GRAILS

See the light - agile, industrial strength, rapid web application development made easy

The Grails Framework - Reference Documentation

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Version: null

Table of Contents

1 Introduction

Java web development as it stands today is dramatically more complicated than it needs to be. Most moc are over complicated and don't embrace the Don't Repeat Yourself (DRY) principles.

Dynamic frameworks like Rails, Django and TurboGears helped pave the way to a more modern way of t builds on these concepts and dramatically reduces the complexity of building web applications on the J however, is that it does so by building on already established Java technologies like Spring and Hibernate.

Grails is a full stack framework and attempts to solve as many pieces of the web development puzzl associated plugins. Included out the box are things like:

- An easy to use Object Relational Mapping (ORM) layer built on Hibernate
- An expressive view technology called Groovy Server Pages (GSP)
- A controller layer built on Spring MVC
- A command line scripting environment built on the Groovy-powered Gant
- An embedded Tomcat container which is configured for on the fly reloading
- Dependency injection with the inbuilt Spring container
- Support for internationalization (i18n) built on Spring's core MessageSource concept
- A transactional service layer built on Spring's transaction abstraction

All of these are made easy to use through the power of the Groovy language and the extensive use of Dom

This documentation will take you through getting started with Grails and building web applications with th

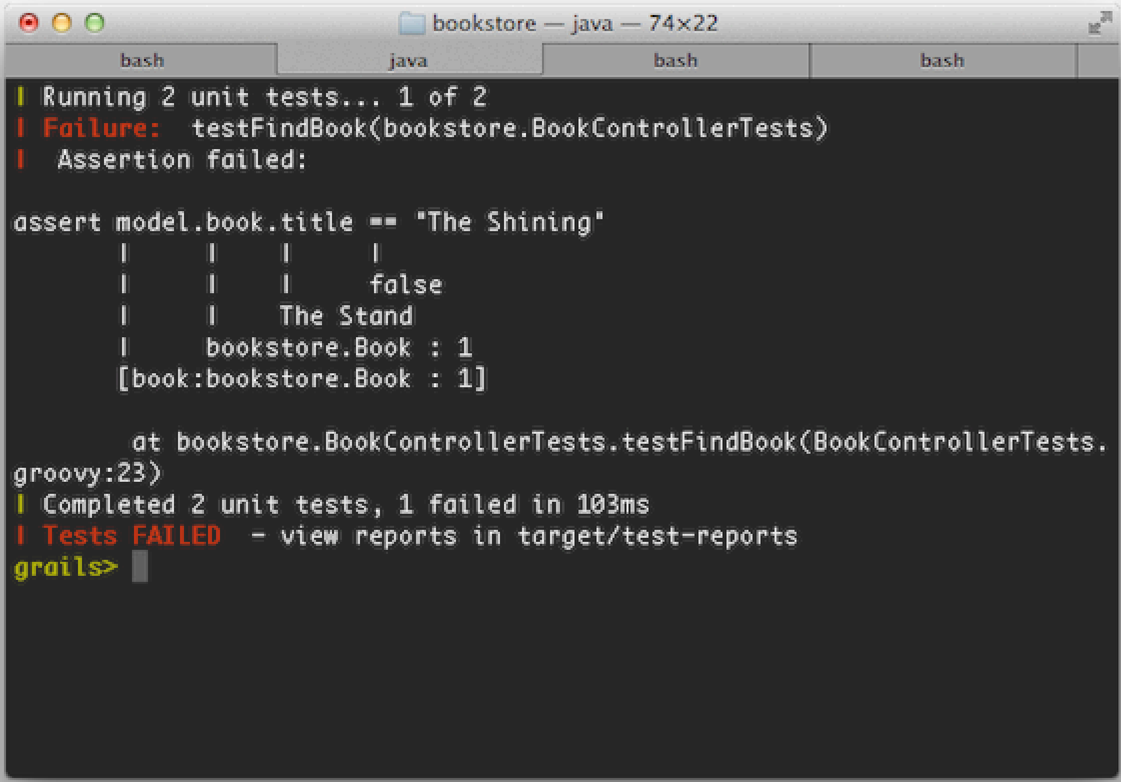
1.1 What's new in Grails 2.0?

This section covers the new features that are present in 2.0 and is broken down into sections covering the persistence enhancements and improvements in testing. Note there are many more small enhancements cover some of the highlights.

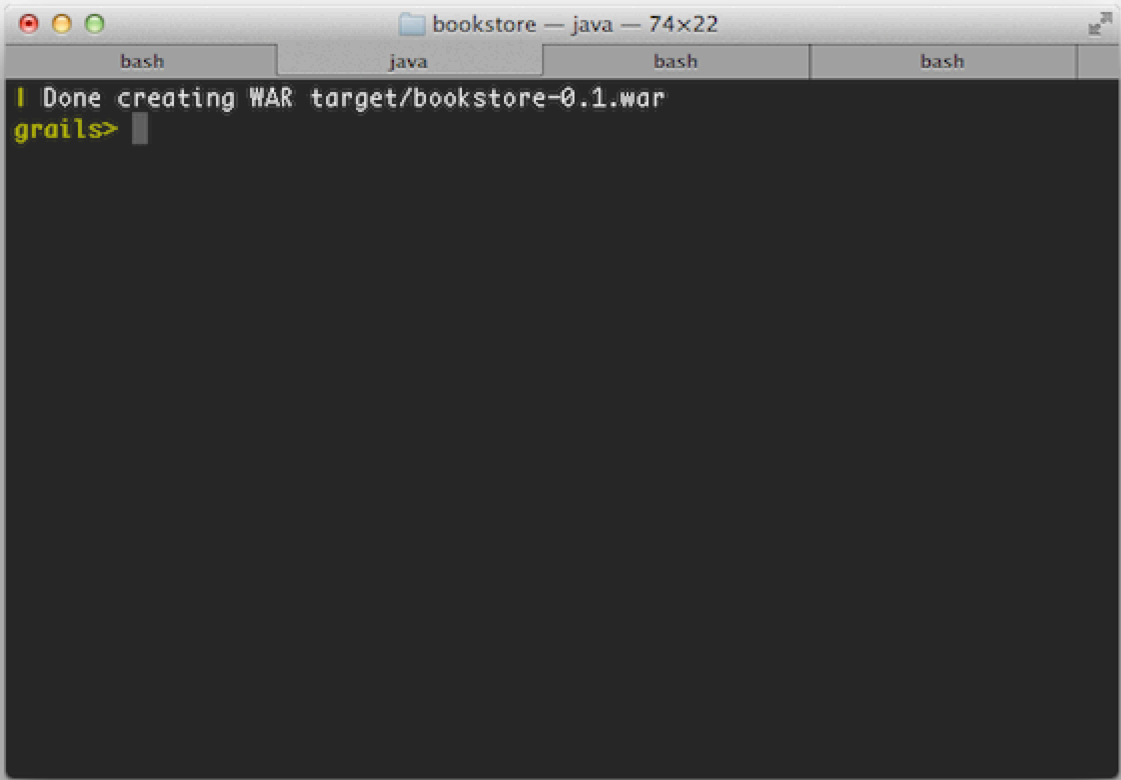
1.1.1 Development Environment Features

Interactive Mode and Console Enhancements

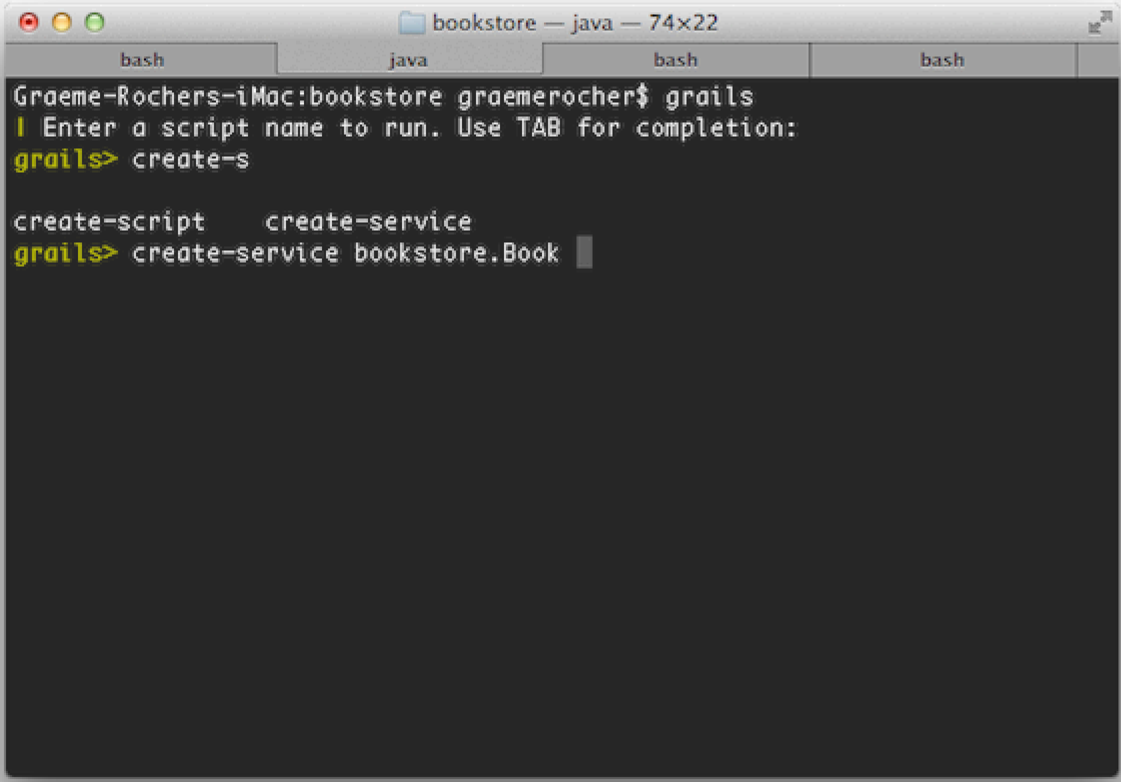
Grails 2.0 features brand new console output that is more concise and user friendly to consume. An exa tests can be seen below:



In general Grails makes its best effort to display update information on a single line and only present the that while in previous versions of Grails the war command produced many lines of output, in Grails 2.0 on



In addition simply typing 'grails' at the command line activates the new interactive mode which features T
keeps the JVM running to ensure commands execute much quicker than otherwise



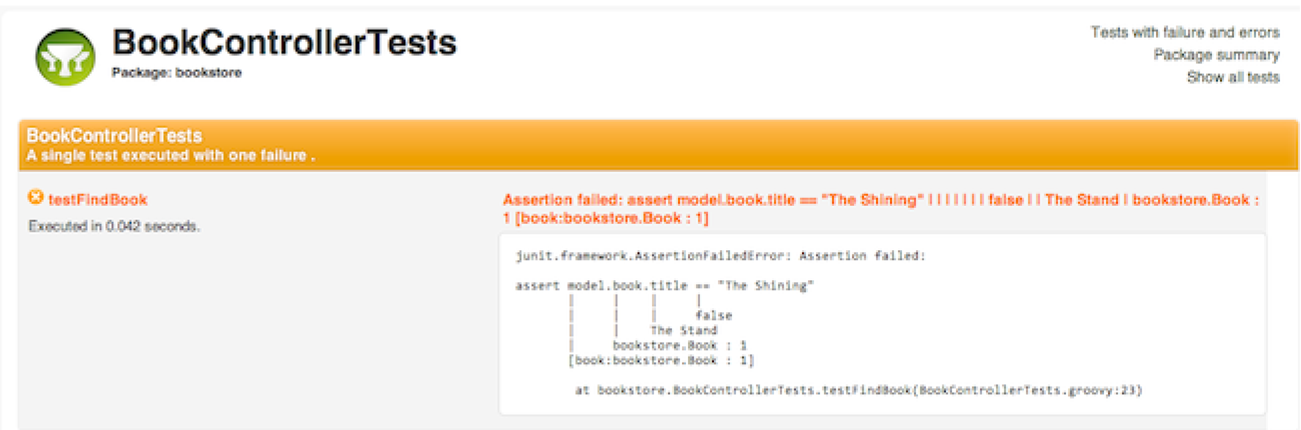
For more information on the new features of the console refer to the section of the user guide that covers th

Reloading Agent

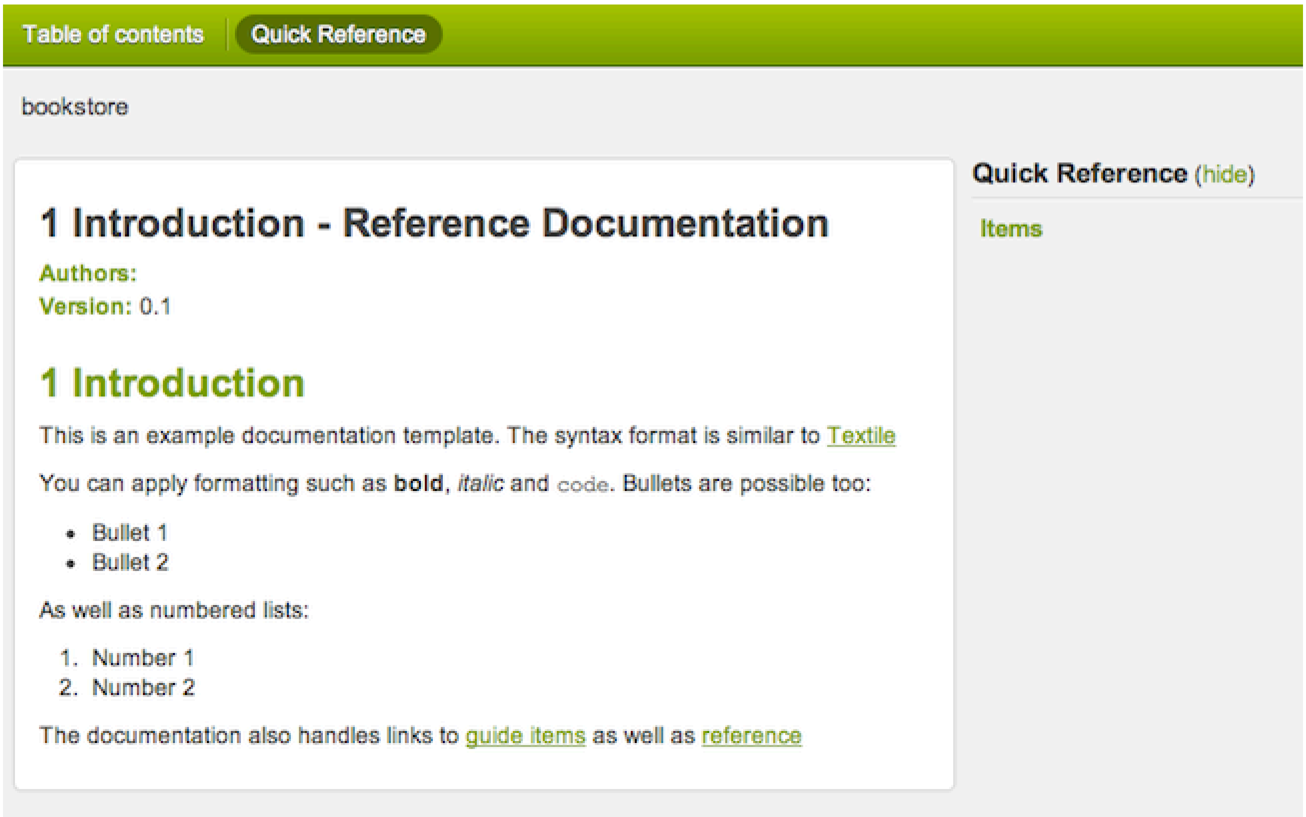
Grails 2.0 reloading mechanism no longer uses class loaders, but instead uses a JVM agent to reload chan
improved reliability when reloading changes and also ensures that the class files stored in disk remain c
memory, which reduces the need to run the [clean](#) command.

New Test Report and Documentation Templates

There are new templates for displaying test results that are clearer and more user friendly than the previous



In addition, the Grails documentation engine has received a facelift with a new template for pres
documentation:



See the section on the [documentation engine](#) for more usage info.

Use a TOC for Project Docs

The old documentation engine relied on you putting section numbers into the gdoc filenames. Althoug
difficult to restructure your user guide by inserting new chapters and sections. In addition, any such res
resulted in breaking changes to the URLs.

You can now use logical names for your gdoc files and define the structure and section titles in a YAMI
the section on the documentation engine. The logical names appear in the URLs, so as long as you don't
remain the same no matter how much restructuring or changing of titles you do.

Grails 2.0 even provides a migrate-docs command to aid you in migrating existing gdoc user guides.

Enhanced Error Reporting and Diagnosis

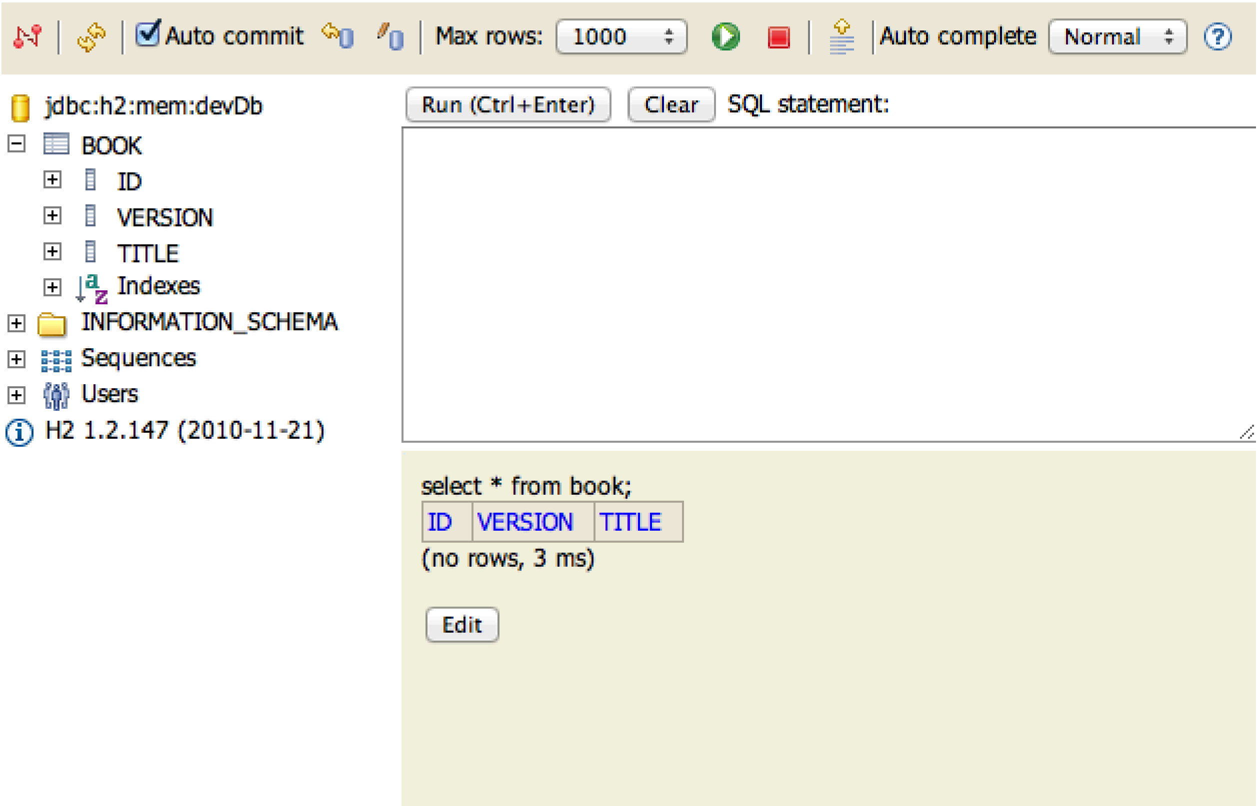
Error reporting and problem diagnosis has been greatly improved with a new errors view that analyse
problem areas in your code:

In addition stack trace filtering has been further enhanced to display only relevant trace information:

```
Line | Method
->>    9 | getValue     in Book.groovy
- - - - - - - - - - - - - - - - - - - - - - - - -
|      7 | getBookValue in BookService.groovy
|    886 | runTask . .  in ThreadPoolExecutor.java
|    908 | run          in     ''
^    662 | run . . . .  in Thread.java
```

H2 Database and Console

Grails 2.0 now uses the H2 database instead of HSQLDB, and enables the H2 database console in develo| that the in-memory database can be easily queried from the browser:



Plugin Usage Tracking

To enhance community awareness of the most popular plugins an opt-in plugin usage tracking syste participate in providing feedback to the plugin community on which plugins are most popular.

This will help drive the roadmap and increase support of key plugins while reducing the need to supp helping plugin development teams focus their efforts.

Dependency Resolution Improvements

There are numerous improvements to dependency resolution handling via Ivy including:

- Grails now makes a best effort to cache the previous resolve and avoid resolving again unless you cha
- Plugins dependencies now appear in the dependency report generated by `grails dependency-r`
- Plugins published with the release plugin now publish their transitive plugin dependencies in the gene
- It is now possible to customize the ivy cache directory via `BuildConfig.groovy`

```
grails.project.dependency.resolution = {
    cacheDir "target/ivy-cache"
}
```

- It is now possible to completely disable resolution from inherited repositories (repositories defined by

```
grails.project.dependency.resolution = {

repositories {
        inherits false // Whether to inherit repository definitions from plugins
        …
    }
    …
}
```

- It is now possible to easily disable checksum validation errors:

```
grails.project.dependency.resolution = {
    checksums false // whether to verify checksums or not
}
```

1.1.2 Core Features

Binary Plugins

Grails plugins can now be packaged as JAR files and published to standard maven repositories. This ev (with resources plugin 1.0.1). See the section on [Binary plugins] for more information.

Groovy 1.8

Grails 2.0 comes with Groovy 1.8 which includes many new [features and enhancements]

Spring 3.1 Profile Support

Grails' existing environment support has been bridged into the Spring 3.1 profile support. For exampl environment called "production", a Spring profile of "production" is activated so that you can use Spring' beans for a specific profile.

1.1.3 Web Features

Controller Actions as Methods

It is now possible to define controller actions as methods instead of using closures as in previous vers preferred way of expressing an action. For example:

```
// action as a method
def index() {

}
// action as a closure
def index = {

}
```

Binding Primitive Method Action Arguments

It is now possible to bind form parameters to action arguments where the name of the form element mat
given the following form:

```
<g:form name="myForm" action="save">
    <input name="name" />
    <input name="age" />
</g:form>
```

You can define an action that declares arguments for each input and automatically converts the parameters

```
def save(String name, int age) {
    // remaining
}
```

Static Resource Abstraction

A new static resource abstraction is included that allows declarative handling of JavaScript, CSS and ordering, compression, caching and gzip handling.

Servlet 3.0 Async Features

Grails now supports Servlet 3.0 including the Asynchronous programming model defined by the specificat

```
def index() {
    def ctx = startAsync()
    ctx.start {
        new Book(title:"The Stand").save()
        render template:"books", model:[books:Book.list()]
        ctx.complete()
    }
}
```

Link Generation API

A general purpose `LinkGenerator` class is now available that is usable anywhere within a Grails applic a controller. For example if you need to generate links in a service or an asynchronous background job out

```
LinkGenerator grailsLinkGenerator

def generateLink() {
    grailsLinkGenerator.link(controller:"book", action:"list")
}
```

Page Rendering API

Like the `LinkGenerator` the new `PageRenderer` can be used to render GSP pages outside the scheduled job or web service. The `PageRenderer` class features a very similar API to the `render` metl

```
grails.gsp.PageRenderer groovyPageRenderer

void welcomeUser(User user) {
    def contents = groovyPageRenderer.render(view:"/emails/welcomeLetter", model:
    sendEmail {
        to user.email
        body contents
    }
}
```

The `PageRenderer` service also allows you to pre-process GSPs into HTML templates:

```
new File("/path/to/welcome.html").withWriter { w ->
    groovyPageRenderer.renderTo(view:"/page/content", w)
}
```

Filter Exclusions

Filters may now express controller, action and uri exclusions to offer more options for expressing to whi
applied.

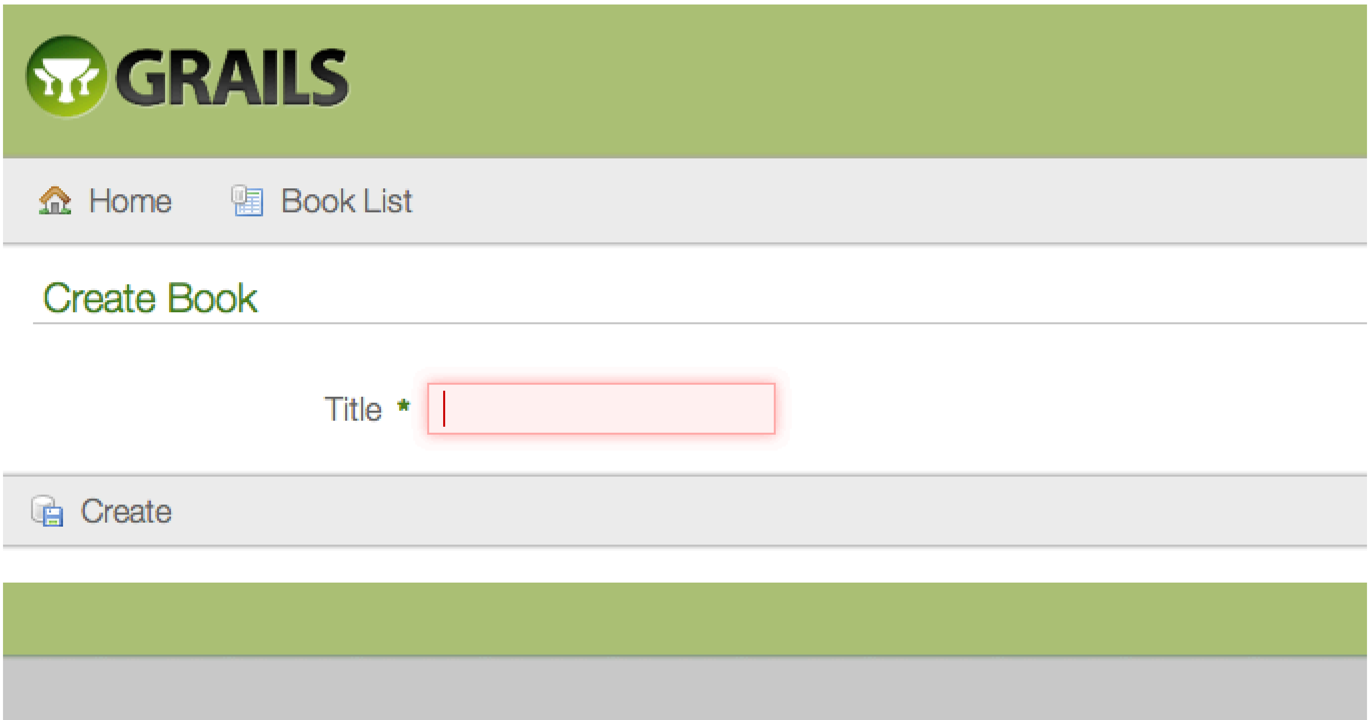
```
filter1(actionExclude: 'log*') {
    before = {
        // …
    }
}
filter2(controllerExclude: 'auth') {
    before = {
        // …
    }
}

filter3(uriExclude: '/secure*') {
    before = {
        // …
    }
}
```

Performance Improvements

Performance of GSP page rendering has once again been improved by optimizing the GSP compiler to inli

HTML5 Scaffolding

There is a new HTML5-based scaffolding UI:



jQuery by Default

The jQuery plugin is now the default JavaScript library installed into a Grails application. For backwa available. Refer to the documentation on the Prototype plugin for installation instructions.

1.1.4 Persistence Features

The GORM API

The GORM API has been formalized into a set of classes (`GormStaticApi`, `GormInstanceApi` statically wired into every domain class at the byte code level. The result is better code completion for ID potential for more GORM implementations for other types of data stores.

New findOrCreate and findOrSave Methods

Domain classes have support for the findOrCreateWhere, findOrSaveWhere, findOrCreateBy and findO just like findWhere and findBy methods except that they should never return null. If a matching instance new instance is created, populated with values represented in the query parameters and returned. findOrSaveBy, the instance is saved before being returned.

```
def book = Book.findOrCreateWhere(author: 'Douglas Adams', title: "The Hitchiker'
def book = Book.findOrSaveWhere(author: 'Daniel Suarez', title: 'Daemon')
def book = Book.findOrCreateByAuthorAndTitle('Daniel Suarez', 'Daemon')
def book = Book.findOrSaveByAuthorAndTitle('Daniel Suarez', 'Daemon')
```

Abstract Inheritance

GORM now supports abstract inheritance trees which means you can define queries and associations linki

```
abstract class Media {
    String title
    …
}
class Book extends Media {
}
class Album extends Media {

}
class Account {
    static hasMany = [purchasedMedia:Media]
}

..

def allMedia = Media.list()
```

Multiple Data Sources Support

It is now possible to define multiple datasources in `DataSource.groovy` and declare one or more d default:

```
class ZipCode {

String code

static mapping = {
      datasource 'ZIP_CODES'
   }
}
```

If multiple datasources are specified for a domain then you can use the name of a particular datasource GORM method:

```
def zipCode = ZipCode.auditing.get(42)
```

For more information see the section on Multiple Data Sources in the user guide.

Database Migrations

A new database migration plugin has been designed and built for Grails 2.0 allowing you to apply migrat and diff your domain model with the current state of the database.

Database Reverse Engineering

A new database reverse engineering plugin has been designed and built for Grails 2.0 that allows you existing database schema.

Hibernate 3.6

Grails 2.0 is now built on Hibernate 3.6

Bag Collections

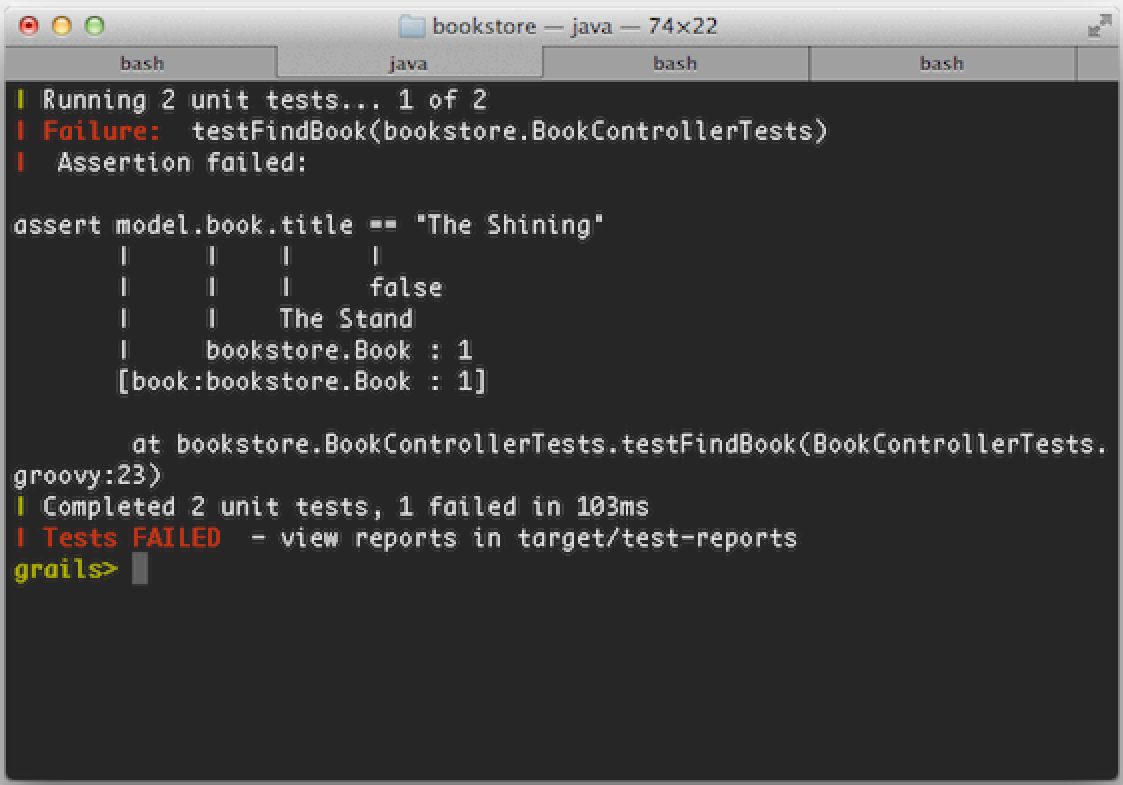
You can now use Hibernate [Bags](#)s for mapped collections to avoid the memory and performance issues o
`Set` uniqueness or `List` order.

For more information see the section on [Sets, Lists and Maps](#) in the user guide.

1.1.5 Testing Features

New Unit Testing Console Output

Test output from the test-app command has been improved:



New Unit Testing API

There is a new unit testing API based on mixins that supports JUnit 3, 4 and Spock style tests (with Spock

```
import grails.test.mixin.TestFor

@TestFor(SimpleController)
class SimpleControllerTests  {
    void testIndex() {
        controller.home()

assert view == "/simple/homePage"
        assert model.title == "Hello World"
    }
}
```

The documentation on testing has also been re-written around this new framework.

Unit Testing GORM

A new in-memory GORM implementation is present that supports many more features of the GORM API
named queries and other previously unsupported methods possible.

