

Book of Vaadin

Vaadin 6.3

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Book of Vaadin: Vaadin 6.3

Oy IT Mill Ltd
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Vaadin 6.3.0

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Abstract

Vaadin is a server-side AJAX web application development framework that enables developers to build high-quality user interfaces with Java. It provides a library of ready-to-use user interface components and a clean framework for creating your own components. The focus is on ease-of-use, re-usability, extensibility, and meeting the requirements of large enterprise applications. Vaadin has been used in production since 2001 and it has proven to be suitable for building demanding business applications.

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Preface

This book provides an overview of Vaadin and covers the most important topics which you might encounter when developing applications with it. A more detailed documentation of individual classes, interfaces, and methods is given in the Java API Reference.

You can browse an online version of this book at the Vaadin website <http://vaadin.com/>. A PDF version is also included in the Vaadin installation package and if you install the Vaadin Plugin for Eclipse, you can browse it in the Eclipse Help. You may find the HTML or the Eclipse Help plugin version more easily searchable than this printed book or the PDF version, but the content is the same. Just like the rest of Vaadin, this book is open source.

Writing this manual is ongoing work and this edition represents a snapshot around the release of Vaadin 6.3, containing a number of additions and corrections since the first edition, which was for Vaadin 6.1. Especially, the Chapter 10, *Developing Custom Components*, has been revised to comply with the new way of defining widget sets and the mapping from server-side components to their corresponding client-side widgets. Many sections are under work and will be expanded in future.

Who is This Book For?

This book is intended for software developers who use, or are considering to use, Vaadin to develop web applications.

The book assumes that you have some experience with programming in Java, but if not, it is as easy to begin learning Java with Vaadin as with any other UI framework if not easier. No knowledge of AJAX is needed as it is well hidden from the developer.

You may have used some desktop-oriented user interface frameworks for Java, such as AWT, Swing, or SWT. Or a library such as Qt for C++. Such knowledge is useful for understanding the scope of Vaadin, the event-driven programming model, and other common concepts of UI frameworks, but not necessary.

If you don't have a web graphics designer at hand, knowing the basics of HTML and CSS can help, so that you can develop presentation themes for your application. A brief introduction to CSS is provided. Knowledge of Google Web Toolkit (GWT) may be useful if you develop or integrate new client-side components.

Organization of This Book

The Book of Vaadin gives an introduction to what Vaadin is and how you use it to develop web applications.

Chapter 1, *Introduction*

The chapter gives introduction to the application architecture supported by Vaadin, the core design ideas behind the framework, and some historical background.

Chapter 2, *Getting Started with Vaadin*

This chapter gives practical instructions for installing Vaadin and the reference toolchain, including the Vaadin Plugin for Eclipse, how to run and debug the demos, and how to create your own application project in the Eclipse IDE.

Chapter 3, <i>Architecture</i>	This chapter gives an introduction to the architecture of Vaadin and its major technologies, including AJAX, Google Web Toolkit, JSON, and event-driven programming.
Chapter 4, <i>Writing a Web Application</i>	This chapter gives all the practical knowledge required for creating applications with Vaadin, such as window management, application lifecycle, deployment in a servlet container, and handling events, errors, and resources.
Chapter 5, <i>User Interface Components</i>	This chapter essentially gives the reference documentation for all the core user interface components in Vaadin and their most significant features. The text gives examples for using each of the components.
Chapter 6, <i>Managing Layout</i>	This chapter describes the layout components, which are used for managing the layout of the user interface, just like in any desktop application frameworks.
Chapter 7, <i>Visual User Interface Design with Eclipse (experimental)</i>	This chapter gives instructions for using the visual editor for Eclipse, which is included in the Vaadin Plugin for the Eclipse IDE.
Chapter 8, <i>Themes</i>	This chapter gives an introduction to Cascading Style Sheets (CSS) and explains how you can use them to build custom visual themes for your application.
Chapter 9, <i>Binding Components to Data</i>	This chapter gives an overview of the built-in data model of Vaadin, consisting of properties, items, and containers.
Chapter 10, <i>Developing Custom Components</i>	This chapter describes the process of creating new client-side widgets with Google Web Toolkit (GWT) and integrating them with server-side counterparts. The chapter also gives practical instructions for creating widget projects in Eclipse, and using the GWT Development Mode to debug widgets.
Chapter 11, <i>Advanced Web Application Topics</i>	This chapter provides many special topics that are commonly needed in applications, such as opening new browser windows, embedding applications in regular web pages, low-level management of resources, shortcut keys, debugging, etc.
Appendix A, <i>User Interface Definition Language (UIIDL)</i>	This chapter gives an outline of the low-level UIDL messaging language, normally hidden from the developer. The chapter includes the description of the serialization API needed for synchronizing the component state between the client-side and server-side components.
Appendix B, <i>Songs of Vaadin</i>	Mythological background of the name Vaadin.

Supplementary Material

The Vaadin installation package and websites offer plenty of material that can help you understand what Vaadin is, what you can do with it, and how you can do it.

Demo Applications

The installation package of Vaadin includes a number of demo applications that you can run and use with your web browser. The content browser allows you to view the source code of the individual demo applications. You should find especially the Sampler demo a good friend of yours.

You can find the demo applications online at <http://vaadin.com/>.

Address Book Tutorial

The Address Book is a sample application accompanied with a tutorial that gives detailed step-by-step instructions for creating a real-life web application with Vaadin. You can find the tutorial from the product website.

Developer's Website

Vaadin Developer's Site at <http://dev.vaadin.com/> provides various online resources, such as the ticket system, a development wiki, source repositories, activity timeline, development milestones, and so on.

The wiki provides instructions for developers, especially for those who wish to check-out and compile Vaadin itself from the source repository. The technical articles deal with integration of Vaadin applications with various systems, such as JSP, Maven, Spring, Hibernate, and portals. The wiki also provides answers to Frequently Asked Questions.

Online Documentation

You can read this book online at <http://vaadin.com/book>. Lots of additional material, including technical HOWTOs, answers to Frequently Asked Questions and other documentation is also available on Vaadin web-site [<http://dev.vaadin.com/>].

Support

Stuck with a problem? No need to lose your hair over it, the Vaadin developer community and the IT Mill company offer support for all of your needs.

Community Support Forum

You can find the user and developer community forum for Vaadin at <http://vaadin.com/forum>. Please use the forum to discuss any problems you might encounter, wishes for features, and so on. The answer for your problems may already lie in the forum archives, so searching the discussions is always the best way to begin.

Report Bugs

If you have found a possible bug in Vaadin, the demo applications, or the documentation, please report it by filing a ticket at the Vaadin developer's site at <http://dev.vaadin.com/>. You may want to check the existing

tickets before filing a new one. You can make a ticket to make a request for a new feature as well, or to suggest modifications to an existing feature.

Commercial Support

IT Mill offers full commercial support and training services for the Vaadin products. Read more about the commercial products at <http://vaadin.com/pro> for details.

About the Author

Marko Grönroos is a professional writer and software developer working at IT Mill Ltd in Turku, Finland. He has been involved in web application development since 1994 and has worked on several application development frameworks in C, C++, and Java. He has been active in many open source software projects and holds an M.Sc. degree in Computer Science from the University of Turku.

Acknowledgements

Much of the book is the result of close work within the development team at IT Mill. Joonas Lehtinen, CEO of IT Mill Ltd, wrote the first outline of the book, which became the basis for the first two chapters. Since then, Marko Grönroos has become the primary author. The development team has contributed several passages, answered numerous technical questions, reviewed the manual, and made many corrections.

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About Oy IT Mill Ltd

Oy IT Mill Ltd is a Finnish software company specializing in the design and development of Rich Internet Applications. The company offers planning, implementation, and support services for the software projects of its customers, as well as sub-contract software development. Vaadin, previously known as IT Mill Toolkit, is the flagship open source product of the company, for which it provides commercial development and support services.

Chapter 1

Introduction

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This chapter provides an introduction to software development with Vaadin, including installation of Vaadin, the Eclipse development environment, and any other necessary or useful utilities. We look into the design philosophy behind Vaadin, its history, and recent major changes.

1.1. Overview

The core piece of Vaadin is the Java library that is designed to make creation and maintenance of high quality web-based user interfaces easy. The key idea in the server-driven programming model of Vaadin is that it allows you to forget the web and lets you program user interfaces much like you would program any Java desktop application with conventional toolkits such as AWT, Swing, or SWT. But easier.

While traditional web programming is a fun way to spend your time learning new web technologies, you probably want to be productive and concentrate on the application logic. With the server-driven programming model, Vaadin takes care of managing the user interface in the browser and AJAX communications between the browser and the server. With the Vaadin approach, you do not need to learn and debug browser technologies, such as HTML or JavaScript.

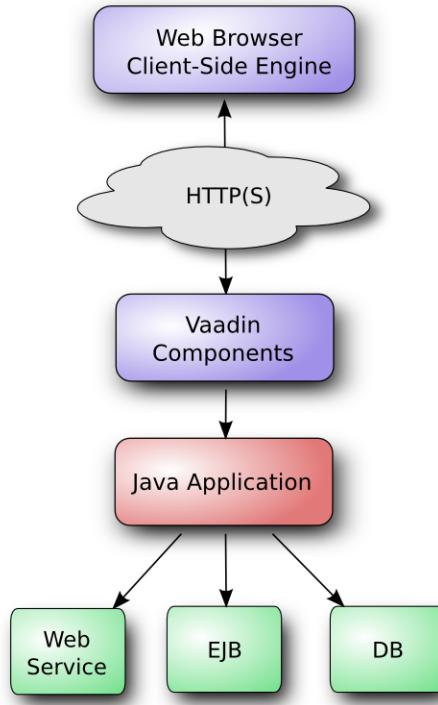
Figure 1.1. General Architecture of Vaadin

Figure 1.1, “General Architecture of Vaadin” illustrates the basic architecture of web applications made with Vaadin. Vaadin consists of the *server-side framework* and a *client-side engine* that runs in the browser as a JavaScript program, rendering the user interface and delivering user interaction to the server. As the application runs as a persistent Java Servlet session in an application server, you can easily bind your application to data and logic tiers.

Because HTML, JavaScript, and other browser technologies are essentially invisible to the application logic, you can think of the web browser as only a thin client platform. A thin client displays the user interface and communicates user events to the server at a low level. The control logic of the user interface runs on a Java-based web server, together with your business logic. By contrast, a normal client-server architecture with a dedicated client application would include a lot of application specific communications between the client and the server. Essentially removing the user interface tier from the application architecture makes our approach a very effective one.

As the Client-Side Engine is executed as JavaScript in the browser, no browser plugins are needed for using applications made with Vaadin. This gives it a sharp edge over frameworks based on Flash, Java Applets, or other plugins. Vaadin relies on the support of GWT for a wide range of browsers, so that the developer doesn't need to worry about browser support.

Behind the server-driven development model, Vaadin makes the best use of AJAX (*Asynchronous JavaScript and XML*) techniques that make it possible to create Rich Internet Applications (RIA) that are as responsive and interactive as desktop applications. If you're a newcomer to AJAX, see Section 3.2.1, “AJAX” to find out what it is and how AJAX applications differ from traditional web applications.

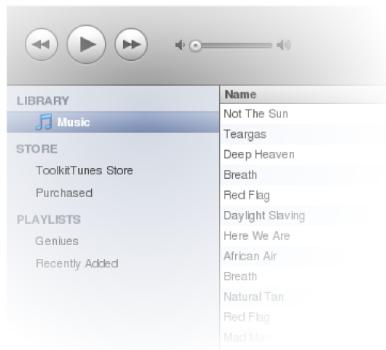
Hidden well under the hood, Vaadin uses *GWT*, the *Google Web Toolkit*, for rendering the user interface in the browser. GWT programs are written in Java, but compiled into JavaScript, thus freeing the developer from learning JavaScript and other browser technologies. GWT is ideal for implementing advanced user interface components (or widgets in GWT terminology) and interaction

logic in the browser, while Vaadin handles the actual application logic in the server. Vaadin is designed to be extensible, and you can indeed use any 3rd-party GWT components easily, in addition to the component repertoire offered in Vaadin. The use of GWT also means that all the code you need to write is pure Java.

The Vaadin library defines a clear separation between user interface presentation and logic and allows you to develop them separately. Our approach to this is *themes*, which dictate the visual appearance of applications. Themes control the appearance of the user interfaces using CSS and (optional) HTML page templates. As Vaadin provides excellent default themes, you do not usually need to make much customization, but you can if you need to. For more about themes, see Chapter 8, *Themes*.

We hope that this is enough about the basic architecture and features of Vaadin for now. You can read more about it later in Chapter 3, *Architecture*, or jump straight to more practical things in Chapter 4, *Writing a Web Application*.

"It looks Just Awesome..."



1.2. Example Application Walkthrough

Let us follow the long tradition of first saying "Hello World!" when learning a new programming environment. After that, we can go through a more detailed example that implements the model-view-controller architecture. The two examples given are really simple, but this is mostly because Vaadin is designed to make things simple.

Example 1.1. HelloWorld.java

```
import com.vaadin.ui.*;

public class HelloWorld extends com.vaadin.Application {

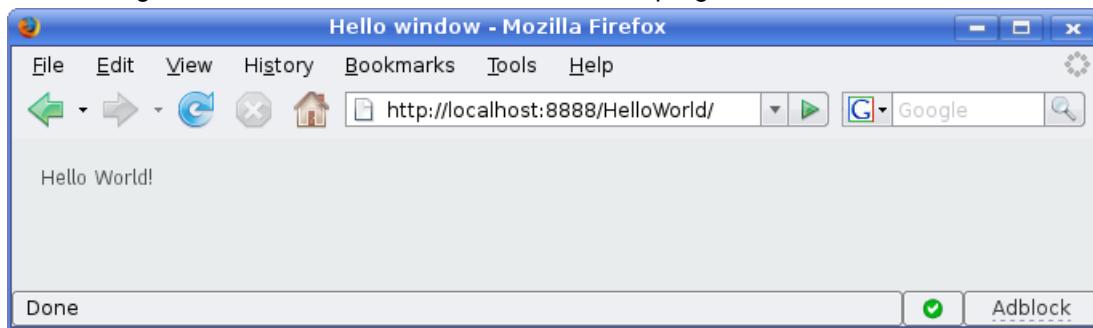
    public void init() {
        Window main = new Window("Hello window");
        setMainWindow(main);
        main.addComponent(new Label("Hello World!"));
    }
}
```

The first thing to note is that the example application extends **com.vaadin.Application** class. The **Application** class is used as the base class for all user applications. Instances of the **Application** are essentially user sessions, and one is created for each user using the application. In the context of our HelloWorld application, it is sufficient to know that the application is started when the user first accesses it and at that time `init` method is invoked.

Initialization of the application first creates a new window object and sets "Hello window" as its caption. The window is then set as the main window of the application; an application can actually have many windows. This means that when a user launches the application, the contents of the "main window" are shown to the user in the web page. The caption is shown as the title of the (browser) window.

A new user interface component of class **com.vaadin.ui.Label** is created. The label is set to draw the text "Hello World!". Finally, the label is added to the main window. And here we are, when the application is started, it draws the text "Hello World!" to the browser window.

The following screenshot shows what the "Hello World!" program will look like in a web browser.



Before going into details, we should note that this example source code is complete and does not need any additional declaratively defined template files to be run. To run the program, you can just add it to your web application, as explained in Section 4.8, "Setting Up the Application Environment".

1.3. Support for the Eclipse IDE

While Vaadin is not bound to any specific IDE, and you can in fact easily use it without any IDE altogether, we provide special support for the Eclipse IDE, which has become the standard environment for Java development. The support includes:

- Import the installation package as a QuickStart demo project in Eclipse
- Install the Vaadin Plugin for Eclipse, which allows you to:
 - Create new Vaadin projects
 - Create custom themes
 - Create custom client-side widgets and widget sets
 - Edit components with a visual (WYSIWYG) editor
 - Easily upgrade to a newer version of the Vaadin library

The Vaadin Plugin for Eclipse is our recommended way of installing Vaadin; the actual installation package contains demos and documentation that are available also from the website, so you do not normally need to download and install it, unless you want to experiment with the demos or try debugging.

Installing and updating the plugin is covered in Section 2.2.5, "Vaadin Plugin for Eclipse" and the creation of a new Vaadin project using the plugin in Section 2.4.1, "Creating the Project". See Section 8.4, "Creating a Theme in Eclipse", Section 10.2, "Doing It the Simple Way in Eclipse", and Chapter 7, *Visual User Interface Design with Eclipse (experimental)* for instructions on using the different features of the plugin.

1.4. Goals and Philosophy

Simply put, Vaadin's ambition is to be the best possible tool when it comes to creating web user interfaces for business applications. It is easy to adopt, as it is designed to support both entry-level and advanced programmers, as well as usability experts and graphical designers.

When designing Vaadin, we have followed the philosophy inscribed in the following rules.

Right tool for the right purpose

Because our goals are high, the focus must be clear. This toolkit is designed for creating web applications. It is not designed for creating websites or advertisements demos. For such purposes, you might find (for instance) JSP/JSF or Flash more suitable.

Simplicity and maintainability

We have chosen to emphasize robustness, simplicity, and maintainability. This involves following the well-established best practices in user interface frameworks and ensuring that our implementation represents an ideal solution for its purpose without clutter or bloat.

XML is not designed for programming

The Web is inherently document-centered and very much bound to the declarative presentation of user interfaces. The Vaadin framework frees the programmer from these limitations. It is far more natural to create user interfaces by programming them than by defining them in declarative templates, which are not flexible enough for complex and dynamic user interaction.

Tools should not limit your work

There should not be any limits on what you can do with the framework: if for some reason the user interface components do not support what you need to achieve, it must be easy to add new ones to your application. When you need to create new components, the role of the framework is critical: it makes it easy to create re-usable components that are easy to maintain.

1.5. Background

The library was not written overnight. After working with web user interfaces since the beginning of the Web, a group of developers got together in 2000 to form IT Mill. The team had a desire to develop a new programming paradigm that would support the creation of real user interfaces for real applications using a real programming language.

The library was originally called Millstone Library. The first version was used in a large production application that IT Mill designed and implemented for an international pharmaceutical company. IT Mill made the application already in the year 2001 and it is still in use. Since then, the company has produced dozens of large business applications with the library and it has proven its ability to solve hard problems easily.

The next generation of the library, IT Mill Toolkit Release 4, was released in 2006. It introduced an entirely new AJAX-based presentation engine. This allowed the development of AJAX applications without the need to worry about communications between the client and the server.

Release 5 Into the Open

IT Mill Toolkit 5, released initially at the end of 2007, took a significant step further into AJAX. The client-side rendering of the user interface was completely rewritten using GWT, the Google Web Toolkit.

IT Mill Toolkit 5 introduced many significant improvements both in the server-side API and in the functionality. Rewriting the Client-Side Engine with GWT allowed the use of Java both on the

client and the server-side. The transition from JavaScript to GWT made the development and integration of custom components and customization of existing components much easier than before, and it also allows easy integration of existing GWT components. The adoption of GWT on the client-side did not, by itself, cause any changes in the server-side API, because GWT is a browser technology that is hidden well behind the API. Also themeing was completely revised in IT Mill Toolkit 5.

The Release 5 was published under the Apache License 2, an unrestrictive open source license, to create faster expansion of the user base and make the formation of a developer community possible.

Stabilization of the release 5 took over a year of work from the development team. It introduced a number of changes in the API, the client-side customization layer, and the themes. Many significant changes were done during the beta phase, until the stable version 5.3.0 was released in March 2009.

Birth of Vaadin Release 6

IT Mill Toolkit was renamed as *Vaadin* in spring 2009 to avoid common confusions with the name (IT Mill is a company not the product) and to clarify the separation between the company and the open source project. Vaadin means a female semi-domesticated mountain reindeer in Finnish.

The most notable enhancements in Vaadin 6 are the external development tools:

- Eclipse Plugin
- Visual user interface editor under Eclipse (experimental)

The Eclipse Plugin allows easy creation of Vaadin projects and custom client-side widgets. See Section 2.2.5, “Vaadin Plugin for Eclipse” for details. The visual editor, described in Chapter 7, *Visual User Interface Design with Eclipse (experimental)* makes prototyping easy and new users of Vaadin should find it especially useful for introducing oneself to Vaadin. Like Vaadin itself, the tools are open source.

While the API in Vaadin 6 is essentially backward-compatible with IT Mill Toolkit 5.4, the package names and some name prefixes were changed to comply with the new product name:

- Package name com.itmill.toolkit was renamed as com.vaadin.
- The static resource directory `ITMILL` was changed to `VAADIN`.
- Client-side widget prefix was changed from "i" to "v".
- CSS style name prefix was changed from "`i-`" to "`v-`".

Other enhancements in Vaadin 6 are listed in the Release Notes for Vaadin 6.0.0, which also gives detailed instructions for upgrading from IT Mill Toolkit 5.

Chapter 2

Getting Started with Vaadin

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2.3. QuickStart with Eclipse	18
2.4. Your First Project with Vaadin	23

This chapter gives practical instructions for installing Vaadin and the reference toolchain, installing the Vaadin plugin in Eclipse, and running and debugging the demo applications.

2.1. Installing Vaadin

This section gives an overview of the Vaadin package and its installation. You have two options for installing:

1. Download and install the installation package
2. If you use Eclipse, you can install the Vaadin plugin for Eclipse, as described in Section 2.2.5, “Vaadin Plugin for Eclipse”

Even if you use Eclipse, you can install the installation package and import it under Eclipse as the QuickStart project. It allows you to run and debug the demo applications and contains documentation.

2.1.1. Installing the Distribution Package

You can install the Vaadin installation package in a few simple steps:

1. Download the newest Vaadin installation package from the download page at <http://vaadin.com/download/>.
2. Unpack the installation package to a directory using a decompression program available in your operating system (see below).
 - In Windows, use the default ZIP decompression program to unpack the package into your chosen directory e.g. C:\dev.



Warning

At least the Windows XP default decompression program and some versions of WinRAR cannot unpack the installation package properly in certain cases. Decompression can result in an error such as "*The system cannot find the file specified.*" This happens because the decompression program is unable to handle long file paths where the total length exceeds 256 characters. This occurs, for example, if you try to unpack the package under Desktop. You should unpack the package directly into C:\dev or some other short path or use another decompression program.

- In Linux, Mac OS X, and other UNIX-like systems, use Info-ZIP or other ZIP software with the **unzip vaadin-6.x.x.zip** command.

The files will be, by default, decompressed into a directory with the name vaadin-6.x.x.

2.1.2. Starting the Content Browser

The Content Browser is your best friend when using Vaadin. It allows you to browse documentation and example source code, and run the demo applications. The demo applications demonstrate most of the core features of Vaadin. You can find the demo applications also at the vaadin website: <http://vaadin.com/demo>.

To start the Content Browser, run the start script in the Vaadin installation directory as instructed below. The start script launches a stand-alone web server running on the local host at port 8888, and a web browser at address <http://localhost:8888>/.

The Content Browser will open the default web browser configured in your system. If your default browser is not compatible with Vaadin the demo applications may not work properly. In that case launch a supported browser manually and navigate to <http://localhost:8888/>.

If the Content Browser fails to start, make sure that no other service is using port 8888.



JRE must be installed

You must have Java Runtime Environment (JRE) installed or the batch file will fail and close immediately. A JRE can be downloaded from <http://java.sun.com/javase/downloads/index.jsp>.

**Firewall software**

Executing the Content Browser locally may cause a security warning from your firewall software because of the started web server. You need to allow connections to port 8888 for the Content Browser to work.

Windows

Run the `start.bat` batch file by double-clicking on the icon. Wait until the web server and web browser has started, it can take a while.

Linux / UNIX

Open a shell window, change to the Vaadin installation directory, and run the `start.sh` shell script. You have to run it with the following command:

```
$ sh start.sh
-----
Starting Vaadin in Desktop Mode.
Running in http://localhost:8888
-----
2007-12-04 12:44:55.657::INFO: Logging to STDERR via org.mortbay.log.StderrLog
2007-12-04 12:44:55.745::INFO: jetty-6.1.5
2007-12-04 12:45:03.642::INFO: NO JSP Support for , did not find
org.apache.jasper.servlet.JspServlet
2007-12-04 12:45:03.821::INFO: Started SelectChannelConnector@0.0.0.0:8888
```

Wait until the web server and web browser has started, it can take a while.

Mac OS X

Double-click on the **Start Vaadin** icon. Wait until the web server and web browser has started, it can take a while.

If the start icon fails in your environment for some reason, you can start the Content Browser by following the instructions for Linux/UNIX above: open a shell window, change to the installation directory, and execute `sh start.sh`.

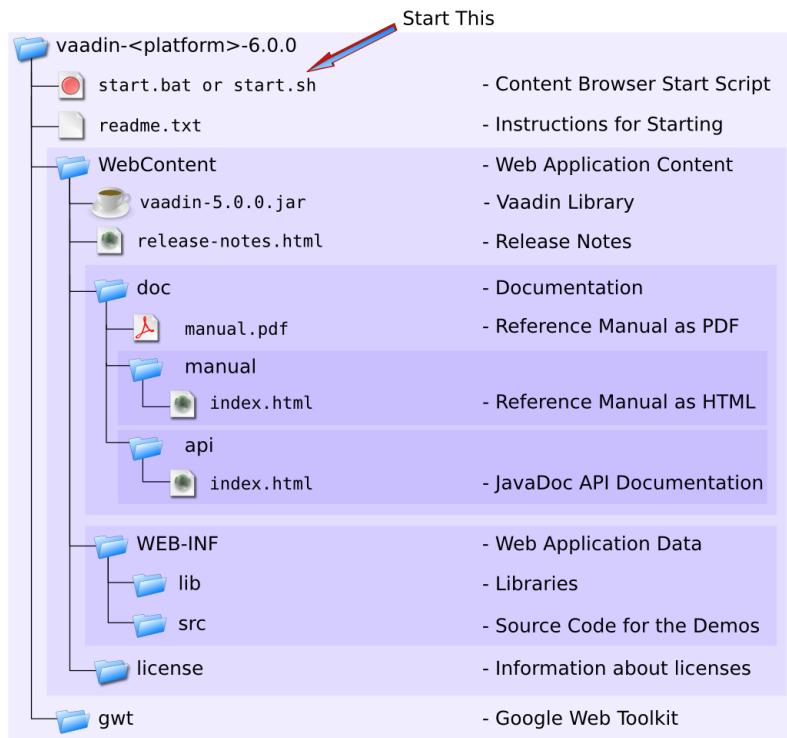
**Browser support**

Vaadin supports the most commonly used web browsers, including Internet Explorer 6-8, Firefox 3, Safari 3 and Opera 9.6. In addition to these, most of the modern web browsers also work even if they are not supported. The definitive list of supported browsers can be found on <http://vaadin.com/features>.

2.1.3. Package Contents

At the root of installation directory, you can find the `start.bat` (Windows) or `start.sh` (Linux and Mac) script that launches the Vaadin Content Browser, which allows you to run the demo applications and read the documentation included in the package.

Figure 2.1. Vaadin Package Contents



The `WebContent` directory contains all files related to Vaadin and the Content Browser. If you do not wish to or can not run the Content Browser, you can open `index.html` in a web browser to view the installation package contents and documentation. The demos will not be usable though. The `release-notes.html` file contains information about changes in the latest release and the release history. The `license` subdirectory contains licensing guidelines (`licensing-guidelines.html`) for Vaadin and licenses for other libraries included in the installation package. The `COPYING` file in the installation root also contains license information.

The Vaadin Library itself is located at `WebContent/vaadin-6.x.x.jar`. The JAR package contains, in addition to the compiled files, the full source code of the library.

The `WebContent/docs` directory contains full documentation for Vaadin, including JavaDoc API Reference Documentation (`api` subdirectory) and this manual in both HTML and printable PDF format.

The `WebContent/WEB-INF` directory contains source code for the demo applications in the `src` subdirectory and the required libraries in the `lib` subdirectory.

The `gwt` folder contains the full Google Web Toolkit installation package, including runtime libraries for the selected operating system, full documentation, and examples. You will need GWT if you intend to compile custom client-side widgets for Vaadin (described in Chapter 10, *Developing Custom Components*).

In addition, the installation directory contains project files to allow importing the installation package as a project into the Eclipse IDE. See Section 2.3, “QuickStart with Eclipse” for details on how to do this.

2.1.4. Demo Applications

The Content Browser allows you to run several demo applications included in the installation package. The applications demonstrate how you can use Vaadin for different tasks. Below is a selection of the included demos. Notice that the source code for all demos is included in the installation package and you can directly modify them if you import the package as a project in Eclipse, as instructed in Section 2.3, “QuickStart with Eclipse”.

Sampler

Sampler demonstrates the various standard components and features of Vaadin. Clicking on one of the available sample icons will take you to the sample page, where you can see a live version of the sample together with a short description of feature. The Sampler allows you to view the full source code of each sample and provides links to the API documentation and to related samples. Sampler is the best place to get an overview of what is included in Vaadin.

Address Book Tutorial

This step-by-step tutorial covers everything needed to build a Vaadin application. The tutorial shows how you create layouts/views, implement navigation between views, bind components to a data source, use notifications, and much more. It also includes a section on how to create a custom theme for your application.

Reservation Application

The Reservation Application demonstrates the use of various components in a semi-real application connected to a local database. It also shows how to integrate a Google Maps view inside an application.

Coverflow

A simple example on how you can integrate Vaadin with Flex.

VaadinTunes

A non-functional application that demonstrates how you can create complex layouts using Vaadin.

Note: starting the demo applications can take several seconds.

2.2. Setting up the Development Environment

This section gives a step-by-step guide for setting up a development environment. Vaadin supports a wide variety of tools, so you can use any IDE for writing the code, most web browsers for viewing the results, any operating system or processor supported by the Java 1.5 platform, and almost any Java server for deploying the results.

In this example, we use the following toolchain:

- Windows XP [<http://www.microsoft.com/windowsxp/>], Linux, or Mac OS X
- Sun Java 2 Standard Edition 6.0 [<http://java.sun.com/javase/downloads/index.jsp>] (Java 1.5 or newer is required)
- Eclipse IDE for Java EE Developers [<http://www.eclipse.org/downloads/>]
- Apache Tomcat 6.0 (Core) or newer [<http://tomcat.apache.org/>]

- Firefox 3.0.7 or newer [<http://www.getfirefox.com/>]
- Firebug 1.3.3 or newer [<http://www.getfirebug.com/>] (optional)
- Vaadin 6.x.x [<http://vaadin.com/download/>]

The above is a good choice of tools, but you can use almost any tools you are comfortable with.

Figure 2.2. Development Toolchain and Process

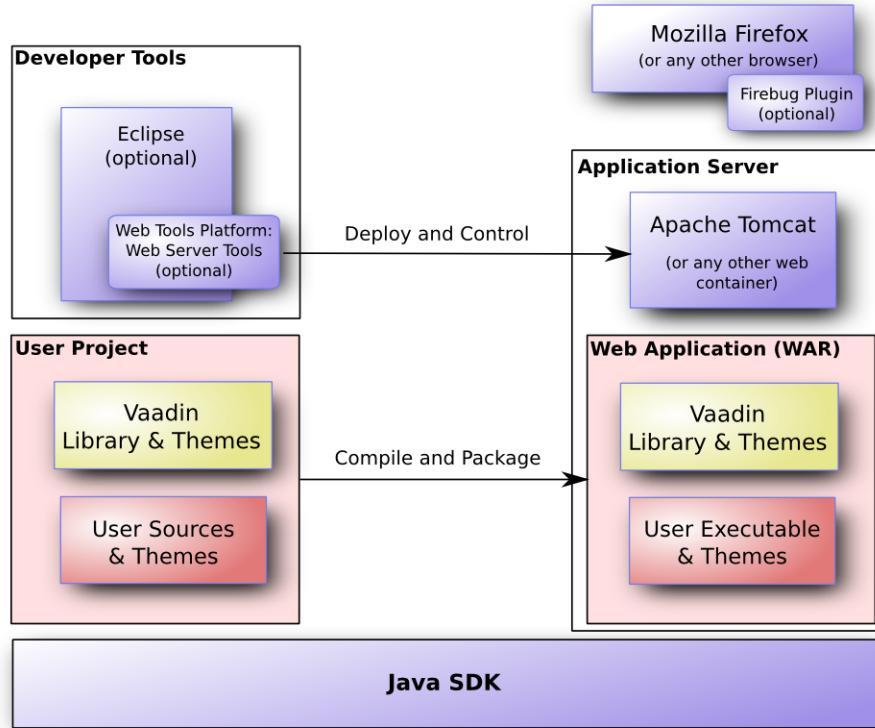


Figure 2.2, “Development Toolchain and Process” illustrates the development environment and process. You develop your application as an Eclipse project. The project must include, in addition to your source code, the Vaadin Library. It can also include your project-specific themes.

You must compile and deploy a project to a web container before you can use it. You can deploy a project through the Web Tools Platform for Eclipse, which allows automatic deployment of web applications from Eclipse. You can deploy a project also manually, by creating a web application archive (WAR) and deploying it through the web container’s interface.

2.2.1. Installing Java SDK

Java SDK is required by Vaadin and also by the Eclipse IDE. Vaadin is compatible with Java 1.5 and later editions.

Windows

1. Download Sun Java 2 Standard Edition 6.0 from <http://java.sun.com/javase/downloads/index.jsp> [<http://java.sun.com/javase/downloads/index.jsp>]

2. Install the Java SDK by running the installer. The default options are fine.

Linux / UNIX

1. Download Sun Java 2 Standard Edition 6.0 from <http://java.sun.com/javase/downloads/index.jsp> [<http://java.sun.com/javase/downloads/index.jsp>]
2. Decompress it under a suitable base directory, such as `/opt`. For example, for Java SDK, enter (either as root or with `sudo` in Linux):

```
# cd /opt  
# sh (path-to-installation-package)/jdk-6u1-linux-i586.bin
```

and follow the instructions in the installer.

2.2.2. Installing Eclipse IDE

Windows

Eclipse is now installed in `C:\dev\eclipse` and can be started from there (by double clicking `eclipse.exe`).

1. Download Eclipse IDE for Java EE Developers (Ganymede version) from <http://www.eclipse.org/downloads/> [<http://www.eclipse.org/downloads/>]
2. Decompress the Eclipse IDE package to a suitable directory. You are free to select any directory and to use any ZIP decompressor, but in this example we decompress the ZIP file by just double-clicking it and selecting "Extract all files" task from Windows compressed folder task. In our installation example, we use `C:\dev` as the target directory.

Linux / UNIX

You have two basic options for installing Eclipse in Linux and UNIX: you can either install it using the package manager of your operating system or by downloading and installing the packages manually. The *manual installation method is recommended*, because the latest versions of the packages available in a Linux package repository may be incompatible with Eclipse plugins that are not installed using the package manager.

1. Download Download Eclipse IDE for Java EE Developers (Ganymede version) from <http://www.eclipse.org/downloads/> [<http://www.eclipse.org/downloads/>]
2. Decompress the Eclipse package into a suitable base directory. It is important to make sure that there is no old Eclipse installation in the target directory. Installing a new version on top of an old one probably renders Eclipse unusable.
3. Eclipse should normally be installed as a regular user, as this makes installation of plugins easier. Eclipse also stores some user settings in the installation directory. To install the package, enter:

```
$ tar zxf (path-to-installation-package)/eclipse-jee-ganymede-SR2-linux-gtk.tar.gz
```

This will extract the package to a subdirectory with the name `eclipse`.

4. You may wish to add the Eclipse installation directory and the `bin` subdirectory in the installation directory of Java SDK to your system or user PATH.

An alternative to the above procedure is to use the package management system of your operating system. For example, in Ubuntu Linux, which includes Sun Java SDK and Eclipse in its APT repository, you can install the programs from a package manager GUI or from command-line with a command such as:

```
$ sudo apt-get install sun-java6-jdk eclipse
```

This is, however, *not recommended*, because the Eclipse package may not include all the necessary Java EE tools, most importantly the Web Standard Tools, and it may cause incompatibilities with some components that are not installed with the package management system of your operating system.

2.2.3. Installing Apache Tomcat

Apache Tomcat is a lightweight Java web server suitable for both development and production. There are many ways to install it, but here we simply decompress the installation package.

Apache Tomcat should be installed with user permissions. During development, you will be running Eclipse or some other IDE with user permissions, but deploying web applications to a Tomcat server that is installed system-wide requires administrator or root permissions.

1. Download the installation package:

Apache Tomcat 6.0 (Core Binary Distribution) from <http://tomcat.apache.org/>

2. Decompress Apache Tomcat package to a suitable target directory, such as C:\dev (Windows) or /opt (Linux or Mac OS X). The Apache Tomcat home directory will be C:\dev\apache-tomcat-6.0.x or /opt/apache-tomcat-6.0.x, respectively.

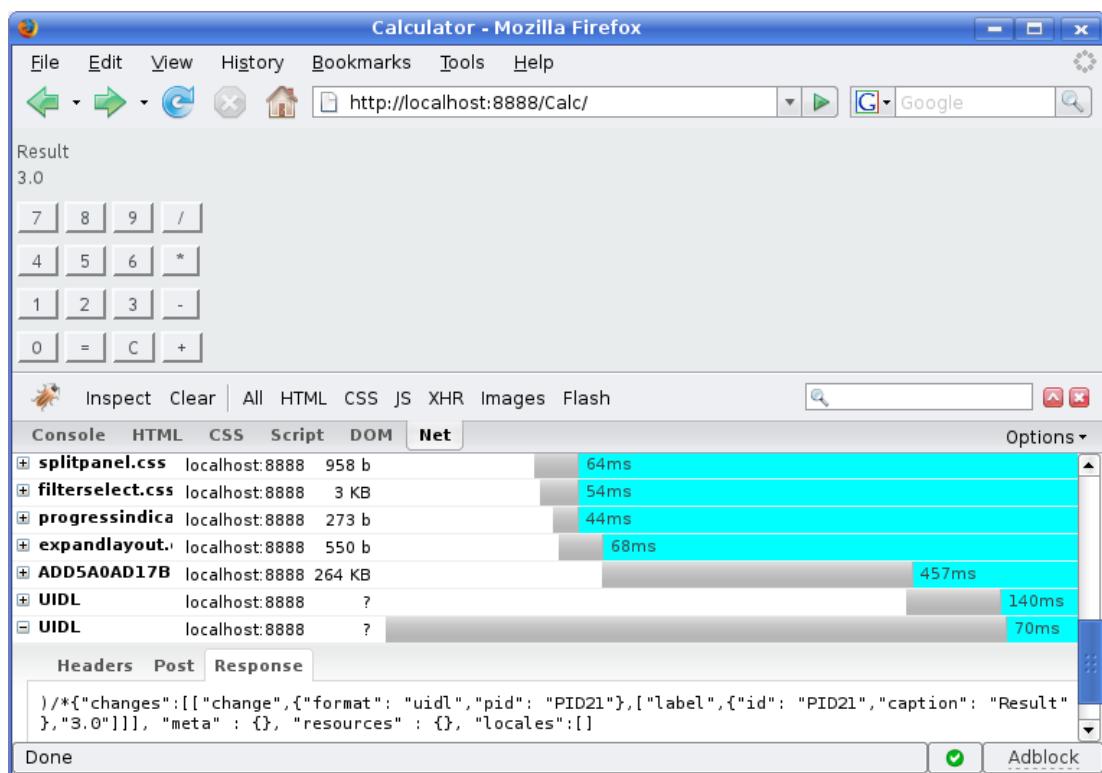
2.2.4. Firefox and Firebug

Vaadin supports many web browsers and you can use any of them for development. If you plan to create a custom theme, customized layouts or new user interface components, we recommend that you use Firefox together with Firebug for debugging. Vaadin contains special support for Firebug and can show debug information in its console.

If you do not have Firefox installed already, go to www.getfirefox.com [<http://www.getfirefox.com/>] and download and run the installer.

Optional. After installing Firefox, use it to open <http://www.getfirebug.com/> [<http://www.getfirebug.com/>]. Follow the instructions on the site to install the latest stable version of Firebug available for the browser. You might need to tell Firefox to allow the installation by clicking the yellow warning bar at the top of the browser-window.

When Firebug is installed, it can be enabled at any time from the bottom right corner of the Firefox window. Figure 2.3, “Firebug Debugger for Firefox” shows an example of what Firebug looks like.

Figure 2.3. Firebug Debugger for Firefox

Now that you have installed the development environment, you can proceed to creating your first application.

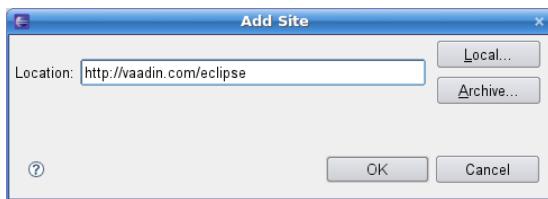
2.2.5. Vaadin Plugin for Eclipse

If you are using the Eclipse IDE, using the Vaadin plugin should help greatly. The plugin includes:

- An integration plugin with *wizards* for creating new Vaadin-based projects, themes, and client-side widgets and widget sets.
- A *visual editor* for editing custom composite user interface components in a WYSIWYG fashion. With full round-trip support from source code to visual model and back, the editor integrates seamlessly with your development process.
- A version of *Book of Vaadin* that you can browse in the Eclipse Help system.

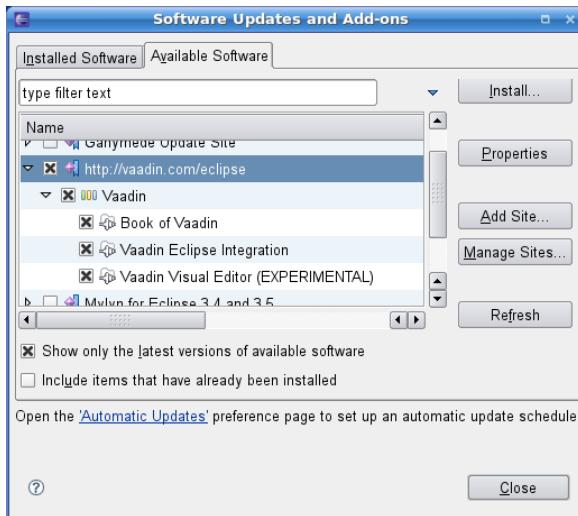
You can install the plugin as follows:

1. Start Eclipse.
2. Select **Help → Software Updates....**
3. Select the **Available Software** tab.
4. Add the Vaadin plugin update site by clicking **Add Site....**



Enter the URL of the Vaadin Update Site: <http://vaadin.com/eclipse> and click **OK**. The Vaadin site should now appear in the **Software Updates** window.

5. Select all the Vaadin plugins in the tree.



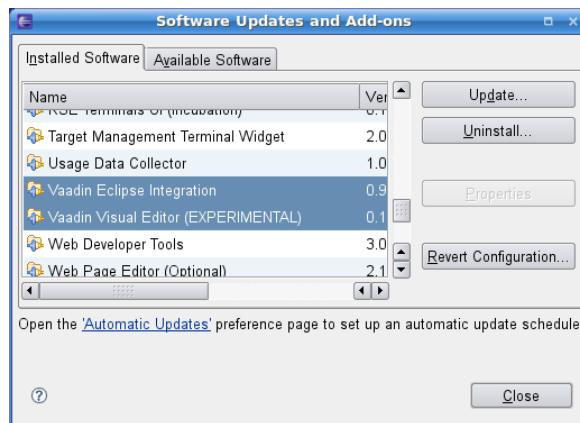
Finally, click **Install**.

Detailed and up-to-date installation instructions for the Eclipse plugin can be found at <http://vaadin.com/eclipse>.

Updating the Vaadin Plugin

If you have automatic updates enabled in Eclipse (see **Window → Preferences → Install/Update → Automatic Updates**), the Vaadin plugin will be updated automatically along with other plugins. Otherwise, you can update the Vaadin plugin (there are actually multiple plugins) manually as follows:

1. Select **Help → Software Updates...**, the **Software Updates and Add-ons** window will open.
2. Select the **Installed Software** tab.
3. If you want to update only the Vaadin plugins, select them in the list by clicking the plugins and holding the **Ctrl** key pressed for all but the first.



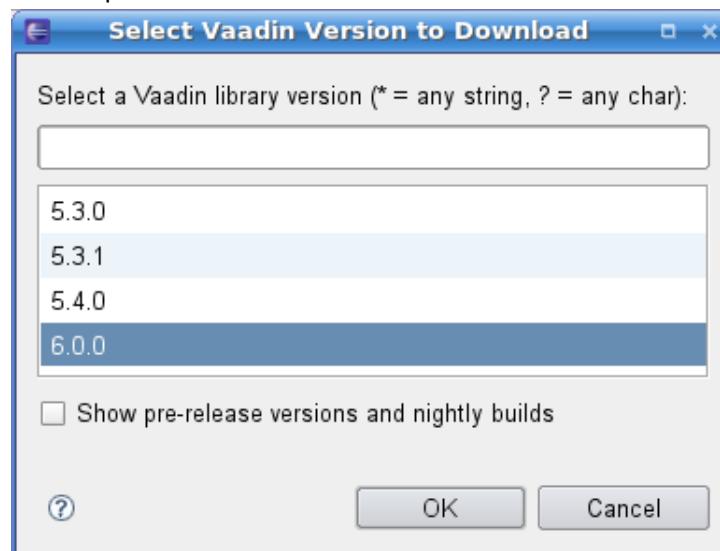
4. Click **Update**.

Notice that updating the Vaadin plugin updates only the plugin and *not* the Vaadin library, which is project specific. See below for instructions for updating the library.

Updating the Vaadin Library

Updating the Vaadin plugin does not update Vaadin library. The library is project specific, as a different version might be required for different projects, so you have to update it separately for each project. To change the library to a newer (or some other) version, do as follows:

1. Select the project in the **Project Explorer** and select **Project → Preferences** or press **Alt-Enter**.
2. In the project preferences window that opens, select **Vaadin → Vaadin Version**.
3. If the version that you want to use is not included in the **Vaadin version** drop-down list, click **Download** to open the download window.



If you want to use a development version, select **Show pre-release versions and nightly builds**. Select the version that you want to download and click **OK**.

4. Select the version that you want to use from the **Vaadin version** down-down list and click **Apply**.

You can observe that the new library appears in the `WebContent/WEB-INF/lib` folder.

2.3. QuickStart with Eclipse

Eager to start developing your own applications using Vaadin? This section presents a QuickStart into running and debugging Vaadin demos under Eclipse. The QuickStart includes a web server, so you do not need to have a full-weight web container such as Apache Tomcat installed.

2.3.1. Starting Eclipse

If you have followed the instructions given in Section 2.2, “Setting up the Development Environment”, you can start Eclipse by running `C:\dev\eclipse\eclipse.exe` (Windows) or `/opt/eclipse/eclipse` (Linux or OS X). Depending on your environment, you may need to give additional memory settings for Eclipse, as the default values are known to cause problems often in some systems.

When starting Eclipse for the first time, it asks where to save the workspace. You can select any directory, but here we select `C:\dev\workspace` (Windows) or `/home/<user>/workspace` (Linux or OS X). We suggest that you also set this as the default.

Close the Eclipse “Welcome” -screen when you are ready to continue.

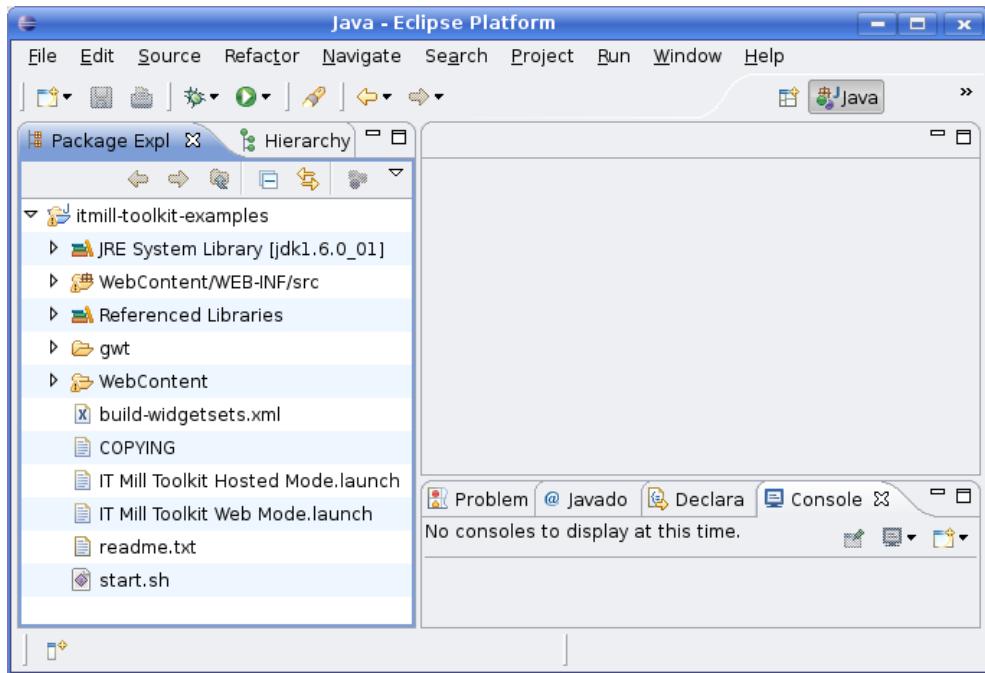
2.3.2. Importing Vaadin as a Project

If you have not yet downloaded the Vaadin package, instructions for downloading and unpacking are available at Section 2.1.1, “Installing the Distribution Package”.

The installation directory of Vaadin contains all necessary files to allow importing it as a ready-to-run Eclipse project:

1. Start Eclipse with any workspace you like. Switch to the Java Perspective through **Window → Open Perspective → Java**.
2. Select **File → Import...** to open the import dialog.
3. In the **Import** dialog, select **General → Existing Projects into Workspace** and click **Next**.
4. In the **Select root directory** option, click the **Browse** button, and select the folder where you unpacked Vaadin, e.g. `c:/dev/vaadin-windows-6.x.x`. Click **OK** in the selection window. The Projects list now shows a project named **vaadin-examples**. Click **Finish** in the **Import** window to finish importing the project.

The newly imported project should look like Figure 2.4, “Vaadin demo project imported into Eclipse”.

Figure 2.4. Vaadin demo project imported into Eclipse

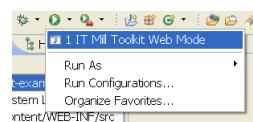
You can now browse the source code of the demo applications in Eclipse. The next section describes how you can run the demos.

2.3.3. Running the Demo Applications in Eclipse

Once the project is imported, as described above, you can run the Content Browser, including the demo applications, as follows:

1. From the main menu, select **Run → Run Configurations....**
2. From the list on the left, select **Java Application → Vaadin Web Mode**.
3. Click **Run**.

Note that after the application has been launched once, it appears in the Favorites list. You can then click on the small dropdown arrow on the right side of the **Run** button on Eclipse toolbar and select **Vaadin Web Mode**.



Running the application in Web Mode will start an embedded web server and open a browser window with the Content Browser. The default system web browser is opened; make sure that the browser is compatible with Vaadin. The **Console** view in the lower pane of Eclipse will display text printed to standard output by the application. Clicking on the red **Terminate** button will stop the server.

Figure 2.5. Vaadin Content Browser Started Under Eclipse

Note that executing the web application locally may cause a security warning from your firewall software because of the started web server. You need to allow connections to port 8888 for the Content Browser to work. Also, if the web service fails to start, make sure that no other service is using port 8888.

Launching the GWT Development Mode

The Google Web Toolkit Development Mode allows debugging client-side GWT Java code in an IDE such as Eclipse. This is made possible by the Google Web Toolkit Developer Plugin, which is available for major browsers, such as Mozilla Firefox, Google Chrome, Safari, and Internet Explorer.

To run the demo applications in the GWT Development Mode, follow the following steps:

1. If not already started, start the demo application in Web Mode as described above. We only need the server so close the web browser which is automatically opened.
2. From the main menu, select **Run → Debug Configurations...**.
3. From the list select **Java Application → GWT Development Mode**.
4. Click **Debug**. This will open the **GWT Development Mode** window.
5. Click **Launch Default Browser**.

This will open the application page in the default browser with a `gwt.codesvr` parameter, which will make the application use the GWT Development Mode. If you have not yet installed the GWT Developer Plugin, the browser will open an installation page, which allows you to download and install the plugin. Please follow the instructions. After the installation is complete (the browser may need to be restarted), the application will be started.

Starting demo applications under the GWT Development Mode can take considerable time!

Starting the development mode compiles the widget set of the application, which can take 10-60 seconds, depending on the hardware. During this time, the web browser is completely unresponsive and does not update its window - you should not think that the browser is stuck.

As with the Web Mode launcher, after you have run the GWT Development Mode launcher once, you can click the dropdown marker on right of the **Debug** button in the toolbar and find the **GWT Development Mode** in the dropdown list.

To use the GWT Development Mode in other projects, you need to create a launch configuration in Eclipse. See Section 10.8.6, “GWT Development Mode” for more detailed information about the Development Mode and how to create the launch configuration.

How to Stop the Run

To stop the launched Jetty web container that serves the Content Browser web application, select the **Console** tab and click on the **Terminate** button.

Figure 2.6. Terminating a Launch



To clean up all terminated launches from the **Console** window, click on the **Remove All Terminated Launches** button.

Figure 2.7. Removing Terminated Launches

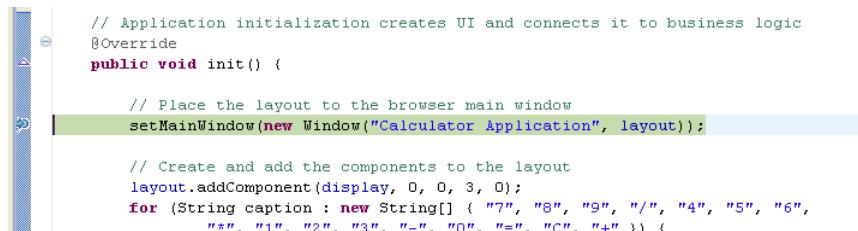


2.3.4. Debugging the Demo Applications in Eclipse

At some point when developing an application, you want to debug it. Running a web application in debug mode is easy in Eclipse. Next, we will show you how to debug the demo applications by inserting a breakpoint in the Calc example.

1. Make sure to stop any previous **Run** command as instructed above at the end of Section 2.3.3, “Running the Demo Applications in Eclipse”.
2. Select **Run → Debug Configurations...** from the main menu and the Debug configuration window will open.
3. Select **Java Application → Vaadin Web Mode** and click **Debug**. The server will start and the web browser will open.
4. Open the source code for the Calc program. It is located in `WebContent/WEB-INF/src/com.vaadin.demo.Calc`. `WebContent/WEB-INF/src` is the project's source folder, shown right below the JRE System Library. Double-click the class to open the source code in the editor.
5. Insert a breakpoint in the `init()` by right-clicking on the gray bar on the left of the editor window to open the context menu, and select **Toggle Breakpoint**.
6. Switch to the browser window and click the **Calc** link (below **More Examples**) to open it.
7. Eclipse encounters the breakpoint and asks to switch to the Debug perspective. Click **Yes**. The debug window will show the current line where the execution stopped as illustrated in Figure 2.8, “Execution Stopped at Breakpoint in Debug Perspective in Eclipse”:

Figure 2.8. Execution Stopped at Breakpoint in Debug Perspective in Eclipse



8. You can now step forward or use any commands you would normally use when debugging an application in Eclipse. Note that you can only debug the application code in this

way. If you are debugging the application with the GWT Development Mode, you can also insert break-points in client side component code and debug it.

2.3.5. Using QuickStart as a Project Skeleton

If you like, you can also use the imported Vaadin demo project as a skeleton for your own project. Just remove any unnecessary files or files related to the demo applications from the project. The proper way of creating a new Vaadin project will be described in the next section: Section 2.4, “Your First Project with Vaadin”.

2.4. Your First Project with Vaadin

This section gives instructions for creating a new Eclipse project using the Vaadin Plugin. The task will include the following steps:

1. Create a new project
2. Write the source code
3. Configure and start Tomcat (or some other web server)
4. Open a web browser to use the web application

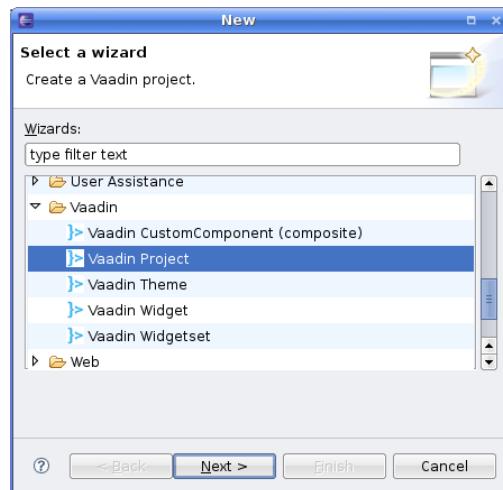
We also show how you can debug the application in the debug mode in Eclipse.

This walkthrough assumes that you have already installed the Vaadin Plugin and set up your development environment, as instructed in Section 2.1.1, “Installing the Distribution Package” and Section 2.2, “Setting up the Development Environment”.

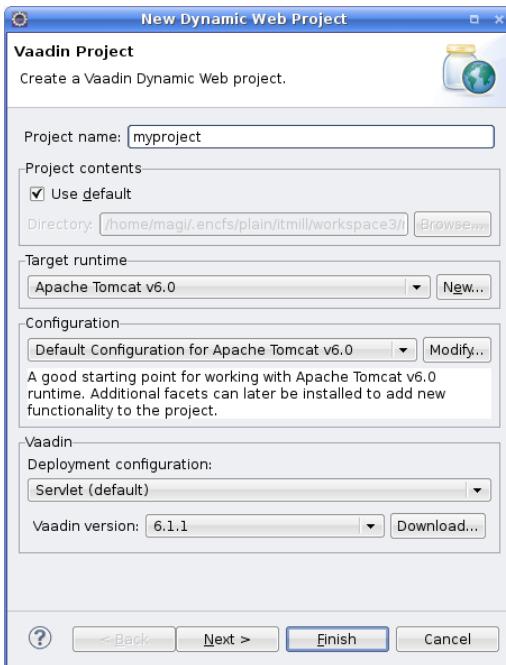
2.4.1. Creating the Project

Let us create the first application project with the tools installed in the previous section. First, launch Eclipse and follow the following steps:

1. Start creating a new project by selecting from the menu **File → New → Project....**
2. In the **New Project** window that opens, select **Web → Vaadin Project** and click **Next**.



3. In the **Vaadin Project** step, you need to set the basic web project settings. You need to give at least the project name and the runtime; the default values should be good for the other settings.

**Project name**

Give the project a name. The name should be a valid identifier usable cross-platform as a filename and inside a URL, so using only lower-case alphanumeric, underscore, and minus sign is recommended.

Use default

Defines the directory under which the project is created. You should normally leave it as it is. You may need to set the directory, for example, if you are creating an Eclipse project on top of a version-controlled source tree.

Target runtime

Defines the application server to use for deploying the application. The server that you have installed, for example Apache Tomcat, should be selected automatically. If not, click **New** to configure a new server under Eclipse.

Configuration

Select the configuration to use; you should normally use the default configuration for the application server. If you need to modify the project facets, click **Modify**.

Deployment configuration

This setting defines the environment to which the application will be deployed, to generate the appropriate project directory layout and configuration files. The choices are:

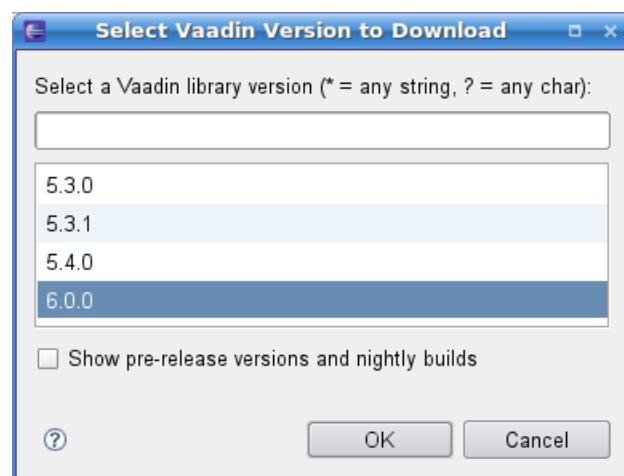
- **Servlet (default)**,

- **Google App Engine Servlet**, and
- **Generic Portlet (Portlet 2.0)**.
- **Old Portlet (Portlet 1.0)**.

The further steps in the New Project Wizard depend on the selected deployment configuration; the steps listed in this section are for the default servlet configuration. See Section 11.9, “Google App Engine Integration” and Section 11.8, “Portal Integration” for details on the use of Vaadin in the alternative environments.

Vaadin version

Select the Vaadin version to use. The drop-down list shows, by default, the latest available version of Vaadin. If you want to use another version, click **Download**. The dialog that opens lists all official releases of Vaadin.

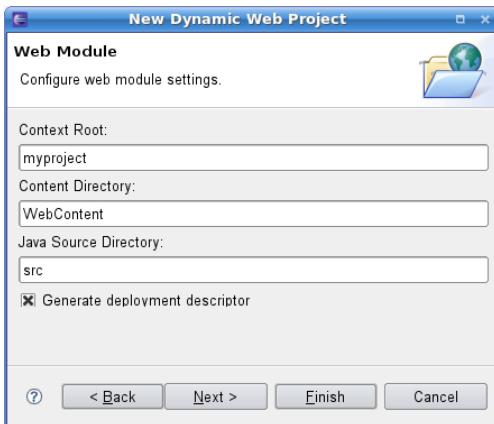


If you want to use a pre-release version or a nightly development build, select **Show pre-release versions and nightly builds**. Select a version and click **Ok** to download it. It will appear as a choice in the drop-down list.

If you want to change the project to use another version of Vaadin, for example to upgrade to a newer one, you can go to project settings and download and select the other version.

You can click **Finish** here to use the defaults for the rest of the settings, or click **Next**.

4. The settings in the **Web Module** step define the basic servlet-related settings and the structure of the web application project. All the settings are pre-filled, and you should normally accept them as they are.

**Context Root**

The context root (of the application) identifies the application in the URL used for accessing it. For example, if the server runs in the apps context and the application has `myproject` context, the URL would be `http://example.com/app/url`. The wizard will suggest `myproject` for the context name.

Content Directory

The directory containing all the content to be included in the servlet and served by the web server. The directory is relative to the root directory of the project.

Java Source Directory

The default source directory containing the application sources. The `src` directory is suggested; another convention common in web applications is to use `WebContent/WEB-INF/src`, in which case the sources are included in the servlet (but not served in HTTP requests).

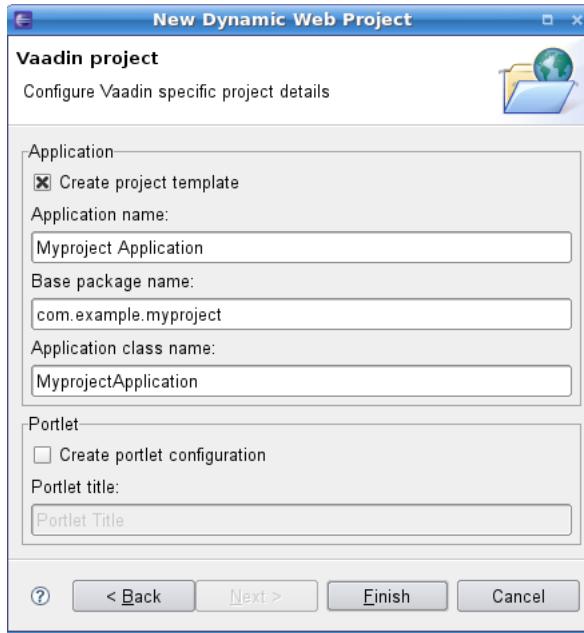
Generate deployment descriptor

Should the wizard generate the `web.xml` deployment descriptor required for running the servlet in the `WebContent/WEB-INF` directory. Strongly recommended. See Section 4.8.3, “Deployment Descriptor `web.xml`” for more details.

This will be the sub-path in the URL, for example `http://localhost:8080/myproject`. The default for the application root will be / (root).

You can just accept the defaults and click **Next**.

5. The **Vaadin project** step page has various Vaadin-specific application settings. If you are trying Vaadin out for the first time, you should not need to change anything. You can set most of the settings afterwards, except the creation of the portlet configuration.



Create project template	Make the wizard create an application class stub.
Application Name	The name of the application appears in the browser window title.
Base package name	The name of the Java package under which the application class is to be placed.
Application class name	Name of the Vaadin application class.
Create portlet configuration	When this option is selected, the wizard will create the files needed for running the application in a portal. See Section 11.8, “Portal Integration” for more information on portlets.

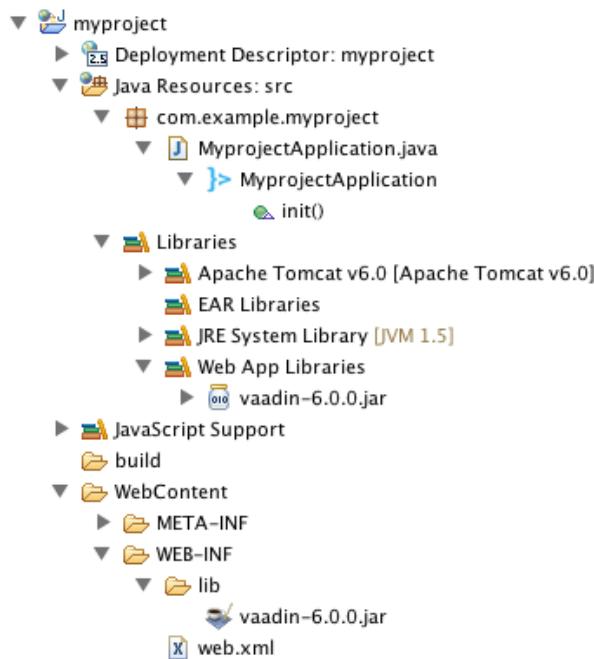
Finally, click **Finish** to create the project.

6. Eclipse may ask to switch to J2EE perspective. A Dynamic Web Project uses an external web server and the J2EE perspective provides tools to control the server and manage application deployment. Click **Yes**.

2.4.2. Exploring the Project

After the **New Project** wizard exists, it has done all the work for us: Vaadin libraries are installed in the `WebContent/WEB-INF/lib` directory, an application class skeleton has been written to `src` directory, and `WebContent/WEB-INF/web.xml` already contains a deployment descriptor.

Figure 2.9. A New Dynamic Web Project



The application class created by the plugin contains the following code:

```
package com.example.myproject;

import com.vaadin.Application;
import com.vaadin.ui.*;
public class MyprojectApplication extends Application
{
    @Override
    public void init() {
        Window mainWindow =
            new Window("Myproject Application");
        Label label = new Label("Hello Vaadin user");
        mainWindow.addComponent(label);
        setMainWindow(mainWindow);
    }
}
```

Let us add a button to the application to make it a bit more interesting. The resulting `init()` method could look something like:

```
public void init() {
    final Window mainWindow =
        new Window("Myproject Application");

    Label label = new Label("Hello Vaadin user");
    mainWindow.addComponent(label);

    mainWindow.addComponent(
        new Button("What is the time?",
            new Button.ClickListener() {
                public void buttonClick(ClickEvent event) {
                    mainWindow.showNotification(
                        "The time is " + new Date());
                }
            }));
}
```

```
    setMainWindow(mainWindow);
}
```

The deployment descriptor `WebContent/WEB-INF/web.xml` defines Vaadin framework servlet, the application class, and servlet mapping:

Example 2.1. Web.xml Deployment Descriptor for our project

```
<?xml version="1.0" encoding="UTF-8"?>
<web-app xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://java.sun.com/xml/ns/javaee"
  xmlns:web="http://java.sun.com/xml/ns/javaee/web-app_2_5.xsd"
  id="WebApp_ID" version="2.5">

  <display-name>myproject</display-name>

  <context-param>
    <description>Vaadin production mode</description>
    <param-name>productionMode</param-name>
    <param-value>false</param-value>
  </context-param>

  <servlet>
    <servlet-name>Myproject Application</servlet-name>
    <servlet-class>
      com.vaadin.terminal.gwt.server.ApplicationServlet
    </servlet-class>
    <init-param>
      <description>Vaadin application class to start</description>
      <param-name>application</param-name>
      <param-value>
        com.example.myproject.MyprojectApplication
      </param-value>
    </init-param>
  </servlet>

  <servlet-mapping>
    <servlet-name>Myproject Application</servlet-name>
    <url-pattern>/*</url-pattern>
  </servlet-mapping>
</web-app>
```

For a more detailed treatment of the `web.xml` file, see Section 4.8.3, “Deployment Descriptor `web.xml`”.

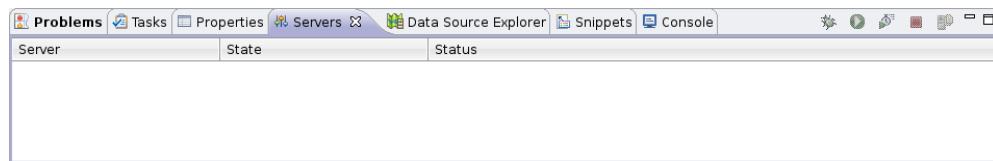
2.4.3. Setting Up and Starting the Web Server

Eclipse IDE for Java EE Developers has the Web Standard Tools package installed, which supports control of various web servers and automatic deployment of web content to the server when changes are made to a project.

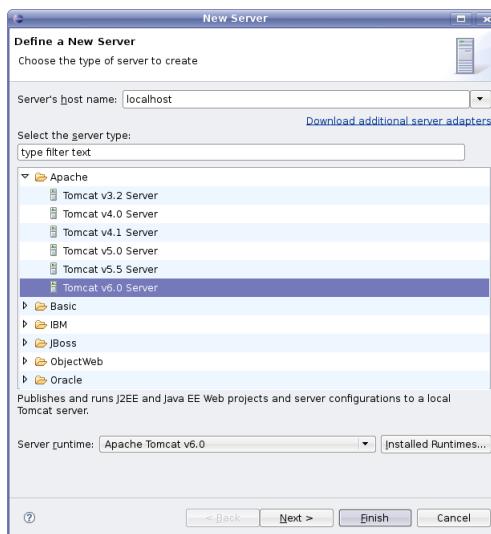
Make sure that Tomcat was installed with user permissions. Configuration of the web server in Eclipse will fail if the user does not have write permissions to the configuration and deployment directories under the Tomcat installation directory.

Follow the following steps.

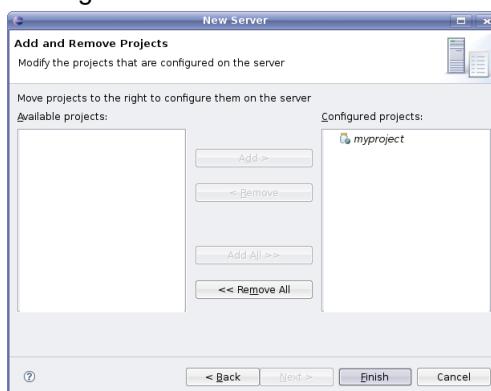
1. Switch to the **Servers** tab in the lower panel in Eclipse. List of servers should be empty after Eclipse is installed. Right-click on the empty area in the panel and select **New** → **Server**.



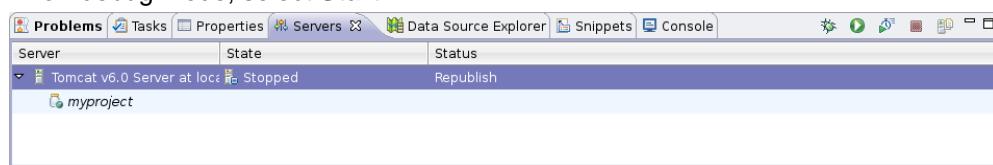
2. Select **Apache** → **Tomcat v6.0 Server** and set **Server's host name** as localhost, which should be the default. If you have only one Tomcat installed, **Server runtime** has only one choice. Click **Next**.



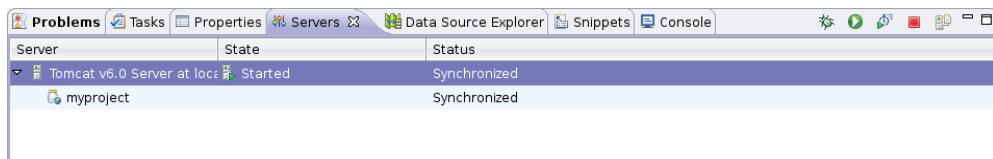
3. Add your project to the server by selecting it on the left and clicking **Add** to add it to the configured projects on the right. Click **Finish**.



4. The server and the project are now installed in Eclipse and are shown in the **Servers** tab. To start the server, right-click on the server and select **Debug**. To start the server in non-debug mode, select **Start**.



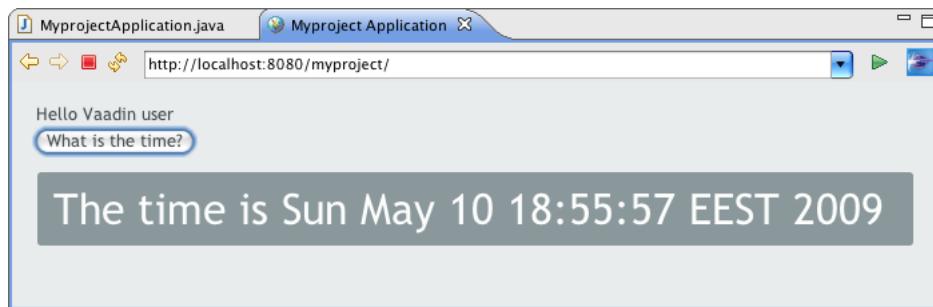
5. The server starts and the WebContent directory of the project is published to the server on <http://localhost:8080/myproject/>.



2.4.4. Running and Debugging

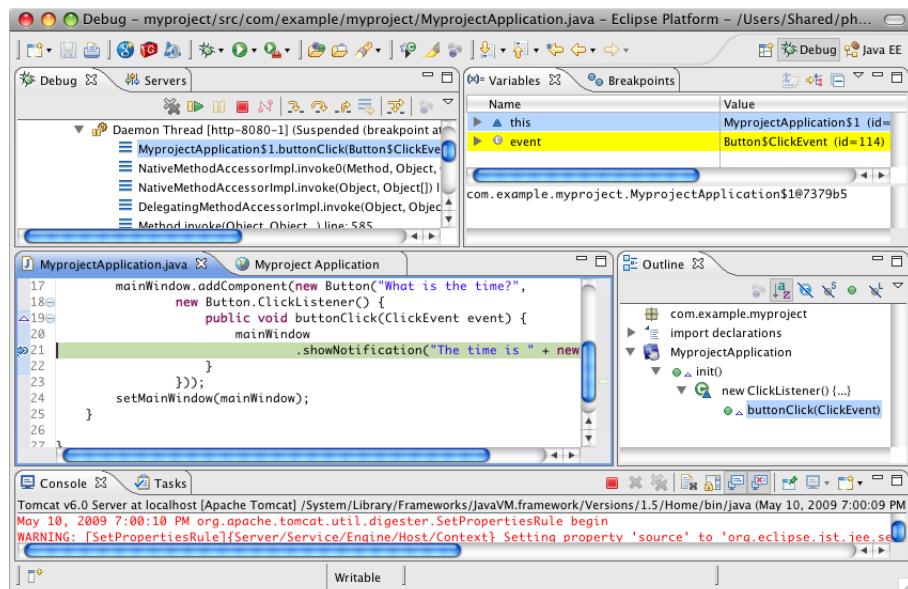
Starting your application is as easy as selecting **myproject** from the **Project Explorer** and then **Run → Debug As → Debug on Server**. Eclipse then opens the application in built-in web browser.

