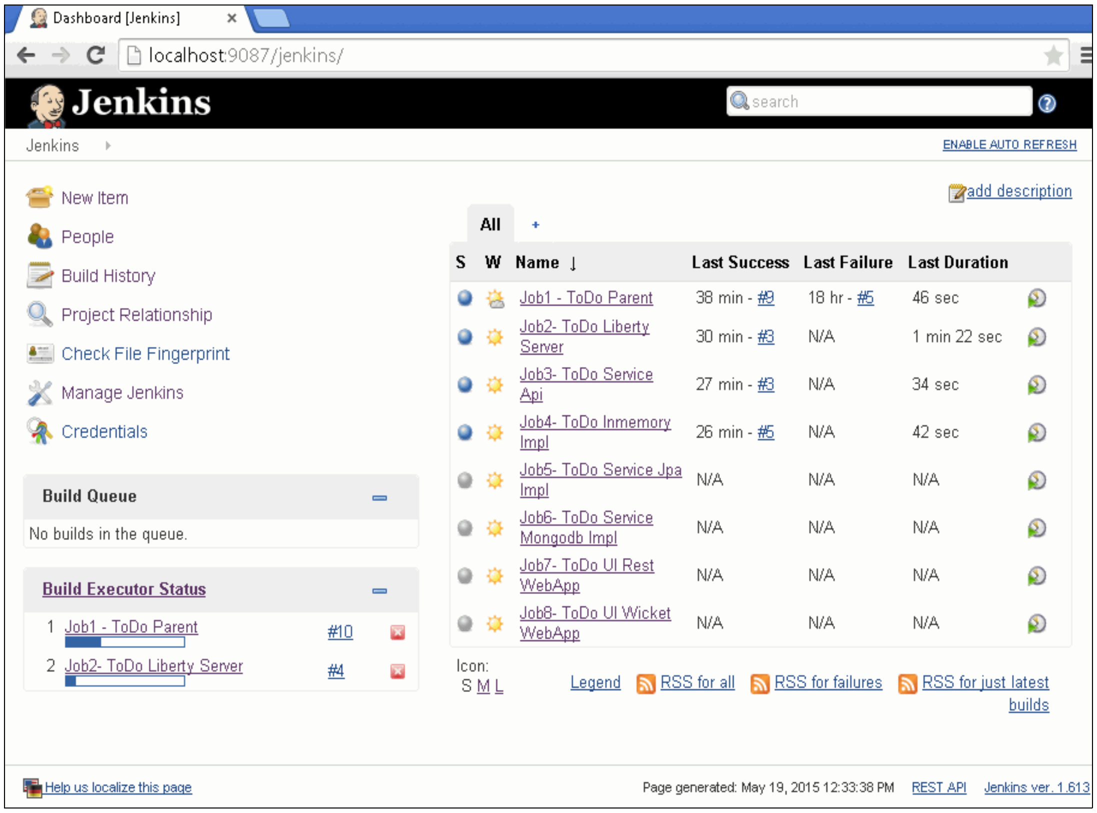
1 Idle
2 Idle

S	W	Name ↓	Last Success	Last Failure	Last Duration
		Job1 - ToDo Parent	38 min - #9	18 hr - #5	46 sec
		Job2- ToDo Liberty Server	30 min - #3	N/A	1 min 22 sec
		Job3- ToDo Service Api	27 min - #3	N/A	34 sec
		Job4- ToDo Inmemory Impl	26 min - #5	N/A	42 sec
		Job5- ToDo Service Jpa Impl	N/A	N/A	N/A
		Job6- ToDo Service Mongodb Impl	N/A	N/A	N/A
		Job7- ToDo UI Rest WebApp	N/A	N/A	N/A
		Job8- ToDo UI Wicket WebApp	N/A	N/A	N/A

Page generated: May 19, 2015 12:33:38 PM REST API Jenkins ver. 1.613

Figure 4-14 Set up and configure the remaining modules

The Jenkins job instances now automatically poll the Subversion repository at the specified intervals, and create and run Maven goals in new builds when changes are detected. Jenkins also automatically forms a build chain for any module dependencies, as shown in Figure 4-15.



Build Queue

No builds in the queue.

Build Executor Status

1	Job1 - ToDo Parent	#10
2	Job2- ToDo Liberty Server	#4

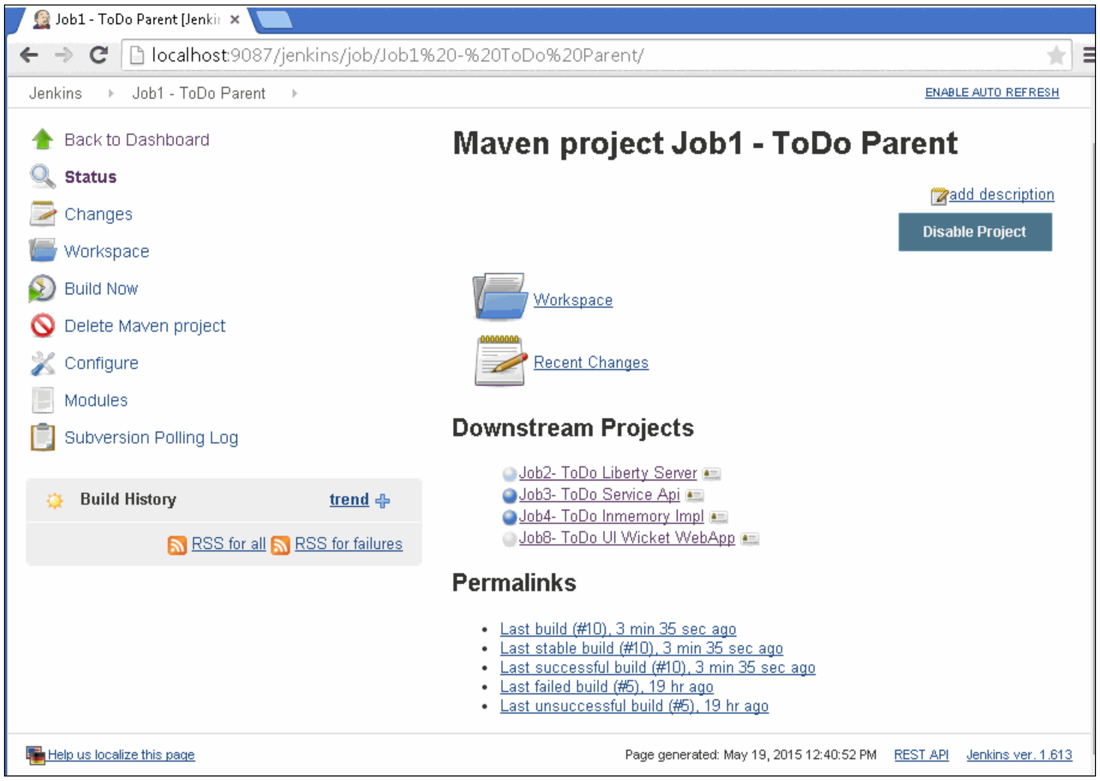
S	W	Name ↓	Last Success	Last Failure	Last Duration
		Job1 - ToDo Parent	38 min - #9	18 hr - #5	46 sec
		Job2- ToDo Liberty Server	30 min - #3	N/A	1 min 22 sec
		Job3- ToDo Service Api	27 min - #3	N/A	34 sec
		Job4- ToDo Inmemory Impl	26 min - #5	N/A	42 sec
		Job5- ToDo Service Jpa Impl	N/A	N/A	N/A
		Job6- ToDo Service Mongodb Impl	N/A	N/A	N/A
		Job7- ToDo UI Rest WebApp	N/A	N/A	N/A
		Job8- ToDo UI Wicket WebApp	N/A	N/A	N/A

Icon: S M L   Legend   RSS for all   RSS for failures   RSS for just latest builds

Help us localize this page   Page generated: May 19, 2015 12:33:38 PM   REST API   Jenkins ver. 1.613

Figure 4-15 Jenkins job build chain

Selecting any of the Todo jobs shows the upstream and downstream projects, as shown in Figure 4-16.



Maven project Job1 - ToDo Parent

Downstream Projects

- Job2- ToDo Liberty Server
- Job3- ToDo Service Api
- Job4- ToDo Inmemory Impl
- Job8- ToDo UI Wicket WebApp

Permalinks

- Last build (#10), 3 min 35 sec ago
- Last stable build (#10), 3 min 35 sec ago
- Last successful build (#10), 3 min 35 sec ago
- Last failed build (#5), 19 hr ago
- Last unsuccessful build (#5), 19 hr ago

Page generated: May 19, 2015 12:40:52 PM

Figure 4-16 Upstream and downstream projects in a job

5

Front-end development on the Liberty profile server

This chapter continues to extend the sample Todo list application to include two extra components: a RESTful web service with an Ajax client-side UI and a more traditional server-generated UI that uses Apache Wicket.

The chapter includes the following topics:

- RESTful web service with an Ajax front end
- Apache Wicket

5.1 RESTful web service with an Ajax front end

In recent years, web application design has moved away from traditional server-side page rendering. Using Asynchronous JavaScript And XML (Ajax) technologies, modern web applications can send and receive data from servers in the background, updating interface components dynamically (without reloading the page).

5.1.1 Java web services on the Liberty profile server

The Liberty profile server is an ideal platform for developing and hosting modern web applications. Supporting several popular Java Platform, Enterprise Edition technologies, the Liberty profile server makes creating a back-end web service simple and fast.

This chapter explains the implementation of the sample application component (`todo-ui-rest-webapp`) that uses a JAX-RS web service back end and Dojo Toolkit front end to allow browsing of todo lists and their items. This example illustrates the simplicity of using the Liberty profile server to develop a modern and dynamic web application by using the WebSphere developer tools.

Representational State Transfer (REST) refers to an architectural style of web service API design. A RESTful API design matches the HTTP request methods (GET, PUT, POST, PATCH, and DELETE) to resource URLs to expose the required functions.Table 5-1 illustrates this concept by using our sample web service component.

Table 5-1 Mapping of HTTP request methods to web service API functions

Resource (relative URLs)	GET	PUT	POST	DELETE
`/items`	Retrieve all items (tasks).	Replace all items with a new set.	Create an item	N/A
`/items/1`	Retrieve the todo item with an ID value of 1.	Replace the item with a new one.	N/A	Delete the item.
`/lists`	Retrieve all todo lists.	Replace all todo lists with a new set.	Create a todo list.	N/A
`/lists/1`	Retrieve the todo list with an ID value of 1.	Replace the todo list with a new one.	N/A	Delete the todo list.
`/lists/1/items`	Retrieve all items that are assigned to the list with ID 1.	Replace all items that belong to the list with a new set.	Create an item for this todo list.	N/A
`/lists/1/items /1`	Retrieve the item with an ID value of 1 in the todo list with the ID value of 1	Replace the todo list item with a new one.	N/A	Delete the todo list item.

5.1.2 Java API for RESTful web services

The Java API for RESTful web services, also known as JAX-RS, provides a simple mechanism for creating web service APIs with little extra code or configuration. JAX-RS extends the Java syntax to allow mapping of Java classes and methods to web service requests by using the following Java annotations:

- `@Path`: The relative URL of the request, for example, `/items` in Table 5-1 on page 54
- `@HEAD`, `@GET`, `@PUT`, `@POST`, and `@DELETE`: The HTTP request type
- `@Consumes`: The Internet media type of the request (for example, “application/json”)
- `@Produces`: The Internet media type of the response

In addition, to allow for request parameters to be extracted and mapped to regular Java method parameters, JAX-RS includes the following variable annotations:

- `@PathParam`: URL path variables (for example, `/items/`**`123`**).
- `@QueryParam`: HTTP query parameters (for example, `?searchString=`**`keywords`**).
- `@Matrixparam`: HTTP matrix parameters (for example, `;type=`**`chore`**).
- `@HeaderParam`: HTTP header value (for example, `Content-Length: `**`123`**).
- `@CookieParam`: HTTP cookie value (for example, `Cookie: openList=`**`main`**).
- `@FormParam`: Submitted form field value (for example, `name=`**`go+shopping`**).
- `@DefaultValue`: A default value to use when the parameter is not specified.
- `@Context`: Allows the lookup of request context information, such as the authenticated user, the full URI of the request, or whether a secure connection is enabled.

RESTful API implementation example

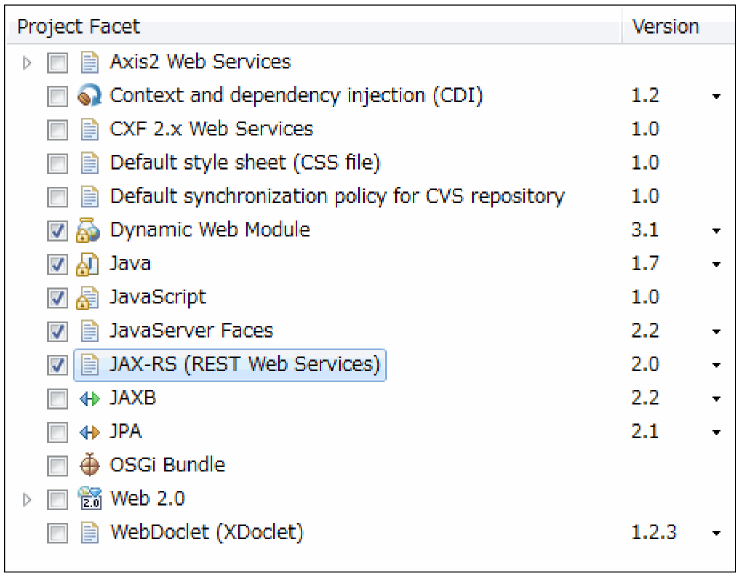
To create a RESTful web service API on the Liberty profile server, you must enable the JAX-RS feature on the Liberty profile server.