Faster Unit Testing with Interactive Mode

The new interactive mode (activated by typing 'grails') greatly improves the execution time of running unit

Unit Test Scaffolding

A unit test is now generated for scaffolded controllers

2 Getting Started

2.1 Downloading and Installing

The first step to getting up and running with Grails is to install the distribution. To do so follow these steps

- [Download](#) a binary distribution of Grails and extract the resulting zip file to a location of your choice
- Set the GRAILS_HOME environment variable to the location where you extracted the zip
  - On Unix/Linux based systems this is typically a matter of adding somethi `GRAILS_HOME=/path/to/grails` to your profile
  - On Windows this is typically a matter of setting an environment variable under `My Com` `Variables`
- Then add the `bin` directory to your `PATH` variable:
  - On Unix/Linux based systems this can be done by adding `export PATH="$PATH:$GRAILS`
  - On Windows this is done by modifying the `Path` environment variable under `My Com` `Variables`

If Grails is working correctly you should now be able to type `grails -version` in the terminal windo

```
Grails version: 2.0.0
```

2.2 Upgrading from previous versions of Grails

Although the Grails development team have tried to keep breakages to a minimum there are a number (Grails 1.0.x, 1.1.x, 1.2.x, or 1.3.x applications to Grails 2.0. The major changes are described in detail belo

Upgrading from Grails 1.3.x

HSQLDB Has Been Replaced With H2

HSQLDB is still bundled with Grails but is not configured as a default runtime dependency. Upgrad references in DataSource.groovy with H2 references or adding HSQLDB as a runtime dependency for the

If you want to run an application with different versions of Grails, it's simplest to add HSQLDB as a run BuildConfig.groovy:

```
grails.project.dependency.resolution = {
    inherits("global") {
    }
    repositories {
        grailsPlugins()
        grailsHome()
        grailsCentral()
    }

dependencies {
        // Add HSQLDB as a runtime dependency
        runtime 'hsqldb:hsqldb:1.8.0.10'
    }
}
```

A default DataSource.groovy which is compatible with H2 looks like this:

```
dataSource {
    driverClassName = "org.h2.Driver"
    username = "sa"
    password = ""
}
// environment specific settings
environments {
    development {
        dataSource {
            dbCreate = "create-drop" // one of 'create', 'create-drop','update'
            url = "jdbc:h2:mem:devDb"
        }
    }
    test {
        dataSource {
            dbCreate = "update"
            url = "jdbc:h2:mem:testDb"
        }
    }
    production {
        dataSource {
            dbCreate = "update"
            url = "jdbc:h2:prodDb"
        }
    }
}
```

Another significant difference between H2 and HSQLDB is in the handling of `byte[]` domain class prc
is large and so you typically don't need to specify a maximum size. But H2 defaults to a maximum size c
database, the saves are likely to fail because of this. The easy fix is to add a `maxSize` constraint to the `by`

```
class MyDomain {
    byte[] data

static constraints = {
        data maxSize: 1024 * 1024 * 2 // 2MB
    }
}
```

This constraint influences schema generation, so in the above example H2 will have the `data` column set

Abstract Inheritance Changes

In previous versions of Grails abstract classes in `grails-app/domain` were not treated as persisten
significant impact on upgrading your application. For example consider the following domain model in a (

```
abstract class Sellable {

}
class Book extends Sellable {

}
```

In Grails 1.3.x you would get a BOOK table and the properties from the `Sellable` class would be stor
Grails 2.0.x you will get `SELLABLE` table and the default table-per-hierarchy inheritance rules apply with
`SELLABLE` table.

You have two options when upgrading in this scenario:

1. Move the abstract `Sellable` class into the src/groovy package. If the `Sellable` class is in the `s1`
   be regarded a persistent
2. Use the database migration plugin to apply the appropriate changes to the database (typically renami
   the inheritance tree)

Criteria Queries Default to INNER JOIN

The previous default of LEFT JOIN for criteria queries across associations is now INNER JOIN.

Logging By Convention Changes

The packages that you should use for Grails artifacts have mostly changed. In particular:

- `service` -> `services`
- `controller` -> `controllers`
- `tagLib` -> `taglib` (case change)
- `bootstrap` -> `conf`
- `dataSource` -> `conf`

You can find out more about logging by convention in the main part of the user guide, under "Configurin
of injecting the `log` property into artefacts at compile time.

jQuery Replaces Prototype

The Protoype Javascript library has been removed from Grails core and now new Grails applications
default. This will only impact you if you are using Prototype with the adaptive AJAX tags in your applica
those tags will break as soon as you upgrade.

To resolve this issue, simply install the Prototype plugin in your application. You can also ren
`web-app/js/prototype` directory if you want.

Access Control and Resources

The Resources plugin is a great new feature of Grails, but you do need to be aware that it adds an extra control in your application, this may mean that the static resources require an authenticated user to load t account of the `/static` URL.

Controller Public Methods

As of Grails 2.0, public methods of controllers are now treated as actions in addition to actions define relying on the use of methods for privacy controls or as helper methods then this could result in unexpec should mark all methods of your application that are not to be exposed as actions as `private` methods.

The redirect Method

The [redirect](#) method no longer commits the response. The result of this is code that relies of this behavior v

```
redirect action: "next"
if (response.committed) {
    // do something
}
```

In this case in Grails 1.3.x and below the `response.committed` property would return true and the `i` is no longer the case and you should instead use the new `isRedirected()` method of the `request` ob

```
redirect action: "next"
if (request.redirected) {
    // do something
}
```

Another side-effect of the changes to the redirect method is that it now always uses the `grails.serv` Previous versions of Grails included default values for all the environments, but when upgrading to Grai break redirection. So, we recommend you remove the development and test settings for `grails.serve` appropriate for your application.

Content Negotiation

As of Grails 2.0 the [withFormat](#) method of controllers no longer takes into account the request content t header), but instead deals exclusively with the response content type (dictated by the `ACCEPT` header or application has code that relies on reading XML from the request using `withFormat` this will no longer

```
def processBook() {
    withFormat {
        xml {
            // read request XML
        }
        html {
            // read request parameters
        }
    }
}
```

Instead you use the `withFormat` method provided on the `request` object:

```
def processBook() {
    request.withFormat {
        xml {
            // read request XML
        }
        html {
            // read request parameters
        }
    }
}
```

Command Line Output

Ant output is now hidden by default to keep the noise in the terminal to a minimum. That means if y communicate messages to the user, we recommend switching to an alternative mechanism.

For status related messages, you can use the event system:

```
event "StatusUpdate", ["Some message"]
event "StatusFinal",  ["Some message"]
event "StatusError",  ["Some message"]
```

For more control you can use the `grailsConsole` script variable, which gives you access to an instar can log information messages with `log()` or `info()`, errors and warnings with `error()` and `war` `userInput()`.

Updated Underlying APIs

Grails 2.0 contains updated dependencies including Servlet 3.0, Tomcat 7, Spring 3.1, Hibernate 3.6 an plugins and applications that that depend on earlier versions of these APIs may no longer w `HttpServletRequest` interface includes new methods, so if a plugin implements this interface for said plugin will break. The same can be said of any Spring interface.

Removal of release-plugin

The built in `release-plugin` command for releases plugins to the central Grails plugin repository has should be used instead which provides an equivalent `publish-plugin` command.

Removal of Deprecated Classes

The following deprecated classes have been removed: `grails.web.JsonBuilder`, `grails.web.C`

Upgrading from Grails 1.2.x

Plugin Repositories

As of Grails 1.3, Grails no longer natively supports resolving plugins against secured SVN repositories Grails 1.2 and below has been replaced by one built on Ivy, the upside of which is that you can now repositories as well as regular Grails repositories.

Ivy supports a much richer setter of repository resolvers for resolving plugins, including support for W section on resolvers in the Ivy docs for all the available options and the section of plugin repositories ir configure additional resolvers.

If you still need support for resolving plugins against secured SVN repositories then the IvySvn projec repositories.

Upgrading from Grails 1.1.x

Plugin paths

In Grails 1.1.x typically a `pluginContextPath` variable was used to establish paths to plugin resource

```
<g:resource dir="${pluginContextPath}/images" file="foo.jpg" />
```

In Grails 1.2 views have been made plugin aware and this is no longer necessary:

```
<g:resource dir="images" file="foo.jpg" />
```

Additionally the above example will no longer link to an application image from a plugin view. To do so c

```
<g:resource contextPath="" dir="images" file="foo.jpg" />
```

The same rules apply to the javascript and render tags.

Tag and Body return values

Tags no longer return `java.lang.String` instances but instead return a Grails `StreamCharBuffer` class implements all the same methods as `String` but doesn't extend `String`, so code like this will brea

```
def foo = body()
if (foo instanceof String) {
    // do something
}
```

In these cases you should check for the `java.lang.CharSequence` interface, which both `String` ar

```
def foo = body()
if (foo instanceof CharSequence) {
    // do something
}
```

New JSONBuilder

There is a new version of `JSONBuilder` which is semantically different from the one used in earlie application depends on the older semantics you can still use the deprecated implementation by settir Config.groovy:

```
grails.json.legacy.builder=true
```

Validation on Flush

Grails now executes validation routines when the underlying Hibernate session is flushed to ensure that nc your constraints (such as a custom validator) executes a query then this can cause an additional flush, res For example:

```
static constraints = {
    author validator: { a ->
        assert a != Book.findByTitle("My Book").author
    }
}
```

The above code can lead to a `StackOverflowError` in Grails 1.2. The solution is to run the query ir recommended in general as doing Hibernate work during flushing can cause other issues):

```
static constraints = {
    author validator: { a ->
        Book.withNewSession {
            assert a != Book.findByTitle("My Book").author
        }
    }
}
```

Upgrading from Grails 1.0.x

Groovy 1.6

Grails 1.1 and above ship with Groovy 1.6 and no longer supports code compiled against Groovy 1.5. I with Groovy 1.5 you must recompile it against Groovy 1.6 or higher before using it with Grails 1.1.

Java 5.0

Grails 1.1 now no longer supports JDK 1.4, if you wish to continue using Grails then it is recommended y you are able to upgrade your JDK.

Configuration Changes

1) The setting `grails.testing.reports.destDir` has been renamed to `grails.project.te`

2) The following settings have been moved from `grails-app/c` `grails-app/conf/BuildConfig.groovy`:

- `grails.config.base.webXml`
- `grails.project.war.file` (renamed from `grails.war.destFile`)
- `grails.war.dependencies`
- `grails.war.copyToWebApp`
- `grails.war.resources`

3) The `grails.war.java5.dependencies` option is no longer supported, since Java 5.0 is now the

4) The use of jsessionid (now considered harmful) is disabled by default. If your application requires jse adding the following to `grails-app/conf/Config.groovy`:

```
grails.views.enable.jsessionid=true
```

5) The syntax used to configure Log4j has changed. See the user guide section on Logging for more inforn

Plugin Changes

As of version 1.1, Grails no longer stores plugins inside your `PROJECT_HOME/plugins` directory by errors in your application unless you either re-install all your plugins or se `grails-app/conf/BuildConfig.groovy`:

```
grails.project.plugins.dir="./plugins"
```

Script Changes

1) If you were previously using Grails 1.0.3 or below the following syntax is no longer support for importi

```
Ant.property(environment:"env")
grailsHome = Ant.antProject.properties."env.GRAILS_HOME"
includeTargets << new File("${grailsHome}/scripts/Bootstrap.groovy")
```

Instead you should use the new `grailsScript` method to import a named script:

```
includeTargets << grailsScript("_GrailsBootstrap")
```

2) Due to an upgrade of Gant all references to the variable `Ant` should be changed to `ant`.

3) The root directory of the project is no longer on the classpath, so loading a resource like this will no lon

```
def stream = getClass().classLoader.getResourceAsStream(
                   "grails-app/conf/my-config.xml")
```

Instead you should use the Java File APIs with the `basedir` property:

```
new File("${basedir}/grails-app/conf/my-config.xml").withInputStream { stream ->
    // read the file
}
```

Command Line Changes

The `run-app-https` and `run-war-https` commands no longer exist and have been replaced by an a

```
grails run-app -https
```

Data Mapping Changes

1) Enum types are now mapped using their String value rather than the ordinal value. You can revert mapping as follows:

```
static mapping = {
    someEnum enumType:"ordinal"
}
```

2) Bidirectional one-to-one associations are now mapped with a single column on the owning side and need to change anything; however you should drop column on the inverse side as it contains duplicate data

REST Support

Incoming XML requests are now no longer automatically parsed. To enable parsing of REST requests you argument inside a URL mapping:

```
"/book"(controller:"book",parseRequest:true)
```

Alternatively, you can use the new `resource` argument, which enables parsing by default:

```
"/book"(resource:"book")
```

2.3 Creating an Application

To create a Grails application you first need to familiarize yourself with the usage of the `grails` cor manner:

```
grails [command name]
```

Run create-app to create an application:

```
grails create-app helloworld
```

This will create a new directory inside the current one that contains the project. Navigate to this directory i

bc. cd helloworld

2.4 A Hello World Example

"hello world!" create-controller:

```
grails create-controller hello
```

(Controllers) `grails-app/controllers` `helloworld/HelloController.groovy`.

> create-controller Grails `grails.project.groupId` Config.groovy

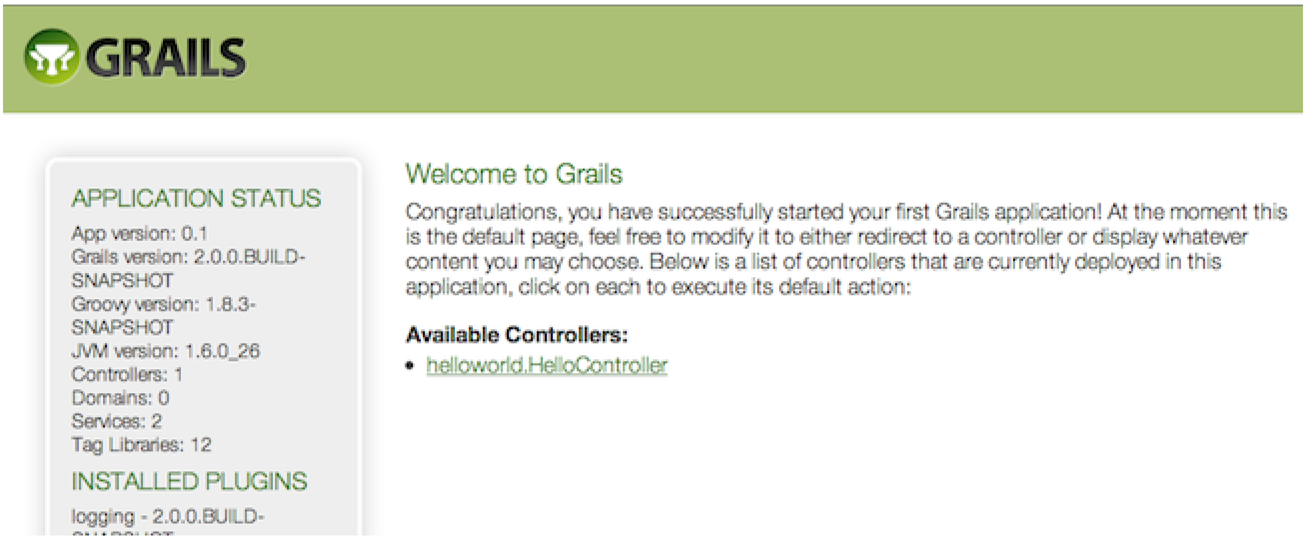
web requests "hello world!"

```
package helloworld
class HelloController {
def world() {
        render "Hello World!"
    }
}
```

run-app:

```
grails run-app
```

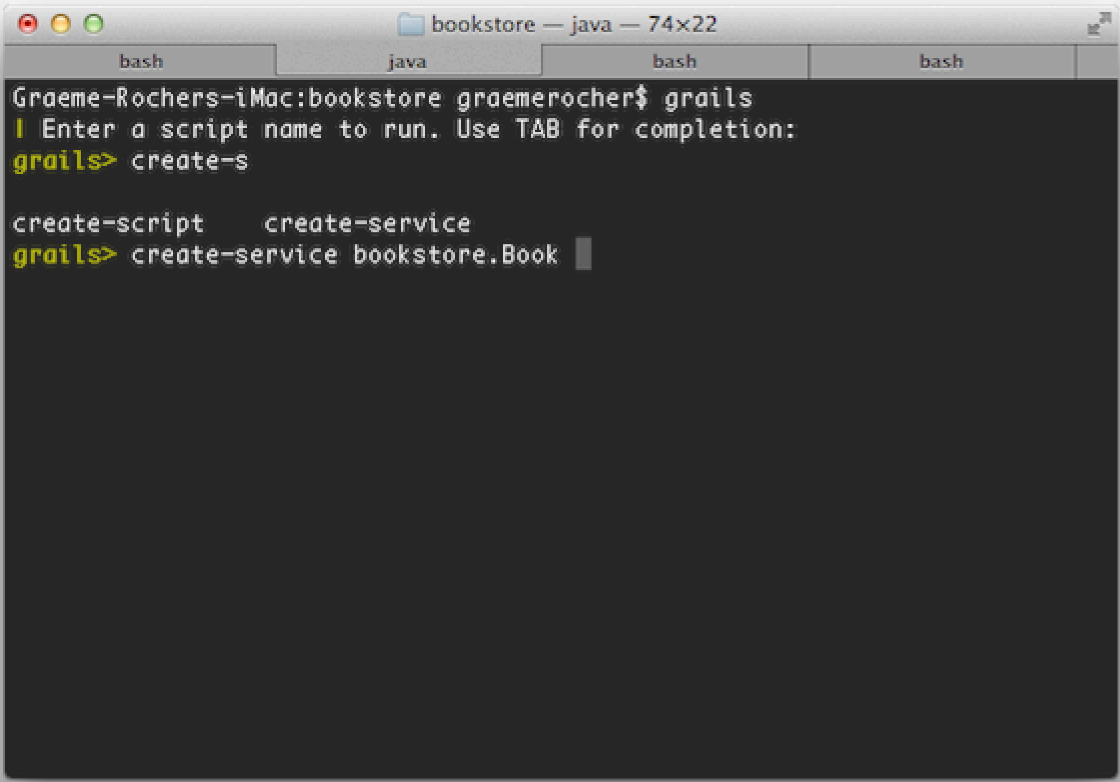
8080 URL: `http://localhost:8080/helloworld`



Grails `web-app/index.gsp` "Hello World!"

2.5 Using Interactive Mode

Grails 2.0 features an interactive mode which makes command execution faster since the JVM doesn't hav use interactive mode simple type 'grails' from the root of any projects and use TAB completion to get screenshot below for an example:



For more information on the capabilities of interactive mode refer to the section on [Interactive Mode](#) in the

2.6 Getting Set Up in an IDE

IntelliJ IDEA

IntelliJ IDEA and the JetGroovy plugin offer good support for Groovy and Grails developers. Refer to th on the JetBrains website for a feature overview.

To integrate Grails with IntelliJ run the following command to generate appropriate project files:

```
grails integrate-with --intellij
```

Eclipse

We recommend that users of Eclipse looking to develop Grails application take a look at SpringSource T for Grails including automatic classpath management, a GSP editor and quick access to Grails command overview.

NetBeans

NetBeans provides a Groovy/Grails plugin that automatically recognizes Grails projects and provides the IDE, code completion and integration with the Glassfish server. For an overview of features see the Ne website which was written by the NetBeans team.

TextMate

Since Grails' focus is on simplicity it is often possible to utilize more simple editors and TextMate on th bundle available from the Texmate bundles SVN.

To integrate Grails with TextMate run the following command to generate appropriate project files:

```
grails integrate-with --textmate
```

Alternatively TextMate can easily open any project with its command line integration by issuing the foll project:

```
mate .
```

2.7 Convention over Configuration

Grails uses "convention over configuration" to configure itself. This typically means that the name and loc configuration, hence you need to familiarize yourself with the directory structure provided by Grails.

Here is a breakdown and links to the relevant sections:

- `grails-app` - top level directory for Groovy sources
  - `conf` - Configuration sources.
  - `controllers` - Web controllers - The C in MVC.
  - `domain` - The application domain.
  - `i18n` - Support for internationalization (i18n).
  - `services` - The service layer.
  - `taglib` - Tag libraries.
  - `utils` - Grails specific utilities.
  - `views` - Groovy Server Pages - The V in MVC.
- `scripts` - Gant scripts.
- `src` - Supporting sources
  - `groovy` - Other Groovy sources
  - `java` - Other Java sources
- `test` - Unit and integration tests.

2.8 Running an Application

Grails applications can be run with the built in Tomcat server using the run-app command which will load

```
grails run-app
```

You can specify a different port by using the `server.port` argument:

```
grails -Dserver.port=8090 run-app
```

More information on the run-app command can be found in the reference guide.

2.9 Testing an Application

The `create-*` commands in Grails automatically create unit or integration tests for you within the `t`
directory. It is of course up to you to populate these tests with valid test logic, information on which can be

To execute tests you run the test-app command as follows:

```
grails test-app
```

2.10 Deploying an Application

Grails applications are deployed as Web Application Archives (WAR files), and Grails includes the war co

```
grails war
```

This will produce a WAR file under the `target` directory which can then be deployed as per your contai

Unlike most scripts which default to the `development` environment unless overridden, the `war` environment by default. You can override this like any script by specifying the environment name, for exa

```
grails dev war
```

> NEVER deploy Grails using the run-app command as this command sets Grails up for aut which has a severe performance and scalability implications

When deploying Grails you should always run your containers JVM with the `-server` option and with set of VM flags would be:

```
-server -Xmx512M -XX:MaxPermSize=256m
```

2.11 Supported Java EE Containers

Grails runs on any container that supports Servlet 2.5 and above and is known to work on the following sp

- Tomcat 7
- Tomcat 6
- SpringSource tc Server
- Eclipse Virgo
- GlassFish 3
- GlassFish 2
- Resin 4
- Resin 3
- JBoss 6
- JBoss 5
- Jetty 7
- Jetty 6
- IBM Websphere 7.0
- IBM Websphere 6.1
- Oracle Weblogic 10.3
- Oracle Weblogic 10
- Oracle Weblogic 9

Some containers have bugs however, which in most cases can be worked around. A list of known deploy
wiki.

2.12 Generating an Application

To get started quickly with Grails it is often useful to use a feature called Scaffolding to generate the sk
one of the `generate-*` commands such as generate-all, which will generate a controller (and its unit tes

```
grails generate-all Book
```

2.13 Creating Artefacts

Grails ships with a few convenience targets such as create-controller, create-domain-class and so on th
artefact types for you.

> These are just for your convenience and you can just as easily use an IDE or your favourite te

For example to create the basis of an application you typically need a domain model:

```
grails create-domain-class book
```

This will result in the creation of a domain class at `grails-app/domain/Book.groovy` such as:

```
class Book {
}
```

There are many such `create-*` commands that can be explored in the command line reference guide.

> To decrease the amount of time it takes to run Grails scripts, use the interactive mode.

3 Configuration

It may seem odd that in a framework that embraces "convention-over-configuration" that we tackle this t there is typically a one-off, it is best to get it out the way.

With Grails' default settings you can actually develop an application without doing any configuration wha servlet container and in-memory H2 database, so there isn't even a database to set up.

However, typically you should configure a more robust database at some point and that is described in the

3.1 Basic Configuration

For general configuration Grails provides a file called `grails-app/conf/Config.groovy`. This f is very similar to Java properties files except it is pure Groovy hence you can reuse variables and use prop

You can add your own configuration in here, for example:

```
foo.bar.hello = "world"
```

Then later in your application you can access these settings in one of two ways. The most common is from available as a variable in controllers and tag libraries:

```
assert "world" == grailsApplication.config.foo.bar.hello
```

The other way involves getting a reference to the ConfigurationHolder class that holds a reference to the c

```
import org.codehaus.groovy.grails.commons.*
…
def config = ConfigurationHolder.config
assert "world" == config.foo.bar.hello
```

ConfigurationHolder and ApplicationHolder are deprecated and will be removed in a future is highly preferable to access the `GrailsApplication` and config from the `grailsApp`

3.1.1 Built in options

Grails also provides the following configuration options:

* `grails.config.locations` - The location of properties files or addition Grails Config fi configuration
* `grails.enable.native2ascii` - Set this to false if you do not require native2ascii conversion
* `grails.views.default.codec` - Sets the default encoding regime for GSPs - can be one of 'n To reduce risk of XSS attacks, set this to 'html'.
* `grails.views.gsp.encoding` - The file encoding used for GSP source files (default is 'utf-8')
* `grails.mime.file.extensions` - Whether to use the file extension to dictate the mime type i
* `grails.mime.types` - A map of supported mime types used for Content Negotiation
* `grails.serverURL` - A string specifying the server URL portion of absolute l grails.serverURL="http://my.yourportal.com". See createLink.

War generation

* `grails.project.war.file` - Sets the name and location of the WAR file generated by the war
* `grails.war.dependencies` - A closure containing Ant builder syntax or a list of JAR filename included in the WAR file.
* `grails.war.copyToWebApp` - A closure containing Ant builder syntax that is legal inside an you control what gets included in the WAR file from the "web-app" directory.
* `grails.war.resources` - A closure containing Ant builder syntax. Allows the application to d the final WAR file

For more information on using these options, see the section on deployment

3.1.2 Logging

The Basics

Grails uses its common configuration mechanism to provide the settings for the underlying Log4j log s `log4j` setting to the file `grails-app/conf/Config.groovy`.

So what does this `log4j` setting look like? Here's a basic example:

```
log4j = {
    error  'org.codehaus.groovy.grails.web.servlet',  //  controllers
           'org.codehaus.groovy.grails.web.pages' //  GSP

warn   'org.apache.catalina'
}
```

This says that for loggers whose name starts with 'org.codehaus.groovy.grails.web.servlet' or 'org.cc messages logged at 'error' level and above will be shown. Loggers with names starting with 'org.apache. the 'warn' level and above. What does that mean? First of all, you have to understand how levels work.

Logging levels

The are several standard logging levels, which are listed here in order of descending priority:

1. off
2. fatal
3. error
4. warn
5. info
6. debug
7. trace
8. all

When you log a message, you implicitly give that message a level. For example, the method `log.error` level. Likewise, `log.debug(msg)` will log it at 'debug'. Each of the above levels apart from 'off' and 'a the same name.

The logging system uses that *message* level combined with the configuration for the logger (see next sect gets written out. For example, if you have an 'org.example.domain' logger configured like so:

```
warn 'org.example.domain'
```

then messages with a level of 'warn', 'error', or 'fatal' will be written out. Messages at other levels will be ig

Before we go on to loggers, a quick note about those 'off' and 'all' levels. These are special in that they car can't log messages at these levels. So if you configure a logger with a level of 'off', then no messages wi that you will see all messages. Simple.

Loggers

Loggers are fundamental to the logging system, but they are a source of some confusion. For a start, what configure them?

A logger is the object you log messages to, so in the call `log.debug(msg)`, `log` is a logger instance (and uniquely identified by name, so if two separate classes use loggers with the same name, those loggers

There are two main ways to get hold of a logger:

1. use the `log` instance injected into artifacts such as domain classes, controllers and services;
2. use the Commons Logging API directly.

If you use the dynamic `log` property, then the name of the logger is 'grails.app.<type>.<className>', wh example 'controller' or 'service, and `className` is the fully qualified name of the artifact. For example, i

```
package org.example
class MyService {
    …
}
```

then the name of the logger will be 'grails.app.services.org.example.MyService'.

For other classes, the typical approach is to store a logger based on the class name in a constant static field

```
package org.other

import org.apache.commons.logging.LogFactory

class MyClass {
    private static final log = LogFactory.getLog(this)
    …
}
```

This will create a logger with the name 'org.other.MyClass' - note the lack of a 'grails.app.' prefix since pass a name to the `getLog()` method, such as "myLogger", but this is less common because the logging special way.

Configuring loggers

You have already seen how to configure loggers in Grails:

```
log4j = {
    error  'org.codehaus.groovy.grails.web.servlet'
}
```

This example configures loggers with names starting with 'org.codehaus.groovy.grails.web.servlet' to igno of 'warn' or lower. But is there a logger with this name in the application? No. So why have a configuratio to any logger whose name *begins with* 'org.codehaus.groovy.grails.servlet.' as well. For exam `org.codehaus.groovy.grails.web.servlet.GrailsDispatcherServlet` `org.codehaus.groovy.grails.web.servlet.mvc.GrailsWebRequest` one.

In other words, loggers are hierarchical. This makes configuring them by package much simpler than it wo

The most common things that you will want to capture log output from are your controllers, services, a mentioned earlier to do that: *grails.app.<artifactType>.<className>* . In particular the class name must if there is one:

```
log4j = {
    // Set level for all application artifacts
    info "grails.app"

// Set for a specific controller in the default package
    debug "grails.app.controllers.YourController"

// Set for a specific domain class
    debug "grails.app.domain.org.example.Book"

// Set for all taglibs
    info "grails.app.taglib"
}
```

The standard artifact names used in the logging configuration are:

- `conf` - For anything under `grails-app/conf` such as `BootStrap.groovy` and filters
- `taglib` - For tag libraries
- `services` - For service classes
- `controllers` - For controllers
- `domain` - For domain entities

Grails itself generates plenty of logging information and it can sometimes be helpful to see that. Here internals that you can use, especially when tracking down problems with your application:

- `org.codehaus.groovy.grails.commons` - Core artifact information such as class loading e
- `org.codehaus.groovy.grails.web` - Grails web request processing
- `org.codehaus.groovy.grails.web.mapping` - URL mapping debugging
- `org.codehaus.groovy.grails.plugins` - Log plugin activity
- `grails.spring` - See what Spring beans Grails and plugins are defining
- `org.springframework` - See what Spring is doing
- `org.hibernate` - See what Hibernate is doing

So far, we've only looked at explicit configuration of loggers. But what about all those loggers that *don't* h simply ignored? The answer lies with the root logger.

The Root Logger

All logger objects inherit their configuration from the root logger, so if no explicit configuration is p messages that go to that logger are subject to the rules defined for the root logger. In other words, configuration for the logging system.

Grails automatically configures the root logger to only handle messages at 'error' level and above, and all t (stdout for those with a C background). You can customise this behaviour by specifying a 'root' section in y

```
log4j = {
    root {
        info()
    }
    …
}
```

The above example configures the root logger to log messages at 'info' level and above to the default con the root logger to log to one or more named appenders (which we'll talk more about shortly):

```
log4j = {
    appenders {
        file name:'file', file:'/var/logs/mylog.log'
    }
    root {
        debug 'stdout', 'file'
    }
}
```

In the above example, the root logger will log to two appenders - the default 'stdout' (console) appender an

For power users there is an alternative syntax for configuring the root logger: the root `org.apache.lo` argument to the log4j closure. This lets you work with the logger directly:

```
log4j = { root ->
    root.level = org.apache.log4j.Level.DEBUG
    …
}
```

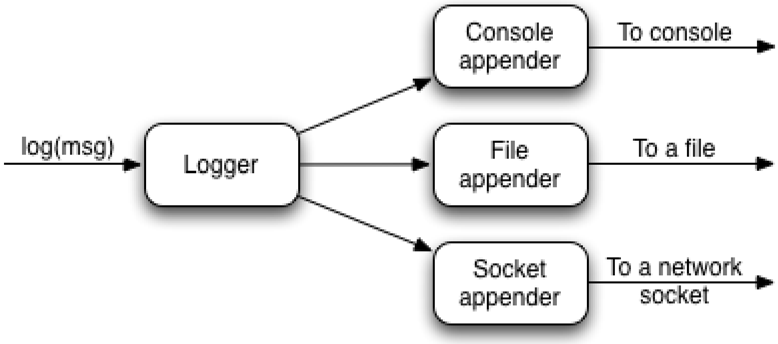
For more information on what you can do with this `Logger` instance, refer to the Log4j API documentatic

Those are the basics of logging pretty well covered and they are sufficient if you're happy to only send lc you want to send them to a file? How do you make sure that messages from a particular logger go to a fil and more will be answered as we look into appenders.

Appenders

Loggers are a useful mechanism for filtering messages, but they don't physically write the messages anyw which there are various types. For example, there is the default one that writes messages to the console, several others. You can even create your own appender implementations!

This diagram shows how they fit into the logging pipeline:



As you can see, a single logger may have several appenders attached to it. In a standard Grails configuratic is attached to all loggers through the default root logger configuration. But that's the only one. Adding ı 'appenders' block:

```
log4j = {
    appenders {
        rollingFile name: "myAppender",
                    maxFileSize: 1024,
                    file: "/tmp/logs/myApp.log"
    }
}
```

The following appenders are available by default:

Name	Class	Description
jdbc	JDBCAppender	Logs to a JDBC connection.
console	ConsoleAppender	Logs to the console.
file	FileAppender	Logs to a single file.
rollingFile	RollingFileAppender	Logs to rolling files, for example a new file each day.

Each named argument passed to an appender maps to a property of the underlying Appender implementa `name`, `maxFileSize` and `file` properties of the `RollingFileAppender` instance.

You can have as many appenders as you like - just make sure that they all have unique names. You can ev appender type, for example several file appenders that log to different files.

If you prefer to create the appender programmatically or if you want to use an appender implementation t simply declare an `appender` entry with an instance of the appender you want:

```
import org.apache.log4j.*

log4j = {
    appenders {
        appender new RollingFileAppender(
                name: "myAppender",
                maxFileSize: 1024,
                file: "/tmp/logs/myApp.log")
    }
}
```

This approach can be used to configure `JMSAppender`, `SocketAppender`, `SMTPAppender`, and mo

Once you have declared your extra appenders, you can attach them to specific loggers by passing the methods from the previous section:

```
error myAppender: "grails.app.controllers.BookController"
```

This will ensure that the 'grails.app.controllers.BookController' logger sends log messages to 'myAppend for the root logger. To add more than one appender to the logger, then add them to the same level declarati

```
error myAppender:      "grails.app.controllers.BookController",
      myFileAppender:  ["grails.app.controllers.BookController",
                        "grails.app.services.BookService"],
      rollingFile:     "grails.app.controllers.BookController"
```

The above example also shows how you can configure more than one logger at a time for a given appende

Be aware that you can only configure a single level for a logger, so if you tried this code:

```
error myAppender:      "grails.app.controllers.BookController"
debug myFileAppender:  "grails.app.controllers.BookController"
fatal rollingFile:     "grails.app.controllers.BookController"
```

you'd find that only 'fatal' level messages get logged for 'grails.app.controllers.BookController'. That's bec logger wins. What you probably want to do is limit what level of messages an appender writes.

An appender that is attached to a logger configured with the 'all' level will generate a lot of logging inforn makes working at the console difficult. So we configure the console appender to only write out messages a

```
log4j = {
    appenders {
        console name: "stdout", threshold: org.apache.log4j.Level.INFO
    }
}
```

The key here is the `threshold` argument which determines the cut-off for log messages. This argumen note that you currently have to specify a `Level` instance - a string such as "info" will not work.

Custom Layouts

By default the Log4j DSL assumes that you want to use a PatternLayout. However, there are other layouts

- `xml` - Create an XML log file
- `html` - Creates an HTML log file
- `simple` - A simple textual log
- `pattern` - A Pattern layout

You can specify custom patterns to an appender using the `layout` setting:

```
log4j = {
    appenders {
        console name: "customAppender",
                layout: pattern(conversionPattern: "%c{2} %m%n")
    }
}
```

This also works for the built-in appender "stdout", which logs to the console:

```
log4j = {
    appenders {
        console name: "stdout",
                layout: pattern(conversionPattern: "%c{2} %m%n")
    }
}
```

Environment-specific configuration

Since the logging configuration is inside `Config.groovy`, you can put it inside an environment-speci with this approach: you have to provide the full logging configuration each time you define the `log4` selectively override parts of the configuration - it's all or nothing.

To get around this, the logging DSL provides its own environment blocks that you can put anywhere in the

```
log4j = {
    appenders {
        console name: "stdout",
                layout: pattern(conversionPattern: "%c{2} %m%n")

environments {
            production {
                rollingFile name: "myAppender", maxFileSize: 1024,
                            file: "/tmp/logs/myApp.log"
            }
        }
    }

root {
        //…
    }

// other shared config
    info "grails.app.controller"

environments {
        production {
            // Override previous setting for 'grails.app.controller'
            error "grails.app.controller"
        }
    }
}
```

The one place you can't put an environment block is *inside* the `root` definition, but you can put the r block.

Full stacktraces

When exceptions occur, there can be an awful lot of noise in the stacktrace from Java and Groovy irrelevant details and restricts traces to non-core Grails/Groovy class packages.