Figure 2.10. Running a Vaadin Application



You can insert break points in the Java code by double-clicking on the left margin bar of the source code window. For example, if you insert a breakpoint in the `buttonClick()` method and click the **What is the time?** button, Eclipse will ask to switch to the Debug perspective. Debug perspective will show where the execution stopped at the breakpoint. You can examine and change the state of the application. To continue execution, select **Resume** from **Run** menu.

Figure 2.11. Debugging a Vaadin Application



The procedure described above allows debugging the server-side application. For more information on debugging client-side widgets, see Section 10.8.6, “GWT Development Mode”.

Chapter 3

Architecture

3.1. Overview	33
3.2. Technological Background	36
3.3. Applications as Java Servlet Sessions	37
3.4. Client-Side Engine	37
3.5. Events and Listeners	39

This chapter provides an introduction to the architecture of Vaadin at somewhat technical level.

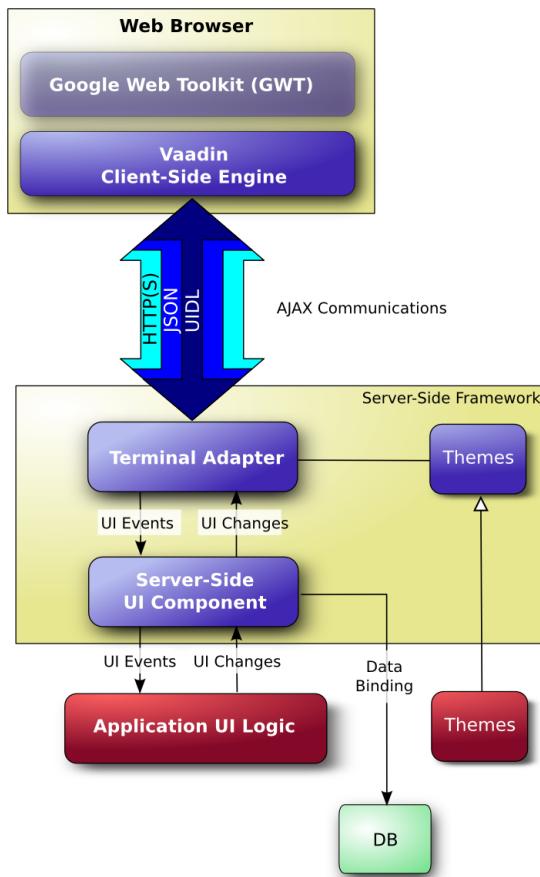
3.1. Overview

In Chapter 1, *Introduction*, we gave a short introduction to the general architecture of Vaadin. Let us now look deeper into it. Figure 3.1, “Vaadin Architecture” below illustrates the architecture.

Vaadin consists of a *web application API*, a horde of *user interface components*, *themes* for controlling the appearance, and a *data model* that allows binding the user interface components directly to data. Behind the curtains it also employs a *terminal adapter* to receive requests from web browsers and make responses by rendering the pages.

An application using Vaadin runs as a servlet in a Java web server, serving HTTP requests. The terminal adapter receives client requests through the web server’s Java Servlet API, and interprets them to user events for a particular session. An event is associated with a UI component and delivered to the application. As the application logic makes changes to the UI components, the terminal adapter renders them in the web browser by generating a response. In AJAX rendering mode, a client-side JavaScript component receives the responses and uses them to make any necessary changes to the page in the browser.

The top level of a user application consists of an application class that inherits **com.vaadin.Application**. It creates the UI components (see below) it needs, receives events regarding them,

Figure 3.1. Vaadin Architecture

and makes necessary changes to the components. For detailed information about inheriting the **Application**, see Chapter 4, *Writing a Web Application*.

The major parts of the architecture and their function are as follows:

User Interface Components

The user interface consists of UI components that are created and laid out by the application. Each server-side component has a client-side counterpart, with which the user interacts. The server-side components can serialize themselves over the client connection using a terminal adapter. The client-side components, in turn, can serialize user interaction back to the application, which is received in the server-side components as events. The components relay these events to the application logic. Most components are bound to a data source (see below). For a complete description of UI component architecture, see Chapter 5, *User Interface Components*.

Client-Side Engine

The Client-Side Engine of Vaadin manages the rendering in the web browser using Google Web Toolkit (GWT). It communicates user interaction and UI changes with the server-side Terminal Adapter using

the User Interface Definition Language (UIDL), a JSON-based language. The communications are made using asynchronous HTTP or HTTPS requests. See Section 3.4, “Client-Side Engine”.

Terminal Adapter

The UI components do not render themselves directly as a web page, but use a *Terminal Adapter*. This abstraction layer allows users to use Vaadin applications with practically any web browser. Releases 3 and 4 of IT Mill Toolkit supported HTML and simple AJAX based rendering, while Vaadin Release 5 supports advanced AJAX-based rendering using Google Web Toolkit (GWT). You could imagine some other browser technology, not even based on HTML, and you - or we for that matter - could make it work just by writing a new adapter. Your application would still just see the Vaadin API. To allow for this sort of abstraction, UI components communicate their changes to the Terminal Adapter, which renders them for the user's browser. When the user does something in the web page, the events are communicated to the terminal adapter (through the web server) as asynchronous AJAX requests. The terminal adapter delivers the user events to the UI components, which deliver them to the application's UI logic.

Themes

The user interface separates between presentation and logic. While the UI logic is handled as Java code, the presentation is defined in *themes* as CSS. Vaadin provides a default themes. User themes can, in addition to style sheets, include HTML templates that define custom layouts and other resources, such as images. Themes are discussed in detail in Chapter 8, *Themes*.

UIDL

The Terminal Adapter draws the user interface to the web page and any changes to it using a special User Interface Definition Language (UIDL). The UIDL communications are done using JSON (JavaScript Object Notation), which is a lightweight data interchange format that is especially efficient for interfacing with JavaScript-based AJAX code in the browser. See Section 3.2.3, “JSON” and Appendix A, *User Interface Definition Language (UIDL)* for details.

Events

User interaction with UI components creates events, which are first processed on the client-side with JavaScript and then passed all the way through the HTTP server, terminal adapter, and user component layers to the application. See Section 3.5, “Events and Listeners”.

Data Model

In addition to the user interface model, Vaadin provides a *data model* for interfacing data presented in UI components. Using the data model, the user interface components can update the application data directly,

without the need for any control code. All the UI components use this data model internally, but they can be bound to a separate data source as well. For example, you can bind a table component to an SQL query response. For a complete overview of the Vaadin Data Model, please refer to Chapter 9, *Binding Components to Data*.

3.2. Technological Background

This section provides an introduction to the various technologies and designs on which Vaadin is based: AJAX-based web applications in general, Google Web Toolkit, and JSON data interchange format. This knowledge is not necessary for using Vaadin, but provides some background if you need to make low-level extensions to Vaadin.

3.2.1. AJAX

AJAX (Asynchronous JavaScript and XML) is a technique for developing web applications with responsive user interaction, similar to traditional desktop applications. While conventional JavaScript-enabled HTML pages can receive new content only with page updates, AJAX-enabled pages send user interaction to the server using an asynchronous request and receive updated content in the response. This way, only small parts of the page data can be loaded. This goal is achieved by the use of a certain set of technologies: XHTML, CSS, DOM, JavaScript, XMLHttpRequest, and XML.

AJAX, with all the fuss and pomp it receives, is essentially made possible by a simple API, namely the `XMLHttpRequest` class in JavaScript. The API is available in all major browsers and, as of 2006, the API is under way to become a W3C standard.

Communications between the browser and the server usually require some sort of *serialization* (or *marshalling*) of data objects. AJAX suggests the use of XML for data representation in communications between the browser and the server. While Vaadin Release 4 used XML for data interchange, Release 5 uses the more efficient JSON. For more information about JSON and its use in Vaadin, see Section 3.2.3, “JSON”.

If you're a newcomer to Ajax, Section 11.1, “Special Characteristics of AJAX Applications” discusses the history and motivations for AJAX-based web applications, as well as some special characteristics that differ from both traditional web applications and desktop applications.

3.2.2. Google Web Toolkit

Google Web Toolkit is a software development kit for developing client-side web applications easily, without having to use JavaScript or other browser technologies directly. Applications using GWT are developed with Java and compiled into JavaScript with the GWT Compiler.

GWT is essentially a client-side technology, normally used to develop user interface logic in the web browser. GWT applications still need to communicate with a server using RPC calls and by serializing any data. Vaadin effectively hides all client-server communications, allows handling user interaction logic in a server application, and allows software development in a single server-side application. This makes the architecture of an AJAX-based web application much simpler.

Vaadin uses GWT to render user interfaces in the web browser and handle the low-level tasks of user interaction in the browser. Use of GWT is largely invisible in Vaadin for applications that do not need any custom GWT components.

See Section 3.4, “Client-Side Engine” for a description of how GWT is used in the Client-Side Engine of Vaadin. Chapter 10, *Developing Custom Components* provides information about the integration of GWT-based user interface components with Vaadin.

3.2.3. JSON

JSON is a lightweight data-interchange format that is easy and fast to generate and parse. JSON messages are said to be possibly a hundred times faster to parse than XML with current browser technology. The format is a subset of the JavaScript language, which makes it possible to evaluate JSON messages directly as JavaScript expressions. This makes JSON very easy to use in JavaScript applications and therefore also for AJAX applications.

The Client-Side Engine of Vaadin uses JSON through Google Web Toolkit, which supports JSON communications in the `com.google.gwt.json.client` package. Together with advanced update optimization and caching, Vaadin is able to update changes in the user interface to the browser in an extremely efficient way.

The use of JSON is completely invisible to a developer using Vaadin. Implementation of client-server serialization in custom widgets uses abstract interfaces that may be implemented as any low-level interchange format, such as XML or JSON. Details on JSON communications are given in Section A.2, “JSON Rendering”.

3.3. Applications as Java Servlet Sessions

Vaadin framework does basically everything it does on top of the Java Servlet API, which lies hidden deep under the hood, with the terminal adapter being the lowest level layer for handling requests from the web container.

When the web container gets the first request for a URL registered for an application, it creates an instance of the **ApplicationServlet** class in Vaadin framework that inherits the **HttpServlet** class defined in Java Servlet API. It follows sessions by using **HttpSession** interface and associates an **Application** instance with each session. During the lifetime of a session, the framework relays user actions to the proper application instance, and further to a user interface component.

3.4. Client-Side Engine

This section gives an overview of the client-side architecture of Vaadin. Knowledge of the client-side technologies is generally not needed unless you develop or use custom GWT components. The client-side engine is based on Google Web Toolkit (GWT), which allows the development of the engine and client-side components solely with Java.

Chapter 10, *Developing Custom Components* provides information about the integration of GWT-based user interface components with Vaadin.

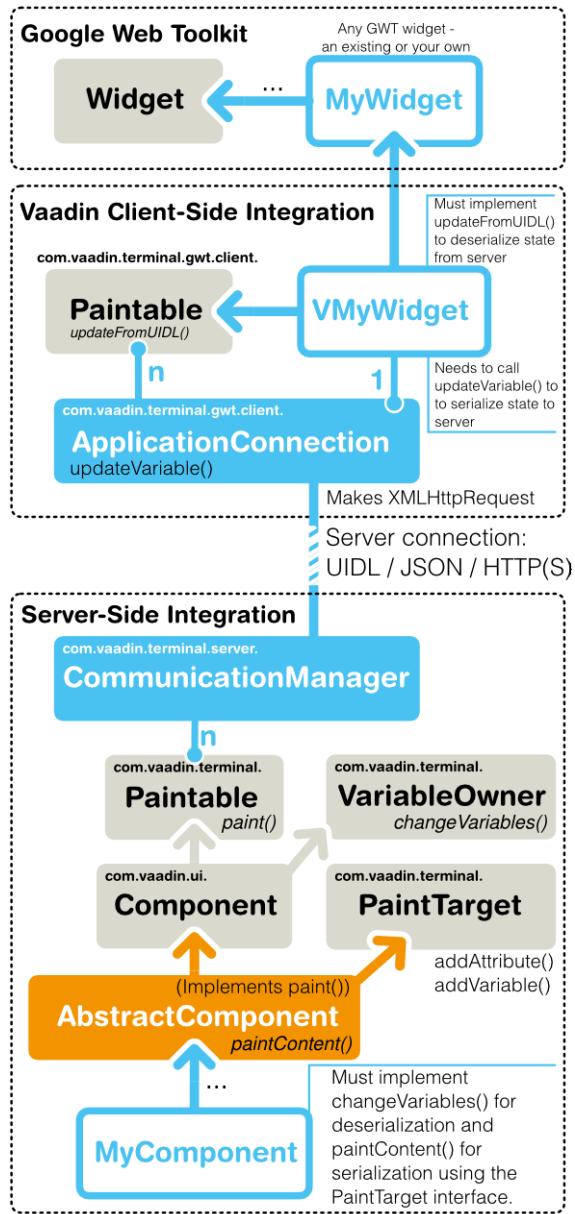
Figure 3.2. Architecture of Vaadin Client-Side Engine

Figure 3.2, “Architecture of Vaadin Client-Side Engine” illustrates the architecture of the client-side engine using a button component as an example. The user interface is managed by the **ApplicationConnection** class, which handles AJAX requests to the server and renders the user interface according to responses. Communications are done over HTTP(S) using the JSON data interchange format and the User Interface Definition Language (UIDL). In the server-side application, the button is used with the **Button** class of Vaadin. On the client-side, the user interface consists of various GWT components that inherit **Widget** class. In the figure above, the GWT class **Button** is used to render the button in the browser (the inheritance of **Button** is simplified in the figure). Vaadin provides an **VButton** class, which implements the **Paintable** interface needed for rendering the component with GWT.

The actual initial web page that is loaded in the browser is an empty page that loads the JavaScript code of the Vaadin Client-Side Engine. After it is loaded and started, it handles the AJAX requests to the server. All server communications are done through the **ApplicationConnection** class.

The communication with the server is done as UIDL (User Interface Definition Language) messages using the JSON message interchange format over a HTTP(S) connection. UIDL is described in Appendix A, *User Interface Definition Language (UIDL)* and JSON in Section 3.2.3, “JSON” and Section A.2, “JSON Rendering”.

3.5. Events and Listeners

When a user does something, such as clicks a button or selects an item, the application needs to know about it. Many Java-based user interface frameworks follow the *Observer* design pattern to communicate user input to the application logic. So does Vaadin. The design pattern involves two kinds of elements: an object and a number of observers that listen for events regarding the object. When an event related to the object occurs, the observers receive a notification regarding the event. In most cases there is only one observer, defined in the application logic, but the pattern allows for multiple observers. As in the event-listener framework of Java SE, we call the observing objects *listeners*.

In the ancient times of C programming, *callback functions* filled largely the same need as listeners do now. In object-oriented languages, we have only classes and methods, not functions, so the application has to give a class interface instead of a callback function pointer to the framework. However, Vaadin supports defining a method as a listener as well.

Events can serve many kinds of purposes. In Vaadin, the usual purpose of events is handling user interaction in a user interface. Session management can require special events, such as time-out, in which case the event is actually the lack of user interaction. Time-out is a special case of timed or scheduled events, where an event occurs at a specific date and time or when a set time has passed. Database and other asynchronous communications can cause events too.

To receive events of a particular type, an application must include a class that implements the corresponding listener interface. In small applications, the application class itself could implement the needed listener interfaces. Listeners are managed by the **AbstractComponent** class, the base class of all user interface components. This means that events regarding any component can be listened to. The listeners are registered in the components with `addListener()` method.

Most components that have related events define their own event class and corresponding listener classes. For example, the **Button** has **Button.ClickEvent** events, which can be listened to through the **Button.ClickListener** interface. This allows an application to listen to many different kinds of events and to distinguish between them at class level. This is usually not enough, as applications usually have many components of the same class and need to distinguish between the particular components. We will look into that more closely later. The purpose of this sort of class level separation is to avoid having to make type conversions in the handlers.

Notice that many listener interfaces inherit the **java.util.EventListener** superinterface, but it is not generally necessary to inherit it.

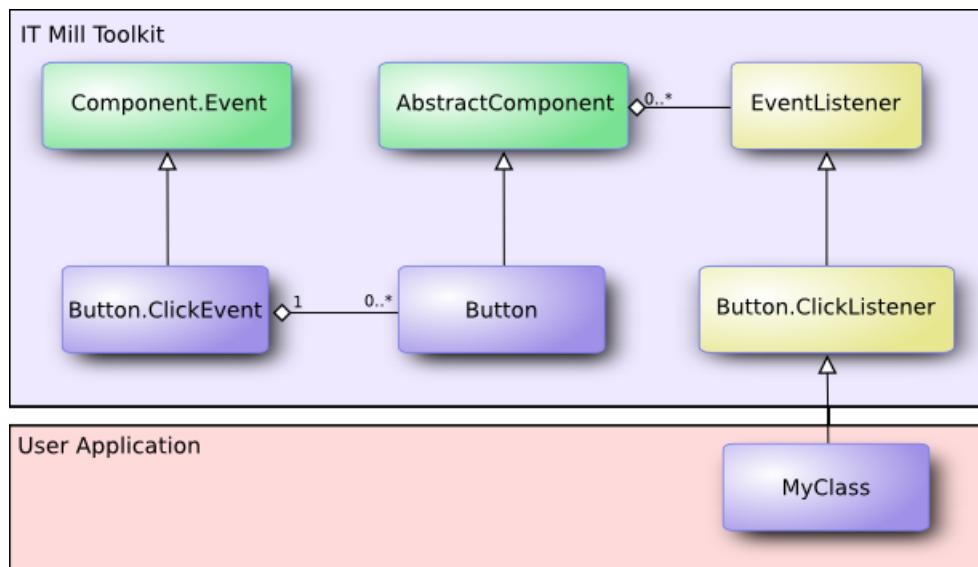
Figure 3.3. Class Diagram of a Button Click Listener

Figure 3.3, “Class Diagram of a Button Click Listener” illustrates an example where an application-specific class inherits the **Button.ClickListener** interface to be able to listen for button click events. The application must instantiate the listener class and register it with `addListener()`. When an event occurs, an event object is instantiated, in this case a **ClickEvent**. The event object knows the related UI component, in this case the **Button**.

Section 4.4, “Handling Events with Listeners” goes into details of handling events in practice.

Chapter 4

Writing a Web Application

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This chapter provides the fundamentals of web application development with Vaadin, concentrating on the basic elements of an application from a practical point-of-view.

If you are a newcomer to AJAX development, you may benefit from Section 11.1, “Special Characteristics of AJAX Applications”. It explains the role of pages in AJAX web applications, and provides some basic design patterns for applications.

4.1. Overview

An application made with Vaadin runs as a Java Servlet in a Servlet container. The entry-point is the application class, which needs to create and manage all necessary user interface components, including windows. User interaction is handled with event listeners, simplified by binding user interface components directly to data. Visual appearance is defined in themes as CSS files.

Icons, other images, and downloadable files are handled as *resources*, which can be external or served by the application server or the application itself.

Figure 4.1. Application Architecture

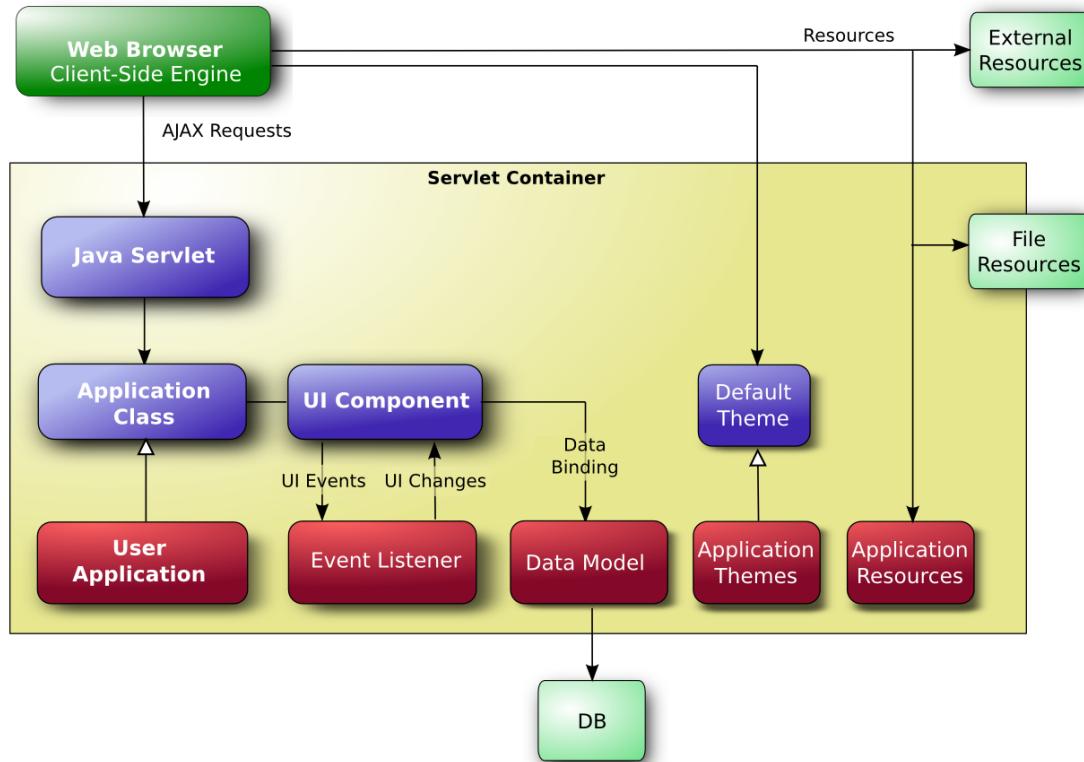


Figure 4.1, “Application Architecture” above gives the basic architecture of an application made with the Vaadin framework, with all the major elements, which are introduced below and discussed in detail in this chapter.

First of all, an application that uses Vaadin must define an application class that inherits the abstract **com.vaadin.Application** class. The application class must implement the `init()` method.

```

public class MyApp extends com.vaadin.Application {
    public void init() {
        ... initialization code goes here ...
    }
}
  
```

Besides acting as the entry-point in the servlet, the **Application** class provides facilities for window access, execution control, and theme selection. The application API may seem similar to Java Servlet API, but that is only superficial. Vaadin framework associates requests with sessions so that an application class instance is really a session object. Because of this, you can develop web applications much like you would develop desktop applications.

The most important thing in the initialization is the creation of the main window (see below), which any application has. This, and the deployment of the application as a Java Servlet in the Servlet container, as described in Section 4.8, “Setting Up the Application Environment”, are the minimal requirements for an application.

Below is a short overview of the basic elements of an application:

Windows

An application always has a *main window*, as described in Section 4.2, “Managing the Main Window”. An application can actually have a number of such application-level windows, all bound to the same application session, as described in Section 11.2, “Application-Level Windows”. Application-level windows can contain non-native sub-windows, which are essentially floating layout components handled inside the browser.

User Interface Components

The user interface consists of UI components that are created and laid out by the application. User interaction with the components causes events (see below) related to the component, which the application must handle. Most components are bound to some data using the Data Model (see below). You can make your own UI components through either inheritance or composition. For a thorough reference of UI components, see Chapter 5, *User Interface Components*, for layout components, see Chapter 6, *Managing Layout*, and for composing components, see Section 5.20, “Component Composition with **CustomComponent**”.

Events and Listeners

Events, and listeners that handle events, are the basis of handling user interaction in an application. Section 3.5, “Events and Listeners” gave an introduction to events and listeners from an architectural point-of-view, while Section 4.4, “Handling Events with Listeners” later in this chapter takes a more practical view.

Resources

A user interface can display images or have links to web pages or downloadable documents. These are *resources*, which can be external or provided by the web server or the application itself. Section 4.5, “Referencing Resources” gives a practical overview of the different types of resources.

Themes

The presentation and logic of the user interface are separated. While the UI logic is handled as Java code, the presentation is defined in *themes* as CSS. Vaadin provides a default theme. User-defined themes can, in addition to style sheets, include HTML templates that define custom layouts and other theme resources, such as images. Themes are discussed in detail in Chapter 8, *Themes*, custom layouts in Section 6.11, “Custom Layouts”, and theme resources in Section 4.5.4, “Theme Resources”.

Data Binding

Field components are essentially views to data, represented in a *data model*. Using the data model, the components can update the application data directly, without the need for any control code. A field component model is always bound to a *property*, an *item*, or a *container*, depending on the field type. While all the components

have a default data model, they can be bound to a user-defined data source. For example, you can bind a table component to an SQL query response. For a complete overview of data binding in Vaadin, please refer to Chapter 9, *Binding Components to Data*.

4.2. Managing the Main Window

As explained in Section 11.1, “Special Characteristics of AJAX Applications”, an AJAX web application usually runs in a single “web page” in a browser window. The page is generally not reloaded after it is opened initially, but it communicates user interaction with the server through AJAX communications. A window in an AJAX application is therefore more like a window in a desktop application and less like a web page.

A **Window** is the top-level container of a user interface displayed in a browser window. As an AJAX application typically runs on a single “page” (URL), there is usually just one window -- the main window. The main window can be accessed using the URL of the application. You set the main window with the `setMainWindow()` method of the **Application** class.

```
import com.vaadin.ui.*;

public class HelloWorld extends com.vaadin.Application {
    public void init() {
        Window main = new Window("The Main Window");
        setMainWindow(main);

        ... fill the main window with components ...
    }
}
```

You can add components to the main window, or to any other window, with the `addComponent()` method, which actually adds the given component to the root layout component bound to the window. If you wish to use other than the default root layout, you can set it with `setContent()`, as explained in Section 6.2, “Window and Panel Root Layout”.

Vaadin has two basic kinds of windows: *application-level windows*, such as the main window, and *child windows* (or sub-windows) inside the application-level windows. The child windows are explained in the next section, while application-level windows are covered in Section 11.2, “Application-Level Windows”.

4.3. Child Windows

An application-level window can have a number of floating child windows. They are managed by the client-side JavaScript runtime of Vaadin using HTML features. Vaadin allows opening and closing child windows, refreshing one window from another, resizing windows, and scrolling the window content. Child windows are typically used for *Dialog Windows* and *Multiple Document Interface* applications. Child windows are by default not modal; you can set them modal as described in Section 4.3.3, “Modal Windows”.

As with all user interface components, the appearance of a window and its contents is defined with themes.

User control of a child window is limited to moving, resizing, and closing the window. Maximizing or minimizing are not yet supported.

4.3.1. Opening and Closing a Child Window

You can open a new window by creating a new **Window** object and adding it to the main window with `addWindow()` method of the **Application** class.

```
mywindow = new Window("My Window");
mainwindow.addWindow(mywindow);
```

You close the window in a similar fashion, by calling the `removeWindow()` of the **Application** class:

```
myapplication.removeWindow (mywindow);
```

The user can, by default, close a child window by clicking the close button in the upper-right corner of the window. You can disable the button by setting the window as *read-only* with `setReadOnly(true)`. Notice that you could disable the button also by making it invisible in CSS with a "`display: none`" formatting. The problem with such a cosmetic disabling is that a malicious user might re-enable the button and close the window, which might cause problems and possibly be a security hole. Setting the window as read-only not only disables the close button on the client side, but also prevents processing the close event on the server side.

The following example demonstrates the use of a child window in an application. The example manages the window using a custom component that contains a button for opening and closing the window.

```
/** Component contains a button that allows opening a window. */
public class WindowOpener extends CustomComponent
    implements Window.CloseListener {
    Window mainwindow; // Reference to main window
    Window mywindow; // The window to be opened
    Button openbutton; // Button for opening the window
    Button closebutton; // A button in the window
    Label explanation; // A descriptive text

    public WindowOpener(String label, Window main) {
        mainwindow = main;

        // The component contains a button that opens the window.
        final VerticalLayout layout = new VerticalLayout();

        openbutton = new Button("Open Window", this,
            "openButtonClick");
        explanation = new Label("Explanation");
        layout.addComponent(openbutton);
        layout.addComponent(explanation);

        setCompositionRoot(layout);
    }

    /** Handle the clicks for the two buttons. */
    public void openButtonClick(Button.ClickEvent event) {
        /* Create a new window. */
        mywindow = new Window("My Dialog");
        mywindow.setPositionX(200);
        mywindow.setPositionY(100);

        /* Add the window inside the main window. */
        mainwindow.addWindow(mywindow);

        /* Listen for close events for the window. */
        mywindow.addListener(this);

        /* Add components in the window. */
    }
}
```

```
mywindow.addComponent(
    new Label("A text label in the window."));
closebutton = new Button("Close", this, "closeButtonClick");
mywindow.addComponent(closebutton);

/* Allow opening only one window at a time. */
openbutton.setEnabled(false);

explanation.setValue("Window opened");
}

/** Handle Close button click and close the window. */
public void closeButtonClick(Button.ClickEvent event) {
    /* Windows are managed by the application object. */
    mainwindow.removeWindow(mywindow);

    /* Return to initial state. */
    openbutton.setEnabled(true);

    explanation.setValue("Closed with button");
}

/** In case the window is closed otherwise. */
public void windowClose(CloseEvent e) {
    /* Return to initial state. */
    openbutton.setEnabled(true);

    explanation.setValue("Closed with window controls");
}
}
```

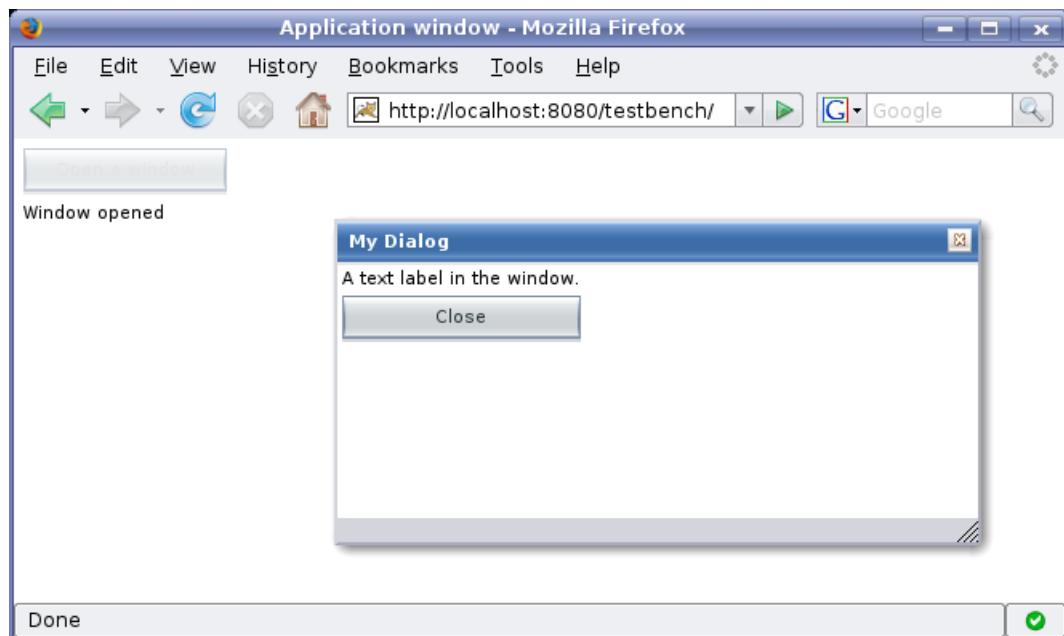
The example implements a custom component that inherits the **CustomComponent** class. It consists of a **Button** that it uses to open a window and a **Label** to describe the state of the window. When the window is open, the button is disabled. When the window is closed, the button is enabled again.

You can use the above custom component in the application class with:

```
public void init() {
    Window main = new Window("The Main Window");
    setMainWindow(main);

    addComponent(new WindowOpener("Window Opener", main));
}
```

When added to an application, the screen will look as illustrated in the following screenshot:

Figure 4.2. Opening a Child Window

4.3.2. Window Positioning

When created, a window will have a default size and position. You can specify the size of a window with `setHeight()` and `setWidth()` methods. You can set the position of the window with `setPositionX()` and `setPositionY()` methods.

```
/* Create a new window. */
mywindow = new Window("My Dialog");

/* Set window size. */
mywindow.setHeight("200px");
mywindow.setWidth("400px");

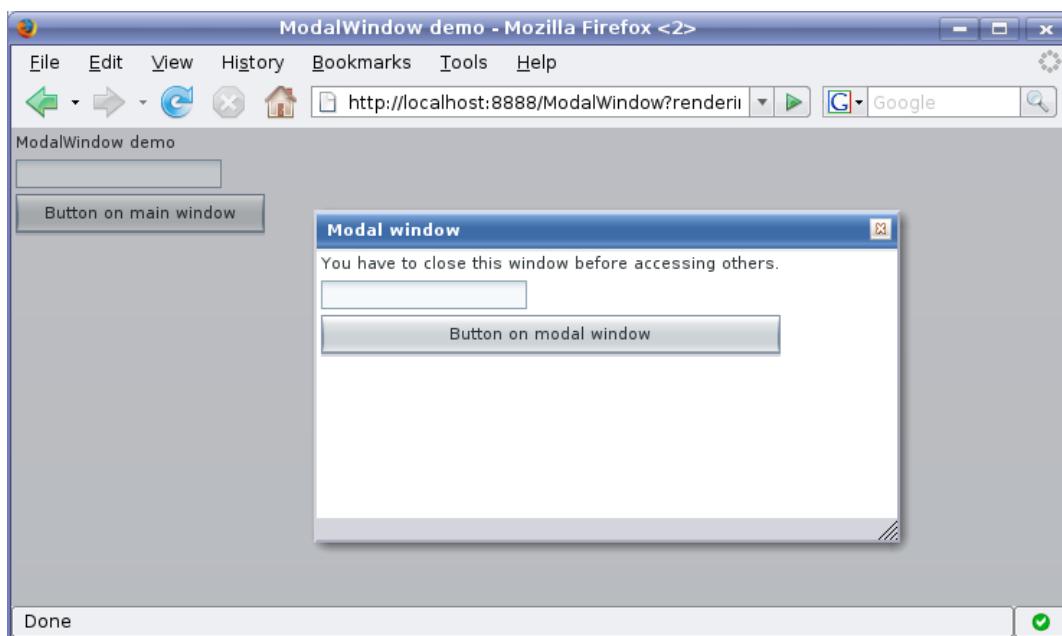
/* Set window position. */
mywindow.setPositionX(200);
mywindow.setPositionY(50);
```

Notice that the size of the main window is unknown and the `getHeight` and `getWidth` methods will return -1.

4.3.3. Modal Windows

A modal window is a child window that has to be closed by the user before the use of the parent window can continue. Dialog windows are typically modal. The advantage of modal windows is the simplification of user interaction, which may contribute to the clarity of the user interface. Modal windows are also easy to use from a development perspective, because as user interaction is isolated to them, changes in application state are more limited while the modal window is open. The disadvantage of modal windows is that they can restrict workflow too much.

Figure 4.3. Screenshot of the Modal Window Demo Application



Depending on theme settings, the parent window may be grayed while the modal window is open.

The demo application of Vaadin includes an example of using modal windows. Figure 4.3, “Screenshot of the Modal Window Demo Application” above is from the demo application. The example includes the source code.



Security Warning

Modality of child windows is purely a client-side feature and can be circumvented with client-side attack code. You should not trust in the modality of child windows in security-critical situations such as login windows.

4.4. Handling Events with Listeners

Let us put into practice what we learned of event handling in Section 3.5, “Events and Listeners”. You can handle events in three basic ways, as shown below.

The following example follows a typical pattern where you have a **Button** component and a listener that handles user interaction (clicks) communicated to the application as events. Here we define a class that listens click events.

```
public class TheButton implements Button.ClickListener {
    Button thebutton;

    /** Creates button into given container. */
    public TheButton(AbstractComponentContainer container) {
        thebutton = new Button ("Do not push this button");
        thebutton.addListener(this);
        container.addComponent(thebutton);
    }

    /** Handle button click events from the button. */
    public void buttonClick (Button.ClickEvent event) {
        thebutton.setCaption ("Do not push this button again");
    }
}
```

```
    }
}
```

As an application often receives events for several components of the same class, such as multiple buttons, it has to be able to distinguish between the individual components. There are several techniques to do this, but probably the easiest is to use the property of the received event, which is set to the object sending the event. This requires keeping at hand a reference to every object that emits events.

```
public class TheButtons implements Button.ClickListener {
    Button thebutton;
    Button secondbutton;

    /** Creates two buttons in given container. */
    public TheButtons(AbstractComponentContainer container) {
        thebutton = new Button ("Do not push this button");
        thebutton.addListener(this);
        container.addComponent(thebutton);

        secondbutton = new Button ("I am a button too");
        secondbutton.addListener(this);
        container.addComponent (secondbutton);
    }

    /** Handle button click events from the two buttons. */
    public void buttonClick (Button.ClickEvent event) {
        if (event.getButton() == thebutton)
            thebutton.setCaption("Do not push this button again");
        else if (event.getButton() == secondbutton)
            secondbutton.setCaption("I am not a number");
    }
}
```

Another solution to handling multiple events of the same class involves attaching an event source to a listener method instead of the class. An event can be attached to a method using another version of the `addListener()` method, which takes the event handler method as a parameter either as a name of the method name as a string or as a **Method** object. In the example below, we use the name of the method as a string.

```
public class TheButtons2 {
    Button thebutton;
    Button secondbutton;

    /** Creates two buttons in given container. */
    public TheButtons2(AbstractComponentContainer container) {
        thebutton = new Button ("Do not push this button");
        thebutton.addListener(Button.ClickEvent.class, this,
                            "theButtonClick");
        container.addComponent(thebutton);

        secondbutton = new Button ("I am a button too");
        secondbutton.addListener(Button.ClickEvent.class, this,
                            "secondButtonClick");
        container.addComponent (secondbutton);
    }

    public void theButtonClick (Button.ClickEvent event) {
        thebutton.setCaption ("Do not push this button again");
    }

    public void secondButtonClick (Button.ClickEvent event) {
        secondbutton.setCaption ("I am not a number!");
    }
}
```

Adding a listener method with `addListener()` is really just a wrapper that creates a **com.vaadin.event.ListenerMethod** listener object, which is an adapter from a listener class to a method. It implements the **java.util.EventListener** interface and can therefore work for any event source using the interface. Notice that not all listener classes necessarily inherit the **EventListener** interface.

The third way, which uses anonymous local class definitions, is often the easiest as it does not require cumbering the managing class with new interfaces or methods. The following example defines an anonymous class that inherits the **Button.ClickListener** interface and implements the `buttonClick()` method.

```
public class TheButtons3 {
    Button thebutton;
    Button secondbutton;

    /** Creates two buttons in given container. */
    public TheButtons3(AbstractComponentContainer container) {
        thebutton = new Button ("Do not push this button");

        /* Define a listener in an anonymous class. */
        thebutton.addListener(new Button.ClickListener() {
            /* Handle the click. */
            public void buttonClick(ClickEvent event) {
                thebutton.setCaption (
                    "Do not push this button again");
            }
        });
        container.addComponent(thebutton);

        secondbutton = new Button ("I am a button too");
        secondbutton.addListener(new Button.ClickListener() {
            public void buttonClick(ClickEvent event) {
                secondbutton.setCaption ("I am not a number!");
            }
        });
        container.addComponent (secondbutton);
    }
}
```

Other techniques for separating between different sources also exist. They include using object properties, names, or captions to separate between them. Using captions or any other visible text is generally discouraged, as it may create problems for internationalization. Using other symbolic strings can also be dangerous, because the syntax of such strings is checked only runtime.

Events are usually emitted by the framework, but applications may need to emit them too in some situations, such as when updating some part of the UI is required. Events can be emitted using the `fireEvent(Component.Event)` method of **AbstractComponent**. The event is then relayed to all the listeners of the particular event class for the object. Some components have a default event type, for example, a **Button** has a nested **Button.ClickEvent** class and a corresponding **Button.ClickListener** interface. These events can be triggered with `fireComponentEvent()`.

4.5. Referencing Resources

Web applications work over the web and have various resources, such as images or downloadable files, that the web browser has to get from the server. These resources are typically used in **Embedded** (images) or **Link** (downloadable files) user interface components. Various components, such as **TabSheet**, can also include icons, which are also handled as resources.

A web server can handle many of such requests for static resources without having to ask them from the application, or the **Application** object can provide them. For dynamic resources, the user application must be able to create them dynamically. Vaadin provides resource request interfaces for applications so that they can return various kinds of resources, such as files or dynamically created resources. These include the **StreamResource** class and URI and parameter handlers described in Section 11.5.1, “URI Handlers” and Section 11.5.2, “Parameter Handlers”, respectively.

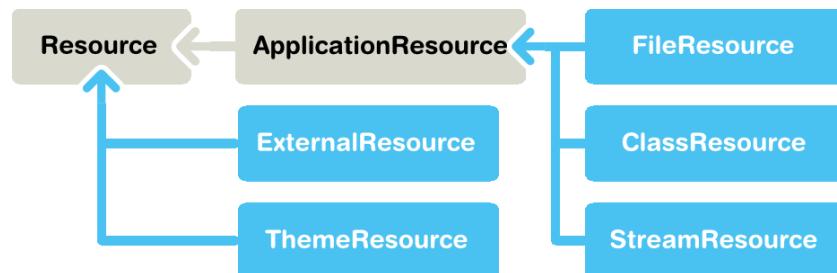
Vaadin provides also low-level facilities for retrieving the URI and other parameters of a HTTP request. We will first look into how applications can provide various kinds of resources and then look into low-level interfaces for handling URIs and parameters to provide resources and functionalities.

Notice that using URI or parameter handlers to create "pages" is not meaningful in Vaadin or in AJAX applications generally. Please see Section 11.1, “Special Characteristics of AJAX Applications” for a detailed explanation.

4.5.1. Resource Interfaces and Classes

Vaadin has two interfaces for resources: a generic **Resource** interface and a more specific **ApplicationResource** interface for resources provided by the application.

Figure 4.4. Resource Interface and Class Diagram



ApplicationResource resources are managed by the **Application** class. When you create such a resource, you give the application object to the constructor. The constructor registers the resource in the application using the **addResource** method.

Application manages requests for the resources and allows accessing resources using a URI. The URI consists of the base name of the application and a relative name of the resource. The relative name is "APP/ "+resourceid+ "/" +filename, for example "APP/1/myimage.png". The `resourceid` is a generated numeric identifier to make resources unique, and `filename` is the file name of the resource given in the constructor of its class. However, the application using a resource does not usually need to consider its URI. It only needs to give the resource to an appropriate **Embedded** or **Link** or some other user interface component, which manages the rendering of the URI.

4.5.2. File Resources

File resources are files stored anywhere in the file system. The use of file resources generally falls into two main categories: downloadable files and embedded images.

A file object that can be accessed as a file resource is defined with the standard **java.io.File** class. You can create the file either with an absolute or relative path, but the base path of the

relative path depends on the installation of the web server. For example, in Apache Tomcat, the default current directory is the installation path of Tomcat.

4.5.3. Class Loader Resources

The **ClassResource** allows resources to be loaded from the deployed package of the application using Java Class Loader. The one-line example below loads an image resource from the application package and displays it in an **Embedded** component.

```
mainwindow.addComponent(new Embedded ("",
    new ClassResource("smiley.jpg",
        mainwindow.getApplication())));
```

4.5.4. Theme Resources

Theme resources are files included in a theme, typically images. See Chapter 8, *Themes* for more information on themes.

4.5.5. Stream Resources

Stream resources are application resources that allow creating dynamic resource content. Charts are typical examples of dynamic images. To define a stream resource, you need to implement the **StreamResource.StreamSource** interface and its `getStream` method. The method needs to return an **InputStream** from which the stream can be read.

The following example demonstrates the creation of a simple image in PNG image format.

```
import java.awt.image.*;

public class MyImageSource
    implements StreamResource.StreamSource {
    ByteArrayOutputStream imagebuffer = null;
    int reloads = 0;

    /* We need to implement this method that returns
     * the resource as a stream. */
    public InputStream getStream () {
        /* Create an image and draw something on it. */
        BufferedImage image = new BufferedImage (200, 200,
            BufferedImage.TYPE_INT_RGB);
        Graphics drawable = image.getGraphics();
        drawable.setRGB(0,0,200,200);
        drawable.setRGB(25,25,150,150);
        drawable.setRGB(0,0,199,199);
        drawable.setRGB(0,0,199,199);
        drawable.drawString("Reloads="+reloads, 75, 100);
        reloads++;

        try {
            /* Write the image to a buffer. */
            imagebuffer = new ByteArrayOutputStream();
            ImageIO.write(image, "png", imagebuffer);

            /* Return a stream from the buffer. */
            return new ByteArrayInputStream(
                imagebuffer.toByteArray());
        } catch (IOException e) {
            return null;
        }
    }
}
```

```
    }  
}
```

The content of the generated image is dynamic, as it updates the reloads counter with every call. The **ImageIO.write()** method writes the image to an output stream, while we had to return an input stream, so we stored the image contents to a temporary buffer.

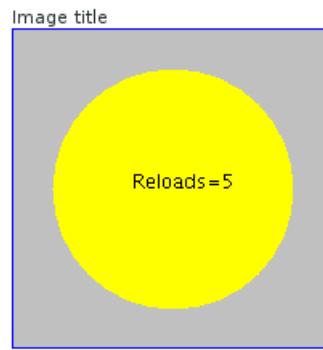
You can use resources in various ways. Some user interface components, such as **Link** and **Embedded**, take their parameters as a resource.

Below we display the image with the **Embedded** component. The **StreamResource** constructor gets a reference to the application and registers itself in the application's resources. Assume that **main** is a reference to the main window and **this** is the application object.

```
// Create an instance of our stream source.  
StreamResource.StreamSource imagesource = new MyImageSource ();  
  
// Create a resource that uses the stream source and give it a name.  
// The constructor will automatically register the resource in  
// the application.  
StreamResource imageresource =  
    new StreamResource(imagesource, "myimage.png", this);  
  
// Create an embedded component that gets its contents  
// from the resource.  
main.addComponent(new Embedded("Image title", imageresource));
```

The image will look as follows:

Figure 4.5. Screenshot of the stream resource example with an embedded image



We named the resource as `myimage.png`. The application adds a resource key to the file name of the resource to make it unique. The full URI will be like `http://localhost:8080/testbench/APP/1/myimage.png`. The end `APP/1/myimage.png` is the *relative* part of the URI. You can get the relative part of a resource's URI from the application with `Application.getRelativeLocation()`.

Another solution for creating dynamic content is an URI handler, possibly together with a parameter handler. See Section 11.5.1, “URI Handlers” and Section 11.5.2, “Parameter Handlers”.

4.6. Shutting Down an Application

A user can log out or close the web page or browser, so a session and the associated application instance can end. Ending an application can be initiated by the application logic. Otherwise, it will be ended automatically when the Servlet session times out.

4.6.1. Closing an Application

If the user quits the application through the user interface, an event handler should call the `close()` method in the **Application** class to shutdown the session.

In the following example, we have a **Logout** button, which ends the user session.

```
Button closeButton = new Button("Logout");

closeButton.addListener(new Button.ClickListener() {
    @Override
    public void buttonClick(ClickEvent event) {
        getMainWindow().getApplication().close();
    }
});

main.addComponent(closeButton);
```

You will soon notice that closing the application simply reloads the application with a new **Application** instance. You can set the window to redirect to a different URL (that does not reload the application) with `setLogoutURL`. In your application class, write:

```
setLogoutURL("/logout.html");
```

4.6.2. Handling the Closing of a Window

Closing the main window (or all application-level windows) does not close session and the application instance will be left hanging. You need to program such behaviour by handling the close events of the windows.

If the user closes a browser window, such as the main window or any other application-level window, the window will send a final AJAX request to the server, which will fire a **Window.CloseEvent** for the closed window. You can handle the event with a **Window.CloseListener**. In case the user closes the browser, the event is fired for every open window.

```
// Close the application if the main window is closed.
main.addListener(new Window.CloseListener(){
    @Override
    public void windowClose(CloseEvent e) {
        System.out.println("Closing the application");
        getMainWindow().getApplication().close();
    }
});
```

Notice that *refreshing a window means closing and reopening it*. Therefore, if you have a close handler as above, the user loses the possibility to refresh the browser window.

In the likely case that the browser crashes, no close event is communicated to the server. As the server has no way of knowing about the problem, and the session will be left hanging until the session timeout expires. During this time, the user can restart the browser, open the application URL, and the main window will be rendered where the user left off. This can be desired behaviour in many cases, but sometimes it is not and can create a security problem.

4.7. Handling Errors

4.7.1. Error Indicator and message

All components have a built-in error indicator that can be set explicitly with `setComponentError()` or can be turned on implicitly if validating the component fails. As with component caption, the placement of the indicator is managed by the layout in which the component is contained. Usually, the error indicator is placed right of the caption text. Hovering the mouse pointer over the field displays the error message.

The following example shows how you can set the component error explicitly. The example essentially validates field value without using an actual validator.

```
// Create a field.
final TextField textfield = new TextField("Enter code");
main.addComponent(textfield);

// Let the component error be initially clear.
textfield.setComponentError(null); // (actually the default)

// Have a button right of the field (and align it properly).
final Button button = new Button("Ok!");
main.addComponent(button);
((VerticalLayout)main.getLayout())
    .setComponentAlignment(button, Alignment.BOTTOM_LEFT);

// Handle button clicks
button.addListener(new Button.ClickListener() {
    public void buttonClick(ClickEvent event) {
        // If the field value is bad, set its error.
        // (Allow only alphanumeric characters.)
        if (! ((String) textfield.getValue()).matches("^\\w*\\$")) {
            // Put the component in error state and
            // set the error message.
            textfield.setComponentError(
                new UserError("Must be letters and numbers"));
        } else {
            // Otherwise clear it.
            textfield.setComponentError(null);
        }
    }
});
```

Figure 4.6. Error indicator active



The **Form** component handles and displays also the errors of its contained fields so that it displays both the error indicator and the message in a special error indicator area. See Section 5.17, “**Form**” and Section 5.17.3, “Validating Form Input” for details on the **Form** component and validation of form input.

4.7.2. Notifications

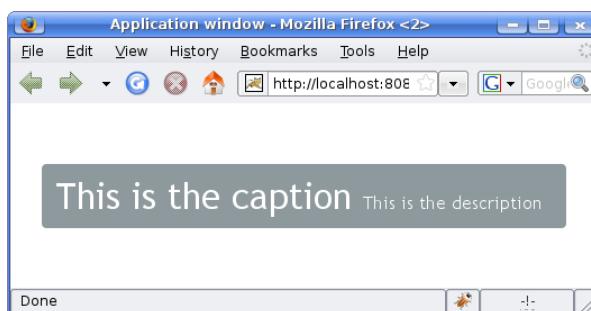
Notifications are error or information boxes that appear typically at the center of the screen. A notification box has a caption and optional description and icon. The box stays on the screen

either for a defined time or until the user clicks it. The notification type defines the default appearance and behaviour of a notification.

Notifications are always associated with a window object, which can be a child window (the positioning is always relative to the entire browser view). The **Window** class provides a `showNotification()` method for displaying notifications. The method takes the caption and an optional description and notification type as parameters. The method also accepts a notification object of type **Window.Notification**, as described further below.

```
mainwindow.showNotification("This is the caption",
                            "This is the description");
```

Figure 4.7. Notification



The caption and description are, by default, written on the same line. If you want to have a line break between them, use the XHTML line break markup "`
`". You can use any XHTML markup in the caption and description of a notification. If it is possible to get the notification content from user input, you should sanitize the content carefully, as noted in Section 11.10.1, "Sanitizing User Input to Prevent Cross-Site Scripting".

```
main.showNotification("This is a warning",
                      "<br/>This is the <i>last</i> warning",
                      Window.Notification.TYPE_WARNING_MESSAGE);
```

Figure 4.8. Notification with Formatting



The notification type defines the overall default style and behaviour of a notification. If no notification type is given, the "humanized" type is used as the default. The notification types, listed below, are defined in the **Window.Notification** class.

`TYPE_HUMANIZED_MESSAGE`
Humanized message
For minimal annoyance

A user-friendly message that does not annoy too much: it does not require confirmation by clicking and disappears quickly. It is centered and has a neutral gray color.

`TYPE_WARNING_MESSAGE`
Warning message
For notifications of medium importance

Warnings are messages of medium importance. They are displayed with colors that are neither neutral nor too distractive. A warning is displayed for 1.5 seconds, but the user can click the message box to dismiss it. The user can continue to interact with the application while the warning is displayed.



Error messages are notifications that require the highest user attention, with alert colors and by requiring the user to click the message to dismiss it. The error message box does not itself include an instruction to click the message, although the close box in the upper right corner indicates it visually. Unlike with other notifications, the user can not interact with the application while the error message is displayed.



Tray notifications are displayed in the "system tray" area, that is, in the lower-right corner of the browser view. As they do not usually obscure any user interface, they are displayed longer than humanized or warning messages, 3 seconds by default. The user can continue to interact with the application normally while the tray notification is displayed.

All of the features of specific notification types can be controlled with the attributes of **Window.Notification**. You can pass an explicitly created notification object to the `showNotification()` method.

```
// Create a notification with default settings for a warning.  
Window.Notification notif = new Window.Notification(  
    "Be warned!",  
    "This message lurks in the top-left corner!",  
    Window.Notification.TYPE_WARNING_MESSAGE);  
  
// Set the position.  
notif.setPosition(Window.Notification.POSITION_TOP_LEFT);  
  
// Let it stay there until the user clicks it  
notif.setDelayMsec(-1);  
  
// Show it in the main window.  
main.showNotification(notif);
```

The `setPosition()` method allows setting the positioning of the notification. The method takes as its parameter any of the constants:

```
Window.Notification.POSITION_CENTERED  
Window.Notification.POSITION_CENTERED_TOP  
Window.Notification.POSITION_CENTERED_BOTTOM  
Window.Notification.POSITION_TOP_LEFT  
Window.Notification.POSITION_TOP_RIGHT  
Window.Notification.POSITION_BOTTOM_LEFT  
Window.Notification.POSITION_BOTTOM_RIGHT
```

The `setDelayMSec()` allows you to set the time in milliseconds for how long the notification is displayed. Parameter value -1 means that the message is displayed until the user clicks the message box. It also prevents interaction with other parts of the application window, as is default behaviour for error messages. It does not, however, add a close box that the error notification has.

4.7.3. Handling Uncaught Exceptions

Application development with Vaadin follows the event-driven programming model. Mouse and keyboard events in the client cause (usually higher-level) events on the server-side, which can be handled with listeners, and that is how most of the application logic works. Handling the events can result in exceptions either in the application logic or in the framework itself, but some of them may not be caught properly.

For example, in the following code excerpt, we throw an error in an event listener but do not catch it, so it falls to the framework.

```
final Button button = new Button ("Fail Me");

button.addListener(new Button.ClickListener() {
    public void buttonClick(ClickEvent event) {
        // Throw some exception.
        throw new RuntimeException("You can't catch this.");
    }
});
```

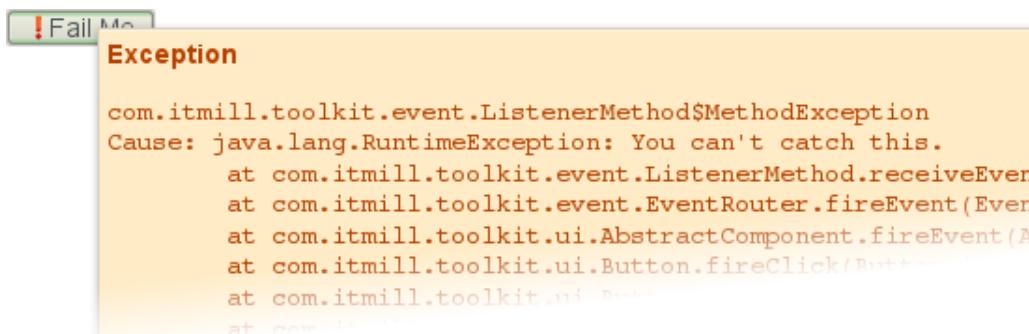
Any such exceptions that occur in the call chain, but are not caught at any other level, are eventually caught by the terminal adapter in **ApplicationServlet**, the lowest-level component that receives client requests. The terminal adapter passes all such caught exceptions as events to the error listener of the **Application** instance through the **Terminal.ErrorListener** interface. The **Application** class does not, by default, throw such exceptions forward.

The reason for this error-handling logic lies in the logic that handles component state synchronization between the client and the server. We want to handle *all* the serialized variable changes in the client request, because otherwise the client-side and server-side component states would become unsynchronized very easily, which could put the entire application in an invalid state.

The default implementation of the `Terminal.ErrorListener` interface in the `Application` class simply prints the error to console. It also tries to find out a component related to the error. If the exception occurred in a listener attached to a component, that component is considered as the component related to the exception. If a related component is found, the error handler sets the `componentError` for it, the same attribute which you can set with `setComponentError()`.

In UI, the component error is shown with a small red "!" -sign (in the default theme). If you hover the mouse pointer over it, you will see the entire backtrace of the exception in a large tooltip box, as illustrated in Figure 4.9, “Uncaught Exception in Component Error Indicator” for the above code example.

Figure 4.9. Uncaught Exception in Component Error Indicator



You can change the logic of handling the terminal errors easily by overriding the `terminalError()` method in your application class (the one that inherits **Application**) or by setting a custom error listener with the `setErrorHandler` method. You can safely discard the default handling or extend its usage with your custom error handling or logging system. In the example code below, the exceptions are also reported as notifications in the main window.

```
@Override  
public void terminalError(Terminal.ErrorEvent event) {  
    // Call the default implementation.  
    super.terminalError(event);  
  
    // Some custom behaviour.  
    if (getMainWindow() != null) {  
        getMainWindow().showNotification(  
            "An unchecked exception occurred!",  
            event.getThrowable().toString(),  
            Notification.TYPE_ERROR_MESSAGE);  
    }  
}
```

Handling other exceptions works in the usual way for Java Servlets. Uncaught exceptions are finally caught and handled by the application server.

4.8. Setting Up the Application Environment

While more and more server based frameworks, libraries, standards, and architectures for Java are invented to make the programmer's life easier, software deployment seems to get harder and harder. For example, Java Enterprise Beans tried to make the creation of persistent and networked objects easy and somewhat automatic, but the number of deployment descriptions got enormous. As Vaadin lives in a Java Servlet container, it must follow the rules, but it tries to avoid adding extra complexity.

All Vaadin applications are deployed as Java web applications, which can be packaged as WAR files. For a detailed tutorial on how web applications are packaged, please refer to any Java book that discusses Servlets. Sun has an excellent reference online at http://java.sun.com/j2ee/tutorial/1_3-fcs/doc/WCC3.html [http://java.sun.com/j2ee/tutorial/1_3-fcs/doc/WCC3.html].

4.8.1. Creating Deployable WAR in Eclipse

To deploy an application to a web server, you need to create a WAR package. Here we give the instructions for Eclipse.

Open project properties and first set the name and destination of the WAR file in Tomcat **Export to WAR settings** tab. Exporting to WAR is done by selecting **Export to WAR** from **Tomcat Project** in project context menu (just click calc with the right mouse button on **Package contents tree**).

4.8.2. Web Application Contents

The following files are required in a web application in order to run it.

Web application organization

WEB-INF/web.xml

This is the standard web application descriptor that defines how the application is organized. You can refer

to any Java book about the contents of this file. Also see an example in Example 4.1, “web.xml”.

WEB-INF/lib/vaadin-6.2.0.jar	This is the Vaadin library. It is included in the product package in lib directory.
Your application classes	You must include your application classes either in a JAR file in WEB-INF/lib or as classes in WEB-INF/classes
Your own theme files (OPTIONAL)	If your application uses a special theme (look and feel), you must include it in WEB-INF/lib/themes/themename directory.

4.8.3. Deployment Descriptor web.xml

The deployment descriptor is an XML file with the name `web.xml` in the `WEB-INF` directory of a web application. It is a standard component in Java EE describing how a web application should be deployed. The structure of the deployment descriptor is illustrated by the following example. You simply deploy applications as servlets implemented by the special `com.vaadin.terminal.gwt.server.ApplicationServlet` wrapper class. The class of the actual application is specified by giving the `application` parameter with the name of the specific application class to the servlet. The servlet is then connected to a URL in a standard way for Java Servlets.

Example 4.1. web.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<web-app
    id="WebApp_ID" version="2.4"
    xmlns="http://java.sun.com/xml/ns/j2ee"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://java.sun.com/xml/ns/j2ee
        http://java.sun.com/xml/ns/j2ee/web-app_2_4.xsd">

    <servlet>
        <servlet-name>myservlet</servlet-name>
        <servlet-class>
            com.vaadin.terminal.gwt.server.ApplicationServlet
        </servlet-class>
        <init-param>
            <param-name>application</param-name>
            <param-value>MyApplicationClass</param-value>
        </init-param>
    </servlet>

    <servlet-mapping>
        <servlet-name>myservlet</servlet-name>
        <url-pattern>/*</url-pattern>
    </servlet-mapping>
</web-app>
```

The descriptor defines a servlet with name `myservlet`. The servlet class, **com.vaadin.terminal.gwt.server.ApplicationServlet**, is provided by Vaadin framework and it should be the same for all Vaadin projects. The servlet takes the class name **Calc** of the user application class as a parameter, including the full package path to the class. If the class is in the default package the package path is obviously not used.

The `url-pattern` is defined above as `/*`. This matches to any URL under the project context. We defined above the project context as `myproject` so the application URL will be `http://localhost:8080/myproject/`. If the project were to have multiple applications or servlets, they would have to be given different names to distinguish them. For example, `url-pattern /myapp/*` would match a URL such as `http://localhost:8080/myproject/myapp/`. Notice that the slash and the asterisk *must* be included at the end of the pattern.

Notice also that if the URL pattern is other than root `/*` (such as `/myapp/*`), you will also need to make a servlet mapping to `/VAADIN/*` (unless you are serving it statically as noted below). For example:

```
...
<servlet-mapping>
    <servlet-name>myservlet</servlet-name>
    <url-pattern>/myurl/*</url-pattern>
</servlet-mapping>

<servlet-mapping>
    <servlet-name>myservlet</servlet-name>
    <url-pattern>/VAADIN/*</url-pattern>
</servlet-mapping>
```

You do not have to provide the above `/VAADIN/*` mapping if you serve both the widget sets and (custom and default) themes statically in `WebContent/VAADIN/` directory. The mapping simply allows serving them dynamically from the Vaadin JAR. Serving them statically is recommended for production environments as it is much faster.

For a complete example on how to deploy applications, see the demos included in the Vaadin installation package, especially the `WebContent/WEB-INF` directory.

Deployment Descriptor Parameters

Deployment descriptor can have many parameters and options that control the execution of a servlet. You can find a complete documentation of the deployment descriptor in Java Servlet Specification at <http://java.sun.com/products/servlet/>.

By default, Vaadin applications run in *debug mode*, which should be used during development. This enables various debugging features. For production use, you should have put in your `web.xml` the following parameter:

```
<context-param>
    <param-name>productionMode</param-name>
    <param-value>true</param-value>
    <description>Vaadin production mode</description>
</context-param>
```

The parameter and the debug and production modes are described in detail in Section 11.4, “Debug and Production Mode”.

One often needed option is the session timeout. Different servlet containers use varying defaults for timeouts, such as 30 minutes for Apache Tomcat. You can set the timeout with:

```
<session-config>
    <session-timeout>30</session-timeout>
</session-config>
```

After the timeout expires, the `close()` method of the **Application** class will be called. You should implement it if you wish to handle timeout situations.

Chapter 5

User Interface Components

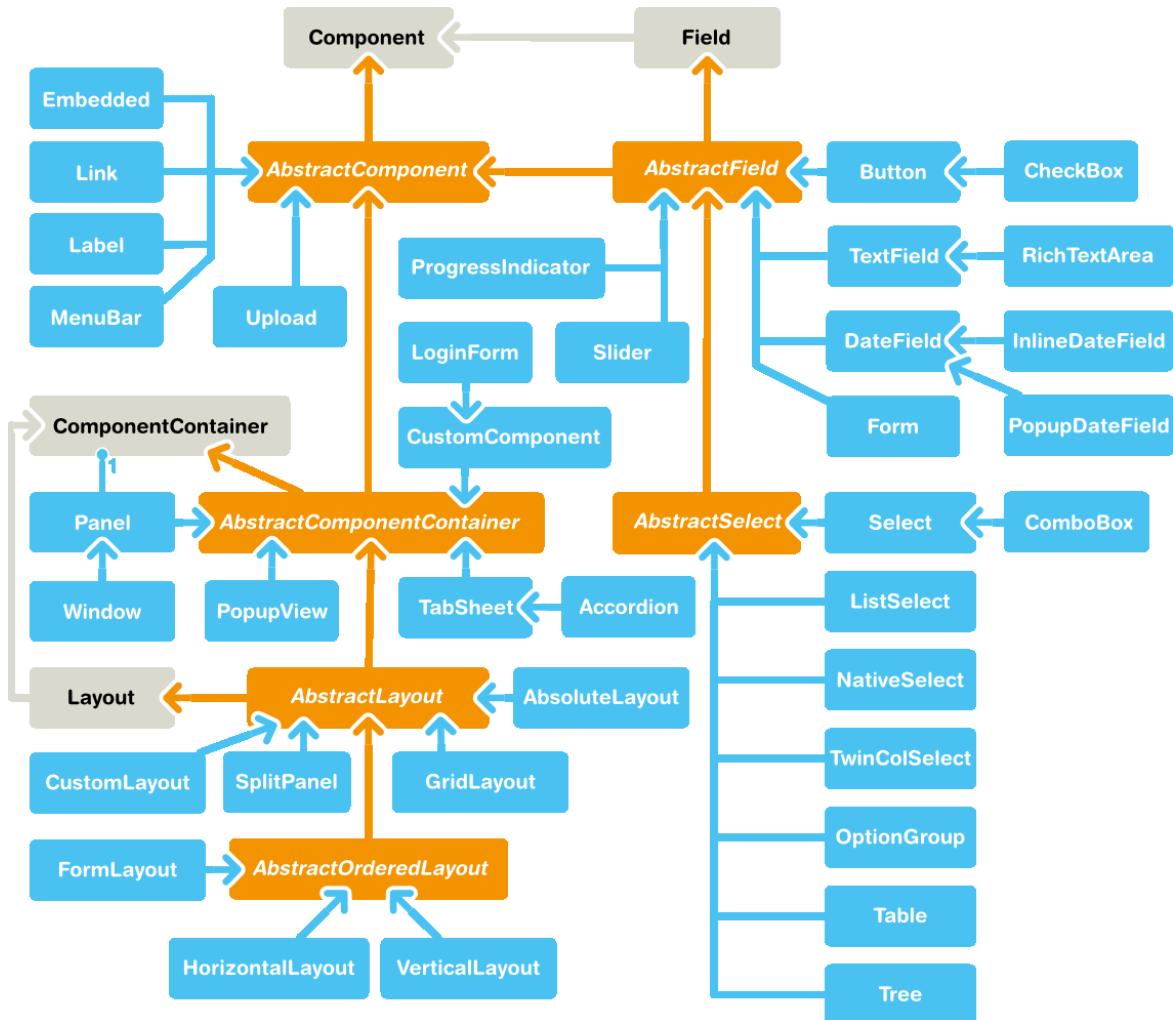
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This chapter provides an overview and a detailed description of all non-layout components in Vaadin.

5.1. Overview

Vaadin provides a comprehensive set of user interface components and allows you to define custom components. Figure 5.1, “UI Component Inheritance Diagram” illustrates the inheritance hierarchy of the UI component classes and interfaces. Interfaces are displayed in gray, abstract classes in orange, and regular classes in blue. An annotated version of the diagram is featured in the [Vaadin Cheat Sheet](#).

Figure 5.1. UI Component Inheritance Diagram



At the top of the interface hierarchy, we have the **Component** interface. At the top of the class hierarchy, we have the **AbstractComponent** class. It is inherited by two other abstract classes: **AbstractField**, inherited further by field components, and **AbstractComponentContainer**, inherited by various container and layout components. Components that are not bound to a content data model, such as labels and links, inherit **AbstractComponent** directly.

The layout of the various components in a window is controlled, logically, by layout components, just like in conventional Java UI toolkits for desktop applications. In addition, with the **Custom-**

Layout component, you can write a custom layout as an XHTML template that includes the locations of any contained components. Looking at the inheritance diagram, we can see that layout components inherit the **AbstractComponentContainer** and the **Layout** interface. Layout components are described in detail in Chapter 6, *Managing Layout*.

Looking at it from the perspective of an object hierarchy, we would have a **Window** object, which contains a hierarchy of layout components, which again contain other layout components, field components, and other visible components.

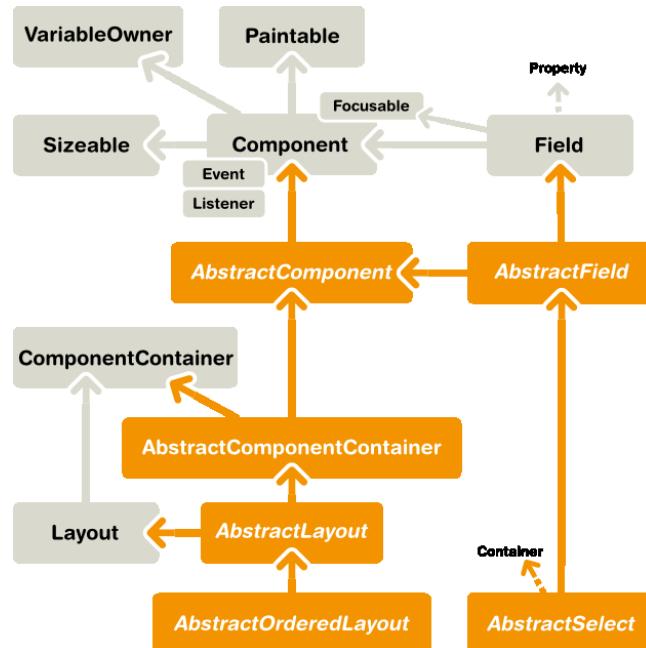
You can browse the available UI components in the Sampler application of the Vaadin Demo. The Sampler shows a description, JavaDoc documentation, and a code samples for each of the components.

5.2. Interfaces and Abstractions

Vaadin user interface components are built on a skeleton of interfaces and abstract classes that define and implement the features common to all components and the basic logic how the component states are serialized between the server and the client.

This section gives details on the basic component interfaces and abstractions. The layout and other component container abstractions are described in Chapter 6, *Managing Layout*. The interfaces that define the Vaadin data model are described in Chapter 9, *Binding Components to Data*.

Figure 5.2. Component Interfaces and Abstractions



All components also implement the **Paintable** interface, which is used for serializing ("painting") the components to the client, and the reverse **VariableOwner** interface, which is needed for deserializing component state or user interaction from the client.

In addition to the interfaces defined within the Vaadin framework, all components implement the **java.io.Serializable** interface to allow serialization. Serialization is needed in many clustering and cloud computing solutions.

5.2.1. Component Interface

The **Component** interface is paired with the **AbstractComponent** class, which implements all the methods defined in the interface.

Component Tree Management

Components are laid out in the user interface hierarchically. The layout is managed by layout components, or more generally components that implement the **ComponentContainer** interface. Such a container is the parent of the contained components.

The `getParent()` method allows retrieving the parent component of a component. While there is a `setParent()`, you rarely need it as you usually add components with the `addComponent()` method of the **ComponentContainer** interface, which automatically sets the parent.

A component does not know its parent when the component is created, so you can not refer to the parent in the constructor with `getParent()`. Also, it is not possible to fetch a reference to the application object with `getApplication()` before having a parent. For example, the following is invalid:

```
public class AttachExample extends CustomComponent {  
    public AttachExample() {  
        // ERROR: We can't access the application object yet.  
        ClassResource r = new ClassResource("smiley.jpg",  
                                           getApplication());  
        Embedded image = new Embedded("Image:", r);  
        setCompositionRoot(image);  
    }  
}
```

Adding a component to an application triggers calling the `attach()` method for the component. Correspondingly, removing a component from a container triggers calling the `detach()` method. If the parent of an added component is already connected to the application, the `attach()` is called immediately from `setParent()`.

```
public class AttachExample extends CustomComponent {  
    public AttachExample() {}  
  
    @Override  
    public void attach() {  
        super.attach(); // Must call.  
  