Enabling the Liberty profile server JAX-RS feature

To enable the JAX-RS feature by using the WebSphere Developer Tools plug-ins for Eclipse, complete the following steps:

1. Right-click the project and select **Properties**.
2. Click **Project Facets**.

3. Select the **JAX-RS (REST Web Services)** check box, as shown in Figure 5-1.



Project Facet	Version
☐ Axis2 Web Services	
☐ Context and dependency injection (CDI)	1.2
☐ CXF 2.x Web Services	1.0
☐ Default style sheet (CSS file)	1.0
☐ Default synchronization policy for CVS repository	1.0
☑ Dynamic Web Module	3.1
☑ Java	1.7
☑ JavaScript	1.0
☑ JavaServer Faces	2.2
☑ JAX-RS (REST Web Services)	2.0
☐ JAXB	2.2
☐ JPA	2.1
☐ OSGi Bundle	
☐ Web 2.0	
☐ WebDoclet (XDoclet)	1.2.3

Figure 5-1 Web project facets

Enabling JAX-RS adds the required features to the Liberty profile server configuration, as shown in Figure 5-2.

```
<featureManager>
   ...
   <feature>jaxrs-2.0</feature>
   ...
</featureManager>
```

Figure 5-2 Additions to the Liberty profile server.xml configuration file

The JAX-RS application class

The application class defines the components and additional metadata configuration for a JAX-RS application. In the TodoListRestApplication sample, set the `@ApplicationPath` annotation to a value of `"api"`. This means that all requests that begin with the URL prefix of `"/api"` are handled by this application. We also define several constants to use from our resource classes.

Note: We omit manually specifying our resource classes (in Figure 5-3) in the application because they are automatically discovered when defined in the same Java package.

```
package todo.ui.rest.jaxrs;

import javax.ws.rs.ApplicationPath;
import javax.ws.rs.core.Application;

@ApplicationPath("api")
public class TodoListRestApplication extends Application
{
   // Static constants to use for parameters in resource request Paths
   public static final String ITEM_ID = "itemId";
   public static final String LIST_ID = "listId";
   public static final String SEARCH_STRING = "searchString";
}
```

Figure 5-3 Sample JAX-RS application

The JAX-RS resources

Our sample REST application includes two resource classes: one for todo items (tasks) and one for todo lists. Figure 5-4 contains a snippet from the item class, demonstrating how the JAX-RS annotations are used in practice.

The code snippet includes `@Singleton` and `@EJB` annotations to inject our concrete implementation of the back-end logic. This relationship allows for any class that implements the TodoListService interface to be used by simply modifying the build dependencies in the Maven project. This means that we can easily swap between storing the data in memory, using a MongoDB database wrapper, or even Hibernate for persisting data to a database like H2 for storage.

```
package todo.ui.rest.jaxrs.resources;
...
@Singleton
@Path("items")
@Produces(MediaType.APPLICATION_JSON)
public class Item
{
   @EJB
   private TodoListService realService;
...
   @GET
   @Path("{" + ITEM_ID + "}")
   public TodoListItem getItemById(@PathParam(ITEM_ID) final String itemId)
   {
      return realService.getItemById(itemId);
   }
...
}
```

Figure 5-4 Snippet illustrating the structure of a JAX-RS resource class

When developing your own resource classes, WebSphere Developer Tools for Eclipse can be useful. By opting to run the project on a Liberty profile server, each time a file is changed the project files are recompiled and deployed into the running server, making changes testable instantly.

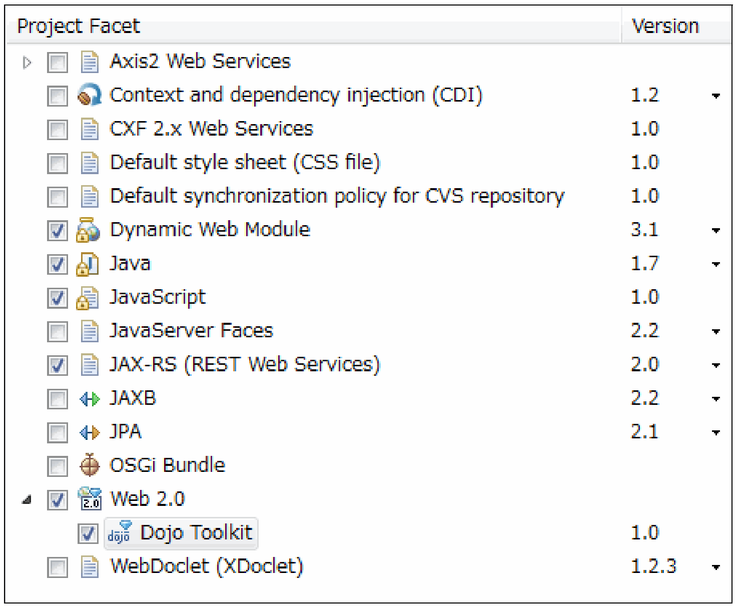
5.1.3 Dojo Toolkit

The Dojo Toolkit is an open source JavaScript framework that began development in 2004. To support and encourage adoption of Dojo, the non-profit Dojo Foundation organization was created, receiving support from several organizations, including IBM.

Compared to using straight JavaScript, Dojo offers an extensive array of utility functions, UI widgets, and tools for packaging, testing, and documentation. These functions are organized into four main components:

- Dojo: Core functions and utility libraries that ensure consistent behavior in all supported web browsers (a time-consuming issue when trying to support older platforms)
- Dijit: UI widget and theme library
- Dojox: Collection of newer and experimental modules that are not considered stable enough for inclusion in the core Dojo component
- Util: Tools for performing optimization, building (minifying and packaging), documentation, and testing

Dojo is available as part of WebSphere Developer Tools for Eclipse. When installed, Dojo can be configured from the Eclipse project Properties menu, under the Project Facets section (see Figure 5-5). From there, the Dojo JavaScript files can be configured to be downloaded in to your project, referenced from an existing location on disk, or from a public CDN. Our sample project uses Dojo from the Google CDN to avoid the need to package or build the source files in our example.



	Project Facet	Version
☐	Axis2 Web Services	
☐	Context and dependency injection (CDI)	1.2
☐	CXF 2.x Web Services	1.0
☐	Default style sheet (CSS file)	1.0
☐	Default synchronization policy for CVS repository	1.0
✓	Dynamic Web Module	3.1
✓	Java	1.7
✓	JavaScript	1.0
☐	JavaServer Faces	2.2
✓	JAX-RS (REST Web Services)	2.0
☐	JAXB	2.2
☐	JPA	2.1
☐	OSGi Bundle	
✓	Web 2.0	
✓	Dojo Toolkit	1.0
☐	WebDoclet (XDoclet)	1.2.3

Figure 5-5 Enabling the Dojo Toolkit option for your web project

Dojo front-end user interface sample

The structure of our sample Dojo user interface component begins in the `index.html` source file. This file is where we specify the location of our Dojo and custom application script file resources, stylesheets, and the core HTML anchor nodes for placing our dynamic interface components.

For the purposes of this example, we based our interface design on the Dojox mobile theme that is described in the official Dojo tutorial that is found at this website:

http://dojotoolkit.org/documentation/tutorials/1.9/mobile/tweetview/getting_started/

Figure 5-6 shows the body section of an HTML file, which has the `<div>` element that contains all of our Dojo interface components and the declaration of our application script file that creates them. We reiterate this point again: By using WebSphere Developer Tools and a running Liberty profile server when developing an application such as the example one, developers can view changes as they are made by simply refreshing the page. In addition, WebSphere Developer Tools add support for creating Dojo modules and widgets by using Eclipse wizards to help you get started quickly with premade templates.

```
...
<body>
   <!-- Container to add the todo list and item widgets to programmatically -->
   <div id="view-container">
   </div>

   <!-- Application JavaScript -->
   <script type="text/javascript" src="app/main.js"></script>
</body>
</html>
```

Figure 5-6 The body of our Dojo sample index.html file

Our `main.js` module begins by listing its dependencies. The last dependency, `domReady`, is a special Dojo module that causes our main module to wait until the user's browser finishes loading the Document Object Module (DOM) of the web page. It also uses a simple Dojo *topic* module to handle global operation requests in the application, which allows for a simplified dependency relationship between modules and allows operation handling to be centralized. Topic subscription works by linking a unique topic keyword to a function. This can be called by using the special topic keyword followed by any arguments to pass to the handler function, as shown in Figure 5-7.

```
require([
   'app/RestUtilities',
   'app/ViewUtilities',
   'dojo/when',
   'dojo/topic',
   'dojo/domReady!'
], function (restUtilities, viewUtilities, when, topic) {
   var rootListId = 'root';
   var rootListName = 'Todo Lists';

   // Listen for requests to create list views
   topic.subscribe('createListView', viewUtilities.createListView);

   // Create the base view containing all todo lists
   when(restUtilities.requestResources('lists'), function (items) {
      topic.publish('createListView', rootListId, rootListName, items);
   });
});
```

Figure 5-7 The main.js sample application

This `main.js` module also references our two utility modules: RestUtilities and ViewUtilities. These utilities are designed to wrap commonly used functions, such as making a request from the server with a particular set of arguments. Figure 5-8 shows the contents of the RestUtilities module. It includes a declaration of the request path prefix to the same value (api) that our RESTful web service is mapped to, and also setting the expected content type of responses to JSON. This setup saves configuring these constants in each separate location that a request is made from the server. In a more fully fledged example, this might be expanded to include functions for posting data back to the server.

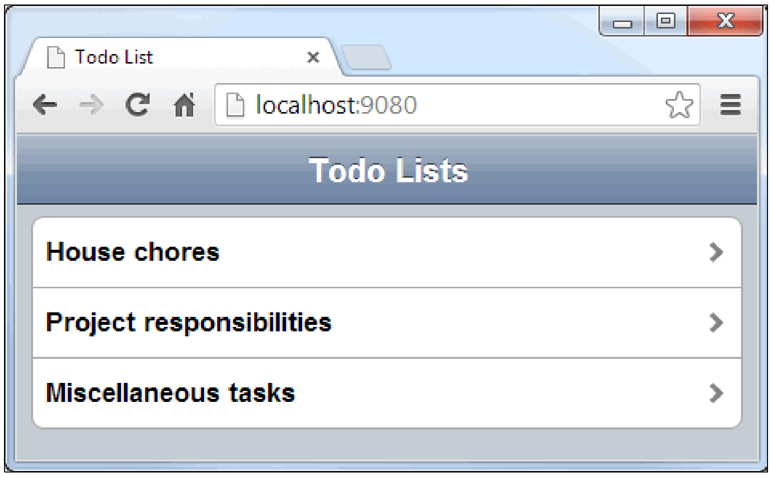
```
define([
   'dojo/request',
   'exports'
], function (request, exports) {
   var apiUri = 'api/';

   exports.requestResources = function (requestUri) {
      return request.get(apiUri + requestUri, {
         handleAs: 'json'
      });
   };

   return exports;
});
```

Figure 5-8 The RestUtilities.js utility module

Beginning with Figure 5-9, the subsequent two figures show the Dojo todo list UI sample running on a Liberty profile server, which is populated with sample data.



Todo Lists

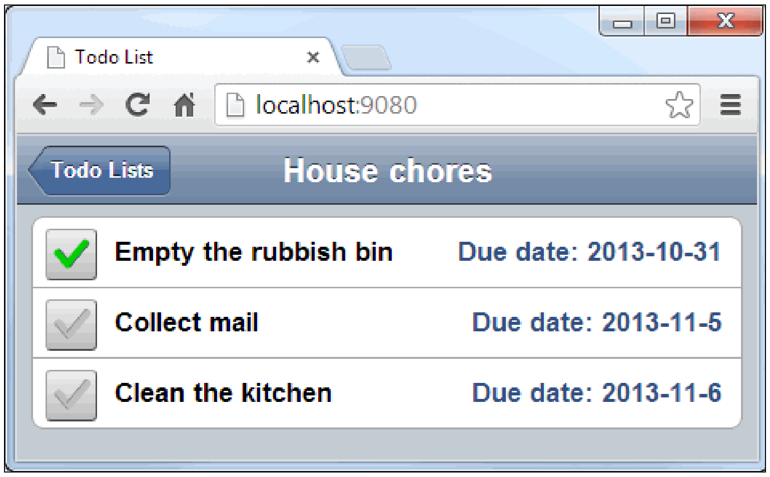
House chores

Project responsibilities

Miscellaneous tasks

Figure 5-9 The Dojo UI home page showing all todo lists

Figure 5-10 on page 61 shows a list of items for the House chores todo list. It is using the JSON that is returned from the JAX-RS API to set the item description, whether it is completed, and the completion deadline.



Empty the rubbish bin Due date: 2013-10-31

Collect mail Due date: 2013-11-5

Clean the kitchen Due date: 2013-11-6

Figure 5-10 The Dojo UI todo list view showing all the items in that list

5.1.4 Integration testing with JWebUnit on the Liberty profile server

For integration testing our web application, we use a combination of JWebUnit for UI testing and REST-assured for REST API testing. These testing tools are based on the standard JUnit structure and integrate seamlessly with our continuous integration system that uses Jenkins.