When this happens, the full trace is always logged to the `StackTrace` logger, which by defau `stacktrace.log`. As with other loggers though, you can change its behaviour in the configuration. Fo to go to the console, add this entry:

```
error stdout: "StackTrace"
```

This won't stop Grails from attempting to create the stacktrace.log file - it just redirects where stack traces
is to change the location of the 'stacktrace' appender's file:

```
log4j = {
    appenders {
        rollingFile name: "stacktrace", maxFileSize: 1024,
                    file: "/var/tmp/logs/myApp-stacktrace.log"
    }
}
```

or, if you don't want to the 'stacktrace' appender at all, configure it as a 'null' appender:

```
log4j = {
    appenders {
        'null' name: "stacktrace"
    }
}
```

You can of course combine this with attaching the 'stdout' appender to the 'StackTrace' logger if you want

Finally, you can completely disable stacktrace filtering by setting the `grails.full.stacktrace` VM

```
grails -Dgrails.full.stacktrace=true run-app
```

Masking Request Parameters From Stacktrace Logs

When Grails logs a stacktrace, the log message may include the names and values of all of the request
mask out the values of secure request parameters, specify the parameter names in the `grails.except`
config property:

```
grails.exceptionresolver.params.exclude = ['password', 'creditCard']
```

Request parameter logging may be turned off altogether by setting the `grails.exceptionresolve`
property to `false`. The default value is `true` when the application is running in DEVELOPMENT mode

```
grails.exceptionresolver.logRequestParameters=false
```

Logger inheritance

Earlier, we mentioned that all loggers inherit from the root logger and that loggers are hierarchical based
is that unless you override a parent setting, a logger retains the level and the appenders configured for that

```
log4j = {
    appenders {
        file name:'file', file:'/var/logs/mylog.log'
    }
    root {
        debug 'stdout', 'file'
    }
}
```

all loggers in the application will have a level of 'debug' and will log to both the 'stdout' and 'file' appe
'stdout' for a particular logger? Change the 'additivity' for a logger in that case.

Additivity simply determines whether a logger inherits the configuration from its parent. If additivity is f
for all loggers is true, i.e. they inherit the configuration. So how do you change this setting? Here's an exar

```
log4j = {
    appenders {
        …
    }
    root {
        …
    }

info additivity: false
         stdout: ["grails.app.controllers.BookController",
                  "grails.app.services.BookService"]
}
```

So when you specify a log level, add an 'additivity' named argument. Note that you when you specify
loggers for a named appender. The following syntax will *not* work:

```
info additivity: false, ["grails.app.controllers.BookController",
                         "grails.app.services.BookService"]
```

Customizing stack trace printing and filtering

Stacktraces in general and those generated when using Groovy in particular are quite verbose and c
interesting when diagnosing problems. So Grails uses a ir
`org.codehaus.groovy.grails.exceptions.StackTraceFilterer` interface to filter out
the approach used for filtering, implement that interface in a class in src/groovy or src/java and register it i

```
grails.logging.stackTraceFiltererClass =
         'com.yourcompany.yourapp.MyStackTraceFilterer'
```

In addition, Grails customizes the display of the filtered stacktrace to make the information more readal
`org.codehaus.groovy.grails.exceptions.StackTracePrinter` interface in a class in s
`Config.groovy`:

```
grails.logging.stackTracePrinterClass =
         'com.yourcompany.yourapp.MyStackTracePrinter'
```

Finally, to render error information in the error GSP, an HTML-generating printer implementation is n `org.codehaus.groovy.grails.web.errors.ErrorsViewStackTracePrinter` and it's r own implementation, either implement the `org.codehaus.groovy.grails.exceptions.S` subclass `ErrorsViewStackTracePrinter` and register it in `grails-app/conf/spring/reso`

```
import com.yourcompany.yourapp.MyErrorsViewStackTracePrinter

beans = {

errorsViewStackTracePrinter(MyErrorsViewStackTracePrinter,
                                ref('grailsResourceLocator'))
}
```

3.1.3 GORM

Grails provides the following GORM configuration options:

- `grails.gorm.failOnError` - If set to `true`, causes the `save()` method o `grails.validation.ValidationException` if validation fails during a save. This option representing package names. If the value is a list of Strings then the failOnError behavior will only packages (including sub-packages). See the save method docs for more information.

For example, to enable failOnError for all domain classes:

```
grails.gorm.failOnError=true
```

and to enable failOnError for domain classes by package:

```
grails.gorm.failOnError = ['com.companyname.somepackage',
                           'com.companyname.someotherpackage']
```

- `grails.gorm.autoFlush` = If set to `true`, causes the merge, save and delete methods to fl explicitly flush using `save(flush: true)`.

3.2 Environments

Per Environment Configuration

Grails supports the concept of per environment configuration. The `Config.groovy`, `DataSource.` files in the `grails-app/conf` directory can use per-environment configuration using the syntax prov consider the following default `DataSource` definition provided by Grails:

```
dataSource {
    pooled = false
    driverClassName = "org.h2.Driver"
    username = "sa"
    password = ""
}
environments {
    development {
        dataSource {
            dbCreate = "create-drop"
            url = "jdbc:h2:mem:devDb"
        }
    }
    test {
        dataSource {
            dbCreate = "update"
            url = "jdbc:h2:mem:testDb"
        }
    }
    production {
        dataSource {
            dbCreate = "update"
            url = "jdbc:h2:prodDb"
        }
    }
}
```

Notice how the common configuration is provided at the top level and then an `environments` block spe
`dbCreate` and `url` properties of the `DataSource`.

Packaging and Running for Different Environments

Grails' command line has built in capabilities to execute any command within the context of a specific env

```
grails [environment] [command name]
```

In addition, there are 3 preset environments known to Grails: `dev`, `prod`, and `test` for `develop`
example to create a WAR for the `test` environment you wound run:

```
grails test war
```

To target other environments you can pass a `grails.env` variable to any command:

```
grails -Dgrails.env=UAT run-app
```

Programmatic Environment Detection

Within your code, such as in a Gant script or a bootstrap class you can detect the environment using the En

```
import grails.util.Environment

...

switch (Environment.current) {
    case Environment.DEVELOPMENT:
        configureForDevelopment()
        break
    case Environment.PRODUCTION:
        configureForProduction()
        break
}
```

Per Environment Bootstrapping

Its often desirable to run code when your application starts up on a per-environment ba `grails-app/conf/BootStrap.groovy` file's support for per-environment execution:

```
def init = { ServletContext ctx ->
    environments {
        production {
            ctx.setAttribute("env", "prod")
        }
        development {
            ctx.setAttribute("env", "dev")
        }
    }
    ctx.setAttribute("foo", "bar")
}
```

Generic Per Environment Execution

The previous `BootStrap` example uses the `grails.util.Environment` class internally to execu to execute your own environment specific logic:

```
Environment.executeForCurrentEnvironment {
    production {
        // do something in production
    }
    development {
        // do something only in development
    }
}
```

3.3 The DataSource

Since Grails is built on Java technology setting up a data source requires some knowledge of JDBC (the Database Connectivity).

If you use a database other than H2 you need a JDBC driver. For example for MySQL you would need Co

Drivers typically come in the form of a JAR archive. It's best to use Ivy to resolve the jar if it's available i could add a dependency for the MySQL driver like this:

```
grails.project.dependency.resolution = {
    inherits("global")
    log "warn"
    repositories {
        grailsPlugins()
        grailsHome()
        grailsCentral()
        mavenCentral()
    }
    dependencies {
        runtime 'mysql:mysql-connector-java:5.1.16'
    }
}
```

Note that the built-in `mavenCentral()` repository is included here since that's a reliable location for thi

If you can't use Ivy then just put the JAR in your project's `lib` directory.

Once you have the JAR resolved you need to get familiar Grails' DataSourc `grails-app/conf/DataSource.groovy`. This file contains the dataSource definition which inclu

- `driverClassName` - The class name of the JDBC driver
- `username` - The username used to establish a JDBC connection
- `password` - The password used to establish a JDBC connection
- `url` - The JDBC URL of the database
- `dbCreate` - Whether to auto-generate the database from the domain model - one of 'create-drop', 'cr
- `pooled` - Whether to use a pool of connections (defaults to true)
- `logSql` - Enable SQL logging to stdout
- `formatSql` - Format logged SQL
- `dialect` - A String or Class that represents the Hibernate dialect used to communicate with the package for available dialects.
- `readOnly` - If `true` makes the DataSource read-only, which results in the connection pool call `Connection`
- `properties` - Extra properties to set on the DataSource bean. See the [Commons DBCP BasicDataS

A typical configuration for MySQL may be something like:

```
dataSource {
    pooled = true
    dbCreate = "update"
    url = "jdbc:mysql://localhost/yourDB"
    driverClassName = "com.mysql.jdbc.Driver"
    dialect = org.hibernate.dialect.MySQL5InnoDBDialect
    username = "yourUser"
    password = "yourPassword"
}
```

When configuring the DataSource do not include the type or the def keyword before an settings as Groovy will treat these as local variable definitions and they will not be proce following is invalid:

```
dataSource {
    boolean pooled = true // type declaration results in ignored local variable
    …
}
```

Example of advanced configuration using extra properties:

```
dataSource {
    pooled = true
    dbCreate = "update"
    url = "jdbc:mysql://localhost/yourDB"
    driverClassName = "com.mysql.jdbc.Driver"
    dialect = org.hibernate.dialect.MySQL5InnoDBDialect
    username = "yourUser"
    password = "yourPassword"
    properties {
        maxActive = 50
        maxIdle = 25
        minIdle = 5
        initialSize = 5
        minEvictableIdleTimeMillis = 60000
        timeBetweenEvictionRunsMillis = 60000
        maxWait = 10000
        validationQuery = "/* ping */"
    }
}
```

More on dbCreate

Hibernate can automatically create the database tables required for your domain model. You have some through the `dbCreate` property, which can take these values:

- **create** - Drops the existing schemaCreates the schema on startup, dropping existing tables, indexes, e
- **create-drop** - Same as **create**, but also drops the tables when the application shuts down cleanly.
- **update** - Creates missing tables and indexes, and updates the current schema without dropping properly handle many schema changes like column renames (you're left with the old column containi
- **validate** - Makes no changes to your database. Compares the configuration with the existing database
- any other value - does nothing

You can also remove the `dbCreate` setting completely, which is recommended once your schema is rel application and database are deployed in production. Database changes are then managed through proper migration tool like Liquibase (the Database Migration plugin uses Liquibase and is tightly integrated with

3.3.1 DataSources and Environments

The previous example configuration assumes you want the same config for all environments: production, t

Grails' DataSource definition is "environment aware", however, so you can do:

```
dataSource {
    pooled = true
    driverClassName = "com.mysql.jdbc.Driver"
    dialect = org.hibernate.dialect.MySQL5InnoDBDialect
    // other common settings here
}

environments {
    production {
        dataSource {
            url = "jdbc:mysql://liveip.com/liveDb"
            // other environment-specific settings here
        }
    }
}
```

3.3.2 JNDI DataSources

Referring to a JNDI DataSource

Most Java EE containers supply `DataSource` instances via [Java Naming and Directory Interface](#) (JNDI) data sources as follows:

```
dataSource {
    jndiName = "java:comp/env/myDataSource"
}
```

The format on the JNDI name may vary from container to container, but the way you define the `DataSou`

Configuring a Development time JNDI resource

The way in which you configure JNDI data sources at development time is plugin dependent. Using th resources using the `grails.naming.entries` setting in `grails-app/conf/Config.groovy`:

```
grails.naming.entries = [
    "bean/MyBeanFactory": [
        auth: "Container",
        type: "com.mycompany.MyBean",
        factory: "org.apache.naming.factory.BeanFactory",
        bar: "23"
    ],
    "jdbc/EmployeeDB": [
        type: "javax.sql.DataSource", //required
        auth: "Container", // optional
        description: "Data source for Foo", //optional
        driverClassName: "org.h2.Driver",
        url: "jdbc:h2:mem:database",
        username: "dbusername",
        password: "dbpassword",
        maxActive: "8",
        maxIdle: "4"
    ],
    "mail/session": [
        type: "javax.mail.Session,
        auth: "Container",
        "mail.smtp.host": "localhost"
    ]
]
```

3.3.3 Automatic Database Migration

The `dbCreate` property of the `DataSource` definition is important as it dictates what Grails s automatically generating the database tables from GORM classes. The options are described in the DataSo

- `create`
- `create-drop`
- `update`
- `validate`
- no value

In development mode `dbCreate` is by default set to "create-drop", but at some point in development (ar you'll need to stop dropping and re-creating the database every time you start up your server.

It's tempting to switch to `update` so you retain existing data and only update the schema when your support is very conservative. It won't make any changes that could result in data loss, and doesn't detect r left with the old one and will also have the new one.

Grails supports Rails-style migrations via the Database Migration plugin which can be installed by running

```
grails install-plugin database-migration
```

The plugin uses Liquibase and and provides access to all of its functionality, and also has support for GC set by comparing your domain classes to a database).

3.3.4 Transaction-aware DataSource Proxy

The actual `dataSource` bean is wrapped in a transaction-aware proxy so you will be given the conn transaction or Hibernate `Session` if one is active.

If this were not the case, then retrieving a connection from the `dataSource` would be a new connec changes that haven't been committed yet (assuming you have a sensible transaction isolation setting, e.g. R

The "real" unproxied `dataSource` is still available to you if you need access to it; its bean name is `data`

You can access this bean like any other Spring bean, i.e. using dependency injection:

```
class MyService {
def dataSourceUnproxied
    …
}
```

or by pulling it from the `ApplicationContext`:

```
def dataSourceUnproxied = ctx.dataSourceUnproxied
```

3.3.5 Database Console

The [H2 database console](#) is a convenient feature of H2 that provides a web-based interface to any databas it's very useful to view the database you're developing against. It's especially useful when running against a

You can access the console by navigating to **http://localhost:8080/appname/dbconsole** in a browser. `grails.dbconsole.urlRoot` attribute in Config.groovy and defaults to `'/dbconsole'`.

The console is enabled by default in development mode and can be disabled or enabled in `grails.dbconsole.enabled` attribute in Config.groovy. For example you could enable the console

```
environments {
    production {
        grails.serverURL = "http://www.changeme.com"
        grails.dbconsole.enabled = true
        grails.dbconsole.urlRoot = '/admin/dbconsole'
    }
    development {
        grails.serverURL = "http://localhost:8080/${appName}"
    }
    test {
        grails.serverURL = "http://localhost:8080/${appName}"
    }
}
```

If you enable the console in production be sure to guard access to it using a trusted security fra

Configuration

By default the console is configured for an H2 database which will work with the default settings if you ha you just need to change the JDBC URL to `jdbc:h2:mem:devDB`. If you've configured an external da you can use the Saved Settings dropdown to choose a settings template and fill in the url and usern DataSource.groovy.

3.3.6 Multiple Datasources

By default all domain classes share a single `DataSource` and a single database, but you have the optic two or more `DataSources`.

Configuring Additional DataSources

The default `DataSource` configuration in `grails-app/conf/DataSource.groovy` looks somet

```
dataSource {
    pooled = true
    driverClassName = "org.h2.Driver"
    username = "sa"
    password = ""
}
hibernate {
    cache.use_second_level_cache = true
    cache.use_query_cache = true
    cache.provider_class = 'net.sf.ehcache.hibernate.EhCacheProvider'
}

environments {
    development {
        dataSource {
            dbCreate = "create-drop"
            url = "jdbc:h2:mem:devDb"
        }
    }
    test {
        dataSource {
            dbCreate = "update"
            url = "jdbc:h2:mem:testDb"
        }
    }
    production {
        dataSource {
            dbCreate = "update"
            url = "jdbc:h2:prodDb"
        }
    }
}
```

This configures a single `DataSource` with the Spring bean named `dataSource`. To configure `dataSource` block (at the top level, in an environment block, or both, just like the standard `DataSo` separated by an underscore. For example, this configuration adds a second `DataSource`, using MySQ Oracle in production:

```
environments {
    development {
        dataSource {
            dbCreate = "create-drop"
            url = "jdbc:h2:mem:devDb"
        }
        dataSource_lookup {
            dialect = org.hibernate.dialect.MySQLInnoDBDialect
            driverClassName = 'com.mysql.jdbc.Driver'
            username = 'lookup'
            password = 'secret'
            url = 'jdbc:mysql://localhost/lookup'
            dbCreate = 'update'
        }
    }
    test {
        dataSource {
            dbCreate = "update"
            url = "jdbc:h2:mem:testDb"
        }
    }
    production {
        dataSource {
            dbCreate = "update"
            url = "jdbc:h2:prodDb"
        }
        dataSource_lookup {
            dialect = org.hibernate.dialect.Oracle10gDialect
            driverClassName = 'oracle.jdbc.driver.OracleDriver'
            username = 'lookup'
            password = 'secret'
            url = 'jdbc:oracle:thin:@localhost:1521:lookup'
            dbCreate = 'update'
        }
    }
}
```

You can use the same or different databases as long as they're supported by Hibernate.

Configuring Domain Classes

If a domain class has no `DataSource` configuration, it defaults to the standard `'dataSource'`. S `mapping` block to configure a non-default `DataSource`. For example, if you want to use the `Zip` `DataSource`, configure it like this;

```
class ZipCode {

String code

static mapping = {
      datasource 'lookup'
   }
}
```

A domain class can also use two or more `DataSources`. Use the `datasources` property with a list of example:

```
class ZipCode {
String code
static mapping = {
      datasources(['lookup', 'auditing'])
   }
}
```

If a domain class uses the default `DataSource` and one or more others, use the special name `DataSource`:

```
class ZipCode {
String code
static mapping = {
      datasources(['lookup', 'DEFAULT'])
   }
}
```

If a domain class uses all configured `DataSource`s use the special value `'ALL'`:

```
class ZipCode {
String code
static mapping = {
      datasource 'ALL'
   }
}
```

Namespaces and GORM Methods

If a domain class uses more than one `DataSource` then you can use the namespace implied by each `Dat` for a particular `DataSource`. For example, consider this class which uses two `DataSource`s:

```
class ZipCode {
String code
static mapping = {
      datasources(['lookup', 'auditing'])
   }
}
```

The first `DataSource` specified is the default when not using an explicit namespace, so in this case w GORM methods on the 'auditing' `DataSource` with the `DataSource` name, for example:

```
def zipCode = ZipCode.auditing.get(42)
…
zipCode.auditing.save()
```

As you can see, you add the `DataSource` to the method call in both the static case and the instance case.

Services

Like Domain classes, by default Services use the default `DataSource` and `PlatformTransactio` use a different `DataSource`, use the static `datasource` property, for example:

```
class DataService {
static datasource = 'lookup'
void someMethod(...) {
         …
   }
}
```

A transactional service can only use a single `DataSource`, so be sure to only make changes for doma same as the Service.

Note that the datasource specified in a service has no bearing on which datasources are used for dom declared datasources in the domain classes themselves. It's used to declare which transaction manager to us

What you'll see is that if you have a Foo domain class in dataSource1 and a Bar domain class in dataSource1, a service method that saves a new Foo and a new Bar will only be transactional for Foo transaction won't affect the Bar instance. If you want both to be transactional you'd need to use two servi commit, e.g. with the Atomikos plugin.

XA and Two-phase Commit

Grails has no native support for [XA](#) `DataSource`s or [two-phase commit](#), but the [Atomikos plugin](#) make for the simple changes needed in your `DataSource` definitions to reconfigure them as XA `DataSourc`

3.4 Externalized Configuration

Some deployments require that configuration be sourced from more than one place and be changeal application. In order to support deployment scenarios such as these the configuration can be externalized. of the configuration files that should be used by adding a `grails.config.locations` setting in `Co`

```
grails.config.locations = [
    "classpath:${appName}-config.properties",
    "classpath:${appName}-config.groovy",
    "file:${userHome}/.grails/${appName}-config.properties",
    "file:${userHome}/.grails/${appName}-config.groovy" ]
```

In the above example we're loading configuration files (both Java Properties files and [ConfigSlurper](#) conf classpath and files located in `USER_HOME`.

It is also possible to load config by specifying a class that is a config script.

```
grails.config.locations = [com.my.app.MyConfig]
```

This can be useful in situations where the config is either coming from a plugin or some other part of yo re-using configuration provided by plugins across multiple applications.

Ultimately all configuration files get merged into the `config` property of the GrailsApplication object an

Values that have the same name as previously defined values will overwrite the existing values, and th loaded in the order in which they are defined.

Config Defaults

The configuration values contained in the locations described by the `grails.config.locatio` defined in your application `Config.groovy` file which may not be what you want. You may want to h that can be overridden in either your application's `Config.groovy` file or in a named config `grails.config.defaults.locations` property.

This property supports the same values as the `grails.config.locations` property (i.e. paths to c but the config described by `grails.config.defaults.locations` will be loaded *before* a overridden. Some plugins use this mechanism to supply one or more sets of default configuration th application config.

> Grails also supports the concept of property place holders and property override configurers a more information on these see the section on Grails and Spring

3.5 Versioning

Versioning Basics

Grails has built in support for application versioning. The version of the application is set to `0.1` when y create-app command. The version is stored in the application meta data file `application.propertie`

To change the version of your application you can edit the file manually, or run the set-version command:

```
grails set-version 0.2
```

The version is used in various commands including the war command which will append the application file.

Detecting Versions at Runtime

You can detect the application version using Grails' support for application metadata using the Grails/ controllers there is an implicit grailsApplication variable that can be used:

```
def version = grailsApplication.metadata['app.version']
```

You can retrieve the the version of Grails that is running with:

```
def grailsVersion = grailsApplication.metadata['app.grails.version']
```

or the `GrailsUtil` class:

```
import grails.util.GrailsUtil
…
def grailsVersion = GrailsUtil.grailsVersion
```

3.6 Project Documentation

Since Grails 1.2, the documentation engine that powers the creation of this documentation has been availal

The documentation engine uses a variation on the Textile syntax to automatically create project documenta

Creating project documentation

To use the engine you need to follow a few conventions. First, you need to create a `src/docs/guid` source files will go. Then, you need to create the source docs themselves. Each chapter should have its sub-sections. You will end up with something like:

```
+ src/docs/guide/introduction.gdoc
+ src/docs/guide/introduction/changes.gdoc
+ src/docs/guide/gettingStarted.gdoc
+ src/docs/guide/configuration.gdoc
+ src/docs/guide/configuration/build.gdoc
+ src/docs/guide/configuration/build/controllers.gdoc
```

Note that you can have all your gdoc files in the top-level directory if you want, but you can also put sub- the parent section - as the above example shows.

Once you have your source files, you still need to tell the documentation engine what the structure of you you add a `src/docs/guide/toc.yml` file that contains the structure and titles for each section. Thi represents the structure of the user guide in tree form. For example, the above files could be represented as

```
introduction:
  title: Introduction
  changes: Change Log
gettingStarted: Getting Started
configuration:
  title: Configuration
  build:
    title: Build Config
    controllers: Specifying Controllers
```

The format is pretty straightforward. Any section that has sub-sections is represented with the corr extension) followed by a colon. The next line should contain `title:` plus the title of the section as seen has its own line after the title. Leaf nodes, i.e. those without any sub-sections, declare their title on the san colon.

That's it. You can easily add, remove, and move sections within the `toc.yml` to restructure the generated that all section names, i.e. the gdoc filenames, should be unique since they are used for creating internal li worry though, the documentation engine will warn you of duplicate section names.

Creating reference items

Reference items appear in the Quick Reference section of the documentation. Each reference item bel directory located in the `src/docs/ref` directory. For example, suppose you have defined a new contr belongs to the `Controllers` category so you would create a gdoc text file at the following location:

```
+ src/docs/ref/Controllers/renderPDF.gdoc
```

Configuring Output Properties

There are various properties you can set within your `grails-app/conf/Config.groovy` f documentation such as:

- **grails.doc.authors** - The authors of the documentation
- **grails.doc.license** - The license of the software
- **grails.doc.copyright** - The copyright message to display
- **grails.doc.footer** - The footer to use

Other properties such as the name of the documentation and the version are pulled from your project itself.

Generating Documentation

Once you have created some documentation (refer to the syntax guide in the next chapter) you c documentation using the command:

```
grails doc
```

This command will output an `docs/manual/index.html` which can be opened in a browser to view

Documentation Syntax

As mentioned the syntax is largely similar to Textile or Confluence style wiki markup. The following basics.

Basic Formatting

Monospace: `monospace`

```
@monospace@
```

Italic: *italic*

```
_italic_
```

Bold: **bold**

```
*bold*
```

Image:

```
!http://grails.org/images/new/grailslogo_topNav.png!
```

Linking

There are several ways to create links with the documentation generator. A basic external link can either style markup:

```
[SpringSource|http://www.springsource.com/]
```

or

```
"SpringSource":http://www.springsource.com/
```

For links to other sections inside the user guide you can use the `guide:` prefix with the name of the sectio

```
[Intro|guide:introduction]
```

The section name comes from the corresponding gdoc filename. The documentation engine will warn yo break.

To link to reference items you can use a special syntax:

```
[controllers|renderPDF]
```

In this case the category of the reference item is on the left hand side of the | and the name of the reference

Finally, to link to external APIs you can use the `api:` prefix. For example:

```
[String|api:java.lang.String]
```

The documentation engine will automatically create the appropriate javadoc link in this case. To add … configure them in `grails-app/conf/Config.groovy`. For example:

```
grails.doc.api.org.hibernate=
            "http://docs.jboss.org/hibernate/stable/core/javadocs"
```

The above example configures classes within the `org.hibernate` package to link to the Hibernate web

Lists and Headings

Headings can be created by specifying the letter 'h' followed by a number and then a dot:

```
h3.<space>Heading3
h4.<space>Heading4
```

Unordered lists are defined with the use of the * character:

```
* item 1
** subitem 1
** subitem 2
* item 2
```

Numbered lists can be defined with the # character:

```
# item 1
```

Tables can be created using the `table` macro:

Name	Number
Albert	46
Wilma	1348
James	12

```
{table}
 *Name* | *Number*
 Albert | 46
 Wilma | 1348
 James | 12
{table}
```

Code and Notes

You can define code blocks with the `code` macro:

```
class Book {
    String title
}
```

```
{code}
class Book {
    String title
}
{code}
```

The example above provides syntax highlighting for Java and Groovy code, but you can also highlight XM

```
<hello>world</hello>
```

```
{code:xml}
<hello>world</hello>
{code}
```

There are also a couple of macros for displaying notes and warnings:

Note:

> This is a note!

```
{note}
This is a note!
{note}
```

Warning:

> This is a warning!

```
{warning}
This is a warning!
{warning}
```

3.7 Dependency Resolution

Grails features a dependency resolution DSL that lets you control how plugins and JAR dependencies are r

You specify a `grails.project.dependency.resolution` property inside the `grails-app/`
that configures how dependencies are resolved:

```
grails.project.dependency.resolution = {
   // config here
}
```

The default configuration looks like the following:

```
grails.project.class.dir = "target/classes"
grails.project.test.class.dir = "target/test-classes"
grails.project.test.reports.dir = "target/test-reports"
//grails.project.war.file = "target/${appName}-${appVersion}.war"

grails.project.dependency.resolution = {
    // inherit Grails' default dependencies
    inherits("global") {
        // uncomment to disable ehcache
        // excludes 'ehcache'
    }
    log "warn"
    repositories {
        grailsPlugins()
        grailsHome()
        grailsCentral()

// uncomment these to enable remote dependency resolution
        // from public Maven repositories
        //mavenCentral()
        //mavenLocal()
        //mavenRepo "http://snapshots.repository.codehaus.org"
        //mavenRepo "http://repository.codehaus.org"
        //mavenRepo "http://download.java.net/maven/2/"
        //mavenRepo "http://repository.jboss.com/maven2/"
    }
    dependencies {
        // specify dependencies here under either 'build', 'compile',
        // 'runtime', 'test' or 'provided' scopes eg.

// runtime 'mysql:mysql-connector-java:5.1.16'
    }

plugins {
        compile ":hibernate:$grailsVersion"
        compile ":jquery:1.6.1.1"
        compile ":resources:1.0"

build ":tomcat:$grailsVersion"
    }
}
```

The details of the above will be explained in the next few sections.

3.7.1 Configurations and Dependencies

Grails features five dependency resolution configurations (or 'scopes'):

- `build`: Dependencies for the build system only
- `compile`: Dependencies for the compile step
- `runtime`: Dependencies needed at runtime but not for compilation (see above)
- `test`: Dependencies needed for testing but not at runtime (see above)
- `provided`: Dependencies needed at development time, but not during WAR deployment

Within the `dependencies` block you can specify a dependency that falls into one of these configuration example if your application requires the MySQL driver to function at `runtime` you can specify that like t

```
runtime 'com.mysql:mysql-connector-java:5.1.16'
```

This uses the string syntax: `group:name:version`. You can also use a Map-based syntax:

```
runtime group: 'com.mysql',
        name: 'mysql-connector-java',
        version: '5.1.16'
```

In Maven terminology, `group` corresponds to an artifact's `groupId` and `name` corresponds to its `artif`

Multiple dependencies can be specified by passing multiple arguments:

```
runtime 'com.mysql:mysql-connector-java:5.1.16',
        'net.sf.ehcache:ehcache:1.6.1'

// Or

runtime(
    [group:'com.mysql', name:'mysql-connector-java', version:'5.1.16'],
    [group:'net.sf.ehcache', name:'ehcache', version:'1.6.1']
)
```

Disabling transitive dependency resolution

By default, Grails will not only get the JARs and plugins that you declare, but it will also get their transit you want, but there are occasions where you want a dependency without all its baggage. In such cases, resolution on a case-by-case basis:

```
runtime('com.mysql:mysql-connector-java:5.1.16',
        'net.sf.ehcache:ehcache:1.6.1') {
    transitive = false
}

// Or
runtime group:'com.mysql',
        name:'mysql-connector-java',
        version:'5.1.16',
        transitive:false
```

Excluding specific transitive dependencies

A far more common scenario is where you want the transitive dependencies, but some of them cause issu unnecessary. For example, many Apache projects have 'commons-logging' as a transitive dependency, b project (we use SLF4J). That's where the `excludes` option comes in:

```
runtime('com.mysql:mysql-connector-java:5.1.16',
        'net.sf.ehcache:ehcache:1.6.1') {
    excludes "xml-apis", "commons-logging"
}

// Or
runtime(group:'com.mysql', name:'mysql-connector-java', version:'5.1.16') {
    excludes([ group: 'xml-apis', name: 'xml-apis'],
             [ group: 'org.apache.httpcomponents' ],
             [ name: 'commons-logging' ])
```

As you can see, you can either exclude dependencies by their artifact ID (also known as a module name) o IDs (if you use the Map notation). You may also come across `exclude` as well, but that can only accept a

```
runtime('com.mysql:mysql-connector-java:5.1.16',
        'net.sf.ehcache:ehcache:1.6.1') {
    exclude "xml-apis"
}
```

Using Ivy module configurations

If you use Ivy module configurations and wish to depend on a specific configuration `dependencyConfiguration` method to specify the configuration to use.

```
provided("my.org:web-service:1.0") {
    dependencyConfiguration "api"
}
```

If the dependency configuration is not explicitly set, the configuration named `"default"` will be use dependencies coming from Maven style repositories).

3.7.2 Dependency Repositories

Remote Repositories

Initially your BuildConfig.groovy does not use any remote public Maven repositories. There is a default locate the JAR files Grails needs from your Grails installation. To use a public repository, specify it in the

```
repositories {
    mavenCentral()
}
```

In this case the default public Maven repository is specified. To use the SpringSource Enterprise Bund
method:

```
repositories {
    ebr()
}
```

You can also specify a specific Maven repository to use by URL:

```
repositories {
    mavenRepo "http://repository.codehaus.org"
}
```

Controlling Repositories Inherited from Plugins

A plugin you have installed may define a reference to a remote repository just as an application can. By c
repository definition when you install the plugin.

If you do not wish to inherit repository definitions from plugins then you can disable repository inheritance

```
repositories {
    inherit false
}
```

In this case your application will not inherit any repository definitions from plugins and it is down to
internal) repository definitions.

Local Resolvers

If you do not wish to use a public Maven repository you can specify a flat file repository:

```
repositories {
    flatDir name:'myRepo', dirs:'/path/to/repo'
}
```

To specify your local Maven cache (`~/.m2/repository`) as a repository:

```
repositories {
    mavenLocal()
}
```

Custom Resolvers

If all else fails since Grails builds on Apache Ivy you can specify an Ivy resolver:

```
/*
 * Configure our resolver.
 */
def libResolver = new org.apache.ivy.plugins.resolver.URLResolver()
['libraries', 'builds'].each {

libResolver.addArtifactPattern(
            "http://my.repository/${it}/" +
            "[organisation]/[module]/[revision]/[type]s/[artifact].[ext]")

libResolver.addIvyPattern(
            "http://my.repository/${it}/" +
            "[organisation]/[module]/[revision]/[type]s/[artifact].[ext]")
}

libResolver.name = "my-repository"
libResolver.settings = ivySettings

resolver libResolver
```

It's also possible to pull dependencies from a repository using SSH. Ivy comes with a dedicated resolver
your project like so:

```
import org.apache.ivy.plugins.resolver.SshResolver
…
repositories {
    ...

def sshResolver = new SshResolver(
            name: "myRepo",
            user: "username",
            host: "dev.x.com",
            keyFile: new File("/home/username/.ssh/id_rsa"),
            m2compatible: true)

sshResolver.addArtifactPattern(
            "/home/grails/repo/[organisation]/[artifact]/" +
            "[revision]/[artifact]-[revision].[ext]")

sshResolver.latestStrategy =
            new org.apache.ivy.plugins.latest.LatestTimeStrategy()

sshResolver.changingPattern = ".*SNAPSHOT"

sshResolver.setCheckmodified(true)

resolver sshResolver
}
```

Download the JSch JAR and add it to Grails' classpath to use the SSH resolver. You can do this by passing

```
grails -classpath /path/to/jsch compile|run-app|etc.
```

You can also add its path to the `CLASSPATH` environment variable but be aware this it affects many Java
to create an alias for `grails -classpath ...` so that you don't have to type the extra arguments eac

Authentication

If your repository requires authentication you can configure this using a `credentials` block:

```
credentials {
    realm = ".."
    host = "localhost"
    username = "myuser"
    password = "mypass"
}
```

This can be placed in your `USER_HOME/.grails/settings.groovy` file using the `grails.` setting:

```
grails.project.ivy.authentication = {
    credentials {
        realm = ".."
        host = "localhost"
        username = "myuser"
        password = "mypass"
    }
}
```

3.7.3 Debugging Resolution

If you are having trouble getting a dependency to resolve you can enable more verbose debugging fron method:

```
// log level of Ivy resolver, either 'error', 'warn',
// 'info', 'debug' or 'verbose'
log "warn"
```

3.7.4 Inherited Dependencies

By default every Grails application inherits several framework dependencies. This is done through the line

```
inherits "global"
```

Inside the `BuildConfig.groovy` file. To exclude specific inherited dependencies you use the `excluc`

```
inherits("global") {
    excludes "oscache", "ehcache"
}
```

3.7.5 Providing Default Dependencies

Most Grails applications have runtime dependencies on several jar files that are provided by the Grails f Spring, Sitemesh, Hibernate etc. When a war file is created, all of these dependencies will be included i exclude these jar files from the war. This is useful when the jar files will be provided by the container, as Grails applications are deployed to the same container.