        // Now we know who ultimately owns us.  
        ClassResource r = new ClassResource("smiley.jpg",  
                                           getApplication());  
        Embedded image = new Embedded("Image:", r);  
        setCompositionRoot(image);  
    }  
}
```

The attachment logic is implemented in **AbstractComponent**, as described in Section 5.2.2, “**AbstractComponent**”.

5.2.2. AbstractComponent

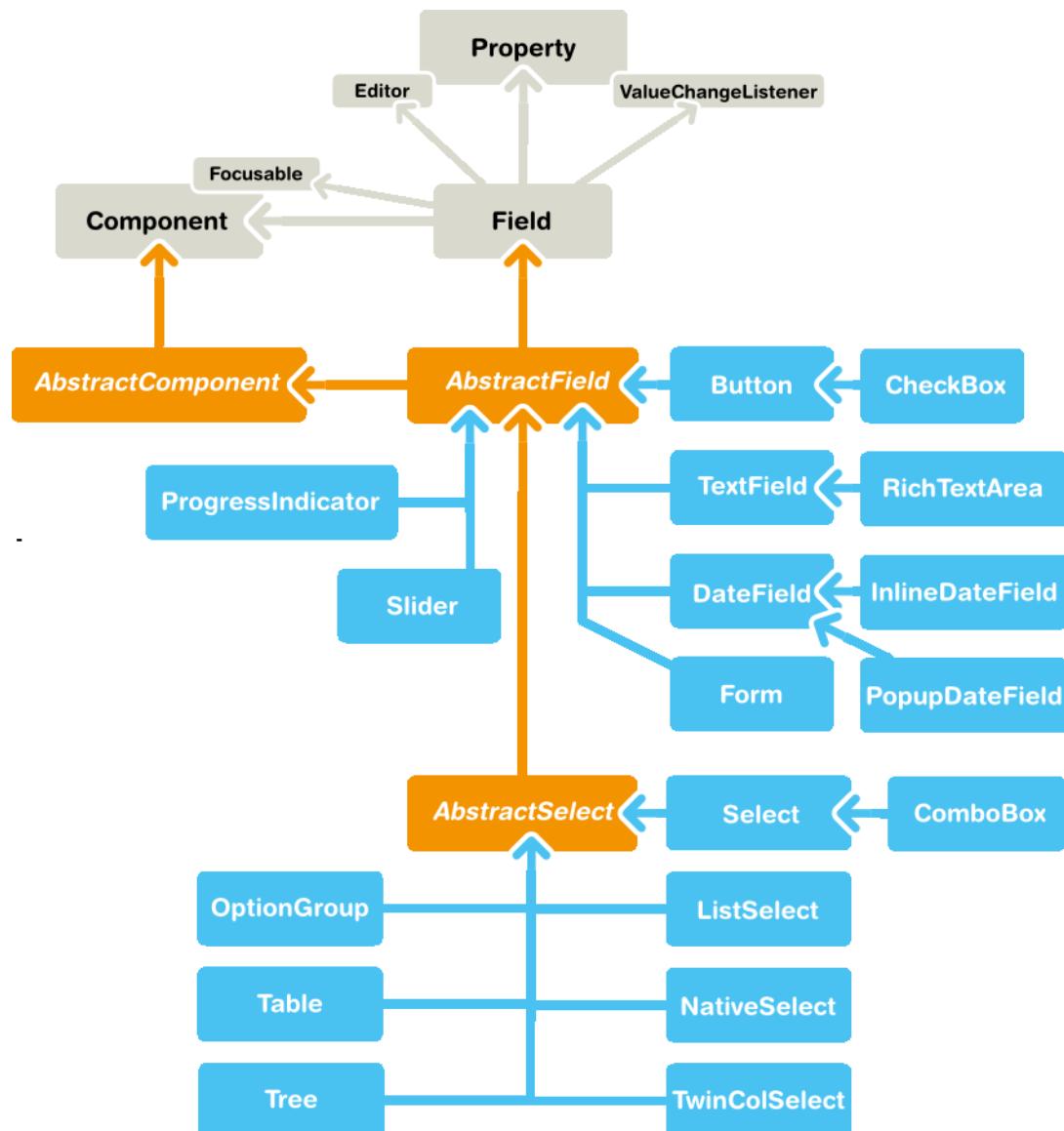
AbstractComponent is the base class for all user interface components. It is the (only) implementation of the **Component** interface, implementing all the methods defined in the interface.

AbstractComponent has a single abstract method, `getTag()`, which returns the serialization identifier of a particular component class. It needs to be implemented when (and only when) creating entirely new components. **AbstractComponent** manages much of the serialization of component states between the client and the server. Creation of new components and serialization is described in Chapter 10, *Developing Custom Components*, and the server-side serialization API in Appendix A, *User Interface Definition Language (UIDL)*.

5.2.3. Field Components (Field and AbstractField)

Fields are components that have a value that the user can change through the user interface. Figure 5.3, “Field Components” illustrates the inheritance relationships and the important interfaces and base classes.

Figure 5.3. Field Components



Field components are built upon the framework defined in the **Field** interface and the **AbstractField** base class.

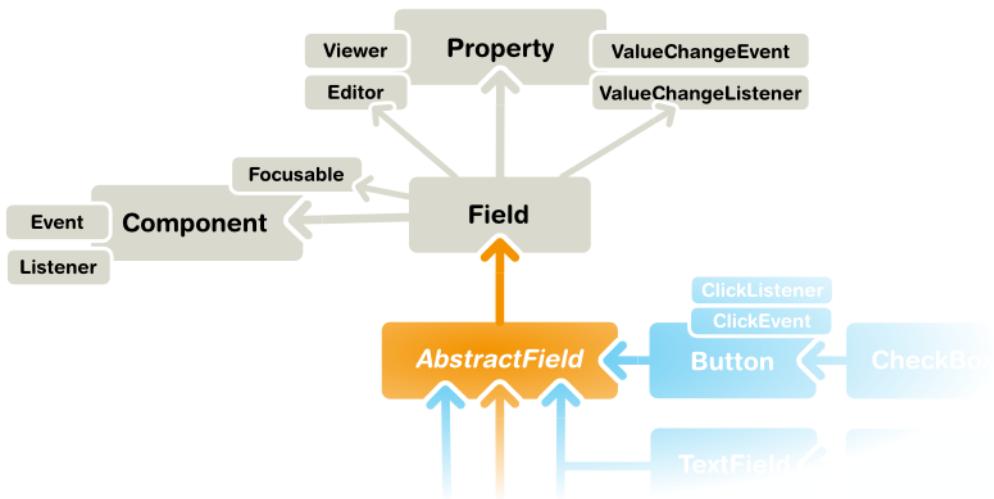
Fields are strongly coupled with the Vaadin data model. The field value is handled as a **Property** of the field component. Selection fields allow management of the selectable items through the **Container** interface.

The description of the field interfaces and base classes is broken down in the following sections.

Field Interface

The **Field** interface inherits the **Component** superinterface and also the **Property** interface to have a value for the field. **AbstractField** is the only class implementing the **Field** interface directly. The relationships are illustrated in Figure 5.4, “Field Interface Inheritance Diagram”.

Figure 5.4. Field Interface Inheritance Diagram



You can set the field value with the `setValue()` and read with the `getValue()` method defined in the **Property** interface. The actual value type depends on the component.

The **Field** interface defines a number of attributes, which you can retrieve or manipulate with the corresponding setters and getters.

description All fields have a description. Notice that while this attribute is defined in the **Field** component, it is implemented in **AbstractField**, which does not directly implement **Field**, but only through the **AbstractField** class.

required A field can be marked as required and a required indicator marker (usually * character) is displayed in front of the field. If such fields are validated but are empty, the error indicator is shown and the component error is set to the text defined with the `requiredError` attribute (see below). Without validation, the required indicator is merely a visual guide.

requiredError Defines the error message to show when a value is required for a field but no value is given. The error message is set as the component error

for the field and is usually displayed in a tooltip. The **Form** component can display the error message in a special error indicator area.

Handling Field Value Changes

Field inherits **Property.ValueChangeListener** to allow listening for field value changes and **Property.Editor** to allow editing values.

When the value of a field changes, a **Property.ValueChangeEvent** is triggered for the field. You should not implement the `valueChange()` method in a class inheriting **AbstractField**, as it is already implemented in **AbstractField**. You should instead implement the method explicitly by adding the implementing object as a listener.

AbstractField Base Class

AbstractField is the base class for all field components. In addition to the component features inherited from **AbstractComponent**, it implements a number of features defined in **Property**, **Buffered**, **Validatable**, and **Component.Focusable** interfaces.

5.3. Common Component Features

The component base classes and interfaces provide a large number of features. Let us look at some of the most commonly needed features. Features not documented here can be found from the Java API Reference.

The interface defines a number of properties, which you can retrieve or manipulate with the corresponding setters and getters.

5.3.1. Caption

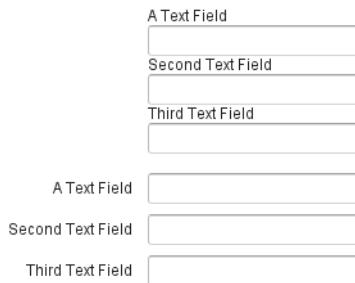
A caption is an explanatory textual label accompanying a user interface component, usually shown above, left of, or inside the component. The contents of a caption are automatically quoted, so no raw XHTML can be rendered in a caption.

The caption can usually be given as the first parameter of a constructor or later with the `setCaption()` method.

```
// New text field with caption "Name"
TextField name = new TextField("Name");
layout.addComponent(name);
```

The caption of a component is, by default, managed and displayed by the layout component or component container in which the component is placed. For example, the **VerticalLayout** component shows the captions left-aligned above the contained components, while the **FormLayout** component shows the captions on the left side of the vertically laid components, with the captions and their associated components left-aligned in their own columns. The **CustomComponent** does not manage the caption of its composition root, so if the root component has a caption, it will not be rendered.

Figure 5.5. Caption Management by VerticalLayout and FormLayout components.



Some components, such as **Button** and **Panel**, manage the caption themselves and display it inside the component.

Icon (see Section 5.3.4, “Icon”) is closely related to caption and is usually displayed horizontally before or after it, depending on the component and the containing layout.

An alternative way to implement a caption is to use another component as the caption, typically a **Label**, a **TextField**, or a **Panel**. A **Label**, for example, allows highlighting a shortcut key with XHTML markup or to bind the caption to a data source. The **Panel** provides an easy way to add both a caption and a border around a component.

Setting the caption with `setCaption()` will cause updating the component. A reimplementation of `setCaption()` should call the superclass implementation.

CSS Style Rules

A caption will be rendered inside an HTML element that has the `<component>-caption` CSS style class, where `<component>` is the identifier of the component to which the caption is attached. For example, the caption of a **TextField** would have `v:textfield-caption` style. The containing layout may enclose a caption inside other caption-related elements.

5.3.2. Description and Tooltips

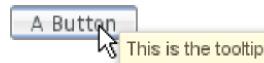
All components (that inherit **AbstractComponent**) have a description separate from their caption. The description is usually shown as a tooltip that appears when the mouse pointer hovers over the component for a short time.

You can set the description with `setDescription()` and retrieve with `getDescription()`.

```
Button button = new Button("A Button");
button.setDescription("This is the tooltip");
```

The tooltip is shown in Figure 5.6, “Component Description as a Tooltip”.

Figure 5.6. Component Description as a Tooltip



A description is rendered as a tooltip in most components. **Form** shows it as text in the top area of the component, as described in Section 5.17.1, “Form as a User Interface Component”.

When a component error has been set with `setComponentError()`, the error is usually also displayed in the tooltip, below the description (**Form** displays it in the bottom area of the form). Components that are in error state will also display the error indicator. See Section 4.7.1, “Error Indicator and message”.

The description is actually not plain text, but you can use XHTML tags to format it. Such a rich text description can contain any HTML elements, including images.

```
button.setDescription(  
    "<h2><img src=\"../VAADIN/themes/sampler/icons/comment_yellow.gif\" />" +  
    "A richtext tooltip</h2>" +  
    "<ul>" +  
    "  <li>Use rich formatting with XHTML</li>" +  
    "  <li>Include images from themes</li>" +  
    "  <li>etc.</li>" +  
    "</ul>");
```

The result is shown in Figure 5.7, “A Rich Text Tooltip”.

Figure 5.7. A Rich Text Tooltip



Notice that the setter and getter are defined for all fields in the **Field** interface, not for all components in the **Component** interface.

5.3.3. Enabled

The `enabled` property controls whether the user can actually use the component. A disabled component is visible, but grayed to indicate the disabled state.

Components are always enabled by default. You can disable a component with `setEnabled(false)`.

```
Button enabled = new Button("Enabled");  
enabled.setEnabled(true); // The default  
layout.addComponent(enabled);  
  
Button disabled = new Button("Disabled");  
disabled.setEnabled(false);  
layout.addComponent(disabled);
```

Figure 5.8, “An Enabled and Disabled Button” shows the enabled and disabled buttons.

Figure 5.8. An Enabled and Disabled Button



A disabled component is automatically put in read-only state. No client interaction with such a component is sent to the server and, as an important security feature, the server-side component does not receive state updates from the client.

CSS Style Rules

Disabled components have the `v-disabled` CSS style in addition to the component-specific style. To match a component with both the styles, you have to join the style class names with a dot as done in the example below.

```
.v-textfield.v-disabled {  
    border: dotted;  
}
```

This would make the border of all disabled text fields dotted.

```
TextField disabled = new TextField("Disabled");  
disabled.setValue("Read-only value");  
disabled.setEnabled(false);  
layout.addComponent(disabled);
```

The result is illustrated in Figure 5.9, “Styling Disabled Components”.

Figure 5.9. Styling Disabled Components



5.3.4. Icon

An icon is an explanatory graphical label accompanying a user interface component, usually shown above, left of, or inside the component. Icon is closely related to caption (see Section 5.3.1, “Caption”) and is usually displayed horizontally before or after it, depending on the component and the containing layout.

The icon of a component can be set with the `setIcon()` method. The image is provided as a resource, perhaps most typically a **ThemeResource**.

```
// Component with an icon from a custom theme  
TextField name = new TextField("Name");  
name.setIcon(new ThemeResource("icons/user.png"));  
layout.addComponent(name);  
  
// Component with an icon from another theme ('runo')  
Button ok = new Button("OK");  
ok.setIcon(new ThemeResource("../runo/icons/16/ok.png"));  
layout.addComponent(ok);
```

The icon of a component is, by default, managed and displayed by the layout component or component container in which the component is placed. For example, the **VerticalLayout** component shows the icons left-aligned above the contained components, while the **FormLayout** component shows the icons on the left side of the vertically laid components, with the icons and their associated components left-aligned in their own columns. The **CustomComponent** does not manage the icon of its composition root, so if the root component has an icon, it will not be rendered.

Figure 5.10. Displaying an Icon from a Theme Resource.



Some components, such as **Button** and **Panel**, manage the icon themselves and display it inside the component.

CSS Style Rules

An icon will be rendered inside an HTML element that has the `v-icon` CSS style class. The containing layout may enclose an icon and a caption inside elements related to the caption, such as `v-caption`.

5.3.5. Locale

The locale property defines the country and language used in a component. You can use the locale information in conjunction with an internationalization scheme to acquire localized resources. Some components, such as **DateField**, use the locale for component localization.

You can set the locale of a component (or the application) with `setLocale()`.

```
// Component for which the locale is meaningful
InlineDateField date = new InlineDateField("Datum");

// German language specified with ISO 639-1 language
// code and ISO 3166-1 alpha-2 country code.
date.setLocale(new Locale("de", "DE"));

date.setResolution(DateField.RESOLUTION_DAY);
layout.addComponent(date);
```

The resulting date field is shown in Figure 5.11, “Set Locale for **InlineDateField**”.

Figure 5.11. Set Locale for **InlineDateField**



You can get the locale of a component with `getLocale()`. If the locale is undefined for a component, that is, not explicitly set, the locale of the parent component is used. If none of the parent components have a locale set, the locale of the application is used, and if that is not set, the default system locale is set, as given by `Locale.getDefault()`.

Because of the requirement that the component must be attached to the application, it is awkward to use `getLocale()` for internationalization. You can not use it in the constructor, so you would have to get the locale in `attach()` as shown in the following example:

```
Button cancel = new Button() {
    @Override
    public void attach() {
        ResourceBundle bundle = ResourceBundle.getBundle(
            MyAppCaptions.class.getName(), getLocale());
        setCaption(bundle.getString("CancelKey"));
    }
};
layout.addComponent(cancel);
```

It is normally a better practice to get the locale from an application-global parameter and use it to get the localized resource right when the component is created.

```
// Captions are stored in MyAppCaptions resource bundle
// and the application object is known in this context.
ResourceBundle bundle =
    ResourceBundle.getBundle(MyAppCaptions.class.getName(),
                           getApplication().getLocale());

// Get a localized resource from the bundle
Button cancel = new Button(bundle.getString("CancelKey"));
layout.addComponent(cancel);
```

Selecting a Locale

A common task in many applications is selecting a locale. This is done in the following example with a **Select** component.

```
// The locale in which we want to have the language
// selection list
Locale displayLocale = Locale.ENGLISH;

// All known locales
final Locale[] locales = Locale.getAvailableLocales();

// Allow selecting a language. We are in a constructor of a
// CustomComponent, so preselecting the current
// language of the application can not be done before
// this (and the selection) component are attached to
// the application.
final Select select = new Select("Select a language") {
    @Override
    public void attach() {
        setValue(getLocale());
    }
};
for (int i=0; i<locales.length; i++) {
    select.addItem(locales[i]);
    select.setItemCaption(locales[i],
                          locales[i].getDisplayName(displayLocale));

    // Automatically select the current locale
    if (locales[i].equals(getLocale()))
        select.setValue(locales[i]);
}
layout.addComponent(select);

// Locale code of the selected locale
final Label localeCode = new Label("");
layout.addComponent(localeCode);

// A date field which language the selection will change
final InlineDateField date =
    new InlineDateField("Calendar in the selected language");
date.setResolution(DateField.RESOLUTION_DAY);
layout.addComponent(date);

// Handle language selection
select.addListener(new Property.ValueChangeListener() {
    public void valueChange(ValueChangeEvent event) {
        Locale locale = (Locale) select.getValue();
        date.setLocale(locale);
        localeCode.setValue("Locale code: " +
                           locale.getLanguage() + "_" +
                           locale.getCountry());
    }
});
```

```
});  
select.setImmediate(true);
```

The user interface is shown in Figure 5.12, “Selecting a Locale”.

Figure 5.12. Selecting a Locale



5.3.6. Read-Only

The `readonly` property defines whether the user can change the value of a component. As only **Field** components have a value that can be input or edited by the user, this method is mainly applicable to field components. The `read-only` property does not prevent changing the value of a component programmatically.

```
TextField readwrite = new TextField("Read-Write");  
readwrite.setValue("You can change this");  
readwrite.setReadOnly(false); // The default  
layout.addComponent(readwrite);  
  
TextField readonly = new TextField("Read-Only");  
readonly.setValue("You can't touch this!");  
readonly.setReadOnly(true);  
layout.addComponent(readonly);
```

The resulting read-only text field is shown in Figure 5.13, “A Read-Only Component”.

Figure 5.13. A Read-Only Component.



Even when a component is read-only, the user may be able to interact with some component features, such as scrolling.

Client-side state modifications will not be communicated to the server-side and, more important, server-side field components will not accept changes to the value of a read-only component. This is an important security feature, because a malicious user can not fabricate state changes in a read-only component. Notice that this occurs at the level of **AbstractField** in `setValue()` and therefore only applies to the property value of the component; a component could itself accept some variable changes from the client-side.

CSS Style Rules

The appearance of the component can change to indicate that the value is not editable. A read-only component will have the `v-readonly` style. The following CSS rule would make the text in all read-only **TextField** components appear in italic.

```
.v-textfield.v-readonly {  
    font-style: italic;  
}
```

An icon will be rendered inside an HTML element that has the `v-icon` CSS style class. The containing layout may enclose an icon and a caption inside elements related to the caption, such as `v-caption`.

5.3.7. Style Name

The `style name` property defines one or more custom CSS style class names for the component. The `getStyleNames()` returns the current style names as a space-separated list. The `setStyleName()` replaces all the styles with the given style name or a space-separated list of style names. You can also add and remove individual style names with `addStyleName()` and `removeStyleName()`. A style name must be a valid CSS style name.

```
Label label = new Label("This text has a lot of style");  
label.addStyleName("mystyle");  
layout.addComponent(label);
```

The style name will appear in the component's HTML element in two forms: literally as given and prefixed with the component class specific style name. For example, if you add a style name `mystyle` to a **Button**, the component would get both `mystyle` and `v-button-mystyle` styles. Neither form may conflict with built-in style names of Vaadin or GWT. For example, `focus` style would conflict with a built-in style of the same name, and an `option` style for a **Select** component would conflict with the built-in `v-select-option` style.

The following CSS rule would apply the style to any component that has the `mystyle` style.

```
.mystyle {  
    font-family: fantasy;  
    font-style: italic;  
    font-size: 25px;  
    font-weight: bolder;  
    line-height: 30px;  
}
```

The resulting styled component is shown in Figure 5.14, “Component with a Custom Style”

Figure 5.14. Component with a Custom Style

This text has style

5.3.8. Visible

Components can be hidden by setting the `visible` property to `false`. Also the caption, icon and any other component features are made hidden. Hidden components are not just invisible, but their content is not communicated to the browser at all. That is, they are not made invisible cosmetically with only CSS rules. This feature is important for security if you have components that contain security-critical information that must only be shown in specific application states.

```
TextField readonly = new TextField("Read-Only");  
readonly.setValue("You can't see this!");  
readonly.setVisible(false);  
layout.addComponent(readonly);
```

The resulting invisible component is shown in Figure 5.15, “An Invisible Component.”.

Figure 5.15. An Invisible Component.

If you need to make a component only cosmetically invisible, you should use a custom theme to set it `display: none`. This is mainly useful for certain special components such as **ProgressIndicator**, which have effects even when made invisible in CSS. If the hidden component has undefined size and is enclosed in a layout that also has undefined size, the containing layout will collapse when the component disappears. If you want to have the component keep its size, you have to make it invisible by setting all its font and other attributes to be transparent. In such cases, the invisible content of the component can be made visible easily in the browser.

An invisible component has no particular CSS style class to indicate that it is hidden. The element does exist though, but has `display: none` style, which overrides any CSS styling.

5.3.9. Sizing Components

Vaadin components are sizeable; not in the sense that they were fairly large or that the number of the components and their features are sizeable, but in the sense that you can make them fairly large on the screen if you like, or small or whatever size.

The **Sizeable** interface, shared by all components, provides a number of manipulation methods and constants for setting the height and width of a component in absolute or relative units, or for leaving the size undefined.

The size of a component can be set with `setWidth()` and `setHeight()` methods. The methods take the size as a floating-point value. You need to give the unit of the measure as the second parameter for the above methods. The available units are listed in Table 5.1, "Size Units" below.

```
mycomponent.setWidth(100, Sizeable.UNITS_PERCENTAGE);
mycomponent.setWidth(400, Sizeable.UNITS_PIXELS);
```

Alternatively, you can specify the size as a string. The format of such a string must follow the HTML/CSS standards for specifying measures.

```
mycomponent.setWidth("100%");
mycomponent.setHeight("400px");
```

The "100%" percentage value makes the component take all available size in the particular direction (see the description of `Sizeable.UNITS_PERCENTAGE` in the table below). You can also use the shorthand method `setSizeFull()` to set the size to 100% in both directions.

The size can be *undefined* in either or both dimensions, which means that the component will take the minimum necessary space. Most components have undefined size by default, but some layouts have full size in horizontal direction. You can set the height or width as undefined with `Sizeable.SIZE_UNDEFINED` parameter for `setWidth()` and `setHeight()`.

You always need to keep in mind that a *layout with undefined size may not contain components with defined relative size*, such as "full size". See Section 6.10.1, "Layout Size" for details.

The Table 5.1, "Size Units" lists the available units and their codes defined in the **Sizeable** interface.

Table 5.1. Size Units

<i>UNITS_PIXELS</i>	px	The <i>pixel</i> is the basic hardware-specific measure of one physical display pixel.
<i>UNITS_POINTS</i>	pt	The <i>point</i> is a typographical unit, which is usually defined as 1/72 inches or about 0.35 mm. However, on displays the size can vary significantly depending on display metrics.
<i>UNITS_PICAS</i>	pc	The <i>pica</i> is a typographical unit, defined as 12 points, or 1/7 inches or about 4.233 mm. On displays, the size can vary depending on display metrics.
<i>UNITS_EM</i>	em	A unit relative to the used font, the width of the upper-case "M" letter.
<i>UNITS_EX</i>	ex	A unit relative to the used font, the height of the lower-case "x" letter.
<i>UNITS_MM</i>	mm	A physical length unit, millimeters on the surface of a display device. However, the actual size depends on the display, its metrics in the operating system, and the browser.
<i>UNITS_CM</i>	cm	A physical length unit, <i>centimeters</i> on the surface of a display device. However, the actual size depends on the display, its metrics in the operating system, and the browser.
<i>UNITS_INCH</i>	in	A physical length unit, <i>inches</i> on the surface of a display device. However, the actual size depends on the display, its metrics in the operating system, and the browser.
<i>UNITS_PERCENTAGE</i>	%	A relative percentage of the available size. For example, for the top-level layout <code>100%</code> would be the full width or height of the browser window. The percentage value must be between 0 and 100.

If a component inside **HorizontalLayout** or **VerticalLayout** has full size in the namesake direction of the layout, the component will expand to take all available space not needed by the other components. See Section 6.10.1, “Layout Size” for details.

5.3.10. Managing Input Focus

When the user clicks on a component, the component gets the *input focus*, which is indicated by highlighting according to style definitions. If the component allows inputting text, the focus and insertion point are indicated by a cursor. Pressing the **Tab** key moves the focus to the component next in the *focus order*.

Focusing is supported by all **Field** components and also by **Form** and **Upload**.

The focus order or *tab index* of a component is defined as a positive integer value, which you can set with `setTabIndex()` and get with `getTabIndex()`. The tab index is managed in the context of the application-level **Window** in which the components are contained. The focus order can therefore jump between two any lower-level component containers, such as sub-windows or panels.

The default focus order is determined by the natural hierarchical order of components in the order in which they were added under their parents. The default tab index is 0 (zero).

Giving a negative integer as the tab index removes the component from the focus order entirely.

CSS Style Rules

The component having the focus will have an additional style class with the `-focus` prefix. For example, a **TextField** would have style `v-textfield-focus`.

For example (if we have the `focusexample` style defined for a parent of a text field), the following would make a text field blue when it has focus.

```
.focusexample .v-textfield-focus {  
    background: lightblue;  
}
```

5.4. Label

Label is a text component that you can use to display non-editable text. The text will wrap around if the width of the containing component limits the length of the lines (except for preformatted text).

```
// A container for the Label.  
Panel panel = new Panel("Panel Containing a Label");  
panel.setWidth("200px"); // Defined width.  
main.addComponent(panel);  
  
panel.addComponent(  
    new Label("This is a Label inside a Panel. There is enough " +  
        "text in the label to make the text wrap if it " +  
        "exceeds the width of the panel."));
```

As the size of the **Panel** in the above example is fixed, the text in the **Label** will wrap to fit the panel, as shown in Figure 5.16, “The Label Component”.

Figure 5.16. The Label Component



The contents of a label are formatted depending on the content mode. By default, the text is assumed to be plain text and any contained XML-specific characters will be quoted appropriately to allow rendering the contents of a label in XHTML in a web browser. The content mode can be set in the constructor or with `setContentMode()`, and can have the following values:

CONTENT_DEFAULT	The default content mode is CONTENT_TEXT (see below).
CONTENT_PREFORMATTED	Content mode, where the label contains preformatted text. It will be, by default, rendered with a fixed-width typewriter font. Preformatted text can contain line breaks, written in Java with the <code>\n</code> escape sequence for a newline character (ASCII 0x0a), or tabulator characters written with <code>\t</code> (ASCII 0x08).
CONTENT_RAW	Content mode, where the label contains raw text. Output is not required to be valid XML. It can be, for example, HTML, which can be unbalanced or otherwise invalid XML. The example below uses the <code>
</code> tag in HTML. While XHTML

should be preferred in most cases, this can be useful for some specific purposes where you may need to display loosely formatted HTML content. The raw mode also preserves character entities, some of which might otherwise be interpreted incorrectly.

CONTENT_TEXT	Content mode, where the label contains only plain text. All characters are allowed, including the special <, >, and & characters in XML or HTML, which are quoted properly in XHTML while rendering the component. This is the default mode.
CONTENT_XHTML	Content mode, where the label contains XHTML. The content will be enclosed in a DIV element having the namespace "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd".
CONTENT_XML	Content mode, where the label contains well-formed and well-balanced XML. Each of the root elements must have their default namespace specified.
CONTENT_UIDL	Formatted content mode, where the contents are XML that is restricted to UIDL 1.0, the internal language of Vaadin for AJAX communications between the server and the browser. Obsolete since IT Mill Toolkit 5.0.



Warning

Notice that the validity of XML or XHTML in a **Label** is not checked in the server when rendering the component and any errors can result in an error in the browser! You should validate the content before displaying it in the component, especially if it comes from an uncertain source.

The following example demonstrates the use of **Label** in different modes.

```
GridLayout labelgrid = new GridLayout (2,1);

labelgrid.addComponent (new Label ("CONTENT_DEFAULT"));
labelgrid.addComponent (
    new Label ("This is a label in default mode: <plain text>",
        Label.CONTENT_DEFAULT));

labelgrid.addComponent (new Label ("CONTENT_PREFORMATTED"));
labelgrid.addComponent (
    new Label ("This is a preformatted label.\n"+
        "The newline character \\n breaks the line.",
        Label.CONTENT_PREFORMATTED));

labelgrid.addComponent (new Label ("CONTENT_RAW"));
labelgrid.addComponent (
    new Label ("This is a label in raw mode.<br>It can contain, "+
        "for example, unbalanced markup.",
        Label.CONTENT_RAW));

labelgrid.addComponent (new Label ("CONTENT_TEXT"));
labelgrid.addComponent (
    new Label ("This is a label in (plain) text mode",
        Label.CONTENT_TEXT));

labelgrid.addComponent (new Label ("CONTENT_XHTML"));
labelgrid.addComponent (
```

```
new Label ("<i>This</i> is an <b>XHTML</b> formatted label",
Label.CONTENT_XHTML));

labelgrid.addComponent (new Label ("CONTENT_XML"));
labelgrid.addComponent (
    new Label ("This is an <mylelement>XML</mylelement> " +
    "formatted label",
Label.CONTENT_XML));

main.addComponent(labelgrid);
```

The rendering will look as follows:

Figure 5.17. Label Modes Rendered on Screen

CONTENT_DEFAULT	This is a label in default mode: <plain text>
CONTENT_PREFORMATTED	This is a preformatted label. The newline character \n breaks the line.
CONTENT_RAW	This is a label in raw mode. It can contain, for example, unbalanced markup.
CONTENT_TEXT	This is a label in (plain) text mode
CONTENT_XHTML	This is an XHTML formatted label
CONTENT_XML	This is an XML formatted label

Using the XHTML, XML, or raw modes allow inclusion of, for example, images within the text flow, which is not possible with any regular layout components. The following example includes an image within the text flow, with the image coming from a class loader resource.

```
ClassResource labelimage = new ClassResource ("labelimage.jpg",
                                              this);
main.addComponent(new Label("Here we have an image <img src=\"" +
                           this.getRelativeLocation(labelimage) +
                           "\"/> within text.",
                           Label.CONTENT_XHTML));
```

When you use a class loader resource, the image has to be included in the JAR of the web application. In this case, the `labelimage.jpg` needs to be in the default package. When rendered in a web browser, the output will look as follows:

Figure 5.18. Referencing An Image Resource in Label

Here we have an image  within some text.

Another solution would be to use the **CustomLayout** component, where you can write the component content as an XHTML fragment in a theme, but such a solution may be too heavy for most cases, and not flexible enough if the content needs to be dynamically generated.

Notice that the rendering of XHTML depends on the assumption that the client software and the terminal adapter are XHTML based. It is possible to write a terminal adapter for a custom thin client application, which may not be able to render XHTML at all. There are also differences between web browsers in their support of XHTML.

5.5. Link

The **Link** component allows making references to resources that are either external or provided by the web server or by the application itself. While a **Link** appears like a hyperlink, it is not handled in the web browser. When a user clicks a link, the server receives an event and typically opens the referenced resource in the target window of the link. Resources are explained in Section 4.5, “Referencing Resources”.

Links to external resources can be made by using a URI as follows:

```
Link link = new Link ("link to a resource",
    new ExternalResource("http://www.itmill.com/"));
```

With the simple constructor used in the above example, the link is opened in the current window. Using the constructor that takes the target window as a parameter, or by setting the window with `setWindow`, you can open the resource in another window, such as a native popup window or a **FrameWindow**. As the target window can be defined as a target string managed by the browser, the target can be any window, including windows not managed by the application itself.

When the user clicks the link, the application will receive an event regarding the click and handle it to provide the resource. The link is therefore not an `<a href>` element in HTML and it does not have an URI. This has some additional consequences, such as that a link can not be marked as "visited" by the browser, unlike normal hyperlinks. If you wish to have an actual HTML anchor element, you need to customize the rendering of the component or use a **Label** with XHTML content mode and write the anchor element by yourself.

CSS Style Rules

The **Link** component has `v-link` style by default.

```
.v-link { }
```

When the mouse pointer hovers over the link, it will also have the `over` style.

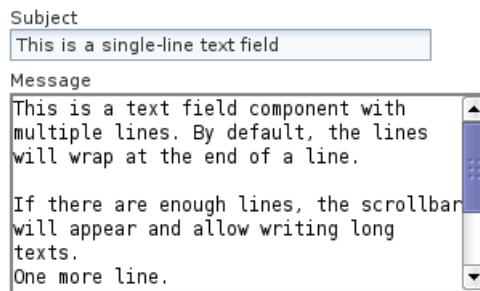
5.6. TextField

TextField is one of the most common user interface components and is highly versatile. It supports both single- and multi-line editing, password input, and buffering.

The following example creates two simple text fields: a single-line and a multi-line **TextField**.

```
/* Add a single-line text field. */
TextField subject = new TextField("Subject");
subject.setColumns(40);
main.addComponent(subject);

/* Add a multi-line text field. */
TextField message = new TextField("Message");
message.setRows(7);
message.setColumns(40);
main.addComponent(message);
```

Figure 5.19. Single- and Multi-Line Text Field Example

Notice how font size affects the width of the text fields even though the width was set with the same number of columns. This is a feature of HTML.

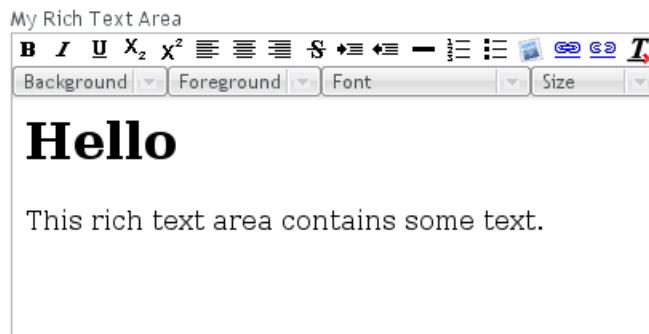
5.7. RichTextArea

The **RichTextArea** field allows entering or editing formatted text. The toolbar provides all basic editing functionalities. The text content of **RichTextArea** is represented in HTML format. **RichTextArea** inherits **TextField** and does not add any API functionality over it. You can add new functionality by extending the client-side components **VRichTextArea** and **VRichTextToolbar**.

As with **TextField**, the textual content of the rich text area is the **Property** of the field and can be set with `setValue()` and read with `getValue()`.

```
// Create a rich text area
final RichTextArea rtarea = new RichTextArea();
rtarea.setCaption("My Rich Text Area");

// Set initial content as HTML
rtarea.setValue("<h1>Hello</h1>\n" +
    "<p>This rich text area contains some text.</p>");
```

Figure 5.20. Rich Text Area Component

Above, we used context-specific tags such as `<h1>` in the initial HTML content. The rich text area component does not allow creating such tags, only formatting tags, but it does preserve them unless the user edits them away. Any non-visible whitespace such as the new line character (`\n`) are removed from the content. For example, the value set above will be as follows when read from the field with `getValue()`:

```
<h1>Hello</h1> <p>This rich text area contains some text.</p>
```

The rich text area is one of the few components in Vaadin that contain textual labels. The selection boxes in the toolbar are in English, and not be localized currently otherwise but by inheriting or reimplementing the client-side **VRichTextToolbar** widget. The buttons can be localized simply with CSS by downloading a copy of the toolbar background image, editing it, and replacing the default toolbar. The toolbar is a single image file from which the individual button icons are picked, so the order of the icons is different from the rendered. The image file depends on the client-side implementation of the toolbar.

```
.v-richtextarea-richtextexample .gwt-ToggleButton  
.gwt-Image {  
    background-image: url(img/richtextarea-toolbar-fi.png)  
    !important;  
}
```

Figure 5.21. Regular English and a Localized Rich Text Area Toolbar



Cross-Site Scripting with RichTextArea

The user input from a **RichTextArea** is transmitted as XHTML from the browser to server-side and is not sanitized. As the entire purpose of the **RichTextArea** component is to allow input of formatted text, you can not sanitize it just by removing all HTML tags. Also many attributes, such as *style*, should pass through the sanitization.

See Section 11.10.1, “Sanitizing User Input to Prevent Cross-Site Scripting” for more details on Cross-Site scripting vulnerabilities and sanitization of user input.

CSS Style Rules

```
.v-richtextarea { }  
.v-richtextarea .gwt-RichTextToolbar { }  
.v-richtextarea .gwt-RichTextArea { }
```

The rich text area consists of two main parts: the toolbar with overall style `.gwt-RichTextToolbar` and the editor area with style `.gwt-RichTextArea`. The editor area obviously contains all the elements and their styles that the HTML content contains. The toolbar contains buttons and drop-down list boxes with the following respective style names:

```
.gwt-ToggleButton { }  
.gwt-ListBox { }
```

5.8. Date and Time Input

The **DateField** component provides the means to display and input date and time. The field comes in two variations: **PopupDateField** with numeric input fields and a popup calendar view and **InlineDateField** with the calendar view always visible and the numeric input fields only for time. The **DateField** base class defaults to the popup variation.

The example below illustrates the use of the **DateField** with the default style. We set the time of the **DateField** to current time with the default constructor of the `java.util.Date` class.

```
/* Create a DateField with the default style. */
DateField date = new DateField();

/* Set the date and time to present. */
date.setValue(new java.util.Date());
```

Figure 5.22. Example of the Date Field with Default Style



The default style provides date input using a text box for the date and combo boxes for the time, down to milliseconds. Pressing the "..." button right of the date opens a month view for selecting the date.

You probably will not need milliseconds in most applications, and might not even need the time, but just the date. The visibility of the input components is controlled by *resolution* of the field which can be set with `setResolution()` method. The method takes as its parameters the lowest visible component, typically `RESOLUTION_DAY` for just dates and `RESOLUTION_MIN` for dates with time in hours and minutes. Please see the API Reference for a complete list of resolution parameters.

5.8.1. Calendar

The *calendar* style of the **DateField** provides a date picker component with a month view, just like the one in the default style that opens by clicking the "..." button. The user can navigate months and years by clicking the appropriate arrows.

```
// Create a DateField with the calendar style.
DateField date = new DateField("Here is a calendar field");
date.setStyle("calendar");

// Set the date and time to present.
date.setValue(new java.util.Date());

main.addComponent(date);
```

Figure 5.23. Example of the Date Field with Calendar Style



5.8.2. DateField Locale

The date fields use the locale set for the component, which defaults to the system locale. You can set a custom locale with the `setLocale()` method of **AbstractComponent**.

5.9. Button

The **Button** is a user interface component that is normally used for finalizing input and initiating some action. When the user clicks a button, a **Button.ClickEvent** is emitted. A listener that inherits the **Button.ClickListener** interface can handle clicks with the `buttonClick()` method.

```
public class TheButton extends CustomComponent
    implements Button.ClickListener {
    Button thebutton;

    public TheButton() {
        // Create a Button with the given caption.
        thebutton = new Button ("Do not push this button");

        // Listen for ClickEvents.
        thebutton.addListener(this);

        setCompositionRoot(thebutton);
    }

    /** Handle click events for the button. */
    public void buttonClick (Button.ClickEvent event) {
        thebutton.setCaption ("Do not push this button again");
    }
}
```

Figure 5.24. An Example of a Button



As a user interface often has several buttons, you can differentiate between them either by comparing the **Button** object reference returned by the `getButton()` method of **Button.ClickEvent** to a kept reference or by using a separate listener method for each button. The listening object and method can be given to the constructor. For a detailed description of these patterns together with some examples, please see Section 3.5, “Events and Listeners”.

CSS Style Rules

```
.v-button { }
```

The exact CSS style name can be different if a **Button** has the `switchMode` attribute enabled. See the alternative CSS styles below.

5.10. CheckBox

CheckBox is a two-state selection component that can be either checked or unchecked. The caption of the check box will be placed right of the actual check box. Vaadin provides two ways to create check boxes: individual check boxes with the **CheckBox** component described in this section and check box groups with the **OptionGroup** component in multiple selection mode, as described in Section 5.11.3, “Radio Button and Check Box Groups with **OptionGroup**”.

Clicking on a check box will change its state. The state is the **Boolean** property of the **Button**, and can be set with `setValue()` and obtained with `getValue()` method of the **Property** interface. Changing the value of a check box will cause a **ValueChangeEvent**, which can be handled by a **ValueChangeListener**.

```

// A check box with default state (not checked, false).
final CheckBox checkbox1 = new CheckBox("My CheckBox");
main.addComponent(checkbox1);

// Another check box with explicitly set checked state.
final CheckBox checkbox2 = new CheckBox("Checked CheckBox");
checkbox2.setValue(true);
main.addComponent(checkbox2);

// Make some application logic. We use anonymous listener
// classes here. The above references were defined as final
// to allow accessing them from inside anonymous classes.
checkbox1.addValueChangeListener() {
    public void valueChange(ValueChangeEvent event) {
        // Copy the value to the other checkbox.
        checkbox2.setValue(checkbox1.getValue());
    }
});
checkbox2.addValueChangeListener() {
    public void valueChange(ValueChangeEvent event) {
        // Copy the value to the other checkbox.
        checkbox1.setValue(checkbox2.getValue());
    }
});

```

Figure 5.25. An Example of a Check Box



For an example on the use of check boxes in a table, see Section 5.12, “[Table](#)”.

CSS Style Rules

```
.v-checkbox { }
```

5.11. Selecting Items

Vaadin provides several alternative choices for selecting one or more items from a list. The selection components allow selecting one or more items from a list of items. The items are objects that implement the **Item** interface, and contained in a **Container**. The choices are based on the **AbstractSelect** base class.

The following selection classes are available:

- | | |
|----------------------|--|
| Select | Provides a drop-down list for single selection and a multi-line list in multiselect mode. |
| NativeSelect | Provides selection using the native selection component of the browser, typically a drop-down list for single selection and a multi-line list in multiselect mode. This uses the <select> element in HTML. |
| OptionGroup | Shows the items as a vertically arranged group of radio buttons in the single selection mode and of check boxes in multiple selection mode. |
| TwinColSelect | Shows two list boxes side by side where the user can select items from a list of available items and move them to a list of selected items using control buttons. |

In addition, the **Tree** and **Table** components allow special forms of selection. They also inherit the **AbstractSelect**.

A selection component provides the current selection as the property of the component (with the **Property** interface). The property value is an item identifier object that identifies the selected item. You can get the identifier with `getValue()` of the **Property** interface. You can select an item with the corresponding `setValue()` method. In multiselect mode, the property will be an unmodifiable set of item identifiers. If no item is selected, the property will be `null` in single selection mode or an empty collection in multiselect mode.

New items are added with the `addItem()` method, implemented for the **Container** interface. The method takes the *item identifier* (IID) object as a parameter, and by default uses the identifier also as the caption of the item. The identifier is typically a **String**. The `addItem()` method also creates an empty **Item**, which itself has little relevance in the **Select** component, as the properties of an item are not used in any way by the component.

```
// Create a Select component.  
Select select = new Select ("Select something here");  
main.addComponent(select);  
  
// Fill the component with some items.  
final String[] planets = new String[] {  
    "Mercury", "Venus", "Earth", "Mars",  
    "Jupiter", "Saturn", "Uranus", "Neptune"};  
  
for (int i=0; i<planets.length; i++)  
    select.addItem(planets[i]);
```

We could as well have added the item identifiers as integers, for example, and set the captions explicitly.

The **Select** and **NativeSelect** components will show "-" selection when no actual item is selected. This is the *null selection item identifier*. You can set an alternative ID with `setNullSelectionItemId()`. Setting the alternative null ID is merely a visual text; the `getValue()` will still return `null` value if no item is selected, or an empty set in multiselect mode.

The item identifier of the currently selected item will be set as the property of the **Select** object. You can access it with the `getValue()` method of the **Property** interface of the component. Also, when handling changes in a **Select** component with the **Property.ValueChangeListener** interface, the **Property.ValueChangeEvent** will have the selected item as the property of the event, accessible with the `getProperty()` method.

Figure 5.26. Selected Item



The item and its identifier can be of any object type. The caption of the items can be retrieved from various sources, as defined with the caption mode of the component, which you can set with the `setItemCaptionMode()` method. The default mode is `ITEM_CAPTION_MODE_EXPLICIT_DEFAULTS_ID`. In addition to a caption, an item can have an icon. The icon of an item is set with `setItemIcon()`.

Caption Modes for Selection Components

`ITEM_CAPTION_MODE_EXPLICIT_DEFAULTS_ID` This is the default caption mode and its flexibility allows using it in most cases. By default, the item identifier will be used as the caption. The caption is retrieved with `toString()` method of the item identifier object. If the caption is specified explicitly with `setItemCaption()`, it overrides the item identifier.

`ITEM_CAPTION_MODE_EXPLICIT` Captions must be explicitly specified with `setItemCaption()`. If they are not, the caption will be empty. Such items with empty captions will nevertheless be displayed in the **Select** component as empty rows. If they have an icon, they will be visible.

`ITEM_CAPTION_MODE_ICON_ONLY` Only icons are shown, captions are hidden.

`ITEM_CAPTION_MODE_ID` String representation of the item identifier object is used as caption. This is useful when the identifier is actually an application specific object. For example:

```
class Planet extends Object {  
    String planetName;  
    Planet (String name) {  
        planetName = name;  
    }  
    public String toString () {  
        return "The Planet " + planetName;  
    }  
  
    ... + equals() and hashCode() implementations  
}  
...  
SelectExample (Application application) {  
    ...  
    for (int i=0; i<planets.length; i++)  
        select.addItem(new Planet(planets[i]));  
  
    ...  
}
```

`ITEM_CAPTION_MODE_INDEX` Index number of item is used as caption. This caption mode is applicable only to data sources that implement the **Container.Indexed** interface. If the interface is not available, the component will throw a **ClassCastException**. The **Select** component itself does not implement this interface, so the mode is not usable without a separate data source. An **IndexedContainer**, for example, would work.

`ITEM_CAPTION_MODE_ITEM` **String** representation of item, acquired with `toString()`, is used as the caption. This is applicable mainly when using a custom **Item** class, which also requires using a custom **Container** that is used as a data source for the **Select** component.

ITEM_CAPTION_MODE_PROPERTY Item captions are read from the **String** representation of the property with the identifier specified with `setItemCaptionPropertyId()`. This is useful, for example, when you have a container that you use as the data source for a **Select**, and you want to use a specific property for caption.

In the example below, we bind a selection component to a bean container and use a property of the bean as the caption.

```
/* A bean with a "name" property. */
public class Planet implements Serializable {
    String name;

    public Planet(String name) {
        this.name = name;
    }

    public void setName(String name) {
        this.name = name;
    }

    public String getName() {
        return name;
    }
}

void propertyModeExample() {
    VerticalLayout layout = new VerticalLayout();

    // Have a bean container to put the beans in
    BeanItemContainer<Planet> container =
        new
    BeanItemContainer<Planet>(Planet.class);

    // Put some example data in it
    container.addItem(new Planet("Mercury"));
    container.addItem(new Planet("Venus"));
    container.addItem(new Planet("Earth"));
    container.addItem(new Planet("Mars"));

    // Create a selection component bound to the
    // container
    Select select = new Select("Planets",
        container);

    // Set the caption mode to read the caption
    // directly
    // from the 'name' property of the bean
    select.setItemCaptionMode(
        Select.ITEM_CAPTION_MODE_PROPERTY);
    select.setItemCaptionPropertyId("name");

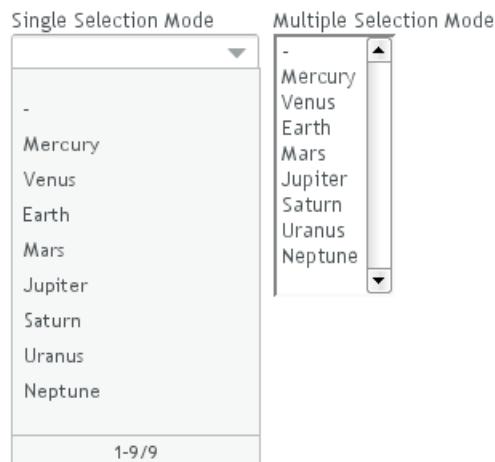
    layout.addComponent(select);
}
```

You can set an icon for each item with `setItemIcon()`, or define an item property that provides the icon resource with `setItemIconPropertyId()`, in a fashion similar to captions. Notice, however, that icons are not supported in **NativeSelect**, **TwinColSelect**, and some other selection components and modes. This is because HTML does not support images inside the native select elements. Icons are also not really visually applicable.

5.11.1. Basic Select Component

The **Select** component allows, in single selection mode, selecting an item from a drop-down list, or in multiple selection mode, from a list box that shows multiple items.

Figure 5.27. The Select Component



Combo Box Behaviour

The **Select** component will act as a combo box in single selection mode, allowing either to choose the value from the drop-down list or to write the value in the text field part of the component.

Filtered Selection

The **Select** component allows filtering the items available for selection. The component shows as an input box for entering text. The text entered in the input box is used for filtering the available items shown in a drop-down list. Pressing **Enter** will complete the item in the input box. Pressing **Up-** and **Down-**arrows can be used for selecting an item from the drop-down list. The drop-down list is paged and clicking on the scroll buttons will change to the next or previous page. The list selection can also be done with the arrow keys on the keyboard. The shown items are loaded from the server as needed, so the number of items held in the component can be quite large.

Vaadin provides two filtering modes: *FILTERINGMODE_CONTAINS* matches any item that contains the string given in the text field part of the component and *FILTERINGMODE_STARTSWITH* matches only items that begin with the given string. The filtering mode is set with `setFilteringMode()`. Setting the filtering mode to the default value *FILTERINGMODE_OFF* disables filtering.

```
Select select = new Select("Enter containing substring");

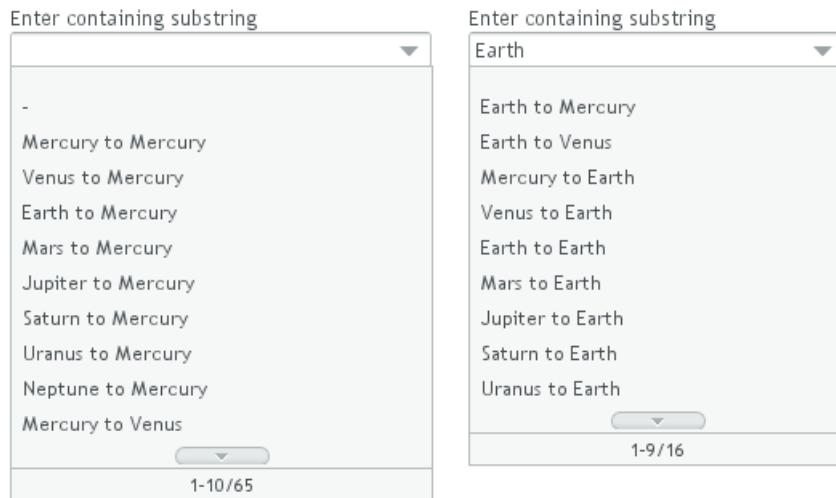
select.setFilteringMode(AbstractSelect.Filtering.FILTERINGMODE_CONTAINS);

/* Fill the component with some items. */
final String[] planets = new String[] {
    "Mercury", "Venus", "Earth", "Mars",
    "Jupiter", "Saturn", "Uranus", "Neptune" };

for (int i = 0; i < planets.length; i++)
    for (int j = 0; j < planets.length; j++) {
        select.addItem(planets[j] + " to " + planets[i]);
```

The above example uses the containment filter that matches to all items containing the input string. As shown in Figure 5.28, “Filtered Selection” below, when we type some text in the input area, the drop-down list will show all the matching items.

Figure 5.28. Filtered Selection



The FilterSelect demo in the Vaadin Demo Application provides an example of filtering items in a **Select** component.

CSS Style Rules

```
.v-filterselect { }
.v-filterselect-input { }
.v-filterselect-button { }
.v-filterselect-suggestpopup { }
.v-filterselect-prefpage-off { }
.v-filterselect-suggestmenu { }
.v-filterselect-status { }
```

In its default state, only the input field of the **Select** component is visible. The entire component is enclosed in `v-filterselect` style, the input field has `v-filterselect-input` style and the button in the right end that opens and closes the drop-down result list has `v-filterselect-button` style.

The drop-down result list has an overall `v-filterselect-suggestpopup` style. It contains the list of suggestions with `v-filterselect-suggestmenu` style and a status bar in the bottom with `v-filterselect-status` style. The list of suggestions is padded with an area with `v-filterselect-prefpage-off` style above and below the list.

5.11.2. Native Selection Component NativeSelect

NativeSelect offers the native selection component in web browsers, using an HTML `<select>` element. In single selection mode, the component is shown as a drop-down list, and in multiple selection mode as a list box.

CSS Style Rules

```
.v-select-optiongroup {}
.v-checkbox, .v-select-option {}
.v-radio, .v-select-option {}
```

The `v-select-optiongroup` is the overall style for the component. Each check box will have the `v-checkbox` style and each radio button the `v-radio` style. Both the radio buttons and check boxes will also have the `v-select-option` style that allows styling regardless of the option type.

5.11.3. Radio Button and Check Box Groups with OptionGroup

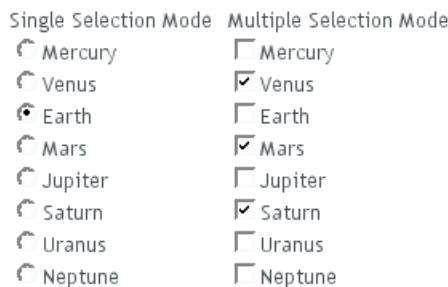
The **OptionGroup** class provides selection from alternatives using a group of radio buttons in single selection mode. In multiple selection mode, the items show up as check boxes.

```
OptionGroup optiongroup = new OptionGroup("My Option Group");

// Use the multiple selection mode.
myselect.setMultiSelect(true);
```

Figure 5.29, “Option Button Group in Single and Multiple Selection Mode” shows the option group in single and multiple selection mode.

Figure 5.29. Option Button Group in Single and Multiple Selection Mode



You can create check boxes individually using the **CheckBox** class, as described in Section 5.10, “**CheckBox**”. The advantages of the **OptionGroup** component are that as it maintains the individual check box objects, you can get an array of the currently selected items easily, and that you can easily change the appearance of a single component.

CSS Style Rules

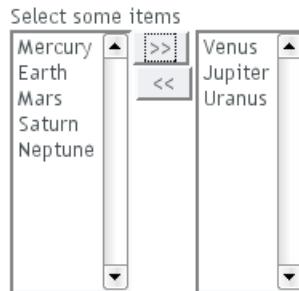
```
.v-select-optiongroup {}
.v-checkbox, .v-select-option {}
.v-radio, .v-select-option {}
```

The `v-select-optiongroup` is the overall style for the component. Each check box will have the `v-checkbox` style and each radio button the `v-radio` style. Both the radio buttons and check boxes will also have the `v-select-option` style that allows styling regardless of the option type.

5.11.4. Twin Column Selection with TwinColSelect

The **TwinColSelect** class provides a multiple selection component that shows two lists side by side. The user can select items from the list on the left and click on the ">>" button to move them to the list on the right. Items can be moved back by selecting them and clicking on the "<<" button.

Figure 5.30. Twin Column Selection



CSS Style Rules

```
.v-select-twincol {}
.v-select-twincol-options {}
.v-select-twincol-selections {}
.v-select-twincol-buttons {}
.v-select-twincol-deco {}
```

5.11.5. Allowing Adding New Items

The selection components allow the user to add new items, with a user interface similar to combo boxes in desktop user interfaces. You need to enable the `newItemsAllowed` mode with the `setNewItemsAllowed()` method.

```
myselect.setNewItemsAllowed(true);
```

The user interface for adding new items depends on the selection component and the selection mode. The regular **Select** component in single selection mode, which appears as a combo box, allows you to simply type the new item in the combo box and hit **Enter** to add it. In most other selection components, as well as in the multiple selection mode of the regular **Select** component, a text field that allows entering new items is shown below the selection list, and clicking the **+** button will add the item in the list, as illustrated in Figure 5.31, “Select Component with Adding New Items Allowed”.

Figure 5.31. Select Component with Adding New Items Allowed

The identifier of an item added by the user will be a **String** object identical to the caption of the item. You should consider this if the item identifier of automatically filled items is some other type or otherwise not identical to the caption.

Adding new items is possible in both single and multiple selection modes and in all styles. Adding new items may not be possible if the **Select** is bound to an external **Container** that does not allow adding new items.

5.11.6. Multiple Selection Mode

Setting the **Select**, **NativeSelect**, or **OptionGroup** components to multiple selection mode with the `setMultiSelect()` method changes their appearance to allow selecting multiple items.

Select and **NativeSelect**

These components appear as a native HTML selection list, as shown in Figure 5.31, “Select Component with Adding New Items Allowed”. By holding the **Ctrl** or **Shift** key pressed, the user can select multiple items.

OptionGroup

The option group, which is a radio button group in single selection mode, will show as a check box group in multiple selection mode. See Section 5.11.3, “Radio Button and Check Box Groups with **OptionGroup**”.

The **TwinColSelect**, described in Section 5.11.4, “Twin Column Selection with **TwinColSelect**”, is a special multiple selection mode that is not meaningful for single selection.

```
myselect.setMultiSelect(true);
```

As in single selection mode, the selected items are set as the property of the **Select** object. In multiple selection mode, the property is a **Collection** of currently selected items. You can get and set the property with the `getValue()` and `setValue()` methods as usual.

A change in the selection will trigger a **ValueChangeEvent**, which you can handle with a **Property.ValueChangeListener**. As usual, you should use `setImmediate(true)` to trigger the event immediately when the user changes the selection. The following example shows how to handle selection changes with a listener.

```
public class SelectExample
    extends CustomComponent
    implements Property.ValueChangeListener {
    // Create a Select object with a caption.
    Select select = new Select("This is a Select component");
```

```
VerticalLayout layout = new VerticalLayout();
Label status = new Label("-");

SelectExample () {
    setCompositionRoot (layout);
    layout.addComponent(select);

    // Fill the component with some items.
    final String[] planets = new String[] {
        "Mercury", "Venus", "Earth", "Mars",
        "Jupiter", "Saturn", "Uranus", "Neptune"};
    for (int i=0; i<planets.length; i++)
        select.addItem(planets[i]);

    // By default, the change event is not triggered
    // immediately when the selection changes.
    // This enables the immediate events.
    select.setImmediate(true);

    // Listen for changes in the selection.
    select.addListener(this);

    layout.addComponent(status);
}

/* Respond to change in the selection. */
public void valueChange(Property.ValueChangeEvent event) {
    // The event.getProperty() returns the Item ID (IID)
    // of the currently selected item in the component.
    status.setValue("Currently selected item ID: " +
                    event.getProperty());
}
}
```

5.12. Table

The **Table** component is intended for presenting tabular data organized in rows and columns. The **Table** is one of the most versatile components in Vaadin. Table cells can include text or arbitrary UI components. You can easily implement editing of the table data, for example clicking on a cell could change it to a text field for editing.

The data contained in a **Table** is managed using the Data Model of Vaadin (see Chapter 9, *Binding Components to Data*), through the **Container** interface of the **Table**. This makes it possible to bind a table directly to a data source, such as a database query. Only the visible part of the table is loaded into the browser and moving the visible window with the scrollbar loads content from the server. While the data is being loaded, a tooltip will be displayed that shows the current range and total number of items in the table. The rows of the table are *items* in the container and the columns are *properties*. Each table row (item) is identified with an *item identifier* (IID), and each column (property) with a *property identifier* (PID).

When creating a table, you first need to define columns with `addContainerProperty()`. This method comes in two flavors. The simpler one takes the property ID of the column and uses it also as the caption of the column. The more complex one allows differing PID and header for the column. This may make, for example, internationalization of table headers easier, because if a PID is internationalized, the internationalization has to be used everywhere where the PID is used. The complex form of the method also allows defining an icon for the column from a resource. The "default value" parameter is used when new properties (columns) are added to the table, to fill in the missing values. (This default has no meaning in the usual case, such as below, where we add items after defining the properties.)

```

/* Create the table with a caption. */
Table table = new Table("This is my Table");

/* Define the names and data types of columns.
 * The "default value" parameter is meaningless here. */
table.addContainerProperty("First Name", String.class, null);
table.addContainerProperty("Last Name", String.class, null);
table.addContainerProperty("Year", Integer.class, null);

/* Add a few items in the table. */
table.addItem(new Object[] {
    "Nicolaus", "Copernicus", new Integer(1473), new Integer(1));
table.addItem(new Object[] {
    "Tycho", "Brahe", new Integer(1546), new Integer(2));
table.addItem(new Object[] {
    "Giordano", "Bruno", new Integer(1548), new Integer(3));
table.addItem(new Object[] {
    "Galileo", "Galilei", new Integer(1564), new Integer(4));
table.addItem(new Object[] {
    "Johannes", "Kepler", new Integer(1571), new Integer(5));
table.addItem(new Object[] {
    "Isaac", "Newton", new Integer(1643), new Integer(6));

```

In this example, we used an increasing **Integer** object as the Item Identifier, given as the second parameter to `addItem()`. The actual rows are given simply as object arrays, in the same order in which the properties were added. The objects must be of the correct class, as defined in the `addContainerProperty()` calls.

Figure 5.32. Basic Table Example

This is my Table		
First Name	Last Name	Year
Nicolaus	Copernicus	1473
Tycho	Brahe	1546
Giordano	Bruno	1548
Galileo	Galilei	1564
Johannes	Kepler	1571

Scalability of the **Table** is largely dictated by the container. The default **IndexedContainer** is relatively heavy and can cause scalability problems, for example, when updating the values. Use of an optimized application-specific container is recommended. Table does not have a limit for the number of items and is just as fast with hundreds of thousands of items as with just a few. With the current implementation of scrolling, there is a limit of around 500 000 rows, depending on the browser and the pixel height of rows.

5.12.1. Selecting Items in a Table

The **Table** allows selecting one or more items by clicking them with the mouse. When the user selects an item, the IID of the item will be set as the property of the table and a **ValueChangeEvent** is triggered. To enable selection, you need to set the table `selectable`. You will also need to set it as *immediate* in most cases, as we do below, because without it, the change in the property will not be communicated immediately to the server.

The following example shows how to enable the selection of items in a **Table** and how to handle **ValueChangeEvent** events that are caused by changes in selection. You need to handle the event with the `valueChange()` method of the **Property.ValueChangeListener** interface.

```
// Allow selecting items from the table.  
table.setSelectable(true);  
  
// Send changes in selection immediately to server.  
table.setImmediate(true);  
  
// Shows feedback from selection.  
final Label current = new Label("Selected: -");  
  
// Handle selection change.  
table.addListener(new Property.ValueChangeListener() {  
    public void valueChange(ValueChangeEvent event) {  
        current.setValue("Selected: " + table.getValue());  
    }  
});
```

Figure 5.33. Table Selection Example

First Name	Last Name	Year	
Nicolaus	Copernicus	1473	▲
Tycho	Brahe	1546	⋮
Giordano	Bruno	1548	⋮
Galileo	Galilei	1564	⋮
Johannes	Kepler	1571	▼

Selected: 2

If the user clicks on an already selected item, the selection will deselect and the table property will have `null` value. You can disable this behaviour by setting `setNullSelectionAllowed(false)` for the table.

A table can also be in *multiselect* mode, where a user can select and unselect any item by clicking on it. The mode is enabled with the `setMultiSelect()` method of the **Select** interface of **Table**. Selecting an item triggers a **ValueChangeEvent**, which will have as its parameter an array of item identifiers.

5.12.2. CSS Style Rules

Styling the overall style of a **Table** can be done with the following CSS rules.

```
.v-table {}  
.v-table-header-wrap {}  
.v-table-header {}  
.v-table-header-cell {}  
.v-table-resizer {} /* Column resizer handle. */  
.v-table-caption-container {}  
.v-table-body {}  
.v-table-row-spacer {}  
.v-table-table {}  
.v-table-row {}  
.v-table-cell-content {}
```

Notice that some of the widths and heights in a table are calculated dynamically and can not be set in CSS.

Setting Individual Cell Styles

The **Table.CellStyleGenerator** interface allows you to set the CSS style for each individual cell in a table. You need to implement the `getStyle()`, which gets the row (item) and column (property) identifiers as parameters and can return a style name for the cell. The returned style name will be concatenated to prefix "v-table-cell-content-".

Alternatively, you can use a **Table.ColumnGenerator** (see Section 5.12.4, “Generated Table Columns”) to generate the actual UI components of the cells and add style names to them. A cell style generator is not used for the cells in generated columns.

```
Table table = new Table("Table with Cell Styles");
table.addStyleName("checkerboard");

// Add some columns in the table. In this example, the property
// IDs of the container are integers so we can determine the
// column number easily.
table.addContainerProperty("0", String.class, null, "", null, null);
for (int i=0; i<8; i++)
    table.addContainerProperty(""+(i+1), String.class, null,
        String.valueOf((char) (65+i)), null, null);

// Add some items in the table.
table.addItem(new Object[]{
    "1", "R", "N", "B", "Q", "K", "B", "N", "R"}, new Integer(0));
table.addItem(new Object[]{
    "2", "P", "P", "P", "P", "P", "P", "P"}, new Integer(1));
for (int i=2; i<6; i++)
    table.addItem(new Object[]{String.valueOf(i+1),
        "", "", "", "", "", "", ""}, new Integer(i));
table.addItem(new Object[]{
    "7", "P", "P", "P", "P", "P", "P", "P"}, new Integer(6));
table.addItem(new Object[]{
    "8", "R", "N", "B", "Q", "K", "B", "N", "R"}, new Integer(7));
table.setPageLength(8);

// Set cell style generator
table.setCellStyleGenerator(new Table.CellStyleGenerator() {
    public String getStyle(Object itemId, Object propertyId) {
        int row = ((Integer)itemId).intValue();
        int col = Integer.parseInt((String)propertyId);

        // The first column.
        if (col == 0)
            return "rowheader";

        // Other cells.
        if ((row+col)%2 == 0)
            return "black";
        else
            return "white";
    }
});
```

You can then style the cells, for example, as follows:

```
/* Center the text in header. */
.v-table-header-cell {
    text-align: center;
}

/* Basic style for all cells. */
.v-table-checkerboard .v-table-cell-content {
    text-align: center;
    vertical-align: middle;
```

```

padding-top: 12px;
width: 20px;
height: 28px;
}

/* Style specifically for the row header cells. */
.v-table-cell-content-rowheader {
background: #E7EDF3
url(..../default/table/img/header-bg.png) repeat-x scroll 0 0;
}

/* Style specifically for the "white" cells. */
.v-table-cell-content-white {
background: white;
color: black;
}

/* Style specifically for the "black" cells. */
.v-table-cell-content-black {
background: black;
color: white;
}

```

The table will look as shown in Figure 5.34, “Cell Style Generator for a Table”.

Figure 5.34. Cell Style Generator for a Table

	A	B	C	D	E	F	G	H
1	R	N	B	Q	K	B	N	R
2	P	P	P	P	P	P	P	P
3								
4								
5								
6								
7	P	P	P	P	P	P	P	P
8	R	N	B	Q	K	B	N	R

5.12.3. Table Features

Page Length and Scrollbar

The default style for **Table** provides a table with a scrollbar. The scrollbar is located at the right side of the table and becomes visible when the number of items in the table exceeds the page length, that is, the number of visible items. You can set the page length with `setPageLength()`.

Setting the page length to zero makes all the rows in a table visible, no matter how many rows there are. Notice that this also effectively disables buffering, as all the entire table is loaded to the browser at once. Using such tables to generate reports does not scale up very well, as there is some inevitable overhead in rendering a table with Ajax. For very large reports, generating HTML directly is a more scalable solution.

Organizing Columns

The default scrollable style supports most of the table features. User can resize the columns by dragging their borders, change the sorting by clicking on the column headers, collapse the columns if `columnCollapsingAllowed` is `true`, and reorder them if `columnReorderingAllowed` is `true`. You can set the column width of individual columns with `setColumnWidth()`.

Components Inside a Table

The cells of a **Table** can contain any user interface components, not just strings. If the rows are higher than the row height defined in the default theme, you have to define the proper row height in a custom theme.

When handling events for components inside a **Table**, such as for the **Button** in the example below, you usually need to know the item the component belongs to. Components do not themselves know about the table or the specific item in which a component is contained. Therefore, the handling method must use some other means for finding out the Item ID of the item. There are a few possibilities. Usually the easiest way is to use the `setData()` method to attach an arbitrary object to a component. You can subclass the component and include the identity information there. You can also simply search the entire table for the item with the component, although that solution may not be so scalable.

The example below includes table rows with a **Label** in XHTML formatting mode, a multiline **TextField**, a **CheckBox**, and a **Button** that shows as a link.

```
// Create a table and add a style to allow setting the row height in theme.
final Table table = new Table();
table.addStyleName("components-inside");

/* Define the names and data types of columns.
 * The "default value" parameter is meaningless here. */
table.addContainerProperty("Sum", Label.class, null);
table.addContainerProperty("Is Transferred", CheckBox.class, null);
table.addContainerProperty("Comments", TextField.class, null);
table.addContainerProperty("Details", Button.class, null);

/* Add a few items in the table. */
for (int i=0; i<100; i++) {
    // Create the fields for the current table row
    Label sumField = new Label(String.format(
        "Sum is <b>$%04.2f</b><br/><i>(VAT incl.)</i>",
        new Object[] {new Double(Math.random()*1000)}),
        Label.CONTENT_XHTML);
    CheckBox transferredField = new CheckBox("is transferred");

    // Multiline text field. This required modifying the
    // height of the table row.
    TextField commentsField = new TextField();
    commentsField.setRows(3);

    // The Table item identifier for the row.
    Integer itemId = new Integer(i);

    // Create a button and handle its click. A Button does not
    // know the item it is contained in, so we have to store the
    // item ID as user-defined data.
    Button detailsField = new Button("show details");
    detailsField.setData(itemId);
    detailsField.addListener(new Button.ClickListener() {
        public void buttonClick(ClickEvent event) {
            // Get the item identifier from the user-defined data.
            Integer itemId = (Integer)event.getButton().getData();
```

```

        getWindow().showNotification("Link " +
            itemId.intValue() +" clicked.");
    }
});

detailsField.addStyleName("link");

// Create the table row.
table.addItem(new Object[] {sumField, transferredField,
    commentsField, detailsField},
    itemId);
}

// Show just three rows because they are so high.
table.setPageLength(3);

```

The row height has to be set higher than the default with a style rule such as the following:

```

/* Table rows contain three-row TextField components. */
.v-table-components-inside .v-table-cell-content {
    height: 54px;
}

```

The table will look as shown in Figure 5.35, “Components in a Table”.

Figure 5.35. Components in a Table

Sum	Is Transferred	Comments	Details
Sum is \$777,60 (VAT incl.)	<input checked="" type="checkbox"/> is transferred	We sent this money already in last week.	show details
Sum is \$500,40 (VAT incl.)	<input type="checkbox"/> is transferred		show details
Sum is \$836,10 (VAT incl.)	<input type="checkbox"/> is transferred		show details

Editing the Values of a Table

Normally, a **Table** simply displays the items and their fields as text. If you want to allow the user to edit the values, you can either put them inside components as we did above, or you can simply call `setEditable(true)` and the cells are automatically turned into editable fields.

Let us begin with a regular table with some columns with usual Java types, namely a **Date**, **Boolean**, and a **String**.

```

// Create a table. It is by default not editable.
final Table table = new Table();

// Define the names and data types of columns.
table.addContainerProperty("Date", Date.class, null);
table.addContainerProperty("Work", Boolean.class, null);
table.addContainerProperty("Comments", String.class, null);

// Add a few items in the table.
for (int i=0; i<100; i++) {
    Calendar calendar = new GregorianCalendar(2008,0,1);
    calendar.add(Calendar.DAY_OF_YEAR, i);
}

```

```

// Create the table row.
table.addItem(new Object[] {calendar.getTime(),
                           new Boolean(false),
                           ""),
                           new Integer(i)}); // Item identifier
}

table.setPageLength(8);
layout.addComponent(table);

```

You could put the table in **editable** mode right away if you need to. We'll continue the example by adding a mechanism to switch the **Table** from and to the **editable** mode.

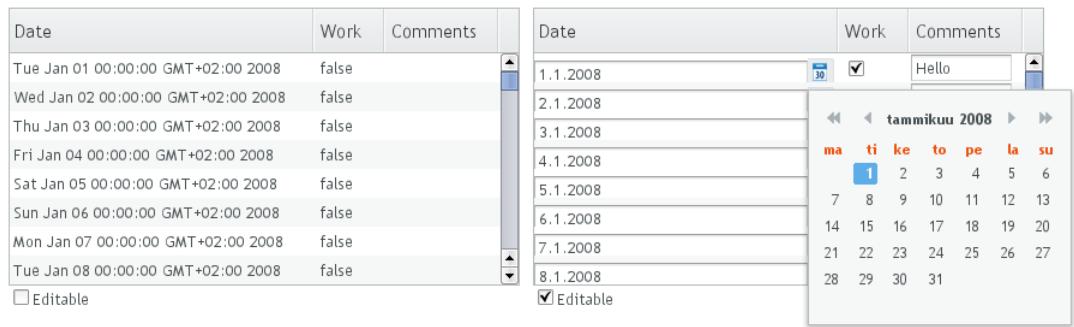
```

final CheckBox switchEditable = new CheckBox("Editable");
switchEditable.addListener(new Property.ValueChangeListener() {
    public void valueChange(ValueChangeEvent event) {
        table.setEditable(((Boolean)event.getProperty()
                           .getValue()).booleanValue());
    }
});
switchEditable.setImmediate(true);
layout.addComponent(switchEditable);

```

Now, when you check to checkbox, the components in the table turn into editable fields, as shown in Figure 5.36, "A Table in Normal and Editable Mode".

Figure 5.36. A Table in Normal and Editable Mode



The field components that allow editing the values of particular types in a table are defined in a field factory that implements the **TableFieldFactory** interface. The default implementation is **DefaultFieldFactory**, which offers the following crude mappings:

Table 5.2. Type to Field Mappings in DefaultFieldFactory

Property Type	Mapped to Field Class
Date	A DateField .
Boolean	A CheckBox .
Item	A Form . The fields of the form are automatically created from the item's properties using a FormFieldFactory . The normal use for this property type is inside a Form and is less useful inside a Table .
others	A TextField . The text field manages conversions from the basic types, if possible.

Field factories are covered with more detail in Section 5.17.2, "Binding Form to Data". You could just implement the **TableFieldFactory** interface, but we recommend that you extend the **DefaultFieldFactory** according to your needs. In the default implementation, the mappings are defined

in the `createFieldByPropertyType()` method (you might want to look at the source code) both for tables and forms.

Iterating Over a Table

As the items in a **Table** are not indexed, iterating over the items has to be done using an iterator. The `getItemIds()` method of the **Container** interface of **Table** returns a **Collection** of item identifiers over which you can iterate using an **Iterator**. For an example about iterating over a **Table**, please see Section 9.4, “Collecting items in Containers”. Notice that you may not modify the **Table** during iteration, that is, add or remove items. Changing the data is allowed.

5.12.4. Generated Table Columns

You might want to have a column that has values calculated from other columns. Or you might want to format table columns in some way, for example if you have columns that display currencies. The **ColumnGenerator** interface allows defining custom generators for such columns.

You add new generated columns to a **Table** with `addGeneratedColumn()`. It takes the column identifier as its parameters. Usually you want to have a more user-friendly and possibly internationalized column header. You can set the header and a possible icon by calling `addContainerProperty()` before adding the generated column.