JWebUnit

JWebUnit is a simple library for testing web application interfaces by simulating user interaction. JWebUnit provides an API for tasks such as finding text on a page, clicking links, changing addresses, and submitting forms. Test results are based on a set of user-specified assertions, where the page elements, such as page titles, text fields, links, form fields, and windows, can be validated against expected values. An example of a basic test case that is taken from our application sample is shown in Figure 5-11. This test sets the web address to point to the home page, and after waiting to ensure that the page has loaded, checks the title of the browser against the expected value. For more information about JWebUnit, see the project website:

http://jwebunit.sourceforge.net/

```
private WebTester wt;

@Before
public void setUp()
{
   wt = new WebTester();
   wt.setTestingEngineKey(TestingEngineRegistry.TESTING_ENGINE_HTMLUNIT);
   wt.setBaseUrl("http://localhost:9080");
}

@Test
public void testHomePage()
{
   wt.beginAt("index.html");
   waitForJavaScriptRendering(DEFAULT_WAIT_TIME);
   wt.assertTitleEquals("Todo Web Application");
}
```

Figure 5-11 Basic integration test by using JWebUnit

REST-assured

REST-assured is a Java based domain-specific language (DSL) that is designed for testing and validating REST web services. It uses a *fluent* method chaining style, facilitating a syntax similar to languages such as Ruby. We selected this tool to enhance the coverage of the sample application integration tests. Using REST-assured, we can post data to the server to create lists and items and then validate that the changes are reflected in the Dojo UI.

The integration test from our sample application (Figure 5-12) demonstrates how to send a POST request to the server to add an item to a todo list, then load the page and validate that it is shown. For more information about REST-assured, see the project home website:

https://code.google.com/p/rest-assured/

```
@Before
public void setUp()
{
   RestAssured.baseURI = "http://localhost";
   RestAssured.port = 9080;
   RestAssured.basePath = "/api";

   wt = new WebTester();
   wt.setTestingEngineKey(TestingEngineRegistry.TESTING_ENGINE_HTMLUNIT);
   wt.setBaseUrl("http://localhost:9080");
}

@Test
public void testAddList()
{
   // Check that no lists exist already
   expect().
      statusCode(200).
      body("size()", is(0)).
   when().
      get("/lists");

   // Add a test list
   given().
      contentType(MediaType.APPLICATION_JSON).
      body("{\"name\": \"test list name\", \"description\": \"test list 
description\"}").
   then().expect().
      statusCode(200).
      body(instanceOf(String.class)).
   when().
      post("/lists");

   // Check that the new list was added
   expect().
      statusCode(200).
      body("size()", is(1)).
   when().
      get("/lists");

   // Check the Dojo UI displays the new list
   wt.beginAt("index.html");
   waitForJavaScriptRendering(DEFAULT_WAIT_TIME);
   wt.assertTextPresent("test list name - test list description");
}
```

Figure 5-12 Integration test that uses JWebUnit and REST-assured

5.2 Apache Wicket

Another web framework that we tested with the Liberty profile server is Apache Wicket. It is a Java based open source web framework offering many unique features. Pages and components are plain old Java objects (POJOs) with the markup in HTML, which means you can use any IDE and develop complex applications by using encapsulation, inheritance, and events. The stateless nature of the framework allows you to create complex web flows that, at any time, you can revert to the previous state of your page object. The clear separation between Java objects and corresponding markup in HTML make development and further maintenance much easier. Page objects can be easily bound to the application data by using Wicket models. Many open source libraries are available that offer easy-to-use web components, such as Ajax-based data grids with built-in sorting or paging, calendars, tabs, and many other components. Changing the component behavior or "look and feel" often is done by overriding the component methods so you do not need to be a JavaScript or HMTL master to use it. For more information about the Wicket framework, see the following website:

http://wicket.apache.org

5.2.1 Simple Todo application in Apache Wicket

Apache Wicket is a server-based Java web framework and it can easily use Spring or EJB beans. Our example uses Spring framework for Dependency Injection. Spring beans use JPA and Hibernate to permit our application data to be in an H2 database. Our goal is to demonstrate the simple create, retrieve, update, and delete application with a bit of style by adding the Bootstrap CSS.

5.2.2 Setting up the Apache Wicket with Spring and JPA Hibernate project

You can start developing in Wicket by creating a simple Java web project in Eclipse and add the Wicket core library or use Maven and the Wicket archetype to generate a project.

For information about setting up the Wicket project with Maven, see the following website:

http://wicket.apache.org/start/quickstart.html

Our Todo application has other dependencies to `todo-service-api` and `todo-service-jpa-impl`. Both projects provide the data model that we are using and the database persistence layer. To inject our database service in our Wicket web application, we use Spring Framework. To add Spring to our project, we add two dependencies:

```
<dependency>
         <!-- Spring Framework -->
         <groupId>org.springframework</groupId>
         <artifactId>spring-web</artifactId>
         <version>${spring.version}</version>
      </dependency>
      <dependency>
         <!-- Spring Support for Wicket -->
         <groupId>org.apache.wicket</groupId>
         <artifactId>wicket-spring</artifactId>
         <version>${wicket.version}</version>
      </dependency>
```

The `spring-web` artifact provides all the necessary Spring libraries that we need and `wicket-spring` is a bridge between Wicket and Spring. Using it, we can use the annotations in Wicket pages for dependency injection. To make our pages nice-looking by enabling the Ajax check box and calendar, we add Wicket extension and date-time libraries:

```
<dependency>
        <groupId>org.apache.wicket</groupId>
        <artifactId>wicket-extensions</artifactId>
        <version>6.10.0</version>
     </dependency>
     <dependency>
        <groupId>org.apache.wicket</groupId>
        <artifactId>wicket-datetime</artifactId>
        <version>6.11.0</version>
     </dependency>
```

The complete Maven `pom.xml` file is available in the source code of the Todo application. Developing in Apache Wicket does not require any specific IDE. You can use Eclipse or, alternatively in the Eclipse Marketplace, you can learn about the QWickie plug-in that helps with development.

5.2.3 Developing the Todo application

Having a Java web project and all the necessary libraries, you can start developing the application. In Wicket, start from the application class that extends the Wicket Application abstract class. In the Todo application example, it is named `WicketApplication.class` and it overrides two methods, as shown in Example 5-1.

Example 5-1 Override

```
@Component("wicketApplication")
public class WicketApplication extends WebApplication
{
   @Override
   public Class< ? extends WebPage> getHomePage()
   {
      return ToDoListsPage.class;
   }

   @Override
   public void init()
   {
      super.init();
      getComponentInstantiationListeners().add(new SpringComponentInjector(this));
      mountBookmarkablePages();
   }
```

As the example shows, a **`getHomePage()`** method returns a `ToDoListPage` class; by doing this, we always get this page as a home page for our application. The second **`init()`** method is important because you might need to initialize several things when the application starts. In the sample Todo application, you must initialize Spring Framework and then mount other pages.

For Spring integration, the line of code in Example 5-2 is needed.

Example 5-2 Necessary code

```
getComponentInstantiationListeners().add(new SpringComponentInjector(this));
and the @Component annotation
@Component("wicketApplication")
public class WicketApplication extends WebApplication
```

To complete the Spring framework integration with Wicket, create the `applicationcontext.xml` file under the `WEB-INF` folder of the application. In this file, enable the annotation scanning for one or more code packages. In the Todo list example, two packages will be scanned.

To enable scanning, add the following two lines in the `applicationcontext.xml` file:

```
<ctx:component-scan base-package="todo.service" />
<ctx:component-scan base-package="todo.ui.wicket" />
```

The last step is to add necessary servlet and filter details in to the `web.xml` descriptor file, as shown in Example 5-3.

Example 5-3 Add servlet and filter details

```
<filter>
      <filter-name>wicket.WicketProject</filter-name>
      <filter-class>org.apache.wicket.protocol.http.WicketFilter</filter-class>
      <init-param>
         <param-name>applicationFactoryClassName</param-name>
         <param-value>org.apache.wicket.spring.SpringWebApplicationFactory</param-value>
      </init-param>
      <init-param>
         <param-name>applicationClassName</param-name>
         <param-value>todo.ui.wicket.WicketApplication</param-value>
      </init-param>
   </filter>

   <filter-mapping>
      <filter-name>wicket.WicketProject</filter-name>
      <url-pattern>/*</url-pattern>
   </filter-mapping>

   <listener>

<listener-class>org.springframework.web.context.ContextLoaderListener</listener-class>
   </listener>
```

Now, you can start developing pages. The first page to be implemented is the ToDoListPage because it is a home page of the application. This class extends an AbstractBasePage class with some common code shared among all pages. This abstract class has a field of type `TodoListService` and reference name `backend` with the `@SpringBean` annotation:

```
@SpringBean
   protected TodoListService backend;
```

The @SpringBean annotation is from the wicket-spring library that acts as a bridge between Wicket and Spring. Based on it, Spring injects the implementation of the TodoListService interface. The implementation is just a POJO class with the Spring @Service annotation in todo-service-jpa-impl. Wicket is a Java framework where pages and its components are Java objects. Examine the code snippet in Example 5-4.

Example 5-4 Code snippet

```
add(new Label("lists-count", new AbstractReadOnlyModel<Object>()
        {
           @Override
           public Object getObject()
           {
              return backend.getLists().size();
           }
        }));
```

As you can see, there is a new Label object that is added to the page by using the keyword add. It has two parameters in its constructor:

- The first is of type String and is named "lists-count". The name "lists-count" is later used in the HTML file corresponding to the POJO page class.
- The second is a model object that holds data to be rendered. This model is a wrapper object that is provided by Wicket.

See the corresponding HTML file that contains the following line:

```
   <div class="panel-heading">You currently have <span
wicket:id="items-count">2</span> items in this TODO list.</div>
```

An important step is to ensure that all your page components have unique names and HTML tags in the corresponding HTML file with the same names. In this example, the wicket:id="items-count" gives Wicket information where you want your label to be rendered. If a mistake in component name exists, Wicket throws an exception, so every page component that is added to the page class must have an HTML tag with a proper wicket:id name.

In more complex scenarios, you also must handle object hierarchy. In the Todo application, you can obtain a form for saving new Todo items. The form object has two fields: name and description. Object hierarchy must be properly defined in the page class and HTML file.

The second parameter of Label object is a new instance of the Wicket's model object. Wicket provides an IModel interface and several implementations that you can use while developing applications. In general, Model in Wicket is an object that wraps and holds data that you want to display or edit on your page. Example 5-4 shows a new AbstractReadOnlyModel<Object> object as a second parameter in the label constructor. This new model object has the **getModelObject()** method that, in the example, returns several Todo list elements. This method uses an injected Spring bean that calls the JPA hibernate and database to retrieve this value. For this simple value, you want to render the *AbstractReadOnlyModel* model implementation on your page. When you must display and edit the value of an object, you use the PropertyModel object or CompoundPropertyModel. In the ToDoListPage.java class, you can find a more complex example of the CompoundPropertyModel that is used in a form object. See Example 5-5.

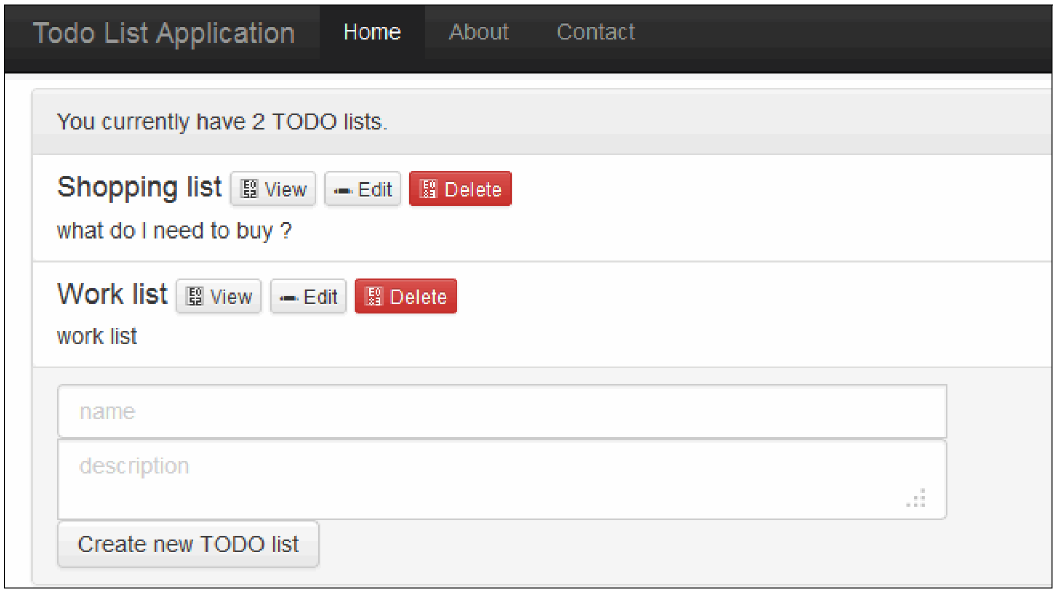
Example 5-5 More complex CompoundProertyModel

```
add(new Form<TodoList>("new-todo-list-form", new
CompoundPropertyModel<TodoList>(newTodoList))
        {
                {
                    add(new TextField<String>("name").setRequired(true));
                    add(new TextArea<String>("description"));
                    final Button submitButton = new Button("submitButton")
                        {
                            @Override
                            public void onSubmit()
                            {
                                LOG.debug("Creating new TODO list[name={}]...",
newTodoList.getName());
                                backend.createList(newTodoList);
                                getSession().info(newTodoList.getName() + " list has been
created.");
                                setResponsePage(ToDoListsPage.class);
                            }
                        };
                    add(submitButton);
                }
            });
```

The CompoundPropertyModel with the <TodoList> type now allows you to define subcomponents of type TextField andTextArea. You now use the names of the TodoList object fields as parameters in the text field constructors. This simplifies development when handling large and complex objects that have many fields. You can use any web component that is offered by the Wicket framework, and by using names that you can map a component to the particular field. Each type of Wicket model holds data differently. Learn more about models in the Wicket documentation that is found at the following website:

https://cwiki.apache.org/confluence/display/WICKET/Models

Finally, when you build and run the Todo application, you are redirected to the `localhost:9080` URL and the Todo list window opens (Figure 5-13).