The dependency resolution DSL provides a mechanism to express that all of the default dependencies wi
done by invoking the `defaultDependenciesProvided` method and passing `true` as an argument:

```
grails.project.dependency.resolution = {

defaultDependenciesProvided true // all of the default dependencies will
                                 // be "provided" by the container

inherits "global" // inherit Grails' default dependencies

repositories {
        grailsHome()
        …
    }
    dependencies {
        …
    }
}
```

> ⚠ `defaultDependenciesProvided` must come before `inherits`, otherwise the Grail
> included in the war.

3.7.6 Dependency Reports

As mentioned in the previous section a Grails application consists of dependencies inherited from the fr
application dependencies itself.

To obtain a report of an application's dependencies you can run the dependency-report command:

```
grails dependency-report
```

By default this will generate reports in the `target/dependency-report` directory. You can specify
a report for by passing an argument containing the configuration name:

```
grails dependency-report runtime
```

3.7.7 Plugin JAR Dependencies

Specifying Plugin JAR dependencies

The way in which you specify dependencies for a plugin is identical to how you specify dependencie
installed into an application the application automatically inherits the dependencies of the plugin.

To define a dependency that is resolved for use with the plugin but not *exported* to the application then y
dependency:

```
test('org.spockframework:spock-core:0.5-groovy-1.8') {
    export = false
}
```

In this case the Spock dependency will be available only to the plugin and not resolved as an applicatio
using the Map syntax:

```
test group: 'org.spockframework', name: 'spock-core',
     version: '0.5-groovy-1.8', export: false
```

> You can use `exported = false` instead of `export = false`, but we recommend
> consistent with the Map argument.

Overriding Plugin JAR Dependencies in Your Application

If a plugin is using a JAR which conflicts with another plugin, or an application dependency then you
dependencies inside an application using exclusions. For example:

```
plugins {
    compile(":hibernate:$grailsVersion") {
        excludes "javassist"
    }
}

dependencies {
    runtime "javassist:javassist:3.4.GA"
}
```

In this case the application explicitly declares a dependency on the "hibernate" plugin and specifies an ex
effectively excluding the javassist library as a dependency.

3.7.8 Maven Integration

When using the Grails Maven plugin, Grails' dependency resolution mechanics are disabled as it is assun
with Maven's `pom.xml` file.

However, if you would like to continue using Grails regular commands like run-app, test-app and so on th
load dependencies from the Maven `pom.xml` file instead.

To do so simply add the following line to your `BuildConfig.groovy`:

```
grails.project.dependency.resolution = {
    pom true
    ..
}
```

The line `pom true` tells Grails to parse Maven's `pom.xml` and load dependencies from there.

3.7.9 Deploying to a Maven Repository

If you use Maven to build your Grails project, you can use the standard Maven targets `mvn instal`
deploy a Grails project or plugin to a Maven repository using the maven-publisher plugin.

The plugin provides the ability to publish Grails projects and plugins to local and remote Maven repositori
added by the plugin:

- **maven-install** - Installs a Grails project or plugin into your local Maven cache
- **maven-deploy** - Deploys a Grails project or plugin to a remote Maven repository

By default this plugin will automatically generate a valid `pom.xml` for you unless a `pom.xml` is alrea
which case this `pom.xml` file will be used.

maven-install

The `maven-install` command will install the Grails project or plugin artifact into your local Maven ca

```
grails maven-install
```

In the case of plugins, the plugin zip file will be installed, whilst for application the application WAR file v

maven-deploy

The `maven-deploy` command will deploy a Grails project or plugin into a remote Maven repository:

```
grails maven-deploy
```

It is assumed that you have specified the necessary `<distributionManagement>` configuration witl
`id` of the remote repository to deploy to:

```
grails maven-deploy --repository=myRepo
```

The `repository` argument specifies the 'id' for the repository. Configure the details of the reposit
`grails-app/conf/BuildConfig.groovy` file or in your `$USER_HOME/.grails/settings`

```
grails.project.dependency.distribution = {
    localRepository = "/path/to/my/local"
    remoteRepository(id: "myRepo", url: "http://myserver/path/to/repo")
}
```

The syntax for configuring remote repositories matches the syntax from the remoteRepository element in
following XML:

```
<remoteRepository id="myRepo" url="scp://localhost/www/repository">
    <authentication username="..." privateKey="${user.home}/.ssh/id_dsa"/>
</remoteRepository>
```

Can be expressed as:

```
remoteRepository(id: "myRepo", url: "scp://localhost/www/repository") {
    authentication username: "...", privateKey: "${userHome}/.ssh/id_dsa"
}
```

By default the plugin will try to detect the protocol to use from the URL of the repository (ie "http" from
different protocol you can do:

```
grails maven-deploy --repository=myRepo --protocol=webdav
```

The available protocols are:

- http
- scp
- scpexe
- ftp
- webdav

Groups, Artifacts and Versions

Maven defines the notion of a 'groupId', 'artifactId' and a 'version'. This plugin pulls this information f
plugin descriptor.

Projects

For applications this plugin will use the Grails application name and version provided by Grails when ge
the version you can run the `set-version` command:

```
grails set-version 0.2
```

The Maven `groupId` will be the same as the project name, unless you specify a different one in Config.g

```
grails.project.groupId="com.mycompany"
```

Plugins

With a Grails plugin the `groupId` and `version` are taken from the following properties in the *GrailsPl

```
String groupId = 'myOrg'
String version = '0.1'
```

The 'artifactId' is taken from the plugin name. For example if you have a plugin called `FeedsGrail` "feeds". If your plugin does not specify a `groupId` then this defaults to "org.grails.plugins".

3.7.10 Plugin Dependencies

As of Grails 1.3 you can declaratively specify plugins as dependencies via the dependency DSL instead of

```
grails.project.dependency.resolution = {
    …
    repositories {
        …
    }
plugins {
        runtime ':hibernate:1.2.1'
    }
dependencies {
        …
    }
    …
}
```

If you don't specify a group id the default plugin group id of `org.grails.plugins` is used. You ca particular plugin by using "latest.integration" as the version number:

```
plugins {
    runtime ':hibernate:latest.integration'
}
```

Integration vs. Release

The "latest.integration" version label will also include resolving snapshot versions. To not include snapsh label:

```
plugins {
    runtime ':hibernate:latest.release'
}
```

> The "latest.release" label only works with Maven compatible repositories. If you have a reg repository then you should use "latest.integration".

And of course if you use a Maven repository with an alternative group id you can specify a group id:

```
plugins {
    runtime 'mycompany:hibernate:latest.integration'
}
```

Plugin Exclusions

You can control how plugins transitively resolves both plugin and JAR dependencies using exclusions. Fo

```
plugins {
    runtime(':weceem:0.8') {
        excludes "searchable"
    }
}
```

Here we have defined a dependency on the "weceem" plugin which transitively depends on the "search method you can tell Grails *not* to transitively install the searchable plugin. You can combine this techniqu plugin:

```
plugins {
    runtime(':weceem:0.8') {
        excludes "searchable" // excludes most recent version
    }
    runtime ':searchable:0.5.4' // specifies a fixed searchable version
}
```

You can also completely disable transitive plugin installs, in which case no transitive dependencies will be

```
plugins {
    runtime(':weceem:0.8') {
        transitive = false
    }
    runtime ':searchable:0.5.4' // specifies a fixed searchable version
}
```

4 The Command Line

Grails' command line system is built on Gant - a simple Groovy wrapper around Apache Ant.

However, Grails takes it further through the use of convention and the `grails` command. When you type

```
grails [command name]
```

Grails searches in the following directories for Gant scripts to execute:

- `USER_HOME/.grails/scripts`
- `PROJECT_HOME/scripts`
- `PROJECT_HOME/plugins/*/scripts`
- `GRAILS_HOME/scripts`

Grails will also convert command names that are in lower case form such as run-app into camel case. So ty

```
grails run-app
```

Results in a search for the following files:

- `USER_HOME/.grails/scripts/RunApp.groovy`
- `PROJECT_HOME/scripts/RunApp.groovy`
- `PLUGINS_HOME/*/scripts/RunApp.groovy`
- `GLOBAL_PLUGINS_HOME/*/scripts/RunApp.groovy`
- `GRAILS_HOME/scripts/RunApp.groovy`

If multiple matches are found Grails will give you a choice of which one to execute.

When Grails executes a Gant script, it invokes the "default" target defined in that script. If there is no defau

To get a list of all commands and some help about the available commands type:

```
grails help
```

which outputs usage instructions and the list of commands Grails is aware of:

```
Usage (optionals marked with *):
grails [environment]* [target] [arguments]*

Examples:
grails dev run-app
grails create-app books

Available Targets (type grails help 'target-name' for more info):
grails bootstrap
grails bug-report
grails clean
grails compile
...
```

> Refer to the Command Line reference in the Quick Reference menu of the reference guide about individual commands

It's often useful to provide custom arguments to the JVM when running Grails commands, in particul example want to set a higher maximum heap size. The Grails command will use any JVM options environment variable, but you can also specify a Grails-specific environment variable too:

```
export GRAILS_OPTS="-Xmx1G -Xms256m -XX:MaxPermSize=256m"
grails run-app
```

non-interactive mode

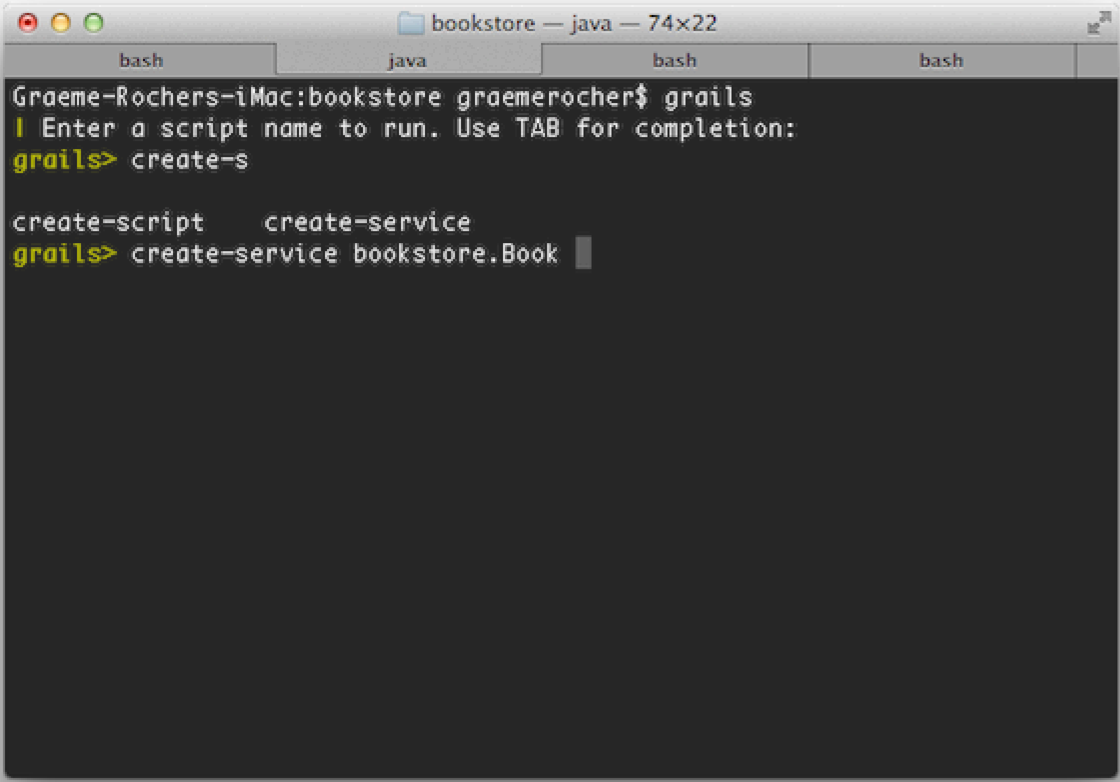
When you run a script manually and it prompts you for information, you can answer the questions and co run a script as part of an automated process, for example a continuous integration build server, there's no can pass the `--non-interactive` switch to the script command to tell Grails to accept the default whether to install a missing plugin.

For example:

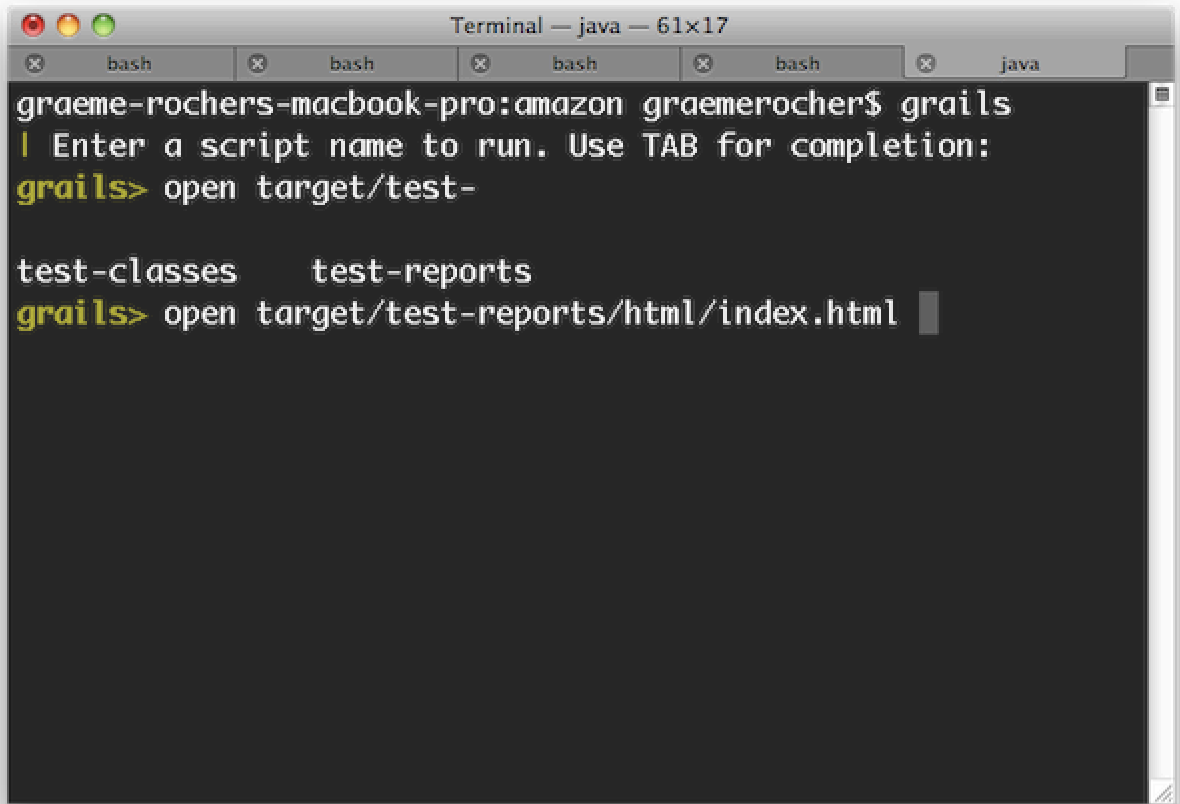
```
grails war --non-interactive
```

4.1 Interactive Mode

Interactive mode is the a feature of the Grails command line which keeps the JVM running and allows f activate interactive mode type 'grails' at the command line and then use TAB completion to get a list of co

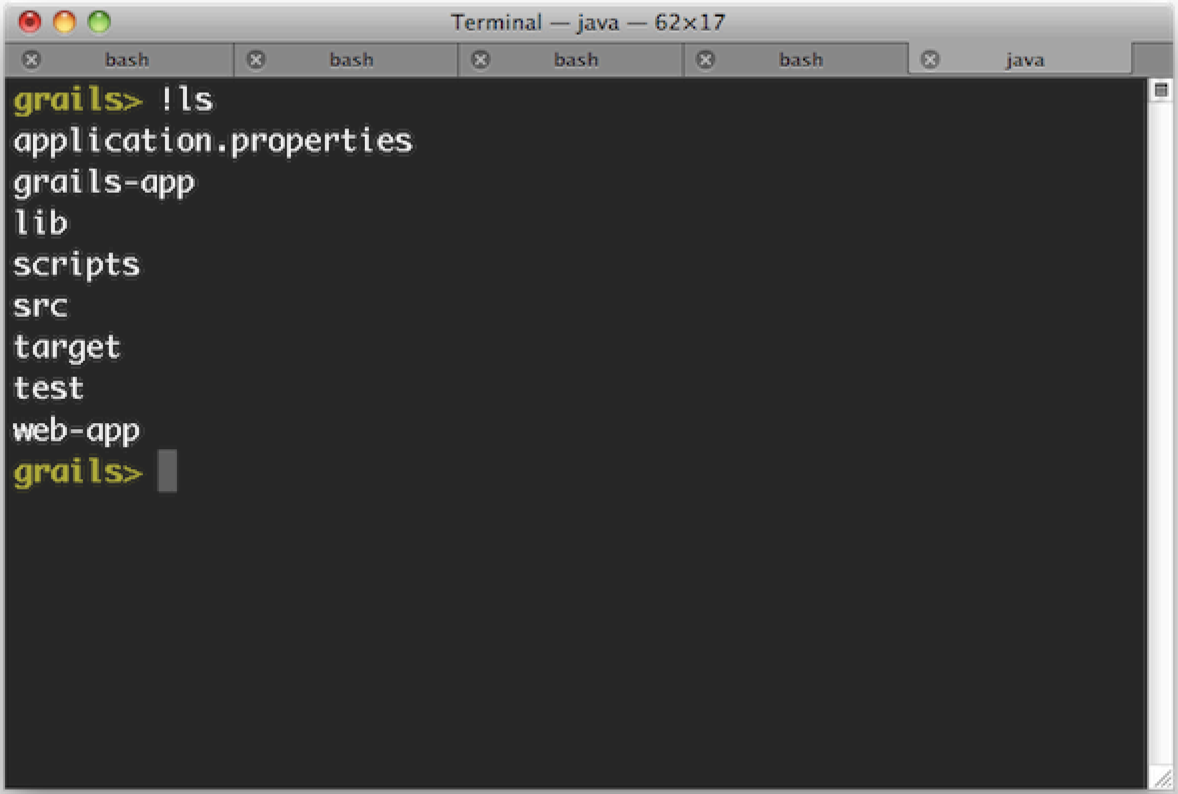


If you need to open a file whilst within interactive mode you can use the `open` command which will TAB



TAB completion also works for class names after the `create-*` commands:

If you need to run an external process whilst interactive mode is running you can do so by starting the com



4.2 Creating Gant Scripts

You can create your own Gant scripts by running the create-script command from the root of your project.

```
grails create-script compile-sources
```

Will create a script called `scripts/CompileSources.groovy`. A Gant script itself is similar to supports the concept of "targets" and dependencies between them:

```
target(default:"The default target is the one that gets executed by Grails") {
    depends(clean, compile)
}
target(clean:"Clean out things") {
    ant.delete(dir:"output")
}
target(compile:"Compile some sources") {
    ant.mkdir(dir:"mkdir")
    ant.javac(srcdir:"src/java", destdir:"output")
}
```

As demonstrated in the script above, there is an implicit `ant` variable (an instance of `groovy.util.A`
Apache Ant API.

In previous versions of Grails (1.0.3 and below), the variable was `Ant`, i.e. with a capital first

You can also "depend" on other targets using the `depends` method demonstrated in the `default` target

The default target

In the example above, we specified a target with the explicit name "default". This is one way of defir alternative approach is to use the `setDefaultTarget()` method:

```
target("clean-compile": "Performs a clean compilation on the app source") {
    depends(clean, compile)
}

target(clean:"Clean out things") {
    ant.delete(dir:"output")
}

target(compile:"Compile some sources") {
    ant.mkdir(dir:"mkdir")
    ant.javac(srcdir:"src/java", destdir:"output")
}

setDefaultTarget("clean-compile")
```

This lets you call the default target directly from other scripts if you wish. Also, although we have put tl the end of the script in this example, it can go anywhere as long as it comes *after* the target it refers to ("cl

Which approach is better? To be honest, you can use whichever you prefer - there don't seem to be any thing we would say is that if you want to allow other scripts to call your "default" target, you should move a default target at all. We'll talk some more about this in the next section.

4.3 Re-using Grails scripts

Grails ships with a lot of command line functionality out of the box that you may find useful in you reference in the reference guide for info on all the commands). Of particular use are the compile, package a

The bootstrap script for example lets you bootstrap a Spring ApplicationContext instance to get acc integration tests use this):

```
includeTargets << grailsScript("_GrailsBootstrap")

target ('default': "Database stuff") {
    depends(configureProxy, packageApp, classpath, loadApp, configureApp)

Connection c
    try {
        c = appCtx.getBean('dataSource').getConnection()
        // do something with connection
    }
    finally {
        c?.close()
    }
}
```

Pulling in targets from other scripts

Gant lets you pull in all targets (except "default") from another Gant script. You can then depend upon or defined in the current script. The mechanism for doing this is the `includeTargets` property. Simply left-shift operator:

```
includeTargets << new File("/path/to/my/script.groovy")
includeTargets << gant.tools.Ivy
```

Don't worry too much about the syntax using a class, it's quite specialised. If you're interested, look into th

Core Grails targets

As you saw in the example at the beginning of this section, you use neither the File- nor the class-based including core Grails targets. Instead, you should use the special `grailsScript()` method that is pro (note that this is not available in normal Gant scripts, just Grails ones).

The syntax for the `grailsScript()` method is pretty straightforward: simply pass it the name of the G information. Here is a list of Grails scripts that you could reuse:

Script	Description
_GrailsSettings	You really should include this! Fortunately, it is included automatically by all other you usually don't have to include it explicitly.
_GrailsEvents	Include this to fire events. Adds an `event(String eventName, List args` all other Grails scripts.
_GrailsClasspath	Configures compilation, test, and runtime classpaths. If you want to use or play included by almost all other Grails scripts.
_GrailsProxy	If you don't have direct access to the internet and use a proxy, include this script to co
_GrailsArgParsing	Provides a `parseArguments` target that does what it says on the tin: parses the they run your script. Adds them to the `argsMap` property.
_GrailsTest	Contains all the shared test code. Useful if you want to add any extra tests.
_GrailsRun	Provides all you need to run the application in the configured servlet container, either or from a WAR file (`runWar`/`runWarHttps`).

There are many more scripts provided by Grails, so it is worth digging into the scripts themselves to find Anything that starts with an " *" is designed for reuse.*

Script architecture

You maybe wondering what those underscores are doing in the names of the Grails scripts. That is Gra _internal , or in other words that it has not corresponding "command". So you can't run "grails _grails-s they don't have a default target.

Internal scripts are all about code sharing and reuse. In fact, we recommend you take a similar approach i into an internal script that can be easily shared, and provide simple command scripts that parse any comm targets in the internal script. For example if you have a script that runs some functional tests, you can split

```
./scripts/FunctionalTests.groovy:

includeTargets << new File("${basedir}/scripts/_FunctionalTests.groovy")

target(default: "Runs the functional tests for this project.") {
    depends(runFunctionalTests)
}

./scripts/_FunctionalTests.groovy:

includeTargets << grailsScript("_GrailsTest")

target(runFunctionalTests: "Run functional tests.") {
    depends(...)
    …
}
```

Here are a few general guidelines on writing scripts:

- Split scripts into a "command" script and an internal one.
- Put the bulk of the implementation in the internal script.
- Put argument parsing into the "command" script.
- To pass arguments to a target, create some script variables and initialise them before calling the target
- Avoid name clashes by using closures assigned to script variables instead of targets. You can then pas

4.4 Hooking into Events

Grails provides the ability to hook into scripting events. These are events triggered during execution of Gra

The mechanism is deliberately simple and loosely specified. The list of possible events is not fixed in a events triggered by plugin scripts, for which there is no equivalent event in the core target scripts.

Defining event handlers

Event handlers are defined in scripts called `_Events.groovy`. Grails searches for these scripts in the fo

- `USER_HOME/.grails/scripts` - user-specific event handlers
- `PROJECT_HOME/scripts` - applicaton-specific event handlers
- `PLUGINS_HOME/*/scripts` - plugin-specific event handlers
- `GLOBAL_PLUGINS_HOME/*/scripts` - event handlers provided by global plugins

Whenever an event is fired, *all* the registered handlers for that event are executed. Note that the automatically by Grails, so you just need to declare them in the relevant `_Events.groovy` file.

Event handlers are blocks defined in `_Events.groovy`, with a name beginning with "event". The /scripts directory to demonstrate the feature:

```
eventCreatedArtefact = { type, name ->
   println "Created $type $name"
}

eventStatusUpdate = { msg ->
   println msg
}

eventStatusFinal = { msg ->
   println msg
}
```

You can see here the three handlers `eventCreatedArtefact`, `eventStatusUpdate`, `eventS` standard events, which are documented in the command line reference guide. For example the compile cor

- `CompileStart` - Called when compilation starts, passing the kind of compile - source or tests
- `CompileEnd` - Called when compilation is finished, passing the kind of compile - source or tests

Triggering events

To trigger an event simply include the Init.groovy script and call the event() closure:

```
includeTargets << grailsScript("_GrailsEvents")

event("StatusFinal", ["Super duper plugin action complete!"])
```

Common Events

Below is a table of some of the common events that can be leveraged:

Event	Parameters	Description
StatusUpdate	message	Passed a string indicating current script status/progress
StatusError	message	Passed a string indicating an error message from the current
StatusFinal	message	Passed a string indicating the final script status message, i.e. target does not exit the scripting environment
CreatedArtefact	artefactType,artefactName	Called when a create-xxxx script has completed and created
CreatedFile	fileName	Called whenever a project source filed is created, not includi
Exiting	returnCode	Called when the scripting environment is about to exit cleanl
PluginInstalled	pluginName	Called after a plugin has been installed
CompileStart	kind	Called when compilation starts, passing the kind of compile
CompileEnd	kind	Called when compilation is finished, passing the kind of con
DocStart	kind	Called when documentation generation is about to start - jav
DocEnd	kind	Called when documentation generation has ended - javadoc
SetClasspath	rootLoader	Called during classpath initialization so plugins rootLoader.addURL(...). Note that this augments the class you cannot use this to load a class that your event script nee if you load the class by name.
PackagingEnd	none	Called at the end of packaging (which is called prior to the web.xml is generated)

4.5 Customising the build

Grails is most definitely an opinionated framework and it prefers convention to configuration, but this doe section, we look at how you can influence and modify the standard Grails build.

The defaults

The core of the Grails build configuration is the `grails.util.BuildSettings` class, which conta controls where classes are compiled to, what dependencies the application has, and other such settings.

Here is a selection of the configuration options and their default values:

Property	Config option	Default value
grailsWorkDir	grails.work.dir	$USER_HOME/.grails/<grailsVersion>
projectWorkDir	grails.project.work.dir	<grailsWorkDir>/projects/<baseDirName>
classesDir	grails.project.class.dir	<projectWorkDir>/classes
testClassesDir	grails.project.test.class.dir	<projectWorkDir>/test-classes
testReportsDir	grails.project.test.reports.dir	<projectWorkDir>/test/reports
resourcesDir	grails.project.resource.dir	<projectWorkDir>/resources
projectPluginsDir	grails.project.plugins.dir	<projectWorkDir>/plugins
globalPluginsDir	grails.global.plugins.dir	<grailsWorkDir>/global-plugins
verboseCompile	grails.project.compile.verbose	`false`

The `BuildSettings` class has some other properties too, but they should be treated as read-only:

Property	Description
baseDir	The location of the project.
userHome	The user's home directory.
grailsHome	The location of the Grails installation in use (may be `null`).
grailsVersion	The version of Grails being used by the project.
grailsEnv	The current Grails environment.
compileDependencies	A list of compile-time project dependencies as `File` instances.
testDependencies	A list of test-time project dependencies as `File` instances.
runtimeDependencies	A list of runtime-time project dependencies as `File` instances.

Of course, these properties aren't much good if you can't get hold of them. Fortunately that's easy to dc available to your scripts as the `grailsSettings` script variable. You can also access `grails.util.BuildSettingsHolder` class, but this isn't recommended.

Overriding the defaults

All of the properties in the first table can be overridden by a system property or a configuration option - si example, to change the project working directory, you could either run this command:

```
grails -Dgrails.project.work.dir=work compile
```

or add this option to your `grails-app/conf/BuildConfig.groovy` file:

```
grails.project.work.dir = "work"
```

Note that the default values take account of the property values they depend on, so setting the project relocate the compiled classes, test classes, resources, and plugins.

What happens if you use both a system property and a configuration option? Then the system property wi `BuildConfig.groovy` file, which in turn takes precedence over the default values.

The `BuildConfig.groovy` file is a sibling of `grails-app/conf/Config.groovy` - the form build, whereas the latter contains those that affect the application at runtime. It's not limited to the optior build configuration options dotted around the documentation, such as ones for specifying the port that the for determining what files get packaged in the WAR file.

Available build settings

Name	Description
grails.server.port.http	Port to run the embedded servlet container on ("run-app" and "run-war"). Ir
grails.server.port.https	Port to run the embedded servlet container on for HTTPS ("run-app --https'
grails.config.base.webXml	Path to a custom web.xml file to use for the application (alternative to usin
grails.compiler.dependencies	Legacy approach to adding extra dependencies to the compiler classpath. S entries. These entries will be processed by an `AntBuilder` so the corresponding XML elements in an Ant build file, e.g. `fileset(dir: "**/*.class)`.
grails.testing.patterns	A list of Ant path patterns that let you control which files are included include the test case suffix, which is set by the next property.
grails.testing.nameSuffix	By default, tests are assumed to have a suffix of "Tests". You can change option. For example, another common suffix is "Test".
grails.project.war.file	A string containing the file path of the generated WAR file, along with example, "target/my-app.war".
grails.war.dependencies	A closure containing "fileset()" entries that allows you complete co "WEB-INF/lib" directory.
grails.war.copyToWebApp	A closure containing "fileset()" entries that allows you complete control o It overrides the default behaviour of including everything under "web-app".
grails.war.resources	A closure that takes the location of the staging directory as its first argum anything you like. It is typically used to remove files from the staging dir into a WAR.
grails.project.web.xml	The location to generate Grails' web.xml to

4.6 Ant and Maven

If all the other projects in your team or company are built using a standard build tool such as Ant or Mav family when you use the Grails command line to build your application. Fortunately, you can easily int main build tools in use today (well, the ones in use in Java projects at least).

Ant Integration

When you create a Grails application with the [create-app] command, Grails doesn't automatically create generate one with the [integrate-with] command:

```
grails integrate-with --ant
```

This creates a `build.xml` file containing the following targets:

- `clean` - Cleans the Grails application
- `compile` - Compiles your application's source code
- `test` - Runs the unit tests
- `run` - Equivalent to "grails run-app"
- `war` - Creates a WAR file
- `deploy` - Empty by default, but can be used to implement automatic deployment

Each of these can be run by Ant, for example:

```
ant war
```

The build file is configured to use Apache Ivy for dependency management, which means that it will au Grails JAR files and other dependencies on demand. You don't even have to install Grails locally to use continuous integration systems such as CruiseControl or Jenkins.

It uses the Grails Ant task to hook into the existing Grails build system. The task lets you run any Grails used by the generated build file. To use the task, you must first declare it:

```
<taskdef name="grailsTask"
         classname="grails.ant.GrailsTask"
         classpathref="grails.classpath"/>
```

This raises the question: what should be in "grails.classpath"? The task itself is in the "grails-bootstrap" classpath at least. You should also include the "groovy-all" JAR. With the task defined, you just need to what attributes are available:

Attribute	Description	Re
home	The location of the Grails installation directory to use for the build.	Ye
classpathref	Classpath to load Grails from. Must include the "grails-bootstrap" artifact and should include "grails-scripts".	Ye `cl`
script	The name of the Grails script to run, e.g. "TestApp".	Ye
args	The arguments to pass to the script, e.g. "-unit -xml".	No
environment	The Grails environment to run the script in.	No
includeRuntimeClasspath	Advanced setting: adds the application's runtime classpath to the build classpath if true.	No

The task also supports the following nested elements, all of which are standard Ant path structures:

- `classpath` - The build classpath (used to load Gant and the Grails scripts).
- `compileClasspath` - Classpath used to compile the application's classes.
- `runtimeClasspath` - Classpath used to run the application and package the WAR @compileClasspath.
- `testClasspath` - Classpath used to compile and run the tests. Typically includes everything in `ru`

How you populate these paths is up to you. If you use the `home` attribute and put your own dependenci even need to use any of them. For an example of their use, take a look at the generated Ant build file for ne

Maven Integration

Grails provides integration with [Maven 2](http://maven.apache.org) with a Maven plugin. The current Maven plugin is based on but who did a great job with the original.

Preparation

In order to use the new plugin, all you need is Maven 2 installed and set up. This is because **you no long use it with Maven!**

> The Maven 2 integration for Grails has been designed and tested for Maven 2.0.9 and above earlier versions.

> The default mvn setup DOES NOT supply sufficient memory to run the Grails environmen you add the following environment variable setting to prevent poor performance:
>
> `export MAVEN_OPTS="-Xmx512m -XX:MaxPermSize=256"`

Creating a Grails Maven Project

To create a Mavenized Grails project simply run the following command:

```
mvn archetype:generate -DarchetypeGroupId=org.grails \
    -DarchetypeArtifactId=grails-maven-archetype \
    -DarchetypeVersion=1.3.2 \
    -DgroupId=example -DartifactId=my-app
```

Choose whichever grails version, group ID and artifact ID you want for your application, but everything e a new Maven project with a POM and a couple of other files. What you won't see is anything that looks step is to create the project structure that you're used to. But first, to set target JDK to Java 6, do that now.

```
<plugin>
  <artifactId>maven-compiler-plugin</artifactId>
  <configuration>
    <source>1.5</source>
    <target>1.5</target>
  </configuration>
</plugin>
```

to

```
<plugin>
  <artifactId>maven-compiler-plugin</artifactId>
  <configuration>
    <source>1.6</source>
    <target>1.6</target>
  </configuration>
</plugin>
```

Then you're ready to create the project structure:

```
cd my-app
mvn initialize
```

> if you see a message similar to this:
>
> ```
> Resolving plugin JAR dependencies …
> :: problems summary ::
> :::: WARNINGS
>         module not found: org.hibernate#hibernate-core;3.3.1.GA
> ```
>
> you need to add the plugins manually to application.properties:
>
> ```
> plugins.hibernate=2.0.0
> plugins.tomcat=2.0.0
> ```
>
> then run
>
> ```
> mvn compile
> ```
>
> and the hibernate and tomcat plugins will be installed.