```
// Define table columns.
table.addContainerProperty(
    "date", Date.class, null, "Date", null, null);
table.addContainerProperty(
    "quantity", Double.class, null, "Quantity (l)", null, null);
table.addContainerProperty(
    "price", Double.class, null, "Price (e/l)", null, null);
table.addContainerProperty(
    "total", Double.class, null, "Total (e)", null, null);

// Define the generated columns and their generators.
table.addGeneratedColumn("date",
    new DateColumnGenerator());
table.addGeneratedColumn("quantity",
    new ValueColumnGenerator("%.2f l"));
table.addGeneratedColumn("price",
    new PriceColumnGenerator());
table.addGeneratedColumn("total",
    new ValueColumnGenerator("%.2f e"));
```

Notice that the `addGeneratedColumn()` always places the generated columns as the last column, even if you defined some other order previously. You will have to set the proper order with `setVisibleColumns()`.

```
table.setVisibleColumns(new Object[] {"date", "quantity", "price", "total"});
```

The generators are objects that implement the **Table.ColumnGenerator** interface and its `generateCell()` method. The method gets the identity of the item and column as its parameters, in addition to the table object. It has to return a component object.

The following example defines a generator for formatting **Double** valued fields according to a format string (as in **java.util.Formatter**).

```
/** Formats the value in a column containing Double objects. */
class ValueColumnGenerator implements Table.ColumnGenerator {
    String format; /* Format string for the Double values. */

    /**
     * Generates the cell for the specified item and column.
     * @param item The item containing the column.
     * @param column The column identifier.
     * @return The component representing the cell.
     */
    public Component generateCell(Item item, String column) {
```

```
* Creates double value column formatter with the given
* format string.
*/
public ValueColumnGenerator(String format) {
    this.format = format;
}

/**
 * Generates the cell containing the Double value.
 * The column is irrelevant in this use case.
 */
public Component generateCell(Table source, Object itemId,
                               Object columnId) {
    // Get the object stored in the cell as a property
    Property prop =
        source.getItem(itemId).getItemProperty(columnId);
    if (prop.getType().equals(Double.class)) {
        Label label = new Label(String.format(format,
            new Object[] { (Double) prop.getValue() }));
        // Set styles for the column: one indicating that it's
        // a value and a more specific one with the column
        // name in it. This assumes that the column name
        // is proper for CSS.
        label.addStyleName("column-type-value");
        label.addStyleName("column-" + (String) columnId);
        return label;
    }
    return null;
}
}
```

The generator is called for all the visible (or more accurately cached) items in a table. If the user scrolls the table to another position in the table, the columns of the new visible rows are generated dynamically. The columns in the visible (cached) rows are also generated always when an item has a value change. It is therefore usually safe to calculate the value of generated cells from the values of different rows (items).

When you set a table as `editable`, regular fields will change to editing fields. When the user changes the values in the fields, the generated columns will be updated automatically. Putting a table with generated columns in editable mode has a few quirks. The editable mode of **Table** does not affect generated columns. You have two alternatives: either you generate the editing fields in the generator or, in case of formatter generators, remove the generator in the editable mode. The example below uses the latter approach.

```
// Have a check box that allows the user
// to make the quantity and total columns editable.
final CheckBox editable = new CheckBox(
    "Edit the input values - calculated columns are regenerated");

editable.setImmediate(true);
editable.addListener(new ClickListener() {
    public void buttonClick(ClickEvent event) {
        table.setEditable(editable.booleanValue());

        // The columns may not be generated when we want to
        // have them editable.
        if (editable.booleanValue()) {
            table.removeGeneratedColumn("quantity");
            table.removeGeneratedColumn("total");
        } else { // Not editable
            // Show the formatted values.
            table.addGeneratedColumn("quantity",
                new ValueColumnGenerator("%.2f l"));
        }
    }
});
```

```
        table.addGeneratedColumn("total",
            new ValueColumnGenerator("%.2f e"));
    }
    // The visible columns are affected by removal
    // and addition of generated columns so we have
    // to redefine them.
    table.setVisibleColumns(new Object[] {"date", "quantity",
        "price", "total", "consumption", "dailycost"});
}
});
```

You will also have to set the editing fields in *immediate* mode to have the update occur immediately when an edit field loses the focus. You can set the fields in *immediate* mode with the a custom **TableFieldFactory**, such as the one given below, that just extends the default implementation to set the mode:

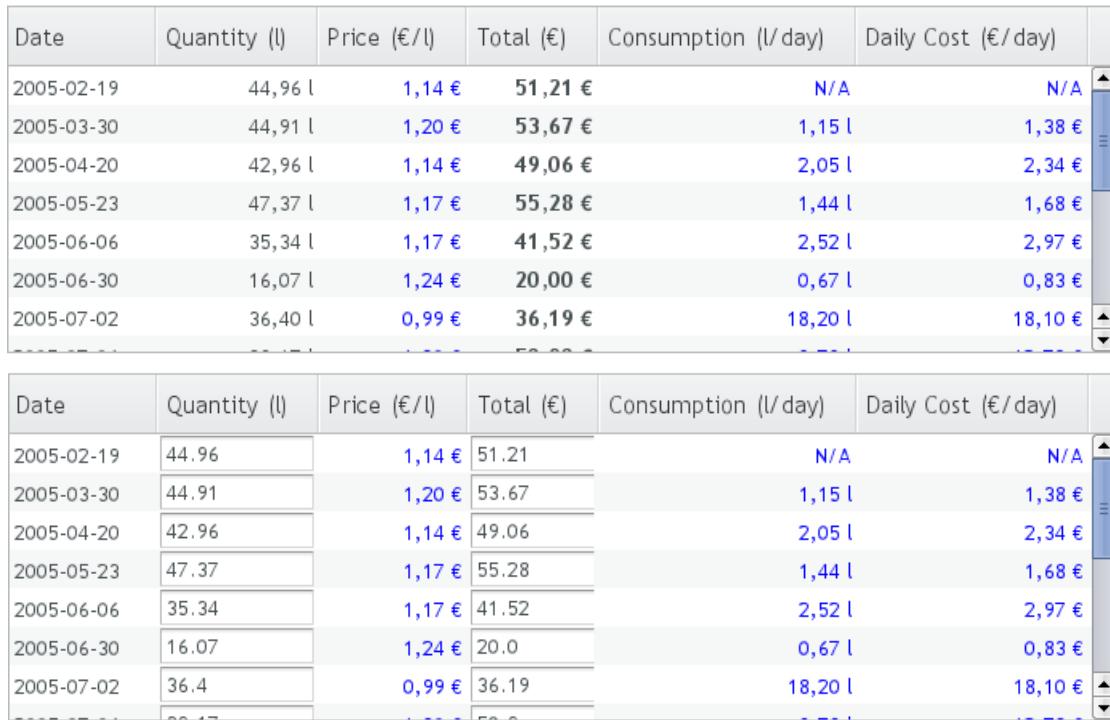
```
public class ImmediateFieldFactory extends DefaultFieldFactory {
    public Field createField(Container container,
        Object itemId,
        Object propertyId,
        Component uiContext) {
        // Let the DefaultFieldFactory create the fields...
        Field field = super.createField(container, itemId,
            propertyId, uiContext);

        // ...and just set them as immediate.
        ((AbstractField)field).setImmediate(true);

        return field;
    }
    ...
    table.setFieldFactory(new ImmediateFieldFactory());
```

If you generate the editing fields with the column generator, you avoid having to use such a field factory, but of course have to generate the fields for both normal and editable modes.

Figure 5.37, “Table with Generated Columns in Normal and Editable Mode” shows a table with columns calculated (blue) and simply formatted (black) with column generators.

Figure 5.37. Table with Generated Columns in Normal and Editable Mode


Date	Quantity (l)	Price (€/l)	Total (€)	Consumption (l/day)	Daily Cost (€/day)
2005-02-19	44,96 l	1,14 €	51,21 €	N/A	N/A
2005-03-30	44,91 l	1,20 €	53,67 €	1,15 l	1,38 €
2005-04-20	42,96 l	1,14 €	49,06 €	2,05 l	2,34 €
2005-05-23	47,37 l	1,17 €	55,28 €	1,44 l	1,68 €
2005-06-06	35,34 l	1,17 €	41,52 €	2,52 l	2,97 €
2005-06-30	16,07 l	1,24 €	20,00 €	0,67 l	0,83 €
2005-07-02	36,40 l	0,99 €	36,19 €	18,20 l	18,10 €

Date	Quantity (l)	Price (€/l)	Total (€)	Consumption (l/day)	Daily Cost (€/day)
2005-02-19	44.96	1,14 €	51.21	N/A	N/A
2005-03-30	44.91	1,20 €	53.67	1,15 l	1,38 €
2005-04-20	42.96	1,14 €	49.06	2,05 l	2,34 €
2005-05-23	47.37	1,17 €	55.28	1,44 l	1,68 €
2005-06-06	35.34	1,17 €	41.52	2,52 l	2,97 €
2005-06-30	16.07	1,24 €	20.0	0,67 l	0,83 €
2005-07-02	36.4	0,99 €	36.19	18,20 l	18,10 €

You can find the complete generated columns example in the Feature Browser demo application in the installation package, in **com.vaadin.demo.featurebrowser.GeneratedColumnExample.java**.

5.13. Tree

The **Tree** component allows a natural way to represent data that has hierarchical relationships, such as filesystems or message threads. The **Tree** component in Vaadin works much like the tree components of most modern desktop user interface toolkits, for example in directory browsing.

The typical use of the **Tree** component is for displaying a hierarchical menu, like a menu on the left side of the screen, as in Figure 5.38, “A **Tree** Component as a Menu”, or for displaying filesystems or other hierarchical datasets. The *menu* style makes the appearance of the tree more suitable for this purpose.

```
final Object[][][] planets = new Object[][][]{
    new Object[]{ "Mercury" },
    new Object[]{ "Venus" },
    new Object[]{ "Earth", "The Moon" },
    new Object[]{ "Mars", "Phobos", "Deimos" },
    new Object[]{ "Jupiter", "Io", "Europa", "Ganymedes",
                  "Callisto" },
    new Object[]{ "Saturn", "Titan", "Tethys", "Dione",
                  "Rhea", "Iapetus" },
    new Object[]{ "Uranus", "Miranda", "Ariel", "Umbriel",
                  "Titania", "Oberon" },
    new Object[]{ "Neptune", "Triton", "Proteus", "Nereid",
                  "Larissa" };
```

```
Tree tree = new Tree("The Planets and Major Moons");
```

```
/* Add planets as root items in the tree. */
for (int i=0; i<planets.length; i++) {
    String planet = (String) (planets[i][0]);
    tree.addItem(planet);

    if (planets[i].length == 1) {
        // The planet has no moons so make it a leaf.
        tree.setChildrenAllowed(planet, false);
    } else {
        // Add children (moons) under the planets.
        for (int j=1; j<planets[i].length; j++) {
            String moon = (String) planets[i][j];

            // Add the item as a regular item.
            tree.addItem(moon);

            // Set it to be a child.
            tree.setParent(moon, planet);

            // Make the moons look like leaves.
            tree.setChildrenAllowed(moon, false);
        }
    }

    // Expand the subtree.
    tree.expandItemsRecursively(planet);
}
}

main.addComponent(tree);
```

Figure 5.38, “A **Tree** Component as a Menu” below shows the tree from the code example in a practical situation.

You can read or set the currently selected item by the value property of the **Tree** component, that is, with `getValue()` and `setValue()`. When the user clicks an item on a tree, the tree will receive an **ValueChangeEvent**, which you can catch with a **ValueChangeListener**. To receive the event immediately after the click, you need to set the tree as `setImmediate(true)`.

The **Tree** component uses **Container** data sources much like the **Table** component, with the addition that it also utilizes hierarchy information maintained by a **HierarchicalContainer**. The contained items can be of any item type supported by the container. The default container and its `addItem()` assume that the items are strings and the string value is used as the item ID.

5.14. MenuBar

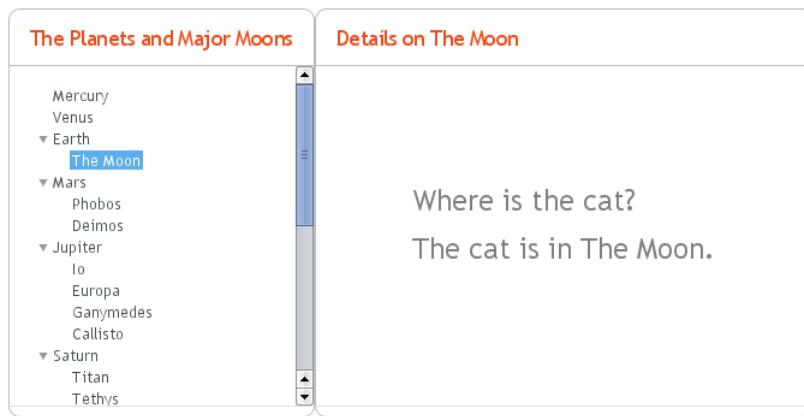
The **MenuBar** component allows creating horizontal dropdown menus, much like the main menu in desktop applications.

```
// Create a menu bar
final MenuBar menubar = new MenuBar();
main.addComponent(menubar);
```

You insert the top-level menu items to a **MenuBar** object with the `addItem()` method. It takes a string label, an icon resource, and a command as its parameters. The icon and command are not required and can be `null`.

```
MenuBar.MenuItem beverages =
menubar.addItem("Beverages", null, null);
```

The command is called when the user clicks the item. A menu command is a class that implements the **MenuBar.Command** interface.

Figure 5.38. A Tree Component as a Menu

```
// A feedback component
final Label selection = new Label("-");
main.addComponent(selection);

// Define a common menu command for all the menu items.
MenuBar.Command mycommand = new MenuBar.Command() {
    public void menuSelected(MenuItem selectedItem) {
        selection.setValue("Ordered a " +
                           selectedItem.getText() +
                           " from menu.");
    }
};
```

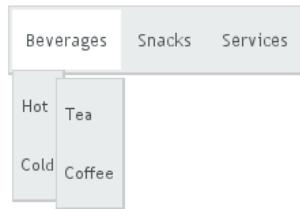
The `addItem()` method returns a **MenuBar.MenuItem** object, which you can use to add submenu items. The **MenuItem** has an identical `addItem()` method.

```
// Put some items in the menu hierarchically
MenuBar.MenuItem beverages =
    menubar.addItem("Beverages", null, null);
MenuBar.MenuItem hot_beverages =
    beverages.addItem("Hot", null, null);
hot_beverages.addItem("Tea", null, mycommand);
hot_beverages.addItem("Coffee", null, mycommand);
MenuBar.MenuItem cold_beverages =
    beverages.addItem("Cold", null, null);
cold_beverages.addItem("Milk", null, mycommand);

// Another top-level item
MenuBar.MenuItem snacks =
    menubar.addItem("Snacks", null, null);
snacks.addItem("Weisswurst", null, mycommand);
snacks.addItem("Salami", null, mycommand);

// Yet another top-level item
MenuBar.MenuItem services =
    menubar.addItem("Services", null, null);
services.addItem("Car Service", null, mycommand);
```

The menu will look as follows:

Figure 5.39. Menu Bar

CSS Style Rules

```
.v-menubar { }  
.gwt-MenuItem {}  
.gwt-MenuItem-selected {}
```

The menu bar has the overall style name `.v-menubar`. Each menu item has `.gwt-MenuItem` style normally and `.gwt-MenuItem-selected` when the item is selected.

5.15. Embedded

The **Embedded** component allows displaying embedded media objects, such as images, animations, or any embeddable media type supported by the browser. The contents of an **Embedded** component are managed as *resources*. For documentation on resources, see Section 4.5, “Referencing Resources”.

The following example displays an image from the same Java package as the class itself using the class loader.

```
Embedded image = new Embedded("Yes, logo:",  
    new ClassResource("vaadin-logo.png", this));  
main.addComponent(image);
```

Figure 5.40. Embedded Image

Yes, logo:



The **Embedded** component supports several different content types, which are rendered differently in HTML. You can set the content type with `setType()`, although for images, as in the above example, the type is determined automatically.

`Embedded.TYPE_OBJECT` The default embedded type, allows embedding certain file types inside HTML `<object>` and `<embed>` elements.

`Embedded.TYPE_IMAGE` Embeds an image inside a HTML `` element.

Embedded.TYPE_BROWSER Embeds a browser frame inside a HTML <iframe> element.

5.15.1. Embedded Objects

The *Embedded.TYPE_OBJECT* is the default and most generic embedded type, which allows embedding media objects inside HTML <object> and <embed> elements. You need define the MIME type for the object type.

Currently, only Shockwave Flash animations are supported (MIME type application/x-shockwave-flash).

```
// Create a Shockwave Flash resource
final ClassResource flashResource =
    new ClassResource("itmill_spin.swf", getApplication());

// Display the resource in a Embedded compoant
final Embedded embedded =
    new Embedded("Embedded Caption", flashResource);

// This is the default type, but we set it anyway.
embedded.setType(Embedded.TYPE_OBJECT);

// This is recognized automatically, but set it anyway.
embedded.setMimeType("application/x-shockwave-flash");
```

You can set object parameters with `setParameter()`, which takes a parameter's name and value as strings. The object parameters are included in the HTML as <param> elements.

5.15.2. Embedded Images

Images are embedded with the type *Embedded.TYPE_IMAGE*, although you do not normally need to set the type explicitly, as it is recognized automatically from the MIME type of the resource, as in the example above.

You can find another example of displaying an image from **FileResource** in Section 5.16, “**Upload**”. Another example, in Section 4.5.5, “Stream Resources”, shows how you can generate the content of an **Embedded** component dynamically using a **StreamResource**.

If you have a dynamically generated image, for example with a **StreamResource**, and the data changes, you need to reload the image in the browser. Because of how caching is handled in some browsers, you are best off by renaming the filename of the resource with a unique name, such as one including a timestamp. You should set cache time to zero with `setCacheTime()` for the resource object when you create it.

```
// Create the stream resource with some initial filename.
StreamResource imageResource =
    new StreamResource(imageSource, "initial-filename.png",
        getApplication());

// Instruct browser not to cache the image.
imageResource.setCacheTime(0);

// Display the image in an Embedded component.
Embedded embedded = new Embedded("", imageResource);
```

When refreshing, you also need to call `requestRepaint()` for the **Embedded** object.

```
// This needs to be done, but is not sufficient.
embedded.requestRepaint();
```

```
// Generate a filename with a timestamp.  
SimpleDateFormat df = new SimpleDateFormat("yyyyMMddHHmmssSSS");  
String filename = "myfilename-" + df.format(new Date()) + ".png";  
  
// Replace the filename in the resource.  
imageResource.setFilename(makeImageFilename());
```

You can find more detailed information about the **StreamResource** in Section 4.5.5, “Stream Resources”.

5.15.3. Browser Frames

The browser frame type allows you to embed external content inside an HTML `<iframe>` element. You can refer to a URL with an **ExternalResource** object. URLs are given with the standard Java **URL** class.

```
URL url = new URL("http://dev.itmill.com/");  
Embedded browser = new Embedded("", new ExternalResource(url));  
browser.setType(Embedded.TYPE_BROWSER);  
main.addComponent(browser);
```

5.16. Upload

The **Upload** component allows a user to upload files to the server. It displays a file name entry box, a file selection button, and an upload submit button. The user can either write the filename in the text area or click the **Browse** button to select a file. After the file is selected, the user sends the file by pressing the upload submit button.

```
// Create the Upload component.  
Upload upload = new Upload("Upload the file here", this);
```

Figure 5.41. Upload Component



You can set the text of the upload button with `setButtonCaption()`, as in the example above, but it is difficult to change the look of the **Browse** button. This is a security feature of web browsers. The language of the **Browse** button is determined by the browser, so if you wish to have the language of the **Upload** component consistent, you will have to use the same language in your application.

```
upload.setButtonCaption("Upload Now");
```

The uploaded files are typically stored as files in a file system, in a database, or as temporary objects in memory. The upload component writes the received data to an **java.io.OutputStream** so you have plenty of freedom in how you can process the upload content.

To use the **Upload** component, you need to define a class that implements the **Upload.Receiver** interface. The `receiveUpload()` method is called when the user clicks the submit button. The method must return an **OutputStream**. To do this, it typically creates a **File** or a memory buffer where the stream is written. The method gets the file name and MIME type of the file, as reported by the browser.

When an upload is finished, successfully or unsuccessfully, the **Upload** component will emit the **Upload.FinishedEvent** event. To receive it, you need to implement the **Upload.FinishedListener** interface, and register the listening object in the **Upload** component. The event object will also

include the file name, MIME type, and length of the file. Notice that the more specific **Upload.FailedEvent** and **Upload.SucceededEvent** events will be called in the cases where the upload failed or succeeded, respectively.

The following example allows uploading images to `/tmp/uploads` directory in (UNIX) filesystem (the directory must exist or the upload fails). The component displays the last uploaded image in an **Embedded** component.

```
import java.io.File;
import java.io.FileOutputStream;
import java.io.OutputStream;
import com.vaadin.terminal.FileResource;
import com.vaadin.ui.*;

public class MyUploader extends CustomComponent
    implements Upload.SucceededListener,
               Upload.FailedListener,
               Upload.Receiver {

    Panel root;           // Root element for contained components.
    Panel imagePanel;    // Panel that contains the uploaded image.
    File file;           // File to write to.

    MyUploader() {
        root = new Panel("My Upload Component");
        setCompositionRoot(root);

        // Create the Upload component.
        final Upload upload =
            new Upload("Upload the file here", this);

        // Use a custom button caption instead of plain "Upload".
        upload.setButtonCaption("Upload Now");

        // Listen for events regarding the success of upload.
        upload.addListener((Upload.SucceededListener) this);
        upload.addListener((Upload.FailedListener) this);

        root.addComponent(upload);
        root.addComponent(new Label("Click 'Browse' to "+
            "select a file and then click 'Upload'."));

        // Create a panel for displaying the uploaded image.
        imagePanel = new Panel("Uploaded image");
        imagePanel.addComponent(
            new Label("No image uploaded yet"));
        root.addComponent(imagePanel);
    }

    // Callback method to begin receiving the upload.
    public OutputStream receiveUpload(String filename,
                                      String MIMEType) {
        FileOutputStream fos = null; // Output stream to write to
        file = new File("/tmp/uploads/" + filename);
        try {
            // Open the file for writing.
            fos = new FileOutputStream(file);
        } catch (final java.io.FileNotFoundException e) {
            // Error while opening the file. Not reported here.
            e.printStackTrace();
            return null;
        }
        return fos; // Return the output stream to write to
    }
}
```

```

// This is called if the upload is finished.
public void uploadSucceeded(Upload.SucceededEvent event) {
    // Log the upload on screen.
    root.addComponent(new Label("File " + event.getFilename()
        + " of type '" + event.getMIMEType()
        + "' uploaded."));
}

// Display the uploaded file in the image panel.
final FileResource imageResource =
    new FileResource(file, getApplication());
imagePanel.removeAllComponents();
imagePanel.addComponent(new Embedded("", imageResource));
}

// This is called if the upload fails.
public void uploadFailed(Upload.FailedEvent event) {
    // Log the failure on screen.
    root.addComponent(new Label("Uploading "
        + event.getFilename() + " of type '"
        + event.getMIMEType() + "' failed."));
}
}

```

The example does not check the type of the uploaded files in any way, which will cause an error if the content is anything else but an image. The program also assumes that the MIME type of the file is resolved correctly based on the file name extension. After uploading an image, the component will look as shown in Figure 5.42, “Image Upload Example” below. The browser shows the **Browse** button localized.

Figure 5.42. Image Upload Example



5.17. Form

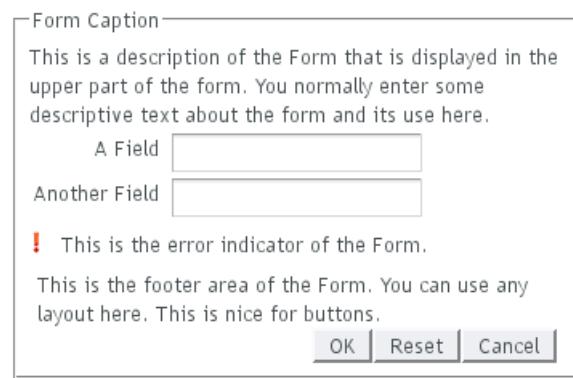
Most web applications need forms. The **Form** component in Vaadin offers an easy way to create forms where the fields can be automatically generated from a data source that is bound to the form. The **BeanItem** adapter allows the data sources to be just JavaBeans or Plain Old Java Objects (POJOs) with just the setter and getter methods. **Form** manages buffering so that the form contents can be committed to the data source only when filling the form is complete, and before that, the user can discard any changes.

The **Form** component is also a layout, with a bounding box, a caption, a description field, and a special error indicator. As such, it can also be used within logical forms to group input fields.

5.17.1. Form as a User Interface Component

To begin with the **Form**, it is a UI component with a layout suitable for its purpose. A **Form** has a caption, a description, a layout that contains the fields, an error indicator, and a footer, as illustrated in Figure 5.43, “Layout of the Form Component” below. Unlike with other components, the caption is shown within the border. (See the details below on how to enable the border with CSS, as it may not be enabled in the default style.)

Figure 5.43. Layout of the Form Component



Unlike most components, **Form** does not accept the caption in the constructor, as forms are often captionless, but you can give the caption with the `setCaption()`. While the description text, which you can set with `setDescription()`, is shown as a tooltip in most other components, a **Form** displays it in top of the form box as shown in the figure above.

```
Form form = new Form();
form.setCaption("Form Caption");
form.setDescription("This is a description of the Form that is " +
    "displayed in the upper part of the form. You normally " +
    "enter some descriptive text about the form and its " +
    "use here.");
```

Form has **FormLayout** as its default layout, but you can set any other layout with `setContent()`. See Section 6.5, “**FormLayout**” for more information. Note that the **Form** itself handles layout for the description, the footer and other common elements of the form. The user-set layout only manages the contained fields and their captions.

The **Form** is most of all a container for fields so it offers many kinds of automation for creating and managing fields. You can, of course, create fields directly in the layout, but it is usually more desirable to bind the fields to the connected data source.

```
// Add a field directly to the layout. This field will
// not be bound to the data source Item of the form.
form.getLayout().addComponent(new TextField("A Field"));

// Add a field and bind it to an named item property.
form.addField("another", new TextField("Another Field"));
```

Binding forms and their fields to data objects is described further in Section 5.17.2, “Binding Form to Data” below.

The **Form** has a special error indicator inside the form. The indicator can show the following types of error messages:

- Errors set with the `setComponentError()` method of the form. For example:

```
form.setComponentError(new UserError("This is the error indicator of the Form."));
```
- Errors caused by a validator attached to the **Form** with `addValidator()`.
- Errors caused by validators attached to the fields inside forms, if `setValidationVisible(true)` is set for the form. This type of validation is explained further in Section 5.17.3, "Validating Form Input" below.
- Errors from automatic validation of fields set as *required* with `setRequired(true)` if an error message has also been set with `setRequiredError()`.

Only a single error is displayed in the error indicator at a time.

Finally, **Form** has a footer area. The footer is a **HorizontalLayout** by default, but you can change it with `setFooter()`.

```
// Set the footer layout.  
form.setFooter(new VerticalLayout());  
  
form.getFooter().addComponent(  
    new Label("This is the footer area of the Form. "+  
        "You can use any layout here. "+  
        "This is nice for buttons."));  
  
// Have a button bar in the footer.  
HorizontalLayout okbar = new HorizontalLayout();  
okbar.setHeight("25px");  
form.getFooter().addComponent(okbar);  
  
// Add an Ok (commit), Reset (discard), and Cancel buttons  
// for the form.  
Button okbutton = new Button("OK", form, "commit");  
okbar.addComponent(okbutton);  
okbar.setComponentAlignment(okbutton, Alignment.TOP_RIGHT);  
okbar.addComponent(new Button("Reset", form, "discard"));  
okbar.addComponent(new Button("Cancel"));
```

CSS Style Rules

```
.v-form {}  
.v-form legend  
.v-form fieldset {}  
.v-form-error {}  
.v-form-errormessage {}  
.v-form-description {}
```

The top-level style name of a **Form** component is `v-form`. It is important to notice that the form is implemented as a HTML `<fieldset>`, which allows placing the caption (or "legend") inside the border. It would not be so meaningful to set a border for the top-level form element. The following example sets a border around the form, as is done in Figure 5.43, "Layout of the Form Component" above.

```
.v-form fieldset {  
    border: thin solid;  
}
```

The top-level element of the form has the style name `v-form-error` if a component error has been set for the form.

5.17.2. Binding Form to Data

The main purpose of the **Form** component is that you can bind it to a data source and let the **Form** generate and manage fields automatically. The data source can be any class that implements the **Item** interface, which is part of the Vaadin Data Model, as described in Chapter 9, *Binding Components to Data*. You can either implement the **Item** interface yourself, which can be overly complicated, or use the ready **BeanItem** adapter to bind the form to any JavaBean object. You can also use **PropertysetItem** to bind the form to an ad hoc set of **Property** objects, resembling a **Map**.

Let us consider the following simple JavaBean with proper setter and getter methods for the member variables.

```
/** A simple JavaBean. */
public class PersonBean {
    String name;
    String city;

    public void setName(String name) {
        this.name = name;
    }

    public String getName() {
        return name;
    }

    public void setCity(String city) {
        this.city = city;
    }

    public String getCity() {
        return city;
    }
}
```

We can now bind this bean to a **Form** using the **BeanItem** adapter as follows.

```
// Create a form and use FormLayout as its layout.
final Form form = new Form();

// Set form caption and description texts
form.setCaption("Contact Information");
form.setDescription("Please specify name of the person and the city where the person
lives in.");

// Create the custom bean.
PersonBean bean = new PersonBean();

// Create a bean item that is bound to the bean.
BeanItem item = new BeanItem(bean);

// Bind the bean item as the data source for the form.
form.setItemDataSource(item);
```

The **Form** uses **FormLayout** layout by default and automatically generates the fields for each of the bean properties, as shown in Figure 5.44, “Form Automatically Generated from a Bean” below.

Figure 5.44. Form Automatically Generated from a Bean

The form has a title "Contact Information". Below it is a message: "Please specify name of the person and the city where the person lives in.". There are two text input fields: one labeled "name" and one labeled "city".

The automatically determined order of the fields can be undesirable. To set the order properly, you can use the `setVisibleItemProperties()` method of the **Form**, which takes an ordered collection as its parameter. Fields that are not listed in the collection are not included in the form.

```
// Set the order of the items in the form.
Vector order = new Vector();
order.add("city");
order.add("name");
form.setVisibleItemProperties(order);
```

The form uses the property identifiers as the captions of the fields by default. If you want to have more proper captions for the fields, which is often the case, you need to use a **FieldFactory** to create the fields, as is shown in the section below.

Generating Proper Fields with a FormFieldFactory

The form generates the fields automatically using very coarse logic. A **String**, **int**, or **double** will result in a **TextField** alike, regardless of the meaning of the field. You might want to have a city name to be input with a combo box, for example. You can create such custom fields by implementing the `createField()` method in the **FormFieldFactory** interface.

The default implementation, **DefaultFieldFactory** is shared with the **Table** component: it also implements the **TableFieldFactory** interface. This allows the **DefaultFieldFactory** to create the fields for both purposes with the same logic. It is usually simplest to just extend the default implementation instead of implementing the interfaces from scratch. You should consult the source code of **DefaultFieldFactory** to see how it works; you may want to reimplement `createFieldByPropertyType()`, which actually creates the fields by type, instead of the `createField()`.

Below is an example of implementing the **FormFieldFactory** interface for a specific form, using the names of the fields of the form to create the editable field components.

```
class MyFieldFactory implements FormFieldFactory {
    public Field createField(Item item, Object propertyId,
                           Component uiContext) {
        // Identify the fields by their Property ID.
        String pid = (String) propertyId;
        if (pid.equals("name")) {
            return new TextField("Name");
        } else if (pid.equals("city")) {
            Select select = new Select("City");
            select.addItem("Berlin");
            select.addItem("Helsinki");
            select.addItem("London");
            select.addItem("New York");
            select.addItem("Turku");
            select.setNewItemAllowed(true);
            return select;
        }
    }
}
```

```
        return null; // Invalid field (property) name.  
    }  
}
```

You set a **Form** to use a custom field factory with `setFieldFactory()`:

```
form.setFieldFactory(new MyFieldFactory());
```

The earlier example will now look as shown in Figure 5.45, “Form Fields Generated with a **FormFieldFactory**”.

Figure 5.45. Form Fields Generated with a FormFieldFactory



5.17.3. Validating Form Input

Validation of the form input is one of the most important tasks in handling forms. The fields in Vaadin can be bound to validators. The validation provides feedback about bad input and the forms can also manage validation results and accept the input only if all validations are successful. Fields can also be set as *required*, which is a special built-in validator. The validators work on the server-side.

Using Validators in Forms

Validators check the validity of input and, if the input is invalid, can provide an error message through an exception. Validators are classes that implement the **Validator** interface. The interface has two methods that you must implement: `isValid()` that returns the success or failure as a truth value, and `validate()`, which reports a failure with an exception. The exception can be associated with an error message describing the details of the error.

Simple validators that only need to produce a single error message in case the validation fails can inherit from **AbstractValidator** or **AbstractStringValidator**. The Vaadin also provides a number of standard validators, including **IntegerValidator** and **DoubleValidator** for validating numerical input, **StringLengthValidator**, **EmailValidator** and the more general **RegexpValidator** for checking that a string matches a Java regular expression:

```
// Postal code that must be 5 digits (10000–99999).  
TextField field = new TextField("Postal Code");  
field.setColumns(5);
```

```
// Create the validator
Validator postalCodeValidator = new RegexpValidator(
    "[1-9][0-9]{4}", "Postal code must be a number 10000-99999.");
field.addValidator(postalCodeValidator);
```

If you are using a custom **FieldFactory** to generate the fields, you may want to set the validators for fields there. It is useful to have the form in *immediate* mode:

```
// Set the form to act immediately on user input. This is
// necessary for the validation of the fields to occur immediately
// when the input focus changes and not just on commit.
form.setImmediate(true);
```

Validation is done always when you call the `commit()` method of the **Form**.

```
// The Commit button calls form.commit().
Button commit = new Button("Commit", form, "commit");
```

If any of the validators in the form fail, the `commit` will fail and a validation exception message is displayed in the error indicator of the form. If the `commit` is successful, the input data is written to the data source. Notice that `commit()` also implicitly sets `setValidationVisible(true)` (if `setValidationVisibleOnCommit()` is *true*, as is the default). This makes the error indicators visible even if they were previously not visible.

Figure 5.46. Form Validation in Action

The screenshot shows a form with four fields: Name (Buffy), Street Address (Somestreet 10 A), Postal Code (1234), and City (Luxemburg). The Postal Code field has a red border and a red exclamation mark icon, indicating an error. Below the form, a validation message reads: "Postal code must be a number 10000-99999." At the bottom are two buttons: "Commit" (highlighted in blue) and "Discard".

For cases in which more complex error handling is required, the validator can also implement the **Validator** interface directly:

```
// Create the validator
Validator postalCodeValidator = new Validator() {

    // The isValid() method returns simply a boolean value, so
    // it can not return an error message.
    public boolean isValid(Object value) {
        if (value == null || !(value instanceof String)) {
            return false;
        }

        return ((String) value).matches("[1-9][0-9]{4}");
    }

    // Upon failure, the validate() method throws an exception
    // with an error message.
    public void validate(Object value)
        throws InvalidValueException {
        if (!isValid(value)) {
            if (value != null &&
                value.toString().startsWith("0")) {
                throw new InvalidValueException(
                    "Postal code must not start with a zero.");
            } else {
                throw new InvalidValueException(

```

```
        "Postal code must be a number 10000-99999." );  
    }  
}  
};
```

Required Fields in Forms

Setting a field as *required* outside a form is usually just a visual clue to the user. Leaving a required field empty does not display any error indicator in the empty field as a failed validation does. However, if you set a form field as required with `setRequired(true)` and give an error message with `setRequiredError()` and the user leaves the required field empty, the form will display the error message in its error indicator.

```
form.getField("name").setRequired(true);
form.getField("name").setRequiredError("Name is missing");
form.getField("address").setRequired(true); // No error message
```

To have the validation done immediately when the fields lose focus, you should set the form as *immediate*, as was done in the section above.

Figure 5.47. Empty Required Field After Clicking Commit

Name * !

Street Address *

Postal Code 20000

City ▾

! Name is missing



Note

It is important that you provide the user with feedback from failed validation of required fields either by setting an error message or by providing the feedback by other means.

Otherwise, when a user clicks the **Ok** button (commits the form), the button does not appear to work and the form does not indicate any reason. As an alternative to setting the error message, you can handle the validation error and provide the feedback about the problem with a different mechanism.

5.17.4. Buffering Form Data

Buffering means keeping the edited data in a buffer and writing it to the data source only when the `commit()` method is called for the component. If the user has made changes to a buffer, calling `discard()` restores the buffer from the data source. Buffering is actually a feature of all **Field** components and **Form** is a **Field**. **Form** manages the buffering of its contained fields so that if `commit()` or `discard()` is called for the **Form**, it calls the respective method for all of its managed fields.

```
final Form form = new Form();
...add components...

// Enable buffering.
form.setWriteThrough(false);

// The Ok button calls form.commit().
```

```
Button commit = new Button("Ok", form, "commit");

// The Restore button calls form.discard().
Button restore = new Button("Restore", form, "discard");
```

The Form example in the Feature Browser of Vaadin demonstrates buffering in forms. The *Widget caching demo* in Additional demos demonstrates buffering in other **Field** components, its source code is available in `BufferedComponents.java`.

5.18. ProgressIndicator

The **ProgressIndicator** component allows displaying the progress of a task graphically. The progress is given as a floating-point value between 0.0 and 1.0.

Figure 5.48. The Progress Indicator Component



The progress indicator polls the server for updates for its value. If the value has changed, the progress is updated. Notice that the user application does not have to handle any polling event, but updating the component is done automatically.

Creating a progress indicator is just like with any other component. You can give the initial progress value as a parameter for the constructor. The default polling frequency is 1000 milliseconds (one second), but you can set some other interval with the `setPollingInterval()` method.

```
// Create the indicator
final ProgressIndicator indicator =
    new ProgressIndicator(new Float(0.0));
main.addComponent(indicator);

// Set polling frequency to 0.5 seconds.
indicator.setPollingInterval(500);
```

CSS Style Rules

```
/* Base element. */
.v-progressindicator {}

/* Progress indication element on top of the base. */
.v-progressindicator div {}
```

The default style for the progress indicator uses an animated GIF image (`img/base.gif`) as the base background for the component. The progress is a `<div>` element inside the base. When the progress element grows, it covers more and more of the base background. By default, the graphic of the progress element is defined in `img/progress.png` under the default style directory.
S e com.vaadin.terminal.gwt/public/default/progressindicator/progressindicator.css.

5.18.1. Doing Heavy Computation

The progress indicator is often used to display the progress of a heavy server-side computation task. In the following example, we create a thread in the server to do some "heavy work". All the thread needs to do is to set the value of the progress indicator with `setValue()` and the current progress is displayed automatically when the browser polls the server.

```
// Create an indicator that makes you look busy
final ProgressIndicator indicator =
```

```
        new ProgressIndicator(new Float(0.0));
main.addComponent(indicator);

// Set polling frequency to 0.5 seconds.
indicator.setPollingInterval(500);

// Add a button to start working
final Button button = new Button("Click to start");
main.addComponent(button);

// Another thread to do some work
class WorkThread extends Thread {
    public void run () {
        double current = 0.0;
        while (true) {
            // Do some "heavy work"
            try {
                sleep(50); // Sleep for 50 milliseconds
            } catch (InterruptedException) {}

            // Show that you have made some progress:
            // grow the progress value until it reaches 1.0.
            current += 0.01;
            if (current>1.0)
                indicator.setValue(new Float(1.0));
            else
                indicator.setValue(new Float(current));

            // After all the "work" has been done for a while,
            // take a break.
            if (current > 1.2) {
                // Restore the state to initial.
                indicator.setValue(new Float(0.0));
                button.setVisible(true);
                break;
            }
        }
    }
}

// Clicking the button creates and runs a work thread
button.addListener(new Button.ClickListener() {
    public void buttonClick(ClickEvent event) {
        final WorkThread thread = new WorkThread();
        thread.start();

        // The button hides until the work is done.
        button.setVisible(false);
    }
});
```

Figure 5.49. Starting Heavy Work



5.19. Slider

The **Slider** is a vertical or horizontal bar that allows setting a numeric value within a defined range by dragging a bar handle with the mouse. The value is shown when dragging the handle.

Slider has a number of different constructors that take a combination of the caption, *minimum* and *maximum* value, *resolution*, and the *orientation* of the slider.

```
// Create a vertical slider
final Slider vertslider = new Slider(1, 100);
vertslider.setOrientation(Slider.ORIENTATION_VERTICAL);
```

Slider Properties

<i>min</i>	Minimum value of the slider range. The default is 0.0.
<i>max</i>	Maximum value of the slider range. The default is 100.0.
<i>resolution</i>	The number of digits after the decimal point. The default is 0.
<i>orientation</i>	The orientation can be either horizontal (<i>Slider.ORIENTATION_HORIZONTAL</i>) or vertical (<i>Slider.ORIENTATION_VERTICAL</i>). The default is horizontal.

As the **Slider** is a field component, you can handle value changes with a **ValueChangeListener**. The value of the **Slider** field is a **Double** object.

```
// Shows the value of the vertical slider
final Label vertvalue = new Label();
vertvalue.setSizeUndefined();

// Handle changes in slider value.
vertslider.addListener(new Property.ValueChangeListener() {
    public void valueChange(ValueChangeEvent event) {
        double value = (Double) vertslider.getValue();

        // Use the value
        box.setHeight((float) value, Sizeable.UNITS_PERCENTAGE);
        vertvalue.setValue(String.valueOf(value));
    }
});

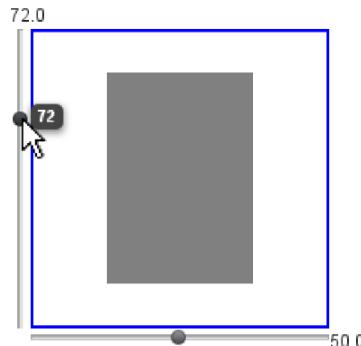
// The slider has to be immediate to send the changes
// immediately after the user drags the handle.
vertslider.setImmediate(true);
```

You can set the value with the `setValue()` method defined in **Slider** that takes the value as a native double value. The setter can throw a **ValueOutOfBoundsException**, which you must handle.

```
// Set the initial value. This has to be set after the
// listener is added if we want the listener to handle
// also this value change.
try {
    vertslider.setValue(50.0);
} catch (ValueOutOfBoundsException e) {
```

Alternatively, you can use the regular `setValue(Object)`, which does not do bounds checking.

Figure 5.50, “The **Slider** Component” shows both vertical (from the code examples) and horizontal sliders that control the size of a box. The slider values are displayed also in separate labels.

Figure 5.50. The Slider Component

CSS Style Rules

```
.v-slider {}
.v-slider-base {}
.v-slider-handle {}
```

The enclosing style for the **Slider** is `v-slider`. The slider bar has style `v-slider-base`. Even though the handle is higher (for horizontal slider) or wider (for vertical slider) than the bar, the handle element is nevertheless contained within the slider bar element. The appearance of the handle comes from a background image defined in the `background` CSS property.

5.20. Component Composition with CustomComponent

The ease of making new user interface components is one of the core features of Vaadin. Typically, you simply combine existing built-in components to produce composite components. In many applications, such composite components make up the majority of the user interface.

To create a composite component, you need to inherit the **CustomComponent** and call the `setCompositionRoot()` in the constructor to set the *composition root* component. The root component is typically a layout component that contains multiple components.

For example:

```
class MyComposite extends CustomComponent {
    public MyComposite(String message) {
        // A layout structure used for composition
        Panel panel = new Panel("My Custom Component");
        panel.setContent(new VerticalLayout());

        // Compose from multiple components
        Label label = new Label(message);
        label.setSizeUndefined(); // Shrink
        panel.addComponent(label);
        panel.addComponent(new Button("Ok"));

        // Set the size as undefined at all levels
        panel.getContent().setSizeUndefined();
        panel.setSizeUndefined();
        setSizeUndefined();

        // The composition root MUST be set
        setCompositionRoot(panel);
    }
}
```

Take note of the sizing when trying to make a custom component that shrinks to fit the contained components. You have to set the size as undefined at all levels; the sizing of the composite component and the composition root are separate.

You can use the component as follows:

```
MyComposite mycomposite = new MyComposite("Hello");
```

The rendered component is shown in Figure 5.51, “A Custom Composite Component”.

Figure 5.51. A Custom Composite Component



You can also inherit any other components, such as layouts, to attain similar composition. Even further, you can create entirely new low-level components, by integrating custom Google Web Toolkit components or by extending the client-side functionality of built-in components. Development of custom GWT components is covered in Chapter 10, *Developing Custom Components*.

Chapter 6

Managing Layout

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Ever since the ancient xeroxians invented graphical user interfaces, programmers have wanted to make GUI programming ever easier for themselves. Solutions started simple. When GUIs appeared on PC desktops, practically all screens were of the VGA type and fixed into 640x480 size. Mac or X Window System on UNIX were not much different. Everyone was so happy with such awesome graphics resolutions that they never thought that an application would have to work on a radically different screen size. At worst, screens could only grow, they thought, giving more space for more windows. In the 80s, the idea of having a computer screen in your pocket was simply not realistic. Hence, the GUI APIs allowed placing UI components using screen coordinates. Visual Basic and some other systems provided an easy way for the designer to drag and drop components on a fixed-sized window. One would have thought that at least translators would have complained about the awkwardness of such a solution, but apparently they were not, as non-engineers, heard or at least cared about. At best, engineers could throw at them a resource editor that would allow them to resize the UI components by hand. Such was the spirit back then.

After the web was born, layout design was doomed to change for ever. At first, layout didn't matter much, as everyone was happy with plain headings, paragraphs, and a few hyperlinks here and there. Designers of HTML wanted the pages to run on any screen size. The screen size was actually not pixels but rows and columns of characters, as the baby web was really just *hypertext*, not graphics. That was soon to be changed. The first GUI-based browser, NCSA Mosaic, launched a revolution that culminated in Netscape Navigator. Suddenly, people who had previously been doing advertisement brochures started writing HTML. This meant that layout design had to be easy not just for programmers, but also allow the graphics designer to do his or her job without having to know a thing about programming. The W3C committee designing web standards came up with the CSS (Cascading Style Sheet) specification, which allowed trivial separation of appearance from content. Later versions of HTML followed, XHTML appeared, as did countless other standards.

Page description and markup languages are a wonderful solution for static presentations, such as books and most web pages. Real applications, however, need to have more control. They need to be able to change the state of user interface components and even their layout on the run. This creates a need to separate the presentation from content on exactly the right level.

Thanks to the attack of graphics designers, desktop applications were, when it comes to appearance, far behind web design. Sun Microsystems had come in 1995 with a new programming language, Java, for writing cross-platform desktop applications. Java's original graphical user interface toolkit, AWT (Abstract Windowing Toolkit), was designed to work on multiple operating systems as well as embedded in web browsers. One of the special aspects of AWT was the layout manager, which allowed user interface components to be flexible, growing and shrinking as needed. This made it possible for the user to resize the windows of an application flexibly and also served the needs of localization, as text strings were not limited to some fixed size in pixels. It became even possible to resize the pixel size of fonts, and the rest of the layout adapted to the new size.

Layout management of Vaadin is a direct successor of the web-based concept for separation of content and appearance and of the Java AWT solution for binding the layout and user interface components into objects in programs. Vaadin layout components allow you to position your UI components on the screen in a hierarchical fashion, much like in conventional Java UI toolkits such as AWT, Swing, or SWT. In addition, you can approach the layout from the direction of the web with the **CustomLayout** component, which you can use to write your layout as a template in XHTML that provides locations of any contained components.

The moral of the story is that, because Vaadin is intended for web applications, appearance is of high importance. The solutions have to be the best of both worlds and satisfy artists of both kind: code and graphics. On the API side, the layout is controlled by UI components, particularly the layout components. On the visual side, it is controlled by themes. Themes can contain any HTML, CSS, and JavaScript that you or your web artists create to make people feel good about your software.

6.1. Overview

The user interface components in Vaadin can roughly be divided in two groups: components that the user can interact with and layout components for placing the other components to specific places in the user interface. The layout components are identical in their purpose to layout managers in regular desktop frameworks for Java and you can use plain Java to accomplish sophisticated component layouting.

You start by creating a root layout for the main window, unless you use the default, and then add the other layout components hierarchically, and finally the interaction components as the leaves of the component tree.

```
// Create the main window.
Window main = new Window("My Application");
setMainWindow(main);

// Set the root layout (VerticalLayout is actually the default).
VerticalLayout root = new VerticalLayout();
main.setContent(root);

// Add the topmost component.
root.addComponent(new Label("The Ultimate Cat Finder"));

// Add a horizontal layout for the bottom part.
HorizontalLayout bottom = new HorizontalLayout();
root.addComponent(bottom);

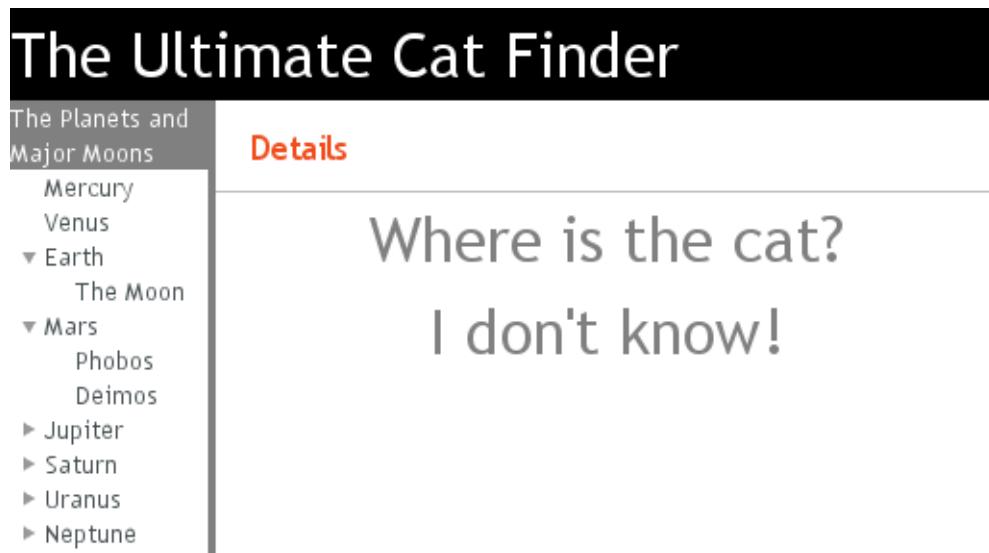
bottom.addComponent(new Tree("Major Planets and Their Moons"));
bottom.addComponent(new Panel());
...
```

You will usually need to tune the layout components a bit by setting sizes, expansion ratios, alignments, spacings, and so on. The general settings are described in Section 6.10, “Layout Formatting”, while the layout component specific settings are described in connection with the component.

Layouts are coupled with themes that specify various layout features, such as backgrounds, borders, text alignment, and so on. Definition and use of themes is described in Chapter 8, *Themes*

You can see the finished version of the above example in Figure 6.1, “Layout Example”.

Figure 6.1. Layout Example



The alternative for using layout components is to use the special **CustomLayout** that allows using HTML templates. This way, you can let the web page designers take responsibility of component layouting using their own set of tools. What you lose is the ability to manage the layout dynamically.



The Visual Editor

While you can always program the layout by hand, the Vaadin plugin for the Eclipse IDE includes a visual (WYSIWYG) editor that you can use to create user interfaces visually. The editor generates the code that creates the user interface and is useful for rapid application development and prototyping. It is especially helpful when you are still learning the framework, as the generated code, which is designed to be as reusable as possible, also works as an example of how you create user interfaces with Vaadin. You can find more about the editor in Chapter 7, *Visual User Interface Design with Eclipse (experimental)*.

6.2. Window and Panel Root Layout

The **Window** and its superclass **Panel** have a single root layout component. The component is usually a **Layout**, but any **ComponentContainer** is allowed. When you create the components, they create a default root layout, usually **VerticalLayout**, but you can change it with the **setContent()** method.

```
Window main = new Window("My Application");
setMainWindow(main);

// Set another root layout for the main window.
TabSheet tabsheet = new TabSheet();
main.setContent(tabsheet);
```

The size of the root layout is the default size of the particular layout component, for example, a **VerticalLayout** has 100% width and undefined height by default. In many applications, you want to use the full area of the browser view. Setting the components contained inside the root layout to full size is not enough, and would actually lead to an invalid state if the height of the root layout is undefined.

```
// This is actually the default.
main.setContent(new VerticalLayout());

// Set the size of the root layout to full width and height.
main.getContent().setSizeFull();

// Add a title area on top of the screen. This takes just the
// vertical space it needs.
main.addComponent(new Label("My Application"));

// Add a menu-view area that takes rest of the vertical space.
HorizontalLayout menuview = new HorizontalLayout();
menuview.setSizeFull();
main.addComponent(menuview);
```

See Section 6.10.1, “Layout Size” for more information about setting layout sizes.

6.3. VerticalLayout and HorizontalLayout

VerticalLayout and **HorizontalLayout** components are containers for laying out components either vertically or horizontally, respectively. Some components, such as **Window** and **Panel**, have a **VerticalLayout** as the root layout, which you can set with **setContent()**.

Typical use of the layouts goes as follows:

```
VerticalLayout vertical = new VerticalLayout();
vertical.addComponent(new TextField("Name"));
vertical.addComponent(new TextField("Street address"));
```

```
vertical.addComponent(new TextField("Postal code"));
main.addComponent(vertical);
```

The text fields have a label attached, which will by default be placed above the field. The layout will look on screen as follows:

Name	<input type="text"/>
Street address	<input type="text"/>
Postal code	<input type="text"/>

Using **HorizontalLayout** gives the following layout:

Name	Street address	Postal code
<input type="text"/>	<input type="text"/>	<input type="text"/>

The layouts can have spacing between the horizontal or vertical cells, defined with `setSpacing()`, as described in Section 6.10.3, “Layout Cell Spacing”. The contained components can be aligned within their cells with `setComponentAlignment()`, as described in Section 6.10.2, “Layout Cell Alignment”.

You can use `setWidth()` and `setHeight()` to specify width and height of a component in either fixed units or relatively with a percentage.

6.3.1. Sizing Contained Components

The components contained within an ordered layout can be laid out in a number of different ways depending on how you specify their height or width in the primary direction of the layout component.

Figure 6.2. Component Widths in **HorizontalLayout**

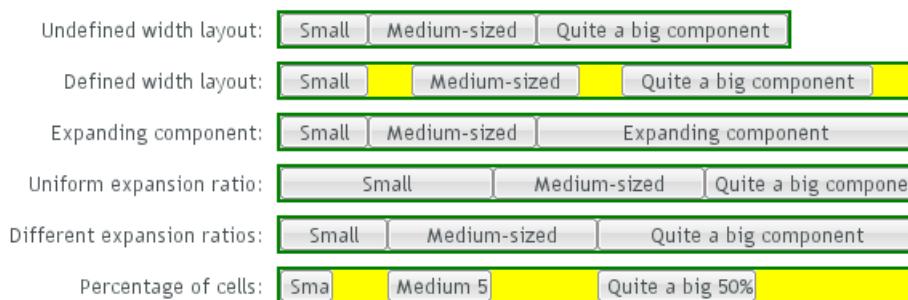
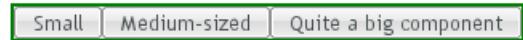


Figure 6.2, “Component Widths in **HorizontalLayout**” above gives a summary of the sizing options for a **HorizontalLayout**. Let us break the figure down as follows.

If a **VerticalLayout** has undefined height or **HorizontalLayout** undefined width, the layout will shrink to fit the contained components so that there is no extra space between them.

```
HorizontalLayout fittingLayout = new HorizontalLayout();
fittingLayout.setWidth(Sizeable.SIZE_UNDEFINED, 0);
fittingLayout.addComponent(new Button("Small"));
fittingLayout.addComponent(new Button("Medium-sized"));
```

```
fittingLayout.addComponent(new Button("Quite a big component"));
parentLayout.addComponent(fittingLayout);
```



If such a vertical layout continues below the bottom of a window (a **Window** object), the window will pop up a vertical scroll bar on the right side of the window area. This way, you get a "web page".

If you set a **HorizontalLayout** to a defined size horizontally or a **VerticalLayout** vertically, and there is space left over from the contained components, the extra space is distributed equally between the component cells. The components are aligned within these cells according to their alignment setting, top left by default, as in the example below.

```
fixedLayout.setWidth("400px");
```



Using percentual sizes for components contained in a layout requires answering the question, "Percentage of what?" There is no sensible default answer for this question in the current implementation of the layouts, so in practice, you may not define "100%" size alone.

Often, you want to have one component that takes all the available space left over from other components. You need to set its size as 100% and set it as *expanding* with `setExpandRatio()`. The second parameter for the method is an expansion ratio, which is relevant if there are more than one expanding component, but its value is irrelevant for a single expanding component.

```
HorizontalLayout layout = new HorizontalLayout();
layout.setWidth("400px");

// These buttons take the minimum size.
layout.addComponent(new Button("Small"));
layout.addComponent(new Button("Medium-sized"));

// This button will expand.
Button expandButton = new Button("Expanding component");

// Use 100% of the expansion cell's width.
expandButton.setWidth("100%");

// The component must be added to layout before setting the ratio.
layout.addComponent(expandButton);

// Set the component's cell to expand.
layout.setExpandRatio(expandButton, 1.0f);

parentLayout.addComponent(layout);
```



Notice that you must call `setExpandRatio()` *after* `addComponent()`, because the layout can not operate on a component that it doesn't (yet) include.



A layout that contains components with percentual size must have a defined size!

If a layout has undefined size and a contained component has, say, 100% size, the component would fill the space given by the layout, while the layout would shrink to

fit the space taken by the component, which is a paradox. This requirement holds for height and width separately. The debug mode allows detecting such invalid cases; see Section 11.4.1, “Debug Mode”.

If you specify an expand ratio for multiple components, they will all try to use the available space according to the ratio.

```
HorizontalLayout layout = new HorizontalLayout();
layout.setWidth("400px");

// Create three equally expanding components.
String[] captions = { "Small", "Medium-sized",
                      "Quite a big component" };
for (int i = 1; i <= 3; i++) {
    Button button = new Button(captions[i-1]);
    button.setWidth("100%");
    layout.addComponent(button);

    // Have uniform 1:1:1 expand ratio.
    layout.setExpandRatio(button, 1.0f);
}
```



As the example used the same ratio for all components, the ones with more content may have the content cut. Below, we use differing ratios:

```
// Expand ratios for the components are 1:2:3.
layout.setExpandRatio(button, i * 1.0f);
```



If the size of the expanding components is defined as a percentage (typically “100%”), the ratio is calculated from the *overall* space available for the relatively sized components. For example, if you have a 100 pixels wide layout with two cells with 1.0 and 4.0 respective expansion ratios, and both the components in the layout are set as `setWidth("100%)`, the cells will have respective widths of 20 and 80 pixels, regardless of the minimum size of the components.

However, if the size of the contained components is undefined or fixed, the expansion ratio is of the excess available space. In this case, it is the excess space that expands, not the components.

```
for (int i = 1; i <= 3; i++) {
    // Button with undefined size.
    Button button = new Button(captions[i - 1]);

    layout4.addComponent(button);

    // Expand ratios are 1:2:3.
    layout4.setExpandRatio(button, i * 1.0f);
}
```



It is not meaningful to combine expanding components with percentually defined size and components with fixed or undefined size. Such combination can lead to a very unexpected size for the percentually sized components.

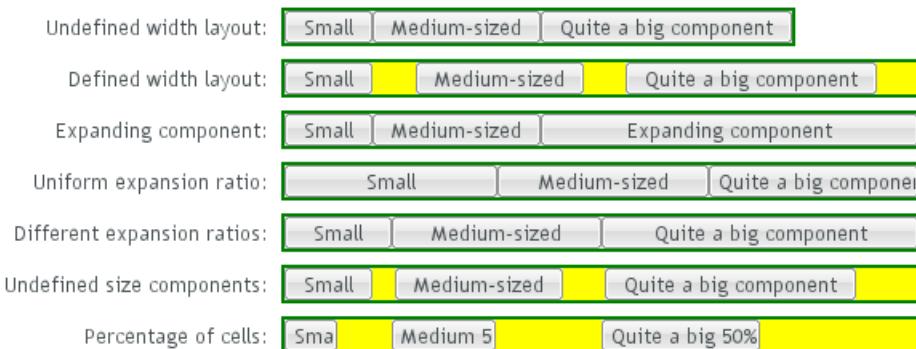
A percentual size of a component defines the size of the component *within its cell*. Usually, you use “100%”, but a smaller percentage or a fixed size (smaller than the cell size) will leave an

empty space in the cell and align the component within the cell according to its alignment setting, top left by default.

```
HorizontalLayout layout50 = new HorizontalLayout();
layout50.setWidth("400px");

String[] captions1 = { "Small 50%", "Medium 50%",
                      "Quite a big 50%" };
for (int i = 1; i <= 3; i++) {
    Button button = new Button(captions1[i-1]);
    button.setWidth("50%");
    layout50.addComponent(button);

    // Expand ratios for the components are 1:2:3.
    layout50.setExpandRatio(button, i * 1.0f);
}
parentLayout.addComponent(layout50);
```



6.4. GridLayout

GridLayout container lays components out on a grid, defined by the number of columns and rows. The columns and rows of the grid serve as coordinates that are used for laying out components on the grid. Each component can use multiple cells from the grid, defined as an area (x1,y1,x2,y2), although they typically take up only a single grid cell.

The grid layout maintains a cursor for adding components in left-to-right, top-to-bottom order. If the cursor goes past the bottom-right corner, it will automatically extend the grid downwards by adding a new row.

The following example demonstrates the use of **GridLayout**. The addComponent takes a component and optional coordinates. The coordinates can be given for a single cell or for an area in x,y (column,row) order. The coordinate values have a base value of 0. If coordinates are not given, the cursor will be used.

```
// Create a 4 by 4 grid layout.
GridLayout grid = new GridLayout(4, 4);
grid.setStyleName("example-gridlayout");

// Fill out the first row using the cursor.
grid.addComponent(new Button("R/C 1"));
for (int i = 0; i < 3; i++) {
    grid.addComponent(new Button("Col " + (grid.getCursorX() + 1)));
}

// Fill out the first column using coordinates.
for (int i = 1; i < 4; i++) {
    grid.addComponent(new Button("Row " + i), 0, i);
}
```

```
// Add some components of various shapes.
grid.addComponent(new Button("3x1 button"), 1, 1, 3, 1);
grid.addComponent(new Label("1x2 cell"), 1, 2, 1, 3);
InlineDateField date = new InlineDateField("A 2x2 date field");
date.setResolution(DateField.RESOLUTION_DAY);
grid.addComponent(date, 2, 2, 3, 3);
```

The resulting layout will look as follows. The borders have been made visible to illustrate the layout cells.

Figure 6.3. The Grid Layout Component

R/C 1	Col 1	Col 2	Col 3
Row 1	3x1 button		
Row 2	1x2 cell	A 2x2 date field	
Row 3			

November
 2007
 Sun Mon Tue Wed Thu Fri Sat
 1 2 3
 4 5 6 7 8 9 10
 11 12 13 14 15 16 17
 18 19 20 21 22 23 24
 25 26 27 28 29 30

A component to be placed on the grid must not overlap with existing components. A conflict causes throwing a `GridLayout.OverlapsException`.

6.4.1. Sizing Grid Cells

You can define the size of both a grid layout and its components in either fixed or percentual units, or leave the size undefined altogether, as described in Section 5.3.9, “Sizing Components”. Section 6.10.1, “Layout Size” gives an introduction to sizing of layouts.

The size of the `GridLayout` component is undefined by default, so it will shrink to fit the size of the components placed inside it. In most cases, especially if you set a defined size for the layout but do not set the contained components to full size, there will be some unused space. The position of the non-full components within the grid cells will be determined by their *alignment*. See Section 6.10.2, “Layout Cell Alignment” for details on how to align the components inside the cells.

The components contained within a `GridLayout` layout can be laid out in a number of different ways depending on how you specify their height or width. The layout options are similar to `HorizontalLayout` and `VerticalLayout`, as described in Section 6.3, “`VerticalLayout` and `HorizontalLayout`”.



A layout that contains components with percentual size must have a defined size!

If a layout has undefined size and a contained component has, say, 100% size, the component would fill the space given by the layout, while the layout would shrink to fit the space taken by the component, which is a paradox. This requirement holds

for height and width separately. The debug mode allows detecting such invalid cases; see Section 11.4.1, “Debug Mode”.

Often, you want to have one or more rows or columns that take all the available space left over from non-expanding rows or columns. You need to set the rows or columns as *expanding* with `setRowExpandRatio()` and `setColumnExpandRatio()`. The first parameter for these methods is the index of the row or column to set as expanding. The second parameter for the methods is an expansion ratio, which is relevant if there are more than one expanding row or column, but its value is irrelevant if there is only one. With multiple expanding rows or columns, the ratio parameter sets the relative portion how much a specific row/column will take in relation with the other expanding rows/columns.

```
GridLayout grid = new GridLayout(3,2);

// Layout containing relatively sized components must have
// a defined size, here is fixed size.
grid.setWidth("600px");
grid.setHeight("200px");

// Add some content
String labels [] = {
    "Shrinking column<br/>Shrinking row",
    "Expanding column (1:)<br/>Shrinking row",
    "Expanding column (5:)<br/>Shrinking row",
    "Shrinking column<br/>Expanding row",
    "Expanding column (1:)<br/>Expanding row",
    "Expanding column (5:)<br/>Expanding row"
};
for (int i=0; i<labels.length; i++) {
    Label label = new Label(labels[i], Label.CONTENT_XHTML);
    label.setWidth(null); // Set width as undefined
    grid.addComponent(label);
}

// Set different expansion ratios for the two columns
grid.setColumnExpandRatio(1, 1);
grid.setColumnExpandRatio(2, 5);

// Set the bottom row to expand
grid.setRowExpandRatio(1, 1);

// Align and size the labels.
for (int col=0; col<grid.getColumns(); col++) {
    for (int row=0; row<grid.getRows(); row++) {
        Component c = grid.getComponent(col, row);
        grid.setComponentAlignment(c, Alignment.TOP_CENTER);

        // Make the labels high to illustrate the empty
        // horizontal space.
        if (col != 0 || row != 0)
            c.setHeight("100%");
    }
}
```

Figure 6.4. Expanding Rows and Columns in GridLayout

Shrinking column Shrinking row	Expanding column (1:) Shrinking row	Expanding column (5:) Shrinking row
Shrinking column Expanding row	Expanding column (1:) Expanding row	Expanding column (5:) Expanding row

If the size of the contained components is undefined or fixed, the expansion ratio is of the excess space, as in Figure 6.4, “Expanding Rows and Columns in **GridLayout**” (excess horizontal space is shown in white). However, if the size of the all the contained components in the expanding rows or columns is defined as a percentage, the ratio is calculated from the *overall* space available for the percentually sized components. For example, if we had a 100 pixels wide grid layout with two columns with 1.0 and 4.0 respective expansion ratios, and all the components in the grid were set as `setWidth("100%")`, the columns would have respective widths of 20 and 80 pixels, regardless of the minimum size of their contained components.

CSS Style Rules

```
.v-gridlayout {}
.v-gridlayout-margin {}
```

The `v-gridlayout` is the root element of the **GridLayout** component. The `v-gridlayout-margin` is a simple element inside it that allows setting a padding between the outer element and the cells.

For styling the individual grid cells, you should style the components inserted in the cells. The implementation structure of the grid can change, so depending on it, as is done in the example below, is not generally recommended. Normally, if you want to have, for example, a different color for a certain cell, just make set the component inside it `setSizeFull()`, and add a style name for it. Sometimes you may need to use a layout component between a cell and its actual component just for styling.

The following example shows how to make the grid borders visible, as in Figure 6.4, “Expanding Rows and Columns in **GridLayout**”.

```
.v-gridlayout-gridexpandratio {
    background: blue; /* Creates a "border" around the grid. */
    margin: 10px; /* Empty space around the layout. */
}

/* Add padding through which the background color shows. */
.v-gridlayout-gridexpandratio .v-gridlayout-margin {
    padding: 2px;
}

/* Add cell borders and make the cell backgrounds white.
 * Warning: This depends heavily on the HTML structure. */
.v-gridlayout-gridexpandratio > div > div > div {
    padding: 2px; /* Layout background will show through. */
    background: white; /* The cells will be colored white. */
}

/* Components inside the layout are a safe way to style cells. */
```

```
.v-gridlayout-gridexpandratio .v-label {  
    text-align: left;  
    background: #fffffc0; /* Pale yellow */  
}
```

You should beware of margin, padding, and border settings in CSS as they can mess up the layout. The dimensions of layouts are calculated in the Client-Side Engine of Vaadin and some settings can interfere with these calculations. For more information on margins and spacing, see Section 6.10.3, “Layout Cell Spacing” and Section 6.10.4, “Layout Margins”

6.5. FormLayout

FormLayout is the default layout of a **Form** component. It lays the form fields and their captions out in two columns, with optional indicators for required fields and errors that can be shown for each field.

A **Form** handles additional layout elements itself, including a caption, a form description, a form error indicator, a footer that is often used for buttons and a border. For more information on these, see Section 5.17, “Form”.

The field captions can have an icon in addition to the text.

```
// A FormLayout used outside the context of a Form  
FormLayout fl = new FormLayout();  
  
// Make the FormLayout shrink to its contents  
fl.setSizeUndefined();  
  
TextField tf = new TextField("A Field");  
fl.addComponent(tf);  
  
// Mark the first field as required  
tf.setRequired(true);  
tf.setRequiredError("The Field may not be empty.");  
  
TextField tf2 = new TextField("Another Field");  
fl.addComponent(tf2);  
  
// Set the second field straining to error state with a message.  
tf2.setComponentError(  
    new UserError("This is the error indicator of a Field."));
```

The resulting layout will look as follows. The error message shows in a tooltip when you hover the mouse pointer over the error indicator.

Figure 6.5. A FormLayout Layout for Forms



CSS Style Rules

```
.v-formlayout {}
.v-formlayout .v-caption {}

/* Columns in a field row. */
.v-formlayout-contentcell {} /* Field content. */
.v-formlayout-captioncell {} /* Field caption. */
.v-formlayout-errorcell {} /* Field error indicator. */

/* Overall style of field rows. */
.v-formlayout-row {}
.v-formlayout-firstrow {}
.v-formlayout-lastrow {}

/* Required field indicator. */
.v-formlayout .v-required-field-indicator {}
.v-formlayout-captioncell .v-caption
    .v-required-field-indicator {}

/* Error indicator. */
.v-formlayout-cell .v-errorindicator {}
.v-formlayout-error-indicator .v-errorindicator {}
```

The top-level element of **FormLayout** has the `v-formlayout` style. The layout is tabular with three columns: the caption column, the error indicator column, and the field column. These can be styled with `v-formlayout-captioncell`, `v-formlayout-errorcell`, and `v-formlayout-contentcell`, respectively. While the error indicator is shown as a dedicated column, the indicator for required fields is currently shown as a part of the caption column.

For information on setting margins and spacing, see also Section 6.10.3, “Layout Cell Spacing” and Section 6.10.4, “Layout Margins”.

6.6. Panel

Panel is a simple container with a frame and an optional caption. The content area is bound to a an inner layout component for laying out the contained components. The default content layout is a **VerticalLayout**, but you can change it with the `setContent()` method to be any class implementing the **ComponentContainer** interface.

The caption can have an icon in addition to the text.

```
// Create a panel with a caption.
final Panel panel = new Panel("Contact Information");
panel.addStyleName("panalexample");

// The width of a Panel is 100% by default, make it
// shrink to fit the contents.
panel.setWidth(Sizeable.SIZE_UNDEFINED, 0);

// Create a layout inside the panel
final FormLayout form = new FormLayout();

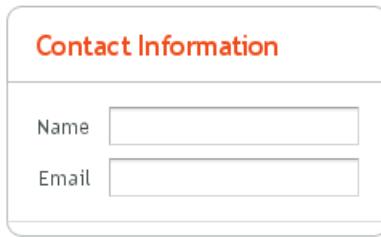
// Have some margin around it.
form.setMargin(true);

// Add some components
form.addComponent(new TextField("Name"));
form.addComponent(new TextField("Email"));

// Set the layout as the root layout of the panel
panel.setContent(form);
```

The resulting layout will look as follows.

Figure 6.6. A Panel Layout



See Section 6.2, “Window and Panel Root Layout” for more information about setting the content layout.

CSS Style Rules

```
.v-panel {}
.v-panel-caption {}
.v-panel-nocaption {}
.v-panel-content {}
.v-panel-deco {}
```

The entire panel has `v-panel` style. A panel consists of three parts: the caption, content, and bottom decorations (shadow). These can be styled with `v-panel-caption`, `v-panel-content`, and `v-panel-deco`, respectively. If the panel has no caption, the caption element will have the style `v-panel-nocaption`.

The built-in *light* style has no borders or border decorations for the **Panel**. You enable it simply by adding the `light` style name for the panel, as is done in the example below.

```
// Have a window with a SplitPanel.
final Window window = new Window("Window with a Light Panel");
window.setWidth("400px");
window.setHeight("200px");
final SplitPanel splitter =
    new SplitPanel(SplitPanel.ORIENTATION_HORIZONTAL);
window.setContent(splitter);

// Create a panel with a caption.
final Panel light = new Panel("Light Panel");
light.setSizeFull();

// The "light" style is a predefined style without borders.
light.addStyleName("light");

light.addComponent(new Label("The light Panel has no borders."));
light.getLayout().setMargin(true);

// The Panel will act as a "caption" of the left panel
// in the SplitPanel.
splitter.addComponent(light);
splitter.setSplitPosition(250, Sizeable.UNITS_PIXELS);

main.addWindow(window);
```

Figure 6.7, “A **Panel** with Light Style” shows the rendered **Panel**.

Figure 6.7. A Panel with Light Style

The *light* style is typical when using a **Panel** as the root layout of a window or some similar layout, as in the example above.

6.7. SplitPanel

SplitPanel is a two-component container that divides the available space into two areas to accommodate the two components. The split direction is vertical by default, but you can change it with `setOrientation()`.

You can set the two components with the dedicated `setFirstComponent()` and `setSecondComponent()` methods, or with the regular `addComponent()` method.