You currently have 2 TODO lists.

Shopping list

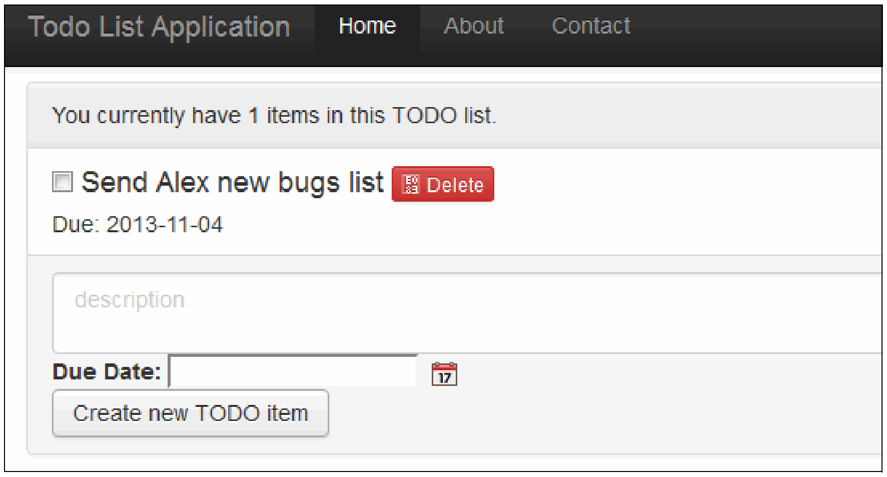
what do I need to buy ?

Work list

work list

Figure 5-13 Todo List Application

You can now create Todo lists in each group, as shown in Figure 5-14 on page 69. For each group with many Todo items, you can manage them on the todoListItem page.



You currently have 1 items in this TODO list.

Send Alex new bugs list

Due: 2013-11-04

Figure 5-14 Todo List Application

5.2.4 Issues found during development

While we worked on the Todo application code in our example, one issue occurred on the Liberty profile server. In some cases, when you try to use the `setResponsePage(page.class)` Wicket method, you are redirected to the page but the context root of your application is missing. Assume that your Todo application is deployed under the `localhost:9080/mytodo` context root path. The problem that you might encounter is that the setResponsePage redirects you to the `localhost:9080` URL. A bug has been reported on the Wicket forum, but a workaround exists for this issue. To get the relative pages redirected correctly, add the code snippet from Example 5-6 to your Wicket Application class.

Example 5-6 Add this code to your Wicket Application class

```
@Override
protected WebResponse newWebResponse(final WebRequest webRequest, final
HttpServletResponse httpServletResponse)
   {
      return new ServletWebResponse((ServletWebRequest) webRequest,
httpServletResponse)
         {
            @Override
            public String encodeRedirectURL(final CharSequence relativeURL)
            {
               return new
UrlRenderer(webRequest).renderFullUrl(Url.parse(relativeURL));
            }
         };
   }
```

This code ensures that Liberty profile server is working only with the absolute URLs. If you do not use the **`setResponsePage()`** method or any Ajax components in your application, you might not encounter this issue.

5.2.5 Testing the Todo Wicket application

For integration and testing purposes in our example, we used the `jwebunit-htmlunit-plugin`, which can be found at the following website:

http://jwebunit.sourceforge.net/jwebunit-htmlunit-plugin/

The HtmlUnit is a Java based headless browser implementation; JWebUnit is an extension providing a slick DSL language to describe test cases. Also, we use the `maven-failsafe-plugin` to stop the Liberty profile server after a failed build. The Wicket project `pom.xml` contains all the needed dependencies and plug-in configuration. The basic concept is that we start the WebSphere Application Server Liberty profile, deploy the wicket Todo application, and run the integration tests. The `server.xml` and `jvm.options` files under the `wlp-config` folder is where you can find the server configuration. The key point is that the tests that are performed by using the `jwebunit-htmlunit-plugin` allows you to test the real HTML output of the server through HTTP. It acts as a normal browser working independently. You can test the HTML components and JavaScript code, and simulate the user interaction with your application. Examine the test code snippet in Example 5-7.

Example 5-7 Test code snippet

```
public void testWicketApplication()
{
final WebTester tester = new WebTester();
   tester.setBaseUrl("http://localhost:9080");
   tester.setTestingEngineKey(TestingEngineRegistry.TESTING_ENGINE_HTMLUNIT);
   tester.beginAt("/");
   tester.assertTitleEquals("Todo List Application");
   tester.assertTextPresent("You currently have");
   tester.assertFormPresent("new_todo_list_form1");
   // create two new todo lists
   tester.setTextField("name", "List1_Name");
   tester.setTextField("description", "List1_Description");
   tester.submit("submitButton");
   tester.setTextField("name", "List2_Name");
   tester.setTextField("description", "List2_Description");
   tester.submit("submitButton");
     tester.assertTextPresent("List1_Name");
   tester.assertTextPresent("List2_Name");
   tester.assertTextPresent("List1_Description");
   tester.assertTextPresent("List2_Description");
```

Developing complex test scenarios independently of any web framework you might have used can be easy to do. In this simple Todo application example, we test only the title of the Todo list page, and ensure that there are some HTML components present with certain names. Finally, we add a test todo list in a form, test the save button, and ensure that we successfully added a new todo list.

We have one more item to mention in the `server.xml` configuration file: the Maven placeholder variable `${project.build.directory}/${project.build.finalName}`. This variable is resolved later by the `maven-resources-plugin` because we do not point to the WAR file but to the exploded WAR location to improve the application start and reload performance. Now, we examine the Maven configuration.

When running integration tests by using the **`mvn verify`** command, based on our configuration in the `pom.xml` file, the `maven-war-plugin` creates the exploded WAR directory and a packaged WAR file in the `/target` directory.

The following list describes each phase:

- The pre-integration-test phase:
  a. The `maven-resources-plugin` copies the server configuration template from the `src/test/resources/wlp-config/server.xml` file to the `target/wlp-config/server.xml` file. At the same time, it filters the file and resolves and replaces property placeholders with property values that are provided by the Maven run time.
  b. The `liberty-maven-plugin` installs the Liberty profile server binary files from the `todo-liberty-server` artifact to the `target/liberty/wlp` location and creates a defaultServer based on using the configuration file that is in the `target/wlp-config/server.xml` file,
  c. The `liberty-maven-plugin` starts the Liberty profile server instance.
  d. Liberty automatically deploys the WAR file that is configured in the `server.xml` file.
- The integration-test phase:
  a. The `maven-failsafe-plugin` runs JUnit on the WicketApplicationITest test case.
  b. The **`testWicketApplication()`** method instantiates an instance of the JWebUnit WebTester client, points it to the running test server at `localhost:9080`, and performs the user simulation.

  Important: The running of tests matching `*ITest.java` is excluded for the surefire plug-in that runs the test case in the wrong phase (test), which is before the Liberty profile server is created and started.

- The post-integration-test phase:

  The `liberty-maven-plugin` stops the Liberty profile server.

This configuration can also be used for console-based deployments during application development when you do not use Eclipse and the installed Liberty profile server. If you want to create only the server, start it, and deploy the Todo application, you must call **`mvn pre-integration-tests`**. This command starts all plug-ins to set up and deploy a server, but skips integration tests and does not shut down the server.

If you want to make changes to the application code under `/src/main` to redeploy the application, run the **`mvn package`** command. This command creates the web archive; because updateTrigger polling is enabled, the server realizes the change and instantly reloads the application.

If unit test cases exist, you can skip them by using the **`mvn -DskipTests`** package.

To stop WebSphere Liberty profile server, run the **`mvn liberty:stop-server`** command.

6

Deploying the Liberty profile server with Opscode Chef

This chapter describes the basic steps of how to install the Liberty profile server on a remote system and to deploy our sample application by using the Opscode Chef deployment automation solution.

The chapter includes the following topics:

- About Knife, Recipe, and other terms
- Preparing for Chef
- Installing Liberty profile server with Chef

6.1 About Knife, Recipe, and other terms

Chef partially uses a unique terminology in an analogy to real-life cooking, and might be confusing when you are getting started:

- Knife: This command-line tool interacts with the Chef framework. It is used to create cookbooks and configurations and to issue **`deploy`** commands.
- Resource: This is a module that knows how to configure components of a specific type. Just as you might have a resource that is named *blender* in your own kitchen that knows how to configure (that is, puree) vegetables and fruits, Chef has a resource that is named *package* that can install and configure binary packages, and a resource that is named *service* that can manage services.
- Recipe: This collection of instructions must be run in a specific order on a target node to achieve eventually a configuration state that you want. Recipes delegate to resources, which are then responsible for configuring the required components. Recipes might also include other recipes, either from the same or a different cookbook.
- Cookbook: This is a container and name space for one or more recipes and the associated resources, configurations, and metadata.
- Kitchen: This local configuration repository holds all cookbooks, node configurations, and so on, that are required to deploy nodes in an environment. Knife is run within a Kitchen. Kitchens can be managed by version control systems.
- Cooking: With Knife (that is, by running the **`knife solo cook <options>`** command), *cooking* effectively means deploying configurations to one or more target nodes.

For more information, see the following resources:

- Overview of the Chef architecture and its building blocks at the following website:

  `http://docs.opscode.com/chef_overview.html`
- Chef glossary at the following website:

  `https://wiki.opscode.com/display/chef/Glossary`

6.2 Preparing for Chef

This section describes the initial preparations for working with Chef.

The standard Chef setup that is advocated by Opscode involves the installation and configuration of a full Chef server and the rollout of Chef agents on all target nodes. The *chef-solo* stand-alone mode allows local deployments without needing the Chef infrastructure. Using chef-solo with the open source add-on *knife-solo* elegantly overcomes the limitation of “local configurations only,” allowing agent-less deployment of remote nodes.

For more information, see the following resources:

- The knife-solo plug-in is available at the following website:

  `http://matschaffer.github.io/knife-solo/`
- A good introductory video to knife-solo is at the following website:

  `http://devops.mashion.net/2011/08/04/chef-solo-basics/`

6.2.1 Preparing the test machines

For the examples in this chapter to work without alteration, you must prepare two servers (for example, virtual machines) with Ubuntu Server as the operating system.

Prepare two physical or virtual machines within the same network segment with Internet connectivity and complete the following steps on *both* machines:

1. Install Ubuntu Server 14.04, which you can download from the following website:

   http://www.ubuntu.com/download/server

2. Install OpenSSH by running the following command:

   ```
   sudo apt-get install ssh
   ```

3. Create a user who is named `chef`, on both machines, by running the following command:

   ```
   sudo adduser chef
   ```

4. Optional: Grant password-less execution of **`sudo`** commands to the chef user by adding the following line to the `/etc/sudoers` file:

   ```
   chef ALL=NOPASSWD: ALL
   ```

   Note: Although granting this permission is optional, when it is not granted, you might receive password prompts during deployments.

Change the host name of the *first* machine to `chefmaster` and enable SSH connectivity to the *second* machine:

1. Edit the `/etc/hostname` file and change `ubuntu` to `chefmaster`.
2. Edit the `/etc/hosts` file to change `ubuntu` to `chefmaster` and add a line with the IP address of the second machine and the host name `chefslave`, as in this example:

   ```
   192.168.140.3 chefslave
   ```

3. Restart the machine.
4. Verify that you can access the subordinate machine through SSH by using `chefslave` as the host name by running the following command:

   ```
   ssh chef@chefslave
   ```

Change the host name of the *second* machine to `chefslave` and enable SSH connectivity to the *first* machine:

1. Edit the `/etc/hostname` file and change `ubuntu` to `chefslave`.
2. Edit the `/etc/hosts` file, change `ubuntu` to `chefslave`, and add a line with the IP address of the second machine and the host name `chefmaster`, as in this example:

   ```
   192.168.140.2 chefmaster
   ```

3. Restart the machine.
4. Verify that you can access the master machine through SSH by using `chefmaster` as the host name:

   ```
   ssh chef@chefmaster
   ```

6.2.2 Installing Chef

After setting up the initial machine, you can now install Chef on the master node. Log in to `chefmaster` and do the following actions on the command line:

1. Configure password-less SSH Public Key authentication for logins to `chefslave` by using the **`ssh-keygen`** and **`ssh-copy-id`** commands (Example 6-1).

   Example 6-1 Configure SSH Public Key authentication

```
chef@chefmaster:~$ ssh-keygen -t rsa -b 2048
Generating public/private rsa key pair.
Enter file in which to save the key (/home/chef/.ssh/id_rsa):
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/chef/.ssh/id_rsa.
Your public key has been saved in /home/chef/.ssh/id_rsa.pub.
...
chef@chefmaster:~$ ssh-copy-id chef@chefslave
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter out any
that are already installed
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompted now
it is to install the new keys
chef@chefslave's password:

Number of key(s) added: 1

Now try logging into the machine, with:   "ssh 'chef@chefslave'"
and check to make sure that only the key(s) you wanted were added.

chef@chefslave:~$ ssh chef@chefslave
Welcome to Ubuntu 14.04.2 LTS (GNU/Linux 3.16.0-30-generic x86_64)

 * Documentation:  https://help.ubuntu.com/
...
chef@chefslave:~$
```

   Note: Even after setting up password-less SSH authentication, you might still be prompted for a password when running knife-solo commands because some of them rely on the running of Linux commands through **`sudo`**. To avoid this situation, add a corresponding change to the **`sudo`** configuration.