Now you have a Grails application all ready to go. The plugin integrates into the standard build cycle, so y
to build and package your app: `mvn clean` , `mvn compile` , `mvn test` , `mvn package` , `mvn in`

You can also use some of the Grails commands that have been wrapped as Maven goals:

- `grails:create-controller` - Calls the create-controller command
- `grails:create-domain-class` - Calls the create-domain-class command
- `grails:create-integration-test` - Calls the create-integration-test command
- `grails:create-pom` - Creates a new Maven POM for an existing Grails project
- `grails:create-script` - Calls the create-script command
- `grails:create-service` - Calls the create-service command
- `grails:create-taglib` - Calls the create-tag-lib command
- `grails:create-unit-test` - Calls the create-unit-test command
- `grails:exec` - Executes an arbitrary Grails command line script
- `grails:generate-all` - Calls the generate-all command
- `grails:generate-controller` - Calls the generate-controller command
- `grails:generate-views` - Calls the generate-views command
- `grails:install-plugin` - Calls the install-plugin command
- `grails:install-templates` - Calls the install-templates command
- `grails:list-plugins` - Calls the list-plugins command
- `grails:package` - Calls the package command
- `grails:run-app` - Calls the run-app command
- `grails:uninstall-plugin` - Calls the uninstall-plugin command

For a complete, up to date list, run `mvn grails:help`

Mavenizing an existing project

Creating a new project is great way to start, but what if you already have one? You don't want to create a of the old one over. The solution is to create a POM for the existing project using this Maven command (grails version of your existing project):

```
mvn org.grails:grails-maven-plugin:1.3.2:create-pom -DgroupId=com.mycompany
```

When this command has finished, you can immediately start using the standard phases, such as `mvn pac` group ID when creating the POM.

You may also want to set target JDK to Java 6; see above.

Adding Grails commands to phases

The standard POM created for you by Grails already attaches the appropriate core Grails commands t "compile" goes in the "compile" phase and "war" goes in the "package" phase. That doesn't help thou command to a particular phase. The classic example is functional tests. How do you make sure that your fu you have decided on) are run during the "integration-test" phase?

Fear not: all things are possible. In this case, you can associate the command to a phase using an extra "exe

```
<plugin>
    <groupId>org.grails</groupId>
    <artifactId>grails-maven-plugin</artifactId>
    <version>1.3.2</version>
    <extensions>true</extensions>
    <executions>
        <execution>
            <goals>
            …
            </goals>
        </execution>
        <!-- Add the "functional-tests" command to the "integration-test" phase -
        <execution>
            <id>functional-tests</id>
            <phase>integration-test</phase>
            <goals>
                <goal>exec</goal>
            </goals>
            <configuration>
                <command>functional-tests</command>
            </configuration>
        </execution>
    </executions>
</plugin>
```

This also demonstrates the `grails:exec` goal, which can be used to run any Grails command. Simply `command` system property, and optionally specify the arguments with the `args` property:

```
mvn grails:exec -Dcommand=create-webtest -Dargs=Book
```

Debugging a Grails Maven Project

Maven can be launched in debug mode using the "mvnDebug" command. To launch your Grails applicatic

```
mvnDebug grails:run-app
```

The process will be suspended on startup and listening for a debugger on port 8000.

If you need more control of the debugger, this can be specified using the MAVEN_OPTS environmen default "mvn" command:

```
MAVEN_OPTS="-Xdebug -Xrunjdwp:transport=dt_socket,server=y,suspend=y,address=5005
mvn grails:run-app
```

Raising issues

If you come across any problems with the Maven integration, please raise a JIRA issue as a sub-task of [GF

5 Object Relational Mapping (GORM)

Domain classes are core to any business application. They hold state about business processes and hopefu
linked together through relationships; one-to-one, one-to-many, or many-to-many.

GORM is Grails' object relational mapping (ORM) implementation. Under the hood it uses Hibernate 3 (a
ORM solution) and thanks to the dynamic nature of Groovy with its static and dynamic typing, along wi
less configuration involved in creating Grails domain classes.

You can also write Grails domain classes in Java. See the section on Hibernate Integration for how to wr
dynamic persistent methods. Below is a preview of GORM in action:

```
def book = Book.findByTitle("Groovy in Action")

book
  .addToAuthors(name:"Dierk Koenig")
  .addToAuthors(name:"Guillaume LaForge")
  .save()
```

5.1 Quick Start Guide

A domain class can be created with the [create-domain-class] command:

```
grails create-domain-class helloworld.Person
```

> If no package is specified with the create-domain-class script, Grails automatically uses the a
> package name.

This will create a class at the location `grails-app/domain/helloworld/Person.groovy` such

```
package helloworld

class Person {
}
```

> If you have the `dbCreate` property set to "update", "create" or "create-drop" on your D
> automatically generate/modify the database tables for you.

You can customize the class by adding properties:

```
class Person {
    String name
    Integer age
    Date lastVisit
}
```

Once you have a domain class try and manipulate it with the shell or console by typing:

```
grails console
```

This loads an interactive GUI where you can run Groovy commands with access to the Spring Application

5.1.1 Basic CRUD

Try performing some basic CRUD (Create/Read/Update/Delete) operations.

Create

To create a domain class use Map constructor to set its properties and call save:

```
def p = new Person(name: "Fred", age: 40, lastVisit: new Date())
p.save()
```

The save method will persist your class to the database using the underlying Hibernate ORM layer.

Read

Grails transparently adds an implicit `id` property to your domain class which you can use for retrieval:

```
def p = Person.get(1)
assert 1 == p.id
```

This uses the get method that expects a database identifier to read the `Person` object back from the dat
read-only state by using the read method:

```
def p = Person.read(1)
```

In this case the underlying Hibernate engine will not do any dirty checking and the object will not be persi
save method then the object is placed back into a read-write state.

In addition, you can also load a proxy for an instance by using the load method:

```
def p = Person.load(1)
```

This incurs no database access until a method other than getId() is called. Hibernate then initializes the pı
if no record is found for the specified id.

Update

To update an instance, change some properties and then call save again:

```
def p = Person.get(1)
p.name = "Bob"
p.save()
```

Delete

To delete an instance use the delete method:

```
def p = Person.get(1)
p.delete()
```

5.2 Domain Modelling in GORM

When building Grails applications you have to consider the problem domain you are trying to solve. Amazon-style bookstore you would be thinking about books, authors, customers and publishers to name a

These are modeled in GORM as Groovy classes, so a `Book` class may have a title, a release date, an I sections show how to model the domain in GORM.

To create a domain class you run the create-domain-class command as follows:

```
grails create-domain-class org.bookstore.Book
```

The result will be a class at `grails-app/domain/org/bookstore/Book.groovy`:

```
package org.bookstore

class Book {
}
```

This class will map automatically to a table in the database called `book` (the same name as the class). This ORM Domain Specific Language

Now that you have a domain class you can define its properties as Java types. For example:

```
package org.bookstore

class Book {
    String title
    Date releaseDate
    String ISBN
}
```

Each property is mapped to a column in the database, where the convention for column names is all lov example `releaseDate` maps onto a column `release_date`. The SQL types are auto-detected from with Constraints or the ORM DSL.

5.2.1 Association in GORM

Relationships define how domain classes interact with each other. Unless specified explicitly at both direction it is defined.

5.2.1.1 Many-to-one and one-to-one

A many-to-one relationship is the simplest kind, and is defined with a property of the type of another doma

Example A

```
class Face {
    Nose nose
}
```

```
class Nose {
}
```

In this case we have a unidirectional many-to-one relationship from `Face` to `Nose`. To make this relatior as follows:

Example B

```
class Face {
    Nose nose
}
```

```
class Nose {
    static belongsTo = [face:Face]
}
```

In this case we use the `belongsTo` setting to say that `Nose` "belongs to" `Face`. The result of this is tha instance to it and when we save or delete the `Face` instance, GORM will save or delete the `Nose`. In othe from `Face` to the associated `Nose`:

```
new Face(nose:new Nose()).save()
```

The example above will save both face and nose. Note that the inverse *is not* true and will result in an erro

```
new Nose(face:new Face()).save() // will cause an error
```

Now if we delete the `Face` instance, the `Nose` will go too:

```
def f = Face.get(1)
f.delete() // both Face and Nose deleted
```

To make the relationship a true one-to-one, use the `hasOne` property on the owning side, e.g. `Face`:

Example C

```
class Face {
    static hasOne = [nose:Nose]
}
```

```
class Nose {
    Face face
}
```

Note that using this property puts the foreign key on the inverse table to the previous example, so in this c
the `nose` table inside a column called `face_id`. Also, `hasOne` only works with bidirectional relationshi

Finally, it's a good idea to add a unique constraint on one side of the one-to-one relationship:

```
class Face {
    static hasOne = [nose:Nose]

static constraints = {
        nose unique: true
    }
}
```

```
class Nose {
    Face face
}
```

5.2.1.2 One-to-many

A one-to-many relationship is when one class, example `Author`, has many instances of a another class, e
such a relationship with the `hasMany` setting:

```
class Author {
    static hasMany = [books: Book]

String name
}
```

```
class Book {
    String title
}
```

In this case we have a unidirectional one-to-many. Grails will, by default, map this kind of relationship wit

The ORM DSL allows mapping unidirectional relationships using a foreign key association in

Grails will automatically inject a property of type `java.util.Set` into the domain class based on the iterate over the collection:

```
def a = Author.get(1)

for (book in a.books) {
    println book.title
}
```

The default fetch strategy used by Grails is "lazy", which means that the collection will be la access. This can lead to the n+1 problem if you are not careful.

If you need "eager" fetching you can use the ORM DSL or specify eager fetching as part of a

The default cascading behaviour is to cascade saves and updates, but not deletes unless a `belongsTo` is a

```
class Author {
    static hasMany = [books: Book]

String name
}
```

```
class Book {
    static belongsTo = [author: Author]
    String title
}
```

If you have two properties of the same type on the many side of a one-to-many you have to use `mappe` mapped:

```
class Airport {
    static hasMany = [flights: Flight]
    static mappedBy = [flights: "departureAirport"]
}
```

```
class Flight {
    Airport departureAirport
    Airport destinationAirport
}
```

This is also true if you have multiple collections that map to different properties on the many side:

```
class Airport {
    static hasMany = [outboundFlights: Flight, inboundFlights: Flight]
    static mappedBy = [outboundFlights: "departureAirport",
                       inboundFlights: "destinationAirport"]
}
```

```
class Flight {
    Airport departureAirport
    Airport destinationAirport
}
```

5.2.1.3 Many-to-many

Grails supports many-to-many relationships by defining a `hasMany` on both sides of the relationship an side of the relationship:

```
class Book {
    static belongsTo = Author
    static hasMany = [authors:Author]
    String title
}
```

```
class Author {
    static hasMany = [books:Book]
    String name
}
```

Grails maps a many-to-many using a join table at the database level. The owning side of the rela responsibility for persisting the relationship and is the only side that can cascade saves across.

For example this will work and cascade saves:

```
new Author(name:"Stephen King")
        .addToBooks(new Book(title:"The Stand"))
        .addToBooks(new Book(title:"The Shining"))
        .save()
```

However this will only save the `Book` and not the authors!

```
new Book(name:"Groovy in Action")
        .addToAuthors(new Author(name:"Dierk Koenig"))
        .addToAuthors(new Author(name:"Guillaume Laforge"))
        .save()
```

This is the expected behaviour as, just like Hibernate, only one side of a many-to-many can take responsib

> Grails' Scaffolding feature **does not** currently support many-to-many relationship and hence y
> to manage the relationship yourself

5.2.1.4 Basic Collection Types

As well as associations between different domain classes, GORM also supports mapping of basic collec
class creates a `nicknames` association that is a `Set` of `String` instances:

```
class Person {
    static hasMany = [nicknames: String]
}
```

GORM will map an association like the above using a join table. You can alter various aspects of ho
`joinTable` argument:

```
class Person {

static hasMany = [nicknames: String]

static mapping = {
       hasMany joinTable: [name: 'bunch_o_nicknames',
                           key: 'person_id',
                           column: 'nickname',
                           type: "text"]
    }
}
```

The example above will map to a table that looks like the following:

bunch_o_nicknames Table

```
---------------------------------------------
| person_id         |     nickname          |
---------------------------------------------
|   1               |      Fred             |
---------------------------------------------
```

5.2.2 Composition in GORM

As well as association, Grails supports the notion of composition. In this case instead of mapping clas
"embedded" within the current table. For example:

```
class Person {
    Address homeAddress
    Address workAddress
    static embedded = ['homeAddress', 'workAddress']
}

class Address {
    String number
    String code
}
```

The resulting mapping would looking like this:

Person Table

id	home_address_number	home_address_code	work_address_number	work_address_code
1	47	343432	67	43545

> If you define the `Address` class in a separate Groovy file in the `grails-app/domain` get an `address` table. If you don't want this to happen use Groovy's ability to define multi include the `Address` class below the `Person` class in the `grails-app/domain/Perso`

5.2.3 Inheritance in GORM

GORM supports inheritance both from abstract base classes and concrete persistent GORM entities. For ex

```
class Content {
     String author
}
```

```
class BlogEntry extends Content {
    URL url
}
```

```
class Book extends Content {
    String ISBN
}
```

```
class PodCast extends Content {
    byte[] audioStream
}
```

In the above example we have a parent `Content` class and then various child classes with more specific b

Considerations

At the database level Grails by default uses table-per-hierarchy mapping with a discriminator colum `Content`) and its subclasses (`BlogEntry`, `Book` etc.), share the **same** table.

Table-per-hierarchy mapping has a down side in that you **cannot** have non-nullable properties with inheri table-per-subclass which can be enabled with the [ORM DSL]

However, excessive use of inheritance and table-per-subclass can result in poor query performance due to our advice is if you're going to use inheritance, don't abuse it and don't make your inheritance hierarchy too

Polymorphic Queries

The upshot of inheritance is that you get the ability to polymorphically query. For example using the [lis] will return all subclasses of `Content`:

```
def content = Content.list() // list all blog entries, books and podcasts
content = Content.findAllByAuthor('Joe Bloggs') // find all by author

def podCasts = PodCast.list() // list only podcasts
```

5.2.4 Sets, Lists and Maps

Sets of Objects

By default when you define a relationship with GORM it is a `java.util.Set` which is an unordered co In other words when you have:

```
class Author {
    static hasMany = [books: Book]
}
```

The books property that GORM injects is a `java.util.Set`. Sets guarantee uniquenes but not order, have custom ordering you configure the Set as a `SortedSet`:

```
class Author {

SortedSet books

static hasMany = [books: Book]
}
```

In this case a `java.util.SortedSet` implementation is used which means you must implement `jav` class:

```
class Book implements Comparable {

String title
    Date releaseDate = new Date()

int compareTo(obj) {
        releaseDate.compareTo(obj.releaseDate)
    }
}
```

The result of the above class is that the Book instances in the books collection of the Author class will be c

Lists of Objects

To keep objects in the order which they were added and to be able to reference them by index like an array a `List`:

```
class Author {

List books

static hasMany = [books: Book]
}
```

In this case when you add new elements to the books collection the order is retained in a sequential list ind

```
author.books[0] // get the first book
```

The way this works at the database level is Hibernate creates a `books_idx` column where it saves the in retain this order at the database level.

When using a `List`, elements must be added to the collection before being saved, otherwise I `org.hibernate.HibernateException`: null index column for collection):

```
// This won't work!
def book = new Book(title: 'The Shining')
book.save()
author.addToBooks(book)

// Do it this way instead.
def book = new Book(title: 'Misery')
author.addToBooks(book)
author.save()
```

Bags of Objects

If ordering and uniqueness aren't a concern (or if you manage these explicitly) then you can use the Hi collections.

The only change required for this is to define the collection type as a `Collection`:

```
class Author {

Collection books

static hasMany = [books: Book]
}
```

Since uniqueness and order aren't managed by Hibernate, adding to or removing from collections mapp
existing instances from the database, so this approach will perform better and require less memory than usi

Maps of Objects

If you want a simple map of string/value pairs GORM can map this with the following:

```
class Author {
    Map books // map of ISBN:book names
}

def a = new Author()
a.books = ["1590597583":"Grails Book"]
a.save()
```

In this case the key and value of the map MUST be strings.

If you want a Map of objects then you can do this:

```
class Book {

Map authors

static hasMany = [authors: Author]
}

def a = new Author(name:"Stephen King")

def book = new Book()
book.authors = [stephen:a]
book.save()
```

The static `hasMany` property defines the type of the elements within the Map. The keys for the map **must**

A Note on Collection Types and Performance

The Java `Set` type doesn't allow duplicates. To ensure uniqueness when adding an entry to a `Set` asso
associations from the database. If you have a large numbers of entries in the association this can be costly i

The same behavior is required for `List` types, since Hibernate needs to load the entire associati
recommended that if you anticipate a large numbers of records in the association that you make the assoc
be created on the inverse side. For example consider the following code:

```
def book = new Book(title:"New Grails Book")
def author = Author.get(1)
book.author = author
book.save()
```

In this example the association link is being created by the child (Book) and hence it is not necessary resulting in fewer queries and more efficient code. Given an `Author` with a large number of associate code like the following you would see an impact on performance:

```
def book = new Book(title:"New Grails Book")
def author = Author.get(1)
author.addToBooks(book)
author.save()
```

You could also model the collection as a Hibernate Bag as described above.

5.3 Persistence Basics

A key thing to remember about Grails is that under the surface Grails is using Hibernate for persistence. I using ActiveRecord or iBatis Hibernate's "session" model may feel a little strange.

Grails automatically binds a Hibernate session to the currently executing request. This lets you use the sa GORM methods transparently.

Transactional Write-Behind

A useful feature of Hibernate over direct JDBC calls and even other frameworks is that when you call perform any SQL operations **at that point**. Hibernate batches up SQL statements and executes them as request when flushing and closing the session. This is typically done for you automatically by Grails, whic

Hibernate caches database updates where possible, only actually pushing the changes when it knows tha triggered programmatically. One common case where Hibernate will flush cached updates is when information might be included in the query results. But as long as you're doing non-conflicting saves, u until the session is flushed. This can be a significant performance boost for applications that do a lot of dat

Note that flushing is not the same as committing a transaction. If your actions are performed in the contex SQL updates but the database will save the changes in its transaction queue and only finalize the updates w

5.3.1 Saving and Updating

An example of using the save method can be seen below:

```
def p = Person.get(1)
p.save()
```

This save will be not be pushed to the database immediately - it will be pushed when the next flush occ want to control when those statements are executed or, in Hibernate terminology, when the session is "fl argument to the save method:

```
def p = Person.get(1)
p.save(flush: true)
```

Note that in this case *all* pending SQL statements including previous saves, deletes, etc. will be synchro you catch any exceptions, which is typically useful in highly concurrent scenarios involving optimistic loc

```
def p = Person.get(1)
try {
    p.save(flush: true)
}
catch (org.springframework.dao.DataIntegrityViolationException e) {
    // deal with exception
}
```

Another thing to bear in mind is that Grails [validates](#) a domain instance every time you save it. If that valic be persisted to the database. By default, `save()` will simply return `null` in this case, but if you would use the `failOnError` argument:

```
def p = Person.get(1)
try {
    p.save(failOnError: true)
}
catch (ValidationException e) {
    // deal with exception
}
```

You can even change the default behaviour with a setting in `Config.groovy`, as described in the sectic when you are saving domain instances that have been bound with data provided by the user, the likelihoo and you won't want those exceptions propagating to the end user.

You can find out more about the subtleties of saving data in this article - a must read!

5.3.2 Deleting Objects

An example of the delete method can be seen below:

```
def p = Person.get(1)
p.delete()
```

As with saves, Hibernate will use transactional write-behind to perform the delete; to perform the de argument:

```
def p = Person.get(1)
p.delete(flush: true)
```

Using the `flush` argument lets you catch any errors that occur during a delete. A common error that constraint, although this is normally down to a programming or schema error. The following `DataIntegrityViolationException` that is thrown when you violate the database constraints:

```
def p = Person.get(1)

try {
    p.delete(flush: true)
}
catch (org.springframework.dao.DataIntegrityViolationException e) {
    flash.message = "Could not delete person ${p.name}"
    redirect(action: "show", id: p.id)
}
```

Note that Grails does not supply a `deleteAll` method as deleting data is discouraged and can often be a

If you really need to batch delete data you can use the [executeUpdate](#) method to do batch DML statements

```
Customer.executeUpdate("delete Customer c where c.name = :oldName",
                       [oldName: "Fred"])
```

5.3.3 Understanding Cascading Updates and Deletes

It is critical that you understand how cascading updates and deletes work when using GORM. The key setting which controls which class "owns" a relationship.

Whether it is a one-to-one, one-to-many or many-to-many, defining `belongsTo` will result in updates dependant (the other side of the relationship), and for many-/one-to-one and one-to-many relationships del

If you *do not* define `belongsTo` then no cascades will happen and you will have to manually save one-to-many, in which case saves will cascade automatically if a new instance is in a `hasMany` collection

Here is an example:

```
class Airport {
    String name
    static hasMany = [flights: Flight]
}
```

```
class Flight {
    String number
    static belongsTo = [airport: Airport]
}
```

If I now create an `Airport` and add some `Flight`s to it I can save the `Airport` and have the updat saving the whole object graph:

```
new Airport(name: "Gatwick")
        .addToFlights(new Flight(number: "BA3430"))
        .addToFlights(new Flight(number: "EZ0938"))
        .save()
```

Conversely if I later delete the `Airport` all `Flight`s associated with it will also be deleted:

```
def airport = Airport.findByName("Gatwick")
airport.delete()
```

However, if I were to remove `belongsTo` then the above cascading deletion code **would not work**. To summaries below that describe the default behaviour of GORM with regards to specific associations. A series of articles to get a deeper understanding of relationships and cascading.

Bidirectional one-to-many with belongsTo

```
class A { static hasMany = [bees: B] }
```

```
class B { static belongsTo = [a: A] }
```

In the case of a bidirectional one-to-many where the many side defines a `belongsTo` then the cascade s and "NONE" for the many side.

Unidirectional one-to-many

```
class A { static hasMany = [bees: B] }
```

```
class B {  }
```

In the case of a unidirectional one-to-many where the many side defines no belongsTo then the cascade str

Bidirectional one-to-many, no belongsTo

```
class A { static hasMany = [bees: B] }
```

```
class B { A a }
```

In the case of a bidirectional one-to-many where the many side does not define a `belongsTo` "SAVE-UPDATE" for the one side and "NONE" for the many side.

Unidirectional one-to-one with belongsTo

```
class A {  }
```

```
class B { static belongsTo = [a: A] }
```

In the case of a unidirectional one-to-one association that defines a `belongsTo` then the cascade strategy the relationship (A->B) and "NONE" from the side that defines the `belongsTo` (B->A)

Note that if you need further control over cascading behaviour, you can use the ORM DSL.

5.3.4 Eager and Lazy Fetching

Associations in GORM are by default lazy. This is best explained by example:

```
class Airport {
    String name
    static hasMany = [flights: Flight]
}
```

```
class Flight {
    String number
    Location destination
    static belongsTo = [airport: Airport]
}
```

```
class Location {
    String city
    String country
}
```

Given the above domain classes and the following code:

```
def airport = Airport.findByName("Gatwick")
for (flight in airport.flights) {
    println flight.destination.city
}
```

GORM will execute a single SQL query to fetch the `Airport` instance, another to get its flights, and the the `flights` association to get the current flight's destination. In other words you get N+1 queries (if airport).

Configuring Eager Fetching

An alternative approach that avoids the N+1 queries is to use eager fetching, which can be specified as foll

```
class Airport {
    String name
    static hasMany = [flights: Flight]
    static mapping = {
        flights lazy: false
    }
}
```

In this case the `flights` association will be loaded at the same time as its `Airport` instance, althou fetch the collection. You can also use `fetch: 'join'` instead of `lazy: false` , in which case GO get the airports and their flights. This works well for single-ended associations, but you need to be careful as you'd expect right up to the moment you add a limit to the number of results you want. At that point, y than you were expecting. The reason for this is quite technical but ultimately the problem arises from GOR

So, the recommendation is currently to use `fetch: 'join'` for single-ended associations and `lazy:`

Be careful how and where you use eager loading because you could load your entire database into mem You can find more information on the mapping options in the [section on the ORM DSL](#).

Using Batch Fetching

Although eager fetching is appropriate for some cases, it is not always desirable. If you made everything e entire database into memory resulting in performance and memory problems. An alternative to eager fet configure Hibernate to lazily fetch results in "batches". For example:

```
class Airport {
    String name
    static hasMany = [flights: Flight]
    static mapping = {
        flights batchSize: 10
    }
}
```

In this case, due to the `batchSize` argument, when you iterate over the `flights` association, Hibernat example if you had an `Airport` that had 30 flights, if you didn't configure batch fetching you would get `30` queries to fetch each flight. With batch fetching you get 1 query to fetch the `Airport` and 3 queries t In other words, batch fetching is an optimization of the lazy fetching strategy. Batch fetching can also be c

```
class Flight {
    …
    static mapping = {
        batchSize 10
    }
}
```

Check out [part 3](#) of the GORM Gotchas series for more in-depth coverage of this tricky topic.

5.3.5 Pessimistic and Optimistic Locking

Optimistic Locking

By default GORM classes are configured for optimistic locking. Optimistic locking is a feature of Hibe value in a special `version` column in the database that is incremented after each update.

The `version` column gets read into a `version` property that contains the current versioned state of pers

```
def airport = Airport.get(10)

println airport.version
```

When you perform updates Hibernate will automatically check the version property against the version co will throw a [StaleObjectException](). This will roll back the transaction if one is active.

This is useful as it allows a certain level of atomicity without resorting to pessimistic locking that ha downside is that you have to deal with this exception if you have highly concurrent writes. This requires fl

```
def airport = Airport.get(10)

try {
    airport.name = "Heathrow"
    airport.save(flush: true)
}
catch (org.springframework.dao.OptimisticLockingFailureException e) {
    // deal with exception
}
```

The way you deal with the exception depends on the application. You could attempt a programmatic merg ask them to resolve the conflict.

Alternatively, if it becomes a problem you can resort to pessimistic locking.

> ⚠ The `version` will only be updated after flushing the session.

Pessimistic Locking

Pessimistic locking is equivalent to doing a SQL "SELECT * FOR UPDATE" statement and locking implication that other read operations will be blocking until the lock is released.

In Grails pessimistic locking is performed on an existing instance with the [lock]() method:

```
def airport = Airport.get(10)
airport.lock() // lock for update
airport.name = "Heathrow"
airport.save()
```

Grails will automatically deal with releasing the lock for you once the transaction has been committed. H doing is "upgrading" from a regular SELECT to a SELECT..FOR UPDATE and another thread could still call to `get()` and the call to `lock()`.

To get around this problem you can use the static [lock]() method that takes an id just like [get]():

```
def airport = Airport.lock(10) // lock for update
airport.name = "Heathrow"
airport.save()
```

In this case only SELECT..FOR UPDATE is issued.

As well as the lock method you can also obtain a pessimistic locking using queries. For example using a dy

```
def airport = Airport.findByName("Heathrow", [lock: true])
```

Or using criteria:

```
def airport = Airport.createCriteria().get {
    eq('name', 'Heathrow')
    lock true
}
```

5.3.6 Modification Checking

Once you have loaded and possibly modified a persistent domain class instance, it isn't straightforward to to reload the instance using get Hibernate will return the current modified instance from its Session cache trigger a flush which could cause problems if your data isn't ready to be flushed yet. So GORM provides values that Hibernate caches when it loads the instance (which it uses for dirty checking).

isDirty

You can use the isDirty method to check if any field has been modified:

```
def airport = Airport.get(10)
assert !airport.isDirty()

airport.properties = params
if (airport.isDirty()) {
   // do something based on changed state
}
```

> `isDirty()` does not currently check collection associations, but it does check all other pe associations.

You can also check if individual fields have been modified:

```
def airport = Airport.get(10)
assert !airport.isDirty()

airport.properties = params
if (airport.isDirty('name')) {
   // do something based on changed name
}
```

getDirtyPropertyNames

You can use the getDirtyPropertyNames method to retrieve the names of modified fields; this may be emp

```
def airport = Airport.get(10)
assert !airport.isDirty()

airport.properties = params
def modifiedFieldNames = airport.getDirtyPropertyNames()
for (fieldName in modifiedFieldNames) {
   // do something based on changed value
}
```

getPersistentValue

You can use the getPersistentValue method to retrieve the value of a modified field:

```
def airport = Airport.get(10)
assert !airport.isDirty()

airport.properties = params
def modifiedFieldNames = airport.getDirtyPropertyNames()
for (fieldName in modifiedFieldNames) {
    def currentValue = airport."$fieldName"
    def originalValue = airport.getPersistentValue(fieldName)
    if (currentValue != originalValue) {
        // do something based on changed value
    }
}
```

5.4 Querying with GORM

GORM supports a number of powerful ways to query from dynamic finders, to criteria to Hibernate's obje

Groovy's ability to manipulate collections with GPath and methods like sort, findAll and so on combi combination.

However, let's start with the basics.

Listing instances

Use the list method to obtain all instances of a given class:

```
def books = Book.list()
```

The list method supports arguments to perform pagination:

```
def books = Book.list(offset:10, max:20)
```

as well as sorting:

```
def books = Book.list(sort:"title", order:"asc")
```

Here, the `sort` argument is the name of the domain class property that you wish to sort on, and the `orde`
or `desc` for **desc**ending.

Retrieval by Database Identifier

The second basic form of retrieval is by database identifier using the get method:

```
def book = Book.get(23)
```

You can also obtain a list of instances for a set of identifiers using getAll:

```
def books = Book.getAll(23, 93, 81)
```

5.4.1 Dynamic Finders

GORM supports the concept of **dynamic finders**. A dynamic finder looks like a static method invocat
actually exist in any form at the code level.

Instead, a method is auto-magically generated using code synthesis at runtime, based on the properties c
`Book` class:

```
class Book {
    String title
    Date releaseDate
    Author author
}
```

```
class Author {
    String name
}
```

The Book class has properties such as title, releaseDate and author. These can be used by the
form of "method expressions":

```
def book = Book.findByTitle("The Stand")
book = Book.findByTitleLike("Harry Pot%")
book = Book.findByReleaseDateBetween(firstDate, secondDate)
book = Book.findByReleaseDateGreaterThan(someDate)
book = Book.findByTitleLikeOrReleaseDateLessThan("%Something%", someDate)
```

Method Expressions

A method expression in GORM is made up of the prefix such as findBy followed by an expression that
basic form is:

```
Book.findBy([Property][Comparator][Boolean Operator])?[Property][Comparator]
```

The tokens marked with a '?' are optional. Each comparator changes the nature of the query. For example:

```
def book = Book.findByTitle("The Stand")
book =  Book.findByTitleLike("Harry Pot%")
```

In the above example the first query is equivalent to equality whilst the latter, due to the Like com
expression.

The possible comparators include:

- `InList` - In the list of given values
- `LessThan` - less than a given value
- `LessThanEquals` - less than or equal a give value
- `GreaterThan` - greater than a given value
- `GreaterThanEquals` - greater than or equal a given value
- `Like` - Equivalent to a SQL like expression
- `Ilike` - Similar to a `Like`, except case insensitive
- `NotEqual` - Negates equality
- `Between` - Between two values (requires two arguments)
- `IsNotNull` - Not a null value (doesn't take an argument)
- `IsNull` - Is a null value (doesn't take an argument)

Notice that the last three require different numbers of method arguments compared to the rest, as demonstr

```
def now = new Date()
def lastWeek = now - 7
def book = Book.findByReleaseDateBetween(lastWeek, now)

books = Book.findAllByReleaseDateIsNull()
books = Book.findAllByReleaseDateIsNotNull()
```

Boolean logic (AND/OR)

Method expressions can also use a boolean operator to combine two or more criteria:

```
def books = Book.findAllByTitleLikeAndReleaseDateGreaterThan(
                      "%Java%", new Date() - 30)
```

In this case we're using `And` in the middle of the query to make sure both conditions are satisfied, but you

```
def books = Book.findAllByTitleLikeOrReleaseDateGreaterThan(
                      "%Java%", new Date() - 30)
```

You can combine as many criteria as you like, but they must all be combined with `And` or all `Or`. If you number of criteria creates a very long method name, just convert the query to a Criteria or HQL query.

Querying Associations

Associations can also be used within queries:

```
def author = Author.findByName("Stephen King")

def books = author ? Book.findAllByAuthor(author) : []
```

In this case if the `Author` instance is not null we use it in a query to obtain all the `Book` instances for the

Pagination and Sorting

The same pagination and sorting parameters available on the list method can also be used with dynamic parameter:

```
def books = Book.findAllByTitleLike("Harry Pot%",
               [max: 3, offset: 2, sort: "title", order: "desc"])
```

5.4.2 Criteria

Criteria is a type safe, advanced way to query that uses a Groovy builder to construct potentially comple than building up query strings using a `StringBuffer`.

Criteria can be used either with the createCriteria or withCriteria methods. The builder uses Hibernate's
map the static methods found in the Restrictions class of the Hibernate Criteria API. For example:

```
def c = Account.createCriteria()
def results = c {
    between("balance", 500, 1000)
    eq("branch", "London")
    or {
        like("holderFirstName", "Fred%")
        like("holderFirstName", "Barney%")
    }
    maxResults(10)
    order("holderLastName", "desc")
}
```

This criteria will select up to 10 `Account` objects matching the following criteria:

- `balance` is between 500 and 1000
- `branch` is 'London'
- `holderFirstName` starts with 'Fred' or 'Barney'

The results will be sorted in descending order by `holderLastName`.

Conjunctions and Disjunctions

As demonstrated in the previous example you can group criteria in a logical OR using an `or { }` block:

```
or {
    between("balance", 500, 1000)
    eq("branch", "London")
}
```

This also works with logical AND:

```
and {
    between("balance", 500, 1000)
    eq("branch", "London")
}
```

And you can also negate using logical NOT:

```
not {
    between("balance", 500, 1000)
    eq("branch", "London")
}
```

All top level conditions are implied to be AND'd together.

Querying Associations

Associations can be queried by having a node that matches the property name. For example say the `Acc`
objects:

```
class Account {
    …
    static hasMany = [transactions: Transaction]
    …
}
```

We can query this association by using the property name `transaction` as a builder node:

```
def c = Account.createCriteria()
def now = new Date()
def results = c.list {
    transactions {
        between('date', now - 10, now)
    }
}
```

The above code will find all the `Account` instances that have performed `transactions` within the
association queries within logical blocks:

```
def c = Account.createCriteria()
def now = new Date()
def results = c.list {
    or {
        between('created', now - 10, now)
        transactions {
            between('date', now - 10, now)
        }
    }
}
```

Here we find all accounts that have either performed transactions in the last 10 days OR have been recently

Querying with Projections

Projections may be used to customise the results. Define a "projections" node within the criteria buil
equivalent methods within the projections node to the methods found in the Hibernate Projections class:

```
def c = Account.createCriteria()

def numberOfBranches = c.get {
    projections {
        countDistinct('branch')
    }
}
```

Using SQL Restrictions

You can access Hibernate's SQL Restrictions capabilities.

```
def c = Person.createCriteria()

def peopleWithShortFirstNames = c.list {
    sqlRestriction "char_length(first_name) <= 4"
}
```

Note that the parameter there is SQL. The `first_name` attribute referenced in the persistence model, not the object model like in HQL queries. The `Person` property named f to the `first_name` column in the database and you must refer to that in the `sqlRestrict`

Also note that the SQL used here is not necessarily portable across databases.