```
SplitPanel splitpanel = new SplitPanel();

// Set the orientation.
splitpanel.setOrientation(SplitPanel.ORIENTATION_HORIZONTAL);

// Put two components in the container.
splitpanel.setFirstComponent(new Label("Left Panel"));
splitpanel.setSecondComponent(new Label("Right Panel"));
```

A split bar that divides the two panels is enabled by default. The user can drag the bar with mouse to change the split position. To disable the bar, lock the split position with `setLocked(true)`.

The following example shows how you can create a layout with two nested **SplitPanel** components (one of which has a locked split position):

```
// A top-level panel to put everything in.
Panel panel = new Panel("Nested SplitPanels");

// Allow it to shrink to the size of the contained SplitPanel.
panel.setSizeUndefined();

// Have a vertical SplitPanel as the main component.
SplitPanel vertical = new SplitPanel();
panel.addComponent(vertical);

// Set the size of the SplitPanel rather than the containing Panel,
// because then we know how much space we have for the panels.
vertical.setHeight("150px");
vertical.setWidth("250px");

// Set the split position to 50 pixels, which is more than
// enough height for the Label in the upper panel.
vertical.setSplitPosition(50, SplitPanel.UNITS_PIXELS);
```

```

// Put a label in the upper panel.
vertical.addComponent(new Label("The contents of the upper area."));

// Put a horizontal SplitPanel in the lower area.
SplitPanel horizontal = new SplitPanel();
horizontal.setOrientation(SplitPanel.ORIENTATION_HORIZONTAL);
horizontal.setSplitPosition(65); // percent
vertical.addComponent(horizontal);

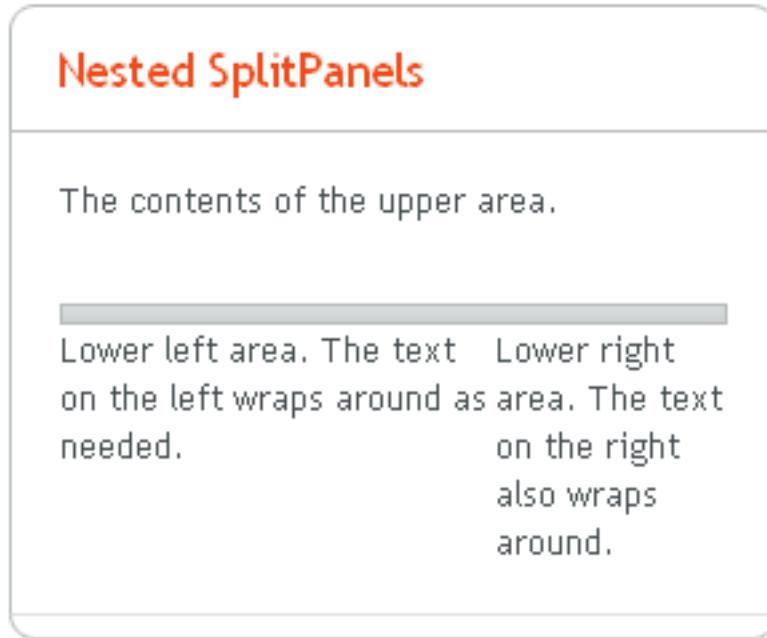
// The lower SplitPanel is locked, so the user cannot move
// the split position.
horizontal.setLocked(true);

// Component in the left panel:
horizontal.addComponent(new Label("Lower left area. "+
    "The text on the left wraps around as needed."));

// Component in the right panel:
horizontal.addComponent(new Label("Lower right area. "+
    "The text on the right also wraps around."));

```

Figure 6.8. A Layout With Nested SplitPanels



CSS Style Rules

```

/* For a horizontal SplitPanel. */
.v-splitpanel-horizontal {}
.v-splitpanel-hsplitter {}
.v-splitpanel-hsplitter-locked {}

/* For a vertical SplitPanel. */
.v-splitpanel-vertical {}
.v-splitpanel-vsplitter {}
.v-splitpanel-vsplitter-locked {}

/* The two container panels. */
.v-splitpanel-first-container {} /* Top or left panel. */
.v-splitpanel-second-container {} /* Bottom or right panel. */

```

The entire accordion has the style `v-splitpanel-horizontal` or `v-splitpanel-vertical`. The split bar or *splitter* between the two content panels has either the `...-splitter` or `...-splitter-locked` style, depending on whether its position is locked or not.

6.8. TabSheet

The **TabSheet** is a multicomponent container that allows switching between the components with "tabs". The tabs are organized as a tab bar at the top of the tab sheet. Clicking on a tab opens its contained component in the main display area of the layout.

You add new tabs to a tab sheet with the `addTab()` method. The simple version of the method takes as its parameter the root component of the tab. You can use the root component to retrieve its corresponding **Tab** object. Typically, you put a layout component as the root component.

```
// Create an empty tab sheet.  
TabSheet tabsheet = new TabSheet();  
  
// Create a component to put in a tab and put  
// some content in it.  
VerticalLayout myTabRoot = new VerticalLayout();  
myTabRoot.addComponent(new Label("Hello, I am a Tab!"));  
  
// Add the component to the tab sheet as a new tab.  
tabsheet.addTab(myTabRoot);  
  
// Get the Tab holding the component and set its caption.  
tabsheet.getTab(myTabRoot).setCaption("My Tab");
```

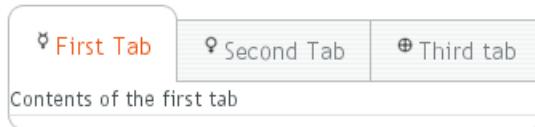
Each tab in a tab sheet is represented as a **Tab** object, which manages the tab caption, icon, and attributes such as hidden and visible. You can set the caption with `setCaption()` and the icon with `setIcon()`. If the component added with `addTab()` has a caption or icon, it is used as the default for the **Tab** object. However, changing the attributes of the root component later does not affect the tab, but you must make the setting through the **Tab** object. The `addTab()` returns the new **Tab** object, so you can easily set an attribute using the reference.

```
// Set an attribute using the returned reference  
tabsheet.addTab(myTab).setCaption("My Tab");
```

You can also give the caption and the icon as parameters for the `addTab()` method. The following example demonstrates the creation of a simple tab sheet, where each tab shows a different **Label** component. The tabs have an icon, which are (in this example) loaded as Java class loader resources from the application.

```
TabSheet tabsheet = new TabSheet();  
  
// Make the tabsheet shrink to fit the contents.  
tabsheet.setSizeUndefined();  
  
tabsheet.addTab(new Label("Contents of the first tab"),  
    "First Tab",  
    new ClassResource("images/Mercury_small.png", this));  
tabsheet.addTab(new Label("Contents of the second tab"),  
    "Second Tab",  
    new ClassResource("images/Venus_small.png", this));  
tabsheet.addTab(new Label("Contents of the third tab"),  
    "Third tab",  
    new ClassResource("images/Earth_small.png", this));
```

Figure 6.9. A Simple TabSheet Layout



The `hideTabs()` method allows hiding the tab bar entirely. This can be useful in tabbed document interfaces (TDI) when there is only one tab. An individual tab can be made invisible by setting `setVisible(false)` for the **Tab** object. A tab can be disabled by setting `setEnabled(false)`.

Clicking on a tab selects it. This fires a **TabSheet.SelectedTabChangeEvent**, which you can handle by implementing the **TabSheet.SelectedTabChangeListener** interface. The source component of the event, which you can retrieve with `getSource()` method of the event, will be the **TabSheet** component. You can find the currently selected tab with `getSelectedTab()` and select (open) a particular tab programmatically with `setSelectedTab()`. Notice that also adding the first tab fires the **SelectedTabChangeEvent**, which may cause problems in your handler if you assume that everything is initialized before the first change event.

The example below demonstrates handling **TabSheet** related events and enabling and disabling tabs. The sort of logic used in the example is useful in sequential user interfaces, often called *wizards*, where the user goes through the tabs one by one, but can return back if needed.

```
import com.vaadin.ui.*;
import com.vaadin.ui.Button.ClickEvent;
import com.vaadin.ui.TabSheet.SelectedTabChangeEvent;

public class TabSheetExample extends CustomComponent implements
    Button.ClickListener, TabSheet.SelectedTabChangeListener {
    TabSheet tabsheet = new TabSheet();
    Button tab1 = new Button("Push this button");
    Label tab2 = new Label("Contents of Second Tab");
    Label tab3 = new Label("Contents of Third Tab");

    TabSheetExample() {
        setCompositionRoot(tabsheet);

        // Listen for changes in tab selection.
        tabsheet.addListener(this);

        // First tab contains a button, for which we
        // listen button click events.
        tab1.addListener(this);

        // This will cause a selectedTabChange() call.
        tabsheet.addTab(tab1, "First Tab", null);

        // A tab that is initially invisible.
        tabsheet.addTab(tab2, "Second Tab", null);
        tabsheet.getTab(tab2).setVisible(false);

        // A tab that is initially disabled.
        tabsheet.addTab(tab3, "Third tab", null);
        tabsheet.getTab(tab3).setEnabled(false);
    }

    public void buttonClick(ClickEvent event) {
        // Enable the invisible and disabled tabs.
        tabsheet.getTab(tab2).setVisible(true);
        tabsheet.getTab(tab3).setEnabled(true);

        // Change selection automatically to second tab.
    }
}
```

```

        tabsheet.setSelectedTab(tab2);
    }

    public void selectedTabChange(SelectedTabChangeEvent event) {
        // Cast to a TabSheet. This isn't really necessary in
        // this example, as we have only one TabSheet component,
        // but would be useful if there were multiple TabSheets.
        final TabSheet source = (TabSheet) event.getSource();

        if (source == tabsheet) {
            // If the first tab was selected.
            if (source.getSelectedTab() == tab1) {
                // The 2. and 3. tabs may not have been set yet.
                if (tabsheet.getTab(tab2) != null
                    && tabsheet.getTab(tab3) != null) {
                    tabsheet.getTab(tab2).setVisible(false);
                    tabsheet.getTab(tab3).setEnabled(false);
                }
            }
        }
    }
}

```

Figure 6.10. A TabSheet with Hidden and Disabled Tabs



CSS Style Rules

```

.v-tabsheet {}
.v-tabsheet-tabs {}
.v-tabsheet-content {}
.v-tabsheet-deco {}
.v-tabsheet-tabcontainer {}
.v-tabsheet-tabsheetspanel {}
.v-tabsheet-hidetabs {}

.v-tabsheet-scroller {}
.v-tabsheet-scrollerPrev {}
.v-tabsheet-scrollerNext {}
.v-tabsheet-scrollerPrev-disabled{}
.v-tabsheet-scrollerNext-disabled{}

.v-tabsheet-tabitem {}
.v-tabsheet-tabitem-selected {}
.v-tabsheet-tabitemcell {}
.v-tabsheet-tabitemcell-first {}

.v-tabsheet-tabs td {}
.v-tabsheet-spacertd {}

```

The entire tabsheet has the `v-tabsheet` style. A tabsheet consists of three main parts: the tabs on the top, the main content pane, and decorations around the tabsheet.

The tabs area at the top can be styled with `v-tabsheet-tabs`, `v-tabsheet-tabcontainer` and `v-tabsheet-tabitem*`.

The style `v-tabsheet-spacer` is used for any empty space after the tabs. If the tabsheet has too little space to show all tabs, scroller buttons enable browsing the full tab list. These use the styles `v-tabsheet-scroller*`.

The content area where the tab contents are shown can be styled with `v-tabsheet-content`, and the surrounding decoration with `v-tabsheet-deco`.

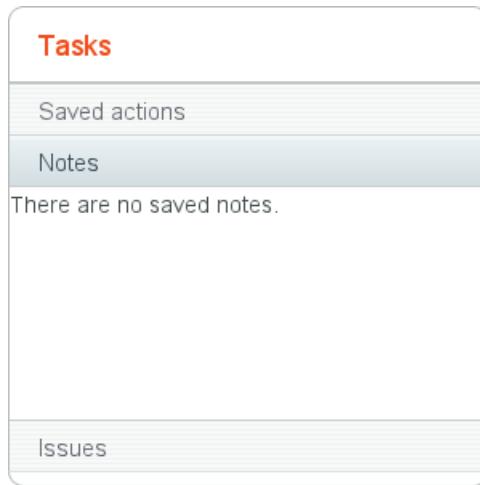
6.9. Accordion

Accordion is a multicomponent container similar to **TabSheet**, except that the "tabs" are arranged vertically. Clicking on a tab opens its contained component in the space between the tab and the next one. You can use an **Accordion** identically to a **TabSheet**, which it actually inherits. See Section 6.8, "**TabSheet**" for more information.

The following example shows how you can create a simple accordion. As the **Accordion** is rather naked alone, we put it inside a Panel that acts as its caption and provides it a border.

```
// Create the Accordion.  
Accordion accordion = new Accordion();  
  
// Have it take all space available in the layout.  
accordion.setSizeFull();  
  
// Some components to put in the Accordion.  
Label l1 = new Label("There are no previously saved actions.");  
Label l2 = new Label("There are no saved notes.");  
Label l3 = new Label("There are currently no issues.");  
  
// Add the components as tabs in the Accordion.  
accordion.addTab(l1, "Saved actions", null);  
accordion.addTab(l2, "Notes", null);  
accordion.addTab(l3, "Issues", null);  
  
// A container for the Accordion.  
Panel panel = new Panel("Tasks");  
panel.setWidth("300px");  
panel.setHeight("300px");  
panel.addComponent(accordion);  
  
// Trim its layout to allow the Accordion take all space.  
panel.getLayout().setSizeFull();  
panel.getLayout().setMargin(false);
```

Figure 6.11, "An Accordion" shows what the example would look like with the default theme.

Figure 6.11. An Accordion

CSS Style Rules

```
.v-accordion {}
.v-accordion-item {}
.v-accordion-item-open {}
.v-accordion-item-first {}
.v-accordion-item-caption {}
.v-accordion-item-caption .v-caption {}
.v-accordion-item-content {}
```

The top-level element of **Accordion** has the `v-accordion` style. An **Accordion** consists of a sequence of item elements, each of which has a `caption` element (the tab) and a content area element.

The selected item (tab) has also the `v-accordion-open` style. The content area is not shown for the closed items.

6.10. Layout Formatting

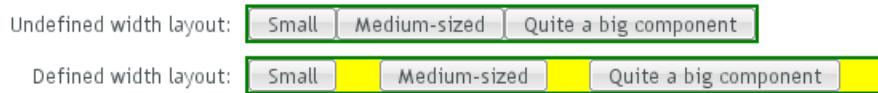
While the formatting of layouts is mainly done with style sheets, just as with other components, style sheets are not ideal or even possible to use in some situations. For example, CSS does not allow defining the spacing of table cells, which is done with the `cellspacing` attribute in HTML.

Moreover, as many layout sizes are calculated dynamically in the Client-Side Engine of Vaadin, some CSS settings can fail altogether.

6.10.1. Layout Size

The size of a layout component can be specified with the `setWidth()` and `setHeight()` methods defined in the **Sizeable** interface, just like for any component. It can also be undefined, in which case the layout shrinks to fit the component(s) inside it. Section 5.3.9, “Sizing Components” gives details on the interface.

Figure 6.12. HorizontalLayout with Undefined vs Defined size



Many layout components take 100% width by default, while they have the height undefined.

The sizes of components inside a layout can also be defined as a percentage of the space available in the layout, for example with `setWidth("100%")`; or with the (most commonly used method) `setSizeFull()` that sets 100% size in both directions. If you use a percentage in a **HorizontalLayout**, **VerticalLayout**, or **GridLayout**, you will also have to set the component as *expanding*, as noted below.



Warning

A layout that contains components with percentual size must have a defined size!

If a layout has undefined size and a contained component has, say, 100% size, the component will try to fill the space given by the layout, while the layout will shrink to fit the space taken by the component, which is a paradox. This requirement holds for height and width separately. The debug mode allows detecting such invalid cases; see Section 11.4.1, “Debug Mode”.

For example:

```
// This takes 100% width but has undefined height.
VBoxLayout layout = new VerticalLayout();

// A button that takes all the space available in the layout.
Button button = new Button("100%x100% button");
button.setSizeFull();
layout.addComponent(button);

// We must set the layout to a defined height vertically, in
// this case 100% of its parent layout, which also must
// not have undefined size.
layout.setHeight("100%");
```

The default layout of **Window** and **Panel** is **VerticalLayout** with undefined height. If you insert enough components in such a layout, it will grow outside the bottom of the view area and scrollbars will appear in the browser. If you want your application to use all the browser view, nothing more or less, you should use `setSizeFull()` for the root layout.

```
// Create the main window.
Window main = new Window("Main Window");
setMainWindow(main);

// Use full size.
main.getLayout().setSizeFull();
```

Expanding Components

If you set a **HorizontalLayout** to a defined size horizontally or a **VerticalLayout** vertically, and there is space left over from the contained components, the extra space is distributed equally between the component cells. The components are aligned within these cells, according to their alignment setting, top left by default, as in the example below.



Often, you don't want such empty space, but want one or more components to take all the leftover space. You need to set such a component to 100% size and use `setExpandRatio()`. If there is just one such expanding component in the layout, the ratio parameter is irrelevant.



If you set multiple components as expanding, the expand ratio dictates how large proportion of the available space (overall or excess depending on whether the components are sized as a percentage or not) each component takes. In the example below, the buttons have 1:2:3 ratio for the expansion.



GridLayout has corresponding method for both of its directions, `setRowExpandRatio()` and `setColumnExpandRatio()`.

Expansion is dealt in detail in the documentation of the layout components that support it. See Section 6.3, “**VerticalLayout** and **HorizontalLayout**” and Section 6.4, “**GridLayout**” for details on components with relative sizes.

6.10.2. Layout Cell Alignment

You can set the alignment of the component inside a specific layout cell with the `setComponentAlignment()` method. The method takes as its parameters the component contained in the cell to be formatted, and the horizontal and vertical alignment.

Figure 6.13, “Cell Alignments” illustrates the alignment of components within a **GridLayout**.

Figure 6.13. Cell Alignments

Top Left	Top Center	Top Right
Middle Left	Middle Center	Middle Right
Bottom Left	Bottom Center	Bottom Right

The easiest way to set alignments is to use the constants defined in the **Alignment** class. Let us look how the buttons in the top row of the above **GridLayout** are aligned with constants:

```
// Create a grid layout
final GridLayout grid = new GridLayout(3, 3);

grid.setWidth(400, Sizeable.UNITS_PIXELS);
grid.setHeight(200, Sizeable.UNITS_PIXELS);

Button topleft = new Button("Top Left");
grid.addComponent(topleft, 0, 0);
grid.setComponentAlignment(topleft, Alignment.TOP_LEFT);

Button topcenter = new Button("Top Center");
grid.addComponent(topcenter, 1, 0);
grid.setComponentAlignment(topcenter, Alignment.TOP_CENTER);
```

```
Button topright = new Button("Top Right");
grid.addComponent(topright, 2, 0);
grid.setComponentAlignment(topright, Alignment.TOP_RIGHT);
...
```

The following table lists all the **Alignment** constants by their respective locations:

Table 6.1. Alignment Constants

<i>TOP_LEFT</i>	<i>TOP_CENTER</i>	<i>TOP_RIGHT</i>
<i>MIDDLE_LEFT</i>	<i>MIDDLE_CENTER</i>	<i>MIDDLE_RIGHT</i>
<i>BOTTOM_LEFT</i>	<i>BOTTOM_CENTER</i>	<i>BOTTOM_RIGHT</i>

Another way to specify the alignments is to create an **Alignment** object and specify the horizontal and vertical alignment with separate constants. You can specify either of the directions, in which case the other alignment direction is not modified, or both with a bitmask operation between the two directions.

```
Button middleleft = new Button("Middle Left");
grid.addComponent(middleleft, 0, 1);
grid.setComponentAlignment(middleleft,
    new Alignment(Bits.ALIGNMENT_VERTICAL_CENTER |
        Bits.ALIGNMENT_LEFT));

Button middlecenter = new Button("Middle Center");
grid.addComponent(middlecenter, 1, 1);
grid.setComponentAlignment(middlecenter,
    new Alignment(Bits.ALIGNMENT_VERTICAL_CENTER |
        Bits.ALIGNMENT_HORIZONTAL_CENTER));

Button middleright = new Button("Middle Right");
grid.addComponent(middleright, 2, 1);
grid.setComponentAlignment(middleright,
    new Alignment(Bits.ALIGNMENT_VERTICAL_CENTER |
        Bits.ALIGNMENT_RIGHT));
```

Obviously, you may combine only one vertical bitmask with one horizontal bitmask, though you may leave either one out. The following table lists the available alignment bitmask constants:

Table 6.2. Alignment Bitmasks

Horizontal	<i>Bits.ALIGNMENT_LEFT</i>
	<i>Bits.ALIGNMENT_HORIZONTAL_CENTER</i>
	<i>Bits.ALIGNMENT_RIGHT</i>
Vertical	<i>Bits.ALIGNMENT_TOP</i>
	<i>Bits.ALIGNMENT_VERTICAL_CENTER</i>
	<i>Bits.ALIGNMENT_BOTTOM</i>

You can determine the current alignment of a component with `getComponentAlignment()`, which returns an **Alignment** object. The class provides a number of getter methods for decoding the alignment, which you can also get as a bitmask value.

6.10.3. Layout Cell Spacing

The **VerticalLayout**, **HorizontalLayout**, and **GridLayout** layouts offer a `setSpacing()` method for enabling space between the cells in the layout. Enabling the spacing adds a spacing style for all cells except the first so that, by setting the left or top padding, you can specify the amount of spacing.

To enable spacing, simply call `setSpacing(true)` for the layout as follows:

```
HorizontalLayout layout2 = new HorizontalLayout();
layout2.setStyleName("spacingexample");
layout2.setSpacing(true);
layout2.addComponent(new Button("Component 1"));
layout2.addComponent(new Button("Component 2"));
layout2.addComponent(new Button("Component 3"));

VerticalLayout layout4 = new VerticalLayout();
layout4.setStyleName("spacingexample");
layout4.setSpacing(true);
layout4.addComponent(new Button("Component 1"));
layout4.addComponent(new Button("Component 2"));
layout4.addComponent(new Button("Component 3"));
```

In practise, the `setSpacing()` method toggles between the "v-COMPONENTCLASSNAME-spacing-on" and "-off" CSS class names in the cell elements. Elements having those class names can be used to define the spacing metrics in a theme.

The layouts have a spacing style name to define spacing also when spacing is off. This allows you to define a small default spacing between components by default and a larger one when the spacing is actually enabled.

Spacing can be horizontal (for **HorizontalLayout**), vertical (for **VerticalLayout**), or both (for **GridLayout**). The name of the spacing style for horizontal and vertical spacing is the base name of the component style name plus the "-spacing-on" suffix, as shown in the following table:

Table 6.3. Spacing Style Names

VerticalLayout	v-verticallayout-spacing-on
HorizontalLayout	v-horizontallayout-spacing-on
GridLayout	v-gridlayout-spacing-on

In the CSS example below, we specify the exact amount of spacing for the code example given above, for the layouts with the custom "spacingexample" style:

```
/* Set the amount of horizontal cell spacing in a
 * specific element with the "-spacingexample" style. */
.v-horizontallayout-spacingexample .v-horizontallayout-spacing-on {
    padding-left: 30px;
}

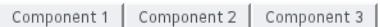
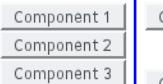
/* Set the amount of vertical cell spacing in a
 * specific element with the "-spacingexample" style. */
.v-verticallayout-spacingexample .v-verticallayout-spacing-on {
    padding-top: 30px;
}

/* Set the amount of both vertical and horizontal cell spacing
 * in a specific element with the "-spacingexample" style. */
.v-gridlayout-spacingexample .v-gridlayout-spacing-on {
    padding-top: 30px;
```

```
padding-left: 50px;
}
```

The resulting layouts will look as shown in Figure 6.14, "Layout Spacings", which also shows the layouts with no spacing.

Figure 6.14. Layout Spacings

		No spacing:	Vertical spacing:
No spacing:			
Horizontal spacing:			



Note

Spacing is unrelated to "cell spacing" in HTML tables. While many layout components are implemented with HTML tables in the browser, this implementation is not guaranteed to stay the same and at least **Vertical-/HorizontalLayout** could be implemented with `<div>` elements as well. In fact, as GWT compiles widgets separately for different browsers, the implementation could even vary between browsers.

Also note that HTML elements with spacing classnames don't necessarily exist in a component after rendering, because the Client-Side Engine of Vaadin processes them.

6.10.4. Layout Margins

By default, layout components do not have any margin around them. You can add margin with CSS directly to the layout component. Below we set margins for a specific layout component (here a `horizontalLayout`):

```
layout1.addStyleName("marginexample1");

.v-horizontalLayout-marginexample1
    .v-horizontalLayout-margin {
        padding-left: 200px;
        padding-right: 100px;
        padding-top: 50px;
        padding-bottom: 25px;
    }
```

Similar settings exist for other layouts such as `verticalLayout`.

The layout size calculations require the margins to be defined as CSS `padding` rather than as CSS `margin`.

As an alternative to the pure CSS method, you can set up a margin around the layout that can be enabled with `setMargin(true)`. The `margin` element has some default margin widths, but you can adjust the widths in CSS if you need to.

Let us consider the following example, where we enable the margin on all sides of the layout:

```
// Create a layout
HorizontalLayout layout2 = new HorizontalLayout();
```

```
containinglayout.addComponent(  
    new Label("Layout with margin on all sides"));  
containinglayout.addComponent(layout2);  
  
// Set style name for the layout to allow styling it  
layout2.addStyleName("marginexample");  
  
// Have margin on all sides around the layout  
layout2.setMargin(true);  
  
// Put something inside the layout  
layout2.addComponent(new Label("Cell 1"));  
layout2.addComponent(new Label("Cell 2"));  
layout2.addComponent(new Label("Cell 3"));
```

You can enable the margins only for specific sides. The margins are specified for the `setMargin()` method in clockwise order for top, right, bottom, and left margin. The following would enable the top and left margins:

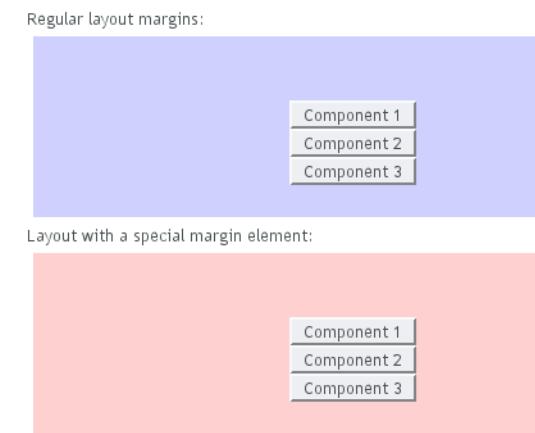
```
layout2.setMargin(true, false, false, true);
```

You can specify the actual margin widths in the CSS if you are not satisfied with the default widths (in this example for a **HorizontalLayout**):

```
.v-horizontallayout-marginexample .v-horizontallayout-margin-left {padding-left:  
200px;}  
.v-horizontallayout-marginexample .v-horizontallayout-margin-right {padding-right:  
100px;}  
.v-horizontallayout-marginexample .v-horizontallayout-margin-top {padding-top:  
50px;}  
.v-horizontallayout-marginexample .v-horizontallayout-margin-bottom {padding-bottom:  
25px;}
```

The resulting margins are shown in Figure 6.15, “Layout Margins” below. The two ways produce identical margins.

Figure 6.15. Layout Margins



CSS Style Rules

The CSS style names for the margin widths for `setMargin()` consist of the specific layout name plus `-margin-left` and so on. The CSS style names for CSS-only margins consist of the specific layout name plus `-margin`. Below, the style rules are given for **VerticalLayout**:

```
/* Alternative 1: CSS only style */
.v-verticallayout-margin {
    padding-left: ____px;
    padding-right: ____px;
    padding-top: ____px;
    padding-bottom: ____px;
}
/* Alternative 2: CSS rules to be enabled in code */
.v-verticallayout-margin-left {padding-left: ____px;}
.v-verticallayout-margin-right {padding-right: ____px;}
.v-verticallayout-margin-top {padding-top: ____px;}
.v-verticallayout-margin-bottom {padding-bottom: ____px;}
```

6.11. Custom Layouts

While it is possible to create almost any typical layout with the standard layout components, it is sometimes best to separate the layout completely from code. With the **CustomLayout** component, you can write your layout as a template in XHTML that provides locations of any contained components. The layout template is included in a theme. This separation allows the layout to be designed separately from code, for example using WYSIWYG web designer tools such as Adobe Dreamweaver.

A template is a HTML file located under layouts folder under a theme folder under the WebContent / VAADIN / themes / folder, for example, WebContent/VAADIN/themes/themename/layouts/mylayout.html. (Notice that the root path WebContent/VAADIN/themes/ for themes is fixed.) A template can also be provided dynamically from an **InputStream**, as explained below. A template includes <div> elements with a *location* attribute that defines the location identifier. All custom layout HTML-files must be saved using UTF-8 character encoding.

```
<table width="100%" height="100%">
    <tr height="100%">
        <td>
            <table align="center">
                <tr>
                    <td align="right">User&nbsp;name:</td>
                    <td><div location="username"></div></td>
                </tr>
                <tr>
                    <td align="right">Password:</td>
                    <td><div location="password"></div></td>
                </tr>
            </table>
        </td>
    </tr>
    <tr>
        <td align="right" colspan="2">
            <div location="okbutton"></div>
        </td>
    </tr>
</table>
```

The client-side engine of Vaadin will replace contents of the location elements with the components. The components are bound to the location elements by the location identifier given to addComponent(), as shown in the example below.

```
// Have a Panel where to put the custom layout.
Panel panel = new Panel("Login");
panel.setSizeUndefined();
main.addComponent(panel);

// Create custom layout from "layoutname.html" template.
```

```
CustomLayout custom = new CustomLayout("layoutname");
custom.addStyleName("customlayoutexample");

// Use it as the layout of the Panel.
panel.setContent(custom);

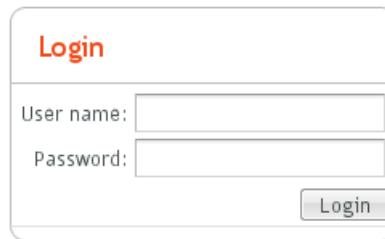
// Create a few components and bind them to the location tags
// in the custom layout.
TextField username = new TextField();
custom.addComponent(username, "username");

TextField password = new TextField();
custom.addComponent(password, "password");

Button ok = new Button("Login");
custom.addComponent(ok, "okbutton");
```

The resulting layout is shown below in Figure 6.16, “Example of a Custom Layout Component”.

Figure 6.16. Example of a Custom Layout Component



You can use `addComponent()` also to replace an existing component in the location given in the second parameter.

In addition to a static template file, you can provide a template dynamically with the **CustomLayout** constructor that accepts an **InputStream** as the template source. For example:

```
new CustomLayout(new ByteArrayInputStream("<b>Template</b>".getBytes()));
```

or

```
new CustomLayout(new FileInputStream(file));
```

Chapter 7

Visual User Interface Design with Eclipse (experimental)

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This chapter provides instructions for developing the graphical user interface of Vaadin components with a visual editor (experimental) included in the Vaadin Plugin for the Eclipse IDE.

7.1. Overview

The visual or WYSIWYG editor for Vaadin allows you to design the user interface of an entire application or specific custom components. The editor generates the actual Java code, which is designed to be reusable, so you can design the basic layout of the user interface with the visual

editor and build the user interaction logic on top of the generated code. You can use inheritance and composition to modify the components further.

The editor is included in the Vaadin Plugin for Eclipse (actually as a separate plugin in the plugin set). For installing the Vaadin plugin, see Section 2.2.5, “Vaadin Plugin for Eclipse”.



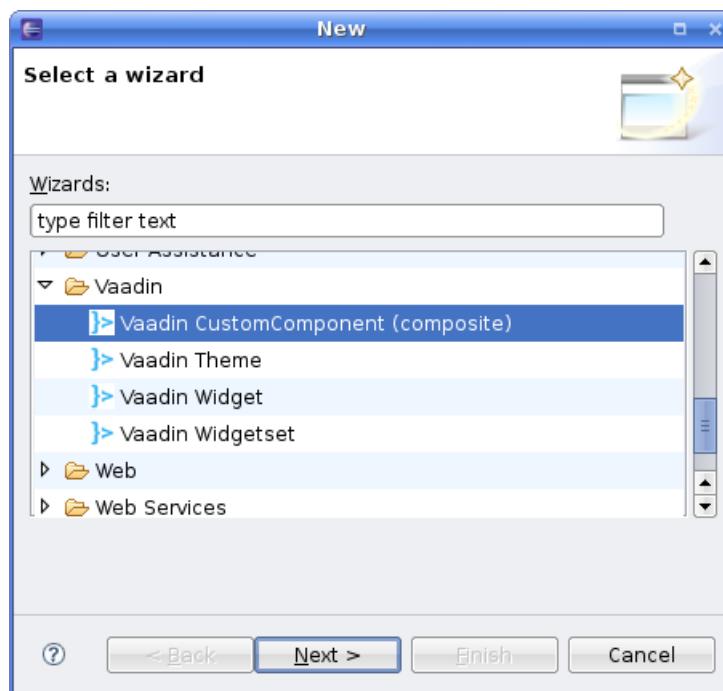
Ongoing Work

The first preview version of the visual editor was released in May 2009 and is still *under development* at the time of the publication of this book and should be considered as experimental. While the preview version is incomplete and probably not suitable for demanding use, you can use it for simple tasks, especially when familiarizing yourself with Vaadin.

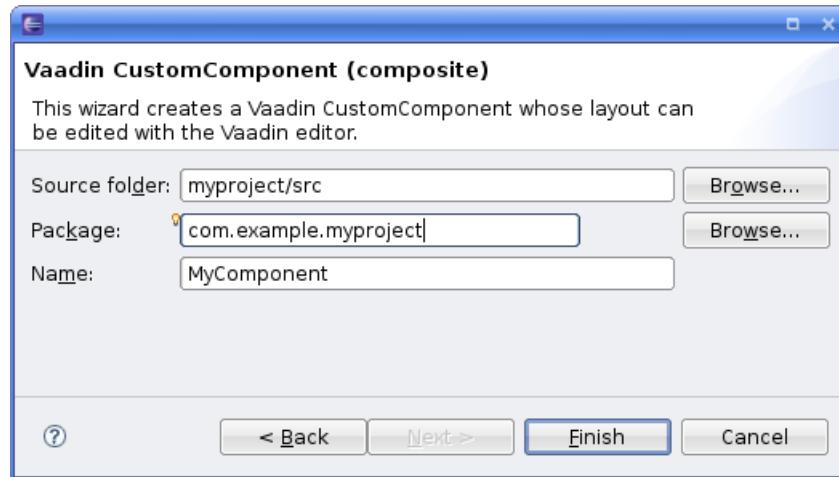
7.2. Creating a New CustomComponent

The visual editor works with custom component classes that extend the **CustomComponent** class, which is the basic technique in Vaadin for creating composite components. Custom components are described in Section 5.20, “Component Composition with **CustomComponent**”. Any **CustomComponent** will not do for the visual editor; you need to create a new one as instructed below.

1. Select **File → New → Other...** in the main menu or right-click the **Project Explorer** and select **New → Other...** to open the **New** window.
2. In the first, **Select a wizard** step, select **Vaadin → Vaadin CustomComponent** and click **Next**.



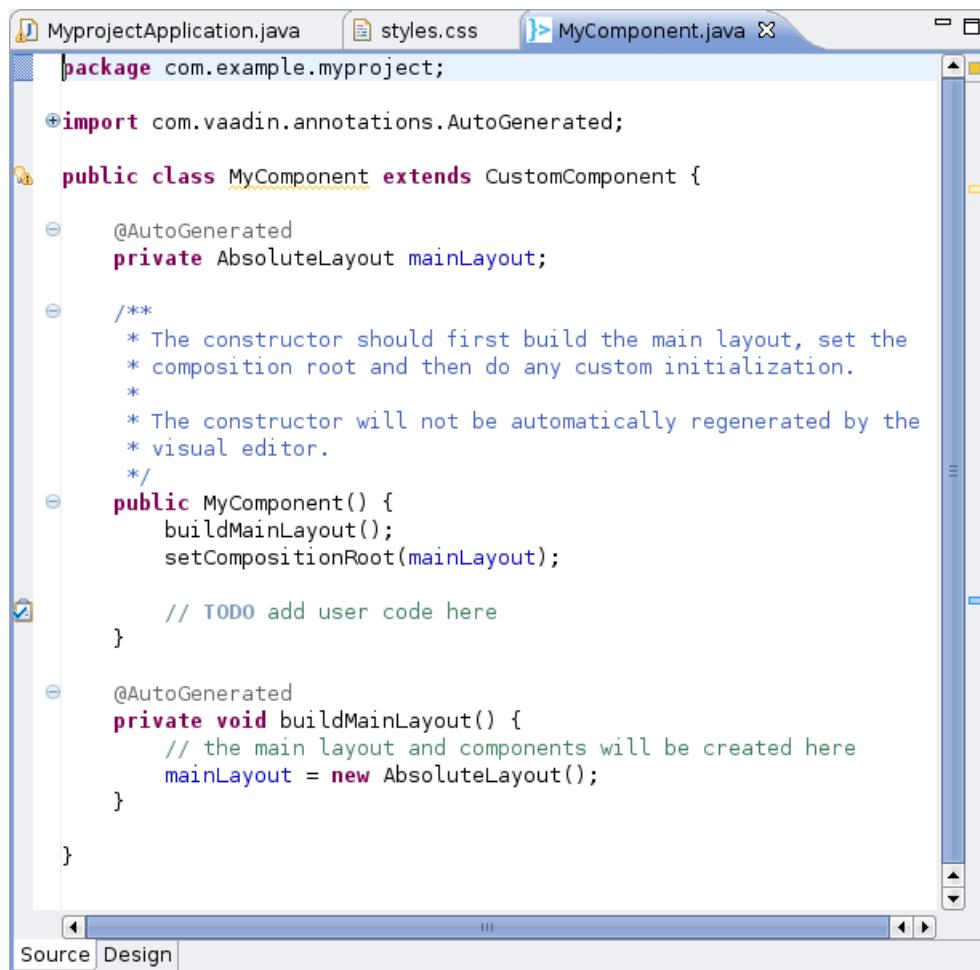
3. The **Source folder** is the root source directory where the new component will be created. This is by default the default source directory of your project.



Enter the Java **Package** under which the new component class should be created or select it by clicking the **Browse** button. Also enter the class **Name** of the new component.

Finally, click **Finish** to create the component.

A newly created composite component is opened in the editor window, as shown in Figure 7.1, "New Composite Component".

Figure 7.1. New Composite Component


```

package com.example.myproject;

import com.vaadin.annotations.AutoGenerated;

public class MyComponent extends CustomComponent {

    @AutoGenerated
    private AbsoluteLayout mainLayout;

    /**
     * The constructor should first build the main layout, set the
     * composition root and then do any custom initialization.
     *
     * The constructor will not be automatically regenerated by the
     * visual editor.
     */
    public MyComponent() {
        buildMainLayout();
        setCompositionRoot(mainLayout);

        // TODO add user code here
    }

    @AutoGenerated
    private void buildMainLayout() {
        // the main layout and components will be created here
        mainLayout = new AbsoluteLayout();
    }
}

```

You can observe that a component that you can edit with the visual editor has two tabs at the bottom of the view: **Source** and **Design**. These tabs allow switching between the source view and the visual editing view.

7.3. Using The Visual Editor

The visual editor view consists of, on the left side, an editing area that displays the current layout and, on the right side, a *control panel* that contains a *component tree*, *component property panel*, and a *component list* for adding new components.

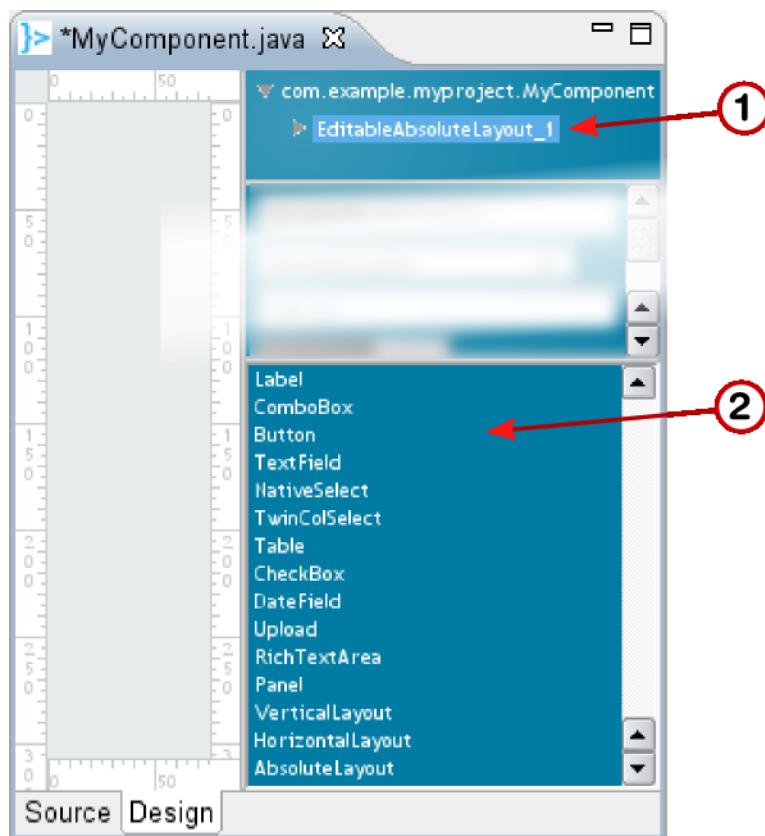
7.3.1. Adding New Components

Adding new components in the user interface is done by adding nodes to the component tree at the top of the editor control panel. The list box at the bottom of the editor control panel shows the components allowed under the selected component; you can generally add components only under a layout (**Layout**) or a component container (**ComponentContainer**).

To add a new node:

1. select an existing node (in the component tree) under which you wish to insert the new node
2. click on a component in the component list at the bottom of the panel.

Figure 7.2. Adding a New Component Node



The component will be added under the selected component in the component tree. You can delete a component by right-clicking it in the component tree and selecting **Remove**.

7.3.2. Setting Component Properties

The property setting area of the control panel allows setting component properties. The area is divided into basic properties, size and position settings, and other properties, which includes also styles.

Basic Properties

The top section of the property panel, shown in Figure 7.3, "Basic Component Properties", allows settings basic component properties.

Figure 7.3. Basic Component Properties



The basic properties are:

Component name	The name of the component, which is used for the reference to the component, so it must obey Java notation for variable names.
Caption	The caption of a component is usually displayed above the component. Some components, such as Button , display the caption inside the component. For Label text, you should set the value of the label instead of the caption, which should be left empty.
Description (tooltip)	The description is usually displayed as a tooltip when the mouse pointer hovers over the component for a while. Some components, such as Form have their own way of displaying the description.
Icon	The icon of a component is usually displayed above the component, left of the caption. Some components, such as Button , display the icon inside the component.
Formatting type	Some components allow different formatting types, such as Label , which allow formatting either as Text , XHTML , Preformatted , and Raw .
Value	The component value. The value type and how it is displayed by the component varies between different component types and each value type has its own editor. The editor opens by clicking on the ... button.

Most of the basic component properties are defined in the **Component** interface; see Section 5.2.1, “Component Interface” for further details.

Size and Position

The size of a component is determined by its width and height, which you can give in the two edit boxes in the control panel. You can use any unit specifiers for components, as described in Section 5.3.9, “Sizing Components”. Emptying a size box will make the size “automatic”, which means setting the size as *undefined*. In the generated code, the undefined value will be expressed as “-1px”.

Setting width of “100px” and *auto* (undefined or empty) height would result in the following generated settings for a button:

```
// myButton
myButton = new Button();
...
myButton.setHeight( "-1px" );
myButton.setWidth( "100px" );
...
```

Figure 7.4, “Component Size and Position” shows the control panel area for the size and position.

Figure 7.4. Component Size and Position



The generated code for the example would be:

```
// myButton
myButton = new Button();
myButton.setWidth( "-1px" );
myButton.setHeight( "-1px" );
myButton.setImmediate( true );
myButton.setCaption( "My Button" );
mainLayout.addComponent( myButton,
                        "top:243.0px;left:152.0px;" );
```

The position is given as a CSS position in the second parameter for `addComponent()`. The values `"-1px"` for width and height will make the button to be sized automatically to the minimum size required by the caption.

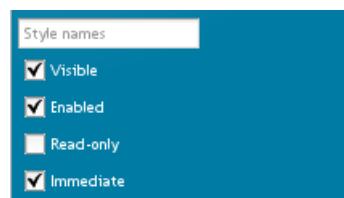
When editing the position of a component inside an **AbsoluteLayout**, the editor will display vertical and horizontal guides, which you can use to set the position of the component. See Section 7.3.3, “Editing an **AbsoluteLayout**” for more information about editing absolute layouts.

The **ZIndex** setting controls the “Z coordinate” of the components, that is, which component will overlay which when they overlap. Value `-1` means automatic, in which case the components added to the layout later will be on top.

Other Properties

The bottom section of the property panel, shown in Figure 7.5, “Other Properties”, allows settings other often used component properties.

Figure 7.5. Other Properties



Style Names	Enter the enabled CSS style names for the component as a space-separated list. See Chapter 8, <i>Themes</i> for information on component styles in themes.
Visible	Defines whether the component is visible or hidden, as set with the <code>setVisible()</code> method.
Enabled	Defines whether the component is enabled or disabled, as set with the <code>setEnabled()</code> method. If disabled, no user interaction is allowed for the component and it is usually shown as shadowed.
Read-only	Defines whether editing the component is allowed, as set with the <code>setReadOnly()</code> method.
Immediate	Defines whether user interaction with the component is updated immediately (after the component loses focus) in the server as a state or value change in the component value.

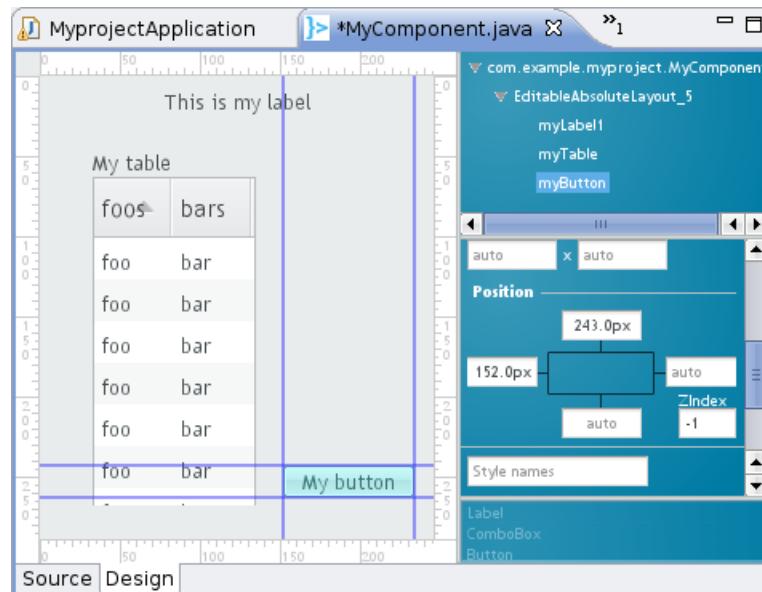
Most of the component properties mentioned above are defined in the **Component** interface; see Section 5.2.1, “**Component** Interface” for further details.

7.3.3. Editing an **AbsoluteLayout**

The visual editor has interactive support for the **AbsoluteLayout** component that allows positioning components exactly at specified coordinates. You can position the components using guides that control the position attributes, shown in the control panel on the right. The position values are measured in pixels from the corresponding edge; the vertical and horizontal rulers show the distances from the top and left edge.

Figure 7.6, “Positioning with **AbsoluteLayout**” shows three components, a **Label**, a **Table**, and a **Button**, inside an **AbsoluteLayout**.

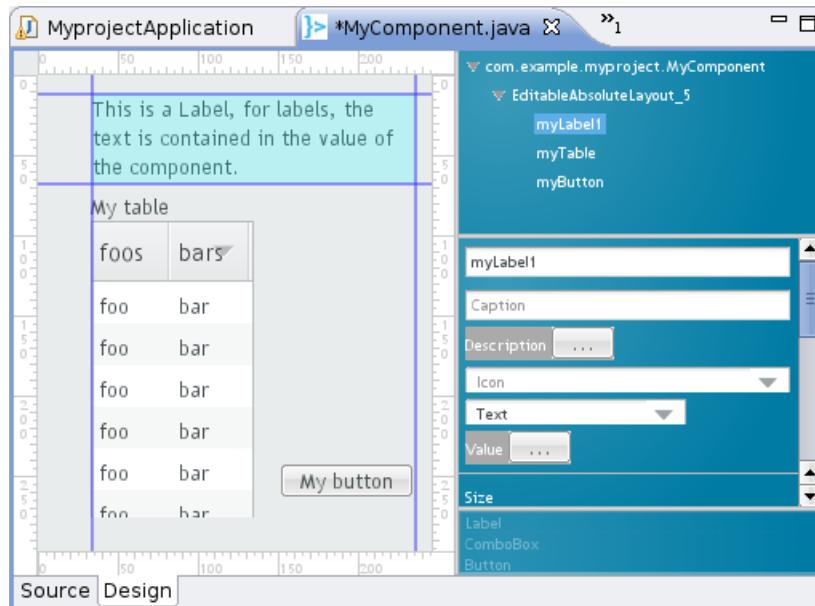
Figure 7.6. Positioning with **AbsoluteLayout**



Position attributes that are empty are *automatic* and can be either zero (at the edge) or dynamic to make it shrink to fit the size of the component, depending on the component. Guides are shown also for the automatic position attributes and move automatically; in Figure 7.6, “Positioning with **AbsoluteLayout**” the right and bottom edges of the **Button** are automatic.

Moving an automatic guide manually makes the guide and the corresponding the position attribute non-automatic. To make a manually set attribute automatic, empty it in the control panel. Figure 7.7, “Manually positioned **Label**” shows a **Label** component with all the four edges set manually. Notice that if an automatic position is 0, the guide is at the edge of the ruler.

Figure 7.7. Manually positioned Label



7.4. Structure of a Visually Editable Component

A component created by the wizard and later managed by the visual editor has a very specific structure that allows you to insert your user interface logic in the component while keeping a minimal amount of code off-limits. You need to know what you can edit yourself and what exactly is managed by the editor. The managed member variables and methods are marked with the **AutoGenerated** annotation, as you can see later.

A visually editable component consists of:

- Member variables containing sub-component references
- Sub-component builder methods
- The constructor

The structure of a composite component is hierarchical, a nested hierarchy of layout components containing other layout components as well as regular components. The root layout of the component tree, or the *composition root* of the **CustomComponent**, is named `mainLayout`. See Section 5.20, “Component Composition with **CustomComponent**” for a detailed description of the structure of custom (composite) components.

7.4.1. Sub-Component References

The **CustomComponent** class will include a reference to each contained component as a member variable. The most important of these is the `mainLayout` reference to the composition root layout. Such automatically generated member variables are marked with the `@AutoGenerated` annotation. They are managed by the editor, so you should not edit them manually, unless you know what you are doing.

A composite component with an **AbsoluteLayout** as the composition root, containing a **Button** and a **Table** would have the references as follows:

```
public class MyComponent extends CustomComponent {

    @AutoGenerated
    private AbsoluteLayout mainLayout;
    @AutoGenerated
    private Button myButton;
    @AutoGenerated
    private Table myTable;
    ...
}
```

The names of the member variables are defined in the component properties panel of the visual editor, in the **Component name** field, as described in the section called “Basic Properties”. While you can change the name of any other components, the name of the root layout is always `mainLayout`. It is fixed because the editor does not make changes to the constructor, as noted in Section 7.4.3, “The Constructor”. You can, however, change the type of the root layout, which is an **AbsoluteLayout** by default.

Certain typically static components, such as the **Label** label component, will not have a reference as a member variable. See the description of the builder methods below for details.

7.4.2. Sub-Component Builders

Every managed layout component will have a builder method that creates the layout and all its contained components. The builder puts references to the created components in their corresponding member variables, and it also returns a reference to the created layout component.

Below is an example of an initial main layout:

```
@AutoGenerated
private AbsoluteLayout buildMainLayout() {
    // common part: create layout
    mainLayout = new AbsoluteLayout();

    // top-level component properties
    setHeight("100.0%");
    setWidth("100.0%");

    return mainLayout;
}
```

Notice that while the builder methods return a reference to the created component, they also write the reference directly to the member variable. The returned reference might not be used by the generated code at all (in the constructor or in the builder methods), but you can use it for your purposes.

The builder of the main layout is called in the constructor, as explained in Section 7.4.3, “The Constructor”. When you have a layout with nested layout components, the builders of each layout will call the appropriate builder methods of their contained layouts to create their contents.

7.4.3. The Constructor

When you create a new composite component using the wizard, it will create a constructor for the component and fill its basic content.

```
public MyComponent() {  
    buildMainLayout();  
    setCompositionRoot(mainLayout);  
  
    // TODO add user code here  
}
```

The most important thing to do in the constructor is to set the composition root of the **Custom-Component** with the `setCompositionRoot()` (see Section 5.20, “Component Composition with **CustomComponent**” for more details on the composition root). The generated constructor first builds the root layout of the composite component with `buildMainLayout()` and then uses the `mainLayout` reference.

The editor will not change the constructor afterwards, so you can safely change it as you want. The editor does not allow changing the member variable holding a reference to the root layout, so it is always named `mainLayout`.

Chapter 8

Themes

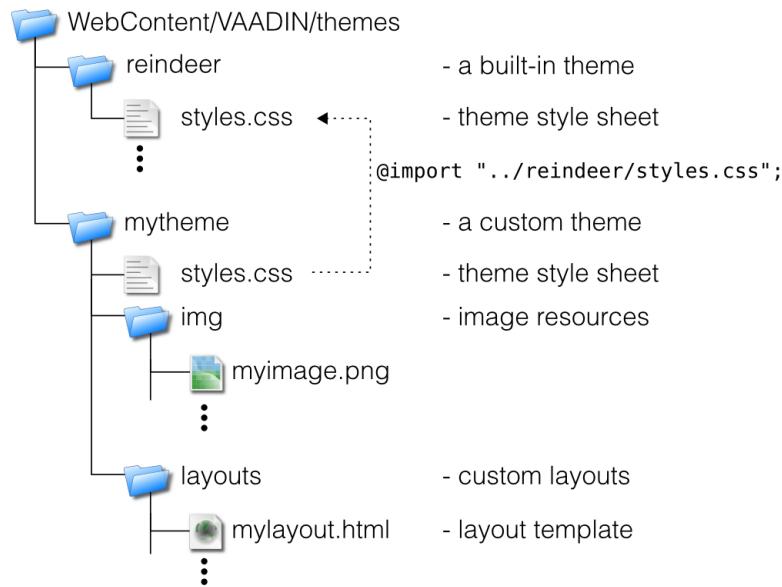
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This chapter provides details about using and creating *themes* that control the visual look of web applications. Themes consist of Cascading Style Sheets (CSS) and other theme resources such as images. We provide an introduction to CSS, especially concerning the styling of HTML by element classes.

8.1. Overview

Vaadin separates the appearance of the user interface from its logic using *themes*. Themes can include CSS style sheets, custom HTML layouts, and any necessary graphics. Theme resources can also be accessed from an application as **ThemeResource** objects.

Custom themes are placed under the `WebContents/VAADIN/themes/` folder of the web application. This location is fixed -- the `VAADIN` folder specifies that these are static resources specific to Vaadin. The folder should normally contain also the built-in themes, although you can let them be loaded dynamically from the Vaadin JAR (even though that is somewhat inefficient). Figure 8.1, “Contents of a Theme” illustrates the contents of a theme.

Figure 8.1. Contents of a Theme

The name of a theme folder defines the name of the theme. The name is used in the `setTheme()` call. A theme must contain the `styles.css` stylesheet, but other contents have free naming. We suggest a convention for naming the folders as `img` for images, `layouts` for custom layouts, and `css` for additional stylesheets.

Custom themes that use an existing complete theme need to inherit the theme. See Section 8.3.2, “Built-in Themes” and Section 8.3.4, “Theme Inheritance” for details on inheriting a theme. Copying and modifying a complete theme is also possible, but it may need more work to maintain if the modifications are small.

You use a theme with a simple `setTheme()` method call for the **Application** object as follows:

```

public class MyApplication
    extends com.vaadin.Application {
    public void init() {
        setTheme("demo");
        ...
    }
}
  
```

An application can use different themes for different users and switch between themes during execution. For smaller changes, a theme can contain alternate styles for user interface components, which can be changed as needed.

In addition to style sheets, a theme can contain HTML templates for custom layouts used with **CustomLayout**. See Section 6.11, “Custom Layouts” for details.

Resources provided in a theme can also be accessed using the **ThemeResource** class, as described in Section 4.5.4, “Theme Resources”. This allows using theme resources, such as images, for example in **Embedded** objects and other objects that allow inclusion of images using resources.

8.2. Introduction to Cascading Style Sheets

Cascading Style Sheets or CSS is a technique to separate the appearance of a web page from the content represented in HTML or XHTML. Let us give a short introduction to Cascading Style Sheets and look how they are relevant to software development with Vaadin.

8.2.1. Basic CSS Rules

A style sheet is a file that contains a set of *rules*. Each rule consists of one or more *selectors*, separated with commas, and a *declaration block* enclosed in curly braces. A declaration block contains a list of *property* statements. Each property has a label and a value, separated with a colon. A property statement ends with a semicolon.

Let us look at an example:

```
p, td {  
    color: blue;  
}  
  
td {  
    background: yellow;  
    font-weight: bold;  
}
```

In the example above, `p` and `td` are element type selectors that match with `<p>` and `<td>` elements in HTML, respectively. The first rule matches with both elements, while the second matches only with `<td>` elements. Let us assume that you have saved the above style sheet with the name `mystylesheet.css` and consider the following HTML file located in the same folder.

```
<html>  
    <head>  
        <link rel="stylesheet" type="text/css"  
              href="mystylesheet.css"/>  
    </head>  
    <body>  
        <p>This is a paragraph</p>  
        <p>This is another paragraph</p>  
        <table>  
            <tr>  
                <td>This is a table cell</td>  
                <td>This is another table cell</td>  
            </tr>  
        </table>  
    </body>  
</html>
```

The `<link>` element defines the style sheet to use. The HTML elements that match the above rules are emphasized. When the page is displayed in the browser, it will look as shown in the figure below.

Figure 8.2. Simple Styling by Element Type

This is a paragraph.

This is another paragraph.

This is a table cell	This is another table cell
----------------------	----------------------------

CSS has an *inheritance* mechanism where contained elements inherit the properties of their parent elements. For example, let us change the above example and define it instead as follows:

```
table {  
    color: blue;  
    background: yellow;  
}
```

All elements contained in the `<table>` element would have the same properties. For example, the text in the contained `<td>` elements would be in blue color.

Each HTML element type accepts a certain set of properties. The `<div>` elements are generic elements that can be used to create almost any layout and formatting that can be created with a specific HTML element type. Vaadin uses `<div>` elements extensively, especially for layouts.

Matching elements by their type is, however, rarely if ever used in style sheets for Vaadin components or Google Web Toolkit widgets.

8.2.2. Matching by Element Class

Matching HTML elements by the *class* attribute of the elements is the most relevant form of matching with Vaadin. It is also possible to match with the *identifier* of a HTML element.

The class of an HTML element is defined with the *class* attribute as follows:

```
<html>  
  <body>  
    <p class="normal">This is the first paragraph</p>  
  
    <p class="another">This is the second paragraph</p>  
  
    <table>  
      <tr>  
        <td class="normal">This is a table cell</td>  
        <td class="another">This is another table cell</td>  
      </tr>  
    </table>  
  </body>  
</html>
```

The class attributes of HTML elements can be matched in CSS rules with a selector notation where the class name is written after a period following the element name. This gives us full control of matching elements by their type and class.

```
p.normal  {color: red;}  
p.another {color: blue;}  
td.normal  {background: pink;}  
td.another {background: yellow;}
```

The page would look as shown below:

Figure 8.3. Matching HTML Element Type and Class

This is a paragraph with "normal" class

This is a paragraph with "another" class

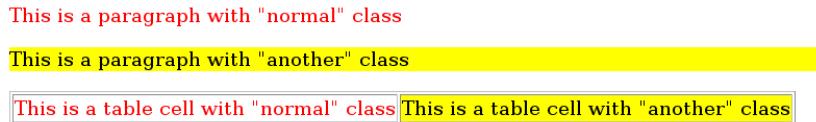
This is a table cell with "normal" class This is a table cell with "another" class

We can also match solely by the class by using the universal selector * for the element name, for example *.normal. The universal selector can also be left out altogether so that we use just the class name following the period, for example .normal.

```
.normal {  
    color: red;  
}  
  
.another {  
    background: yellow;  
}
```

In this case, the rule will match with all elements of the same class regardless of the element type. The result is shown in Figure 8.4, “Matching Only HTML Element Class”. This example illustrates a technique to make style sheets compatible regardless of the exact HTML element used in drawing a component.

Figure 8.4. Matching Only HTML Element Class



To assure compatibility, we recommend that you use only matching based on the element classes and *do not* match for specific HTML element types in CSS rules, because either Vaadin or GWT may use different HTML elements to render some components in the future. For example, IT Mill Toolkit Release 4 used `<div>` elements extensively for layout components. However, IT Mill Toolkit Release 5 and Vaadin use GWT to render the components, and GWT uses the `<table>` element to implement most layouts. Similarly, IT Mill Toolkit Release 4 used `<div>` element also for buttons, but in Release 5, GWT uses the `<button>` element. Vaadin has little control over how GWT renders its components, so we can not guarantee compatibility in different versions of GWT. However, both `<div>` and `<table>` as well as `<tr>` and `<td>` elements accept most of the same properties, so matching only the class hierarchy of the elements should be compatible in most cases.

8.2.3. Matching by Descendant Relationship

CSS allows matching HTML by their containment relationship. For example, consider the following HTML fragment:

```
<body>  
    <p class="mytext">Here is some text inside a  
        paragraph element</p>  
    <table class="mytable">  
        <tr>  
            <td class="mytext">Here is text inside  
                a table and inside a td element.</td>  
        </tr>  
    </table>  
</body>
```

Matching by the class name `.mytext` alone would match both the `<p>` and `<td>` elements. If we want to match only the table cell, we could use the following selector:

```
.mytable .mytext {color: blue;}
```

To match, a class listed in a rule does not have to be an immediate descendant of the previous class, but just a descendant. For example, the selector ".v-panel .v-button" would match all elements with class .v-button somewhere inside an element with class .v-panel.

Let us give an example with a real case. Consider the following Vaadin component.

```
public class LoginBox extends CustomComponent {
    Panel panel = new Panel("Log In");

    public LoginBox () {
        setCompositionRoot(panel);

        panel.addComponent(new TextField("Username:"));
        panel.addComponent(new TextField("Password:"));
        panel.addComponent(new Button("Login"));
    }
}
```

The component will look by default as shown in the following figure.

Figure 8.5. Themeing Login Box Example with 'runo' theme.



Now, let us look at the HTML structure of the component. The following listing assumes that the application contains only the above component in the main window of the application.

```
<body>
<div id="itmtk-ajax-window">
<div>
    <div class="v-orderedlayout">
        <div>
            <div class="v-panel">
                <div class="v-panel-caption">Log In</div>
                <div class="v-panel-content">
                    <div class="v-orderedlayout">
                        <div>
                            <div>
                                <div class="v-caption">
                                    <span>Username:</span>
                                </div>
                                <div>
                                    <input type="text" class="v-textfield"/>
                                </div>
                            </div>
                            <div>
                                <div class="v-caption">
                                    <span>Password:</span>
                                </div>
                                <div>
                                    <input type="password"
                                           class="v-textfield"/>
                                </div>
                            </div>
                        </div>
                    </div>
                </div>
            </div>
        </div>
    </div>
</div>
```

```

        <button type="button"
               class="v-button">Login</button>
        </div>
    </div>
</div>
<div class="v-panel-deco" />
</div>
</div>
</div>
</div>
</body>

```

Now, consider the following theme where we set the backgrounds of various elements.

```

.v-panel .v-panel-caption {
    background: #80ff80; /* pale green */
}

.v-panel .v-panel-content {
    background: yellow;
}

.v-panel .v-textfield {
    background: #e0e0ff; /* pale blue */
}

.v-panel .v-button {
    background: pink;
}

```

The coloring has changed as shown in the following figure.

Figure 8.6. Themeing Login Box Example with Custom Theme



An element can have multiple classes separated with a space. With multiple classes, a CSS rule matches an element if any of the classes match. This feature is used in many Vaadin components to allow matching based on the state of the component. For example, when the mouse is over a **Link** component, `over` class is added to the component. Most of such styling is a feature of Google Web Toolkit.

8.2.4. Notes on Compatibility

CSS was first proposed in 1994. The specification of CSS is maintained by the CSS Working Group of World Wide Web Consortium (W3C). Its versions are specified as *levels* that build upon the earlier version. CSS Level 1 was published in 1996, Level 2 in 1998. Development of CSS Level 3 was started in 1998 and is still under way.

While the support for CSS has been universal in all graphical web browsers since at least 1995, the support has been very incomplete at times and there still exists an unfortunate number of incompatibilities between browsers. While we have tried to take these incompatibilities into account in the built-in themes in Vaadin, you need to consider them while developing custom themes.

Compatibility issues are detailed in various CSS handbooks.

8.3. Creating and Using Themes

Custom themes are placed in VAADIN/themes folder of the web application (in the WebContent directory) as illustrated in Figure 8.1, “Contents of a Theme”. This location is fixed. You need to have a theme folder for each theme you use in your application, although applications rarely need more than a single theme. For example, if you want to define a theme with the name mytheme, you will place it in folder VAADIN/themes/mytheme.

A custom theme must also inherit a built-in theme, as shown in the example below:

```
@import "../reindeer/styles.css";  
  
.v-app {  
    background: yellow;  
}
```

Vaadin 6.0 includes two built-in themes: reindeer and runo. The latter is a compatibility theme for IT Mill Toolkit 5; there is no longer a "default" theme. See Section 8.3.2, “Built-in Themes” and Section 8.3.4, “Theme Inheritance” below for details on inheriting themes.

8.3.1. Styling Standard Components

Each user interface component in Vaadin has a CSS style class that you can use to control the appearance of the component. Some components have additional sub-elements that also allow styling.

Table 8.1, “Default CSS Style Names of Vaadin Components” lists the style classes of all Vaadin components, together with their client-side widgets. Notice that a single server-side component can have multiple client-side implementations. For example, a **Button** can be rendered on the client side either as a regular button or a check box, depending on the *switchMode* attribute of the button. For details regarding the mapping to client-side components, see Section 10.5, “Defining a Widget Set”. Each client-side component type has its own style class and a number of additional classes that depend on the client-side state of the component. For example, a text field will have *v-textfield-focus* class when mouse pointer hovers over the component. This state is purely on the client-side and is not passed to the server.

Table 8.1. Default CSS Style Names of Vaadin Components

Server-Side Component	Client-Side Widget	CSS Class Name
AbsoluteLayout	VAbsoluteLayout	v-absolutelayout
Accordion	VAccordion	v-accordion
Button	VButton	v-button
CheckBox	VCheckBox	v-checkbox
CssLayout	VCssLayout	v-csslayout
CustomComponent	VCustomComponent	v-customcomponent
CustomLayout	VCustomLayout	v-customlayout
DateField	VDateField	v-datepicker
	VCalendar	v-datepicker-entrycalendar
	VDatePickerCalendar	v-datepicker-calendar
	VPopupCalendar	v-datepicker-calendar
	VTextualDate	v-textualdate
Embedded	VEmbedded	-
Form	VForm	v-form
FormLayout	VFormLayout	-
GridLayout	VGridLayout	-
Label	VLabel	v-label
Link	VLink	v-link
OptionGroup	VOptionGroup	v-select-optiongroup
HorizontalLayout	VHorizontalLayout	v-horizontallayout
VerticalLayout	VVerticalLayout	v-verticallayout
Panel	VPanel	v-panel
Select		
	VListSelect	v-listselect
	VFilterSelect	v-filterselect
Slider	VSlider	v-slider
SplitPanel	VSplitPanel	-
	VSplitPanelHorizontal	-
	VSplitPanelVertical	-
Table	VScrollTable	v-table
	VTablePaging	v-table
TabSheet	VTabsheet	v-tabsheet
TextField	VTextField	v-textfield
	VTextArea	
	VPasswordField	
Tree	VTree	v-tree
TwinColSelect	VTwinColSelect	v-select-twincol

Server-Side Component	Client-Side Widget	CSS Class Name
Upload	VUpload	-
Window	VWindow	v-window
-	CalendarEntry	-
-	CalendarPanel	v-datepicker-calendarpanel
-	ContextMenu	v-contextmenu
-	VUnknownComponent	vaadin-unknown
-	VView	-
-	Menubar	gwt-MenuBar
-	MenuItem	gwt-MenuItem
-	Time	v-datepicker-time

Please see the documentation of the particular components for a listing of possible sub-component styles.

Some client-side components can be shared by different server-side components. There is also the **VUnknownComponent**, which is a component that indicates an internal error in a situation where the server asked to render a component which is not available on the client-side.

8.3.2. Built-in Themes

Vaadin currently includes two built-in themes: `reindeer` and `runo`. The latter is the default theme for IT Mill Toolkit 5 (where its name is "default"); the default theme in Vaadin 6.0 is `reindeer`.

The built-in themes are provided in the respective `VAADIN/themes/reindeer/styles.css` and `VAADIN/themes/runo/styles.css` stylesheets in the Vaadin library JAR. These stylesheets are compilations of the separate stylesheets for each component in the corresponding subdirectory. The stylesheets are compiled to a single file for efficiency: the browser needs to load just a single file.



Serving Built-In Themes Staticly

The built-in themes included in the Vaadin library JAR are served dynamically from the JAR by the servlet. Serving a theme statically by the web server is much more efficient. You only need to extract the `VAADIN/` directory from the JAR under your `WebContent` directory. Just make sure to update it if you upgrade to a newer version of Vaadin.

Creation of a default theme for custom GWT widgets is described in Section 10.3.3, "Styling GWT Widgets".

8.3.3. Using Themes

Using a theme is simple, you only need to set the theme with `setTheme()` in the application object. The Eclipse wizard for creating custom Vaadin themes automatically adds such call in the `init()` method of the application class, as explained in Section 8.4, "Creating a Theme in Eclipse".

Defining the appearance of a user interface component is fairly simple. First, you create a component and add a custom style name for it with `addStyleName()`. Then you write the CSS element that defines the formatting for the component.

8.3.4. Theme Inheritance

When you define your own theme, you will need to inherit a built-in theme (unless you just copy the built-in theme).

Inheritance in CSS is done with the `@import` statement. In the typical case, when you define your own theme, you inherit a built-in theme as follows:

```
@import "../reindeer/styles.css";  
  
.v-app {  
    background: yellow;  
}
```

You can even create a deep hierarchy of themes by inheritance. Such a solution is often useful if you have some overall theme for your application and a slightly modified theme for different user classes. You can even make it possible for each user to have his or her own theme.

For example, let us assume that we have the base theme of an application with the name **myapp** and a specific **myapp-student** theme for users with the student role. The stylesheet of the base theme would be located in `themes/myapp/styles.css`. We can then "inherit" it in `themes/myapp-student/styles.css` with a simple `@import` statement:

```
@import "../myapp/styles.css";  
  
.v-app {  
    background: green;  
}
```

This would make the page look just as with the base theme, except for the green background. You could use the theme inheritance as follows:

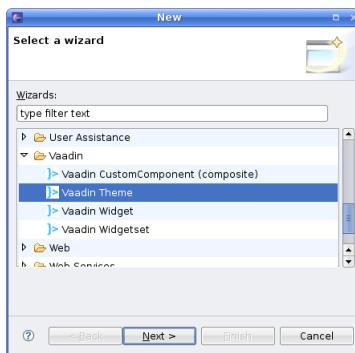
```
public class MyApplication extends com.vaadin.Application {  
  
    public void init() {  
        setTheme("myapp");  
        ...  
    }  
  
    public void login(User user) {  
        if (user.role == User.ROLE_STUDENT)  
            setTheme("myapp-student");  
        ...  
    }  
  
    public void logout() {  
        setTheme("myapp");  
        ...  
    }  
}
```

In the above example, the **User** class is an imaginary class assumed to hold user information.

8.4. Creating a Theme in Eclipse

The Eclipse plugin provides a wizard for creating custom themes. Do the following steps to create a new theme.

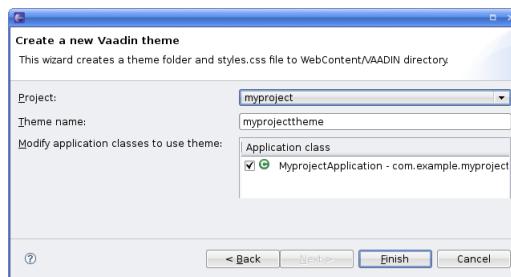
1. Select **File → New → Other...** in the main menu or right-click the **Project Explorer** and select **New → Other...**. A window will open.
2. In the **Select a wizard** step, select the **Vaadin → Vaadin Theme** wizard.



Click **Next** to proceed to the next step.

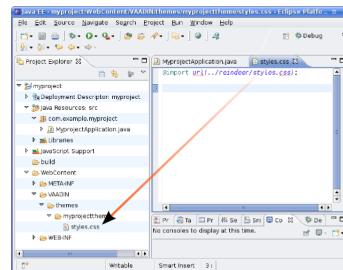
3. In the **Create a new Vaadin theme** step, you have the following settings:

Project (mandatory)	The project in which the theme should be created.
Theme name (mandatory)	The theme name is used as the name of the theme folder and in a CSS tag (prefixed with "v-theme-"), so it must be a proper identifier. Only latin alphanumeric, underscore, and minus sign are allowed.
Modify application classes to use theme (optional)	The setting allows the wizard to write a code statement that enables the theme in the constructor of the selected application class(es). If you need to control the theme with dynamic logic, you can leave the setting unchecked or change the generated line later.



Click **Finish** to create the theme.

The wizard creates the theme folder under the `WebContent/VAADIN/themes` folder and the actual style sheet as `styles.css`, as illustrated in Figure 8.7, "Newly Created Theme".

Figure 8.7. Newly Created Theme

The created theme inherits a built-in base theme with an `@import` statement. See the explanation of theme inheritance in Section 8.3, “Creating and Using Themes”. Notice that the `reindeer` theme is not located in the `widgetsets` folder, but in the Vaadin JAR. See Section 8.3.2, “Built-in Themes” for information for serving the built-in themes.

If you selected an application class or classes in the **Modify application classes to use theme** in the theme wizard, the wizard will add the following line at the end of the `init()` method of the application class(es):

```
setTheme( "myprojecttheme" );
```

Notice that renaming a theme by changing the name of the folder will not change the `setTheme()` calls in the application classes or vice versa. You need to change such references to theme names in the calls manually.

Chapter 9

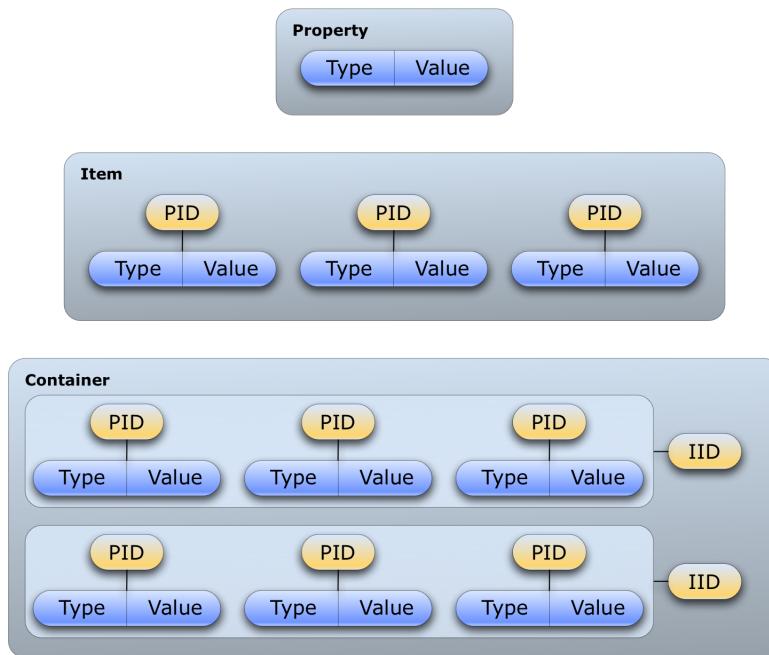
Binding Components to Data

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This chapter describes the Vaadin Data Model and shows how you can use it to bind components directly to data sources, such as database queries.

9.1. Overview

The Vaadin Data Model is one of the core concepts of the library. To allow the view (user interface components) to access the application data directly, we have introduced a standard data interface. Application data needs a common interface so that the data can be accessed by the view and the controller alike. In Vaadin, we have solved this with the Data Model.

Figure 9.1. Vaadin Data Model

The Vaadin Data Model allows binding user interface components directly to the data they show and modify. There are three nested levels of hierarchy in the data model: *property*, *item* and *container*. Using a spreadsheet application as an analogy, these would correspond to the data underlying a cell, a row and a table, respectively. The components would display the data in these and optionally allow direct editing of the corresponding entities.

The Data Model is realized as a set of interface classes in the fittingly named package **com.vaadin.data**. The package contains the interfaces **Property**, **Item**, and **Container**, along with a number of more specialized interfaces and classes.

Notice that the Data Model does not define data representation, but only interfaces. This leaves the representation fully to the implementation of the containers. The representation can be almost anything, such as a Java object structure, a filesystem, or a database query.

The Data Model is used heavily in UI components of Vaadin. A key feature of all UI components is that they can either maintain their data by themselves or be bound to an external data source. Various components also implement some of these interfaces themselves, so you can actually use them as data sources for other components.

The Data Model has many important and useful features, such as support for change notification, transactions, validation, and lazy loading.

9.2. Properties

Vaadin data model is one of the core concepts in the library and the **Property**-interface is the base of that model. Property provides a standardized API for a single data object that can be read (get) and written (set). A property is always typed, but can optionally support data type conversions. The type of a property can be any Java class. Optionally, properties can provide value change events for following their changes.

Properties are in themselves unnamed objects. Properties are collected in an **item**, which associates the properties with names, the *Property Identifiers* or *PIDs*. Items can be contained in containers and are identified with *Item Identifiers* or *IIDs*. In the spreadsheet analogy, *Property Identifiers* would correspond to column names and *Item Identifiers* to row names. The identifiers can be arbitrary objects, but should implement the `equals(Object)` and `hashCode()` methods so that they can be used in any standard Java **Collection**.

The most important function of the Property as well as other data models is to connect classes implementing the interface directly to editor and viewer classes. Typically this is used to connect different data sources to UI components for editing and viewing their contents.

Properties can be utilized either by implementing the interface or by using some of the existing property implementations. Vaadin includes **Property** interface implementations for arbitrary function pairs or Bean-properties as well as simple object properties.

Many of the UI components also implement Property interface and allow setting of other components as their data-source. Simple UI-components that control a single property (their displayed value or state) include various **Field** implementations such as **TextField**, **DateField** and **Button** as well as the **Label**. You can access this property through the **Property** interface inherited by the components.

In addition to the simple components, a variety of selectable components such as Select, Table and Tree have a property that contains their current selection (the identifier of the selected item or a set of item identifiers).

Components manage their *property* by default using an internal data source object, in which case the property is contained within the component, but you can bind the the components to external data sources with the `setPropertyDataSource()` method of the **com.vaadin.ui.AbstractField** class inherited by such components.

9.3. Holding properties in Items

Item is an object that contains a set of named properties. Each property is identified by a property identifier (PID) and a reference to the property can be queried from the **Item**. **Item** defines inner interfaces for maintaining the item property set and listening changes in the item property set. Concrete examples or items include a row in a table (with its properties corresponding to cells on the row), the data underlying a form (with properties corresponding to individual fields) or a node in a filesystem tree.

In addition to being used indirectly by many user interface components, items provide the basic data model underlying **Form** components. In simple cases, forms can even be generated automatically from items. The properties of the item correspond to the fields of the form.

Items generally represent objects in the object-oriented model, but with the exception that they are configurable and provide an event mechanism. The simplest way of utilizing **Item** interface is to use existing Item implementations. Provided utility classes include a configurable property set (**PropertysetItem**) and a bean-to-item adapter (**BeanItem**), in addition to which a **Form** can also be used directly as an item.

9.4. Collecting items in Containers

Container is the most advanced of the data model supported by Vaadin. It provides a very flexible way of managing a set of items that share common properties. Each item is identified by an item

id. Properties can be requested from container with item and property ids. Another way of accessing properties is to first request an item from container and then request its properties from it.

By implementing a container interface, you can bind UI components directly to data. As containers can be unordered, ordered, indexed, or hierarchical, they can interface practically any kind of data representation. Vaadin includes data connectors for some common data sources, such as the simple data tables and filesystem.

The **Container** interface was designed with flexibility and efficiency in mind. It contains inner interfaces that containers can optionally implement for ordering the items sequentially, indexing the items and accessing them hierarchically. Those ordering models provide the basis for the **Table**, **Tree**, and **Select** UI components. As with other data models, the containers support events for notifying about changes made to their contents.

In addition to separate container objects, also many UI components are containers in addition to being properties. This is especially true for selectable components (that implement **Select**), because they are containers that contain selectable items. Their property is the currently selected item. This is useful as it enables binding components to view and update each others' data directly, and makes it easy to reuse already constructed data models - e.g. a form could edit a row (item) of a table directly, and the table could use a database container as its underlying container. The fields of the form would correspond to the properties of the item, i.e. the cells of the table row. For more details on components, see Chapter 5, *User Interface Components*.

The library contains a set of utilities for converting between different container implementations by adding external ordering or hierarchy into existing containers. In-memory containers implementing indexed and hierarchical models provide easy-to-use tools for setting up in-memory data storages. Such default container implementations include **IndexedContainer**, which can be thought of as a generalization of a two-dimensional data table, and **BeanItemContainer** which maps standard Java objects (beans) to items of an indexed container. In addition, the default containers include a hierarchical container for direct file system browsing.

9.4.1. Iterating Over a Container

As the items in a **Container** are not necessarily indexed, iterating over the items has to be done using an **Iterator**. The `getitemid()` method of **Container** returns a **Collection** of item identifiers over which you can iterate. The following example demonstrates a typical case where you iterate over the values of check boxes in a column of a **Table** component. The context of the example is the example used in Section 5.12, “**Table**”.