2. Install Chef by using the Opscode multiplatform installer *Omnibus Installer*. See Example 6-2.

   Example 6-2 Install Chef with the Omnibus Installer

```
chef@chefmaster:~$ curl -L https://www.opscode.com/chef/install.sh | sudo bash
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 18736  100 18736    0     0  13557      0  0:00:01  0:00:01 --:--:-- 13566
Downloading Chef  for ubuntu...
...
Installing Chef
installing with dpkg...
Selecting previously unselected package chef.
(Reading database ... 61256 files and directories currently installed.)
Preparing to unpack .../chef_12.3.0-1_amd64.deb ...
Unpacking chef (12.3.0-1) ...
```

```
Setting up chef (12.3.0-1) ...
Thank you for installing Chef!
```

If the **`curl`** command is not installed, you can either install it by running **`sudo apt-get install curl`** or use **`wget`** instead as follows:

```
wget -qO- https://www.opscode.com/chef/install.sh | sudo bash
```

3. Verify that the Chef binary files are installed correctly by using the commands in Example 6-3.

Example 6-3 Chef installation verification

```
chef@ubuntu:~$ tree -L 1 /opt/chef/
/opt/chef/
··· bin
··· embedded
··· version-manifest.json
··· version-manifest.txt

2 directories, 2file

chef@ubuntu:~$ knife -v
Chef: 12.3.0
```

4. Install knife-solo, which adds the **`solo`** subcommand to the **`knife`** command-line tool. After issuing the command, it might take some time until you see any progress in the console. See Example 6-4.

Example 6-4 Install knife-solo

```
chef@chefmaster:~$ sudo /opt/chef/embedded/bin/gem install knife-solo
Fetching: knife-solo-0.4.2.gem (100%)
Thanks for installing knife-solo!

If you run into any issues please let us know at:
  https://github.com/matschaffer/knife-solo/issues

If you are upgrading knife-solo please uninstall any old versions by
running `gem clean knife-solo` to avoid any errors.

See http://bit.ly/CHEF-3255 for more information on the knife bug
that causes this.
Successfully installed knife-solo-0.4.2
Parsing documentation for knife-solo-0.4.2
Installing ri documentation for knife-solo-0.4.2
Done installing documentation for knife-solo after 1 seconds
1 gem installed
```

5. Configure knife with several default values. See Example 6-5. You can ignore the displayed warnings.

Example 6-5 Configure knife

```
chef@chefmaster:~$ knife configure -r . --defaults
WARNING: No knife configuration file found
*****

You must place your client key in:
  /home/chef/.chef/chef.pem
Before running commands with Knife!
```

```
*****

You must place your validation key in:
  /etc/chef-server/chef-validator.pem
Before generating instance data with Knife!

*****
Configuration file written to /home/chef/.chef/knife.rb
```

6. Create a configuration repository called `mychefrepo` in the user's home directory by using the **`knife solo init <reponame>`** command (see Example 6-6).

Example 6-6 Create a configuration repository

```
chef@chefmaster:~$ knife solo init mychefrepo
Creating kitchen...
Creating knife.rb in kitchen...
Creating cupboards...

chef@chefmaster:~$ tree -a mychefrepo/ | grep -v .git
mychefrepo/
··· .chef
·   ··· knife.rb
··· cookbooks
··· data_bags
··· environments
··· nodes
··· roles
··· site-cookbooks

7 directories, 8 files
```

7. Use the **`cd`** command (Example 6-7) to change to the newly created repository and run the **`knife solo prepare chef@chefslave`** command, which installs Chef on the remote subordinate node.

Example 6-7 Install Chef on the remote subordinate node

```
chef@chefmaster:~$ cd mychefrepo
chef@chefmaster:~/mychefrepo$ knife solo prepare chef@chefslave
Bootstrapping Chef...
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 18736  100 18736    0     0  14360      0  0:00:01  0:00:01 --:--:-- 14368
Downloading Chef 12.3.0 for ubuntu...
downloading
https://www.opscode.com/chef/metadata?v=12.3.0&prerelease=false&nightlies=false&p=ubuntu
&pv=14.04&m=x86_64
  to file /tmp/install.sh.8218/metadata.txt
trying wget...
url
https://opscode-omnibus-packages.s3.amazonaws.com/ubuntu/10.04/x86_64/chef_12.3.0-1_amd6
4.deb
md5     d8421c9b3010deb03e713ada00387e8a
sha256  e06eb748e44d0a323f4334aececdf3c2c74d2f97323678ad3a43c33ac32b4f81
downloaded metadata file looks valid...
```

```
downloading
https://opscode-omnibus-packages.s3.amazonaws.com/ubuntu/10.04/x86_64/chef_12.3.0-1_amd6
4.deb
  to file /tmp/install.sh.8218/chef_12.3.0-1_amd64.deb
trying wget...
Comparing checksum with sha256sum...
Installing Chef 12.3.0
installing with dpkg...
Selecting previously unselected package chef.
(Reading database ... 61272 files and directories currently installed.)
Preparing to unpack .../chef_12.3.0-1_amd64.deb ...
Unpacking chef (12.3.0-1) ...
Setting up chef (12.3.0-1) ...
Thank you for installing Chef!
Generating node config 'nodes/chefslave.json'...
```

8. In addition to installing Chef on the subordinate node, the **`knife solo prepare`** command also creates a node configuration file under the `mychefrepo/nodes/chefslave.json` location, with an empty run list configuration of `{"run_list":[]}`. The run list describes which recipes should be run on this node during “cooking”. Even with an empty run list, the deployment process can be started for verification purposes. See Example 6-8.

Example 6-8 Deployment test run

```
chef@chefmaster:~/mychefrepo$ knife solo cook chef@chefslave
Running Chef on chefslave...
Checking Chef version...
Uploading the kitchen...
Generating solo config...
Running Chef...
Starting Chef Client, version 12.3.0
Compiling Cookbooks...
Converging 0 resources

Running handlers:
Running handlers complete
Chef Client finished, 0/0 resources updated in 1.465028986 seconds
```

When you run the **`knife solo cook`** command, knife-solo generates a chef-solo configuration based on the content of `mychefrepo`, uploads it to the `/home/chef/chef-solo` directory on the remote node (`chefslave`), and starts the **`chef-solo`** command on the remote node to perform the local deployment based on the currently empty run list configuration.

6.3 Installing Liberty profile server with Chef

Now that knife-solo is installed and remote connectivity is verified, you can configure `mychefrepo` for the Liberty profile server deployments to the subordinate node.

6.3.1 Loading the wlp cookbook

To install the Liberty profile server by using Chef, the wlp cookbook that contains the necessary recipes must be loaded into the local repository. To achieve this task, first download the cookbook by using the **`knife cookbook site download <cookbook>`** command and then extract the archives content into the `mychefrepo` `cookbooks` directory. See Example 6-9.

Example 6-9 Install the wlp cookbook

```
chef@chefmaster:~/mychefrepo$ cd cookbooks

chef@chefmaster:~/mychefrepo/cookbooks$ knife cookbook site download wlp
Downloading wlp from the cookbooks site at version 0.3.0 to
/home/chef/mychefrepo/cookbooks/wlp-0.3.0.tar.gz
Cookbook saved: /home/chef/mychefrepo/cookbooks/wlp-0.3.0.tar.gz

chef@chefmaster:~/mychefrepo/cookbooks$ tar -xzf wlp-0.3.0.tar.gz

chef@chefmaster:~/mychefrepo/cookbooks$ rm wlp-0.3.0.tar.gz

chef@chefmaster:~/mychefrepo/cookbooks$ tree -L 2
.
··· wlp
    ··· attributes
    ··· Berksfile
    ··· CHANGELOG.md
    ··· CONTRIBUTING.md
    ··· DEVELOPING.md
    ··· Gemfile
    ··· libraries
    ··· LICENSE
    ··· metadata.json
    ··· metadata.rb
    ··· providers
    ··· Rakefile
    ··· README.md
    ··· recipes
    ··· resources
    ··· templates
```

6.3.2 Deploying the Liberty profile server binary files

Download the Liberty binary JAR files from the following location and place them in a directory on a web server that is reachable from the test servers:

`https://developer.ibm.com/wasdev/downloads/liberty-profile-using-non-eclipse-environments/`

For example, place them here:

`http://repo.local/wlp/8.5.5.6/`

The cookbook's website lists all the contained recipes and configurable attributes:

http://community.opscode.com/cookbooks/wlp

Based on this information, modify the chefslave's node configuration at `mychefrepo/nodes/chefslave.json`, as shown in Example 6-10.

Example 6-10 Chef subordinate node configuration to install the Liberty profile server

```
{
   "wlp": {
      "user": "wlp",
      "group": "wlp",
      "base_dir": "/opt/ibm",
      "install_method": "archive",
      "install_java": true,
      "archive": {
         "base_url": "http://repo.local/wlp/8.5.5.6/",
         "accept_license": true,
         "extended": { "install": true },
         "extras": { "install": false }
      }
   },

   "run_list":["recipe[wlp::default]"]
}
```

This configuration instructs chef to run the default receipt that is found in the wlp cookbook and parameterize its execution with the configuration parameters. The current configuration results in an installation of the Liberty profile server at `/opt/ibm/wlp` under ownership of a to-be-created user wlp. The Liberty profile server binary files are automatically downloaded from the specified IBM website during installation, including the extended content.

No cost versus license: Be aware that these binary files are provided as a no-charge option for development purposes only. If you plan to deploy Liberty profile server to production, you must purchase an appropriate license.

To install Liberty profile server, you must "cook" the subordinate node again by running **`knife`**. See Example 6-11.

Example 6-11 Deploy Liberty profile server binary files - failing attempt

```
chef@chefmaster:~/mychefrepo$ knife solo cook chef@chefslave
Running Chef on chefslave...
Checking Chef version...
Uploading the kitchen...
Generating solo config...
Running Chef...
Starting Chef Client, version 12.3.0
Compiling Cookbooks...

Running handlers:
[2015-05-28T12:12:28+09:00] ERROR: Running exception handlers
Running handlers complete
[2015-05-28T12:12:28+09:00] ERROR: Exception handlers complete
```

```
[2015-05-28T12:12:28+09:00] FATAL: Stacktrace dumped to
/var/chef/cache/chef-stacktrace.out
Chef Client failed. 0 resources updated in 1.279817549 seconds
[2015-05-28T12:12:29+09:00] ERROR: Cookbook java not found. If you're loading java
from another cookbook, make sure you configure the dependency in your metadata
[2015-05-28T12:12:29+09:00] FATAL: Chef::Exceptions::ChildConvergeError: Chef run
process exited unsuccessfully (exit code 1)
ERROR: RuntimeError: chef-solo failed. See output above.
```

Unfortunately, the first attempt to deploy Liberty profile server failed. The reason is that the wlp cookbook has a reference to another cookbook called *java*, which must be made available to the local repository too. Several other cookbooks are also missing, which you realize on subsequent attempts. To have the deployment succeed, you must install these cookbooks: java, aws, windows, and chef_handler. See Example 6-12.

Example 6-12 Load the required cookbooks in to the repository

```
chef@chefmaster:~/mychefrepo$ cd cookbooks/

chef@chefmaster:~/mychefrepo/cookbooks$ knife cookbook site download java
Downloading java from the cookbooks site at version 1.31.0 to
/home/chef/mychefrepo/cookbooks/java-1.31.0.tar.gz
Cookbook saved: /home/chef/mychefrepo/cookbooks/java-1.31.0.tar.gz

chef@chefmaster:~/mychefrepo/cookbooks$ knife cookbook site download aws
Downloading aws from the cookbooks site at version 2.7.0 to
/home/chef/mychefrepo/cookbooks/aws-2.7.0.tar.gz
Cookbook saved: /home/chef/mychefrepo/cookbooks/aws-2.7.0.tar.gz

chef@chefmaster:~/mychefrepo/cookbooks$ knife cookbook site download windows
Downloading windows from the cookbooks site at version 1.37.0 to
/home/chef/mychefrepo/cookbooks/windows-1.37.0.tar.gz
Cookbook saved: /home/chef/mychefrepo/cookbooks/windows-1.37.0.tar.gz

chef@chefmaster:~/mychefrepo/cookbooks$ knife cookbook site download chef_handler
Downloading chef_handler from the cookbooks site at version 1.1.9 to
/home/chef/mychefrepo/cookbooks/chef_handler-1.1.9.tar.gz
Cookbook saved: /home/chef/mychefrepo/cookbooks/chef_handler-1.1.9.tar.gz

chef@chefmaster:~/mychefrepo/cookbooks$ find *.tar.gz -exec tar -xzf {} \;

chef@chefmaster:~/mychefrepo/cookbooks$ rm *.tar.gz

chef@chefmaster:~/mychefrepo/cookbooks$ ls
aws  chef_handler  java  windows  wlp
```

After the required cookbooks are installed, you can retry the deployment. See Example 6-13.