Using Scrollable Results

You can use Hibernate's [ScrollableResults] feature by calling the scroll method:

```
def results = crit.scroll {
    maxResults(10)
}
def f = results.first()
def l = results.last()
def n = results.next()
def p = results.previous()

def future = results.scroll(10)
def accountNumber = results.getLong('number')
```

To quote the documentation of Hibernate ScrollableResults:

> *A result iterator that allows moving around within the results by arbitrary increments. The Query / similar to the JDBC PreparedStatement/ ResultSet pattern and the semantics of methods of this inte named methods on ResultSet.*

Contrary to JDBC, columns of results are numbered from zero.

Setting properties in the Criteria instance

If a node within the builder tree doesn't match a particular criterion it will attempt to set a property on th access to all the properties in this class. This example calls `setMaxResults` and `setFirstResult` o

```
import org.hibernate.FetchMode as FM
…
def results = c.list {
    maxResults(10)
    firstResult(50)
    fetchMode("aRelationship", FM.JOIN)
}
```

Querying with Eager Fetching

In the section on Eager and Lazy Fetching we discussed how to declaratively specify fetching to avoid the
can also be achieved using a criteria query:

```
def criteria = Task.createCriteria()
def tasks = criteria.list{
    eq "assignee.id", task.assignee.id
    join 'assignee'
    join 'project'
    order 'priority', 'asc'
}
```

Notice the usage of the `join` method: it tells the criteria API to use a `JOIN` to fetch the named assc
probably best not to use this for one-to-many associations though, because you will most likely end up
'select' fetch mode:

```
import org.hibernate.FetchMode as FM
…
def results = Airport.withCriteria {
    eq "region", "EMEA"
    fetchMode "flights", FM.SELECT
}
```

Although this approach triggers a second query to get the `flights` association, you will get reliable
option.

> ⚠ `fetchMode` and `join` are general settings of the query and can only be specified at the to
> use them inside projections or association constraints.

An important point to bear in mind is that if you include associations in the query constraints, those ass
loaded. For example, in this query:

```
def results = Airport.withCriteria {
    eq "region", "EMEA"
    flights {
        like "number", "BA%"
    }
}
```

the `flights` collection would be loaded eagerly via a join even though the fetch mode has not been expli

Method Reference

If you invoke the builder with no method name such as:

```
c { … }
```

The build defaults to listing all the results and hence the above is equivalent to:

```
c.list { … }
```

Method	Description
list	This is the default method. It returns all matching rows.
get	Returns a unique result set, i.e. just one row. The criteria has to be formed that way, that it not to be confused with a limit to just the first row.
scroll	Returns a scrollable result set.
listDistinct	If subqueries or associations are used, one may end up with the same row multiple times ir distinct entities and is equivalent to `DISTINCT_ROOT_ENTITY` of the CriteriaSpecificatio
count	Returns the number of matching rows.

5.4.3 Hibernate Query Language (HQL)

GORM classes also support Hibernate's query language HQL, a very complete reference for which can be of the Hibernate documentation.

GORM provides a number of methods that work with HQL including find, findAll and executeQuery. An

```
def results =
      Book.findAll("from Book as b where b.title like 'Lord of the%'")
```

Positional and Named Parameters

In this case the value passed to the query is hard coded, however you can equally use positional parameters

```
def results =
      Book.findAll("from Book as b where b.title like ?", ["The Shi%"])
```

```
def author = Author.findByName("Stephen King")
def books = Book.findAll("from Book as book where book.author = ?",
                         [author])
```

Or even named parameters:

```
def results =
      Book.findAll("from Book as b " +
                   "where b.title like :search or b.author like :search",
                   [search: "The Shi%"])
```

```
def author = Author.findByName("Stephen King")
def books = Book.findAll("from Book as book where book.author = :author",
                         [author: author])
```

Multiline Queries

Use the line continuation character to separate the query across multiple lines:

```
def results = Book.findAll("\
from Book as b, \
     Author as a \
where b.author = a and a.surname = ?", ['Smith'])
```

> Triple-quoted Groovy multiline Strings will NOT work with HQL queries.

Pagination and Sorting

You can also perform pagination and sorting whilst using HQL queries. To do so simply specify the pagin
method call and include an "ORDER BY" clause in the HQL:

```
def results =
      Book.findAll("from Book as b where " +
                   "b.title like 'Lord of the%' " +
                   "order by b.title asc",
                   [max: 10, offset: 20])
```

5.5 Advanced GORM Features

The following sections cover more advanced usages of GORM including caching, custom mapping and ev

5.5.1 Events and Auto Timestamping

GORM supports the registration of events as methods that get fired when certain events occurs sucl
following is a list of supported events:

- `beforeInsert` - Executed before an object is initially persisted to the database
- `beforeUpdate` - Executed before an object is updated
- `beforeDelete` - Executed before an object is deleted
- `beforeValidate` - Executed before an object is validated
- `afterInsert` - Executed after an object is persisted to the database
- `afterUpdate` - Executed after an object has been updated
- `afterDelete` - Executed after an object has been deleted
- `onLoad` - Executed when an object is loaded from the database

To add an event simply register the relevant closure with your domain class.

> Do not attempt to flush the session within an event (such as with obj.save(flush:true)). Since flushing this will cause a StackOverflowError.

Event types

The beforeInsert event

Fired before an object is saved to the database

```
class Person {
   Date dateCreated

def beforeInsert() {
       dateCreated = new Date()
   }
}
```

The beforeUpdate event

Fired before an existing object is updated

```
class Person {
   Date dateCreated
   Date lastUpdated

def beforeInsert() {
       dateCreated = new Date()
   }
   def beforeUpdate() {
       lastUpdated = new Date()
   }
}
```

The beforeDelete event

Fired before an object is deleted.

```
class Person {
   String name
   Date dateCreated
   Date lastUpdated

def beforeDelete() {
      ActivityTrace.withNewSession {
         new ActivityTrace(eventName:"Person Deleted",data:name).save()
      }
   }
}
```

Notice the usage of `withNewSession` method above. Since events are triggered whilst Hibernate is fl `save()` and `delete()` won't result in objects being saved unless you run your operations with a new S

Fortunately the `withNewSession` method lets you share the same transactional JDBC connection underlying `Session`.

The beforeValidate event

Fired before an object is validated.

```
class Person {
   String name

static constraints = {
       name size: 5..45
   }

def beforeValidate() {
       name = name?.trim()
   }
}
```

The `beforeValidate` method is run before any validators are run.

GORM supports an overloaded version of `beforeValidate` which accepts a `List` parameter which r which are about to be validated. This version of `beforeValidate` will be called when the `validate` `List` of property names as an argument.

```
class Person {
   String name
   String town
   Integer age

static constraints = {
       name size: 5..45
       age range: 4..99
   }

def beforeValidate(List propertiesBeingValidated) {
      // do pre validation work based on propertiesBeingValidated
   }
}

def p = new Person(name: 'Jacob Brown', age: 10)
p.validate(['age', 'name'])
```

> Note that when `validate` is triggered indirectly because of a call to the `save` metho
> method is being invoked with no arguments, not a `List` that includes all of the property nam

Either or both versions of `beforeValidate` may be defined in a domain class. GORM will prefer the `validate` but will fall back on the no-arg version if the `List` version does not exist. Likewise, GOR arguments are passed to `validate` but will fall back on the `List` version if the no-arg version does no `beforeValidate`.

The onLoad/beforeLoad event

Fired immediately before an object is loaded from the database:

```
class Person {
   String name
   Date dateCreated
   Date lastUpdated

def onLoad() {
      log.debug "Loading ${id}"
   }
}
```

`beforeLoad()` is effectively a synonym for `onLoad()`, so only declare one or the other.

The afterLoad event

Fired immediately after an object is loaded from the database:

```
class Person {
   String name
   Date dateCreated
   Date lastUpdated

def afterLoad() {
      name = "I'm loaded"
   }
}
```

Custom Event Listeners

You can also register event handler classes in an application's `grails-app/conf/spring` `doWithSpring` closure in a plugin descriptor by registering a Spring bean named `hibernateEv` property, `listenerMap` which specifies the listeners to register for various Hibernate events.

The values of the Map are instances of classes that implement one or more Hibernate listener interfaces. all of the required interfaces, or one concrete class per interface, or any combination. The valid Map keys here:

Name	Interface
auto-flush	AutoFlushEventListener
merge	MergeEventListener
create	PersistEventListener
create-onflush	PersistEventListener
delete	DeleteEventListener
dirty-check	DirtyCheckEventListener
evict	EvictEventListener
flush	FlushEventListener
flush-entity	FlushEntityEventListener
load	LoadEventListener
load-collection	InitializeCollectionEventListener
lock	LockEventListener
refresh	RefreshEventListener
replicate	ReplicateEventListener
save-update	SaveOrUpdateEventListener
save	SaveOrUpdateEventListener
update	SaveOrUpdateEventListener
pre-load	PreLoadEventListener
pre-update	PreUpdateEventListener
pre-delete	PreDeleteEventListener
pre-insert	PreInsertEventListener
pre-collection-recreate	PreCollectionRecreateEventListener
pre-collection-remove	PreCollectionRemoveEventListener
pre-collection-update	PreCollectionUpdateEventListener
post-load	PostLoadEventListener
post-update	PostUpdateEventListener
post-delete	PostDeleteEventListener
post-insert	PostInsertEventListener
post-commit-update	PostUpdateEventListener
post-commit-delete	PostDeleteEventListener
post-commit-insert	PostInsertEventListener
post-collection-recreate	PostCollectionRecreateEventListener
post-collection-remove	PostCollectionRemoveEventListener
post-collection-update	PostCollectionUpdateEventListener

For example, you could register a class AuditEventListener which implements PostUpdateEventListener, and PostDeleteEventListener using the following in an applic

```
beans = {

auditListener(AuditEventListener)

hibernateEventListeners(HibernateEventListeners) {
      listenerMap = ['post-insert': auditListener,
                     'post-update': auditListener,
                     'post-delete': auditListener]
   }
}
```

or use this in a plugin:

```
def doWithSpring = {

auditListener(AuditEventListener)

hibernateEventListeners(HibernateEventListeners) {
      listenerMap = ['post-insert': auditListener,
                     'post-update': auditListener,
                     'post-delete': auditListener]
   }
}
```

Automatic timestamping

The examples above demonstrated using events to update a lastUpdated and dateCreated prope However, this is actually not necessary. By defining a lastUpdated and dateCreated property thes by GORM.

If this is not the behaviour you want you can disable this feature with:

```
class Person {
   Date dateCreated
   Date lastUpdated
   static mapping = {
      autoTimestamp false
   }
}
```

> If you put nullable: false constraints on either dateCreated or lastUpdated, will fail validation - probably not what you want. Leave constraints off these properties un automatic timestamping.

5.5.2 Custom ORM Mapping

Grails domain classes can be mapped onto many legacy schemas with an Object Relational Mapping following sections takes you through what is possible with the ORM DSL.

⚠ None of this is necessary if you are happy to stick to the conventions defined by GORM fo
names and so on. You only needs this functionality if you need to tailor the way GORM map
or configures caching

Custom mappings are defined using a a static `mapping` block defined within your domain class:

```
class Person {
    …
    static mapping = {

}
}
```

5.5.2.1 Table and Column Names

Table names

The database table name which the class maps to can be customized using the `table` method:

```
class Person {
    …
    static mapping = {
        table 'people'
    }
}
```

In this case the class would be mapped to a table called `people` instead of the default name of `person`.

Column names

It is also possible to customize the mapping for individual columns onto the database. For example to chan

```
class Person {

String firstName

static mapping = {
        table 'people'
        firstName column: 'First_Name'
    }
}
```

Here `firstName` is a dynamic method within the `mapping` Closure that has a single Map parameter. S
class persistent field, the parameter values (in this case just `"column"`) are used to configure the mapping

Column type

GORM supports configuration of Hibernate types with the DSL using the type attribute. This includes s
Hibernate org.hibernate.usertype.UserType interface, which allows complete customization of how a type
a `PostCodeType` you could use it as follows:

```
class Address {

String number
    String postCode

static mapping = {
        postCode type: PostCodeType
    }
}
```

Alternatively if you just wanted to map it to one of Hibernate's basic types other than the default chosen by

```
class Address {

String number
    String postCode

static mapping = {
        postCode type: 'text'
    }
}
```

This would make the `postCode` column map to the default large-text type for the database you're using (

See the Hibernate documentation regarding [Basic Types] for further information.

Many-to-One/One-to-One Mappings

In the case of associations it is also possible to configure the foreign keys used to map associations. In th
association this is exactly the same as any regular column. For example consider the following:

```
class Person {

String firstName
    Address address

static mapping = {
        table 'people'
        firstName column: 'First_Name'
        address column: 'Person_Address_Id'
    }
}
```

By default the `address` association would map to a foreign key column called `address_id`. By usin
the name of the foreign key column to `Person_Adress_Id`.

One-to-Many Mapping

With a bidirectional one-to-many you can change the foreign key column used by changing the column na
as per the example in the previous section on one-to-one associations. However, with unidirectional as
specified on the association itself. For example given a unidirectional one-to-many relationship between
code will change the foreign key in the `address` table:

```
class Person {
String firstName
static hasMany = [addresses: Address]
static mapping = {
        table 'people'
        firstName column: 'First_Name'
        addresses column: 'Person_Address_Id'
    }
}
```

If you don't want the column to be in the `address` table, but instead some intermediate join table you car

```
class Person {
String firstName
static hasMany = [addresses: Address]
static mapping = {
        table 'people'
        firstName column: 'First_Name'
        addresses joinTable: [name: 'Person_Addresses',
                              key: 'Person_Id',
                              column: 'Address_Id']
    }
}
```

Many-to-Many Mapping

Grails, by default maps a many-to-many association using a join table. For example consider this many-to-

```
class Group {
    …
    static hasMany = [people: Person]
}
```

```
class Person {
    …
    static belongsTo = Group
    static hasMany = [groups: Group]
}
```

In this case Grails will create a join table called `group_person` containing foreign keys called `perso`
`person` and `group` tables. To change the column names you can specify a column within the mappings

```
class Group {
   …
   static mapping = {
       people column: 'Group_Person_Id'
   }
}
class Person {
   …
   static mapping = {
       groups column: 'Group_Group_Id'
   }
}
```

You can also specify the name of the join table to use:

```
class Group {
   …
   static mapping = {
       people column: 'Group_Person_Id',
              joinTable: 'PERSON_GROUP_ASSOCIATIONS'
   }
}
class Person {
   …
   static mapping = {
       groups column: 'Group_Group_Id',
              joinTable: 'PERSON_GROUP_ASSOCIATIONS'
   }
}
```

5.5.2.2 Caching Strategy

Setting up caching

Hibernate features a second-level cache with a customizable cache provider. This n
`grails-app/conf/DataSource.groovy` file as follows:

```
hibernate {
    cache.use_second_level_cache=true
    cache.use_query_cache=true
    cache.provider_class='org.hibernate.cache.EhCacheProvider'
}
```

You can customize any of these settings, for example to use a distributed caching mechanism.

> For further reading on caching and in particular Hibernate's second-level cache, re
> documentation on the subject.

Caching instances

Call the `cache` method in your mapping block to enable caching with the default settings:

```
class Person {
    …
    static mapping = {
        table 'people'
        cache true
    }
}
```

This will configure a 'read-write' cache that includes both lazy and non-lazy properties. You can customize

```
class Person {
    …
    static mapping = {
        table 'people'
        cache usage: 'read-only', include: 'non-lazy'
    }
}
```

Caching associations

As well as the ability to use Hibernate's second level cache to cache instances you can also cache co example:

```
class Person {

String firstName

static hasMany = [addresses: Address]

static mapping = {
        table 'people'
        version false
        addresses column: 'Address', cache: true
    }
}
```

```
class Address {
    String number
    String postCode
}
```

This will enable a 'read-write' caching mechanism on the `addresses` collection. You can also use:

```
cache: 'read-write' // or 'read-only' or 'transactional'
```

to further configure the cache usage.

Caching Queries

You can cache queries such as dynamic finders and criteria. To do so using a dynamic finder you can pass

```
def person = Person.findByFirstName("Fred", [cache: true])
```

In order for the results of the query to be cached, you must enable caching in your mappi
previous section.

You can also cache criteria queries:

```
def people = Person.withCriteria {
    like('firstName', 'Fr%')
    cache true
}
```

Cache usages

Below is a description of the different cache settings and their usages:

- `read-only` - If your application needs to read but never modify instances of a persistent class, a rea
- `read-write` - If the application needs to update data, a read-write cache might be appropriate.
- `nonstrict-read-write` - If the application only occasionally needs to update data (ie. if it is ve try to update the same item simultaneously) and strict transaction isolation is not required, a `nonst` appropriate.
- `transactional` - The `transactional` cache strategy provides support for fully transact TreeCache. Such a cache may only be used in a JTA environmen `hibernate.transaction.manager_lookup_class` in the `grails-app/conf/Data` config.

5.5.2.3 Inheritance Strategies

By default GORM classes use `table-per-hierarchy` inheritance mapping. This has the disad `NOT-NULL` constraint applied to them at the database level. If you would prefer to use a `table-per-s` do so as follows:

```
class Payment {
    Integer amount

static mapping = {
        tablePerHierarchy false
    }
}

class CreditCardPayment extends Payment {
    String cardNumber
}
```

The mapping of the root `Payment` class specifies that it will not be using `table-per-hierarchy` ma

5.5.2.4 Custom Database Identity

You can customize how GORM generates identifiers for the database using the DSL. By default GORM r
for generating ids. This is by far the best approach, but there are still many schemas that have different app

To deal with this Hibernate defines the concept of an id generator. You can customize the id generator and

```
class Person {
    …
    static mapping = {
        table 'people'
        version false
        id generator: 'hilo',
           params: [table: 'hi_value',
                    column: 'next_value',
                    max_lo: 100]
    }
}
```

In this case we're using one of Hibernate's built in 'hilo' generators that uses a separate table to generate ids

> ⚠ For more information on the different Hibernate generators refer to the [Hibernate reference dc]()

Although you don't typically specify the `id` field (Grails adds it for you) you can still configure its ı
example to customise the column for the id property you can do:

```
class Person {
    …
    static mapping = {
        table 'people'
        version false
        id column: 'person_id'
    }
}
```

5.5.2.5 Composite Primary Keys

GORM supports the concept of composite identifiers (identifiers composed from 2 or more properties). It
is available to you if you need it:

```
import org.apache.commons.lang.builder.HashCodeBuilder
class Person implements Serializable {
String firstName
    String lastName
boolean equals(other) {
        if (!(other instanceof Person)) {
            return false
        }
other.firstName == firstName && other.lastName == lastName
    }
int hashCode() {
        def builder = new HashCodeBuilder()
        builder.append firstName
        builder.append lastName
        builder.toHashCode()
    }
static mapping = {
        id composite: ['firstName', 'lastName']
    }
}
```

The above will create a composite id of the `firstName` and `lastName` properties of the Person class. prototype of the object itself:

```
def p = Person.get(new Person(firstName: "Fred", lastName: "Flintstone"))
println p.firstName
```

Domain classes mapped with composite primary keys must implement the `Serializable` interface and methods, using the properties in the composite key for the calculations. The example above uses a `HashC` fine to implement it yourself.

Another important consideration when using composite primary keys is associations. If for example you the foreign keys are stored in the associated table then 2 columns will be present in the associated table.

For example consider the following domain class:

```
class Address {
    Person person
}
```

In this case the `address` table will have an additional two columns called `person_first_name` an the change the mapping of these columns then you can do so using the following technique:

```
class Address {
    Person person
    static mapping = {
        person {
            column: "FirstName"
            column: "LastName"
        }
    }
}
```

5.5.2.6 Database Indices

To get the best performance out of your queries it is often necessary to tailor the table index definitions. I and a matter of monitoring usage patterns of your queries. With GORM's DSL you can specify which colu

```
class Person {
    String firstName
    String address
    static mapping = {
        table 'people'
        version false
        id column: 'person_id'
        firstName column: 'First_Name', index: 'Name_Idx'
        address column: 'Address', index: 'Name_Idx,Address_Index'
    }
}
```

Note that you cannot have any spaces in the value of the `index` attribute; in this example `index:'N` cause an error.

5.5.2.7 Optimistic Locking and Versioning

As discussed in the section on [Optimistic and Pessimistic Locking](), by default GORM uses optimisti `version` property into every class which is in turn mapped to a `version` column at the database level.

If you're mapping to a legacy schema that doesn't have version columns (or there's some other reason wh can disable this with the `version` method:

```
class Person {
    …
    static mapping = {
        table 'people'
        version false
    }
}
```

> If you disable optimistic locking you are essentially on your own with regards to concurrent u the risk of users losing data (due to data overriding) unless you use [pessimistic locking]()

Version columns types

By default Grails maps the `version` property as a `Long` that gets incremented by one each time an i
supports using a `Timestamp`, for example:

```
import java.sql.Timestamp

class Person {

…
    Timestamp version

static mapping = {
        table 'people'
    }
}
```

There's a slight risk that two updates occurring at nearly the same time on a fast server can end up with th
very low. One benefit of using a `Timestamp` instead of a `Long` is that you combine the optimistic loc
single column.

5.5.2.8 Eager and Lazy Fetching

Lazy Collections

As discussed in the section on [Eager and Lazy fetching](), GORM collections are lazily loaded by default l
the ORM DSL. There are several options available to you, but the most common ones are:

- lazy: false
- fetch: 'join'

and they're used like this:

```
class Person {

String firstName
    Pet pet

static hasMany = [addresses: Address]

static mapping = {
        addresses lazy: false
        pet fetch: 'join'
    }
}
```

```
class Address {
    String street
    String postCode
}
```

```
class Pet {
    String name
}
```

The first option, `lazy: false` , ensures that when a `Person` instance is loaded, its `addresses` colle
second SELECT. The second option is basically the same, except the collection is loaded with a JOIN r
you want to reduce the number of queries, so `fetch: 'join'` is the more appropriate option. On the o
expensive approach if your domain model and data result in more and larger results than would otherwise l

For more advanced users, the other settings available are:

1. batchSize: N
2. lazy: false, batchSize: N

where N is an integer. These let you fetch results in batches, with one query per batch. As a simple exampl

```
class Person {

String firstName
    Pet pet

static mapping = {
        pet batchSize: 5
    }
}
```

If a query returns multiple `Person` instances, then when we access the first `pet` property, Hibernate will
You can get the same behaviour with eager loading by combining `batchSize` with the `lazy: fals`
these options in the [Hibernate user guide] and this [primer on fetching strategies]. Note that ORM DSL doe
fetching strategy.

Lazy Single-Ended Associations

In GORM, one-to-one and many-to-one associations are by default lazy. Non-lazy single ended associati
many entities because each non-lazy association will result in an extra SELECT statement. If the a
associations, the number of queries grows significantly!

Use the same technique as for lazy collections to make a one-to-one or many-to-one association non-lazy/e

```
class Person {
    String firstName
}
```

```
class Address {

String street
    String postCode

static belongsTo = [person: Person]

static mapping = {
        person lazy: false
    }
}
```

Here we configure GORM to load the associated `Person` instance (through the `person` property) whene

Lazy Single-Ended Associations and Proxies

Hibernate uses runtime-generated proxies to facilitate single-ended lazy associations; Hibernate dynamica the proxy.

Consider the previous example but with a lazily-loaded `person` association: Hibernate will set the p subclass of `Person`. When you call any of the getters (except for the `id` property) or setters on that pro the database.

Unfortunately this technique can produce surprising results. Consider the following example classes:

```
class Pet {
    String name
}
```

```
class Dog extends Pet {
}
```

```
class Person {
    String name
    Pet pet
}
```

and assume that we have a single `Person` instance with a `Dog` as the `pet`. The following code will work

```
def person = Person.get(1)
assert person.pet instanceof Dog
assert Pet.get(person.petId) instanceof Dog
```

But this won't:

```
def person = Person.get(1)
assert person.pet instanceof Dog
assert Pet.list()[0] instanceof Dog
```

The second assertion fails, and to add to the confusion, this will work:

```
assert Pet.list()[0] instanceof Dog
```

What's going on here? It's down to a combination of how proxies work and the guarantees that the Hibern `Person` instance, Hibernate creates a proxy for its `pet` relation and attaches it to the session. Once tha `Pet` instance with a query, a `get()`, or the `pet` relation *within the same session* , Hibernate gives you the

Fortunately for us, GORM automatically unwraps the proxy when you use `get()` and `findBy*()`, or That means you don't have to worry at all about proxies in the majority of cases. But GORM doesn't do th returns a list, such as `list()` and `findAllBy*()`. However, if Hibernate hasn't attached the proxy to t real instances - hence why the last example works.

You can protect yourself to a degree from this problem by using the `instanceOf` method by GORM:

```
def person = Person.get(1)
assert Pet.list()[0].instanceOf(Dog)
```

However, it won't help here if casting is involved. For example, the following code will throw a `ClassC` in the list is a proxy instance with a class that is neither `Dog` nor a sub-class of `Dog`:

```
def person = Person.get(1)
Dog pet = Pet.list()[0]
```

Of course, it's best not to use static types in this situation. If you use an untyped variable for the pet insteac methods on the instance without any problems.

These days it's rare that you will come across this issue, but it's best to be aware of it just in case. At l occurs and be able to work around it.

5.5.2.9 Custom Cascade Behaviour

As described in the section on cascading updates, the primary mechanism to control the way updates and another is the static belongsTo property.

However, the ORM DSL gives you complete access to Hibernate's transitive persistence capabilities using

Valid settings for the cascade attribute include:

- `merge` - merges the state of a detached association
- `save-update` - cascades only saves and updates to an association
- `delete` - cascades only deletes to an association
- `lock` - useful if a pessimistic lock should be cascaded to its associations
- `refresh` - cascades refreshes to an association
- `evict` - cascades evictions (equivalent to `discard()` in GORM) to associations if set
- `all` - cascade *all* operations to associations
- `all-delete-orphan` - Applies only to one-to-many associations and indicates that when a child should be automatically deleted. Children are also deleted when the parent is.

> It is advisable to read the section in the Hibernate documentation on transitive persiste understanding of the different cascade styles and recommendations for their usage

To specify the cascade attribute simply define one or more (comma-separated) of the aforementioned setti

```
class Person {

String firstName

static hasMany = [addresses: Address]

static mapping = {
        addresses cascade: "all-delete-orphan"
    }
}
```

```
class Address {
    String street
    String postCode
}
```

5.5.2.10 Custom Hibernate Types

You saw in an earlier section that you can use composition (with the `embedded` property) to break achieve a similar effect with Hibernate's custom user types. These are not domain classes themselves, bu these types also has a corresponding "meta-type" class that implements org.hibernate.usertype.UserType.

The Hibernate reference manual has some information on custom types, but here we will focus on hov taking a look at a simple domain class that uses an old-fashioned (pre-Java 1.5) type-safe enum class:

```
class Book {

String title
    String author
    Rating rating

static mapping = {
        rating type: RatingUserType
    }
}
```

All we have done is declare the `rating` field the enum type and set the property's type in the custom ma implementation. That's all you have to do to start using your custom type. If you want, you can also "column" to change the column name and "index" to add it to an index.

Custom types aren't limited to just a single column - they can be mapped to as many columns as you wan the mapping what columns to use, since Hibernate can only use the property name for a single column. Fc columns to a property using this syntax:

```
class Book {

String title
    Name author
    Rating rating

static mapping = {
        name type: NameUserType, {
            column name: "first_name"
            column name: "last_name"
        }
        rating type: RatingUserType
    }
}
```

The above example will create "first_name" and "last_name" columns for the `author` property. You'll be
some of the normal column/property mapping attributes in the column definitions. For example:

```
column name: "first_name", index: "my_idx", unique: true
```

The column definitions do *not* support the following attributes: `type`, `cascade`, `lazy`, `cache`, and `jo`

One thing to bear in mind with custom types is that they define the *SQL types* for the corresponding databa
of configuring them yourself, but what happens if you have a legacy database that uses a different SQL ty
override the column's SQL type using the `sqlType` attribute:

```
class Book {

String title
    Name author
    Rating rating

static mapping = {
        name type: NameUserType, {
            column name: "first_name", sqlType: "text"
            column name: "last_name", sqlType: "text"
        }
        rating type: RatingUserType, sqlType: "text"
    }
}
```

Mind you, the SQL type you specify needs to still work with the custom type. So overriding a defau
overriding "text" with "yes_no" isn't going to work.

5.5.2.11 Derived Properties

A derived property is one that takes its value from a SQL expression, often but not necessarily based on th
properties. Consider a Product class like this:

```
class Product {
    Float price
    Float taxRate
    Float tax
}
```

If the tax property is derived based on the value of price and taxRate properties then is probably no
SQL used to derive the value of a derived property may be expressed in the ORM DSL like this:

```
class Product {
    Float price
    Float taxRate
    Float tax

static mapping = {
        tax formula: 'PRICE * TAX_RATE'
    }
}
```

Note that the formula expressed in the ORM DSL is SQL so references to other properties should relate
model, which is why the example refers to PRICE and TAX_RATE instead of price and taxRate.

With that in place, when a Product is retrieved with something like Product.get(42), the SQL tha
something like this:

```
select
    product0_.id as id1_0_,
    product0_.version as version1_0_,
    product0_.price as price1_0_,
    product0_.tax_rate as tax4_1_0_,
    product0_.PRICE * product0_.TAX_RATE as formula1_0_
from
    product product0_
where
    product0_.id=?
```

Since the tax property is derived at runtime and not stored in the database it might seem that the same
method like getTax() to the Product class that simply returns the product of the taxRate and pr
that you would give up the ability query the database based on the value of the tax property. Using a d
retrieve all Product objects that have a tax value greater than 21.12 you could execute a query like this

```
Product.findAllByTaxGreaterThan(21.12)
```

Derived properties may be referenced in the Criteria API:

```
Product.withCriteria {
    gt 'tax', 21.12f
}
```

The SQL that is generated to support either of those would look something like this:

```
select
    this_.id as id1_0_,
    this_.version as version1_0_,
    this_.price as price1_0_,
    this_.tax_rate as tax4_1_0_,
    this_.PRICE * this_.TAX_RATE as formula1_0_
from
    product this_
where
    this_.PRICE * this_.TAX_RATE>?
```

> Because the value of a derived property is generated in the database and depends on the ex derived properties may not have GORM constraints applied to them. If constraints are s property, they will be ignored.

5.5.2.12 Custom Naming Strategy

By default Grails uses Hibernate's `ImprovedNamingStrategy` to convert domain class Class and names by converting from camel-cased Strings to ones that use underscores as word separators. You can in the `mapping` closure but if there's a consistent pattern you can specify a different `NamingStrategy`

Configure the class name to be used in `grails-app/conf/DataSource.groovy` in the `hiberna`

```
dataSource {
    pooled = true
    dbCreate = "create-drop"
    …
}

hibernate {
    cache.use_second_level_cache = true
    …
    naming_strategy = com.myco.myproj.CustomNamingStrategy
}
```

You can use an existing class or write your own, for example one that prefixes table names and column na

```
package com.myco.myproj

import org.hibernate.cfg.ImprovedNamingStrategy
import org.hibernate.util.StringHelper

class CustomNamingStrategy extends ImprovedNamingStrategy {

String classToTableName(String className) {
        "table_" + StringHelper.unqualify(className)
    }

String propertyToColumnName(String propertyName) {
        "col_" + StringHelper.unqualify(propertyName)
    }
}
```

5.5.3 Default Sort Order

You can sort objects using query arguments such as those found in the list method:

```
def airports = Airport.list(sort:'name')
```

However, you can also declare the default sort order for a collection in the mapping:

```
class Airport {
    …
    static mapping = {
        sort "name"
    }
}
```

The above means that all collections of `Airports` will by default be sorted by the airport name. If you a
this syntax:

```
class Airport {
    …
    static mapping = {
        sort name: "desc"
    }
}
```

Finally, you can configure sorting at the association level:

```
class Airport {
    …
    static hasMany = [flights: Flight]

static mapping = {
        flights sort: 'number', order: 'desc'
    }
}
```

In this case, the `flights` collection will always be sorted in descending order of flight number.

> These mappings will not work for default unidirectional one-to-many or many-to-many rela
> involve a join table. See this issue for more details. Consider using a `SortedSet` or queries
> fetch the data you need.

5.6 Programmatic Transactions

Grails is built on Spring and uses Spring's Transaction abstraction for dealing with programmatic transa
been enhanced to make this simpler with the withTransaction method. This method has a single para
parameter which is a Spring TransactionStatus instance.

Here's an example of using `withTransaction` in a controller methods:

```
def transferFunds() {
    Account.withTransaction { status ->
        def source = Account.get(params.from)
        def dest = Account.get(params.to)

def amount = params.amount.toInteger()
        if (source.active) {
            if (dest.active) {
                source.balance -= amount
                dest.amount += amount
            }
            else {
                status.setRollbackOnly()
            }
        }
    }
}
```

In this example we rollback the transaction if the destination account is not active. Also, if an uncheck checked `Exception`, even though Groovy doesn't require that you catch checked exceptions) is thrown automatically be rolled back.

You can also use "save points" to rollback a transaction to a particular point in time if you don't want to r be achieved through the use of Spring's [SavePointManager](#) interface.

The `withTransaction` method deals with the begin/commit/rollback logic for you within the scope of

5.7 GORM and Constraints

Although constraints are covered in the [Validation](#) section, it is important to mention them here as some which the database schema is generated.

Where feasible, Grails uses a domain class's constraints to influence the database columns generate properties.

Consider the following example. Suppose we have a domain model with the following properties:

```
String name
String description
```

By default, in MySQL, Grails would define these columns as

Column	Data Type
name	varchar(255)
description	varchar(255)

But perhaps the business rules for this domain class state that a description can be up to 1000 characters in likely define the column as follows *if* we were creating the table with an SQL script.

Column	Data Type
description	TEXT

Chances are we would also want to have some application-based validation to make sure we don't exce persist any records. In Grails, we achieve this validation with constraints. We would add the following con

```
static constraints = {
    description maxSize: 1000
}
```

This constraint would provide both the application-based validation we want and it would also cause the s Below is a description of the other constraints that influence schema generation.