```
// Collect the results of the iteration into this string.  
String items = "";  
  
// Iterate over the item identifiers of the table.  
for (Iterator i = table.getitemid().iterator(); i.hasNext();) {  
    // Get the current item identifier, which is an integer.  
    int iid = (Integer) i.next();  
  
    // Now get the actual item from the table.  
    Item item = table.getItem(iid);  
  
    // And now we can get to the actual checkbox object.  
    Button button = (Button)  
        (item.getItemProperty("ismember").getValue());  
  
    // If the checkbox is selected.  
    if ((Boolean)button.getValue() == true) {  
        // Do something with the selected item; collect the  
        // first names in a string.
```

```
        items += item.getItemProperty("First Name")
                  .getValue() + " ";
    }
}

// Do something with the results; display the selected items.
layout.addComponent (new Label("Selected items: " + items));
```

Notice that the `getIds()` returns an *unmodifiable collection*, so the **Container** may not be modified during iteration. You can not, for example, remove items from the **Container** during iteration. The modification includes modification in another thread. If the **Container** is modified during iteration, a **ConcurrentModificationException** is thrown and the iterator may be left in an undefined state.

Chapter 10

Developing Custom Components

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This chapter describes how you can create custom client-side components as Google Web Toolkit (GWT) widgets and how you integrate them with Vaadin. The client-side implementations of all standard user interface components in Vaadin use the same client-side interfaces and patterns.

Google Web Toolkit is intended for developing browser-based user interfaces using the Java language, which is compiled into JavaScript that is executed in the browser. Knowledge of such client-side technologies is usually not needed with Vaadin, as its built-in repertoire of user interface components should be sufficient for most applications. The easiest way to create custom components in Vaadin is to make composite components with the **CustomComponent** class, as

described in Section 5.20, “Component Composition with **CustomComponent**”. In some cases, however, you may need to make modifications to existing components, integrate existing GWT widgets with your application, or create entirely new ones.

Creation of new widgets involves a number of rather intricate tasks. The Vaadin Plugin for Eclipse makes many of the tasks much easier, so if you are using Eclipse and the plugin, you should find Section 10.2, “Doing It the Simple Way in Eclipse” helpful.

If you need more background on the architecture, Section 3.4, “Client-Side Engine” gives an introduction to the architecture of the Vaadin Client-Side Engine. If you are new to Google Web Toolkit, Section 3.2.2, “Google Web Toolkit” gives an introduction to GWT and its role in the architecture of Vaadin.



On Terminology

Google Web Toolkit uses the term *widget* for user interface components. In this book, we use the term *widget* to refer to client-side components made with Google Web Toolkit, while using the term *component* in a general sense and also in the special sense for server-side components.

10.1. Overview

The Client-Side Engine of Vaadin runs in the web browser as a JavaScript program and renders the user interface components according to state data received from the server. For each server-side component, there is a client-side widget, which renders the content of the particular component type. The client-side engine and all the built-in client-side widgets of Vaadin have been programmed in Java with GWT, and compiled into JavaScript with the GWT Compiler. Developing custom Vaadin components and integrating existing GWT widgets is easy, requiring only Java programming.

You can start with any existing GWT widget or design a new one. To integrate it with Vaadin, you have to implement the **Paintable** interface of the client-side engine that provides the AJAX communications with the server-side application. You can find the interface in the `com.vaadin.terminal.gwt.client` package. You can also choose to extend an existing Vaadin client-side widget in the `com.vaadin.terminal.gwt.client.ui` package. You can find the source code for the built-in widgets in the Vaadin JAR.

To use custom widgets, you need to define a *widget set* that inherits the **DefaultWidgetSet**, which contains the standard widgets, or some other widget set. You can also define stylesheets for custom widgets. A widget set is defined in a GWT Module Descriptor.

For the server-side API, you need a server-side component that can serialize and deserialize its attributes to and from the client-side counterpart. A server-side component usually inherits the **AbstractComponent** or **AbstractField** class and implements either the `paintContent()` or the more generic `paint()` method to serialize its data to the client. These methods “paint” the component in the browser by generating a UIDL element that is sent to the client. The UIDL element contains all the relevant information about the component, and you can easily add your own attributes to it. Upon reception of UIDL messages, the client-side engine creates or updates user interface widgets as needed.

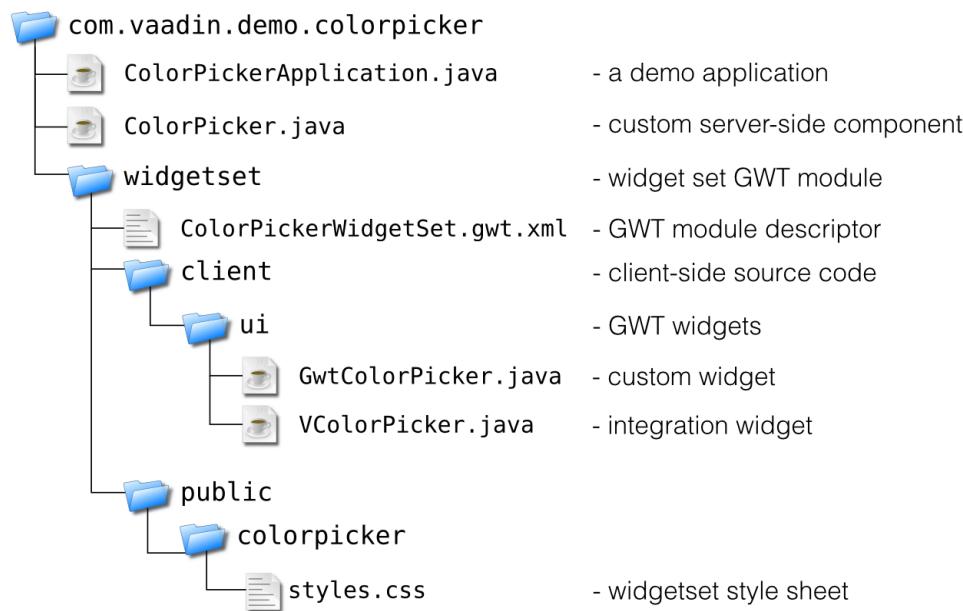
To summarize, you need to do the following:

- Implement the **Paintable** interface of Vaadin in a GWT widget

- Define a widget set that extends an existing widget set with the new widget
- Create a default CSS style sheet for the widget set (optional)
- Create a GWT Module Descriptor (`.gwt.xml`) that defines the widget set and the optional style sheet
- Create a server-side counterpart for the client-side widget

Figure 10.1, “Color Picker Package” illustrates the folder hierarchy of the Color Picker example used in this chapter. The example is available in the demo application of Vaadin with URL `/colorpicker/`. You can find the full source code of the application in the source folder of the demos in the installation package.

Figure 10.1. Color Picker Package



The `ColorPickerApplication.java` application provides an example of using the custom **ColorPicker** component. The source code for the server-side implementation of the component is located in the same folder.

The GWT Compiler takes the root folder of the client-side source code as its argument and compiles all the Java source files into JavaScript. A client-side widget set must therefore be contained within a single package, which in the Color Picker example is the `com.vaadin.demo.colorpicker.gwt.client` package. The inherited widget set and an optional style sheet are specified in a `.gwt.xml` descriptor for the GWT Compiler. In the example, the client-side widget is split in two classes: **GwtColorPicker**, a pure GWT widget, and **VColorPicker** that provides the integration with Vaadin. The default style sheet for the widget set is defined in the descriptor and located in the `gwt/public/colorpicker/styles.css` subfolder.

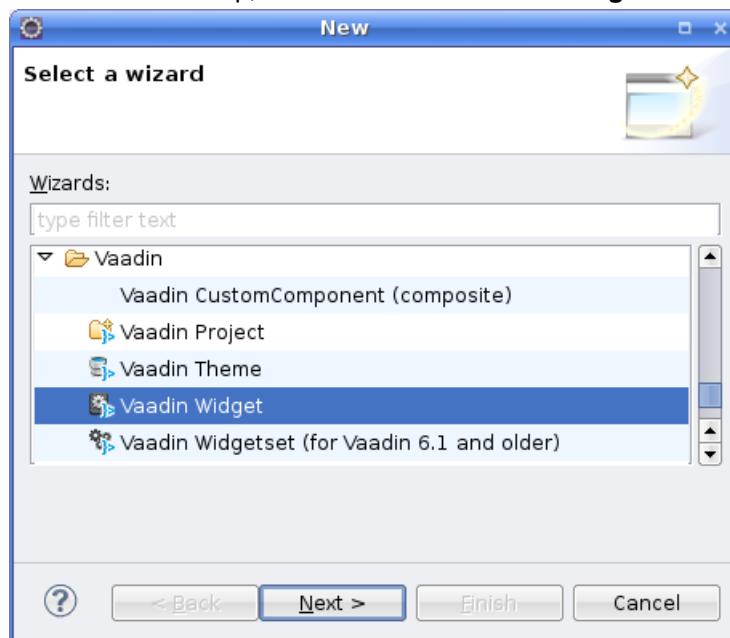
10.2. Doing It the Simple Way in Eclipse

While you can develop new widgets with any IDE or even without, you may find Eclipse and the Vaadin Plugin for it useful, as it automates all the basic routines of widget development, most importantly the creation of new widgets.

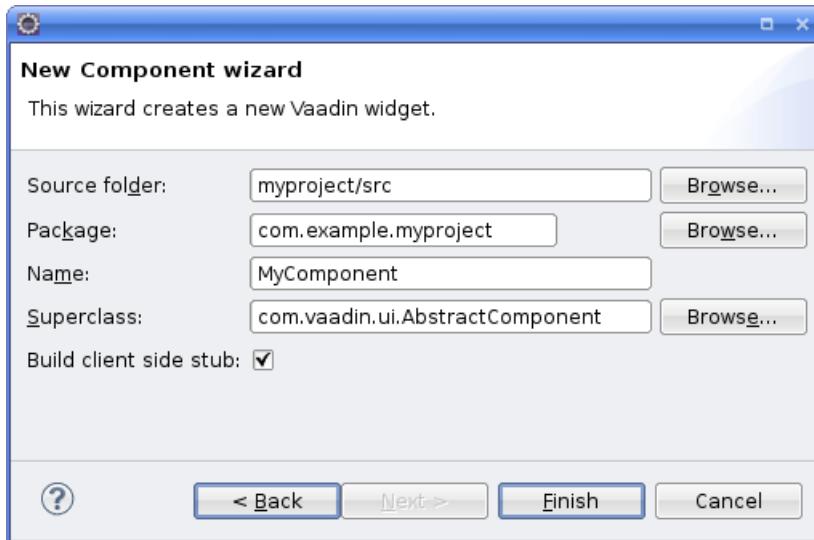
10.2.1. Creating a Widget

You can create a new widget as follows:

1. Select **File → New → Other...** in the main menu or right-click the **Project Explorer** and select **New → Other...** or press **Ctrl-N** to open the **New** dialog.
2. In the first, **Select a wizard** step, select **Vaadin → Vaadin Widget** and click **Next**.



3. In the **New Component wizard** step, fill out the target folder, package, and class information.

**Source folder**

The root folder of the entire source tree. The default value is the default source tree of your project, and you should normally leave it unchanged unless you have a different project structure.

Package

The parent package under which the new server-side component should be created. If it does not already exist, the `.gwt.xml` descriptor that defines the widget set will be created under the widgetset subpackage under this package, and the actual new widget under the `widgetset.client.ui` subpackage.

Name

The class name of the new *server-side component*. The name of the client-side widget stub (if you have its creation enabled) will be the same but with "V-" prefix, for example, **VMycomponent**. You can rename the classes afterwards.

Superclass

The superclass of the server-side component. It is **AbstractComponent** by default, but **com.vaadin.ui.AbstractField** or **com.vaadin.ui.AbstractSelect** are other commonly used superclasses. If you are extending an existing component, you should select it as the superclass. You can easily change the superclass later.

Build client-side stub

When this option is selected (strongly recommended), the wizard will build a stub for the client-side widget.

Finally, click **Finish** to create the new component.

The wizard will:

- Create a server-side component stub in the base package
- Create a GWT module descriptor file (`.gwt.xml`) in the widgetset package under the base package

- Create a client-side widget stub in the `widgetset.client.ui` package under the base package
- Modify the `web.xml` deployment descriptor to specify the widget set class name parameter for the application.

The structure of the server-side component and the client-side widget, and the serialization of component state between them, is explained in the subsequent sections of this chapter.

To compile the widget set, click the **Compile widget set** button in the Eclipse toolbar. See Section 10.2.2, “Recompiling the Widget Set” for details. After the compilation finishes, you should be able to run your application as before, but using the new widget set. The compilation result is written under the `WebContent/VAADIN/widgetsets` folder. When you need to recompile the widget set in Eclipse, see Section 10.2.2, “Recompiling the Widget Set”. For detailed information on compiling widget sets, see Section 10.8.4, “Compiling GWT Widget Sets”.

The following setting is inserted in the `web.xml` deployment descriptor to enable the widget set:

```
<init-param>
    <description>Application widgetset</description>
    <param-name>widgetset</param-name>

    <param-value>com.example.myproject.widgetset.MyprojectApplicationWidgetset</param-value>
</init-param>
```

You can refactor the package structure if you find need for it, but GWT compiler requires that the client-side code *must* always be stored under a package named “client”.

10.2.2. Recompiling the Widget Set

After you edit a widget, you need to recompile the widget set. Vaadin automatically suggests to compile the widget set every time you save a client-side source file. If this gets annoying, you can disable the automatic recompilation from the Vaadin category in project settings, by selecting the **Suspend automatic widgetset builds** option.

You can recompile the widget set manually by clicking the **Compile widgetset** button in the Eclipse toolbar, shown in Figure 10.2, “The **Compile Widgetset** Button in Eclipse Toolbar” while the project is open and selected.

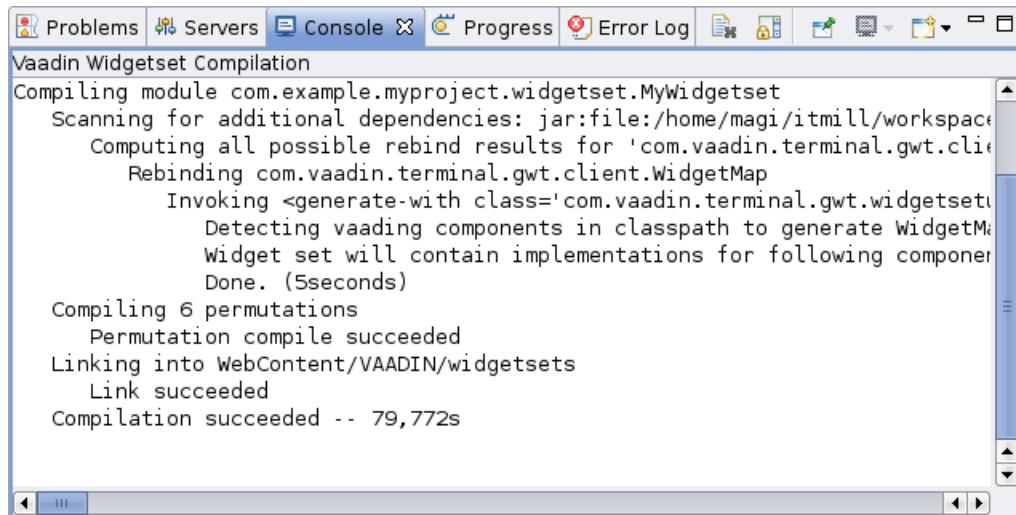
Figure 10.2. The Compile Widgetset Button in Eclipse Toolbar



The compilation progress is shown in the **Console** panel in Eclipse, as illustrated in Figure 10.3, “Recompiling a Widget Set”.

The compilation output is written under the `WebContent/VAADIN/widgetsets` folder, in a widget set specific folder.

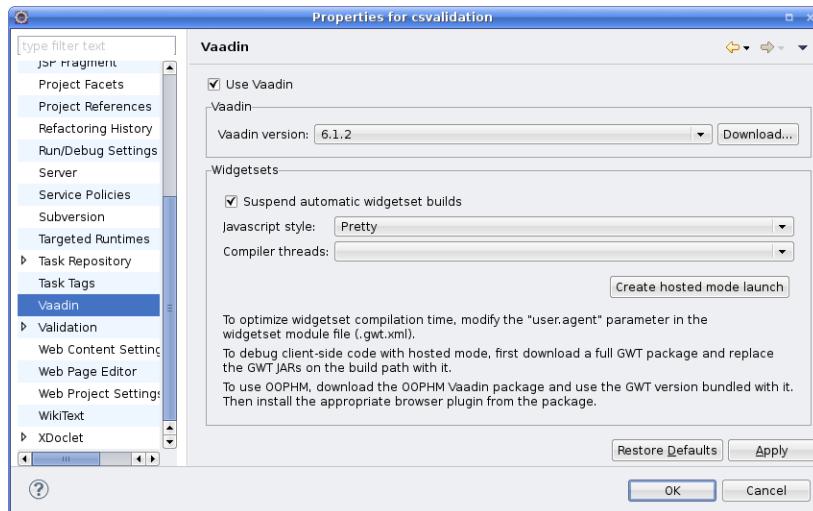
You can speed up the compilation significantly by compiling the widget set only for your browser during development. The generated `.gwt.xml` descriptor stub includes a disabled element that specifies the target browser. See Section 10.5, “Defining a Widget Set” for more details on setting the `user-agent` property.

Figure 10.3. Recompiling a Widget Set

For detailed information on compiling widget sets, see Section 10.8.4, “Compiling GWT Widget Sets”. Should you compile a widget set outside Eclipse, you need to refresh the project by selecting it in **Project Explorer** and pressing **F5**.

10.2.3. Plugin Related Project Settings

When you have the Eclipse Plugin installed, the project settings will have a **Vaadin** section, where you can select the Vaadin version and make settings to widget set building. The settings window is shown in Figure 10.4, “Plugin Related Project Settings”.

Figure 10.4. Plugin Related Project Settings

Suspend automatic widgetset builds

Normally, when this option is unselected, Eclipse will suggest to rebuild the widget set automatically every time you save a widget source file. If this gets annoying, you can suspend the automatic building by enabling

this option. You then have to click the widget set build button in the Eclipse toolbar.

JavaScript style

Normally, GWT outputs obfuscated JavaScript to make the code less readable. The main purpose is to protect the intellectual property, but the obfuscated code is also more compact, reducing the time required to load and parse the files. The **Obfuscated** mode is the default. The other output types are **Pretty**, which makes the JavaScript more readable to a human, and **Detailed**, which is more detailed than the pretty option with, for example, more descriptive variable names.

Compiler threads

You can set the GWT Compiler to use a specific number of threads to use the available processor cores.

Create development mode launch

Clicking this button generates a launch configuration for starting the application in GWT Development Mode. You can use the launch configuration to debug client-side code. See Section 10.8.6, “GWT Development Mode” for detailed information on the GWT Development Mode launch configuration.

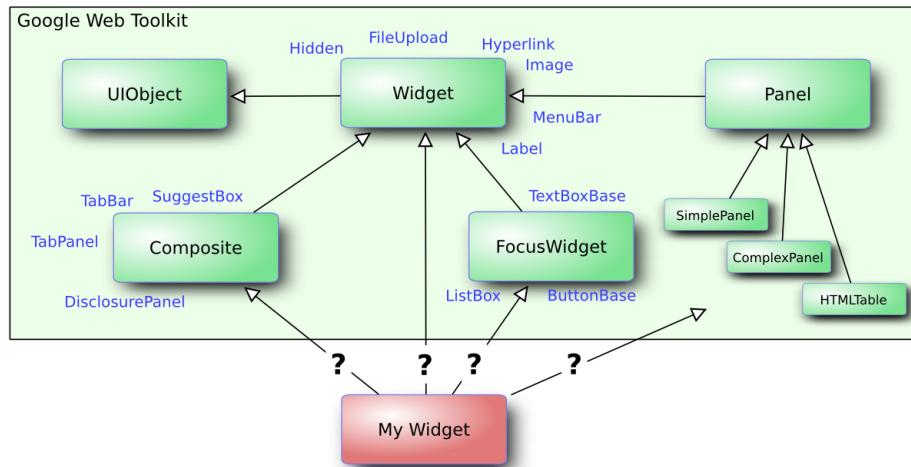
The plugin will automatically download the GWT version compatible with the selected Vaadin package.

10.3. Google Web Toolkit Widgets

Let us take a look into how you create custom GWT widgets. The authoritative sources for developing with GWT are the *Google Web Toolkit Developer Guide* and *Google Web Toolkit Class Reference*, both available from the GWT website.

Google Web Toolkit offers a variety of ways for creating custom widgets. The easiest way is to create *composite* widgets by grouping existing basic widgets and adding some interaction logic to them. You can also develop widgets using the lower-level Java interfaces used by the standard GWT widgets or the really low-level JavaScript interfaces.

A custom GWT widget needs to find its place in the GWT class hierarchy. Figure 10.5, “GWT Widget Base Class Hierarchy” illustrates the abstract base classes for GWT widgets.

Figure 10.5. GWT Widget Base Class Hierarchy

Each of the base classes offers various services for different types of widgets. Many custom widgets, such as the Color Picker example below, extend the **Composite** class to compose the widget from existing GWT widgets. The other base classes offer various features useful for different kinds of widgets. You can also choose to extend an existing GWT widget, as we have done for most of the standard user interface components of Vaadin, or to extend a Vaadin widget.

10.3.1. Extending a Vaadin Widget

Extending an existing Vaadin widget is an easy way to add features, such as advanced client-side validation, to existing standard components. Just extend both the server-side component and the client-side widget, and add the needed properties and other functionality.

A few guidelines apply for extending existing components:

- Do not redefine the `client` or `id` member variables in the subclass. They should always be defined as `protected` and set by the base class where they are defined in `updateFromUIDL()`.
- Call `super()` as the first thing in the constructor.
- In `updateFromUIDL()`:
 - Do not call `client.updateComponent()` as it is already called in the superclass. If the superclass calls it in an undesired way, you have to reimplement the entire functionality and not call `super.updateFromUIDL()` at all.
 - Call `super.updateFromUIDL(uidl, client)`, unless you specifically want to change the behaviour of the superclass implementation of the method. In such case, you have to set the `client` and `id` yourself.
 - Be careful about overloading superclass handlers, etc.

10.3.2. Example: A Color Picker GWT Widget

In the following example, we present a custom widget composed from the **HorizontalPanel**, **Grid**, **Button**, and **Label** GWT widgets. This widget does not include any Vaadin integration with the server-side code, which will be added in a separate integration widget later in this chapter.

```
package com.vaadin.demo.colorpicker.gwt.client.ui;

import com.google.gwt.event.dom.client.*;
import com.google.gwt.user.client.*;
import com.google.gwt.user.client.ui.*;

/**
 * A regular GWT component without integration with Vaadin.
 */
public class GwtColorPicker extends Composite
    implements ClickHandler {

    // The currently selected color name to give client-side
    // feedback to the user.
    protected Label currentcolor = new Label();

    public GwtColorPicker() {
        // Create a 4x4 grid of buttons with names for 16 colors
        final Grid grid = new Grid(4, 4);
        final String[] colors = new String[] { "aqua", "black",
            "blue", "fuchsia", "gray", "green", "lime",
            "maroon", "navy", "olive", "purple", "red",
            "silver", "teal", "white", "yellow" };
        int colornum = 0;
        for (int i = 0; i < 4; i++) {
            for (int j = 0; j < 4; j++, colornum++) {
                // Create a button for each color
                Button button = new Button(colors[colornum]);
                button.addClickHandler(this);

                // Put the button in the Grid layout
                grid.setWidget(i, j, button);

                // Set the button background colors.
                DOM.setStyleAttribute(button.getElement(),
                    "background",
                    colors[colornum]);

                // For dark colors, the button label must be
                // in white.
                if ("black navy maroon blue purple"
                    .indexOf(colors[colornum]) != -1) {
                    DOM.setStyleAttribute(button.getElement(),
                        "color", "white");
                }
            }
        }

        // Create a panel with the color grid and currently
        // selected color indicator.
        final HorizontalPanel panel = new HorizontalPanel();
        panel.add(grid);
        panel.add(currentcolor);

        // Set the class of the color selection feedback box
        // to allow CSS styling. We need to obtain the DOM
        // element for the current color label. This assumes
        // that the <td> element of the HorizontalPanel is
        // the parent of the label element. Notice that the
        // element has no parent before the widget has been
```

```
// added to the horizontal panel.
final Element panelcell =
    DOM.getParent(currentcolor.getElement());
DOM.setProperty(panelcell, "className",
    "colorpicker-currentcolorbox");

// Set initial color. This will be overridden with the
// value read from server.
setColor("white");

// Composite GWT widgets must call initWidget().
initWidget(panel);
}

/** Handles click on a color button. */
@Override
public void onClick(ClickEvent event) {
    // Use the button label as the color name to set
    setColor(((Button) event.getSource()).getText());
}

/** Sets the currently selected color. */
public void setColor(String newcolor) {
    // Give client-side feedback by changing the color
    // name in the label.
    currentcolor.setText(newcolor);

    // Obtain the DOM elements. This assumes that the <td>
    // element of the HorizontalPanel is the parent of the
    // caption element.
    final Element caption = currentcolor.getElement();
    final Element cell = DOM.getParent(caption);

    // Give feedback by changing the background color
    DOM.setStyleAttribute(cell, "background", newcolor);
    DOM.setStyleAttribute(caption, "background", newcolor);
    if ("black navy maroon blue purple"
        .indexOf(newcolor) != -1)
        DOM.setStyleAttribute(caption, "color", "white");
    else
        DOM.setStyleAttribute(caption, "color", "black");
}
}
```

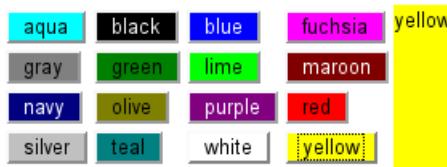
You can find the source code in the source folder of the Vaadin installation package, under the Java package com.vaadin.demo.colorpicker.

This example demonstrates one reason for making a custom widget: it provides client-side feedback to the user in a way that would not be possible or at least practical from server-side code. Server-side code can only select a static CSS style or a theme, while on the client-side we can manipulate styles of HTML elements flexibly. Notice that manipulation of the DOM tree depends somewhat on the browser. In this example, the manipulation should be rather compatible, but in some cases there could be problems. Thd standard GWT and Vaadin widgets handle many of such compatibility issues, but when doing low-level operations such as DOM manipulation, you may need to consider browser compatibility.

The structure of the DOM tree depends on how GWT renders its widgets in a specific browser. It is also not guaranteed that the rendering does not change in future releases of GWT. You should therefore make as few assumptions regarding the DOM structure as possible. Unfortunately, GWT does not provide a way to set the style of, for example, cells of layout elements. The above example therefore assumes that the **Grid** is a table and the **<button>** elements are inside **<td>** elements of the table. See Section 10.3.3, “Styling GWT Widgets” below for more details on compatibility.

The widget will look as shown in Figure 10.6, “Color Picker Widget Without Styling”.

Figure 10.6. Color Picker Widget Without Styling



As you may notice, the widget will look rather uninviting without CSS styling. We will next look how to define a default style for a GWT widget.

10.3.3. Styling GWT Widgets

GWT renders its widgets in the DOM tree of the web browser as HTML elements. Therefore, you can define their style with Cascading Style Sheets (CSS), just as in HTML. The GWT Compiler supports packaging style sheets from the source package tree. The style sheet is defined in the `.gwt.xml` GWT module descriptor file (see Section 10.5, “Defining a Widget Set” for details).

```
<!-- Default theme for the widget set. -->
<stylesheet src="colorpicker/styles.css"/>
```

The style sheet path is relative to the `public` folder under the folder containing the `.gwt.xml` file. In Eclipse, you can add the folders as regular folders instead of Java packages.

Let us define the `colorpicker/styles.css` as follows.

```
/* Set style for the color picker table.
 * This assumes that the Grid layout is rendered
 * as a HTML <table>. */
table.example-colorpicker {
    border-collapse: collapse;
    border: 0px;
}

/* Set color picker button style.
 * This does not make assumptions about the HTML
 * element tree as it only uses the class attributes
 * of the elements. */
.example-colorpicker .gwt-Button {
    height: 60px;
    width: 60px;
    border: none;
    padding: 0px;
}

/* Set style for the right-hand box that shows the
 * currently selected color. While this may work for
 * other implementations of the HorizontalPanel as well,
 * it somewhat assumes that the layout is rendered
 * as a table where cells are <td> elements. */
.colorpicker-currentcolorbox {
    width: 240px;
    text-align: center;
    /* Must be !important to override GWT styling: */
    vertical-align: middle !important;
}
```

The stylesheet above makes some assumptions regarding the HTML element structure. First, it assumes that the **Grid** layout is a table. Second, the custom class name, `colorpicker-currentcolorbox`, of the right-hand **HorizontalPanel** cell was inserted in the DOM representation of the widget in the `GwtColorPicker` implementation. Styling a button makes less assumptions. Using only class names instead of specific element names may make a stylesheet more compatible if the HTML representation is different in different browsers or changes in the future.

Figure 10.7. Color Picker Widget With Styling



10.4. Integrating a GWT Widget

Integration of GWT widgets with Vaadin can be done in two basic ways: by modifying the original widget or by extending it and adding the integration code in the subclass. The latter way is actually the way the standard client-side components in Vaadin are done: they simply inherit the corresponding standard GWT widgets. For example, **VButton** inherits GWT **Button**.

The client-side integration code has the following tasks:

- Receive component state from server
- Send state changes caused by user interaction to server
- Manage CSS style class

The integration is broken down in the following sections into server-client deserialization done in `updateFromUIDL()` and client-server serialization done with `updateVariable()`. The complete example of the integration of the Color Picker widget is given at the end of this section.

If you are using the Eclipse IDE, the Vaadin Plugin for Eclipse allows easy creation of a stub for a new widget, alongside its server-side component. It also manages the widget set for you automatically. See Section 10.2.1, “Creating a Widget” for detailed instructions.



Naming Conventions

While the use of Vaadin does not require the use of any particular naming conventions for GWT widgets, some notes regarding naming may be necessary. Even though Java package names make it possible to use identical class names in the same context, it may be useful to try to make them more distinctive to avoid any inconveni-

ence. GWT uses plain names for its standard widgets, such as **Button**. The standard components of Vaadin use identical or similar names, but that does not cause any inconvenience, because the GWT widgets and server-side components of Vaadin are never used in the same context. For the client-side components of Vaadin, we use the "v" prefix, for example **VButton**. In the Color Picker example, we use **GwtColorPicker** for the GWT widget, **VColorPicker** for the integration implementation, and **ColorPicker** for the server-side component. You may wish to follow similar conventions.

Notice that the naming convention changed when IT Mill Toolkit was renamed as Vaadin. The prefix for client-side widgets in IT Mill Toolkit was **I**, which was changed to **v** in Vaadin. Similarly, CSS style name prefixes were changed from **i-** to **v-**.

10.4.1. Deserialization of Component State from Server

To receive data from the server, a widget must implement the **Paintable** interface and its `updateFromUIDL()` method. The idea is that the method "paints" the user interface description by manipulating the HTML tree on the browser. Typically, when using composite GWT components, most of the DOM tree manipulation is done by standard GWT widgets.

An implementation of the `updateFromUIDL()` method must include some routine tasks:

- Call `updateComponent()` and return if it succeeds
- Manage the component identifier
- Manage a reference to the **ApplicationConnection** object. The widget needs to know it to be able to initiate a server request when a browser event occurs.

The latter two of these tasks are not needed if the widget does not handle any user input that needs to be sent to server.

The following excerpt provides a skeleton for the `updateFromUIDL()` method and shows how the component identifier and connection object reference are managed by a widget.

```
String uidlId;
ApplicationConnection client;

...

public void updateFromUIDL(UIDL uidl,
                           ApplicationConnection client) {
    if (client.updateComponent(this, uidl, true))
        return;

    this.client = client;
    uidlId = uidl.getId();

    ...
}
```

The `updateComponent()` call has several functions important for different kinds of components. It updates various default attributes, such as `disabled`, `readonly`, `invisible`, and (CSS) `style` attributes. If the `manageCaption` argument is `true`, the call will also update the caption of the component. By default, the caption is managed by the parent layout of the component. Components, such as a **Button**, that manage the caption themselves, do not need management of the caption.

The `updateComponent()` is also part of the transmutation mechanism that allows a single server-side component to have alternative client-side implementations, based on its parameters. For example, the **Button** server-side component can manifest either as a clickable **VButton** or as a switchable **VCheckBox** widget on the client-side. If the parameters are changed, the client-side widget can be replaced with another dynamically. Determination of the correct implementation is done in a **WidgetSet**. If `updateComponent()` returns true, the client-side engine can attempt to replace the implementation. For more details on the transmutation mechanism, see Section 10.5, “Defining a Widget Set”.

The component identifier is used when the component needs to serialize its updated state to server. The reference to the application connection manager is needed to make the server request. If a component does not have any state changes that need to be sent to the server, management of the variables is not needed. See Section 10.4.2, “Serialization of Component State to Server” below for further details.

The design of the client-side framework of Vaadin, because the **Paintable** is an interface and can not store any references. Having an API layer between GWT and custom widgets would be a much more complicated solution.

10.4.2. Serialization of Component State to Server

User input is handled in GWT widgets with events.

User input is passed to the server using the `updateVariable()` method. If the *immediate* parameter is *false*, the value is simply added to a queue to be sent to the server at next AJAX request. If the argument is *true*, the AJAX request is made immediately, and will include all queued updates to variables. The *immediate* argument is described in more detail below.

```
if (uidl_id == null || client == null)
    return;

client.updateVariable(uidl_id, "myvariable",
                      newvalue, immediate);
```

The *client* of the above example is a reference to the **ApplicationConnection** object that manages server requests. The *uidl_id* argument is the UIDL identifier obtained during a `updateFromUIDL()` call with `uidl.getId()` method.

The `updateVariable()` method has several varieties to send variables of different types.

Table 10.1. UIDL Variable Types

Type	Description	UIDL Type
String	String object.	s
int	Native integer value.	i
long	Native long integer value.	l
float	Native single-precision floating-point value.	f
double	Native double-precision floating-point value.	d
boolean	Native boolean value.	b
Object[]	Array of object data. The <code>toString()</code> method is used to serialize each of the objects. The content strings are escaped with <code>escapeString()</code> , to allow characters such as quotes.	a

This serialization mechanism is intended to be as simple as possible in most cases, when the user input is typically just one state variable, while also allowing the serialization of more complex data, if necessary.

Immediateness

Server-side components that inherit **AbstractComponent** have an *immediate* attribute, set with `setImmediate()`. This attribute dictates whether a component makes a server request immediately when its state changes, or only afterwards. For example, there is no need to send the contents of a "Username" **TextField** before the "Login" button has been clicked. On the other hand, the server can set the **TextField** as immediate to receive changes for example when the component loses focus.

Most widgets should support immediateness by receiving the *immediate* attribute from the UIDL message that renders the widget. The following example is extracted from the **VTextField** implementation.

```
// Store the immediate attribute in a member variable
private boolean immediate = false;
...

public void updateFromUIDL(UIDL uidl,
                           ApplicationConnection client) {
    if(client.updateComponent(this, uidl, true))
        return;

    // Receive and store the immediate attribute
    immediate = uidl.getBooleanAttribute("immediate");
    ...
}

public void onChange(Widget sender) {
    if(client != null && id != null) {
        // Use the stored immediate attribute to say
        // whether or not make the server request
        // immediately.
        client.updateVariable(id, "text", getText(),
                               immediate);
    }
}
```

In some widgets, the *immediate* attribute would have little meaning, and in fact an accidental `false` value would cause undesired behaviour. For example, a button is always expected to send a request to the server when it is clicked. Such widgets can simply use `true` for the *immediate* argument in `updateVariable()`. For example, **VButton** does as follows:

```
public void onClick(Widget sender) {
    if (id == null || client == null)
        return;
    client.updateVariable(id, "state", true,
                          /* always immediate */ true);
}
```

10.4.3. Example: Integrating the Color Picker Widget

Below is a complete example of an integration component for the Color Picker example. It demonstrates all the basic tasks needed for the integration of a GWT widget with its server-side counterpart component.

```
import com.vaadin.terminal.gwt.client.ApplicationConnection;
import com.vaadin.terminal.gwt.client.Paintable;
```

```
import com.vaadin.terminal.gwt.client.UIDL;

public class VColorPicker extends GwtColorPicker
    implements Paintable {

    /** Set the CSS class name to allow styling. */
    public static final String CLASSNAME = "example-colorpicker";

    /** Component identifier in UIDL communications. */
    String uidlId;

    /** Reference to the server connection object. */
    ApplicationConnection client;

    /**
     * The constructor should first call super() to initialize
     * the component and then handle any initialization relevant
     * to Vaadin.
     */
    public VColorPicker() {
        // The superclass has a lot of relevant initialization
        super();

        // This method call of the Paintable interface sets
        // the component style name in DOM tree
        setStyleName(CLASSNAME);
    }

    /**
     * This method must be implemented to update the client-side
     * component from UIDL data received from server.
     *
     * This method is called when the page is loaded for the
     * first time, and every time UI changes in the component
     * are received from the server.
     */
    public void updateFromUIDL(UIDL uidl,
                               ApplicationConnection client) {
        // This call should be made first. Ensure correct
        // implementation, and let the containing layout
        // manage the caption, etc.
        if (client.updateComponent(this, uidl, true))
            return;

        // Save reference to server connection object to be
        // able to send user interaction later
        this.client = client;

        // Save the UIDL identifier for the component
        uidlId = uidl.getId();

        // Get value received from server and actualize it
        // in the GWT component
        setColor(uidl.getStringVariable("colorname"));
    }

    /**
     * Override the method to communicate the new value
     * to server.
     */
    public void setColor(String newcolor) {
        // Ignore if no change
        if (newcolor.equals(currentcolor.getText()))
            return;

        // Let the original implementation to do
        // whatever it needs to do
    }
}
```

```
super.setColor(newcolor);

// Updating the state to the server can not be done
// before the server connection is known, i.e., before
// updateFromUIDL() has been called.
if (uidlId == null || client == null)
    return;

// Communicate the user interaction parameters to server.
// This call will initiate an AJAX request to the server.
client.updateVariable(uidlId, "colorname",
                      newcolor, true);
}
}
```

10.5. Defining a Widget Set

The client-side components, or in GWT terminology, widgets, must be made usable in the client-side GWT application by defining a widget set. A widget set is actually a GWT application and needs to be defined in the *GWT module descriptor* as the entry point of the client-side engine. A GWT module descriptor is an XML file with extension `.gwt.xml`.

If you are using the Eclipse IDE, the New Vaadin Widget wizard will automatically create the GWT module descriptor. See Section 10.2.1, “Creating a Widget” for detailed instructions.

The following example of `ColorPickerWidgetSet.gwt.xml` shows the GWT module descriptor of the Color Picker application. We also define the default stylesheet for the color picker widget, as described above in Section 10.3.3, “Styling GWT Widgets”.

```
<module>
  <!-- Inherit the default widget set -->
  <inherits name="com.vaadin.terminal.gwt.DefaultWidgetSet" />

  <!-- The default theme of this widget set -->
  <stylesheet src="colorpicker/styles.css"/>
</module>
```

Compiling widget sets takes considerable time. You can reduce the compilation time significantly by compiling the widget sets only for your browser, which is useful during development. You can do this by setting the `user.agent` property in the `.gwt.xml` GWT module descriptor.

```
<set-property name="user.agent" value="gecko"/>
```

The `value` attribute should match your browser. The browsers supported by GWT depend on the GWT version, below is a list of browser identifiers supported by GWT 1.7.

Table 10.2. GWT User Agents

Identifier	Name
gecko	Mozilla Firefox
gecko1_8	Mozilla Firefox 1.5 and 2
ie6	Internet Explorer 6
ie8	Internet Explorer 8
safari	Apple Safari and other Webkit-based browsers including Google Chrome
opera	Opera

For more information about the GWT Module XML Format, please see Google Web Toolkit Developer Guide.

10.6. Server-Side Components

Server-side components provide the API for user applications to build their user interface. Many applications do not ever need to bother with the client-side implementation of the standard components, but those that use their own GWT widgets need to have corresponding server-side components.

If you are using the Vaadin Plugin for Eclipse, the wizard for creating new widgets will also create a stub of the server-side component for you. See Section 10.2.1, “Creating a Widget” for detailed instructions.

A server-side component has two basic tasks: it has to be able to serialize its state variables to the corresponding client-side component, and deserialize any user input received from the client. Many of these tasks are taken care of by the component framework.

10.6.1. Binding to the Client-Side Widget

A server-side component needs to be bound to a specific client-side widget. This is done with a special annotation. For example, for the **ColorPicker** server-side component, we define:

```
import com.vaadin.demo.colorpicker.widgetset.client.ui.VColorPicker;

@ClientWidget(VColorPicker.class)
public class ColorPicker extends AbstractField {
    ...
}
```

The annotation is read during the compilation of the widget with the GWT Compiler. The compiler invokes a **WidgetMapGenerator** that reads the annotations from the compiled server-side component classes. It is therefore necessary that the server-side components are compiled before the client-side compilation, as noted in Section 10.8.4, “Compiling GWT Widget Sets”.

The serialization is broken down into server-client serialization and client-server deserialization in the following sections. We will also present the complete example of the server-side implementation of the Color Picker component below.

10.6.2. Server-Client Serialization

The server-side implementation of a component must be able to serialize its data into a UIDL message that is sent to the client. You need to override the `paintContent()` method, defined in **AbstractComponent**. You should call the superclass to allow it to paint its data as well.

The data is serialized with the variants of the `addAttribute()` and `addVariable()` methods for different basic data types.

The UIDL API offered in **PaintTarget** is covered in Section A.1, “API for Painting Components”.

10.6.3. Client-Server Deserialization

The server-side component must be able to receive state changes from the client-side widget. This is done by overriding the `changeVariables()` method, defined in **AbstractComponent**. A component should always call the superclass implementation in the beginning to allow it handle its variables.

The variables are given as objects in the `variables` map, with the same key with which they were serialized on the client-side. The object type is likewise the same as given for the particular variable in `updateVariable()` in the client-side.

```
@Override
public void changeVariables(Object source, Map variables) {
    // Let superclass read any common variables.
    super.changeVariables(source, variables);

    // Sets the currently selected color
    if (variables.containsKey("colorname") && !isReadOnly()) {
        final String newValue = (String)variables.get("colorname");

        // Changing the property of the component will
        // trigger a ValueChangeEvent
        setValue(newValue, true);
    }
}
```

The above example handles variable changes for a field component inheriting **AbstractField**. Fields have their value as the value property of the object. Setting the value with `setValue()`, as above, will trigger a **ValueChangeEvent**, which the user of the component can catch with a **ValueChangeListener**.

Contained components, such as components inside a layout, are deserialized by referencing them by their *paintable identifier* or *PID*.

10.6.4. Example: Color Picker Server-Side Component

The following example provides the complete server-side **ColorPicker** component for the Color Picker example. It has only one state variable: the currently selected color, which is stored as the property of the component. Implementation of the **Property** interface is provided in the **AbstractField** superclass of the component. The UIDL tag name for the component is `colorpicker` and the state is communicated through the `colorname` variable.

```
package com.vaadin.demo.colorpicker;

import com.vaadin.demo.colorpicker.widgetset.client.ui.VColorPicker;
...

/**
 * Color picker for selecting a color from a palette.
 *
 * @author magi
 */
@ClientWidget(VColorPicker.class)
public class ColorPicker extends AbstractField {
    public ColorPicker() {
        super();
        setValue(new String("white"));
    }

    /** The property value of the field is a String. */
    @Override
    public Class<?> getType() {
        return String.class;
    }

    /** Set the currently selected color. */
    public void setColor(String newcolor) {
        // Sets the color name as the property of the component.
        // Setting the property will automatically cause
        // repainting of the component with paintContent().
    }
}
```

```
        setValue(newcolor);
    }

    /** Retrieve the currently selected color. */
    public String getColor() {
        return (String) getValue();
    }

    /** Paint (serialize) the component for the client. */
    @Override
    public void paintContent(PaintTarget target)
        throws PaintException {
        // Superclass writes any common attributes in the
        // paint target.
        super.paintContent(target);

        // Add the currently selected color as a variable in
        // the paint target.
        target.addVariable(this, "colortext", getColor());
    }

    /** Deserialize changes received from the client. */
    @Override
    public void changeVariables(Object source, Map variables) {
        // Sets the currently selected color
        if (variables.containsKey("colortext") &&
            !isReadOnly()) {
            // Changing the property of the component will
            // trigger a ValueChangeEvent
            setValue((String) variables.get("colortext"), true);
        }
    }
}
```

10.7. Using a Custom Component

A custom component is used like any other Vaadin component. You will, however, need to compile the client-side widget set with the GWT Compiler. See Section 10.8.4, “Compiling GWT Widget Sets” for instructions on how to compile widget sets.

10.7.1. Example: Color Picker Application

The following server-side example application shows how to use the Color Picker custom widget. The example includes also server-side feedback of the user input and changing the color selection to show that the communication of the component state works in both directions.

```
package com.vaadin.demo.colorpicker;

import com.vaadin.data.Property.ValueChangeEvent;
import com.vaadin.data.Property.ValueChangeListener;
import com.vaadin.ui.*;
import com.vaadin.ui.Button.ClickEvent;

/**
 * Demonstration application that shows how to use a simple
 * custom client-side GWT component, the ColorPicker.
 */
public class ColorPickerApplication
    extends com.vaadin.Application {
    Window main = new Window("Color Picker Demo");

    /* The custom component. */
    ColorPicker coloselector = new ColorPicker();
```

```
/* Another component. */
Label colortext;

public void init() {
    setMainWindow(main);
    setTheme("demo");

    // Listen for value change events in the custom
    // component, triggered when user clicks a button
    // to select another color.
    coloselector.addListener(new ValueChangeListener() {
        public void valueChange(ValueChangeEvent event) {
            // Provide some server-side feedback
            colortext.setValue("Selected color: " +
                coloselector.getColor());
        }
    });
    main.addComponent(coloselector);

    // Add another component to give feedback from
    // server-side code
    colortext = new Label("Selected color: " +
        coloselector.getColor());
    main.addComponent(colortext);

    // Server-side manipulation of the component state
    Button button = new Button("Set to white");
    button.addListener(new Button.ClickListener() {
        public void buttonClick(ClickEvent event) {
            coloselector.setColor("white");
        }
    });
    main.addComponent(button);
}
}
```

10.7.2. Web Application Deployment

Deployment of web applications that include custom components is almost identical to the normal case where you use only the default widget set of Vaadin. The default case is documented in Section 4.8.3, “Deployment Descriptor `web.xml`”. You only need to specify the widget set for the application in the `WebContent/WEB-INF/web.xml` deployment descriptor.

If you use the Vaadin Plugin for Eclipse to create a new widget in your project, the plugin will modify the deployment descriptor to use the custom widget set.

The following deployment descriptor specifies the Color Picker Application detailed in the previous section.

```
<?xml version="1.0" encoding="UTF-8"?>
<web-app
    id="WebApp_ID"
    version="2.4"
    xmlns="http://java.sun.com/xml/ns/j2ee"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://java.sun.com/xml/ns/j2ee
        http://java.sun.com/xml/ns/j2ee/web-app_2_4.xsd">

    <display-name>myproject</display-name>

    <servlet>
        <servlet-name>ColorPickerServlet</servlet-name>
        <servlet-class>
            com.vaadin.terminal.gwt.server.ApplicationServlet
        </servlet-class>
    </servlet>

```

```
</servlet-class>
<init-param>
    <param-name>application</param-name>
    <param-value>
        com.vaadin.demo.colorpicker.ColorPickerApplication
    </param-value>
</init-param>
<init-param>
    <param-name>widgetset</param-name>
    <param-value>
        com.vaadin.demo.colorpicker.widgetset.ColorPickerWidgetSet
    </param-value>
</init-param>
</servlet>

<servlet-mapping>
    <servlet-name>ColorPickerServlet</servlet-name>
    <url-pattern>/*</url-pattern>
</servlet-mapping>
</web-app>
```

The project specific parameters are emphasized. Notice that the widget set name is not a file name, but the base name for the `ColorPickerWidgetSet.gwt.xml` module descriptor.

The Eclipse Plugin will automatically generate the `init-param` parameter in the `web.xml` file of your project when you create a new widget.

As the project context root in the above example is `myproject` and the `<url-pattern>` is `/*`, the URL for the application will be `/myproject/`. If you are using an URL pattern such as `/myapp/*`, you need to make an additional mapping to map requests to `/VAADIN/*` context to the same servlet. Otherwise the default widget set and built-in themes in Vaadin will be missing.

```
<servlet-mapping>
    <servlet-name>Book of Vaadin Examples</servlet-name>
    <url-pattern>/VAADIN/*</url-pattern>
</servlet-mapping>
```

10.8. GWT Widget Development

Development of new GWT widgets includes widget set definition (GWT Module Descriptor), compiling the widgets and the Vaadin Client-Side Engine to JavaScript with the GWT Compiler, and debugging the application in the GWT Development Mode.

You can use any IDE for developing GWT components for Vaadin. The examples given in this book are for the Eclipse IDE. It allows easy launching of the GWT Development Mode, debugging, and running an external compiler for GWT widget sets.

10.8.1. Creating a Widget Project

Creation of a Vaadin project that uses the default widget set was covered in Section 2.4, “Your First Project with Vaadin”. Developing custom widgets creates a number of additional requirements for a project.

Let us review the steps required for creating an application that contains custom widgets. Details for each step are given in the subsequent sections.

1. Create a new Vaadin project (for Eclipse, see Section 2.4.1)

2. Copy or import the GWT JARs to the project and add them to the class path (Section 10.8.2)
3. Write the source code for the client-side widgets, their server-side counterparts, and the application (Section 10.8.3)
4. Write the `web.xml` Deployment Descriptor for the web application
 - Define the widget set used in the application (Section 10.7.2)
5. Compile the widget set to JavaScript runtime with GWT Compiler (Section 10.8.4)
6. Deploy the project to an application server (for Eclipse and Tomcat see Section 2.4.3)
7. Either:
 - a. Open a web browser to use the web application.
 - b. Open a web browser in GWT Development Mode to debug the client-side widget code. (Section 10.8.6)

The contents of a ready widget development project are described in Section 10.8.5, “Ready to Run”.

The Vaadin Plugin for Eclipse makes the creation of application custom widgets as well as the application projects easy by taking care of all the above steps (except deployment), so if you use it, please see Section 10.2, “Doing It the Simple Way in Eclipse” for detailed instructions.

10.8.2. Importing GWT Installation Package

You will need to include the Google Web Toolkit in your project to develop custom widgets. The installation directory of Vaadin includes full GWT installation in the `gwt` subdirectory. The package includes precompiled libraries and applications for the specific platform of the installation. To use the libraries, you need to configure them in the classpath of your project as described below.

You can copy or import either the entire `gwt` directory or just the GWT JARs to your project.

If you use Eclipse and copy the GWT directory or the libraries to the project with system tools, remember to select your project folder and press **F5** to refresh the project. You can also import the directory as follows (importing the JARs is similar):

1. Right-click on the project folder in **Project Explorer** and select **Import → Import...**
2. From the Import dialog, select **General → File System** and click **Next**.
3. Click **Browse** button of the "**From directory**" field and browse to the `gwt` directory under the Vaadin installation directory. Click **Ok** in the file selection dialog.
4. Select the `gwt` entry in the list box for importing.
5. In the "**Into folder**" field, enter `myproject/gwt`. (If you do not set this, all the contents of the `gwt` directory will be imported directly below the root directory of the project which is undesirable.)
6. Click **Finish**.

You must include the GWT libraries in the classpath of the project. If using Eclipse, right-click on the project folder in the **Project Explorer** in Eclipse and select **Properties**. Select **Java Build Path** → **Libraries**.

10.8.3. Writing the Code

Guidelines for the Project Structure

The project structure is otherwise free, but if you use the build script described in Section 10.8.4, “Compiling GWT Widget Sets” or configure the GWT Development Mode, as described in Section 10.8.6, “GWT Development Mode”, the examples assume that source files are located under the `WebContent/WEB-INF/src` folder.

We recommend that the name for the package containing the widget set is `widgetset`, but this is not required. GWT does, however, require that the client-side code is written under a `client` package and any stylesheets are located under a `public` directory (not necessarily a package) under the package containing the `.gwt.xml` descriptor.

See Section 10.8.5, “Ready to Run” for an example project structure.

Importing the ColorPicker Demo

If you want to use the Color Picker application as an application skeleton, you need to import it under the source folder.

1. Right-click on the source folder and select **Import**.
2. In the **Import** dialog, select **General** → **File System** and click **Next**.
3. Browse to `WebContent/WEB-INF/src/com/vaadin/demo/colorpicker/` and click **Ok** button in the **Import from directory** dialog.
4. In the **Int o folder** field, enter `myproject/WebContent/WEB-INF/src/com/vaadin/demo/colorpicker`.
5. Check the `colorpicker` entry in the list box.
6. Click **Finish**.

This will import the directory as `com.vaadin.demo.colorpicker` package. If you want to use it as a skeleton for your own project, you should refactor it to some other name. Notice that you will need to refactor the package and application name manually in the `web.xml` and `.gwt.xml` descriptor files.

10.8.4. Compiling GWT Widget Sets

You need to compile the Vaadin Client-Side Engine and your custom widget set to JavaScript with the GWT Compiler. Vaadin installation package includes an Ant build script `build-widgetset.xml` in the `WebContent/docs/example-source/` directory.

If you are using the Vaadin Plugin for Eclipse, it will enable a toolbar button that allows you to compile the widget set. See Section 10.2.2, “Recompiling the Widget Set” for instructions.

To compile the Color Picker widget set example using the Ant build script, just change to the directory and enter:

```
$ ant -f build-widgetset.xml
```

We advice that you copy the build script to your project and use it as a template. Just set the paths in the "configure" target and the widget set class name in the "compile-widgetset" target to suit your project.

Alternatively, you can launch the build script from Eclipse, by right-clicking the script in Package Explorer and selecting **Run As → Ant Build**. Progress of the compilation is shown in the **Console** window.

After compilation, *refresh the project by selecting it and pressing F5*. This makes Eclipse scan new content and become aware of the output of the compilation in the WebContent/VAADIN/widgetsets/ directory. If the project is not refreshed, the JavaScript runtime is not included in the web application and running the application will result in an error message such as the following:

```
Requested resource  
[VAADIN/widgetsets/com.vaadin.demo.colorpicker.gwt.ColorPickerWidgetSet/com.vaadin.demo.colorpicker.gwt.ColorPickerWidgetSet.nocache.js]  
not found from filesystem or through class loader. Add widgetset and/or theme JAR to  
your classpath or add files to WebContent/VAADIN folder.
```

Compilation with GWT is required also initially when using the GWT Development Mode, which is described in Section 10.8.6, “GWT Development Mode”. The compilation with the GWT Compiler must be done at least once, as it provides files that are used also by the GWT Development Mode, even though the browser runs the GWT application in Java Virtual Machine instead of JavaScript.



Warning

Because GWT supports a slightly reduced version of Java, GWT compilation can produce errors that do not occur with the Java compiler integrated in the Eclipse IDE.

Also notice that client-side compilation loads the server-side classes (to find the @ClientWidget annotations) and, as a side effect, executes any static code blocks in the classes, even in any non-component classes such as the application class. This could cause unexpected behaviour during the compilation.

Compiling a Custom Widget Set

If you wish to use the build script to compile your own widget sets, open it in an editor. The build script contains some instructions in the beginning of the file.

First, you need to make some basic configuration in the *configure* target:

```
<target name="configure">  
  
    <!-- Path from this file to the project root -->  
    <property name="base"  
              value=".../.../.../" />  
  
    <!-- The platform (windows, linux, mac, or oopm) -->  
    <property name="gwt-platform"  
              value="linux" />  
  
    <!-- Location of platform-specific GWT distribution -->  
    <property name="gwt-location"  
              value="${base}gwt" />  
  
    <!-- Location of Vaadin JAR -->
```

```

<property name="toolkit-jar-location"
  value="${base}WebContent/WEB-INF/lib/vaad
  in-<version>.jar" />

<!-- Location of project source code -->
<property name="src-location"
  value="${base}WebContent/WEB-INF/src" />

<!-- Target where to compile server-side classes -->
<property name="server-side-destination"
  value="${base}WebContent/WEB-INF/classes" />

<!-- Target where to compile the widget set -->
<property name="client-side-destination"
  value="${base}WebContent/VAADIN/widgetsets" />
</target>

```

You also need to define the widget set in the `configure-widgetset` target:

```

<!-- NOTE: Modify this example to compile your own widgetset -->
<target name="configure-widgetset">

  <!-- Name of the widget set -->
  <property name="widgetset"
    value="com.vaadin.demo.colorpicker.gwt.ColorPickerWidgetSet" />

```

You can use the `compile-widgetset` target as it is, or as a template for your own configuration:

```

<!-- Build the widget set. -->
<target name="compile-widgetset"
  depends="compile-server-side, generate-widgetset">
  <echo>Compiling ${widgetset}...</echo>

  <java classname="com.google.gwt.dev.Compiler"
    failonerror="yes" fork="yes" maxmemory="256m">
    <arg value="-war" />
    <arg value="${client-side-destination}" />
    <arg value="${widgetset}" />
    <jvmarg value="-Xss1024k"/>
    <jvmarg value="-Djava.awt.headless=true"/>
    <classpath>
      <path refid="compile.classpath" />
    </classpath>
  </java>
</target>

```

Notice that the server-side must be compiled before the client-side and the compiled server-side classes must be included in the class path for the GWT Compiler. The reason is that the annotations that define the component-to-widget mappings are read from the class files during the GWT compilation.



Google Web Toolkit Version

You should use a version of GWT suitable for the version of Vaadin you are using; we recommend using the GWT included in the installation package, but other versions may work as well.

If you are upgrading from Vaadin 5, the GWT 1.6 and later versions used by Vaadin 6 contains a new compiler and the old **GWTCompiler** class used previously for compiling GWT widgets is deprecated and replaced with **com.google.gwt.dev.Compiler**. You should update your existing widget set build scripts or launch configurations to use the new compiler class. The only significant

API change is the output directory parameter, previously `-out`, now `-war`, as shown in the example above.



Java Stack Overflow Problems

The `-Xss` parameter for the Java process may be necessary if you experience stack overflow errors with the default stack size. They occur especially with GWT 1.6, which uses large amount of stack space.

Notice further that the Windows version of Sun JRE 1.5 has a bug that makes the stack size setting ineffective. The Windows version also has a smaller default stack size than the other platforms. If you experience the problem, we advice that you either use JRE 1.6 on the Windows platform or use a wrapper that circumvents the problem. To use the wrapper, use class **com.vaadin.launcher.WidgetsetCompiler** in the build script instead of the regular compiler.

The `-Djava.awt.headless=true` is relevant in Linux/UNIX platforms to avoid some X11 warnings.

You can now compile the widget set with the following command:

```
$ ant -f build-widgetset.xml
```

Generating Widget Set Definition

If you use libraries containing other widget sets, you may want to automatically generate the `.gwt.xml` GWT Module Descriptor that defines the widget set that combines the Vaadin default widget set, widget sets included in any libraries, and any widget sets defined in your project.

If you use the `build-widgetset.xml` Ant build script as a template, you need to define the settings required for generating a widget set in the `configure-widgetset` target.