Example 6-13 Deploy Liberty profile server binary files - successful attempt

```
chef@chefmaster:~/mychefrepo$ knife solo cook chef@chefslave
Running Chef on chefslave...
Checking Chef version...
Uploading the kitchen...
Generating solo config...
Running Chef...
```

```
Starting Chef Client, version 12.3.0
Compiling Cookbooks...
Converging 14 resources
Recipe: wlp::default
  * group[wlp] action create
    - create wlp
  * user[wlp] action create
    - create user wlp
  * directory[/opt/ibm] action create
    - create new directory /opt/ibm
    - change mode from '' to '0755'
    - change owner from '' to 'wlp'
    - change group from '' to 'wlp'
Recipe: java::openjdk
  * apt_package[openjdk-6-jdk] action install

    - install version 6b35-1.13.7-1ubuntu0.14.04.1 of package openjdk-6-jdk
  * apt_package[openjdk-6-jre-headless] action install (up to date)
  * java_alternatives[set-java-alternatives] action set
    - Add alternative for apt
    - Add alternative for java
    - Set alternative for java
    - Add alternative for javaws
    - Set alternative for javaws
    - Add alternative for keytool
    - Set alternative for keytool
    - Add alternative for orbd
    - Set alternative for orbd
    - Add alternative for pack200
    - Set alternative for pack200
    - Add alternative for policytool
    - Set alternative for policytool
    - Add alternative for rmid
    - Set alternative for rmid
    - Add alternative for rmiregistry
    - Set alternative for rmiregistry
    - Add alternative for servertool
    - Set alternative for servertool
    - Add alternative for tnameserv
    - Set alternative for tnameserv
    - Add alternative for unpack200
    - Set alternative for unpack200
Recipe: java::default_java_symlink
  * link[/usr/lib/jvm/default-java] action create
    - create symlink at /usr/lib/jvm/default-java to
/usr/lib/jvm/java-6-openjdk-amd64
Recipe: java::set_java_home
  * ruby_block[set-env-java-home] action run
    - execute the ruby block set-env-java-home
  * directory[/etc/profile.d] action create (up to date)
  * file[/etc/profile.d/jdk.sh] action create
    - create new file /etc/profile.d/jdk.sh
    - update content in file /etc/profile.d/jdk.sh from none to 37eba7
    --- /etc/profile.d/jdk.sh   2015-05-28 12:20:57.969165302 +0900
    +++ /etc/profile.d/.jdk.sh20150528-10989-14y6cn     2015-05-28
12:20:57.969165302 +0900
    @@ -1 +1,2 @@
    +export JAVA_HOME=/usr/lib/jvm/java-6-openjdk-amd64
    - change mode from '' to '0755'
Recipe: wlp::_archive_install
  * remote_file[/var/chef/cache/wlp-developers-runtime-8.5.5.4.jar] action create
    - create new file /var/chef/cache/wlp-developers-runtime-8.5.5.4.jar
    - update content in file /var/chef/cache/wlp-developers-runtime-8.5.5.4.jar
from none to 4a65f4
    (file sizes exceed 10000000 bytes, diff output suppressed)
    - change owner from '' to 'wlp'
    - change group from '' to 'wlp'
  * remote_file[/var/chef/cache/wlp-developers-extended-8.5.5.4.jar] action create
    - create new file /var/chef/cache/wlp-developers-extended-8.5.5.4.jar
    - update content in file /var/chef/cache/wlp-developers-extended-8.5.5.4.jar
from none to 590478
    (file sizes exceed 10000000 bytes, diff output suppressed)
    - change owner from '' to 'wlp'
    - change group from '' to 'wlp'
  * execute[install wlp-developers-runtime-8.5.5.4.jar] action run
    - execute java -jar /var/chef/cache/wlp-developers-runtime-8.5.5.4.jar
--acceptLicense /opt/ibm
  * execute[install wlp-developers-extended-8.5.5.4.jar] action run
    - execute java -jar /var/chef/cache/wlp-developers-extended-8.5.5.4.jar
--acceptLicense /opt/ibm

Running handlers:
Running handlers complete
Chef Client finished, 12/14 resources updated in 183.322256896 seconds
```

You can now log in to the subordinate node and verify the correct installation of the Liberty profile server binary files. See Example 6-14.

Example 6-14 Verify the Liberty profile server binary installation on the remote node

```
chef@chefslave:~$ ls -l /opt/ibm/wlp/
total 64
drwxr-xr-x 5 wlp wlp  4096 May 28 12:22 bin
drwxr-xr-x 3 wlp wlp  4096 May 28 12:22 clients
-rw-r--r-- 1 wlp wlp   307 May 28 12:22 Copyright.txt
drwxr-xr-x 5 wlp wlp  4096 May 28 12:22 dev
drwxr-xr-x 3 wlp wlp  4096 May 28 12:22 lafiles
drwxr-xr-x 8 wlp wlp 24576 May 28 12:22 lib
-rw-r--r-- 1 wlp wlp 11428 May 28 12:22 README.TXT
drwxr-xr-x 3 wlp wlp  4096 May 28 12:22 templates
drwxr-xr-x 4 wlp wlp  4096 May 28 12:22 usr

chef@chefslave:~$ /opt/ibm/wlp/bin/productInfo validate
Start product validation...
Validating feature: appSecurity-1.0... PASS!
Validating feature: appSecurity-2.0... PASS!
Validating feature: beanValidation-1.0... PASS!
Validating feature: blueprint-1.0... PASS!
Validating feature: cdi-1.0... PASS!
...
```

```
Validating feature: wasJmsSecurity-1.0... PASS!
Validating feature: wasJmsServer-1.0... PASS!
Validating feature: webCache-1.0... PASS!
Validating feature: webProfile-6.0... PASS!
Validating feature: wmqJmsClient-1.1... PASS!
Validating feature: wsSecurity-1.1... PASS!
Product validation completed successfully.
```

6.3.3 Creating Liberty profile server configurations

Now that the Liberty profile server binary installation is successful, you can extend the node configuration and add instructions to create two dedicated Liberty profile server configurations for the REST-based and the Wicket-based Todo List Application.

This task can be achieved by using the serverconfig recipe of the wlp cookbook. This recipe has its configuration under the [“wlp”] [“servers”] key in the attributes map. Add the configuration that is outlined in Example 6-15 to the `mychefrepo/nodes/chefslave.json` file.

Example 6-15 Extended Chef subordinate node configuration with server creation recipe

```
{
   "wlp": {
      "user": "wlp",
      "group": "wlp",
      "base_dir": "/opt/ibm",
      "install_method": "archive",
      "install_java": true,
      "archive": {
         "base_url": "http://repo.local/wlp/8.5.5.6/",
         "accept_license": true,
         "extended": { "install": true },
         "extras": { ”install": false }
      },
      "servers": {
         "defaultServer" : { "enabled": false },
         "todo-ui-rest" : {
            "enabled": true,
            "description" : "Server for REST-based TODO list application",
            "featureManager" : {
               "feature": [ "servlet-3.1", "jaxrs-2.0", "ejbLite-3.2" ]
            },
            "httpEndpoint" : {
               "id" : "defaultHttpEndpoint",
               "host" : "*",
               "httpPort" : "9081"
            }
         },
         "todo-ui-wicket" : {
            "enabled": true,
            "description" : "Server for Wicket-based TODO list application",
            "featureManager" : {
               "feature": [ "servlet-3.1", "jdbc-4.1", "jndi-1.0" ]
            },
            "httpEndpoint" : {
               "id" : "defaultHttpEndpoint",
               "host" : "*",
               "httpPort" : "9082"
            }
         }
      }
   },

   "run_list":["recipe[wlp::default]", "recipe[wlp::serverconfig]"]
}
```

By default, the `serverconfig` recipe creates a new server configuration called defaultServer. To avoid that, we set the enabled option to `FALSE` for the defaultServer.

Using the feature option for each server, only those runtime features are enabled that are required by the respective application. The `wlp::serverconfig` recipe is added to the end of the `run_list` attribute value. In this way, the recipe is run after the `wlp::default` recipe, which is responsible for installing the Liberty profile server binary files.

After you update the node configuration, run the **knife solo cook** command again (Example 6-16).

Example 6-16 Output of Liberty profile server creation with knife-solo

```
chef@chefmaster:~/mychefrepo$ knife solo cook chef@chefslave
Running Chef on chefslave...
Checking Chef version...
Uploading the kitchen...
Generating solo config...
Running Chef...
Starting Chef Client, version 12.3.0
Compiling Cookbooks...
Converging 18 resources
Recipe: wlp::default
  * group[wlp] action create (up to date)
  * user[wlp] action create (up to date)
  * directory[/opt/ibm] action create (up to date)
Recipe: java::openjdk
  * apt_package[openjdk-6-jdk] action install (up to date)
  * apt_package[openjdk-6-jre-headless] action install (up to date)
  * java_alternatives[set-java-alternatives] action set (up to date)
Recipe: java::default_java_symlink
  * link[/usr/lib/jvm/default-java] action create (up to date)
Recipe: java::set_java_home
  * ruby_block[set-env-java-home] action run
    - execute the ruby block set-env-java-home
  * directory[/etc/profile.d] action create (up to date)
  * file[/etc/profile.d/jdk.sh] action create (up to date)
Recipe: wlp::_archive_install
  * remote_file[/var/chef/cache/wlp-developers-runtime-8.5.5.4.jar] action create
(skipped due to not_if)
 * remote_file[/var/chef/cache/wlp-developers-extended-8.5.5.4.jar] action create
(skipped due to not_if)
  * execute[install wlp-developers-runtime-8.5.5.4.jar] action run (skipped due to
not_if)
  * execute[install wlp-developers-extended-8.5.5.4.jar] action run (skipped due
to not_if)
Recipe: wlp::serverconfig
  * directory[/opt/ibm/wlp/usr/servers/todo-ui-rest] action create
    - create new directory /opt/ibm/wlp/usr/servers/todo-ui-rest
    - change mode from '' to '0775'
    - change owner from '' to 'wlp'
    - change group from '' to 'wlp'
  * wlp_config[/opt/ibm/wlp/usr/servers/todo-ui-rest/server.xml] action create

  * directory[/opt/ibm/wlp/usr/servers/todo-ui-wicket] action create
    - create new directory /opt/ibm/wlp/usr/servers/todo-ui-wicket
    - change mode from '' to '0775'
    - change owner from '' to 'wlp'
    - change group from '' to 'wlp'
  * wlp_config[/opt/ibm/wlp/usr/servers/todo-ui-wicket/server.xml] action create


Running handlers:
Running handlers complete
Chef Client finished, 5/14 resources updated in 3.929106105 seconds
```

Deploying a fresh node with this configuration can result in the installation of Java, the Liberty binary files, and eventually in the creation of the server configurations. Because all operations in Chef are independent, deploying a subordinate node (which already has Java and the Liberty profile server binary files that are installed from the previous deployment) creates only the two server configurations. Execution of the other recipes result in no system changes.

You can now verify the created server configurations on the subordinate node (see Example 6-17).

Example 6-17 Verification of the created server configurations on the subordinate node

```
chef@chefslave:~$ tree /opt/ibm/wlp/usr/servers/
/opt/ibm/wlp/usr/servers/
··· todo-ui-rest
·   ··· server.xml
··· todo-ui-wicket
    ··· server.xml

2 directories, 2 files
chef@chefslave:~$ cat /opt/ibm/wlp/usr/servers/todo-ui-rest/server.xml
<server description="Server for REST-based TODO list application">
  <featureManager>
    <feature>servlet-3.1</feature>
    <feature>jaxrs-2.0</feature>
    <feature>ejbLite-3.2</feature>
  </featureManager>
  <httpEndpoint id="defaultHttpEndpoint" host="*" httpPort="9081"/>
</server>

chef@chefslave:~$ cat /opt/ibm/wlp/usr/servers/todo-ui-wicket/server.xml
<server description="Server for Wicket-based TODO list application">
  <featureManager>
    <feature>servlet-3.1</feature>
    <feature>jdbc-4.1</feature>
    <feature>jndi-1.0</feature>
  </featureManager>
  <httpEndpoint id="defaultHttpEndpoint" host="*" httpPort="9082"/>
</server>
```

6.3.4 Starting Liberty profile servers

At the time of writing, the available version of the wlp cookbook implements functions to start and stop Liberty profile servers only as resource modules and not as recipes. Because only recipes can be specified in a node configuration's run list, we must create our own recipes that use these resources.

When updating the wlp cookbook sample, we do not create our recipes in the existing wlp cookbook but create a cookbook that is named todoapp that holds our recipes, as shown in Example 6-18.

Example 6-18 Create a cookbook

```
chef@chefmaster:~/mychefrepo$ knife cookbook create todoapp -o cookbooks
** Creating cookbook todoapp in /home/chef/mychefrepo/cookbooks
** Creating README for cookbook: todoapp
** Creating CHANGELOG for cookbook: todoapp
** Creating metadata for cookbook: todoapp
```

Because we want to use resources that are defined in the wlp cookbook in our recipes part of the todoapp cookbook, we must declare a dependency to the wlp cookbook. This is done by adding the following line to the `mychefrepo/cookbooks/todoapp/metadata.rb` file (Example 6-19):

```
depends 'wlp'
```

Example 6-19 Cookbook metadata file with declared wlp dependency

```
chef@chefmaster:~/mychefrepo$ cat cookbooks/todoapp/metadata.rb
name             'todoapp'
maintainer       'YOUR_COMPANY_NAME'
maintainer_email 'YOUR_EMAIL'
license          'All rights reserved'
description      'Installs/Configures todoapp'
long_description IO.read(File.join(File.dirname(__FILE__), 'README.md'))
version          '0.1.0'
depends          'wlp'
```

After making the resources of the wlp cookbook available to the local name space of recipes in our cookbook, we now create a recipe that is named *start-servers* that starts all servers that are defined in the node's attributes map under the `["wlp"]["servers"]` key that has the `enabled` attribute set to `TRUE`. We simply reuse the `wlp::serverconfig` recipe's attribute configuration in the node configuration file.

In `mychefrepo`, create a recipe at `cookbooks/todoapp/recipes/start-servers.rb` by using the content that is shown in Example 6-20.

Example 6-20 start-servers recipe

```
#
# Cookbook Name:: todoapp
# Recipe:: start-servers

# iterate over all entries under the ["wlp"]["servers"] key
# of the current node's attributes map
node[:wlp][:servers].each_pair do |key, value|
   map = value.to_hash()
   enabled = map.fetch("enabled", nil)

   # only consider enabled servers
   if enabled.nil? || enabled == true
      # determine the server-name based on the "serverName" attribute value
      # if exists, otherwise use the key of the current "servers" map entry
      serverName = map.fetch("serverName", nil) || key

      # for each server execute the recipe wlp_server::start
      wlp_server "#{serverName}" do
         # clean all caches before server start
         clean true
         action :start
      end

   end
end
```

To use the start-servers recipe, we add it to the run list of the node configuration. Therefore, alter the `run_list` declaration in the `nodes/chefslave.json` file as follows:

```
"run_list":["recipe[wlp::default]", "recipe[wlp::serverconfig]",
"recipe[todoapp::start-servers]"]
```

Rerunning the deployment by running the **`knife solo cook`** command now starts the servers that are defined in the node configuration. See Example 6-21.

Example 6-21 Run a deployment that starts Liberty profile servers

```
chef@chefmaster:~/mychefrepo$ knife solo cook chef@chefslave
Running Chef on chefslave...
Checking Chef version...
Uploading the kitchen...
Generating solo config...
Running Chef...
Starting Chef Client, version 12.3.0
Compiling Cookbooks...
Converging 20 resources
Recipe: wlp::default
   ... (output omitted)
Recipe: todoapp::start-servers
   ... (output omitted)
- change mode from '' to '0755'
    - change owner from '' to 'root'
    - change group from '' to 'root'
  * service[wlp-todo-ui-rest] action enable
    - enable service service[wlp-todo-ui-rest]
  * service[wlp-todo-ui-rest] action start
    - start service service[wlp-todo-ui-rest]
   ... (output omitted)
- change mode from '' to '0755'
    - change owner from '' to 'root'
    - change group from '' to 'root'
  * service[wlp-todo-ui-wicket] action enable
    - enable service service[wlp-todo-ui-wicket]
  * service[wlp-todo-ui-wicket] action start
    - start service service[wlp-todo-ui-wicket]
```

You can verify that the servers are running now by checking for the existence of the corresponding Java process on the subordinate node and also by using the service scripts that were conveniently created by the `wlp::start` resource. See Example 6-22.

Example 6-22 Run a deployment that starts Liberty profile servers

```
chef@chefslave:~$ ps -efww | grep java | grep -v grep

wlp      23612     1  5 13:42 ?        00:00:02
/usr/lib/jvm/java-6-openjdk-amd64/jre/bin/java
-javaagent:/opt/ibm/wlp/bin/tools/ws-javaagent.jar -Djava.awt.headless=true
-XX:MaxPermSize=256m -jar /opt/ibm/wlp/bin/tools/ws-server.jar todo-ui-rest
--clean

wlp      23740     1  8 13:42 ?        00:00:03
/usr/lib/jvm/java-6-openjdk-amd64/jre/bin/java
-javaagent:/opt/ibm/wlp/bin/tools/ws-javaagent.jar -Djava.awt.headless=true
-XX:MaxPermSize=256m -jar /opt/ibm/wlp/bin/tools/ws-server.jar todo-ui-wicket
--clean

chef@chefslave:~$ sudo /etc/init.d/wlp-todo-ui-rest status
Server todo-ui-rest is running with process ID 23612.

chef@chefslave:~$ sudo /etc/init.d/wlp-todo-ui-wicket status
Server todo-ui-wicket is running with process ID 23740.
```

7

Working with third-party tools on the Liberty profile server

This chapter demonstrates how to use third-party tools, such as Apache ActiveMQ, for implementing JMS functions by using Liberty profile. It also demonstrates how to integrate third-party mail servers into Liberty profile for sending and receiving mail from your application code.

The chapter includes the following topics:

- Apache ActiveMQ with Liberty profile server
- Apache James with Liberty profile server

7.1 Apache ActiveMQ with Liberty profile server

Apache ActiveMQ is one of the most popular open source message-oriented middleware products in existence today. It is a prime product that is used in enterprise environments because it supports many advanced features, such as multiple instances to store messages, and clustering environments.

Apache ActiveMQ offers the following features:

- Supports many cross-language clients and protocols.
- Has easy-to-use Enterprise Integration Patterns.
- Supports advanced features, such as message groups, virtual destinations, wildcards, and composite destinations.
- Fully supports JMS 1.1 and Java Platform, Enterprise Edition 1.4 with support for transient, persistent, transactional, and XA messaging.
- Supports pluggable transport protocols, such as in-VM, TCP, SSL, NIO, UDP, multicast, JGroups, and JXTA transports.
- Supports fast persistence by using JDBC along with a high performance journal.
- Is designed for high performance clustering, client/server, and peer based communication.
- Has a REST API to provide technology-independent and language-neutral web-based API for messaging.
- Uses Ajax to support web streaming to web browsers by using pure DHTML, allowing web browsers to be part of the messaging fabric.
- CXF and Axis Support so that ActiveMQ can be easily dropped into either of these web service stacks to provide reliable messaging.

Lack of JMS 2.0 support: Apache ActiveMQ 5.11 does not support the JMS 2.0 API, which is required by the Java Platform, Enterprise Edition 7 specification. For that reason, examples in this chapter must use the JMS 1.1 API.

Liberty profile server supports the following JMS messaging providers:

- Liberty profile server embedded messaging engine as the JMS messaging provider (supports JMS 2.0)
- Service integration bus, which is the default messaging provider of WebSphere Application Server
- WebSphere MQ messaging provider, which uses the WebSphere MQ system as the provider (supports JMS 2.0)

In addition, external JMS providers such as Apache ActiveMQ can also be integrated with Liberty profile server.

7.1.1 Example: Simple JMS application on a Liberty profile server

In this example, you write, deploy, and test a simple JMS application on a Liberty profile server. The application sends and consumes a message through an ActiveMQ instance running outside the Liberty profile server.

Prerequisites

To write and test the JMS application on Liberty profile server, complete these prerequisite steps:

1. Download Apache ActiveMQ for Windows from the following website:

   http://www.apache.org/dyn/closer.cgi?path=/activemq/5.11.1/apache-activemq-5.11.1-bin.zip

2. Extract the compressed file and start ActiveMQ by running the **`activemq start`** command from the `bin` folder, as shown in Example 7-1.

   On a successful start, ActiveMQ starts listening for connection at `tcp://localhost:61616`.

   Example 7-1 Start ActiveMQ

   ```
   C:\apache-activemq-5.11.1\bin>activemq start
   Java Runtime: Oracle Corporation 1.7.0_67 C:\Java\jdk1.7.0_67\jre
     Heap sizes: current=1013632k  free=991262k  max=1013632k
   ....
   INFO | ActiveMQ WebConsole available at http://0.0.0.0:8161/
   INFO | Initializing Spring FrameworkServlet 'dispatcher'
   INFO | jolokia-agent: No access restrictor found at
   classpath:/jolokia-access.xml, access to all MBeans is allowed
   ```

3. You can also open ActiveMQ Web Console by using the following URL:

   `http://localhost:8161/admin/`

4. The default user name and password for ActiveMQ Web Console login is `admin`.

Writing, deploying, and testing the JMS sample application

To write a simple JMS application that can send and receive a message by using JNDI support in ActiveMQ, complete the following steps:

1. Create a simple web application by using Eclipse or Rational Application Developer.
2. Add the `jndi.properties` file (in Figure 7-1) to the class path, which is the `/src` folder.

```
java.naming.factory.initial =
org.apache.activemq.jndi.ActiveMQInitialContextFactory

# use the following property to configure the default connector
java.naming.provider.url = tcp://localhost:61616

# use the following property to specify the JNDI name the connection factory
# should appear as.
#connectionFactoryNames = connectionFactory, queueConnectionFactory,
topicConnectionFactry
connectionFactoryNames = connectionFactory

# register some queues in JNDI using the form
# queue.[jndiName] = [physicalName]
queue.MyQueue = Q1
```

Figure 7-1 jndi.properties

3. Copy the JMS implementation classes (`activemq-all.jar`) from the `root` folder of the ActiveMQ installation directory to the `lib` folder of the web application.

Bundled: The JMS implementation classes (`activemq-all.jar`) are bundled within the application because Liberty profile server does not provide an Apache ActiveMQ implementation.

4. Write a simple servlet that gets InitialContext and then the resource `JNDI names` by reading the `jndi.properties` file (in Figure 7-1 on page 93).

   By using the resource JNDI names and the JMS implementation classes, the servlet sends and receives a message, as shown in Figure 7-2.

```
public void sendAndReceive(HttpServletRequest request,
        HttpServletResponse response) throws Exception {

      PrintWriter out = response.getWriter();
      out.println("SendAndReceive Started");

      Context ctx = new InitialContext();

      QueueConnectionFactory cf1 = (QueueConnectionFactory)
ctx.lookup("connectionFactory");
      Queue queue = (Queue) ctx.lookup("MyQueue");
      out.println("QCF and Queue lookup completed !!");

      QueueConnection con = cf1.createQueueConnection();

      // start the connection to receive message
      con.start();

      // create a queue session to send a message
      QueueSession sessionSender = con.createQueueSession(false,
            javax.jms.Session.AUTO_ACKNOWLEDGE);

      QueueSender send = sessionSender.createSender(queue);
      out.println("Message sent successfully<BR>");
      // send a sample message
      send.send(sessionSender.createTextMessage("Liberty Sample Message"));
      out.println("Message sent successfully<BR>");


      // create a queue receiver object
      QueueReceiver rec = sessionSender.createReceiver(queue);

      // receive message from Queue
      TextMessage msg = (TextMessage) rec.receive();

      out.println("Received Message Successfully :" + msg.getText() +
“<BR>”);

      if (con != null)
         con.close();
      out.println("SendAndReceive Completed<BR>");
   }// end of SendAndReceive
```

Figure 7-2 sendAndReceive method inside the servlet

The project hierarchy now looks like Figure 7-3.

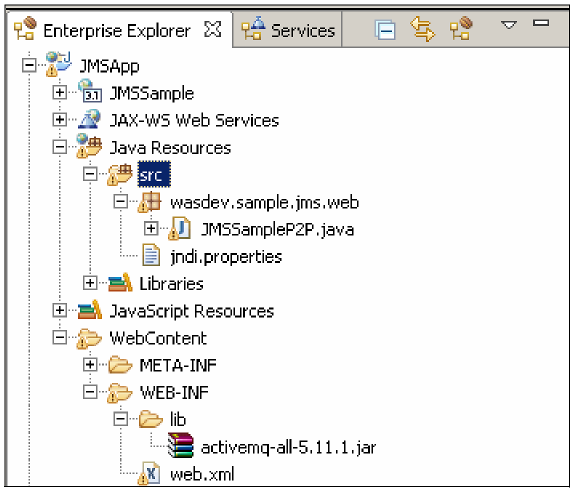


Figure 7-3 JMSApp project hierarchy

5. Save and export the application as the `JMSApp.war` file.
6. Add servlet-3.1 to the Liberty `server.xml` file, as shown in Figure 7-4.

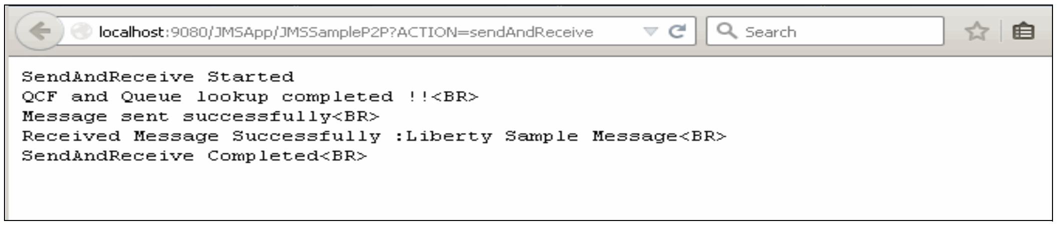
```
<featureManager>
       <feature>servlet-3.1</feature>
</featureManager>
```

Figure 7-4 Liberty server.xml

7. Deploy the `JMSApp.war` file on the Liberty profile server by copying it to the `dropins` folder.
8. Point to the following URL for starting the JMS Servlet on Liberty profile server:

   `http://<hostname>:<httpport>/JMSApp/JMSSampleP2P?ACTION=sendAndReceive`

   The servlet should send and receive a message by using the Apache ActiveMQ JMS provider, as shown in Figure 7-5.



```
SendAndReceive Started
QCF and Queue lookup completed !!<BR>
Message sent successfully<BR>
Received Message Successfully :Liberty Sample Message<BR>
SendAndReceive Completed<BR>
```

Figure 7-5 SendAndReceive window

7.2 Apache James with Liberty profile server

Apache James is a 100% pure Java SMTP, POP3 Mail server, IMAP (James V3), and NNTP News (James V2) server that is a complete and portable enterprise mail/messaging engine solution based on available open messaging protocols.

One of the benefits of James over other mail platforms is its support for building custom mail handling applications.

Liberty profile server supports JavaMail features, as required by the Java EE 7 specification. You can send and receive emails running on a Liberty profile server.

7.2.1 Example

In this example, you write, deploy, and test a simple JavaMail application on the Liberty profile server. This application sends mail to a valid recipient through an externally running Apache James Mail server instance.