```
<target name="configure-widgetset">
  <property name="widgetset"
            value="com.vaadin.demo.GeneratedWidgetSet"/>
  <property name="generate.widgetset" value="1"/>
  <property name="widgetset-path" value="com/vaadin/demo/widgetset"/>
</target>
```

Define the name of the widget set definition file, without the `.gwt.xml` suffix, in the `widgetset` property. The `generate-widgetset` target is executed only if the `generate.widgetset` property is defined. You also need to give a file path to the widget set directory, relative to the `$src-location` directory..

The `generate-widgetset` target is defined as follows:

```
<target name="generate-widgetset"
      depends="compile-server-side, configure-widgetset"
      if="generate.widgetset">

  <!-- Create the directory if it does not already exist. -->
  <mkdir dir="${src-location}/${widgetset-path}" />

  <java classname="com.vaadin.terminal.gwt.widgetsetutils.WidgetSetBuilder"
        failonerror="yes" fork="yes" maxmemory="256m">
    <arg value="${widgetset}" />
    <jvmarg value="-Xss1024k" />
    <jvmarg value="-Djava.awt.headless=true" />
    <classpath>
```

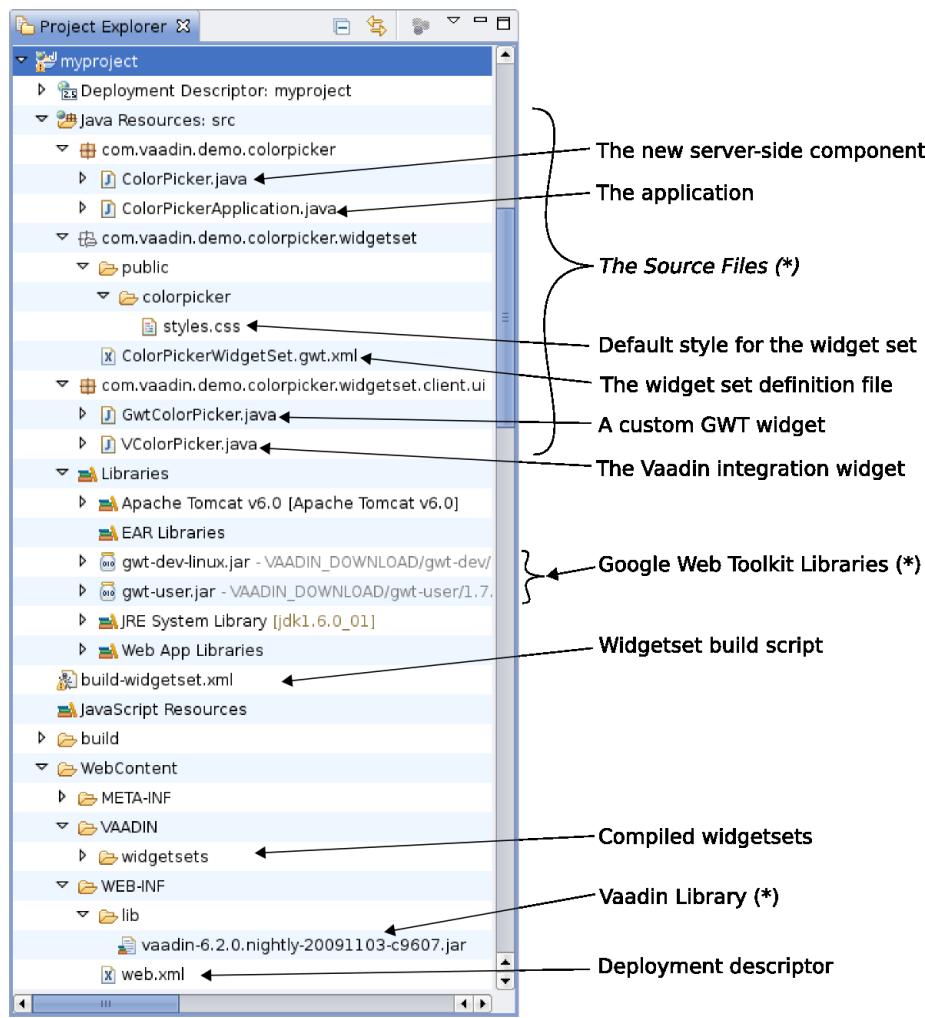
```
<path refid="compile.classpath" />
</classpath>
</java>
</target>
```

The widget set builder assumes that the root of the source directory is the *first* item in the class path, here defined with the `src-location` property. The location must point to the root of the entire source tree, not the path of the widget set under it. Also the location of compiled server-side classes must be included, here defined with the `server-side-destination` property. In the example script, the class path is defined in the `init` target as follows:

```
<path id="compile.classpath">
    <pathelement path="${src-location}" />
    <pathelement path="${server-side-destination}" />
    <pathelement path="${toolkit-jar-location}" />
    <pathelement path="${gwt-location}/gwt-user.jar" />
    <pathelement path="${gwt-location}/gwt-dev-${gwt-platform}.jar" />
        <fileset dir="${base}WebContent/WEB-INF/lib/">
            <include name="**/*.jar"/>
        </fileset>
    </path>
```

10.8.5. Ready to Run

Figure 10.8, “Annotated Project Contents” shows the contents of a ready project.

Figure 10.8. Annotated Project Contents

Notice that the Package Explorer does not correspond with the file system contents. Eclipse displays the items marked with asterisk (*) in a logical location, instead of the physical location in the file system.

You can either run the application in web mode, as introduced in Section 2.4.4, or debug it in the GWT Development Mode, as detailed in the next section.

10.8.6. GWT Development Mode

The GWT Development Mode allows debugging client-side GWT applications in a Java IDE such as Eclipse, as if the applications ran as Java in the browser, even though they actually are JavaScript. This is made possible by the Google Web Toolkit Developer Plugin, which is available for major browsers, such as Mozilla Firefox, Google Chrome, Safari, and Internet Explorer.

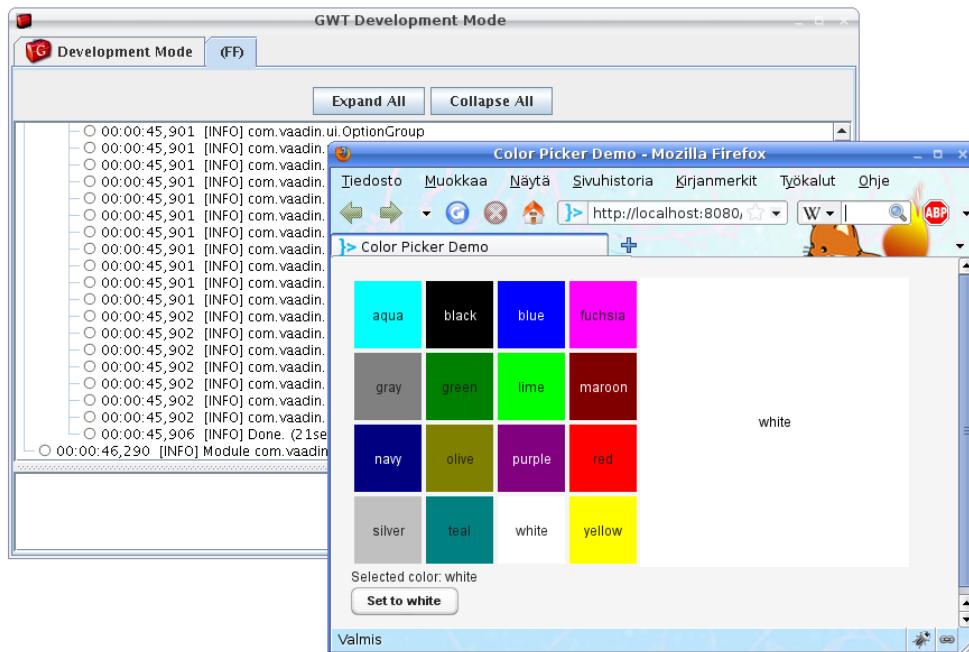
Figure 10.9. GWT Development Mode

Figure 10.9, “GWT Development Mode” shows the GWT Development Mode in action. On the left, you have the GWT Development Mode window. It displays compilation information and possible errors that occur during compilation. You can open the application in a new browser window by clicking **Launch Default Browser**.

The browser window has a **Compile/Browse** button, which runs the GWT Compiler to produce the runtime code and opens a regular web browser to run the application. Notice that even though it is possible to recompile the program with the button, GWT Compiler must be run at least once before launching the GWT Development Mode, as described in Section 10.8.4, “Compiling GWT Widget Sets”, as the compiler creates some required files.

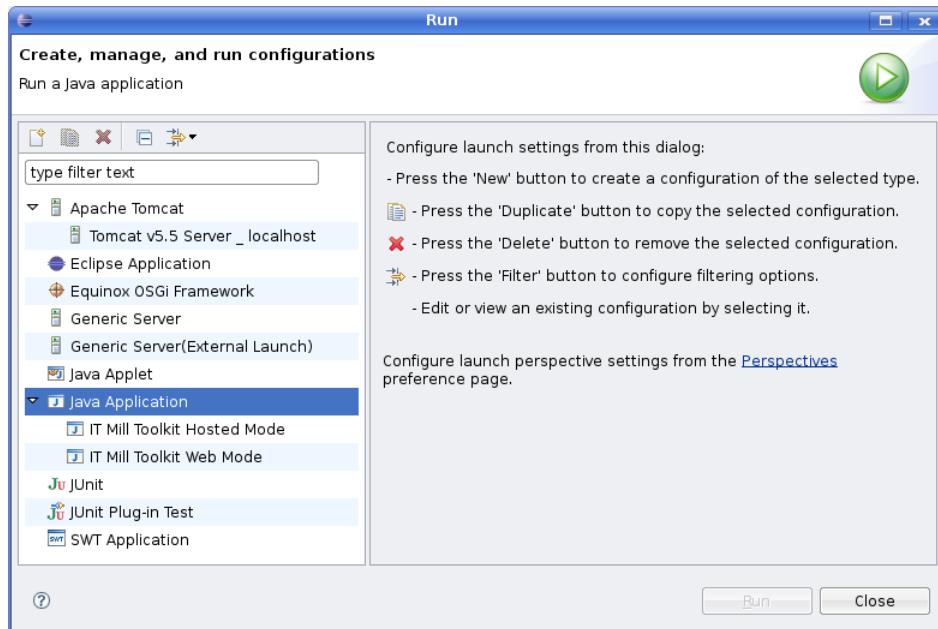
Because GWT supports a slightly reduced version of Java, GWT compilation can produce errors that do not occur with the Java compiler integrated in the Eclipse IDE. Such errors will show up in the GWT Development Mode window.

Configuring GWT Development Mode Launching in Eclipse

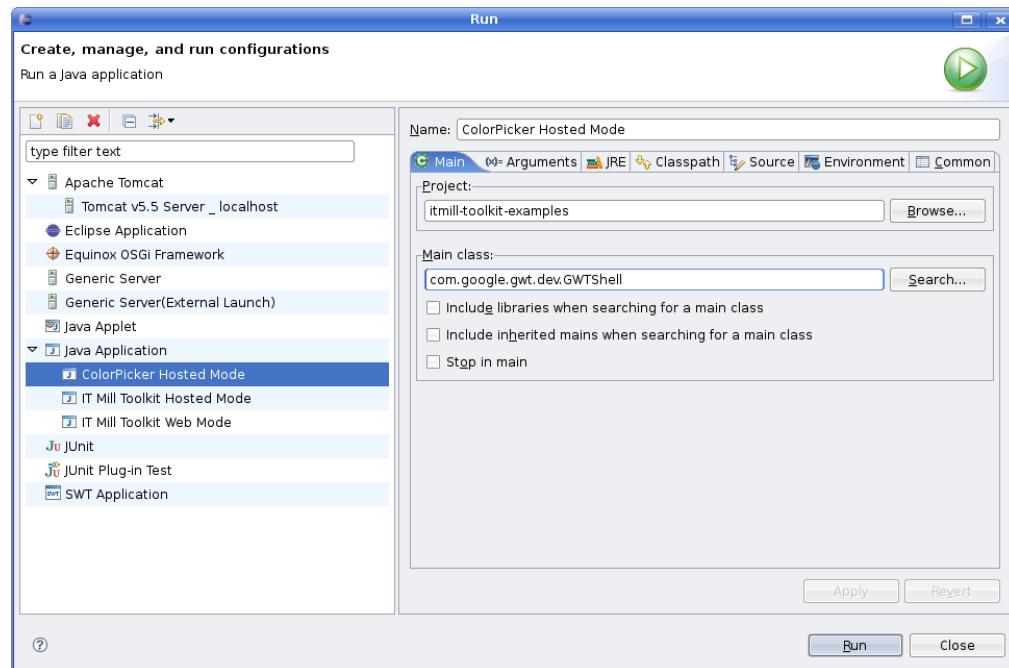
This section gives details on creating a launch configuration for the GWT Development Mode in the Eclipse IDE. We use the QuickStart installation of Vaadin covered in Section 2.3, “QuickStart with Eclipse” as an example project. The project includes source code for the Color Picker demo application.

If you use the Vaadin Plugin for Eclipse, it can create a launch configuration for launching the GWT Development Mode. See Section 10.2.3, “Plugin Related Project Settings” for instructions.

1. Select from menu **Run → Debug...** and the **Debug** configuration window will open. Notice that it is not purposeful to run the GWT Development Mode in the **“Run”** mode, because its entire purpose is to allow debugging.
2. Select the **Java Application** folder and click on the **New** button to create a new launch configuration.

Figure 10.10. Creating New Launch Configuration

3. Click on the created launch configuration to open it on the right-side panel. In the **Main** tab, give the launch configuration a name. Define the **Main class** as `com.google.gwt.dev.DevMode`.

Figure 10.11. Naming Launch Configuration

4. Switch to the **Arguments** tab and enter arguments for the application.

a. In the **Program arguments** field, enter:

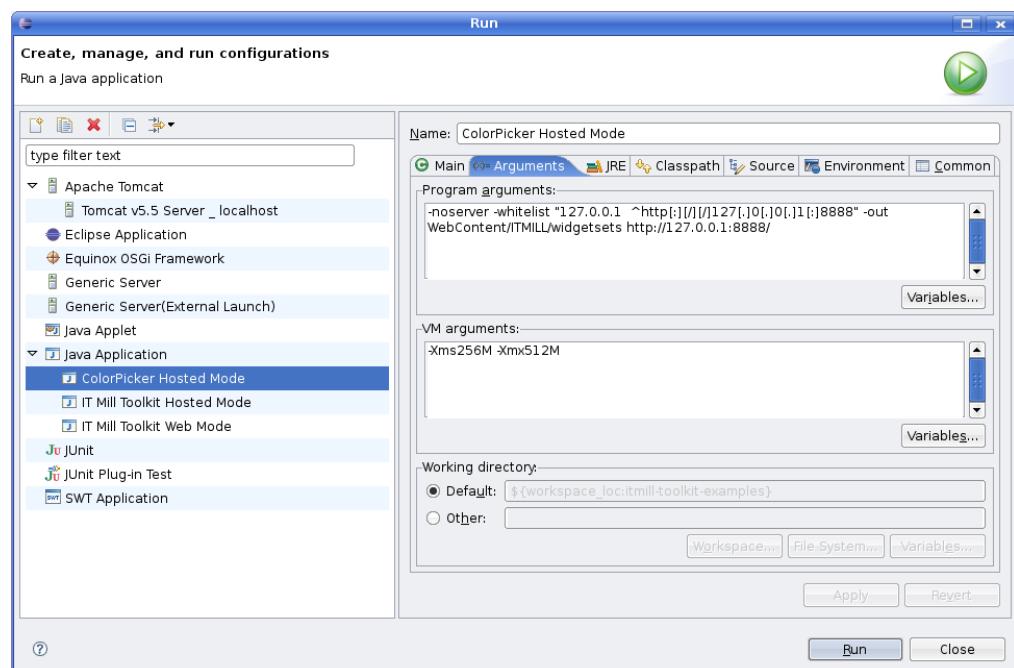
```
-noserver -war WebContent/VAADIN/widgetsets
com.example.myproject.widgetset.MyProjectWidgetSet
-startupUrl http://localhost:8080/myproject
```

The browser application, **DevMode**, takes as its arguments the following parameters:

-noserver	Prevents an embedded web server from starting, thereby allowing to use an already running server.
-whitelist	Adds a regular expression to the list of allowed URL patterns for the web browser. Modify the port number from the 8080 given above as necessary.
-war	Output directory for compiling widgets with GWT Compiler. The directory must be <i>WebContent/VAADIN/widgetsets</i> . You can compile the widgets either from the GWT Development Mode window or externally as explained later in this chapter.
-startupUrl <URL>	The URL to connect to. This must be the same as the whitelist entry given above. The port number must correspond to the port of the running web server. The Jetty web server included in Vaadin will run in port 8888 by default. In contrast, Apache Tomcat installed under Eclipse will run in port 8080 by default.

b. In the **VM arguments** field enter, for example, `-Xms256M -Xmx512M` to give the GWT Development Mode more memory than the default amount. On Mac, add also `-XstartOnFirstThread`.

Figure 10.12. DevMode Arguments



5. In the **Classpath** tab, you will by default have `vaadin-examples`, which contains the default classpath entries for the project. If the classpath entries for the project are sufficient, this should be enough.
6. Click **Apply** to save the launch configuration.
7. Click **Debug** to launch the GWT Development Mode using the launch configuration.

See the following section for details on debugging with the GWT Development Mode.

Debugging with GWT Development Mode

The purpose of the GWT Development Mode is to allow debugging client-side GWT applications, or in our case, GWT widgets. Below is a checklist for important requirements for launching the GWT Development Mode:

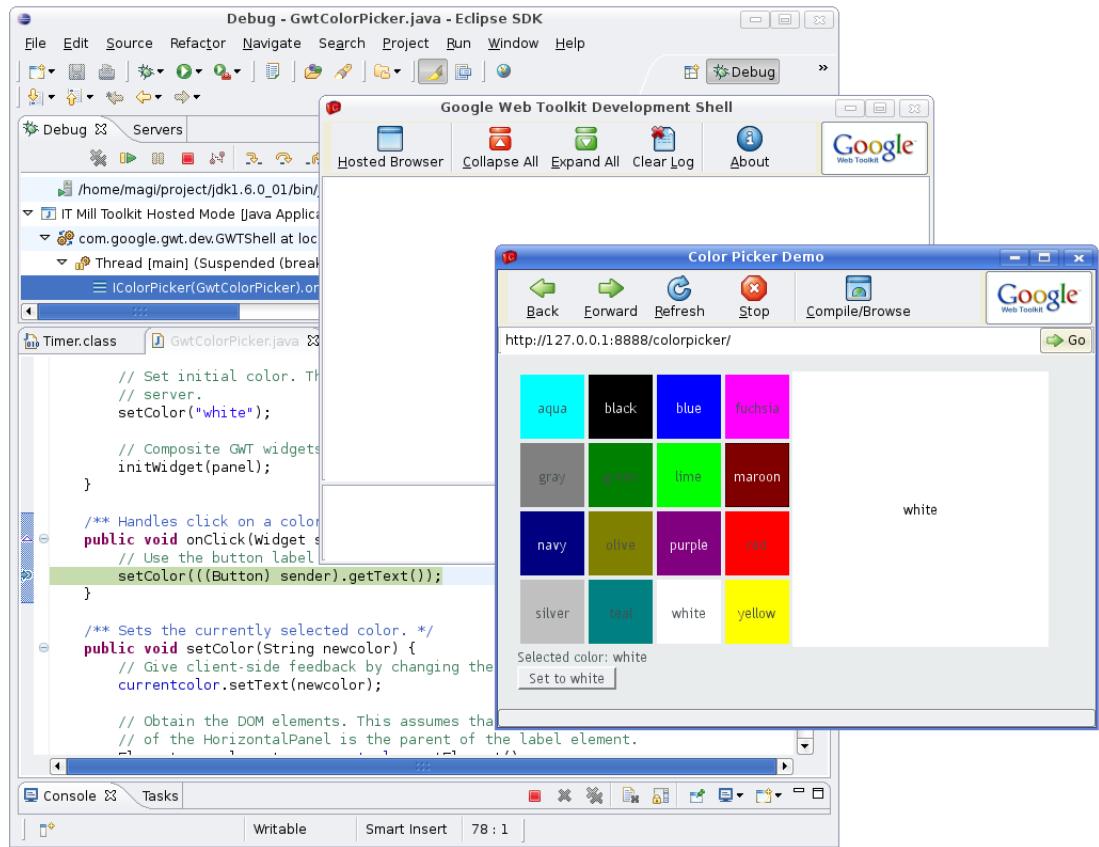
- GWT is installed in the project.
- GWT libraries are included in the project classpath.
- Widget sets have been compiled with GWT Compiler.
- `web.xml` descriptor is configured.
- Web server is running and listening to the correct port.
- GWT Development Mode launch configuration is configured.

Once everything is ready to start debugging, just open a source file, for example, the `com.vaadin.demo.colorpicker.gwt.client.ui.GwtColorPicker` class. Find the `onClick()` method. At the line containing the `setColor()` call, right-click on the leftmost bar in the editor and select **Toggle Breakpoint** from the popup menu. A small magnifying glass will appear in the bar to indicate the breakpoint.

Figure 10.13. Setting a Breakpoint



Select from menu **Run → Debug...** and the **Debug** configuration window will open. Notice that it is not purposeful to run the GWT Development Mode in the "Run" mode, because its entire purpose is to allow debugging.

Figure 10.14. Debugging with GWT Development Mode

Starting demo applications under the GWT Development Mode can take considerable time!
Compiling widgets can take 10-60 seconds, depending on the hardware. During this time, the web browser is unresponsive, does not update its window, and appears "stuck".

Please refer to Eclipse IDE documentation for further instructions on using the debugger.

10.8.7. Packaging a Widget Set

Packaging and reusing custom components is almost as easy as with any Java code, but with a small difference. You can package the *source code* of a widget set as a JAR. A user can drop the JAR in the project and add it to the class path. If using widgets from multiple widget sets, the user has to inherit the widget set in a combining widget set (which can be generated automatically). The user then has to compile the widget set(s) as described in Section 10.8.4, "Compiling GWT Widget Sets".

While you could, in theory, package precompiled widget sets in the JAR as well, it would create a serious danger for incompatibility between the client-side and server-side versions of Vaadin. The user would anyhow have to recompile the widget set if he uses multiple widget sets packaged in different JARs, or has developed project-specific widgets.

The `build-widgetset.xml` Ant script in the `WebContent/docs/example-source` directory of the Vaadin installation package includes an example `package-jar` target for building a JAR. You can use the example as it is or modify it as you need.

You need to make the JAR packaging specific configuration in the `configure-jar` target. Change to property values to reflect your widget set.

```
<target name="configure-jar">
    <!-- The compiled JAR name -->
    <property name="jar-destination"
        value="${base}colorpicker.jar"/>

    <!-- Title of the widget set (for JAR) -->
    <property name="widgetset-title"
        value="ColorPicker"/>

    <!-- Version of the widget set (for JAR) -->
    <property name="widgetset-version" value="1.0"/>

    <!-- Vendor of the widget set (for JAR) -->
    <property name="widgetset-vendor"
        value="IT Mill Oy"/>
</target>
```

You may want to check also the `package-jar` target if you want to use other license information or otherwise customize the package content.

Assuming that you have otherwise configured the build script for your project as described in Section 10.8.4, “Compiling GWT Widget Sets”, you can build the JAR package with the following command:

```
$ ant -f build-widgetset.xml package-jar
```

Notice that the `package-jar` target *does not* depend on the `compile-widgetset` target, as the compiled widget set is not included in the package. If you really wish to do so, add the dependency and include the compiled files as a fileset for the package.

10.8.8. Troubleshooting

Below are some typical cases that may cause you trouble.

Deferred binding fails

The OOPHM widget set compilation produces the following error in Eclipse console:

```
Deferred binding failed for
'com.vaadin.csvvalidation.widgetset.client.ui.VJavaScriptEditor'
(did you forget to inherit a required module?)
```

This problem occurs if the creation of an instance of a widget fails, usually due to an exception in the constructor. The GWT Development Mode console displays a more detailed exception log.

Widgets are missing from the widget set

The widget set compilation displays the list of widgets included in the widget set. If the list includes only the inherited widgets (built-in Vaadin widgets), but your custom widgets are missing, there is a problem.

The typical reason is that the server-side classes are not yet compiled or are missing from the classpath. Check that the server-side compilation output folder (such as `build/classes`) is included in the classpath of GWT Compiler and that you compile the server-side components before the client-side, so that they are

available in the classpath. The reason for this is that GWT Compiler (or more precisely a Vaadin widget set generator) reads the annotations that define the mapping from server-side components to client-side widgets from compiled class files.

The correct widget set is not loaded

The widget set must be specified in WebContent/WEB-INF/web.xml descriptor, as an initialization parameter for the servlet.

```
<init-param>
    <description>Application
widgetset</description>
<param-name>widgetset</param-name>
<param-value>com.example.mylibrary.widgetset.MyWidgetset</param-value>
</init-param>
```

A generated widget set inherits itself

The widget set builder can create a .gwt.xml descriptor that inherits the same widget set. This usually occurs when the class path for the source files is set to something different than the root of the entire source tree, so that the package name of the widget set to be defined with the descriptor would be invalid.

Chapter 11

Advanced Web Application Topics

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This chapter covers various features and topics often needed in applications. While other topics could be considered as "advanced", the first section gives a brief introduction to AJAX development for beginners.

11.1. Special Characteristics of AJAX Applications

New to AJAX? This section is intended for people familiar with the development of either traditional web applications or desktop applications, who are entering AJAX-enabled web application development. AJAX application development has a few special characteristics with respect to other types of applications. Possibly the most important one is how the display is managed in the web browser.

The web was originally not built for applications, but for hypertext pages that you can view with a browser. The purpose of web pages is to provide *content* for the user. Application software has a somewhat different purpose; usually to allow you to work on some data or content, much of which is not ever intended to be accessible through a web browser as web pages. As the web is inherently page-based, conventional web applications had to work with page requests and output HTML as response. JavaScript and AJAX have made it possible to let go of the pages.

Pages are largely an unknown concept to conventional desktop applications. At most, desktop applications can open multiple windows, but usually they work with a single main window, with an occasional dialog window here and there. Same goes usually for web applications developed with Vaadin: an application typically runs on a single page, changing the layout as needed and popping up dialog boxes.

Not having to load pages and use hyperlinks to communicate all user interaction is a relief for application development. However, they are an important feature that ordinary desktop applications lack. They allow referencing different functionalities of an application or resources managed by the application. They are also important for integration with external applications.

Certain resources can be identified through a *URI* or *Universal Resource Identifier*. A URI can easily be passed around or stored as a bookmark. We will see in Section 11.5.1, “URI Handlers” how you can retrieve the URI of a page request. Similarly, a page request can have query parameters, which can be handled as detailed in Section 11.5.2, “Parameter Handlers”.

Using URIs or request parameters to access functionalities or content is not as straight-forward as in conventional page-based web applications. Vaadin, just as any other AJAX framework, uses browser cookies not just for tracking users but also for tracking the application state. Cookies are unique in a browser, so any two windows share the same cookies and therefore also the state. The advantage is that you can close your browser and open it again and the application will be in the state where you left off (except for components such as text fields which did not have the immediate attribute enabled). The disadvantage is that there is no good way to distinguish between the windows, so there can usually be only a single application window. Even if there were several, you would have trouble with synchronization of application data between windows. Many conventional page-based web applications simply ignore out-of-sync situations, but such situations are risky for application platforms that are intended to be stable. Therefore it is safer to work with a single browser window. If you wish to have multiple windows in your application, you can create them inside the main window as **Window** objects. A URI can be used to fetch resources that have no particular state or to provide an entry point to the application.

11.2. Application-Level Windows

Vaadin Release 5 introduces support for multiple application-level windows that can be used just like the main window. All such windows use the same application session. Each window is identified with a URL that is used to access it. This makes it possible to bookmark application-level windows. Such windows can even be created dynamically based on URLs.

Application-level windows allow several uses important for the usability of browser-based applications.

- *Native child windows*. An application can open child windows that are not floating windows inside a parent window.
- *Page-based browsing*. The application can allow the user to open certain content to different windows. For example, in a messaging application, it can be useful to open different messages to different windows so that the user can browse through them while writing a new message.
- *Bookmarking*. Bookmarks in the web browser can provide an entry-point to some content provided by an application.
- *Embedding windows*. Windows can be embedded in web pages, thus making it possible to provide different views to an application from different pages or even from the same page, while keeping the same session. See Section 11.3, “Embedding Applications in Web Pages”.

Because of the special nature of AJAX applications, these uses require some caveats. We will go through them later in Section 11.2.4, “Caveats in Using Multiple Windows”.

11.2.1. Creating New Application-Level Windows

Creating a new application-level window is much like creating a child window (see Section 4.3, “Child Windows”), except that the window is added with `addWindow()` to the application object instead of the main window.

```
public class WindowTestApplication extends Application {
    public void init() {
        // First create the main window.
        final Window main = new Window ("My Test Application");
        setMainWindow(main);

        // Create another application-level window.
        final Window mywindow = new Window("Second Window");

        // Manually set the name of the window.
        mywindow.setName("mywindow");

        // Add some content to the window.
        mywindow.addComponent(new Label("Has content."));

        // Add the window to the application.
        addWindow(mywindow);
    }
}
```

This creates the `window` object that a user can view by opening a URL in a browser. Creating an application-level window object does not open a new browser window automatically to view the object, but if you wish to open one, you have to do it explicitly as shown below. An application-level window has a unique URL, which is based on the application URL and the name of the window given with the `setName()` method. For example, if the application URL is `http://localhost:8080/myapp/` and the window name is `mywindow`, the URL for the window will be `http://localhost:8080/myapp/mywindow/`. If the name of a window is not explicitly set with `setName()`, an automatically generated name will be used. The name can be retrieved with the `getName()` method and the entire URL with `getURL()`.

There are three typical ways to open a new window: using the `open()` method of **Window** class, a **Link**, or referencing it from HTML or JavaScript code written inside a **Label** component.

The **Window** `open()` method takes as parameters a resource to open and the target name. You can use **ExternalResource** to open a specific URL, which you get from the window to be opened with the `getURL()` method.

```
/* Create a button to open a new window. */
main.addComponent(new Button("Click to open new window",
    new Button.ClickListener() {
    public void buttonClick(ClickEvent event) {
        // Open the window.
        main.open(new ExternalResource(mywindow.getURL()),
            "_new");
    }
}));
```

The target name is one of the default HTML target names (`_new`, `_blank`, `_top`, etc.) or a custom target name. How the window is exactly opened depends on the browser. Browsers that support tabbed browsing can open the window in another tab, depending on the browser settings.

Another typical way to open windows is to use a **Link** component with the window URL as an **ExternalResource**.

```
/* Add a link to the second window. */
Link link = new Link("Click to open second window",
    new ExternalResource(mywindow.getURL()));
link.setTargetName("second");
link.setTargetHeight(300);
link.setTargetWidth(300);
link.setTargetBorder(Link.TARGET_BORDER_DEFAULT);
main.addComponent(link);
```

Using a **Link** allows you to specify parameters for the window that opens by clicking on the link. Above, we set the dimensions of the window and specify what window controls the window should contain. The `Link.TARGET_BORDER_DEFAULT` specifies to use the default, which includes most of the usual window controls, such as the menu, the toolbar, and the status bar.

Another way to allow the user to open a window is to insert the URL in HTML code inside a **Label**. This allows even more flexibility in specifying how the window should be opened.

```
// Add the link manually inside a Label.
main.addComponent(
    new Label("Second window: <a href='" + mywindow.getURL()
        + "' target='second'>click to open</a>",
        Label.CONTENT_XHTML));
main.addComponent(
    new Label("The second window can be accessed through URL: "
        + mywindow.getURL()));
```

When an application-level window is closed in the browser the `close()` method is normally called just like for a child window and the **Window** object is purged from the application. However, there are situations where `close()` might not be called. See Section 11.2.3, “Closing Windows” for more information.

11.2.2. Creating Windows Dynamically

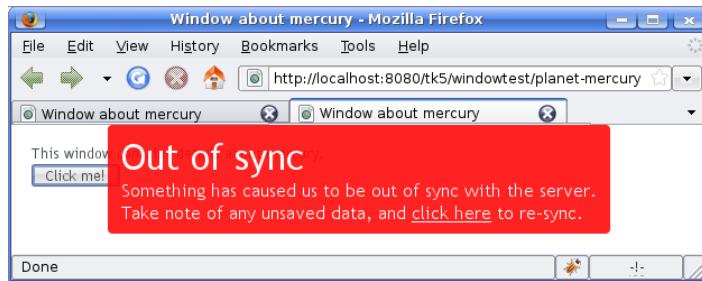
You can create a window object dynamically by its URL path by overriding the `getWindow()` method of the **Application** class. The method gets a window name as its parameter and must return the corresponding **Window** object. The window name is determined from the first URL

path element after the application URL (window name may not contain slashes). See the notes below for setting the actual name of the dynamically created windows below.

The following example allows opening windows with a window name that begins with "planet-" prefix. Since the method is called for every browser request for the application, we filter only the requests where a window with the given name does not yet exist.

```
public class WindowTestApplication extends Application {  
    ...  
  
    @Override  
    public Window getWindow(String name) {  
        // If a dynamically created window is requested, but  
        // it does not exist yet, create it.  
        if (name.startsWith("planet-") &&  
            super.getWindow(name) == null) {  
            String planetName =  
                name.substring("planet-".length());  
  
            // Create the window object.  
            Window newWindow =  
                new Window("Window about " + planetName);  
  
            // DANGEROUS: Set the name explicitly. Otherwise,  
            // an automatically generated name is used, which  
            // is usually safer.  
            newWindow.setName(name);  
  
            // Put some content in it.  
            newWindow.addComponent(  
                new Label("This window contains details about " +  
                    planetName + "."));  
  
            // Add it to the application as a regular  
            // application-level window.  
            addWindow(newWindow);  
  
            return newWindow;  
        }  
  
        // Otherwise the Application object manages existing  
        // windows by their name.  
        return super.getWindow(name);  
    }  
}
```

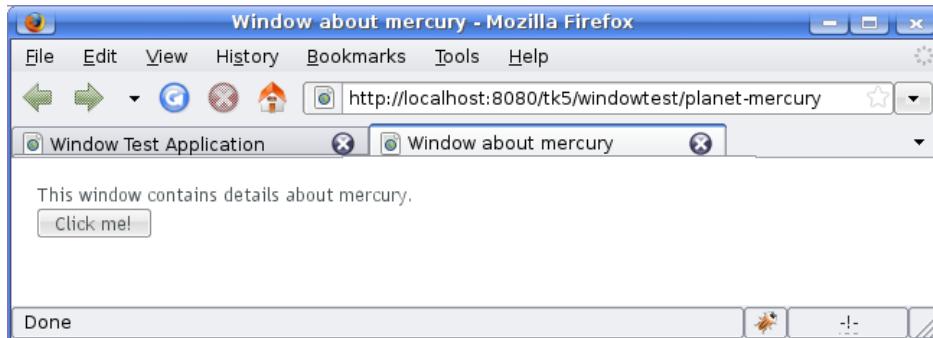
The window name is and must be a unique identifier for each **Window** object instance. If you use `setName()` to set the window name explicitly, as we did above, any browser window that has the same URL (within the same browser) would open the *same* window object. This is dangerous and *generally not recommended*, because the browser windows would share the same window object. Opening two windows with the same static name would immediately lead to a synchronization error, as is shown in Figure 11.1, “Synchronization Error Between Windows with the Same Name” below. (While also the window captions are same, they are irrelevant for this problem.)

Figure 11.1. Synchronization Error Between Windows with the Same Name

There are some cases where setting the name explicitly is useful. The launch application below is one example, as it always opens the other windows in a window target that is specific to the window name, thereby never creating two windows with the same URL. Similarly, if you had embedded the application in a browser frame and the link would open the window in a frame, you would not have problems. Having a single window instance for a URL is also useful if the browser crashes and the user opens the window again, as it will have kept its previous (server-side) state.

Leaving the window name to be automatically generated allows opening multiple windows with the same URL, while each of the windows will have a separate state. The URL in the location bar stays unchanged and the generated window name is used only for the Ajax communications to identify the window object. A generated name is a string representation of a unique random number, such as "1928676448". You should be aware of the generated window names when overriding the `getWindow()` method (and not unintentionally create a new window instance dynamically for each such request). The condition in the above example would also filter out the requests for an already existing window with a generated name.

Figure 11.2, "A Dynamically Created Window" shows a dynamically created application-level window with the URL shown in the address bar. The URL for the application is here `http://localhost:8080/tk5/windowexample/`, including the application context, and the dynamically created window's name is `planet-mars`.

Figure 11.2. A Dynamically Created Window

The application knows the windows it already has and can return them after the creation. The application also handles closing and destruction of application-level window objects, as discussed in Section 11.2.3, "Closing Windows".

Such dynamic windows could be opened as in the following example:

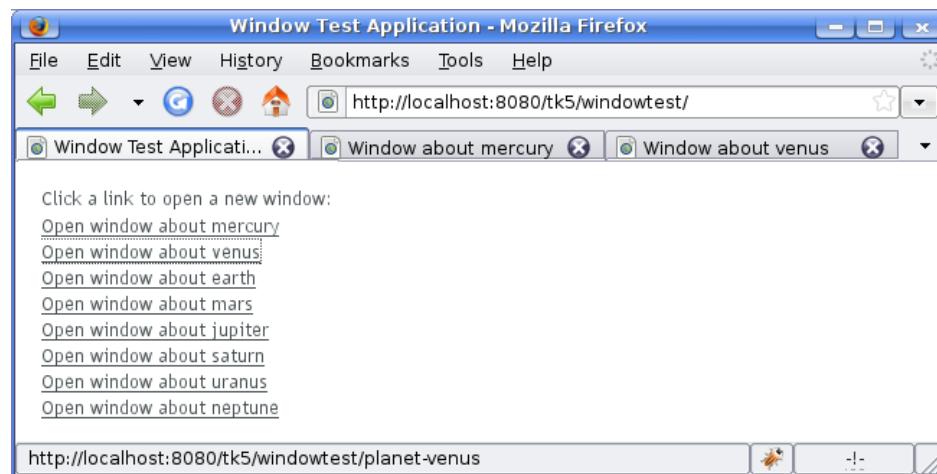
```
public void init() {
    final Window main = new Window("Window Test");
    setMainWindow(main);

    // Have some IDs for the dynamically creatable windows.
    final String[] items = new String[] { "mercury", "venus",
        "earth", "mars", "jupiter", "saturn", "uranus",
        "neptune" };

    // Create a list of links to each of the available window.
    for (int i = 0; i < items.length; i++) {
        // Create a URL for the window.
        String windowUrl = getURL() + "planet-" + items[i];

        // Create a link to the window URL. Using the
        // item ID for the target also opens it in a new
        // browser window (or tab) unique to the window name.
        main.addComponent(
            new Link("Open window about " + items[i],
                new ExternalResource(windowUrl),
                items[i], -1, -1, Window.BORDER_DEFAULT));
    }
}
```

Figure 11.3. Opening Windows



11.2.3. Closing Windows

When the user closes an application-level window, the Client-Side Engine running in the browser will report the event to the server before the page is actually removed. You can catch the event with a **Window.CloseListener**, as is done in the example below.

```
newWindow.addListener(new Window.CloseListener() {
    @Override
    public void windowClose(CloseEvent e) {
        // Do something.
        System.out.println(e.getWindow().getName() +
            " was closed");

        // Add a text to the main window about closing.
        // (This does not update the main window.)
        getMainWindow().addComponent(
            new Label("Window '" + e.getWindow().getName() +
                "' was closed."));
    }
});
```

```
}); }
```

Notice that the change to the server-side state of the main window (or another application-level window) does not refresh the window in the browser, so the change will be unseen until user interaction or polling refreshes the window. This problem and its dangers are discussed in Section 11.2.4, “Caveats in Using Multiple Windows” below.

The close event does not occur if the browser crashes or the connection is otherwise severed violently. In such a situation, the window object will be left hanging, which could become a resource problem if you allow the users to open many such application-level windows. The positive side is that the user can reconnect to the window using the window URL.

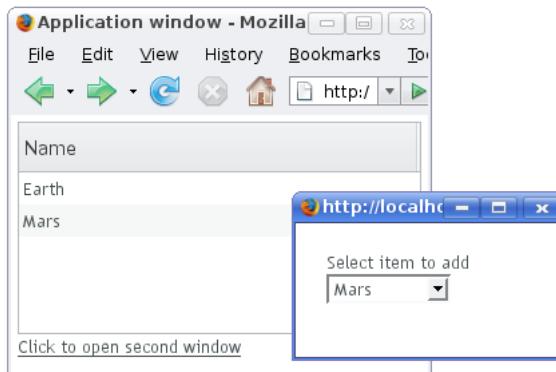
11.2.4. Caveats in Using Multiple Windows

Communication Between Windows

For cases where you need communication between windows, we recommend using floating child windows. In Vaadin Release 5, an application window can not update the data in other windows. The contents of a window can only be updated when the particular window makes a request to the server. The request can be caused by user input or through polling.

Changing the server-side state of a window while processing a user event from another window can potentially cause serious problems. Changing the client-side state of a window does not always immediately communicate the changes to the server. The server-side state can therefore be out of sync with the client-side state.

Figure 11.4. Communication Between Two Application-Level Windows



The following example creates a second window that changes the contents of the main window, as illustrated in the figure above. In this simple case, changing the main window contents is safe.

```
// Create a table in the main window to hold items added
// in the second window
final Table table = new Table();
table.setPageLength(5);
table.getSize().setWidth(100, Size.UNITS_PERCENTAGE);
table.addContainerProperty("Name", String.class, "");
main.addComponent(table);

// Create the second window
final Window adderWindow = new Window("Add Items");
adderWindow.setName("win-adder");
main.getApplication().addWindow(adderWindow);
```

```
// Create selection component to add items to the table
final NativeSelect select = new NativeSelect("Select item to add");
select.setImmediate(true);
adderWindow.addComponent(select);

// Add some items to the selection
String items[] = new String[]{"-- Select --", "Mercury", "Venus",
    "Earth", "Mars", "Jupiter", "Saturn", "Uranus", "Neptune"};
for (int i=0; i<items.length; i++)
    select.addItem(items[i]);
select.setNullSelectionItemId(items[0]);

// When an item is selected in the second window, add
// table in the main window
select.addValueChangeListener(new ValueChangeListener() {
    public void valueChange(ValueChangeEvent event) {
        // If the selected value is something else
        // but a null selection item.
        if (select.getValue() != null) {
            // Add the selected item to the table
            // in the main window
            table.addItem(new Object[]{select.getValue()},
                new Integer(table.size()));
        }
    }
});

// Link to open the selection window
Link link = new Link("Click to open second window",
    new ExternalResource(adderWindow.getURL()),
    "_new", 50, 200,
    Link.TARGET_BORDER_DEFAULT);
main.addComponent(link);

// Enable polling to update the main window
ProgressIndicator poller = new ProgressIndicator();
poller.setStyleName("invisible");
main.addComponent(poller);
```

The example uses an invisible **ProgressIndicator** to implement polling. This is sort of a trick and a more proper API for polling is under design. Making the progress indicator invisible requires the following CSS style definition:

```
.v-progressindicator-invisible {
    display: none;
}
```

11.3. Embedding Applications in Web Pages

Many web applications and especially web sites are not all AJAX, but AJAX is used only for specific functionalities. In practice, many web applications are a mixture of dynamic web pages and AJAX applications embedded to such pages.

Embedding Vaadin applications is easy. There are two basic ways to embed them. One is to have a `<div>` placeholder for the web application and load the Vaadin Client-Side Engine with a simple JavaScript code. The second method is even easier, which is to simply use the `<iframe>` element. Both of these methods have advantages and disadvantages. The `<div>` method can only embed one application in a page, while the `<iframe>` method can embed as many as needed. One disadvantage of the `<iframe>` method is that the size of the `<iframe>` element is not flexible according to the content while the `<div>` method allows such flexibility. The following sections look closer into these two embedding methods.

11.3.1. Embedding Inside a `div` Element

The loading code for the Client-Side Engine changed in IT Mill toolkit version 5.1.2 and the explanation below is no longer compatible with Vaadin. Please view the source code of the initial page of your application in your browser.

You can embed a Vaadin application inside a web page with a method that is equivalent to loading the initial page content from the application servlet in a non-embedded application. Normally, the **ApplicationServlet** servlet generates an initial page that contains the correct parameters for the specific application. You can easily configure it to load multiple Vaadin applications on the same page, assuming that they use the same widget set.

You can view the initial page for your application easily simply by opening the application in a web browser and viewing the HTML source code. You could just copy and paste the embedding code from the default initial page. It has, however, some extra functionality that is not normally needed: it generates some of the script content with `document.write()` calls, which is useful only when you are running the application as a portlet in a portal. The method outlined below is much simpler.

The `WebContent/multiapp.html` file included in the Vaadin installation package provides an example of embedding (multiple) Vaadin applications in a page. After launching the demo application, you can view the example at URL `http://localhost:8888/multiapp.html`. Notice that the example assumes the use of root context for the applications `(/)`.

Embedding requires four elements inside the HTML document:

1. In the `<head>` element, you need to define the application URI and parameters and load the Vaadin Client-Side Engine. The `vaadin` variable is an associative map that can contain various runtime data used by the Client-Side Engine of Vaadin. The `vaadinConfigurations` item is itself an associate map that contains parameters for each of the applications embedded in the page. The map must contain the following items:

appUri	The application URI consists of the context and the application path. If the context is <code>/mycontext</code> and the application path is <code>myapp</code> , the <code>appUri</code> would be <code>/mycontext/myapp</code> . The <code>multiapp.html</code> example assumes the use of root context, which is used in the demo application.
pathInfo	The <code>PATHINFO</code> parameter for the Servlet.
themeUri	URI of the application theme. The URI must include application context and the path to the theme directory. Themes are, by default, stored under the <code>/VAADIN/themes/</code> path.
versionInfo	This item is itself an associative map that contains two parameters: <code>vaadinVersion</code> contains the version number of the Vaadin version used by the application. The <code>applicationVersion</code> parameter contains the version of the particular application.

The following example defines two applications to run in the same window: the Calculator and Hello World examples. In the example, the application context is `/tk5`.

```
<script type="text/javascript">
var vaadin = {
    vaadinConfigurations: {
```

```
'calc': {
    appUri: '/tk5/Calc',
    pathInfo: '/',
    themeUri: '/tk5/VAADIN/themes/example',
    versionInfo : {
        vaadinVersion: "5.9.9-INTERNAL-
NONVERSIONED-DEBUG-BUILD",
        applicationVersion: "NONVERSIONED"
    }
},
'hello': {
    appUri: '/tk5/HelloWorld',
    pathInfo: '/',
    themeUri: '/tk5/VAADIN/themes/example',
    versionInfo : {
        vaadinVersion: "5.9.9-INTERNAL-
NONVERSIONED-DEBUG-BUILD",
        applicationVersion: "NONVERSIONED"
    }
}
}};

</script>
```

2. Loading the Vaadin Client-Side Engine is done with the following kind of line in the `<head>` element:

```
<script language='javascript'
src='vaadin-examples/VAADIN/widgetsets/com.vaadin.terminal.gwt.DefaultWidgetSet/com.vaadin.terminal.gwt.DefaultWidgetSet.made.js'></script>
```

The engine URI consists of the context of the web application, `vaadin-examples` above, followed by the path to the JavaScript (`.js`) file of the widget set, relative to the `WebContent` directory. The file contains the Client-Side Engine compiled for the particular widget set. The line above assumes the use of the default widget set of Vaadin. If you have made custom widgets that are defined in a custom widget set, you need to use the path to the compiled widget set file. Widget sets must be compiled under the `WebContent/VAADIN/widgetsets` directory.

3. In the `<html>` element, you need to do a routine inclusion of GWT history `iframe` element as follows:

```
<iframe id="__gwt_historyFrame"
style="width:0;height:0;border:0"></iframe>
```

4. The location of the Vaadin application is defined with a `div` placeholder element having `id="itmill-ajax-window"` as follows:

```
<div id="itmill-ajax-window"/>
```

Below is a complete example of embedding an application. It works out-of-the-box with the Calculator demo application.

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml" >
<head>
    <title>Embedding Example</title>

    <!-- Set parameters for the Vaadin Client-Side Engine. -->
    <script type="text/javascript">
        var vaadin = {appUri:'Calc', pathInfo: '/'};
    </script>
```

```
<!-- Load the Vaadin Client-Side Engine. -->
<script language='javascript'
src='/vaadin-examples/VADIN/widgetsets/com.vaadin.terminal.gwt.DefaultWidgetSet/com.vaadin.terminal.gwt.DefaultWidgetSet.mosache.js'></script>

<!-- We can stylize the web application. -->
<style>
#vaadin-ajax-window {background: #c0c0ff;}
.v-button {background: pink;}
</style>
</head>

<body>
<!-- This <iframe> element is required by GWT. -->
<iframe id="__gwt_historyFrame"
style="width:0;height:0;border:0"></iframe>

<h1>This is a HTML page</h1>
<p>Below is the Vaadin application inside a table:</p>
<table align="center" border="3" style="background: yellow;">
<tr><th>The Calculator</th></tr>
<tr>
<td>
<!-- Placeholder <div> for the Vaadin application -->
<div id="vaadin-ajax-window"/>
</td>
</tr>
</table>
</body>
</html>
```

The page will look as shown in Figure 11.5, “Embedded Application”.

You can style the web application with themes as described in Chapter 8, *Themes*. The Client-Side Engine loads the style sheets required by the application. In addition, you can do styling in the embedding page, as was done in the example above.

The Reservation Demo and Windowed Demos provide similar examples of embedding an application in a web page. The embedding web pages are `WebContent/reservr.html` and `WebContent/windoweddemos.html`, respectively.

The disadvantage of this embedding method is that there can only be one web application embedded in a page. One is usually enough, but if it is not, you need to use the `<iframe>` method below.

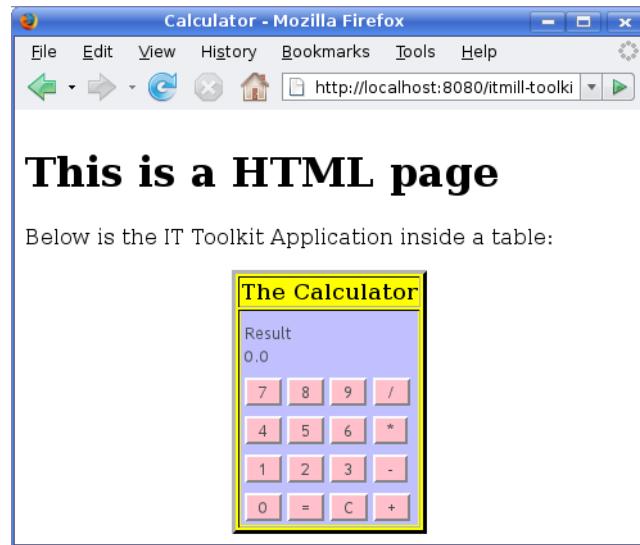
11.3.2. Embedding Inside an `iframe` Element

Embedding a Vaadin application inside an `<iframe>` element is even easier than the method described above, as it does not require definition of any Vaadin specific definitions. The use of `<iframe>` makes it possible to embed multiple web applications or two different views to the same application on the same page.

You can embed an application with an element such as the following:

```
<iframe src="/vaadin-examples/Calc"></iframe>
```

The problem with `<iframe>` elements is that their size of is not flexible depending on the content of the frame, but the content must be flexible to accommodate in the frame. You can set the size of an `<iframe>` element with `height` and `width` attributes.

Figure 11.5. Embedded Application

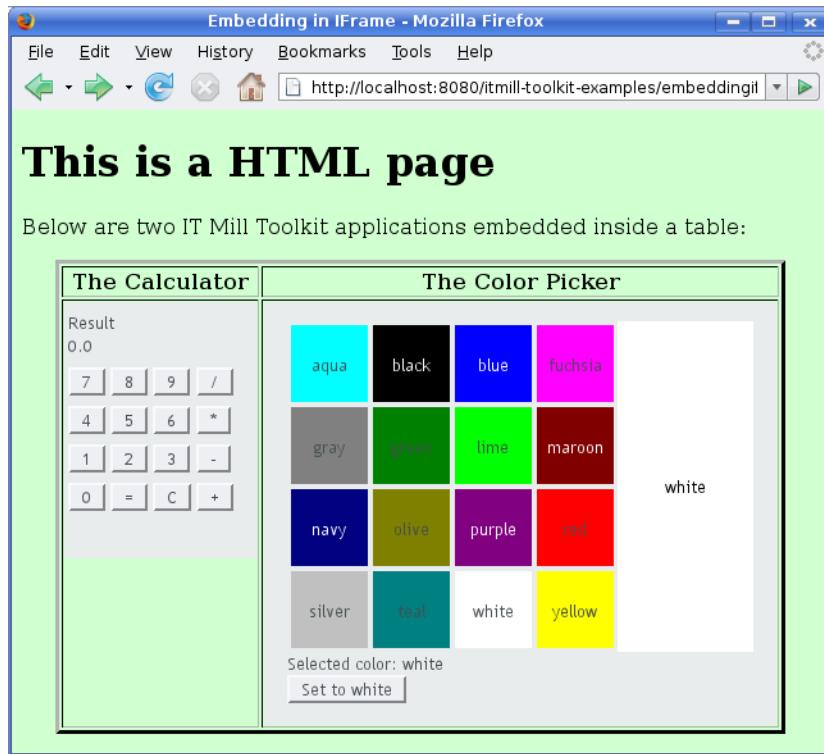
Below is a complete example of using the <iframe> to embed two applications in a web page.

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
  "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml" >
  <head>
    <title>Embedding in IFrame</title>
  </head>

  <body style="background: #d0ffd0;">
    <h1>This is a HTML page</h1>
    <p>Below are two Vaadin applications embedded inside a table:</p>

    <table align="center" border="3">
      <tr>
        <th>The Calculator</th>
        <th>The Color Picker</th>
      </tr>
      <tr valign="top">
        <td>
          <iframe src="/vaadin-examples/Calc" height="200"
                  width="150" frameborder="0"></iframe>
        </td>
        <td>
          <iframe src="/vaadin-examples/colorpicker"
                  height="330" width="400"
                  frameborder="0"></iframe>
        </td>
      </tr>
    </table>
  </body>
</html>
```

The page will look as shown in Figure 11.6, “Vaadin Applications Embedded Inside IFrames” below.

Figure 11.6. Vaadin Applications Embedded Inside IFrames

11.4. Debug and Production Mode

Vaadin applications can be run in two modes: *debug mode* and *production mode*. The debug mode, which is on by default, enables a number of built-in debug features for the developers. The features include:

- Debug Window for accessing debug functionalities
- Display debug information in the Debug Window and server console.
- **Analyze layouting** button that analyzes the layout for possible problems.

All applications are run in the debug mode by default (since IT Mill Toolkit version 5.3.0). The production mode can be enabled, and debug mode thereby disabled, by adding a `productionMode=true` parameter to the servlet context in the `web.xml` deployment descriptor:

```
<context-param>
  <description>Vaadin production mode</description>
  <param-name>productionMode</param-name>
  <param-value>true</param-value>
</context-param>
```

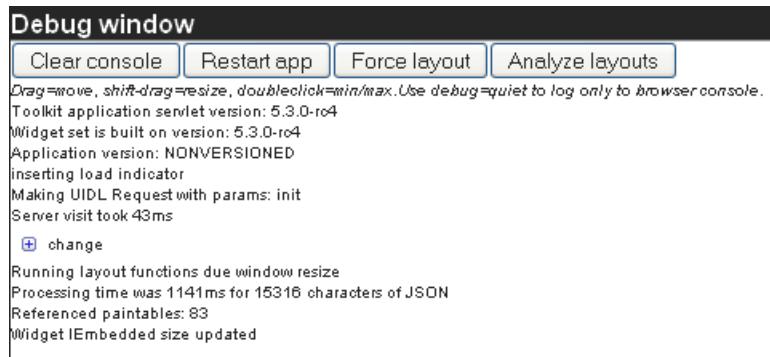
Enabling the production mode disables the debug features, thereby preventing users from easily inspecting the inner workings of the application from the browser.

11.4.1. Debug Mode

Running an application in the debug mode enables the client-side Debug Window in the browser. You can open the Debug Window by adding "?debug" to the application URL, e.g.,

`http://localhost:8080/myapp/?debug`. The Debug Window, shown in Figure 11.7, “Debug Window”, consists of buttons controlling the debugging features and a scrollable log of debug messages.

Figure 11.7. Debug Window



- | | |
|------------------------|--|
| Clear console | Clears the log in the Debug Window. |
| Restart app | Restarts the application. |
| Force layout | Causes all currently visible layouts to recalculate their appearance. Layout components calculate the space required by all child components, so the layout appearance must be recalculated whenever the size of a child component is changed. In normal applications, this is done automatically, but when you do themeing or alter the CSS with Firebug, you may need to force all layouts to recalculate themselves, taking into account the recently made changes. |
| Analyze layouts | This is described in the following section. |

If you use the Firebug plugin in Mozilla Firefox, the log messages will also be printed to the Firebug console. In such a case, you may want to enable client-side debugging without showing the Debug Window with "`?debug=quiet`" in the URL. In the quiet debug mode, log messages will only be printed to the Firebug console.

11.4.2. Analyzing Layouts

The **Analyze layouts** button analyzes the currently visible layouts and makes a report of possible layout related problems. All detected layout problems are displayed in the log and also printed to the console.

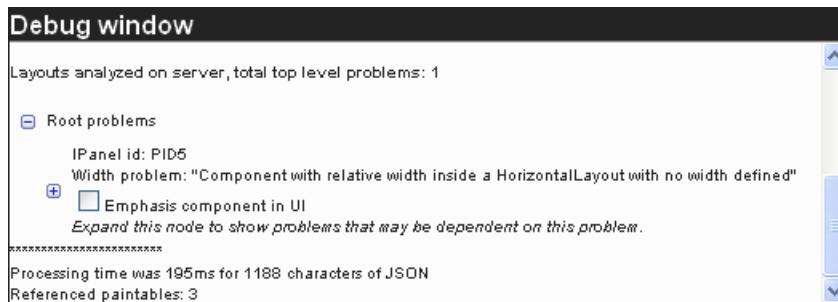
The most common layout problem is caused by placing a component that has a relative size inside a container (layout) that has undefined size, e.g., adding a 100% wide **Panel** inside a **HorizontalLayout** with no width specification. In such a case, the error will look as shown below:

```
Vaadin DEBUG
- Window/1a8bd74 "My window" (width: MAIN WINDOW)
  - HorizontalLayout/1cf243b (width: UNDEFINED)
    - Panel/12e43f1 "My panel" (width: RELATIVE, 100.0 %)
Layout problem detected: Component with relative width inside a HorizontalLayout with no width defined
Relative sizes were replaced by undefined sizes, components may not render as expected.
```

This particular error tells that the **Panel** "My panel" is 100% wide while the width of the containing **HorizontalLayout** is undefined. The components will be rendered as if the the width of the contained **Panel** was undefined, which might not be what the developer wanted. There are two possible fixes for this case: if the **Panel** should fill the main window horizontally, set a width for the **HorizontalLayout** (e.g. 100% wide), or set the width of the **Panel** to "undefined" to render the it as it is currently rendered but avoiding the warning message.

The same error is shown in the Debug Window in a slightly different form and with an additional feature (see Figure 11.8, "Debug Window Showing the Result of Analyze layouts"). Checking the **Emphasize component in UI** box will turn red the background of the component that caused a warning, making it easy for the developer to figure out which component each warning relates to. The messages will also be displayed hierarchically, as a warning from a containing component often causes more warnings from its child components. A good rule of thumb is to work on the upper-level problems first and only after that worry about the warnings from the children.

Figure 11.8. Debug Window Showing the Result of Analyze layouts.



11.4.3. Custom Layouts

CustomLayout components can not be analyzed in the same way as other layouts. For custom layouts, the **Analyze layouts** button analyzes all contained relative-sized components and checks if any relative dimension is calculated to zero so that the component will be invisible. The error log will display a warning for each of these invisible components. It would not be meaningful to emphasize the component itself as it is not visible, so when you select such an error, the parent layout of the component is emphasized if possible.

11.4.4. Debug Functions for Component Developers

You can take advantage of the debug mode when developing client-side components. The static function `ApplicationConnection.getConsole()` will return a reference to a **Console** object which contains logging methods such as `log(String msg)` and `error(String msg)`. These functions will print messages to the Debug Window and Firebug console in the same way as other debugging functionalities of Vaadin do. No messages will be printed if the Debug Window is not open or if the application is running in production mode.

11.5. Resources

In addition to high-level resource classes described in Section 4.5, "Referencing Resources", Vaadin provides low-level facilities for retrieving the URI and other parameters of HTTP requests. In the following, we will look into low-level interfaces for handling URIs and parameters to provide resources and functionalities.

Notice that using URI or parameter handlers to create "pages" is not meaningful in Vaadin or in AJAX applications generally. See Section 11.1, "Special Characteristics of AJAX Applications" for reasons.

11.5.1. URI Handlers

The URI parameter for the application is useful mainly for two purposes: for providing some special functionality according to the URI or for providing dynamic content. Dynamic content can also be provided with **StreamResource**.

You can retrieve the URI for the HTTP request made for your application by implementing the **com.vaadin.terminal.URIHandler** interface. The handler class needs to be registered in the main window object of your application with the `addURIHandler()` method. You then get the URI by implementing the `handleURI()` method. The method gets two parameters: a context and a URI relative to the context. The context is the base URI for your application.

```
public void init() {
    final Window main = new Window("Hello window");
    setMainWindow(main);

    URIHandler uriHandler = new URIHandler() {
        public DownloadStream handleURI(URL context,
                                         String relativeUri) {
            // Do something here
            System.out.println("handleURI=" + relativeUri);

            // Should be null unless providing dynamic data.
            return null;
        }
    };
    main.addURIHandler(uriHandler);
}
```

If you have multiple URI handlers attached to a window, they are executed after one another. The URI handlers should return `null`, unless you wish to provide dynamic content with the call. Other URI handlers attached to the window will not be executed after some handler returns non-null data. The combined parameter and URI handler example below shows how to create dynamic content with a URI handler.

Notice that if you do provide dynamic content with a URI handler, the dynamic content is returned in the HTTP response. If the handler makes any changes to the UI state of the application, these changes are not rendered in the browser, as they are usually returned in the HTTP response made by the Application object and now the custom URI handler overrides the default behaviour. If your client-side code makes a server call that does update the UI state, the client-side must initiate an update from the server. For example, if you have an integration situation where you make a JavaScript call to the server, handle the request with a URI handler, and the server state changes as a side-effect, you can use the `vaadin.forceSync()` method to force the update.

11.5.2. Parameter Handlers

You can retrieve the parameters passed to your application by implementing the **com.vaadin.terminal.ParameterHandler** interface. The handler class needs to be registered in the main window object of your application with the `addParameterHandler()` method. You then get the parameters in the `handleParameters()` method. The parameters are passes as a map from string key to a vector of string values.

```
class MyParameterHandler implements ParameterHandler {
    public void handleParameters(Map parameters) {
        // Print out the parameters to standard output
        for (Iterator it = parameters.keySet().iterator();
             it.hasNext();) {
            String key   = (String) it.next();
            String value = ((String[]) parameters.get(key))[0];
            System.out.println("Key: "+key+", value: "+value);
        }
    }
}
```

The parameter handler is not called if there are no parameters. Parameter handler is called before the URI handler, so if you handle both, you might typically want to just store the URI parameters in the parameter handler and do actual processing in URI handler. This allows you, for example, to create dynamic resources based on the URI parameters.

```
import java.awt.*;
import java.awt.image	BufferedImage;
import java.io.*;
import java.net.URL;
import java.util.Map;
import javax.imageio.ImageIO;
import com.vaadin.terminal.*;

/**
 * Demonstrates handling URI parameters and the URI itself to
 * create a dynamic resource.
 */
public class MyDynamicResource implements URIHandler,
    ParameterHandler {
    String textToDisplay = "- no text given -";

    /**
     * Handle the URL parameters and store them for the URI
     * handler to use.
     */
    public void handleParameters(Map parameters) {
        // Get and store the passed HTTP parameter.
        if (parameters.containsKey("text"))
            textToDisplay =
                ((String[])parameters.get("text"))[0];
    }

    /**
     * Provides the dynamic resource if the URI matches the
     * resource URI. The matching URI is "/myresource" under
     * the application URI context.
     *
     * Returns null if the URI does not match. Otherwise
     * returns a download stream that contains the response
     * from the server.
     */
    public DownloadStream handleURI(URL context,
        String relativeUri) {
        // Catch the given URI that identifies the resource,
        // otherwise let other URI handlers or the Application
        // to handle the response.
        if (!relativeUri.startsWith("myresource"))
            return null;

        // Create an image and draw some background on it.
        BufferedImage image = new BufferedImage (200, 200,
            BufferedImage.TYPE_INT_RGB);
        Graphics drawable = image.getGraphics();
        drawable.setColor(Color.lightGray);
```

```
drawable.fillRect(0,0,200,200);
drawable.setColor(Color.yellow);
drawable.fillOval(25,25,150,150);
drawable.setColor(Color.blue);
drawable.drawRect(0,0,199,199);

// Use the parameter to create dynamic content.
drawable.setColor(Color.black);
drawable.drawString("Text: "+textToDisplay, 75, 100);

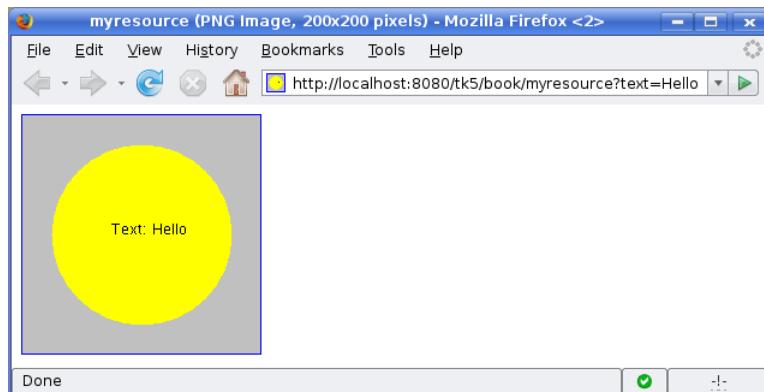
try {
    // Write the image to a buffer.
    ByteArrayOutputStream imagebuffer =
        new ByteArrayOutputStream();
    ImageIO.write(image, "png", imagebuffer);

    // Return a stream from the buffer.
    ByteArrayInputStream istream =
        new ByteArrayInputStream(
            imagebuffer.toByteArray());
    return new DownloadStream (istream,null,null);
} catch (IOException e) {
    return null;
}
}
}
```

When you use the dynamic resource class in your application, you obviously need to provide the same instance of the class as both types of handler:

```
MyDynamicResource myresource = new MyDynamicResource();
mainWindow.addParameterHandler(myresource);
mainWindow.addURIHandler(myresource);
```

Figure 11.9. Dynamic Resource with URI Parameters



11.6. Shortcut Keys

Vaadin provides simple ways for defining shortcut keys for field components and a default button, and a lower-level generic shortcut key binding API based on actions.

11.6.1. Click Shortcuts for Default Buttons

You can add or set a *click shortcut* to a button to set it as "default" button; pressing the defined key, typically **Enter**, in any component in the window causes a click event for the button.

You can define a click shortcut with the `setClickShortcut()` shorthand method:

```
// Have an OK button and set it as the default button
Button ok = new Button("OK");
ok.setClickShortcut(KeyCode.ENTER);
ok.addStyleName("primary");
```

The **primary** style name highlights a button to show the default button status; usually with a bolder font than usual, depending on the theme. The result can be seen in Figure 11.10, “Default Button with Click Shortcut”.

Figure 11.10. Default Button with Click Shortcut



11.6.2. Field Focus Shortcuts

You can define a shortcut key that sets the focus to a field component (any component that inherits **AbstractField**) by adding a **FocusShortcut** as a shortcut listener to the field.

```
// A field with Alt+N bound to it
TextField name = new TextField("Name (Alt+N)");
name.addShortcutListener(
    new AbstractField.FocusShortcut(name, KeyCode.N,
        ModifierKey.ALT));
layout.addComponent(name);

// A field with Alt+A bound to it
TextField address = new TextField("Address (Alt+A)");
address.addShortcutListener(
    new AbstractField.FocusShortcut(address, KeyCode.A,
        ModifierKey.ALT));
layout.addComponent(address);
```

The constructor of the **FocusShortcut** takes the field component as its first parameter, followed by the key code, and an optional list of modifier keys, as listed in Section 11.6.4, “Supported Key Codes and Modifier Keys”.

11.6.3. Generic Shortcut Actions

Shortcut keys can be defined as *actions* using the **ShortcutAction** class. **ShortcutAction** extends the generic **Action** class that is used for example in **Tree** and **Table** for context menus. Currently, the only classes that accept **ShortcutActions** are **Window** and **Panel**.

To handle key presses, you need to define an action handler by implementing the **Handler** interface. The interface has two methods that you need to implement: `getActions()` and `handleAction()`.

The `getActions()` method must return an array of **Action** objects for the component, specified with the second parameter for the method, the *sender* of an action. For a keyboard shortcut, you use a **ShortcutAction**. The implementation of the method could be following:

```
// Have the unmodified Enter key cause an event
Action action_ok = new ShortcutAction("Default key",
    ShortcutAction.KeyCode.ENTER, null);

// Have the C key modified with Alt cause an event
Action action_cancel = new ShortcutAction("Alt+C",
```

```
    ShortcutAction.KeyCode.C,
    new int[] { ShortcutAction.ModifierKey.ALT });

Action[] actions = new Action[] {action_cancel, action_ok};

public Action[] getActions(Object target, Object sender) {
    if (sender == myPanel)
        return actions;

    return null;
}
```

The returned **Action** array may be static or you can create it dynamically for different senders according to your needs.

The constructor of **ShortcutAction** takes a symbolic caption for the action; this is largely irrelevant for shortcut actions in their current implementation, but might be used later if implementors use them both in menus and as shortcut actions. The second parameter is the key code and the third a list of modifier keys, which are listed in Section 11.6.4, “Supported Key Codes and Modifier Keys”.

The following example demonstrates the definition of a default button for a user interface, as well as a normal shortcut key, **Alt-C** for clicking the **Cancel** button.

```
public class DefaultButtonExample extends CustomComponent
    implements Handler {
    // Define and create user interface components
    Panel panel = new Panel("Login");
    FormLayout formlayout = new FormLayout();
    TextField username = new TextField("Username");
    TextField password = new TextField("Password");
    HorizontalLayout buttons = new HorizontalLayout();

    // Create buttons and define their listener methods.
    Button ok = new Button("OK", this, "okHandler");
    Button cancel = new Button("Cancel", this, "cancelHandler");

    // Have the unmodified Enter key cause an event
    Action action_ok = new ShortcutAction("Default key",
        ShortcutAction.KeyCode.ENTER, null);

    // Have the C key modified with Alt cause an event
    Action action_cancel = new ShortcutAction("Alt+C",
        ShortcutAction.KeyCode.C,
        new int[] { ShortcutAction.ModifierKey.ALT });

    public DefaultButtonExample() {
        // Set up the user interface
        setCompositionRoot(panel);
        panel.addComponent(formlayout);
        formlayout.addComponent(username);
        formlayout.addComponent(password);
        formlayout.addComponent(buttons);
        buttons.addComponent(ok);
        buttons.addComponent(cancel);

        // Set focus to username
        username.setFocus();

        // Set this object as the action handler
        System.out.println("adding ah");
        panel.addActionHandler(this);

        System.out.println("start done.");
    }
```

```
/*
 * Retrieve actions for a specific component. This method
 * will be called for each object that has a handler; in
 * this example just for login panel. The returned action
 * list might as well be static list.
 */
public Action[] getActions(Object target, Object sender) {
    System.out.println("getActions()");
    return new Action[] { action_ok, action_cancel };
}

/**
 * Handle actions received from keyboard. This simply directs
 * the actions to the same listener methods that are called
 * with ButtonClick events.
 */
public void handleAction(Action action, Object sender,
                         Object target) {
    if (action == action_ok) {
        okHandler();
    }
    if (action == action_cancel) {
        cancelHandler();
    }
}

public void okHandler() {
    // Do something: report the click
    formlayout.addComponent(new Label("OK clicked. "
        + "User=" + username.getValue() + ", password="
        + password.getValue()));
}

public void cancelHandler() {
    // Do something: report the click
    formlayout.addComponent(new Label("Cancel clicked. User="
        + username.getValue() + ", password="
        + password.getValue()));
}
}
```

Notice that the keyboard actions can currently be attached only to **Panels** and **Windows**. This can cause problems if you have components that require a certain key. For example, multi-line **TextField** requires the **Enter** key. There is currently no way to filter the shortcut actions out while the focus is inside some specific component, so you need to avoid such conflicts.

11.6.4. Supported Key Codes and Modifier Keys

The shortcut key definitions require a key code to identify the pressed key and modifier keys, such as Shift, Alt, or Ctrl, to specify a key combination.

The key codes are defined in the **ShortcutAction.KeyCode** interface and are:

Keys A to Z	Normal letter keys
F1 to F12	Function keys
BACKSPACE, DELETE, ENTER, ESCAPE, INSERT, TAB	Control keys
NUM0 to NUM9	Number pad keys

<i>ARROW_DOWN</i> , <i>ARROW_UP</i> ,	Arrow keys
<i>ARROW_LEFT</i> , <i>ARROW_RIGHT</i>	
<i>HOME</i> , <i>END</i> , <i>PAGE_UP</i> ,	Other movement keys
<i>PAGE_DOWN</i>	

Modifier keys are defined in **ShortcutAction.ModifierKey** and are:

<i>ModifierKey.ALT</i>	Alt key
<i>ModifierKey.CTRL</i>	Ctrl key
<i>ModifierKey.SHIFT</i>	Shift key

All constructors and methods accepting modifier keys take them as a variable argument list following the key code, separated with commas. For example, the following defines a **Ctrl-Shift-N** key combination for a shortcut.

```
TextField name = new TextField("Name (Ctrl+Shift+N)");
name.addShortcutListener(
    new AbstractField.FocusShortcut(name, KeyCode.N,
        ModifierKey.CTRL,
        ModifierKey.SHIFT));
```

Supported Key Combinations

The actual possible key combinations vary greatly between browsers, as most browsers have a number of built-in shortcut keys, which can not be used in web applications. For example, Mozilla Firefox allows binding almost any key combination, while Opera does not even allow binding Alt shortcuts. Other browsers are generally in between these two. Also, the operating system can reserve some key combinations and some computer manufacturers define their own system key combinations.

11.7. Printing

Vaadin does not currently have any special support for printing. Printing on the server-side is, in any case, largely independent from the web UI of an application. You just have to take care that the printing does not block server requests, possibly by running printing in another thread.

For client-side printing, most browsers support printing the web page. Vaadin does not explicitly support launching the printing in browser, but you can easily use the JavaScript `print()` method that opens the print window of the browser.

```
final Button print = new Button("Print This Page");
print.addListener(new ClickListener() {
    public void buttonClick(ClickEvent event) {
        print.getWindow().executeJavaScript("print();");
    }
});
```

This button would print the current page, including the button itself. Often, you want to be able to print a report or receipt and it should not have any visible UI components. In such a case, you could offer it as a PDF resource, or you could open a new window, as is done below, and automatically launch printing.

```
// A button to open the printer-friendly page.
Button print = new Button("Click to Print");

print.addListener(new Button.ClickListener() {
```

```
public void buttonClick(ClickEvent event) {
    // Create a window that contains what you want to print
    Window window = new Window("Window to Print");

    // Have some content to print
    window.addComponent(new Label(
        "<h1>Here's some dynamic content</h1>\n" +
        "<p>This is to be printed to the printer.</p>",
        Label.CONTENT_XHTML));

    // Add the printing window as a new application-level
    // window
    getApplication().addWindow(window);

    // Open it as a popup window with no decorations
    getWindow().open(new ExternalResource(window.getURL()),
        "_blank", 500, 200, // Width and height
        Window.BORDER_NONE); // No decorations

    // Print automatically when the window opens.
    // This call will block until the print dialog exits!
    window.executeJavaScript("print();");

    // Close the window automatically after printing
    window.executeJavaScript("self.close();");
}
});
```

How the browser opens the window, as an actual (popup) window or just a tab, depends on the browser. Notice that calling the `print()` method in the window will block the entire application until the print dialog exits. After printing, we automatically close the window with another JavaScript call, as there is no `close()` method in **Window**.

Printing as PDF would not require creating a **Window** object, but you would need to provide the content as a static or a dynamic resource for the `open()` method. Printing a PDF file would obviously require a PDF viewer capability (such as Adobe Reader) in the browser.

11.8. Portal Integration

Vaadin supports running applications as portlets, as defined in the JSR-168 (Java Portlet API) and JSR-286 (Java Portlet API 2.0) standards. While providing generic support for all portals implementing the standards, Vaadin especially supports the Liferay portal and the needed portal-specific configuration is given below for Liferay.

You can deploy the Vaadin demo package WAR (available from the download site) directly to a portal such as Liferay. It contains all the necessary portlet configuration files. For optimal performance with Liferay, you can install the Vaadin library and other needed resources in Liferay as described later in this section.

You can find more documentation and examples from the Vaadin Developer's Site at <http://dev.vaadin.com/>.

11.8.1. Deploying to a Portal

Deploying a Vaadin application as a portlet is essentially just as easy as deploying a regular application to an application server. You do not need to make any changes to the application itself, but only the following:

- Application packaged as a WAR

- WEB-INF/portlet.xml descriptor
- WEB-INF/web.xml descriptor for Portlet 1.0 portlets
- WEB-INF/liferay-portlet.xml descriptor for Liferay
- WEB-INF/liferay-display.xml descriptor for Liferay
- WEB-INF/liferay-plugin-package.properties for Liferay
- Widget set installed to portal (optional)
- Themes installed to portal (optional)
- Vaadin library installed to portal (optional)
- Portal configuration settings (optional)

Installing the widget set and themes to the portal is required for running two or more Vaadin portlets simultaneously in a single portal page. As this situation occurs quite easily, we recommend installing them in any case.

In addition to the Vaadin library, you will need to copy the `portlet.jar` to your project. It is included in the Vaadin installation package. Notice that you must *not* put the `portlet.jar` in the same `WebContent/WEB-INF/lib` directory as the Vaadin JAR or otherwise include it in the WAR to be deployed, because it would create a conflict with the internal portlet library of the portal.

How you actually deploy a WAR package depends on the portal. In Liferay, you simply drop it to the `deploy` subdirectory under the Liferay installation directory. The deployment depends on the application server under which Liferay runs; for example, if you use Liferay bundled with Tomcat, you will find the extracted package in the `webapps` directory under the Tomcat installation directory included in Liferay.

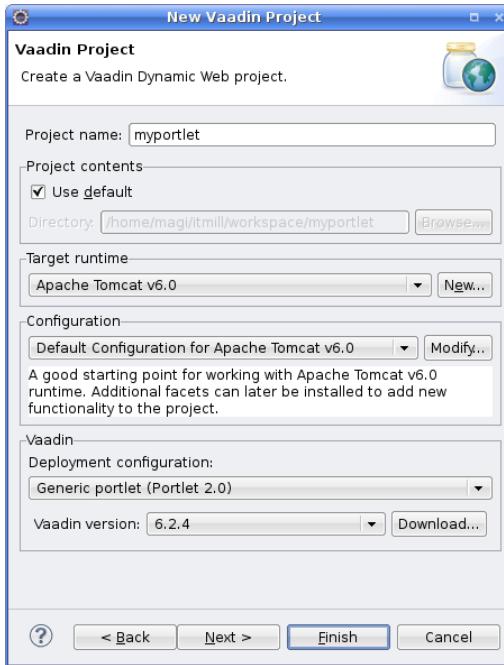
11.8.2. Creating a Portal Application Project in Eclipse

While you can create the needed deployment descriptors manually for any existing Vaadin application, as described in subsequent sections, the Vaadin Plugin for Eclipse provides a wizard for easy creation of portal application projects.

Creation of a portal application project is almost identical to the creation of a regular application project. For a full treatment of the New Project Wizard and the possible options, please see Section 2.4.1, “Creating the Project”.

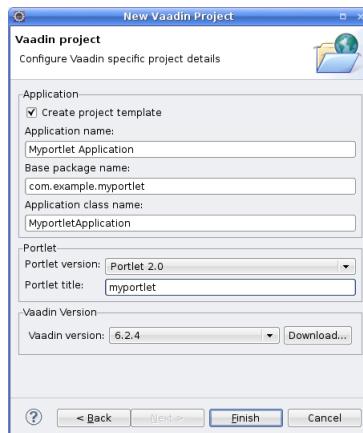
1. Start creating a new project by selecting from the menu **File → New → Project....**

2. In the **New Project** window that opens, select **Web** → **Vaadin Project** and click **Next**.
3. In the **Vaadin Project** step, you need to set the basic web project settings. You need to give at least the project name, the runtime, and select **Generic Portlet** for the deployment configuration; the default values should be good for the other settings.



You can click **Finish** here to use the defaults for the rest of the settings, or click **Next**.

4. The settings in the **Web Module** step define the basic servlet-related settings and the structure of the web application project. All the settings are pre-filled, and you should normally accept them as they are and click **Next**.
5. The **Vaadin project** step page has various Vaadin-specific application settings. These are largely the same as for regular applications. You should not need to change anything as you can change the application titles and other details afterwards. The **Create portlet template** option should be automatically selected. You can give another portlet title if you want. You can change most of the settings afterward.



Create project template	Creates an application class and all the needed portlet deployment descriptors.
Application name	The application name is used in the title of the main window (which is usually invisible in portlets) and as an identifier, either as is or with a suffix, in various deployment descriptors.
Base package name	Java package for the application class.
Application class name	Name of the application class. The default is derived from the project name.
Portlet version	Same as in the project settings.
Portlet title	The portlet title, defined in <code>portlet.xml</code> , can be used as the display name of the portlet (at least in Liferay). The default value is the project name. The title is also used as a short description in <code>liferay-plugin-package.properties</code> .
Vaadin version	Same as in the project settings.

Finally, click **Finish** to create the project.

6. Eclipse may ask you to switch to J2EE perspective. A Dynamic Web Project uses an external web server and the J2EE perspective provides tools to control the server and manage application deployment. Click **Yes**.

11.8.3. Portlet Deployment Descriptors

To deploy a portlet WAR in a portal, you need to provide the basic `portlet.xml` descriptor specified in the Java Portlet standard. In addition, you may need to include possible portal vendor specific deployment descriptors. The ones required by Liferay are described below.

Portlet 2.0 Deployment Descriptor

The portlet WAR must include a portlet descriptor located at `WebContent/WEB-INF/portlet.xml`. A portlet definition includes the portlet name, mapping to a servlet in `web.xml`, modes supported by the portlet, and other configuration. Below is an example of a simple portlet definition in `portlet.xml` descriptor.

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<portlet-app
    xmlns="http://java.sun.com/xml/ns/portlet/portlet-app_2_0.xsd"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    version="2.0"
    xsi:schemaLocation=
        "http://java.sun.com/xml/ns/portlet/portlet-app_2_0.xsd
        http://java.sun.com/xml/ns/portlet/portlet-app_2_0.xsd">

    <portlet>
        <portlet-name>Portlet Example portlet</portlet-name>
        <display-name>Vaadin Portlet Example</display-name>

        <!-- Map portlet to a servlet. -->
        <portlet-class>
            com.vaadin.terminal.gwt.server.ApplicationPortlet2
        </portlet-class>
    </portlet>

```

```
<init-param>
<name>application</name>

    <!-- The application class with package name. -->
    <value>com.example.myportlet.MyportletApplication</value>
</init-param>

    <!-- Supported portlet modes and content types. -->
<supports>
    <mime-type>text/html</mime-type>
    <portlet-mode>view</portlet-mode>
    <portlet-mode>edit</portlet-mode>
    <portlet-mode>help</portlet-mode>
</supports>

    <!-- Not always required but Liferay requires these. -->
<portlet-info>
    <title>Vaadin Portlet Example</title>
    <short-title>Portlet Example</short-title>
</portlet-info>
</portlet>
</portlet-app>
```

Listing supported portlet modes in `portlet.xml` enables the corresponding portlet controls in the portal user interface that allow changing the mode, as described later.