Prerequisites

The following prerequisites must be met before writing and testing the JavaMail application on Liberty profile server:

1. Download Apache James from the following website:

   `http://www.motorlogy.com/apache//james/server/apache-james-2.3.2.zip`

2. Extract the compressed file and start the James Mail server by running the **`run.bat`** command from inside the `bin` folder.
3. Look for the `Apache James is successfully started in XXXX milliseconds` message in the command-line console.

Writing, testing, and deploying the JavaMail sample application

To write a simple JavaMail application that can send a mail to a valid recipient through the James Mail server, complete the following steps:

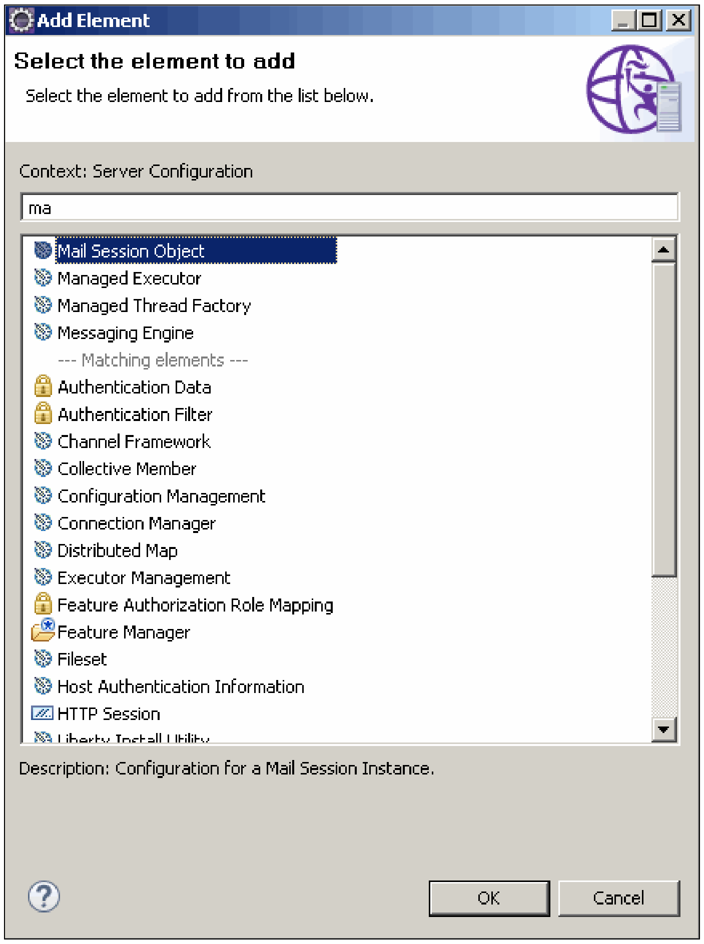
1. Create a simple web application by using Eclipse or Rational Application Developer.
2. Create a servlet by using the content that is shown in Example 7-2. Make sure to use the correct “`toAddress`” value.

Example 7-2 Mail sending servlet

```
@WebServlet("/MailSender")
public class MailSender extends HttpServlet {
   @Resource(lookup="mail/itsoMailSession")
   Session mailSession;

   protected void doGet(HttpServletRequest request, HttpServletResponse
response) throws ServletException, IOException {
      System.out.println("Sending test email");
      String toAddress = "valid@Email.Address";
      String message = "Test message";
      if(request.getParameter("msg") != null) {
         message = request.getParameter("msg");
      }
      Message mail = new MimeMessage(mailSession);
      try {
            mail.setRecipient(Message.RecipientType.TO, new
InternetAddress(toAddress));
            mail.setSubject("Test subject");
            mail.setSentDate(new Date());
            mail.setText(message);
            Transport.send(mail);
            System.out.println("Message sent successfully");
        } catch (MessagingException e) {
            e.printStackTrace();
        }
    }
}
```

3. Configure the mail session in the Liberty profile server:
   a. In the Servers view, expand the Liberty profile server and double-click **Server Configuration**.
   b. In the Configuration Structure section, select **Server Configuration** and click **Add**.
   c. In the Select the element to add field, start typing mail and select **Mail Session Object**, as shown in Figure 7-6.



Select the element to add

Select the element to add from the list below.

Context: Server Configuration

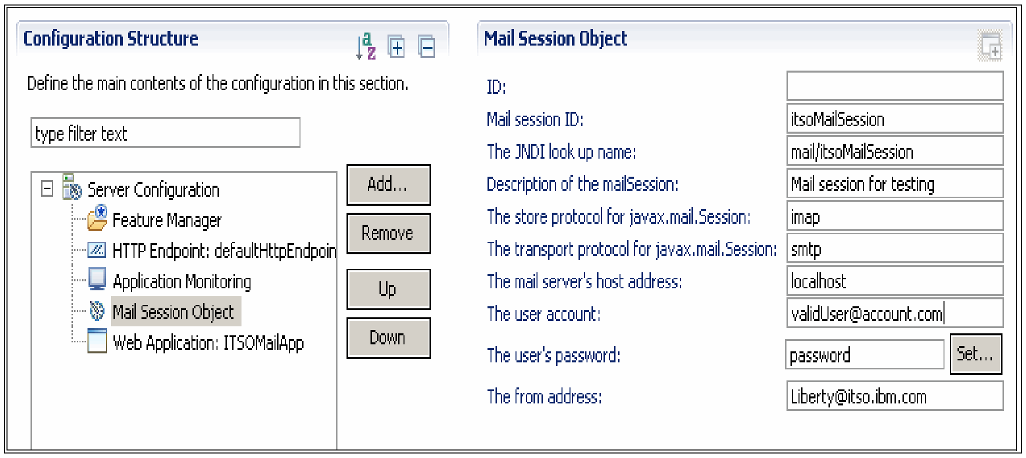
ma

Mail Session Object
Managed Executor
Managed Thread Factory
Messaging Engine
--- Matching elements ---
Authentication Data
Authentication Filter
Channel Framework
Collective Member
Configuration Management
Connection Manager
Distributed Map
Executor Management
Feature Authorization Role Mapping
Feature Manager
Fileset
Host Authentication Information
HTTP Session

Description: Configuration for a Mail Session Instance.

Figure 7-6 Add the Mail Session element

d. Provide the Mail Session parameters, that is, the Mail session ID, JNDI name, description, mail server host, valid user name, and password for your mail server. You can also provide a default “From” address. The parameters are shown in Figure 7-7.



ID:	
Mail session ID:	itsoMailSession
The JNDI look up name:	mail/itsoMailSession
Description of the mailSession:	Mail session for testing
The store protocol for javax.mail.Session:	imap
The transport protocol for javax.mail.Session:	smtp
The mail server's host address:	localhost
The user account:	validUser@account.com
The user's password:	password
The from address:	Liberty@itso.ibm.com

Figure 7-7 Mail Session details

Instead of using tools, the same result can be achieved by editing directly the `server.xml` file. Example 7-3 shows part of the `server.xml` file that is related to this configuration.

Example 7-3 Mail Session in server.xml

```
<mailSession
    description="Mail session for testing"
    from="Liberty2@itso.ibm.com"
    host="localhost"
    jndiName="mail/itsoMailSession"
    mailSessionID="itsoMailSession"
    user="validUser@account.com"
    password="password"/>
```

4. Add the servlet-3.1, cdi-1.2, and javaMail-1.5 features to the Liberty `server.xml` file, as shown in Figure 7-8.

```
<featureManager>
   <feature>servlet-3.1</feature>
   <feature>javaMail-1.5</feature>
   <feature>cdi-1.2</feature>
</featureManager>
```

Figure 7-8 Enable features in the server.xml file

5. Deploy the application on the Liberty profile server by copying it to the `dropins` folder or running it directly from the workspace.
6. Use the following URL to start the MailServlet on Liberty profile server:

   `http://<hostname>:<httpport>/ITSOMailApp/MailSender`

A message should now be sent to the recipient that is mentioned in the servlet that uses the James mail server that is running outside of the Liberty profile server.

A

Additional material

This book refers to additional material that can be downloaded from the Internet as described in the following sections.

Locating the web material

The web material that is associated with this book is available in softcopy on the Internet from the IBM Redbooks web server. Point your web browser at:

ftp://www.redbooks.ibm.com/redbooks/SG248194

Alternatively, you can go to the IBM Redbooks website at:

ibm.com/redbooks

Select the **Additional materials** and open the directory that corresponds with the IBM Redbooks form number, SG24-8194.

Using the web material

The additional web material that accompanies this book includes the following files:

File name	*Description*
SG248194.zip	Todo Sample Source code

Downloading and extracting the web material

Create a subdirectory (folder) on your workstation, and extract the contents of the web material `.zip` file into this folder.

Related publications

The publications that are listed in this section are considered suitable for a more detailed description of the topics that are covered in this book.

IBM Redbooks

The following IBM Redbooks publications provide additional information about the topic in this document. Some publications referenced in this list might be available in softcopy only.

- *WebSphere Application Server Liberty Profile Guide for Developers*, SG24-8076
- *WebSphere Application Server V8.5 Administration and Configuration Guide for Liberty Profile*, SG24-8170
- *WebSphere Application Server V8.5 Administration and Configuration Guide for the Full Profile*, SG24-8056

You can search for, view, download, or order these documents and other Redbooks, Redpapers, Web Docs, draft and additional materials, at the following website:

ibm.com/redbooks

Online resources

These websites are also relevant as further information sources:

- Apache Maven installation instructions:

  http://maven.apache.org/download.cgi#Installation_Instructions
- The Apache Software Foundation - Apache Download Mirrors:

  http://www.apache.org/dyn/closer.cgi?path=/activemq/apache-activemq/5.8.0/apache-activemq-5.8.0-bin.zip
- Arquillian:

  http://arquillian.org/
- Configuration elements in the `server.xml` file:

  http://www-01.ibm.com/support/knowledgecenter/SSD28V_8.5.5/com.ibm.websphere.wlp.core.doc/autodita/rwlp_metatype_core.html?cp=SSD28V_8.5.5%2F1-1-1-0
- Developing applications with WebSphere Developer Tools and Liberty profile:

  https://www.ibmdw.net/wasdev/docs/developing-applications-wdt-liberty-profile/
- DevOpsCasts Chef Solo Basics:

  http://devops.mashion.net/2011/08/04/chef-solo-basics/
- Download Apache James:

  http://www.motorlogy.com/apache//james/server/apache-james-2.3.2.zip
- Download WebSphere Application Server Liberty profile:

  http://wasdev.net/downloads

- flapdoodle-oss / de.flapdoodle.embed.mongo:

  `https://github.com/flapdoodle-oss/de.flapdoodle.embed.mongo`
- Getting Started with dojox/mobile:

  `http://dojotoolkit.org/documentation/tutorials/1.9/mobile/tweetview/getting_started/`
- H2 Database Engine:

  `http://www.h2database.com/`
- JWeUnit:

  `http://jwebunit.sourceforge.net/`
- knife-solo:

  `http://matschaffer.github.io/knife-solo/`
- Liberty profile: Configuration elements in the `server.xml` file:

  `http://www-01.ibm.com/support/knowledgecenter/SSAW57_8.5.5/com.ibm.websphere.wlp.nd.doc/autodita/rwlp_metatype_4ic.html?cp=SSAW57_8.5.5%2F1-0-2-1-0`
- Liberty profile features:

  `http://www-01.ibm.com/support/knowledgecenter/SSAW57_8.5.5/com.ibm.websphere.wlp.nd.multiplatform.doc/ae/rwlp_feat.html?cp=SSAW57_8.5.5%2F3-0-2-2-0`
- Liberty profile - Security:

  `http://www-01.ibm.com/support/knowledgecenter/SSAW57_8.5.5/com.ibm.websphere.wlp.nd.doc/ae/cwlp_sec.html`
- Liberty profile V8.5.5 Next Alpha:

  `https://www.ibmdw.net/wasdev/`
- Maven Integration (m2e):

  `http://www.eclipse.org/m2e/`
- Orika¶:

  `https://code.google.com/p/orika/`
- Opscode Chef Glossary:

  `https://wiki.opscode.com/display/chef/Glossary`
- An Overview of Chef:

  `http://docs.opscode.com/chef_overview.html`
- Packaging a Liberty profile server from the command prompt:

  `http://www-01.ibm.com/support/knowledgecenter/api/redirect/wasinfo/v8r5/index.jsp?topic=%2Fcom.ibm.websphere.wlp.core.doc%2Fae%2Ftwlp_setup_package_server.html`
- Programming model support:

  `http://www-01.ibm.com/support/knowledgecenter/api/redirect/wasinfo/v8r5/topic/com.ibm.websphere.wlp.nd.doc/ae/rwlp_prog_model_support.html`
- REST-assured:

  `https://code.google.com/p/rest-assured/`
- Spring Data – One API To Rule Them All:

  `http://www.infoq.com/articles/spring-data-intro`

- Subclipse download and installation:

  http://subclipse.tigris.org/servlets/ProjectProcess?pageID=p4wYuA
- Tuning the Liberty profile:

  http://www-01.ibm.com/support/knowledgecenter/SSD28V_8.5.5/com.ibm.websphere.wlp.core.doc/ae/twlp_tun.html
- Ubuntu Server:

  http://www.ubuntu.com/download/server
- WLP V8.5 - Managed:

  https://docs.jboss.org/author/display/ARQ/WLP+V8.5+-+Managed

Help from IBM

IBM Support and downloads

ibm.com/support

IBM Global Services

ibm.com/services

Redbooks

Configuring and Deploying Open Source with IBM WebSphere Application Server Liberty Profile

(0.2”spine)
0.17”<->0.473”
90<->249 pages

SG24-8194-01

ISBN 0738440884

Printed in U.S.A.