Portlet 1.0 Deployment Descriptor

The portlet deployment descriptor for Portlet 1.0 API is largely the same as for Portlet 2.0. The main differences are:

1. XML namespace and schema names
2. Portlet-class: **ApplicationPortlet** vs **ApplicationPortlet2**
3. The `application` parameter is a name of the servlet (defined in `web.xml` in Portlet 1.0, but name of the application class in Portlet 2.0. There is no longer a separate `web.xml` file in Servlet 2.0.
4. The `portlet-name` must not be same as the servlet name in Portlet 1.0; in Portlet 2.0 this does not matter.
- 5.

Below is an example of a complete deployment descriptor for Portlet 1.0:

```
<?xml version="1.0" encoding="UTF-8"?>
<portlet-app
    version="1.0"
    xmlns="http://java.sun.com/xml/ns/portlet/portlet-app_1_0.xsd"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation=
        "http://java.sun.com/xml/ns/portlet/portlet-app_1_0.xsd
        http://java.sun.com/xml/ns/portlet/app_1_0.xsd">

    <portlet>
        <!-- Must not be the same as servlet name. -->
        <portlet-name>Portlet Example portlet</portlet-name>
        <display-name>Vaadin Portlet Example</display-name>

        <!-- Map portlet to a servlet. -->
        <portlet-class>
            com.vaadin.terminal.gwt.server.ApplicationPortlet
        </portlet-class>
    </portlet>
</portlet-app>
```

```
</portlet-class>
<init-param>
    <name>application</name>

    <!-- Must match the servlet URL mapping in web.xml. -->
    <value>portletexample</value>
</init-param>

    <!-- Supported portlet modes and content types. -->
    <supports>
        <mime-type>text/html</mime-type>
        <portlet-mode>view</portlet-mode>
        <portlet-mode>edit</portlet-mode>
        <portlet-mode>help</portlet-mode>
    </supports>

    <!-- Not always required but Liferay requires these. -->
    <portlet-info>
        <title>Vaadin Portlet Example</title>
        <short-title>Portlet Example</short-title>
    </portlet-info>
</portlet>
</portlet-app>
```

The value of the application parameter must match the context in the `<url-pattern>` element in the `<servlet-mapping>` in the `web.xml` deployment descriptor, without the path qualifiers in the pattern. The above example would match the following servlet mapping in `web.xml`:

```
<servlet-mapping>
    <servlet-name>Portlet Example</servlet-name>
    <url-pattern>/portletexample/*</url-pattern>
</servlet-mapping>
```

In fact, it would also match the `/*` mapping.

Using a Single Widget Set

If you have just one Vaadin application that you ever need to run in your portal, you can just deploy the WAR as described above and that's it. However, if you have multiple applications, especially ones that use different custom widget sets, you run into problems, because a portal window can load only a single Vaadin widget set at a time. You can solve this problem by combining all the different widget sets in your different applications into a single widget set using inheritance or composition.

For example, the portal demos defined in the `portlet.xml` in the demo WAR have the following setting for all portlets so that they will all use the same widget set:

```
<portlet>
    ...
    <!-- Use the portal default widget set for all portal demos. -->
    <init-param>
        <name>widgetset</name>
        <value>com.vaadin.portal.gwt.PortalDefaultWidgetSet</value>
    </init-param>
    ...

```

The **PortalDefaultWidgetSet** extends **SamplerWidgetSet**, which extends the **DefaultWidgetSet**. The **DefaultWidgetSet** is therefore essentially a subset of **PortalDefaultWidgetSet**, which contains also the widgets required by the Sampler demo. Other applications that would otherwise require only the regular **DefaultWidgetSet**, and do not define their own widgets, can just as well use the larger set, making them compatible with the demos. The **PortalDefaultWidgetSet** will also be the default Vaadin widgetset bundled in Liferay 5.3 and later.

If your portlets are contained in multiple WARs, which can happen quite typically, you need to install the widget set and theme portal-wide so that all the portlets can use them. See Section 11.8.5, “Installing Vaadin in Liferay” on configuring the widget sets in the portal itself.

Liferay Portlet Descriptor

Liferay requires a special `liferay-portlet.xml` descriptor file that defines Liferay-specific parameters. Especially, Vaadin portlets must be defined as "*instanceable*", but not "*ajaxable*".

Below is an example descriptor for the earlier portlet example:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE liferay-portlet-app PUBLIC
  "-//Liferay//DTD Portlet Application 4.3.0//EN"
  "http://www.liferay.com/dtd/liferay-portlet-app_4_3_0.dtd">

<liferay-portlet-app>
  <portlet>
    <!-- Matches definition in portlet.xml.          -->
    <!-- Note: Must not be the same as servlet name. -->
    <portlet-name>Portlet Example portlet</portlet-name>

    <instanceable>true</instanceable>
    <ajaxable>false</ajaxable>
  </portlet>
</liferay-portlet-app>
```

See Liferay documentation for further details on the `liferay-portlet.xml` deployment descriptor.

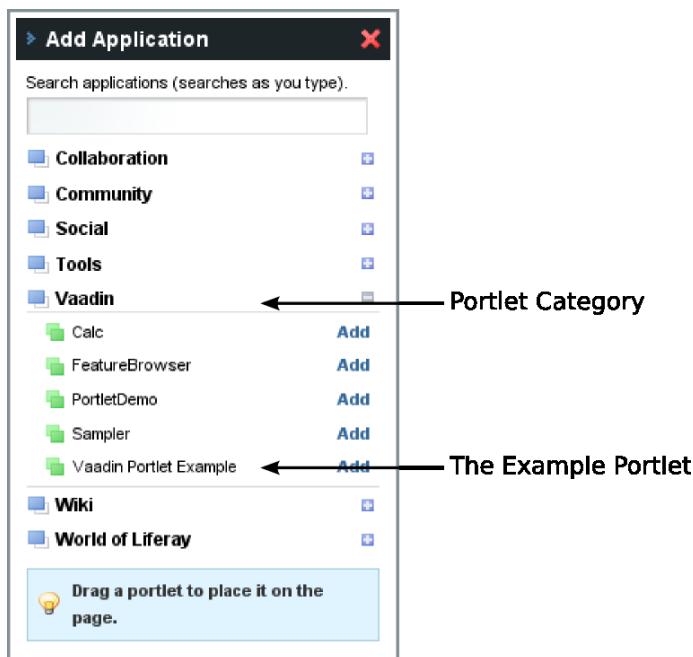
Liferay Display Descriptor

The `WEB-INF/liferay-display.xml` file defines the portlet category under which portlets are located in the **Add Application** window in Liferay. Without this definition, portlets will be organized under the “Undefined” category.

The following display configuration, which is included in the demo WAR, puts the Vaadin portlets under the “Vaadin” category, as shown in Figure 11.11, “Portlet Categories in Add Application Window”.

```
<?xml version="1.0"?>
<!DOCTYPE display PUBLIC
  "-//Liferay//DTD Display 4.0.0//EN"
  "http://www.liferay.com/dtd/liferay-display_4_0_0.dtd">

<display>
  <category name="Vaadin">
    <portlet id="Portlet Example portlet" />
  </category>
</display>
```

Figure 11.11. Portlet Categories in Add Application Window

See Liferay documentation for further details on how to configure the categories in the `liferay-display.xml` deployment descriptor.

Liferay Plugin Package Properties

The `liferay-plugin-package.properties` file defines a number of settings for the portlet, most importantly the Vaadin JAR to be used.

```
name=Portlet Example portlet
short-description=myporlet
module-group-id=Vaadin
module-incremental-version=1
#change-log=
#page-uri=
#author=
license=Proprietary
portal-dependency-jars=\
    vaadin.jar
```

<code>name</code>	The plugin name must match the portlet name.
<code>short-description</code>	A short description of the plugin. This is by default the project name.
<code>module-group-id</code>	The application group, same as the category id defined in <code>liferay-display.xml</code> .
<code>license</code>	The plugin license type; "proprietary" by default.
<code>portal-dependency-jars</code>	The JAR libraries on which this portlet depends. This should have value <code>vaadin.jar</code> , unless you need to use a specific version. The JAR must be installed in the portal,

for example, in Liferay bundled with Tomcat to `tomcat-x.x.x/webapps/ROOT/WEB-INF/lib/vaadin.jar`.

11.8.4. Portlet Hello World

The Hello World program that runs as a portlet is no different from a regular Vaadin application, as long as it doesn't need to handle portlet actions, mode changes, and so on.

```
import com.vaadin.Application;
import com.vaadin.ui.*;

public class PortletExample extends Application {
    @Override
    public void init() {
        Window mainWindow = new Window("Portlet Example");

        Label label = new Label("Hello Vaadin user");
        mainWindow.addComponent(label);
        setMainWindow(mainWindow);
    }
}
```

In addition to the application class, you need the descriptor files, libraries, and other files as described earlier. Figure 11.12, “Portlet Project Structure in Eclipse” shows the complete project structure under Eclipse.

Installed as a portlet in Liferay from the **Add Application** menu, the application will show as illustrated in Figure 11.13, “Hello World Portlet”.

Figure 11.13. Hello World Portlet

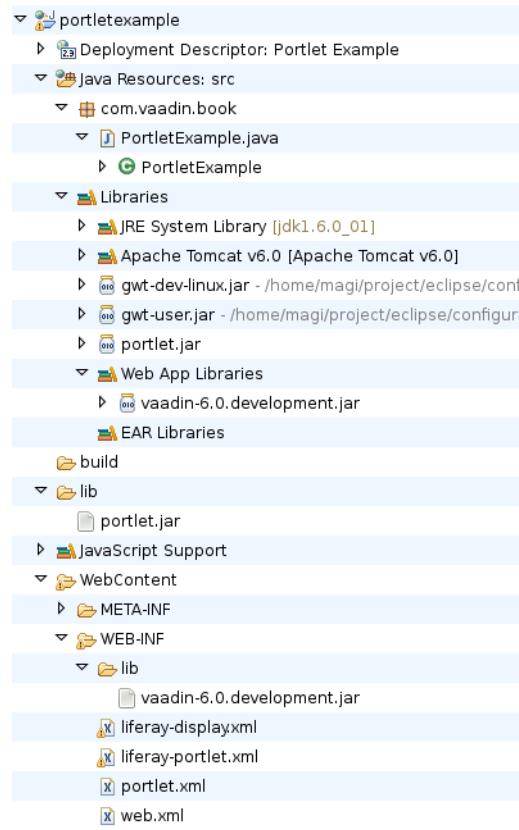


11.8.5. Installing Vaadin in Liferay

Loading widget sets, themes, and the Vaadin JAR from a portlet is possible as long as you have a single portlet, but causes a problem if you have multiple portlets. To solve this, Vaadin portlets need to use a globally installed widget set, themes, and Vaadin JAR. They, and all the required configuration, are bundled with Liferay 5.3 and later, but if you are using an earlier version of Liferay or use a custom widget set, custom themes, or a specific version of Vaadin, you will need to do the configuration manually.

In these instructions, we assume that you use Liferay bundled with Apache Tomcat, although you can use many other application servers with Liferay just as well. The Tomcat installation is included in the Liferay installation package, under the `tomcat-x.x.x` directory.

The Vaadin JAR should be put in `tomcat-x.x.x/webapps/ROOT/WEB-INF/lib/vaadin.jar`. The Vaadin version number should normally be left out from the JAR.

Figure 11.12. Portlet Project Structure in Eclipse

The widget set needs to be located at /html/VAADIN/widgetsets/ and themes at /html/VAADIN/themes/ path under the portal context. You simply need to copy the contents from under your WebContent/VAADIN directory to the tomcat-x.x.x/webapps/ROOT/html/VAADIN directory under the Liferay installation directory. If you use a built-in widget set or theme included in Vaadin, such as the **PortalDefaultWidgetSet**, you should copy it from the Vaadin installation directory, from under WebContent/VAADIN/widgetsets. The default themes are located under WebContent/VAADIN/themes in the installation directory.

You need to define the widget set, the theme, and the JAR in the portal-ext.properties configuration file for Liferay, as described earlier. The file should normally be placed in the Liferay installation directory. See Liferay documentation for details on the configuration file.

Below is an example of a portal-ext.properties file:

```
# Path under which the VAADIN directory is located.
# (/html is the default so it is not needed.)
# vaadin.resources.path=/html

# Portal-wide widget set
vaadin.widgetset=com.vaadin.portal.gwt.PortalDefaultWidgetSet

# Theme to use
vaadin.theme=reindeer
```

The allowed parameters are:

<code>vaadin.resources.path</code>	Specifies the resource root path under the portal context. This is /html by default. Its actual location depends on the portal and the application server; in Liferay with Tomcat it would be located at webapps/ROOT/html under the Tomcat installation directory.
<code>vaadin.widgetset</code>	The widget set class to use. Give the full path to the class name in the dot notation. If the parameter is not given, the default widget set is used.
<code>vaadin.theme</code>	Name of the theme to use. If the parameter is not given, the default theme is used, which is reindeer in Vaadin 6.

You will need to restart Liferay after creating or modifying the `portal-ext.properties` file.

11.8.6. Handling Portlet Requests

Portals such as Liferay are not AJAX applications but reload the page every time a user interaction requires data from the server. They consider a Vaadin application to be a regular web application that works by HTTP requests. All the AJAX communications required by the Vaadin application are done by the Vaadin Client-Side Engine (the widget set) past the portal, so that the portal is unaware of the communications.

The only way a portal can interact with an application is to load it with a HTTP request; reloading does not reset the application. The Portlet 2.0 API supports four types of requests: `render`, `action`, `resource`, and `event` requests. The old Portlet 1.0 API supports only the render and action requests. Requests can be caused by user interaction with the portal controls or by clicking action URLs displayed by the portlet. You can handle portlet requests by implementing the **PortletListener** interface and the handler methods for each of the request types. You can use the request object passed to the handler to access certain portal data, such as user information, the portlet mode, etc.

The **PortletListener** interface is defined in the **PortletApplicationContext2** for Portlet 2.0 API and **com.vaadin.terminal.gwt.server.PortletApplicationContext** class for the old Portlet 1.0 API. You can get the portlet application context with `getContext()` method of the application class.

You need to have the `portlet.jar` in your class path during development. However, you must *not* deploy the `portlet.jar` with the portlet, because it would create a conflict with the internal portlet library of the portal. You should put it in a directory that is not deployed with the portlet, for example, if you are using Eclipse, under the `lib` directory under the project root, not under `WebContent/WEB-INF/lib`, for example.

You can also define portal actions that you can handle in the `handleActionRequest()` method of the interface.

You add your portlet request listener to the application context of your application, which is a **PortletApplicationContext** when (and only when) the application is being run as a portlet.

```
// Check that we are running as a portlet.
if (getContext() instanceof PortletApplicationContext2) {
    PortletApplicationContext2 ctx =
        (PortletApplicationContext2) getContext();

    // Add a custom listener to handle action and
    // render requests.
    ctx.addPortletListener(this, new MyPortletListener());
```

```
    } else {
        getMainWindow().showNotification(
            "Not initialized via Portal!",
            Notification.TYPE_ERROR_MESSAGE);
    }
}
```

The handler methods receive references to request and response objects, which are defined in the Java Servlet API. Please refer to the Servlet API documentation for further details.

The PortletDemo application included in the demo WAR package includes examples of processing mode and portlet window state changes in a portlet request listener.

11.8.7. Handling Portlet Mode Changes

Portals support three portlet modes defined in the Portlet API: *view*, *edit*, and *help* modes. The *view* mode is the default and the portal can have buttons to switch the portlet to the other modes. In addition to the three predefined modes, the Portlet API standards allow custom portlet modes, although portals may support custom modes to a varying degree.

You need to define which portlet modes are enabled in the `portlet.xml` deployment descriptor as follows.

```
<!-- Supported portlet modes and content types. -->
<supports>
    <mime-type>text/html</mime-type>
    <portlet-mode>view</portlet-mode>
    <portlet-mode>edit</portlet-mode>
    <portlet-mode>help</portlet-mode>
</supports>
```

Changes in the portlet mode are received as resource requests, which you can handle with a `handleResourceRequest()`, defined in the **PortletListener** interface. The current portlet mode can be acquired with `getPortletMode()` from the request object.

The following complete example (for Portlet 2.0) shows how to handle the three built-modes in a portlet application.

```
// Use Portlet 2.0 API
import com.vaadin.terminal.gwt.server.PortletApplicationContext2;
import com.vaadin.terminal.gwt.server.PortletApplicationContext2.PortletListener;

public class PortletModeExample extends Application
    implements PortletListener {
    Window mainWindow;
    ObjectProperty data; // Data to view and edit
    VerticalLayout viewContent = new VerticalLayout();
    VerticalLayout editContent = new VerticalLayout();
    VerticalLayout helpContent = new VerticalLayout();

    @Override
    public void init() {
        mainWindow = new Window("Myportlet Application");
        setMainWindow(mainWindow);

        // Data model
        data = new ObjectProperty("<h1>Heading</h1>" +
            "<p>Some example content</p>");

        // Prepare views for the three modes (view, edit, help)
        // Prepare View mode content
        Label viewText = new Label(data, Label.CONTENT_XHTML);
        viewContent.addComponent(viewText);
```

```
// Prepare Edit mode content
RichTextArea editText = new RichTextArea();
editText.setCaption("Edit the value:");
editText.setPropertyDataSource(data);
editContent.addComponent(editText);

// Prepare Help mode content
Label helpText = new Label("<h1>Help</h1>" +
    "<p>This helps you!</p>",
    Label.CONTENT_XHTML);
helpContent.addComponent(helpText);

// Start in the view mode
mainWindow.setContent(viewContent);

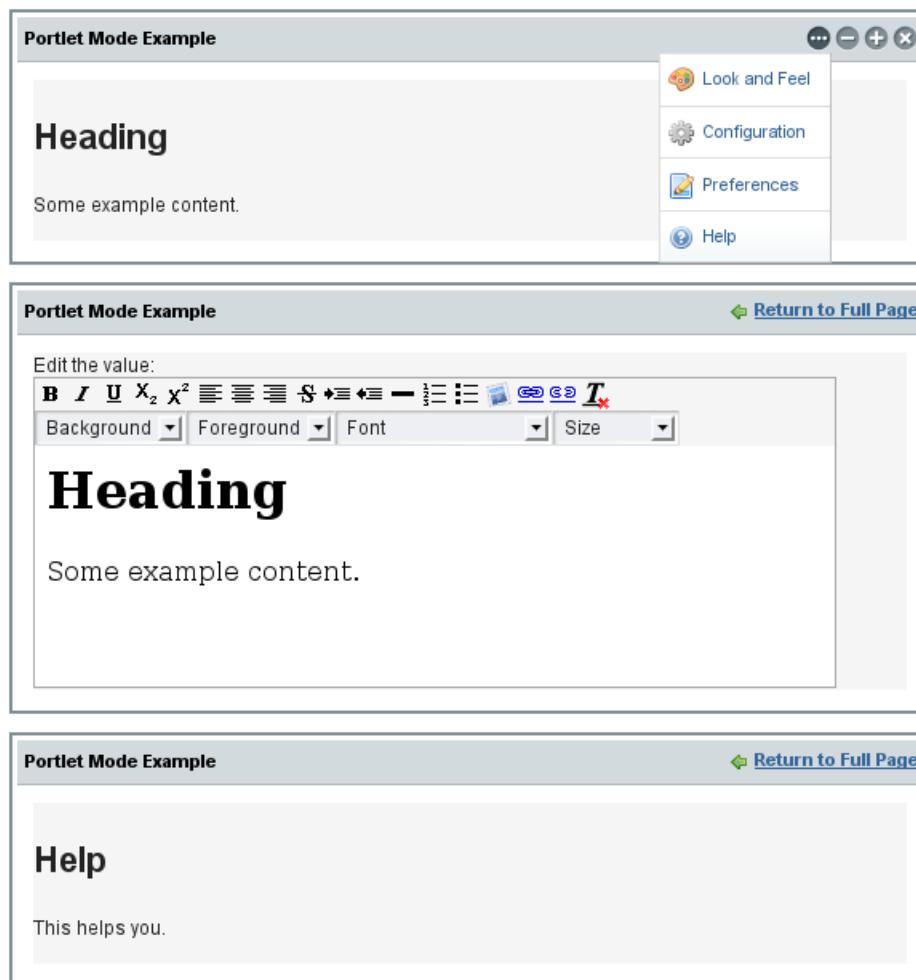
// Check that we are running as a portlet.
if (getContext() instanceof PortletApplicationContext2) {
    PortletApplicationContext2 ctx =
        (PortletApplicationContext2) getContext();

    // Add a custom listener to handle action and
    // render requests.
    ctx.addPortletListener(this, this);
} else {
    mainWindow.showNotification("Not running in portal",
        Notification.TYPE_ERROR_MESSAGE);
}

// Dummy implementations for the irrelevant request types
public void handleActionRequest(ActionRequest request,
    ActionResponse response,
    Window window) {
}
public void handleRenderRequest(RenderRequest request,
    RenderResponse response,
    Window window) {
}
public void handleEventRequest(EventRequest request,
    EventResponse response,
    Window window) {
}

public void handleResourceRequest(ResourceRequest request,
    ResourceResponse response,
    Window window) {
    // Switch the view according to the portlet mode
    if (request.getPortletMode() == PortletMode.EDIT)
        window.setContent(editContent);
    else if (request.getPortletMode() == PortletMode.VIEW)
        window.setContent(viewContent);
    else if (request.getPortletMode() == PortletMode.HELP)
        window.setContent(helpContent);
}
```

Figure 11.14, “Portlet Modes in Action” shows the resulting portlet in the three modes: view, edit, and help. In Liferay, the edit mode is shown in the popup menu as a **Preferences** item.

Figure 11.14. Portlet Modes in Action

11.8.8. Non-Vaadin Portlet Modes

In some cases, it can be useful to implement certain modes of a portlet as pure HTML or JSP pages instead of running the full Vaadin application user interface in them. Common reasons for this are static pages (e.g. a simple help mode), integrating legacy content to a portlet (e.g. a JSP configuration interface) and providing an ultra-lightweight initial view for a portlet (for users behind slow connections).

Fully static modes that do not require the Vaadin server side application to be running can be implemented by subclassing the portlet class **ApplicationPortlet2** (Portlet 2.0). The subclass can either create the HTML content directly or dispatch the request to e.g. a HTML or JSP page via the portal. When using this approach, any Vaadin portlet and portlet request listeners are not called.

Customizing the content for the standard modes (*view*, *edit*, and *help*) can be performed by overriding the methods `doView`, `doEdit` and `doHelp`, respectively. Custom modes can be handled by implementing similar methods with the `@javax.portlet.RenderMode(name = "my-mode")` annotation.

You need to define which portlet modes are enabled in the `portlet.xml` deployment descriptor as described in Section 11.8.7, “Handling Portlet Mode Changes”. Also, the portlet class in `portlet.xml` should point to the customized subclass of **ApplicationPortlet2**.

The following example (for Portlet 2.0) shows how to create a static help page for the portlet.

`portlet.xml:`

```
<!-- Supported portlet modes and content types. -->
<supports>
    <mime-type>text/html</mime-type>
    <portlet-mode>view</portlet-mode>
    <portlet-mode>help</portlet-mode>
</supports>

HtmlHelpPortlet.java::

// Use Portlet 2.0 API
import com.vaadin.terminal.gwt.server.ApplicationPortlet2;

public class HtmlHelpPortlet extends ApplicationPortlet2 {

    // override the help mode, let the Vaadin application handle the view mode
    @Override
    protected void doHelp(RenderRequest request, RenderResponse response)
        throws PortletException, IOException {
        // bypass the Vaadin application entirely
        response.setContentType("text/html");
        response.getWriter().println("This is the help text as plain HTML.");

        // alternatively could use the dispatcher for e.g. JSP help pages:
        // PortletRequestDispatcher dispatcher = getPortletContext()
        //     .getRequestDispatcher("/html/myhelp.jsp");
        // dispatcher.include(request, response);
    }
}
```

To produce pure HTML portlet content from a running Vaadin application instead of statically outside an application, the **ApplicationPortlet2** method `writeAjaxPage` should be overridden. This approach allows using the application state in HTML content generation, and all relevant Vaadin portlet request and portlet listeners are called around the portlet content generation. However, the client side engine (widgetset) is not loaded by the browser, which can shorten the initial page display time.

```
<portlet-class>com.vaadin.demo.portlet.HtmlModePortlet</portlet-class>
<supports>
    <mime-type>text/html</mime-type>
    <portlet-mode>view</portlet-mode>
    <portlet-mode>help</portlet-mode>
</supports>

public class CountApplication extends Application {
    private int count = 0;

    public void init() {
        Window window = new Window("Portlet mode example");
        window.addComponent(new Label("This is the Vaadin application."));
        window.addComponent(new Label("Try opening the help mode."));
        setMainWindow(window);
    }

    public int incrementCount() {
        return ++count;
    }
}
```

```
        }

    // Use Portlet 2.0 API
    public class HtmlModePortlet extends AbstractApplicationPortlet {

        @Override
        protected void writeAjaxPage(RenderRequest request,
                                     RenderResponse response, Window window,
                                     Application application) throws PortletException, IOException {
            if (PortletMode.HELP.equals(request.getPortletMode())) {
                CountApplication app = (CountApplication) application;
                response.setContentType("text/html");
                response.getWriter().println("This is the HTML help, shown "
                    + app.incrementCount() + " times so far.");
            } else {
                super.writeAjaxPage(request, response, window, application);
            }
        }

        @Override
        protected Class<? extends Application> getApplicationClass() {
            return CountApplication.class;
        }
    }
}
```

The user can freely move between Vaadin and non-Vaadin portlet modes with the user interface provided by the portal (for standard modes) or the portlet (e.g. action links). Once the server side application has been started, it continues to run as long as the session is alive. If necessary, specific portlet mode transitions can be disallowed in `portlet.xml`.

In the case of Portlet 1.0, both a portlet and a servlet are involved. A render request is received by **ApplicationPortlet** when the portlet mode is changed, and serving pure HTML in some modes can be achieved by overriding the method `render` and handling the modes of interest separately while calling `super.render()` for other modes. As always, when extending the portlet, the reference to the portlet class in `portlet.xml` needs to be updated.

To serve HTML-only content in the Portlet 1.0 case after starting the server side application and calling the relevant listeners, the servlet class **ApplicationServlet** should be subclassed instead of the portlet. The method `writeAjaxPage` can be overridden to produce custom HTML content for certain modes. However, it should be noted that some HTML content (e.g. loading the portal-wide Vaadin theme) is created by the portlet and not the servlet.

11.9. Google App Engine Integration

Vaadin includes support to run Vaadin applications in the Google App Engine (GAE). The most essential requirement for GAE is the ability to serialize the application state. Vaadin applications are serializable through the **java.io.Serializable** interface.

To run as a GAE application, an application must use **GAEApplicationServlet** instead of **ApplicationServlet** in `web.xml`, and of course implement the **java.io.Serializable** interface for all persistent classes. You also need to enable session support in `appengine-web.xml` with:

```
<sessions-enabled>true</sessions-enabled>
```

The Vaadin Project wizard can create the configuration files needed for GAE deployment. See Section 2.4.1, “Creating the Project”. When the Google App Engine deployment configuration is selected, the wizard will create the project structure following the GAE Servlet convention instead of the regular Servlet convention. The main differences are:

- Source directory: `src/main/java`
- Output directory: `war/WEB-INF/classes`
- Content directory: `war`

Rules and Limitations

Running Vaadin applications in Google App Engine has the following rules and limitations:

- Avoid using the session for storage, usual App Engine limitations apply (no synchronization, that is, it is unreliable).
- Vaadin uses memcache for mutex, the key is of the form `_vmutex<sessionid>`.
- The Vaadin **WebApplicationContext** class is serialized separately into memcache and datastore; the memcache key is `_vac<sessionid>` and the datastore entity kind is `_vac` with identifiers of the type `_vac<sessionid>`.
- *Do not* update the application state when serving an **ApplicationResource** (such as `ClassResource.getStream()`).
- *Avoid* (or be very careful when) updating application state in a **TransactionListener** - it is called even when the application is not locked and won't be serialized (such as with **ApplicationResource**), and changes can therefore be lost (it should be safe to update things that can be safely discarded later, that is, valid only for the current request).
- The application remains locked during uploads - a progress bar is not possible.

11.10. Common Security Issues

11.10.1. Sanitizing User Input to Prevent Cross-Site Scripting

You can put raw XHTML content in many components, such as the **Label** and **CustomLayout**, as well as in tooltips and notifications. In such cases, you should make sure that if the content has any possibility to come from user input, the input is well sanitized before displaying it. Otherwise, a malicious user can easily make a cross-site scripting attack by injecting offensive JavaScript code in such components.

Offensive code can easily be injected with `<script>` markup or in tag attributes as events, such as `onLoad`. Cross-site scripting vulnerabilities are browser dependent, depending on the situations in which different browsers execute scripting markup.

There is no generic way to sanitize user input as different applications can allow different kinds of input. Pruning (X)HTML tags out is somewhat simple, but some applications may need to allow (X)HTML. It is therefore the responsibility of the application to sanitize the input.

Character encoding can make sanitization more difficult, as offensive tags can be encoded so that they are not recognized by a sanitizer. This can be done, for example, with HTML character entities and with variable-width encodings such as UTF-8 or various CJK encodings, by abusing multiple representations of a character. Most trivially, you could input `<` and `>` with `<` and `>`, respectively. The input could also be malformed and the sanitizer must be able to interpret it exactly as the browser would, and different browsers can interpret malformed HTML and variable-width character encodings differently.

Notice that the problem applies also to user input from a **RichTextArea** is transmitted as XHTML from the browser to server-side and is not sanitized. As the entire purpose of the **RichTextArea** component is to allow input of formatted text, you can not just remove all HTML tags. Also many attributes, such as *style*, should pass through the sanitization.

11.11. URI Fragment and History Management with UriFragmentUtility

A major issue in AJAX applications is that as they run in a single web page, bookmarking the application URL (or more generally the *URI*) can only bookmark the application, not an application state. This is a problem for many applications such as product catalogs and forums, in which it would be good to provide links to specific products or messages. Consequently, as browsers remember the browsing history by URI, the history and the **Back** button do not normally work. The solution is to use the *fragment* part of the URI, which is separated from the primary part (address + path + optional query parameters) of the URI with the hash (#) character. For example:

```
http://example.com/path#myfragment
```

The exact syntax of the fragment part is defined in RFC 3986 (Internet standard STD 66) that defines the URI syntax. A fragment may only contain the regular URI *path characters* (see the standard) and additionally the slash and the question mark.

The **UriFragmentUtility** is a special-purpose component that manages the URI fragment; it allows setting the fragment and to handle user-made changes to it. As it is a regular component, though invisible, you must add it to a layout in an application window with the `addComponent()`, as usual.

```
public void init() {
    Window main = new Window("URI Fragment Example");
    setMainWindow(main);

    // Create the URI fragment utility
    final UriFragmentUtility urifu = new UriFragmentUtility();
    main.addComponent(urifu);
```

Notice that the utility component can work only when it is attached to the window, so in practice it must be added in the `init()` method of the application and must afterwards always remain in the application's user interface.

You can set the URI fragment with the `setFragment()` method of the **UriFragmentUtility** object. The method takes the fragment as a string parameter. In the following example, we have a menu, from which the user can select the URI fragment.

```
// Application state menu
final ListSelect menu = new ListSelect("Select a URI Fragment");
menu.addItem("mercury");
menu.addItem("venus");
menu.addItem("earth");
menu.addItem("mars");
menu.setImmediate(true);
main.addComponent(menu);

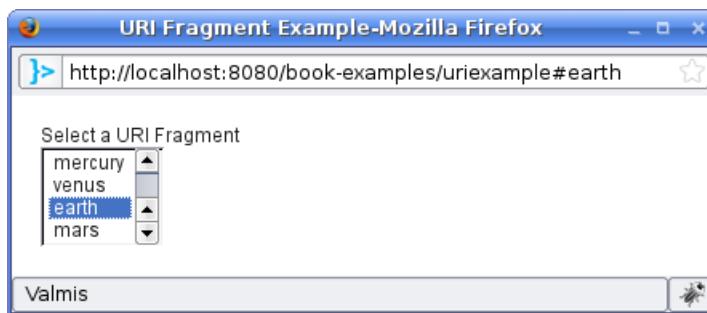
// Set the URI Fragment when menu selection changes
menu.addListener(new Property.ValueChangeListener() {
    public void valueChange(ValueChangeEvent event) {
        String itemid = (String) event.getProperty().getValue();
        urifu.setFragment(itemid);
    }
});
```

The URI fragment and any changes to it are passed to an application as **FragmentChangedEvents**, which you can handle with a **FragmentChangeListener**. You can get the new fragment value with the `getFragment()` method from the URI fragment utility component.

```
// When the URI fragment is given, use it to set menu selection
urifu.addListener(new FragmentChangedListener() {
    public void fragmentChanged(FragmentChangedEventArgs source) {
        String fragment =
            source.getUriFragmentUtility().getFragment();
        if (fragment != null)
            menu.setValue(fragment);
    }
});
```

Figure 11.15, “Application State Management with URI Fragment Utility” shows an application that allows specifying the menu selection with a URI fragment and correspondingly sets the fragment when the user selects a menu item, as done in the code examples above.

Figure 11.15. Application State Management with URI Fragment Utility



11.12. Capturing HTTP Requests

Behind the event-driven processing model of Vaadin lies the Java Servlet API, which is based on processing HTTP requests. These requests are normally hidden from Vaadin applications, but can be caught using the **HttpServletRequestListener** interface. You must implement the interface in your application class. The two methods defined in the interface, `onRequestStart()` and `onRequestEnd()`, allow processing the request before and after other processing.

```
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;

import com.vaadin.Application;
import com.vaadin.terminal.gwt.server.HttpServletRequestListener;
import com.vaadin.ui.*;

public class HttpServletRequestApplication extends Application
    implements HttpServletRequestListener {

    @Override
    public void init() {
        System.out.println(" Application.init() called.");

        Window main = new Window("URI Fragment Example");
        setMainWindow(main);
        setTheme("book-examples");

        // Does nothing but causes a request
        Button button = new Button ("Make a request");
        main.addComponent(button);
    }
}
```

```
}

public void onRequestStart(HttpServletRequest request,
                           HttpServletResponse response) {
    System.out.println("[Start of request]");
    System.out.println(" Query string: " +
                       request.getQueryString());
    System.out.println(" Path: " +
                       request.getPathInfo());
}

public void onRequestEnd(HttpServletRequest request,
                         HttpServletResponse response) {
    System.out.println(" End of request]");
}
}
```

The `onRequestStart()` is called for the first time when the application class is loaded but the `init()` is not yet called. This can be seen in the output of the above code example:

```
[Start of request
Query string: null
Path: null
Application.init() called.
End of request]
[Start of request
Query string: repaintAll=1&sh=1050&sw=1680&cw=500&ch=300&vw=500
Path: /UIDL/
End of request]
[Start of request
Query string: windowName=1071684214
Path: /UIDL/
End of request]
```

The first call is a regular HTML page load, so the URL path is simply the application path. The subsequent calls are AJAX calls made using the UIDL protocol, so the request path includes the `/UIDL/` part. This is important to know when using cookies, as explained later.

11.12.1. Using Request and Response Objects

The **HttpServletRequest** object provides access to the request data, such as request headers, path info, and query string, as well as to some higher-level information such as cookies.

The **HttpServletResponse** object is somewhat different, as most write operations write data directly to the output stream of the server request. It is therefore possible to add new headers and cookies in the `onRequestStart()`, and make other settings, but not later on, especially not in the `onRequestEnd()`, as all the UIDL response data has already been written to the output stream. The framework writes the UIDL response to the output stream of the response *before* calling `onRequestEnd()`. You therefore have to be careful when writing to the response object. You can usually write to it when handling component events in listeners, as is done in the cookie example later.

While it is theoretically possible to redirect the output stream of the response object to write custom data to the response, you should never need to do that, as it would break the UIDL communication protocol.

The servlet request and response objects are defined in the Java Servlet API. Please refer to its documentation for more detailed information.

11.12.2. Managing Cookies

Setting and reading cookies is one of the typical uses of **HttpServletRequestListener**. The application gets the **HttpServletRequest** object containing the cookies in the `onRequestStart()` method.

Setting a Cookie

You normally set a cookie in an event listener. As the request object is a transient object that exists only for the duration of the request, it is not accessible from the **Application** object. The only way to access it is to store it in `onRequestStart()`, as done in the following example.

```
public class CookieExampleApplication extends Application
    implements HttpServletRequestListener {
    HttpServletResponse response;

    public void onRequestStart(HttpServletRequest request,
                               HttpServletResponse response) {
        // Store the reference to the response object for
        // using it in event listeners
        this.response = response;
        ...
    }
    ...
```

We can then use the reference to set or delete cookies in event listeners. Notice that the `cookie path` property is automatically set to the application path (such as `/book-examples/cookies`) on the first request, but contains the UIDL subpath on subsequent calls (such as `/book-examples/cookies/UIDL`). As the cookies are matched against this path, you may need to set the path explicitly with `setPath()`.

```
newuser = new TextField ("Give a user name");
login = new Button("Login");
login.addListener(new Button.ClickListener() {
    public void buttonClick(ClickEvent event) {
        Object value = newuser.getValue();
        if (value != null &&
            !((String)value).equals("")) {
            username = (String) value;

            Cookie cookie = new Cookie("username",
                                       username);
            // Use a fixed path
            cookie.setPath("/book-examples");
            cookie.setMaxAge(3600); // One hour
            response.addCookie(cookie);
            System.out.println("Set cookie.");

            newuser.setEnabled(false);
            login.setEnabled(false);
            restart.setEnabled(true);
            logout.setEnabled(true);
        }
    }
});
loginrow.addComponent(newuser);
loginrow.addComponent(login);
```

Removing cookie can be set in similar way by setting the `maxAge` property to zero.

```
// Delete the cookie
Cookie cookie = new Cookie("username", username);
cookie.setPath("/book-examples");
```

```
cookie.setMaxAge(0); // Delete  
response.addCookie(cookie);
```

Reading a Cookie

Reading a cookie can be done in the `onRequestStart()` event. As this method is called also on the first client request before the application is initialized, it is possible to read user identification cookies and such on the first request.

```
public class CookieExampleApplication extends Application  
    implements HttpServletRequestListener {  
    String username;  
  
    public void onRequestStart(HttpServletRequest request,  
        HttpServletResponse response) {  
        if (username == null) {  
            Cookie[] cookies = request.getCookies();  
            for (int i=0; i<cookies.length; i++) {  
                if (cookies[i].getName().equals("username"))  
                    // Log the user in automatically  
                    username = cookies[i].getValue();  
            }  
        }  
        ...  
    }  
}
```

Notice that the request path is the application path (such as `/book-examples/cookies`) on the first request, but contains the UIDL subpath on subsequent AJAX calls (such as `/book-examples/cookies/UIDL`). So, if you have set the cookie in an AJAX request without setting the cookie path explicitly to such that does not contain the UIDL subpath, the cookie will be filtered out on the initial `onRequestStart()` call.

11.13. Drag and Drop

Dragging an object from one location to another by grabbing it with mouse, holding the mouse button pressed, and then releasing the button to "drop" it to the other location is a common way to move, copy, or associate objects. For example, most operating systems allow dragging and dropping files between folders or dragging a document on a program to open it. In Vaadin, it is possible to drag and drop components and parts of certain components.

Dragged objects, or *transferables*, are essentially data objects. You can drag and drop rows in **Table** and nodes in **Tree** components, either within or between the components. You can also drag entire components by wrapping them inside **DragAndDropWrapper**.

Dragging starts from a *drag source*, which defines the transferable. Transferables implement the **Transferable** interfaces. For trees and tables, which are bound to **Container** data sources, a node or row transferable is a reference to an **Item** in the Vaadin Data Model. Dragged components are referenced with a **WrapperTransferable**. Starting dragging does not require any client-server communication, you only need to enable dragging. All drag and drop logic occurs in two operations: determining (*accepting*) where dropping is allowed and actually dropping. Drops can be done on a *drop target*, which implements the **DropTarget** interface. Three components implement the interface: **Tree**, **Table**, and **DragAndDropWrapper**. These accept and drop operations need to be provided in a *drop handler*. Essentially all you need to do to enable drag and drop is to enable dragging in the drag source and implement the `getAcceptCriterion()` and `drop()` methods in the **DropHandler** interface.

The client-server architecture of Vaadin causes special requirements for the drag and drop functionality. The logic for determining where a dragged object can be dropped, that is, *accepting*

a drop, should normally be done on the client-side, in the browser. Server communications are too slow to have much of such logic on the server-side. The drag and drop feature therefore offers a number of ways to avoid the server communications to ensure a good user experience.

11.13.1. Handling Drops

Most of the user-defined drag and drop logic occurs in a *drop handler*, which is provided by implementing the `drop()` method in the **DropHandler** interface. A closely related definition is the drop accept criterion, which is defined in the `getAcceptCriterion()` method in the same interface. It is described in Section 11.13.4, “Handling Drop Accept Criteria” later.

The `drop()` method gets a **DragAndDropEvent** as its parameters. The event object provides references to two important objects: **Transferable** and **TargetDetails**.

A **Transferable** contains a reference to the object (component or data item) that is being dragged. A tree or table item is represented as a **TreeTransferable** or **TableTransferable** object, which carries the item identifier of the dragged tree or table item. These special transferables, which are bound to some data in a container, are **DataBoundTransferable**. Dragged components are represented as **WrapperTransferable** objects, as the components are wrapped in a **DragAndDropWrapper**.

The **TargetDetails** object provides details regarding the exact location where the transferable object is being dropped. If the target is a tree or a table, the **TreeTargetDetails** and **TableTargetDetails** objects provide the tree or table item on which the drop is being made. For entire components, the information is provided in a **WrapperDropDetails** object. In addition to the target item or component, the details objects provide a *drop location*. For selection components, the location can be obtained with the `getDropLocation()` and for wrapped components with `verticalDropLocation()` and `horizontalDropLocation()`. The locations are specified as either **VerticalDropLocation** or **HorizontalDropLocation** objects. The drop location objects specify whether the transferable is being dropped above, below, or directly on (at the middle of) a component or item.

Dropping on a **Tree**, **Table**, and a wrapped component is explained further in the following sections.

11.13.2. Dropping Items On a Tree

You can drag items from, to, or within a **Tree**. Making tree a drag source requires simply setting the drag mode with `setDragMode()`. **Tree** currently supports only one drag mode, `TreeDragMode.NODE`, which allows dragging single tree nodes. While dragging, the dragged node is referenced with a **TreeTransferable** object, which is a **DataBoundTransferable**. The tree node is identified by the item ID of the container item.

When a transferable is dropped on a tree, the drop location is stored in a **TreeTargetDetails** object, which identifies the target location by item ID of the tree node on which the drop is made. You can get the item ID with `getItemIdOver()` method in **AbstractSelectTargetDetails**, which the **TreeTargetDetails** inherits. A drop can occur directly on or above or below a node; the exact location is a **VerticalDropLocation**, which you can get with the `getDropLocation()` method.

In the example below, we have a **Tree** and we allow reordering the tree items by drag and drop.

```
final Tree tree = new Tree("Inventory");
tree.setContainerDataSource(TreeExample.createTreeContent());
layout.addComponent(tree);

// Expand all items
for (Iterator<?> it = tree.rootItemIds().iterator(); it.hasNext();) {
```

```
tree.expandItemsRecursively(it.next());

// Set the tree in drag source mode
tree.setDragMode(TreeDragMode.NODE);

// Allow the tree to receive drag drops and handle them
tree.setDropHandler(new DropHandler() {
    public AcceptCriterion getAcceptCriterion() {
        return AcceptAll.get();
    }

    public void drop(DragAndDropEvent event) {
        // Wrapper for the object that is dragged
        Transferable t = event.getTransferable();

        // Make sure the drag source is the same tree
        if (t.getSourceComponent() != tree)
            return;

        TreeTargetDetails target = (TreeTargetDetails)
            event.getTargetDetails();

        // Get ids of the dragged item and the target item
        Object sourceItemId = t.getData("itemId");
        Object targetItemId = target.getItemIdOver();

        // On which side of the target the item was dropped
        VerticalDropLocation location = target.getDropLocation();

        HierarchicalContainer container = (HierarchicalContainer)
            tree.getContainerDataSource();

        // Drop right on an item -> make it a child
        if (location == VerticalDropLocation.MIDDLE)
            tree.setParent(sourceItemId, targetItemId);

        // Drop at the top of a subtree -> make it previous
        else if (location == VerticalDropLocation.TOP) {
            Object parentId = container.getParent(targetItemId);
            container.setParent(sourceItemId, parentId);
            container.moveAfterSibling(sourceItemId, targetItemId);
            container.moveAfterSibling(targetItemId, sourceItemId);
        }

        // Drop below another item -> make it next
        else if (location == VerticalDropLocation.BOTTOM) {
            Object parentId = container.getParent(targetItemId);
            container.setParent(sourceItemId, parentId);
            container.moveAfterSibling(sourceItemId, targetItemId);
        }
    }
});
```

Accept Criteria for Trees

Tree defines some specialized accept criteria for trees.

TargetInSubtree (client-side)

Accepts if the target item is in the specified sub-tree. The sub-tree is specified by the item ID of the root of the sub-tree in the constructor. The second constructor includes a depth parameter, which specifies how deep from the given root node are drops accepted. Value -1 means infinite, that is, the entire sub-tree, and is therefore the same as the simpler constructor.

TargetItemAllowsChildren (client-side) Accepts a drop if the tree has `setChildrenAllowed()` enabled for the target item. The criterion does not require parameters, so the class is a singleton and can be acquired with `Tree.TargetItemAllowsChildren.get()`. For example, the following composite criterion accepts drops only on nodes that allow children, but between all nodes:

```
return new Or (Tree.TargetItemAllowsChildren.get(),  
    new Not(VerticalLocationIs.MIDDLE));
```

TreeDropCriterion (server-side) Accepts drops on only some items, which as specified by a set of item IDs. You must extend the abstract class and implement the `getAllowedItemIds()` to return the set. While the criterion is server-side, it is lazy-loading, so that the list of accepted target nodes is loaded only once from the server for each drag operation. See Section 11.13.4, “Handling Drop Accept Criteria” for an example.

In addition, the accept criteria defined in **AbstractSelect** are available for a **Tree**, as listed in Section 11.13.4, “Handling Drop Accept Criteria”.

11.13.3. Dropping Items On a Table

You can drag items from, to, or within a **Table**. Making table a drag source requires simply setting the drag mode with `setDragMode()`. **Table** supports dragging both single rows, with `TableDragMode.ROW`, and multiple rows, with `TableDragMode.MULTIROW`. While dragging, the dragged node or nodes are referenced with a **TreeTransferable** object, which is a **DataBoundTransferable**. Tree nodes are identified by the item IDs of the container items.

When a transferable is dropped on a table, the drop location is stored in a **AbstractSelectTargetDetails** object, which identifies the target row by its item ID. You can get the item ID with `getItemIdOver()` method. A drop can occur directly on or above or below a row; the exact location is a **VerticalDropLocation**, which you can get with the `getDropLocation()` method from the details object.

Accept Criteria for Tables

Table defines one specialized accept criterion for tables.

TableDropCriterion (server-side) Accepts drops only on (or above or below) items that are specified by a set of item IDs. You must extend the abstract class and implement the `getAllowedItemIds()` to return the set. While the criterion is server-side, it is lazy-loading, so that the list of accepted target items is loaded only once from the server for each drag operation.

11.13.4. Handling Drop Accept Criteria

A drop handler must define criteria on objects which it accepts to be dropped on itself. The criteria need to be provided in the `getAcceptCriterion()` method of the **DropHandler** interface. The cri-

teria are represented in an **AcceptCriterion** object, which can be a composite of multiple criteria that are evaluated using logical operations. There are two basic types of criteria: *client-side* and *server-side criteria*. The various built-in criteria allow accepting drops based on the identity of the source and target components, and on the *data flavor* of the dragged objects.

To allow dropping any transferable objects, you can return a universal accept criterion, which you can get with `AcceptAll.get()`.

```
tree.setDropHandler(new DropHandler() {
    public AcceptCriterion getAcceptCriterion() {
        return AcceptAll.get();
    }
    ...
});
```

Client-Side Criteria

The *client-side criteria*, which inherit the **ClientSideCriterion**, are verified on the client-side, so server requests are not needed for verifying whether each component on which the mouse pointer hovers would accept a certain object.

The following client-side criteria are define in `com.vaadin.event.dd.acceptcriterion`:

AcceptAll	Accepts all transferables and targets.
And	Logical AND operation on two client-side criterion; accepts the transferable if all the defined sub-criteria accept it.
ContainsDataFlavour	The transferable must contain the defined data flavour.
Not	Logical NOT operation on two client-side criterion; accepts the transferable if and only if the sub-criterion does not accept it.
Or	Logical OR operation on two client-side criterion; accepts the transferable if any of the defined sub-criteria accept it.
Sources	Accepts all transferables from any of the given source components
SourcesTarget	Accepts the transferable only if the source component is the same as the target. This criterion is useful for ensuring that items are dragged only within a tree or a table, and not from outside it.
TargetDetails	Accepts any transferable if the target detail, such as the item of a tree node or table row, is of the given data flavor and has the given value.

In addition, target components such as **Tree** and **Table** define some component-specific client-side accept criteria. See Section 11.13.2, “Dropping Items On a Tree” for more details.

AbstractSelect defines the following criteria for all selection components, including **Tree** and **Table**.

AcceptItem	Accepts only specific items from a specific selection component. The selection component, which must inherit AbstractSelect , is given as the first parameter for
-------------------	--

the constructor. It is followed by a list of allowed item identifiers in the drag source.

AcceptItem.ALL

Accepts all transferables as long as they are items.

TargetItems

Accepts all drops on the specified target items. The constructor requires the target component (**AbstractSelect**) followed by a list of allowed item identifiers.

VerticalLocationIs.MIDDLE, TOP, and BOTTOM

The three static criteria accepts drops on, above, or below an item. For example, you could accept drops only in between items with the following:

```
public AcceptCriterion getAcceptCriterion() {
    return new Not(VerticalLocationIs.MIDDLE);
}
```

Server-Side Criteria

The *server-side criteria* are verified on the server-side with the `accept()` method of the **ServerSideCriterion** class. This allows fully programmable logic for accepting drops, but the negative side is that it causes a very large amount of server requests. A request is made for every target position on which the pointer hovers. This problem is eased in many cases by the component-specific lazy loading criteria **TableDropCriterion** and **TreeDropCriterion**. They do the server visit once for each drag and drop operation and return all accepted rows or nodes for current **Transferable** at once.

The `accept()` method gets the drag event as a parameter so it can perform its logic much like in `drop()`.

```
public AcceptCriterion getAcceptCriterion() {
    // Server-side accept criterion that allows drops on any other
    // location except on nodes that may not have children
    ServerSideCriterion criterion = new ServerSideCriterion() {
        public boolean accept(DragAndDropEvent dragEvent) {
            TreeTargetDetails target = (TreeTargetDetails)
                dragEvent.getTargetDetails();

            // The tree item on which the load hovers
            Object targetItemId = target.getItemIdOver();

            // On which side of the target the item is hovered
            VerticalDropLocation location = target.getDropLocation();
            if (location == VerticalDropLocation.MIDDLE)
                if (!tree.areChildrenAllowed(targetItemId))
                    return false; // Not accepted

            return true; // Accept everything else
        }
    };
    return criterion;
}
```

The server-side criteria base class **ServerSideCriterion** provides a generic `accept()` method. The more specific **TableDropCriterion** and **TreeDropCriterion** are convenience extensions that allow defining allowed drop targets as a set of items. They also provide some optimization by lazy loading, which reduces server communications significantly.

```
public AcceptCriterion getAcceptCriterion() {
    // Server-side accept criterion that allows drops on any
```

```
// other tree node except on node that may not have children
TreeDropCriterion criterion = new TreeDropCriterion() {
    @Override
    protected Set<Object> getAllowedItemIds(
        DragAndDropEvent dragEvent, Tree tree) {
        HashSet<Object> allowed = new HashSet<Object>();
        for (Iterator<Object> i =
            tree.getItemIds().iterator(); i.hasNext();) {
            Object itemId = i.next();
            if (tree.hasChildren(itemId))
                allowed.add(itemId);
        }
        return allowed;
    }
};
return criterion;
}
```

11.13.5. Dragging Components

Dragging a component requires wrapping the source component within a **DragAndDropWrapper**. You can then allow dragging by putting the wrapper (and the component) in drag mode with `setDragStartMode()`. The method supports two drag modes: `DragStartMode.WRAPPER` and `DragStartMode.COMPONENT`, which defines whether the entire wrapper is shown as the drag image while dragging or just the wrapped component.

Dragged components are referenced in the **WrapperTransferable**. You can get the reference to the dragged component with `getDraggedComponent()`. The method will return `null` if the transferable is not a component. Also HTML 5 drags (see later) are held in wrapper transferables.

11.13.6. Dropping on a Component

Drops on a component can be made by wrapping the component in a **DragAndDropWrapper**. The wrapper is an ordinary component; the constructor takes the wrapped component as a parameter. You just need to define the **DropHandler** for the wrapper.

In the following example, we have allow reordering components in a horizontal layout. The drop handler is omitted.

```
public class SortableLayout extends CustomComponent {
    HorizontalLayout layout = new HorizontalLayout();
    DropHandler dropHandler;

    public SortableLayout() {
        dropHandler = new ReorderLayoutDropHandler(layout);

        // Wrap the layout to accept drops to an empty layout
        DragAndDropWrapper wrapper =
            new DragAndDropWrapper(layout);
        setCompositionRoot(wrapper);
    }

    @Override
    public void addComponent(Component component) {
        // Wrap each component in a wrapper to allow
        // drops on or between the contained components
        DragAndDropWrapper wrapped =
            new DragAndDropWrapper(component);
        wrapped.setDropHandler(dropHandler);
        layout.addComponent(wrapped);
    }
}
```

Drops on a component are handled with a **DropHandler**, as usual. You set the drop handler of a wrapper with `setDropHandler()`. The drop handler receives the drop target details in a **WrapperTargetDetails** object. You can find out the exact x and y coordinates of the drop with `getAbsoluteLeft()` and `getAbsoluteTop()`. The `verticalDropLocation()` and `horizontalDropLocation()` return the more detailed drop location in the target.

The **DragAndDropWrapper** allows dropping files from outside the browser. Dropped files are automatically uploaded to the application and can be acquired from the wrapper with `getFiles()`. The files are represented as **Html5File** objects as defined in the inner class. You can define an upload **Receiver** to receive the content of a file to an **OutputStream**. Dropping files is supported in HTML 5 and requires a compatible browser, such as Mozilla Firefox 3.6 or newer.

Appendix A

User Interface Definition Language (UIDL)

User Interface Definition Language (UIDL) is a language for serializing user interface contents and changes in responses from web server to a browser. The idea is that the server-side components "paint" themselves to the screen (a web page) with the language. The UIDL messages are parsed in the browser and translated to GWT widgets.

The UIDL is used through both server-side and client-side APIs. The server-side API consists of the **PaintTarget** interface, described in Section A.1, "API for Painting Components". The client-side interface depends on the implementation of the client-side engine. In Vaadin Release 5, the client-side engine uses the Google Web Toolkit framework. Painting the user interface with a GWT widget is described in Section 10.3, "Google Web Toolkit Widgets".

UIDL supports painting either the entire user interface or just fragments of it. When the application is started by opening the page in a web browser, the entire user interface is painted. If a user interface component changes, only the changes are painted.

Since Vaadin Release 5, the UIDL communications are currently done using JSON (JavaScript Object Notation), which is a lightweight data interchange format that is especially efficient for interfacing with JavaScript-based AJAX code in the browser. The use of JSON as the interchange format is largely transparent; IT Mill Toolkit version 4 (predecessor of Vaadin released in 2006)

the older versions used an XML-based UIDL representation with the same API. Nevertheless, the UIDL API uses XML concepts such as attributes and elements. Below, we show examples of a **Button** component in both XML and JSON notation.

With XML notation:

```
<button id="PID2" immediate="true"
        caption="My Button" focusid="1">
    <boolean id="v1" name="state"
            value="false"></boolean>
</button>
```

With JSON notation:

```
[ "button",
  { "id": "PID2",
    "immediate":true,
    "caption": "My Button",
    "focusid":1,
    "v":{ "state":false}
  }
]
```

Components are identified with a *PID* or *paintable identifier* in the `id` attribute. Each component instance has its individual PID, which is usually an automatically generated string, but can be set manually with `setDebugId()` method.

Section A.2, “JSON Rendering” gives further details on JSON. For more information about handling UIDL messages in the client-side components, see Chapter 10, *Developing Custom Components*.

You can track and debug UIDL communications easily with the Firebug extension for Mozilla Firefox, as illustrated in Section A.2, “JSON Rendering” below.

A.1. API for Painting Components

Serialization or “painting” of user interface components from server to the client-side engine running in the browser is done through the **PaintTarget** interface. In Vaadin Release 5, the only implementation of the interface is the **JsonPaintTarget**, detailed in Section A.2, “JSON Rendering” below.

The abstract **AbstractComponent** class allows easy painting of user interface components by managing many basic tasks, such as attributes common for all components. Components that inherit the class need to implement the abstract `getTag()` method that returns the UIDL tag of the component. For example, the implementation for the **Button** component is as follows:

```
public String getTag() {
    return "button";
}
```

AbstractComponent implements the `paint()` method of the **Paintable** interface to handle basic tasks in painting, and provides `paintContent()` method for components to paint their special contents. The method gets the **PaintTarget** interface as its parameter. The method should call the default implementation to paint any common attributes.

```
/* Paint (serialize) the component for the client. */
public void paintContent(PaintTarget target)
    throws PaintException {
    // Superclass writes any common attributes in
    // the paint target.
```

```
super.paintContent(target);

// Set any values as variables of the paint target.
target.addVariable(this, "colorname", getColor());
}
```

Serialized data can be attributes or variables, serialized with the `addAttribute()` and `addVariable()` methods, respectively. You must always serialize the attributes first and the variables only after that.

The API provides a number of variations of the methods for serializing different basic data types. The methods support the native Java data types and strings of the **String** class. `addVariable()` also supports vectors of strings.

Contained components are serialized by calling the `paint()` method of a sub-component, which will call the `paintContent()` for the sub-component, allowing the serialization of user interfaces recursively. The `paint()` method is declared in the server-side **Paintable** interface and implemented in the abstract base classes, **AbstractComponent** and **AbstractComponentContainer** (for layouts).

Layout components have to serialize the essential attributes and variables they need, but not the contained components. The **AbstractComponentContainer** and **AbstractLayout** baseclasses manage the recursive painting of all the contained components in layouts.

The **AbstractField** provides an even higher-level base class for user interface components. The field components hold a value or a *property*, and implement the **Property** interface to access this property. For example the property of a **Button** is a **Boolean** value.

```
public void paintContent(PaintTarget target)
    throws PaintException {
    super.paintContent(target);

    // Serialize the switchMode as an attribute
    if (isSwitchMode())
        target.addAttribute("type", "switch");

    // Get the state of the Button safely
    boolean state;
    try {
        state = ((Boolean) getValue()).booleanValue();
    } catch (NullPointerException e) {
        state = false;
    }
    target.addVariable(this, "state", state);
}
```

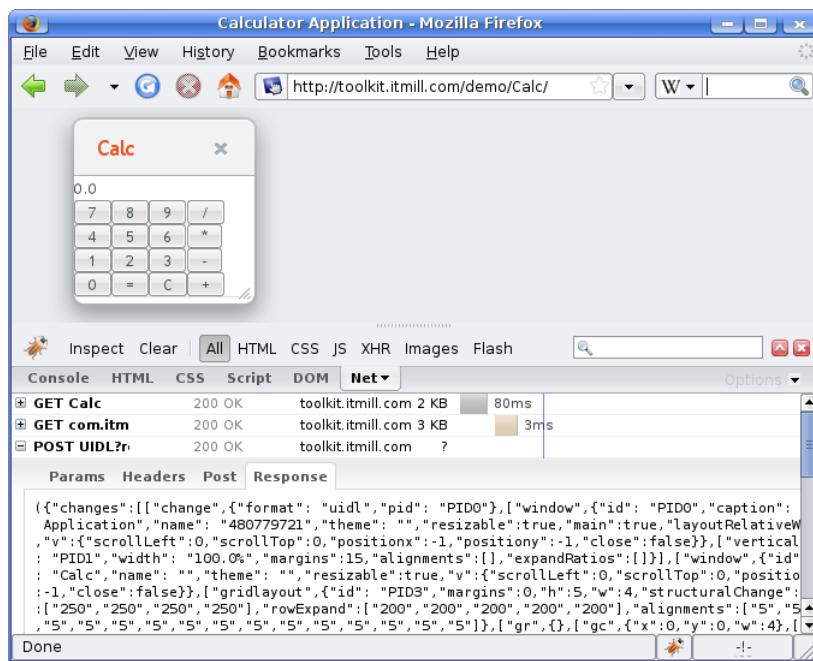
A.2. JSON Rendering

Vaadin 5 uses JSON, a lightweight data-interchange format, to communicate UI rendering with the browser, because it is very fast to parse compared to XML. JSON messages are essentially JavaScript statements that can be directly evaluated by the browser. The client-side engine of Vaadin parses and evaluates the UIDL messages with the JSON library that comes with the Google Web Toolkit.

Section 3.2.3, “JSON” gave a general introduction to JSON as part of the architecture of Vaadin. In this section, we look into the technical details of the format. The technical details of the JSON messages are useful mainly for debugging purposes, for example using the Firebug plugin for Mozilla Firefox.

To view a UIDL message, open the Firebug panel in Firefox, select **Net** tab, select a "POST UIDL" request, open the **Response** tab, and click **Load Response**. This displays the entire UIDL message, as shown in Figure A.1, "Debugging UIDL Messages with Firebug" below.

Figure A.1. Debugging UIDL Messages with Firebug



JSON messages are represented as nested lists and associative arrays (objects with named properties) in JavaScript syntax. At the top level, we can find an associative array with the following fields:

changes	Changes to the UI caused by the request.
meta	Meta-information regarding the response and the application state.
resources	Information about application resources.
locales	Locale-specific data for locale-dependent components, such as names of months and weekdays.

The "changes" field contains the actual UI changes as a list of components. Components that can contain other components are represented in a recursive list structure.

A component is represented as a list that first contains the UIDL tag of the component, which identifies its class, followed by data fields. The basic representation of component data as attributes and variables is defined in the base classes of the framework. Attributes are represented as an associative array and variables as a separate associative array inside the special "v" attribute. For example, a **Button** component is communicated with a JSON representation such as the following:

```
[ "button",
  { "id": "PID5",
    "immediate": true,
    "caption": "7",
    "v": { "state": false} }
]
```

A component can give its data also in additional fields in the list instead of the attributes or variables, as is done for the **Label** component:

```
[ "label",
  { "id": "PID4",
    "width": "100.0%" },
  "Some text here" ]
```

The meta-information field can contain certain types of information, which are not displayed in the UI, but used by the client-side engine. The `repaintAll` parameter tells that the changes include the entire window contents, not just partial changes. Other data includes redirection details for expired sessions.

Appendix B

Songs of Vaadin

Vaadin is a mythological creature in Finnish folklore, the goddess and divine ancestor of the mountain reindeer. It appears frequently in the poetic mythos, often as the trustworthy steed of either *Seppo Ilmarinen* or *Väinämöinen*, the two divine hero figures. In many of the stories, it is referred to as *Steed of Seppo* or *Seponratsu* in Finnish. An artifact itself, according to most accounts, Vaadin helped Seppo Ilmarinen in his quests to find the knowledge necessary to forge magical artefacts, such as *Sampo*.

Some of the Vaadin poems were collected by *Elias Lönnrot*, but he left them out of *Kalevala*, the Finnish epic poem, as they were somewhat detached from the main theme and would have created inconsistencies with the poems included in the epos. Lönnrot edited *Kalevala* heavily and it represents a selection from a much larger and more diverse body of collected poems. Many of the accounts regarding Vaadin were sung by shamans, and still are. A shamanistic tradition, centered on the tales of Seppo and Vaadin, still lives in South-Western Finland, around the city of Turku. Some research in the folklore suggests that the origin of Vaadin is as a shamanistic animal spirit used during trance for voyaging to *Tuonela*, the Land of Dead, with its mechanical construction reflecting the shamanistic tools used for guiding the trance. While the shamanistic interpretation of the origins is disputed by a majority of the research community in a maximalist sense, it is considered a potentially important component in the collection of traditions that preserve the folklore.

Origin or birth poems, *synnyt* in Finnish, provide the most distinct accounts of mythological artefacts in the Finnish folklore, as origin poems or songs were central in the traditional magical practices. Vaadin is no exception and its origin poems are numerous. In many of the versions, Vaadin was created in a mill, for which Seppo had built the millstone. After many a year, grinding the sacred acorns of the *Great Oak* (a version of the *World Tree* in Finnish mythology), the millstone had become saturated with the magical juices of the acorns. Seppo found that the stone could be used to make tools. He cut it in many pieces and built a toolkit suitable for fashioning spider web into any imaginable shape. When Seppo started making *Sampo*, he needed a steed that would

help him find the precious components and the knowledge he required. The magical tools became the skeleton of Vaadin.

*"Lost, his mind was,
gone, was his understanding,
ran away, were his memories,
in the vast land of hills of stone.
Make a steed he had to,
forge bone out of stone,
flesh out of moss,
and skin of bark of the birch.
The length of his hammer,
he put as the spine and the hip,
bellows as the lungs,
tongs as the legs, paired.
So woke Vaadin from the first slumber,
lichen did Seppo give her for eating,
mead did he give her for drinking,
then mounted her for the journey."*

Other versions associate the creation with Väinämöinen instead of Seppo Ilmarinen, and give different accounts for the materials. This ambiguity can be largely explained through the frequent cooperation between Väinämöinen and Seppo in the mythos. Nevertheless, the identity of the steed or steeds is largely implicit in the myths and, because of the differences in the origin myths, can not be unambiguously associated with a unique identity.

The theme of animal ancestor gods is common in the Finnish myth, as we can see in the widespread worship of *Tapio*, the lord of the bear and the forest. With respect to Vaadin, the identification of the animal is not completely clear. The Finnish word *vaadin* refers specifically to an adult female of the semi-domesticated mountain reindeer, which lives in the Northern Finland in Lapland as well as in the Northern Sweden and Norway. On the other hand, the Finnish folklore represented in *Kalevala* and other collections has been collected from Southern Finland, where the mountain reindeer does not exist. Nevertheless, Southern Finnish folklore and *Kalevala* do include many other elements as well that are distinctively from Lapland, so we may assume that the folklore reflects a record of cultural interaction. The distinction between the northern mountain reindeer and the deer species of Southern Finland, the forest reindeer and the elk, is clear in the modern language, but may not have been in old Finnish dialects. For example, *peura*, reindeer, may have been a generic word for a wild animal, as can be seen in *jaloapeura*, the old Finnish word for lion. The identification is further complicated by the fact that the line of poems included in *Kalevala* often refers to a horse. This could be due to the use of the word for horse as a generic name for a steed. While a mountain reindeer is not suitable for riding, animal gods are typically portrayed as uncommonly large in mythology, even to the extremes, so the identification fits quite well in the variety of magical mounts.

The mythology related to Vaadin, especially as represented in *Kalevala*, locates some important characters and people in *Pohjola*, a mythical land in the north from where all evil originates, according to most accounts. For example, *Louhi* or *Pohjolan emäntä*, Queen of Pohjola, is the primary antagonist in the *Kalevala* mythos. Both Seppo Ilmarinen and Väinämöinen make services to Louhi to earn the hand of her daughters for marriage. Vaadin is often mentioned in connection with these services, such as the making of *Sampo*. On the other hand, as *Sampo* can be identified with the mill mentioned in creation stories of Vaadin, its identification in the stories becomes unclear.

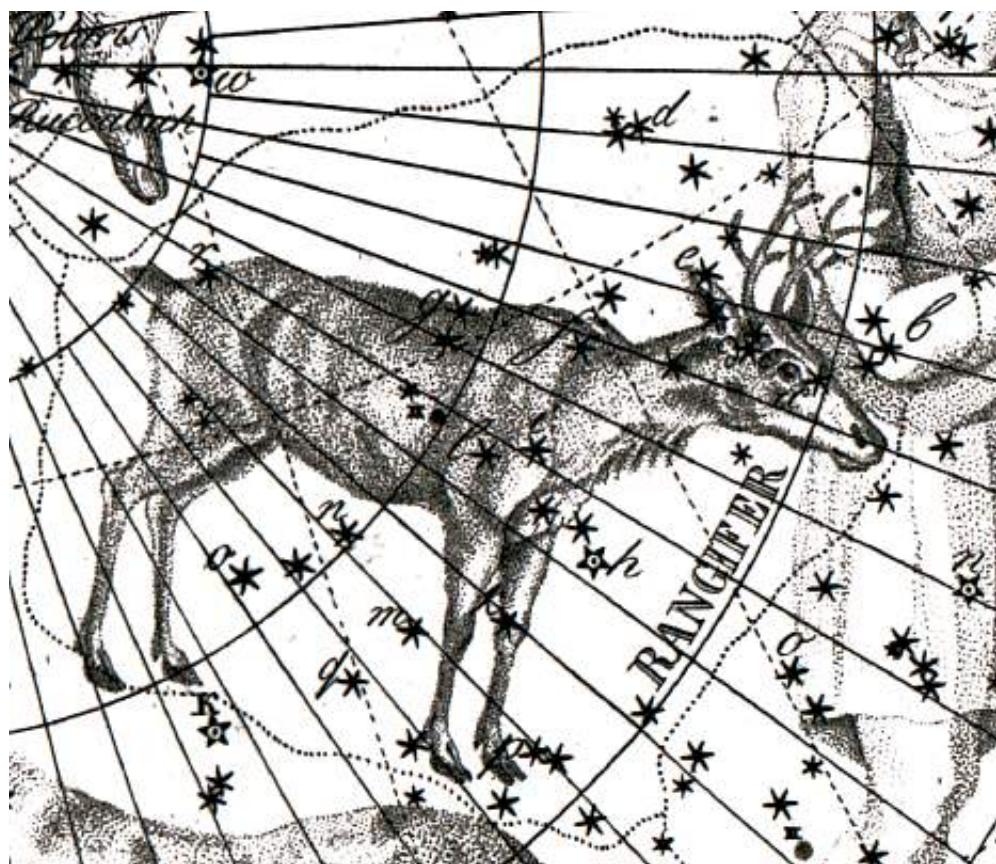
While beginning its life as an artifact, Vaadin is later represented as an anthropomorphic divine being. This is in contrast with the *Bride of Gold*, another creation of Seppo, which failed to become a fully living and thinking being. Finding magical ways around fundamental problems in life are central in *Kalevala*. In some areas, magical solutions are morally acceptable, while in others they are not and the successes and failures in the mythos reflect this ethic. Research in the folklore regarding the *Bride of Gold* myth has provided support for a theory that creating a wife would go against very fundamental social rules of courting and mating, paralleling the disapproval of "playing god" in acts involving life and death (though "cheating death" is usually considered a positive act). The main motivation of the protagonists in *Kalevala* is courting young daughters, which always ends in failure, usually for similar reasons. Animals, such as Vaadin, are outside the social context and considered to belong in the same category with tools and machines. The Vaadin myths present a noteworthy example of this categorization of animals and tools in the same category at an archetypal level.

The Vaadin myths parallel the *Sleipnir* myths in the Scandinavian mythology. This connection is especially visible for the connection of Väinämöinen with *Odin*, who used Sleipnir in his journeys. The use of tongs for the legs of Vaadin actually suggests eight legs, which is the distinguishing attribute of Sleipnir. While Sleipnir is almost universally depicted as a horse, the exact identification of the steed may have changed during the transmission between the cultures.

The *Bridle of Vaadin* is a special artifact itself. There is no headstall, but only the rein, detached from the creature, kept in the hand of the rider. The rein is a chain or set of "gadgets" used for controlling the creature. The rein was built of web with special tools, with Seppo wearing magnifying goggles to work out the small details.

The significance and cultural influence of Vaadin can be seen in its identification with a constellation in the traditional Finnish constellation system. The famous French astronomer *Pierre Charles Le Monnier* (1715-99), who visited Lapland, introduced the constellation to international star charts with the name *Tarandus vel Rangifer*. The constellation was present in many star charts of the time, perhaps most notably in the *Uranographia* published in 1801 by *Johann Elert Bode*, as shown in Figure B.1, "Constellation of Tarandus vel Rangifer in Bode's *Uranographia* (1801)". It was later removed in the unification of the constellation system towards the Greek mythology.

Figure B.1. Constellation of Tarandus vel Rangifer in Bode's *Uranographia* (1801)



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