Constraints Affecting String Properties

- inList
- maxSize
- size

If either the `maxSize` or the `size` constraint is defined, Grails sets the maximum column length based o

In general, it's not advisable to use both constraints on the same domain class property. However, if both constraint are defined, then Grails sets the column length to the minimum of the `maxSize` constraint and (Grails uses the minimum of the two, because any length that exceeds that minimum will result in a valida

If the `inList` constraint is defined (and the `maxSize` and the `size` constraints are not defined), then based on the length of the longest string in the list of valid values. For example, given a list including valu would set the column length to 6 (i.e., the number of characters in the string "Groovy").

Constraints Affecting Numeric Properties

- min
- max
- range

If the `max`, `min`, or `range` constraint is defined, Grails attempts to set the column precision based on th attempted influence is largely dependent on how Hibernate interacts with the underlying DBMS.)

In general, it's not advisable to combine the pair `min`/`max` and `range` constraints together on the same d of these constraints is defined, then Grails uses the minimum precision value from the constraints. (Grails any length that exceeds that minimum precision will result in a validation error.)

- scale

If the scale constraint is defined, then Grails attempts to set the column scale based on the constraint v point numbers (i.e., `java.lang.Float`, `java.Lang.Double`, `java.lang.BigI` `java.lang.BigDecimal`). The success of this attempted influence is largely dependent on how H DBMS.

The constraints define the minimum/maximum numeric values, and Grails derives the maximum number in mind that specifying only one of `min`/`max` constraints will not affect schema generation (since there co with max:100, for example), unless the specified constraint value requires more digits than default Hi moment). For example:

```
someFloatValue max: 1000000, scale: 3
```

would yield:

```
someFloatValue DECIMAL(19, 3) // precision is default
```

but

```
someFloatValue max: 12345678901234567890, scale: 5
```

would yield:

```
someFloatValue DECIMAL(25, 5) // precision = digits in max + scale
```

and

```
someFloatValue max: 100, min: -100000
```

would yield:

```
someFloatValue DECIMAL(8, 2) // precision = digits in min + default scale
```

6 The Web Layer

6.1 Controllers

A controller handles requests and creates or prepares the response. A controller can generate the response (a controller, simply create a class whose name ends with `Controller` in the `grails-app/control` in a package).

The default URL Mapping configuration ensures that the first part of your controller name is mapped to your controller maps to URIs within the controller name URI.

6.1.1 Understanding Controllers and Actions

Creating a controller

Controllers can be created with the create-controller or generate-controller command. For example try rui root of a Grails project:

```
grails create-controller book
```

The command will create a controller at the location `grails-app/controllers/myapp/BookCor`

```
package myapp
class BookController {
def index() { }
}
```

where "myapp" will be the name of your application, the default package name if one isn't specified.

`BookController` by default maps to the /book URI (relative to your application root).

> The `create-controller` and `generate-controller` commands are just for conver as easily create controllers using your favorite text editor or IDE

Creating Actions

A controller can have multiple public action methods; each one maps to a URI:

```
class BookController {
def list() {
// do controller logic
        // create model
return model
    }
}
```

This example maps to the `/book/list` URI by default thanks to the property being named `list`.

Public Methods as Actions

In earlier versions of Grails actions were implemented with Closures. This is still supported, but the prefer

Leveraging methods instead of Closure properties has some advantages:

- Memory efficient
- Allow use of stateless controllers (`singleton` scope)
- You can override actions from subclasses and call the overridden superclass method with `super.ac`
- Methods can be intercepted with standard proxying mechanisms, something that is complicated to do

If you prefer the Closure syntax or have older controller classes created in earlier versions of Grails a methods, you can set the `grails.compile.artefacts.closures.convert` property to true in I

```
grails.compile.artefacts.closures.convert = true
```

and a compile-time AST transformation will convert your Closures to methods in the generated bytecode.

The Default Action

A controller has the concept of a default URI that maps to the root URI of the controller, for example action that is called when the default URI is requested is dictated by the following rules:

- If there is only one action, it's the default
- If you have an action named `index`, it's the default
- Alternatively you can set it explicitly with the `defaultAction` property:

```
static defaultAction = "list"
```

6.1.2 Controllers and Scopes

Available Scopes

Scopes are hash-like objects where you can store variables. The following scopes are available to controlle

- servletContext - Also known as application scope, this scope lets you share state across the entire we instance of ServletContext
- session - The session allows associating state with a given user and typically uses cookies to associ object is an instance of HttpSession
- request - The request object allows the storage of objects for the current request only. Th HttpServletRequest
- params - Mutable map of incoming request query string or POST parameters
- flash - See below

Accessing Scopes

Scopes can be accessed using the variable names above in combination with Groovy's array index ope Servlet API such as the HttpServletRequest:

```
class BookController {
    def find() {
        def findBy = params["findBy"]
        def appContext = request["foo"]
        def loggedUser = session["logged_user"]
    }
}
```

You can also access values within scopes using the de-reference operator, making the syntax even more cl

```
class BookController {
    def find() {
        def findBy = params.findBy
        def appContext = request.foo
        def loggedUser = session.logged_user
    }
}
```

This is one of the ways that Grails unifies access to the different scopes.

Using Flash Scope

Grails supports the concept of flash scope as a temporary store to make attributes available for this reques the attributes are cleared. This is useful for setting a message directly before redirecting, for example:

```
def delete() {
    def b = Book.get(params.id)
    if (!b) {
        flash.message = "User not found for id ${params.id}"
        redirect(action:list)
    }
    … // remaining code
}
```

When the `list` action is requested, the `message` value will be in scope and can be used to display an ir
from the `flash` scope after this second request.

Note that the attribute name can be anything you want, and the values are often strings used to display mes

Scoped Controllers

By default, a new controller instance is created for each request. In fact, because the controller is `prot`
each request happens on its own thread.

You can change this behaviour by placing a controller in a particular scope. The supported scopes are:

- `prototype` (default) - A new controller will be created for each request (recommended for actions a
- `session` - One controller is created for the scope of a user session
- `singleton` - Only one instance of the controller ever exists (recommended for actions as methods)

To enable one of the scopes, add a static `scope` property to your class with one of the valid scope values l

```
static scope = "singleton"
```

You can define the default strategy under in `Config.groovy` with the `grails.controllers.def`

```
grails.controllers.defaultScope = "singleton"
```

> Use scoped controllers wisely. For instance, we don't recommend having any properties
> controller since they will be shared for *all* requests. Setting a default scope other than `proto`
> unexpected behaviors if you have controllers provided by installed plugins that expe
> `prototype`.

6.1.3 Models and Views

Returning the Model

A model is a Map that the view uses when rendering. The keys within that Map correspond to variable nai
couple of ways to return a model. First, you can explicitly return a Map instance:

```
def show() {
    [book: Book.get(params.id)]
}
```

> The above does *not* reflect what you should use with the scaffolding views - see the [scaffo
> details.

If no explicit model is returned the controller's properties will be used as the model, thus allowing you to w

```
class BookController {

List books
    List authors

def list() {
        books = Book.list()
        authors = Author.list()
    }
}
```

This is possible due to the fact that controllers are prototype scoped. In other words a new c
each request. Otherwise code such as the above would not be thread-safe, and all users would

In the above example the `books` and `authors` properties will be available in the view.

A more advanced approach is to return an instance of the Spring [ModelAndView](http://static.springframework.org/spring/docs/2.5.x/api/org/springframework/web/servlet/ModelAndView.html) class:

```
import org.springframework.web.servlet.ModelAndView

def index() {
    // get some books just for the index page, perhaps your favorites
    def favoriteBooks = ...

// forward to the list view to show them
    return new ModelAndView("/book/list", [ bookList : favoriteBooks ])
}
```

One thing to bear in mind is that certain variable names can not be used in your model:

- `attributes`
- `application`

Currently, no error will be reported if you do use them, but this will hopefully change in a future version o

Selecting the View

In both of the previous two examples there was no code that specified which view to render. So how doe
answer lies in the conventions. Grails will look for a view at the location `grails-app/views/book/`

```
class BookController {
    def show() {
         [book: Book.get(params.id)]
    }
}
```

To render a different view, use the render method:

```
def show() {
    def map = [book: Book.get(params.id)]
    render(view: "display", model: map)
}
```

In this case Grails will attempt to render a view at the location `grails-app/views/book/display` qualifies the view location with the `book` directory of the `grails-app/views` directory. This is conv need instead you can use an absolute path instead of a relative one:

```
def show() {
    def map = [book: Book.get(params.id)]
    render(view: "/shared/display", model: map)
}
```

In this case Grails will attempt to render a view at the location `grails-app/views/shared/displ`

Grails also supports JSPs as views, so if a GSP isn't found in the expected location but a JSP is, it will be u

Rendering a Response

Sometimes it's easier (for example with Ajax applications) to render snippets of text or code to the respons the highly flexible `render` method can be used:

```
render "Hello World!"
```

The above code writes the text "Hello World!" to the response. Other examples include:

```
// write some markup
render {
   for (b in books) {
      div(id: b.id, b.title)
   }
}
```

```
// render a specific view
render(view: 'show')
```

```
// render a template for each item in a collection
render(template: 'book_template', collection: Book.list())
```

```
// render some text with encoding and content type
render(text: "<xml>some xml</xml>", contentType: "text/xml", encoding: "UTF-8")
```

If you plan on using Groovy's `MarkupBuilder` to generate HTML for use with the `render` method HTML elements and Grails tags, for example:

```
import groovy.xml.MarkupBuilder
…
def login() {
    def writer = new StringWriter()
    def builder = new MarkupBuilder(writer)
    builder.html {
        head {
            title 'Log in'
        }
        body {
            h1 'Hello'
            form {
            }
        }
    }

def html = writer.toString()
    render html
}
```

This will actually [call the form tag](#) (which will return some text that will be ignored by the `MarkupBui` element, use the following:

```
def login() {
    // …
    body {
        h1 'Hello'
        builder.form {
        }
    }
    // …
}
```

6.1.4 Redirects and Chaining

Redirects

Actions can be redirected using the [redirect](#) controller method:

```
class OverviewController {

def login() {}

def find() {
        if (!session.user)
            redirect(action: 'login')
            return
        }
        …
    }
}
```

Internally the [redirect](#) method uses the [HttpServletResponse](#) object's `sendRedirect` method.

The `redirect` method expects one of:

- Another closure within the same controller class:

```
// Call the login action within the same class
redirect(action: login)
```

- The name of an action (and controller name if the redirect isn't to an action in the current controller):

```
// Also redirects to the index action in the home controller
redirect(controller: 'home', action: 'index')
```

- A URI for a resource relative the application context path:

```
// Redirect to an explicit URI
redirect(uri: "/login.html")
```

- Or a full URL:

```
// Redirect to a URL
redirect(url: "http://grails.org")
```

Parameters can optionally be passed from one action to the next using the `params` argument of the metho

```
redirect(action: 'myaction', params: [myparam: "myvalue"])
```

These parameters are made available through the params dynamic property that accesses request paramet
same name as a request parameter, the request parameter is overridden and the controller parameter is usec

Since the `params` object is a Map, you can use it to pass the current request parameters from one action tc

```
redirect(action: "next", params: params)
```

Finally, you can also include a fragment in the target URI:

```
redirect(controller: "test", action: "show", fragment: "profile")
```

which will (depending on the URL mappings) redirect to something like "/myapp/test/show#profile".

Chaining

Actions can also be chained. Chaining allows the model to be retained from one action to the next. For ex
action:

```
class ExampleChainController {

def first() {
        chain(action: second, model: [one: 1])
    }

def second () {
        chain(action: third, model: [two: 2])
    }

def third() {
        [three: 3])
    }
}
```

results in the model:

```
[one: 1, two: 2, three: 3]
```

The model can be accessed in subsequent controller actions in the chain using the `chainModel` map
actions following the call to the `chain` method:

```
class ChainController {

def nextInChain() {
        def model = chainModel.myModel
        …
    }
}
```

Like the `redirect` method you can also pass parameters to the `chain` method:

```
chain(action: "action1", model: [one: 1], params: [myparam: "param1"])
```

6.1.5 Controller Interceptors

Often it is useful to intercept processing based on either request, session or application state. This can be a
are currently two types of interceptors: before and after.

> If your interceptor is likely to apply to more than one controller, you are almost certainly bet
> Filters can be applied to multiple controllers or URIs without the need to change the logic of e

Before Interception

The `beforeInterceptor` intercepts processing before the action is executed. If it returns `false`
executed. The interceptor can be defined for all actions in a controller as follows:

```
def beforeInterceptor = {
    println "Tracing action ${actionUri}"
}
```

The above is declared inside the body of the controller definition. It will be executed before all actions an
common use case is very simplistic authentication:

```
def beforeInterceptor = [action: this.&auth, except: 'login']

// defined with private scope, so it's not considered an action
private auth() {
    if (!session.user) {
        redirect(action: 'login')
        return false
    }
}

def login() {
    // display login page
}
```

The above code defines a method called `auth`. A private method is used so that it is not exposed as
`beforeInterceptor` then defines an interceptor that is used on all actions *except* the login action a
`auth` method is referenced using Groovy's method pointer syntax. Within the method it detects whether th
redirects to the `login` action and returns `false`, causing the intercepted action to not be processed.

After Interception

Use the `afterInterceptor` property to define an interceptor that is executed after an action:

```
def afterInterceptor = { model ->
    println "Tracing action ${actionUri}"
}
```

The after interceptor takes the resulting model as an argument and can hence manipulate the model or resp

An after interceptor may also modify the Spring MVC [ModelAndView](#) object prior to rendering. In this ca

```
def afterInterceptor = { model, modelAndView ->
    println "Current view is ${modelAndView.viewName}"
    if (model.someVar) modelAndView.viewName = "/mycontroller/someotherview"
    println "View is now ${modelAndView.viewName}"
}
```

This allows the view to be changed based on the model returned by the current action. Note that the `mode`
being intercepted called `redirect` or `render`.

Interception Conditions

Rails users will be familiar with the authentication example and how the 'except' condition was used wher
are called 'filters' in Rails; this terminology conflicts with Servlet filter terminology in Java):

```
def beforeInterceptor = [action: this.&auth, except: 'login']
```

This executes the interceptor for all actions except the specified action. A list of actions can also be define

```
def beforeInterceptor = [action: this.&auth, except: ['login', 'register']]
```

The other supported condition is 'only', this executes the interceptor for only the specified action(s):

```
def beforeInterceptor = [action: this.&auth, only: ['secure']]
```

6.1.6 Data Binding

Data binding is the act of "binding" incoming request parameters onto the properties of an object or ar should deal with all necessary type conversion since request parameters, which are typically delivered by whilst the properties of a Groovy or Java object may well not be.

Grails uses Spring's underlying data binding capability to perform data binding.

Binding Request Data to the Model

There are two ways to bind request parameters onto the properties of a domain class. The first involves usi

```
def save() {
    def b = new Book(params)
    b.save()
}
```

The data binding happens within the code `new Book(params)`. By passing the params object tc automatically recognizes that you are trying to bind from request parameters. So if we had an incoming rec

```
/book/save?title=The%20Stand&author=Stephen%20King
```

Then the `title` and `author` request parameters would automatically be set on the domain class. Y perform data binding onto an existing instance:

```
def save() {
    def b = Book.get(params.id)
    b.properties = params
    b.save()
}
```

This has the same effect as using the implicit constructor.

Data binding and Single-ended Associations

If you have a `one-to-one` or `many-to-one` association you can use Grails' data binding capability example if you have an incoming request such as:

```
/book/save?author.id=20
```

Grails will automatically detect the `.id` suffix on the request parameter and look up the `Author` inst binding such as:

```
def b = new Book(params)
```

An association property can be set to `null` by passing the literal `String` "null". For example:

```
/book/save?author.id=null
```

Data Binding and Many-ended Associations

If you have a one-to-many or many-to-many association there are different techniques for data binding dep

If you have a `Set` based association (the default for a `hasMany`) then the simplest way to populate an as For example consider the usage of `<g:select>` below:

```
<g:select name="books"
          from="${Book.list()}"
          size="5" multiple="yes" optionKey="id"
          value="${author?.books}" />
```

This produces a select box that lets you select multiple values. In this case if you submit the form Grail from the select box to populate the `books` association.

However, if you have a scenario where you want to update the properties of the associated objects the this the subscript operator:

```
<g:textField name="books[0].title" value="the Stand" />
<g:textField name="books[1].title" value="the Shining" />
```

However, with `Set` based association it is critical that you render the mark-up in the same order that you p a `Set` has no concept of order, so although we're referring to `books0` and `books1` it is not guaranteed correct on the server side unless you apply some explicit sorting yourself.

This is not a problem if you use `List` based associations, since a `List` has a defined order and an inde `Map` based associations.

Note also that if the association you are binding to has a size of two and you refer to an element that is outs

```
<g:textField name="books[0].title" value="the Stand" />
<g:textField name="books[1].title" value="the Shining" />
<g:textField name="books[2].title" value="Red Madder" />
```

Then Grails will automatically create a new instance for you at the defined position. If you "skipped" a few

```
<g:textField name="books[0].title" value="the Stand" />
<g:textField name="books[1].title" value="the Shining" />
<g:textField name="books[5].title" value="Red Madder" />
```

Then Grails will automatically create instances in between. For example in the above case Grails w association being bound had a size of 2.

You can bind existing instances of the associated type to a `List` using the same `.id` syntax as you wou For example:

```
<g:select name="books[0].id" from="${bookList}"
          value="${author?.books[0]?.id}" />

<g:select name="books[1].id" from="${bookList}"
          value="${author?.books[1]?.id}" />

<g:select name="books[2].id" from="${bookList}"
          value="${author?.books[2]?.id}" />
```

Would allow individual entries in the `books List` to be selected separately.

Entries at particular indexes can be removed in the same way too. For example:

```
<g:select name="books[0].id"
          from="${Book.list()}"
          value="${author?.books[0]?.id}"
          noSelection="['null': '']"/>
```

Will render a select box that will remove the association at `books0` if the empty option is chosen.

Binding to a `Map` property works the same way except that the list index in the parameter name is replaced

```
<g:select name="images[cover].id"
          from="${Image.list()}"
          value="${book?.images[cover]?.id}"
          noSelection="['null': '']"/>
```

This would bind the selected image into the `Map` property `images` under a key of `"cover"`.

Data binding with Multiple domain classes

It is possible to bind data to multiple domain objects from the params object.

For example so you have an incoming request to:

```
/book/save?book.title=The%20Stand&author.name=Stephen%20King
```

You'll notice the difference with the above request is that each parameter has a prefix such as `author.` o
parameters belong to which type. Grails' `params` object is like a multi-dimensional hash and you can ind
parameters to bind.

```
def b = new Book(params.book)
```

Notice how we use the prefix before the first dot of the `book.title` parameter to isolate only parameter
the same with an `Author` domain class:

```
def a = new Author(params.author)
```

Data Binding and Action Arguments

Controller action arguments are subject to request parameter data binding. There are 2 categories of
category is command objects. Complex types are treated as command objects. See the [Command Objec
The other category is basic object types. Supported types are the 8 primitives, their corresponding type wra
behavior is to map request parameters to action arguments by name:

```
class AccountingController {

// accountNumber will be initialized with the value of params.accountNumber
   // accountType will be initialized with params.accountType
   def displayInvoice(String accountNumber, int accountType) {
       // …
   }
}
```

For primitive arguments and arguments which are instances of any of the primitive type wrapper classes
before the request parameter value can be bound to the action argument. The type conversion happens au
shown above, the `params.accountType` request parameter has to be converted to an `int`. If typ
argument will have its default value per normal Java behavior (null for type wrapper references, false for
corresponding error will be added to the `errors` property of the defining controller.

```
/accounting/displayInvoice?accountNumber=B59786&accountType=bogusValue
```

Since "bogusValue" cannot be converted to type int, the value of accountType will be zero, `controll`
true, `controller.errors.errorCount` will be equal to 1 and `controller.errors.getFi`
contain the corresponding error.

If the argument name does not match the name of the request parameter then the `@grails.web.Req`
applied to an argument to express the name of the request parameter which should be bound to that argume

```
import grails.web.RequestParameter

class AccountingController {

// mainAccountNumber will be initialized with the value of params.accountNumber
   // accountType will be initialized with params.accountType
   def displayInvoice(@RequestParameter('accountNumber') String mainAccountNumber
       // …
   }
}
```

Data binding and type conversion errors

Sometimes when performing data binding it is not possible to convert a particular String into a partic
conversion error. Grails will retain type conversion errors inside the errors property of a Grails domain cla

```
class Book {
    …
    URL publisherURL
}
```

Here we have a domain class `Book` that uses the `java.net.URL` class to represent URLs. Given an inco

```
/book/save?publisherURL=a-bad-url
```

it is not possible to bind the string `a-bad-url` to the `publisherURL` property as a type mismatch err
this:

```
def b = new Book(params)

if (b.hasErrors()) {
    println "The value ${b.errors.getFieldError('publisherURL').rejectedValue}" +
            " is not a valid URL!"
}
```

Although we have not yet covered error codes (for more information see the section on Validation), for ty
message from the `grails-app/i18n/messages.properties` file to use for the error. You can us
as:

```
typeMismatch.java.net.URL=The field {0} is not a valid URL
```

Or a more specific one:

```
typeMismatch.Book.publisherURL=The publisher URL you specified is not a valid URL
```

Data Binding and Security concerns

When batch updating properties from request parameters you need to be careful not to allow clients to bin be persisted in the database. You can limit what properties are bound to a given domain class using the sub

```
def p = Person.get(1)

p.properties['firstName','lastName'] = params
```

In this case only the `firstName` and `lastName` properties will be bound.

Another way to do this is is to use Command Objects as the target of data binding instead of domain flexible bindData method.

The `bindData` method allows the same data binding capability, but to arbitrary objects:

```
def p = new Person()
bindData(p, params)
```

The `bindData` method also lets you exclude certain parameters that you don't want updated:

```
def p = new Person()
bindData(p, params, [exclude: 'dateOfBirth'])
```

Or include only certain properties:

```
def p = new Person()
bindData(p, params, [include: ['firstName', 'lastName]])
```

6.1.7 XML and JSON Responses

Using the render method to output XML

Grails supports a few different ways to produce XML and JSON responses. The first is the render method.

The `render` method can be passed a block of code to do mark-up building in XML:

```
def list() {

def results = Book.list()

render(contentType: "text/xml") {
        books {
            for (b in results) {
                book(title: b.title)
            }
        }
    }
}
```

The result of this code would be something like:

```
<books>
    <book title="The Stand" />
    <book title="The Shining" />
</books>
```

Be careful to avoid naming conflicts when using mark-up building. For example this code would produce a

```
def list() {
def books = Book.list()  // naming conflict here
render(contentType: "text/xml") {
        books {
            for (b in results) {
                book(title: b.title)
            }
        }
    }
}
```

This is because there is local variable `books` which Groovy attempts to invoke as a method.

Using the render method to output JSON

The `render` method can also be used to output JSON:

```
def list() {
def results = Book.list()
render(contentType: "text/json") {
        books = array {
            for (b in results) {
                book title: b.title
            }
        }
    }
}
```

In this case the result would be something along the lines of:

```
[
    {title:"The Stand"},
    {title:"The Shining"}
]
```

The same dangers with naming conflicts described above for XML also apply to JSON building.

Automatic XML Marshalling

Grails also supports automatic marshalling of [domain classes](#) to XML using special converters.

To start off with, import the `grails.converters` package into your controller:

```
import grails.converters.*
```

Now you can use the following highly readable syntax to automatically convert domain classes to XML:

```
render Book.list() as XML
```

The resulting output would look something like the following::

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<list>
  <book id="1">
    <author>Stephen King</author>
    <title>The Stand</title>
  </book>
  <book id="2">
    <author>Stephen King</author>
    <title>The Shining</title>
  </book>
</list>
```

An alternative to using the converters is to use the [codecs](#) feature of Grails. The codecs feature provid
methods:

```
def xml = Book.list().encodeAsXML()
render xml
```

For more information on XML marshalling see the section on [REST](#)

Automatic JSON Marshalling

Grails also supports automatic marshalling to JSON using the same mechanism. Simply substitute `XML` wi

```
render Book.list() as JSON
```

The resulting output would look something like the following:

```
[
    {"id":1,
     "class":"Book",
     "author":"Stephen King",
     "title":"The Stand"},
    {"id":2,
     "class":"Book",
     "author":"Stephen King",
     "releaseDate":new Date(1194127343161),
     "title":"The Shining"}
 ]
```

Again as an alternative you can use the `encodeAsJSON` to achieve the same effect.

6.1.8 More on JSONBuilder

The previous section on on XML and JSON responses covered simplistic examples of rendering XML builder used by Grails is the standard XmlSlurper found in Groovy, the JSON builder is a custom impleme

JSONBuilder and Grails versions

JSONBuilder behaves different depending on the version of Grails you use. For version below 1.2 the de is used. This section covers the usage of the Grails 1.2 JSONBuilder

For backwards compatibility the old `JSONBuilder` class is used with the `render` method for older `JSONBuilder` class set the following in `Config.groovy`:

```
grails.json.legacy.builder = false
```

Rendering Simple Objects

To render a simple JSON object just set properties within the context of the Closure:

```
render(contentType: "text/json") {
    hello = "world"
}
```

The above will produce the JSON:

```
{"hello":"world"}
```

Rendering JSON Arrays

To render a list of objects simple assign a list:

```
render(contentType: "text/json") {
    categories = ['a', 'b', 'c']
}
```

This will produce:

```
{"categories":["a","b","c"]}
```

You can also render lists of complex objects, for example:

```
render(contentType: "text/json") {
    categories = [ { a = "A" }, { b = "B" } ]
}
```

This will produce:

```
{"categories":[ {"a":"A"} , {"b":"B"}] }
```

Use the special `element` method to return a list as the root:

```
render(contentType: "text/json") {
    element 1
    element 2
    element 3
}
```

The above code produces:

```
[1,2,3]
```

Rendering Complex Objects

Rendering complex objects can be done with Closures. For example:

```
render(contentType: "text/json") {
    categories = ['a', 'b', 'c']
    title = "Hello JSON"
    information = {
        pages = 10
    }
}
```

The above will produce the JSON:

```
{"categories":["a","b","c"],"title":"Hello JSON","information":{"pages":10}}
```

Arrays of Complex Objects

As mentioned previously you can nest complex objects within arrays using Closures:

```
render(contentType: "text/json") {
    categories = [ { a = "A" }, { b = "B" } ]
}
```

You can use the `array` method to build them up dynamically:

```
def results = Book.list()
render(contentType: "text/json") {
    books = array {
        for (b in results) {
            book title: b.title
        }
    }
}
```

Direct JSONBuilder API Access

If you don't have access to the `render` method, but still want to produce JSON you can use the API direc

```
def builder = new JSONBuilder()

def result = builder.build {
    categories = ['a', 'b', 'c']
    title = "Hello JSON"
    information = {
        pages = 10
    }
}

// prints the JSON text
println result.toString()

def sw = new StringWriter()
result.render sw
```

6.1.9 Uploading Files

Programmatic File Uploads

Grails supports file uploads using Spring's MultipartHttpServletRequest interface. The first step for file like this:

```
Upload Form: <br />
    <g:uploadForm action="upload">
        <input type="file" name="myFile" />
        <input type="submit" />
    </g:uploadForm>
```

The `uploadForm` tag conveniently adds the `enctype="multipart/form-data"` attribute to the s

There are then a number of ways to handle the file upload. One is to work with the Spring MultipartFile in

```
def upload() {
    def f = request.getFile('myFile')
    if (f.empty) {
        flash.message = 'file cannot be empty'
        render(view: 'uploadForm')
        return
    }

f.transferTo(new File('/some/local/dir/myfile.txt'))
    response.sendError(200, 'Done')
}
```

This is convenient for doing transfers to other destinations and manipulating the file directly as you can ob the MultipartFile interface.

File Uploads through Data Binding

File uploads can also be performed using data binding. Consider this `Image` domain class:

```
class Image {
    byte[] myFile

static constraints = {
        // Limit upload file size to 2MB
        myFile maxSize: 1024 * 1024 * 2
    }
}
```

If you create an image using the `params` object in the constructor as in the example below, Grails will au `byte` to the `myFile` property:

```
def img = new Image(params)
```

It's important that you set the size or maxSize constraints, otherwise your database may be created witl reasonably sized files. For example, both H2 and MySQL default to a blob size of 255 bytes for `byte` pro

It is also possible to set the contents of the file as a string by changing the type of the `myFile` property on

```
class Image {
   String myFile
}
```

6.1.10 Command Objects

Grails controllers support the concept of command objects. A command object is similar to a form bean i useful for populating a subset of the properties needed to update a domain class. Or where there is no do but you need features such as data binding and validation.

Declaring Command Objects

Command objects are typically declared in the same source file as a controller, directly below the controlle

```
class UserController {
    …
}
class LoginCommand {
    String username
    String password
static constraints = {
        username(blank: false, minSize: 6)
        password(blank: false, minSize: 6)
    }
}
```

As this example shows, you can define constraints in command objects just like in domain classes.

Using Command Objects

To use command objects, controller actions may optionally specify any number of command object pa supplied so that Grails knows what objects to create, populate and validate.

Before the controller action is executed Grails will automatically create an instance of the command obje binding the request parameters, and validate the command object. For example:

```
class LoginController {
def login = { LoginCommand cmd ->
        if (cmd.hasErrors()) {
            redirect(action: 'loginForm')
            return
        }
// work with the command object data
    }
}
```

When using methods instead of Closures for actions, you can specify command objects in arguments:

```
class LoginController {
    def login(LoginCommand cmd) {
        if (cmd.hasErrors()) {
            redirect(action: 'loginForm')
            return
        }

// work with the command object data
    }
}
```

Command Objects and Dependency Injection

Command objects can participate in dependency injection. This is useful if your command object has sor
services:

```
class LoginCommand {

def loginService

String username
    String password

static constraints = {
        username validator: { val, obj ->
            obj.loginService.canLogin(obj.username, obj.password)
        }
    }
}
```

In this example the command object interacts with the `loginService` bean which is in
`ApplicationContext`.

6.1.11 Handling Duplicate Form Submissions

Grails has built-in support for handling duplicate form submissions using the "Synchronizer Token Patter
the form tag:

```
<g:form useToken="true" ...>
```

Then in your controller code you can use the withForm method to handle valid and invalid requests:

```
withForm {
   // good request
}.invalidToken {
   // bad request
}
```

If you only provide the withForm method and not the chained `invalidToken` method then by default
`flash.invalidToken` variable and redirect the request back to the original page. This can then be che

```
<g:if test="${flash.invalidToken}">
  Don't click the button twice!
</g:if>
```

The withForm tag makes use of the session and hence requires session affinity or clustere
cluster.

6.1.12 Simple Type Converters

Type Conversion Methods

If you prefer to avoid the overhead of Data Binding and simply want to convert incoming parameters
appropriate type the params object has a number of convenience methods for each type:

```
def total = params.int('total')
```

The above example uses the `int` method, and there are also methods for `boolean`, `long`, `char`, `sho`
null-safe and safe from any parsing errors, so you don't have to perform any additional checks on the parar

Each of the conversion methods allows a default value to be passed as an optional second argument. T
corresponding entry cannot be found in the map or if an error occurs during the conversion. Example:

```
def total = params.int('total', 42)
```

These same type conversion methods are also available on the `attrs` parameter of GSP tags.

Handling Multi Parameters

A common use case is dealing with multiple request parameters of the same name. For example y
`?name=Bob&name=Judy`.

In this case dealing with one parameter and dealing with many has different semantics since Groovy's it
over each character. To avoid this problem the params object provides a `list` method that always returns

```
for (name in params.list('name')) {
    println name
}
```

6.1.13 Asynchronous Request Processing

Grails support asynchronous request processing as provided by the Servlet 3.0 specification. To enable t
servlet target version to 3.0 in BuildConfig.groovy:

```
grails.servlet.version = "3.0"
```

With that done ensure you do a clean re-compile as some async features are enabled at compile time.

> With a Servlet target version of 3.0 you can only deploy on Servlet 3.0 containers such as Tor

Asynchronous Rendering

You can render content (templates, binary data etc.) in an asynchronous manner by calling the `startAs` of the Servlet 3.0 `AsyncContext`. Once you have a reference to the `AsyncContext` you can use (content:

```
def index() {
    def ctx = startAsync()
    ctx.start {
        new Book(title:"The Stand").save()
        render template:"books", model:[books:Book.list()]
        ctx.complete()
    }
}
```

Note that you must call the `complete()` method to terminate the connection.

Resuming an Async Request

You resume processing of an async request (for example to delegate to view rendering) by us `AsyncContext` class:

```
def index() {
    def ctx = startAsync()
    ctx.start {
        // do working
        …
        // render view
        ctx.dispatch()
    }
}
```

6.2 Groovy Server Pages

Groovy Servers Pages (or GSP for short) is Grails' view technology. It is designed to be familiar for users but to be far more flexible and intuitive.

GSPs live in the `grails-app/views` directory and are typically rendered automatically (by conventior

```
render(view: "index")
```

A GSP is typically a mix of mark-up and GSP tags which aid in view rendering.

> ⚠ Although it is possible to have Groovy logic embedded in your GSP and doing this w document, the practice is strongly discouraged. Mixing mark-up and code is a **bad** thing contain no code and needn't do so.

A GSP typically has a "model" which is a set of variables that are used for view rendering. The mo controller. For example consider the following controller action:

```
def show() {
    [book: Book.get(params.id)]
}
```

This action will look up a `Book` instance and create a model that contains a key called `book`. This key view using the name `book`:

```
${book.title}
```

6.2.1 GSP Basics

In the next view sections we'll go through the basics of GSP and what is available to you. First off let's co and ASP should be familiar with.

GSP supports the usage of `<% %>` scriptlet blocks to embed Groovy code (again this is discouraged):

```
<html>
   <body>
     <% out << "Hello GSP!" %>
   </body>
</html>
```

You can also use the `<%= %>` syntax to output values:

```
<html>
   <body>
     <%="Hello GSP!" %>
   </body>
</html>
```

GSP also supports JSP-style server-side comments (which are not rendered in the HTML response) as the

```
<html>
   <body>
     <%-- This is my comment --%>
     <%="Hello GSP!" %>
   </body>
</html>
```

6.2.1.1 Variables and Scopes

Within the `<% %>` brackets you can declare variables:

```
<% now = new Date() %>
```

and then access those variables later in the page:

```
<%=now%>
```

Within the scope of a GSP there are a number of pre-defined variables, including:

- `application` - The javax.servlet.ServletContext instance
- `applicationContext` The Spring ApplicationContext instance
- `flash` - The flash object
- `grailsApplication` - The GrailsApplication instance
- `out` - The response writer for writing to the output stream
- `params` - The params object for retrieving request parameters
- `request` - The HttpServletRequest instance
- `response` - The HttpServletResponse instance
- `session` - The HttpSession instance
- `webRequest` - The GrailsWebRequest instance

6.2.1.2 Logic and Iteration

Using the `<% %>` syntax you can embed loops and so on using this syntax:

```
<html>
   <body>
      <% [1,2,3,4].each { num -> %>
         <p><%="Hello ${num}!" %></p>
      <%}%>
   </body>
</html>
```

As well as logical branching:

```
<html>
   <body>
      <% if (params.hello == 'true')%>
      <%="Hello!"%>
      <% else %>
      <%="Goodbye!"%>
   </body>
</html>
```

6.2.1.3 Page Directives

GSP also supports a few JSP-style page directives.

The import directive lets you import classes into the page. However, it is rarely needed due to Groovy's de

```
<%@ page import="java.awt.*" %>
```

GSP also supports the contentType directive:

```
<%@ page contentType="text/json" %>
```

The contentType directive allows using GSP to render other formats.

6.2.1.4 Expressions

In GSP the `<%= %>` syntax introduced earlier is rarely used due to the support for GSP expressions. A expression or a Groovy GString and takes the form `${expr}`:

```
<html>
  <body>
    Hello ${params.name}
  </body>
</html>
```

However, unlike JSP EL you can have any Groovy expression within the `${..}` block. Variables withi default, so any HTML in the variable's string is rendered directly to the page. To reduce the risk of Cros enable automatic HTML escaping with the `grails.views.default.codec` setting in `grails-ap`

```
grails.views.default.codec='html'
```

Other possible values are 'none' (for no default encoding) and 'base64'.

6.2.2 GSP Tags

Now that the less attractive JSP heritage has been set aside, the following sections cover GSP's built-in define GSP pages.

The section on Tag Libraries covers how to add your own custom tag libraries.

All built-in GSP tags start with the prefix `g:`. Unlike JSP, you don't specify any tag library imports. If assumed to be a GSP tag. An example GSP tag would look like:

```
<g:example />
```

GSP tags can also have a body such as:

```
<g:example>
   Hello world
</g:example>
```

Expressions can be passed into GSP tag attributes, if an expression is not used it will be assumed to be a St

```
<g:example attr="${new Date()}">
   Hello world
</g:example>
```

Maps can also be passed into GSP tag attributes, which are often used for a named parameter style syntax:

```
<g:example attr="${new Date()}" attr2="[one:1, two:2, three:3]">
   Hello world
</g:example>
```

Note that within the values of attributes you must use single quotes for Strings:

```
<g:example attr="${new Date()}" attr2="[one:'one', two:'two']">
   Hello world
</g:example>
```

With the basic syntax out the way, the next sections look at the tags that are built into Grails by default.

6.2.2.1 Variables and Scopes

Variables can be defined within a GSP using the set tag:

```
<g:set var="now" value="${new Date()}" />
```

Here we assign a variable called `now` to the result of a GSP expression (which simply constructs a new `j
also use the body of the `<g:set>` tag to define a variable:

```
<g:set var="myHTML">
   Some re-usable code on: ${new Date()}
</g:set>
```

Variables can also be placed in one of the following scopes:

- `page` - Scoped to the current page (default)
- `request` - Scoped to the current request
- `flash` - Placed within flash scope and hence available for the next request
- `session` - Scoped for the user session
- `application` - Application-wide scope.

To specify the scope, use the `scope` attribute:

```
<g:set var="now" value="${new Date()}" scope="request" />
```

6.2.2.2 Logic and Iteration

GSP also supports logical and iterative tags out of the box. For logic there are if, else and elseif tags for us

```
<g:if test="${session.role == 'admin'}">
   <%-- show administrative functions --%>
</g:if>
<g:else>
   <%-- show basic functions --%>
</g:else>
```

Use the each and while tags for iteration:

```
<g:each in="${[1,2,3]}" var="num">
   <p>Number ${num}</p>
</g:each>

<g:set var="num" value="${1}" />
<g:while test="${num < 5 }">
    <p>Number ${num++}</p>
</g:while>
```

6.2.2.3 Search and Filtering

If you have collections of objects you often need to sort and filter them. Use the findAll and grep tags for t

```
Stephen King's Books:
<g:findAll in="${books}" expr="it.author == 'Stephen King'">
     <p>Title: ${it.title}</p>
</g:findAll>
```

The `expr` attribute contains a Groovy expression that can be used as a filter. The grep tag does a similar jo

```
<g:grep in="${books}" filter="NonFictionBooks.class">
     <p>Title: ${it.title}</p>
</g:grep>
```

Or using a regular expression:

```
<g:grep in="${books.title}" filter="~/.*?Groovy.*?/">
     <p>Title: ${it}</p>
</g:grep>
```

The above example is also interesting due to its usage of GPath. GPath is an XPath-like language in Groo of `Book` instances. Since each `Book` has a `title`, you can obtain a list of Book titles using the exp auto-magically iterate the collection, obtain each title, and return a new list!

6.2.2.4 Links and Resources

GSP also features tags to help you manage linking to controllers and actions. The link tag lets you specify it will automatically work out the link based on the URL Mappings, even if you change them! For example

```
<g:link action="show" id="1">Book 1</g:link>

<g:link action="show" id="${currentBook.id}">${currentBook.name}</g:link>

<g:link controller="book">Book Home</g:link>

<g:link controller="book" action="list">Book List</g:link>

<g:link url="[action: 'list', controller: 'book']">Book List</g:link>

<g:link params="[sort: 'title', order: 'asc', author: currentBook.author]"
        action="list">Book List</g:link>
```

6.2.2.5 Forms and Fields

Form Basics

GSP supports many different tags for working with HTML forms and fields, the most basic of which is t aware version of the regular HTML form tag. The `url` attribute lets you specify which controller and actio

```
<g:form name="myForm" url="[controller:'book',action:'list']">...</g:form>
```

In this case we create a form called `myForm` that submits to the `BookController`'s `list` action attributes apply.

Form Fields

In addition to easy construction of forms, GSP supports custom tags for dealing with different types of fiel

- textField - For input fields of type 'text'
- passwordField - For input fields of type 'password'
- checkBox - For input fields of type 'checkbox'
- radio - For input fields of type 'radio'
- hiddenField - For input fields of type 'hidden'
- select - For dealing with HTML select boxes

Each of these allows GSP expressions for the value:

```
<g:textField name="myField" value="${myValue}" />
```

GSP also contains extended helper versions of the above tags such as radioGroup (for creating groups of r and timeZoneSelect (for selecting locales, currencies and time zones respectively).

Multiple Submit Buttons

The age old problem of dealing with multiple submit buttons is also handled elegantly with Grails usin regular submit, but lets you specify an alternative action to submit to:

```
<g:actionSubmit value="Some update label" action="update" />
```

6.2.2.6 Tags as Method Calls

One major different between GSP tags and other tagging technologies is that GSP tags can be called as eitl controllers, tag libraries or GSP views.

Tags as method calls from GSPs

Tags return their results as a String-like object (a `StreamCharBuffer` which has all of the same metho to the response when called as methods. For example:

```
Static Resource: ${createLinkTo(dir: "images", file: "logo.jpg")}
```

This is particularly useful for using a tag within an attribute:

```
<img src="${createLinkTo(dir: 'images', file: 'logo.jpg')}" />
```

In view technologies that don't support this feature you have to nest tags within tags, which becomes m
effect of WYSWIG tools such as Dreamweaver that attempt to render the mark-up as it is not well-formed

```
<img src="<g:createLinkTo dir="images" file="logo.jpg" />" />
```

Tags as method calls from Controllers and Tag Libraries

You can also invoke tags from controllers and tag libraries. Tags within the default `g:` namespace car
`StreamCharBuffer` result is returned:

```
def imageLocation = createLinkTo(dir:"images", file:"logo.jpg").toString()
```

Prefix the namespace to avoid naming conflicts:

```
def imageLocation = g.createLinkTo(dir:"images", file:"logo.jpg").toString()
```

For tags that use a custom namespace, use that prefix for the method call. For example (from the FCK Edit

```
def editor = fckeditor.editor(name: "text", width: "100%", height: "400")
```

6.2.3 Views and Templates

Grails also has the concept of templates. These are useful for partitioning your views into maintainabl
provide a highly re-usable mechanism for structured views.

Template Basics

Grails uses the convention of placing an underscore before the name of a view to identify it as a tem
template that renders Books located at `grails-app/views/book/_bookTemplate.gsp`:

```
<div class="book" id="${book?.id}">
   <div>Title: ${book?.title}</div>
   <div>Author: ${book?.author?.name}</div>
</div>
```

Use the render tag to render this template from one of the views in `grails-app/views/book`:

```
<g:render template="bookTemplate" model="[book: myBook]" />
```

Notice how we pass into a model to use using the `model` attribute of the `render` tag. If you have multiple the template for each `Book` using the render tag with a `collection` attribute:

```
<g:render template="bookTemplate" var="book" collection="${bookList}" />
```

Shared Templates

In the previous example we had a template that was specific to the `BookController` and its vie However, you may want to share templates across your application.

In this case you can place them in the root views directory at grails-app/views or any subdirectory below th attribute use an absolute location starting with `/` instead of a relative location. For examp `grails-app/views/shared/_mySharedTemplate.gsp`, you would reference it as:

```
<g:render template="/shared/mySharedTemplate" />
```

You can also use this technique to reference templates in any directory from any view or controller:

```
<g:render template="/book/bookTemplate" model="[book: myBook]" />
```

The Template Namespace

Since templates are used so frequently there is template namespace, called `tmpl`, available that make example the following usage pattern:

```
<g:render template="bookTemplate" model="[book:myBook]" />
```

This can be expressed with the `tmpl` namespace as follows:

```
<tmpl:bookTemplate book="${myBook}" />
```

Templates in Controllers and Tag Libraries

You can also render templates from controllers using the [render](#) controller method. This is useful for [Ajax](#) HTML or data responses to partially update the current page instead of performing new request:

```
def bookData() {
    def b = Book.get(params.id)
    render(template:"bookTemplate", model:[book:b])
}
```

The render controller method writes directly to the response, which is the most common behaviour. To ir
String you can use the render tag:

```
def bookData() {
    def b = Book.get(params.id)
    String content = g.render(template:"bookTemplate", model:[book:b])
    render content
}
```

Notice the usage of the `g` namespace which tells Grails we want to use the tag as method call instead of the

6.2.4 Layouts with Sitemesh

Creating Layouts

Grails leverages Sitemesh, a decorator engine, to support view layouts. Layouts are located in the `grail`
A typical layout can be seen below:

```
<html>
    <head>
        <title><g:layoutTitle default="An example decorator" /></title>
        <g:layoutHead />
    </head>
    <body onload="${pageProperty(name:'body.onload')}">
        <div class="menu"><!--my common menu goes here--></menu>
            <div class="body">
                <g:layoutBody />
            </div>
        </div>
    </body>
</html>
```

The key elements are the layoutHead, layoutTitle and layoutBody tag invocations:

- `layoutTitle` - outputs the target page's title
- `layoutHead` - outputs the target page's head tag contents
- `layoutBody` - outputs the target page's body tag contents

The previous example also demonstrates the pageProperty tag which can be used to inspect and return asp

Triggering Layouts

There are a few ways to trigger a layout. The simplest is to add a meta tag to the view:

```
<html>
    <head>
        <title>An Example Page</title>
        <meta name="layout" content="main" />
    </head>
    <body>This is my content!</body>
</html>
```

In this case a layout called `grails-app/views/layouts/main.gsp` will be used to layout the pag previous section the output would resemble this:

```
<html>
    <head>
        <title>An Example Page</title>
    </head>
    <body onload="">
        <div class="menu"><!--my common menu goes here--></div>
        <div class="body">
            This is my content!
        </div>
    </body>
</html>
```

Specifying A Layout In A Controller

Another way to specify a layout is to specify the name of the layout by assigning a value to the "layout" p you have a controller such as:

```
class BookController {
    static layout = 'customer'

def list() { … }
}
```

You can create a layout called `grails-app/views/layouts/customer.gsp` which will `BookController` delegates to. The value of the "layout" property may contain a di `grails-app/views/layouts/` directory. For example:

```
class BookController {
    static layout = 'custom/customer'

def list() { … }
}
```

Views rendered from that controller would be decorated with the `grails-app/views/layouts/cu`

Layout by Convention

Another way to associate layouts is to use "layout by convention". For example, if you have this controller

```
class BookController {
    def list() { … }
}
```

You can create a layout called `grails-app/views/layouts/book.gsp`, which will be applied to delegates to.

Alternatively, you can create a layout called `grails-app/views/layouts/book/list.gsp` w action within the `BookController`.

If you have both the above mentioned layouts in place the layout specific to the action will take precedenc

If a layout may not be located using any of those conventions, the convention of last resort is to look for `grails-app/views/layouts/application.gsp`. The name of the application default layout r in `grails-app/conf/Config.groovy` as follows:

```
grails.sitemesh.default.layout = 'myLayoutName'
```

With that property in place, the application default layout will be `grails-app/views/layouts/my`

Inline Layouts

Grails' also supports Sitemesh's concept of inline layouts with the applyLayout tag. This can be used tc arbitrary section of content. This lets you even further modularize your view structure by "decorating" you

Some examples of usage can be seen below:

```
<g:applyLayout name="myLayout" template="bookTemplate" collection="${books}" />

<g:applyLayout name="myLayout" url="http://www.google.com" />

<g:applyLayout name="myLayout">
The content to apply a layout to
</g:applyLayout>
```

Server-Side Includes

While the applyLayout tag is useful for applying layouts to external content, if you simply want to inclu you use the include tag:

```
<g:include controller="book" action="list" />
```

You can even combine the include tag and the applyLayout tag for added flexibility:

```
<g:applyLayout name="myLayout">
   <g:include controller="book" action="list" />
</g:applyLayout>
```

Finally, you can also call the include tag from a controller or tag library as a method:

```
def content = include(controller:"book", action:"list")
```

The resulting content will be provided via the return value of the include tag.

6.2.5 Static Resources

Grails 2.0 integrates with the Resources plugin to provide sophisticated static resource management. Th
Grails applications.

The basic way to include a link to a static resource in your application is to use the resource tag. This sim
the file.

However modern applications with dependencies on multiple JavaScript and CSS libraries and framewor
Grails plugins) require something more powerful.

The issues that the Resources framework tackles are:

- Web application performance tuning is difficult
- Correct ordering of resources, and deferred inclusion of JavaScript
- Resources that depend on others that must be loaded first
- The need for a standard way to expose static resources in plugins and applications
- The need for an extensible processing chain to optimize resources
- Preventing multiple inclusion of the same resource

The plugin achieves this by introducing new artefacts and processing the resources using the server's local

It adds artefacts for declaring resources, for declaring "mappers" that can process resources, and a servlet f

What you get is an incredibly advanced resource system that enables you to easily create highly optimize
development and in production.

The Resources plugin documentation provides a more detailed overview of the concepts which will be
guide.

6.2.5.1 Including resources using the resource tags

Pulling in resources with r:require

To use resources, your GSP page must indicate which resource modules it requires. For example wit
"jquery" resource module, to use jQuery in any page on your site you simply add:

```
<html>
   <head>
      <r:require module="jquery"/>
      <r:layoutResources/>
   </head>
   <body>
      …
      <r:layoutResources/>
   </body>
</html>
```

This will automatically include all resources needed for jQuery, including them at the correct locations in
disposition to be "head", so they load early in the page.

You can call `r:require` multiple times in a GSP page, and you use the "modules" attribute to provide a

```
<html>
   <head>
      <r:require modules="jquery, main, blueprint, charting"/>
      <r:layoutResources/>
   </head>
   <body>
      …
      <r:layoutResources/>
   </body>
</html>
```

The above may result in many JavaScript and CSS files being included, in the correct order, with some Ja
body to improve the apparent page load time.

However you cannot use r:require in isolation - as per the examples you must have the <r:layoutResources

Rendering the links to resources with r:layoutResources

When you have declared the resource modules that your GSP page requires, the framework needs to re
correct time.

To achieve this correctly, you must include the r:layoutResources tag twice in your page, or more commor

```
<html>
   <head>
      <g:layoutTitle/>
      <r:layoutResources/>
   </head>
   <body>
      <g:layoutBody/>
      <r:layoutResources/>
   </body>
</html>
```

This represents the simplest Sitemesh layout you can have that supports Resources.

The Resources framework has the concept of a "disposition" for every resource. This is an indication of w
included.

The default disposition applied depends on the type of resource. All CSS must be rendered in <head> in
CSS, and will be rendered by the first r:layoutResources. Page load times are improved when JavaScript
default for JavaScript files is "defer", which means it is rendered when the second r:layoutResources is inv

Note that both your GSP page and your Sitemesh layout (as well as any GSP template fragments) can cal
only limitation is that you must call r:require before the r:layoutResources that should render it.

Adding page-specific JavaScript code with r:script

Grails has the [javascript] tag which is adapted to defer to Resources plugin if installed, but it is recomme
when you need to include fragments of JavaScript code.

This lets you write some "inline" JavaScript which is actually **not** rendered inline, but either in the <head>
disposition.

Given a Sitemesh layout like this:

```
<html>
   <head>
      <g:layoutTitle/>
      <r:layoutResources/>
   </head>
   <body>
      <g:layoutBody/>
      <r:layoutResources/>
   </body>
</html>
```

...in your GSP you can inject some JavaScript code into the head or deferred regions of the page like this:

```
<html>
   <head>
      <title>Testing r:script magic!</title>
   </head>
   <body>
      <r:script disposition="head">
         window.alert('This is at the end of <head>');
      </r:script>
      <r:script disposition="defer">
         window.alert('This is at the end of the body, and the page has loaded.')
      </r:script>
   </body>
</html>
```

The default disposition is "defer", so the disposition in the latter r:script is purely included for demonstrati

Note that such r:script code fragments **always** load after any modules that you have used, to ensure that an

Linking to images with r:img

This tag is used to render `<img>` markup, using the Resources framework to process the resource on the f eternally cacheable).

This includes any extra attributes on the `<img>` tag if the resource has been previously declared in a modu

With this mechanism you can specify the width, height and any other attributes in the resource declaratior in as necessary.

Example:

```
<html>
   <head>
      <title>Testing r:img</title>
   </head>
   <body>
      <r:img uri="/images/logo.png"/>
   </body>
</html>
```

Note that Grails has a built-in `g:img` tag as a shortcut for rendering `<img>` tags that refer to a s Resources-aware and will delegate to `r:img` if found. However it is recommended that you use `r:img` d

Alongside the regular Grails resource tag attributes, this also supports the "uri" attribute for increased brev

See r:resource documentation for full details.

6.2.5.2 Other resource tags

r:resource

This is equivalent to the Grails resource tag, returning a link to the processed static resource. Grails' ov implementation if found, but if your code requires the Resources plugin, you should use `r:resource` di

Alongside the regular Grails resource tag attributes, this also supports the "uri" attribute for increased brev

See r:resource documentation for full details.

r:external

This is a resource-aware version of Grails external tag which renders the HTML markup necessary to in CSS, JS or a favicon.

See r:resource documentation for full details.

6.2.5.3 Declaring resources

A DSL is provided for declaring resources and modules. This can go either in your `Config.groo` resources, or more commonly in a resources artefact in `grails-app/conf`.

Note that you do not need to declare all your static resources, especially images. However you mu resources-specific attributes. Any resource that is not declared is called "ad-hoc" and will still be processec

Consider this example resource configuration file, `grails-app/conf/MyAppResources.groovy`

```
modules = {
    core {
        dependsOn 'jquery, utils'

resource url: '/js/core.js', disposition: 'head'
        resource url: '/js/ui.js'
        resource url: '/css/main.css',
        resource url: '/css/branding.css'
        resource url: '/css/print.css', attrs: [media: 'print']
    }

utils {
        dependsOn 'jquery'

resource url: '/js/utils.js'
    }

forms {
        dependsOn 'core,utils'

resource url: '/css/forms.css'
        resource url: '/js/forms.js'
    }
}
```

This defines three resource modules; 'core', 'utils' and 'forms'. The resources in these modules will be according to the module name, resulting in fewer files. You can override this with `bundle:'someOt` `defaultBundle` on the module (see resources plugin documentation).

It declares dependencies between them using `dependsOn`, which controls the load order of the resources.

When you include an <r:require module="forms"/> in your GSP, it will pull in all the reso
'jquery', all in the correct order.

You'll also notice the disposition:'head' on the core.js file. This tells Resources that while it c
of the body, this one must go into the <head>.

The CSS file for print styling adds custom attributes using the attrs map option, and these are passed t
the engine renders the link to the resource, so you can customize the HTML attributes of the generated link

There is no limit to the number of modules or xxxResources.groovy artefacts you can provide, and plugins
applications, which is exactly how the jQuery plugin works.

To define modules like this in your application's Config.groovy, you simply assign the DSL closure to t
Config variable.

For full details of the resource DSL please see the resources plugin documentation.

6.2.5.4 Overriding plugin resources

Because a resource module can define the bundle groupings and other attributes of resources, you may
correct for your application.

For example, you may wish to bundle jQuery and some other libraries all together in one file. There is a lo
often it is the case that you'd like to override some of these settings.

To do this, the DSL supports an "overrides" clause, within which you can change the defaultBundl
individual resources that have been declared with a unique id:

```
modules = {
    core {
        dependsOn 'jquery, utils'
        defaultBundle 'monolith'

resource url: '/js/core.js', disposition: 'head'
        resource url: '/js/ui.js'
        resource url: '/css/main.css',
        resource url: '/css/branding.css'
        resource url: '/css/print.css', attrs: [media: 'print']
    }

utils {
        dependsOn 'jquery'
        defaultBundle 'monolith'

resource url: '/js/utils.js'
    }

forms {
        dependsOn 'core,utils'
        defaultBundle 'monolith'

resource url: '/css/forms.css'
        resource url: '/js/forms.js'
    }

overrides {
        jquery {
            defaultBundle 'monolith'
        }
    }
}
```

This will put all code into a single bundle named 'monolith'. Note that this can still result in multiple fil head and defer dispositions, and JavaScript and CSS files are bundled separately.

Note that overriding individual resources requires the original declaration to have included a unique id for

For full details of the resource DSL please see the resources plugin documentation.

6.2.5.5 Optimizing your resources

The Resources framework uses "mappers" to mutate the resources into the final format served to the user.

The resource mappers are applied to each static resource once, in a specific order. You can create yo plugins provide some already for zipping, caching and minifying.

Out of the box, the Resources plugin provides bundling of resources into fewer files, which is achieved CSS re-writing to handle when your CSS files are moved into a bundle.

Bundling multiple resources into fewer files

The 'bundle' mapper operates by default on any resource with a "bundle" defined - or inherited from a de Modules have an implicit default bundle name the same as the name of the module.

Files of the same kind will be aggregated into this bundle file. Bundles operate across module boundaries:

```
modules = {
    core {
        dependsOn 'jquery, utils'
        defaultBundle 'common'

resource url: '/js/core.js', disposition: 'head'
        resource url: '/js/ui.js', bundle: 'ui'
        resource url: '/css/main.css', bundle: 'theme'
        resource url: '/css/branding.css'
        resource url: '/css/print.css', attrs: [media: 'print']
    }

utils {
        dependsOn 'jquery'

resource url: '/js/utils.js', bundle: 'common'
    }

forms {
        dependsOn 'core,utils'

resource url: '/css/forms.css', bundle: 'ui'
        resource url: '/js/forms.js', bundle: 'ui'
    }
}
```

Here you see that resources are grouped into bundles; 'common', 'ui' and 'theme' - across module boundarie

Note that auto-bundling by module does **not** occur if there is only one resource in the module.

Making resources cache "eternally" in the client browser

Caching resources "eternally" in the client is only viable if the resource has a unique name that chang requires caching headers to be set on the response.

The cached-resources plugin provides a mapper that achieves this by hashing your files and renaming tl caching headers on every response for those resources. To use, simply install the cached-resources plugin.

Note that the caching headers can only be set if your resources are being served by your application. If yo content from your app (e.g. Apache HTTPD), configure it to send caching headers. Alternatively you ca resources from your container.

Zipping resources

Returning gzipped resources is another way to reduce page load times and reduce bandwidth.

The zipped-resources plugin provides a mapper that automatically compresses your content, excluding l such as gif, jpeg and png.

Simply install the zipped-resources plugin and it works.

Minifying

There are a number of CSS and JavaScript minifiers available to obfuscate and reduce the size of your publicly released but releases are imminent.

6.2.5.6 Debugging

When your resources are being moved around, renamed and otherwise mutated, it can be hard to debu especially Safari, Chrome and Firefox have excellent tools that let you view all the resources requested by information about them.

There are several debugging features built in to the Resources framework.

X-Grails-Resources-Original-Src Header

Every resource served in development mode will have the X-Grails-Resources-Original-Src: header adde that make up the response.

Adding the debug flag

If you add a query parameter **_debugResources=y** to your URL and request the page, Resources will byp your original source files.

This also adds a unique timestamp to all your resource URLs, to defeat any caching that browsers may u see your very latest code when you reload the page.

Turning on debug all the time

You can turn on the aforementioned debug mechanism without requiring a query parameter, but turning it

```
grails.resources.debug = true
```

You can of course set this per-environment.

6.2.5.7 Preventing processing of resources

Sometimes you do not want a resource to be processed in a particular way, or even at all. Occasionally yo
mapping.

Preventing the application of a specific mapper to an individual resource

All resource declarations support a convention of noXXXX:true where XXXX is a mapper name.

So for example to prevent the "hashandcache" mapper from being applied to a resource (which renan
relative links written in JavaScript code), you would do this:

```
modules = {
    forms {
        resource url: '/css/forms.css', nohashandcache: true
        resource url: '/js/forms.js', nohashandcache: true
    }
}
```

Excluding/including paths and file types from specific mappers

Mappers have includes/excludes Ant patterns to control whether they apply to a given resource. Mappers
their activity, for example the zipped-resources plugin's "zip" mapper is set to exclude images by default.

You can configure this in your `Config.groovy` using the mapper name e.g:

```
// We wouldn't link to .exe files using Resources but for the sake of example:
grails.resources.zip.excludes = ['**/*.zip', '**/*.exe']

// Perhaps for some reason we want to prevent bundling on "less" CSS files:
grails.resources.bundle.excludes = ['**/*.less']
```

There is also an "includes" inverse. Note that settings these replaces the default includes/excludes for that r

Controlling what is treated as an "ad-hoc" (legacy) resource

Ad-hoc resources are those undeclared, but linked to directly in your application **without** using the Grai
img or external).

These may occur with some legacy plugins or code with hardcoded paths in.

There is a Config.groovy setting **grails.resources.adhoc.patterns** which defines a list of Servlet API coı
Resources filter will use to detect such "ad-hoc resource" requests.

By default this is set to:

```
grails.resources.adhoc.patterns = ['images/*', '*.js', '*.css']
```

6.2.5.8 Other Resources-aware plugins

At the time of writing, the following plugins include support for the Resources framework:

* jquery
* jquery-ui
* blueprint
* lesscss-resources
* zipped-resources
* cached-resources

6.2.6 Sitemesh Content Blocks

Although it is useful to decorate an entire page sometimes you may find the need to decorate independe can use content blocks. To get started, partition the page to be decorated using the `<content>` tag:

```
<content tag="navbar">
… draw the navbar here…
</content>

<content tag="header">
… draw the header here…
</content>

<content tag="footer">
… draw the footer here…
</content>

<content tag="body">
… draw the body here…
</content>
```

Then within the layout you can reference these components and apply individual layouts to each:

```
<html>
    <body>
        <div id="header">
            <g:applyLayout name="headerLayout">
                <g:pageProperty name="page.header" />
            </g:applyLayout>
        </div>
        <div id="nav">
            <g:applyLayout name="navLayout">
                <g:pageProperty name="page.navbar" />
            </g:applyLayout>
        </div>
        <div id="body">
            <g:applyLayout name="bodyLayout">
                <g:pageProperty name="page.body" />
            </g:applyLayout>
        </div>
        <div id="footer">
            <g:applyLayout name="footerLayout">
                <g:pageProperty name="page.footer" />
            </g:applyLayout>
        </div>
    </body>
</html>
```

6.2.7 Making Changes to a Deployed Application

One of the main issues with deploying a Grails application (or typically any servlet-based one) is that any redeploy your whole application. If all you want to do is fix a typo on a page, or change an image link, it c For such simple requirements, Grails does have a solution: the `grails.gsp.view.dir` configuration s

How does this work? The first step is to decide where the GSP files should go. Let's say we `/var/www/grails/my-app` directory. We add these two lines to `grails-app/conf/Config.g`

```
grails.gsp.enable.reload = true
grails.gsp.view.dir = "/var/www/grails/my-app/"
```

The first line tells Grails that modified GSP files should be reloaded at runtime. If you don't have this sett you like but they won't be reflected in the running application until you restart. The second line tells Gra from.

> ⚠ The trailing slash on the `grails.gsp.view.dir` value is important! Without it, Grails the parent directory.

Setting "grails.gsp.view.dir" is optional. If it's not specified, you can update files directly to the applic Depending on the application server, these files might get overwritten when the server is restarted. Most war deployment" which is recommended in this case.

With those settings in place, all you need to do is copy the views from your web application to the externa would look something like this:

```
mkdir -p /var/www/grails/my-app/grails-app/views
cp -R grails-app/views/* /var/www/grails/my-app/grails-app/views
```

The key point here is that you must retain the view directory structure, including the `grails-app/vi` `/var/www/grails/my-app/grails-app/views/...`.

One thing to bear in mind with this technique is that every time you modify a GSP, it uses up perm eventually hit "out of permgen space" errors unless you restart the server. So this technique is not recomm the views.

There are also some System properties to control GSP reloading:

Name	Description
grails.gsp.enable.reload	altervative system property for enabling the GSP reload mode without chang
grails.gsp.reload.interval	interval between checking the lastmodified time of the gsp source file, unit i
grails.gsp.reload.granularity	the number of milliseconds leeway to give before deciding a file is out of different roundings usually cause a 1000ms difference in lastmodified times

GSP reloading is supported for precompiled GSPs since Grails 1.3.5 .

6.2.8 GSP Debugging

Viewing the generated source code

- Adding "?showSource=true" or "&showSource=true" to the url shows the generated Groovy source c It won't show the source code of included templates. This only works in development mode
- The saving of all generated source code can be activated by setting the property "grails.views.gsp.ke must point to a directory that exists and is writable.
- During "grails war" gsp pre-compilation, the generated source code is stored in grails.pro ~/.grails/(grails_version)/projects/(project name)/gspcompile).

Debugging GSP code with a debugger

- See [Debugging GSP in STS]

Viewing information about templates used to render a single url

GSP templates are reused in large web applications by using the `g:render` taglib. Several small templa It might be hard to find out what GSP template actually renders the html seen in the result. The debug ten the output. The comments contain debug information about gsp templates used to render the page.

Usage is simple: append "?debugTemplates" or "&debugTemplates" to the url and view the so "debugTemplates" is restricted to development mode. It won't work in production.

Here is an example of comments added by debugTemplates :

```
<!-- GSP #2 START template: /home/.../views/_carousel.gsp
     precompiled: false lastmodified: … -->
.
.
.
<!-- GSP #2 END template: /home/.../views/_carousel.gsp
     rendering time: 115 ms -->
```

Each comment block has a unique id so that you can find the start & end of each template call.

6.3 Tag Libraries

Like [Java Server Pages] (JSP), GSP supports the concept of custom tag libraries. Unlike JSP, Grails' tag lil completely reloadable at runtime.

Quite simply, to create a tag library create a Groovy class that ends with the convention `grails-app/taglib` directory:

```
class SimpleTagLib {

}
```

Now to create a tag create a Closure property that takes two arguments: the tag attributes and the body con

```
class SimpleTagLib {
    def simple = { attrs, body ->

}
}
```

The `attrs` argument is a Map of the attributes of the tag, whilst the `body` argument is a Closure that retu

```
class SimpleTagLib {
    def emoticon = { attrs, body ->
       out << body() << (attrs.happy == 'true' ? " :-)" : " :-(")
    }
}
```

As demonstrated above there is an implicit `out` variable that refers to the output `Writer` which you can
Then you can reference the tag inside your GSP; no imports are necessary:

```
<g:emoticon happy="true">Hi John</g:emoticon>
```

To help IDEs like SpringSource Tool Suite (STS) and others autocomplete tag attributes, yo
comments to your tag closures with `@attr` descriptions. Since taglibs use Groovy code it can
detect all usable attributes.

For example:

```
class SimpleTagLib {

/**
     * Renders the body with an emoticon.
     *
     * @attr happy whether to show a happy emoticon ('true') or
     * a sad emoticon ('false')
     */
    def emoticon = { attrs, body ->
       out << body() << (attrs.happy == 'true' ? " :-)" : " :-(")
    }
}
```

and any mandatory attributes should include the REQUIRED keyword, e.g.

```
class SimpleTagLib {

/**
     * Creates a new password field.
     *
     * @attr name REQUIRED the field name
     * @attr value the field value
     */
    def passwordField = { attrs ->
        attrs.type = "password"
        attrs.tagName = "passwordField"
        fieldImpl(out, attrs)
    }
}
```

6.3.1 Variables and Scopes

Within the scope of a tag library there are a number of pre-defined variables including:

- `actionName` - The currently executing action name
- `controllerName` - The currently executing controller name
- `flash` - The flash object
- `grailsApplication` - The GrailsApplication instance
- `out` - The response writer for writing to the output stream
- `pageScope` - A reference to the pageScope object used for GSP rendering (i.e. the binding)
- `params` - The params object for retrieving request parameters
- `pluginContextPath` - The context path to the plugin that contains the tag library
- `request` - The HttpServletRequest instance
- `response` - The HttpServletResponse instance
- `servletContext` - The javax.servlet.ServletContext instance
- `session` - The HttpSession instance

6.3.2 Simple Tags

As demonstrated it the previous example it is easy to write simple tags that have no body and just c
`dateFormat` style tag:

```
def dateFormat = { attrs, body ->
    out << new java.text.SimpleDateFormat(attrs.format).format(attrs.date)
}
```

The above uses Java's `SimpleDateFormat` class to format a date and then write it to the response. Th
follows:

```
<g:dateFormat format="dd-MM-yyyy" date="${new Date()}" />
```

With simple tags sometimes you need to write HTML mark-up to the response. One approach would be to

```
def formatBook = { attrs, body ->
    out << "<div id="${attrs.book.id}">"
    out << "Title : ${attrs.book.title}"
    out << "</div>"
}
```

Although this approach may be tempting it is not very clean. A better approach would be to reuse the rend

```
def formatBook = { attrs, body ->
    out << render(template: "bookTemplate", model: [book: attrs.book])
}
```

And then have a separate GSP template that does the actual rendering.

6.3.3 Logical Tags

You can also create logical tags where the body of the tag is only output once a set of conditions have bee of security tags:

```
def isAdmin = { attrs, body ->
    def user = attrs.user
    if (user && checkUserPrivs(user)) {
        out << body()
    }
}
```

The tag above checks if the user is an administrator and only outputs the body content if he/she has the cor

```
<g:isAdmin user="${myUser}">
    // some restricted content
</g:isAdmin>
```

6.3.4 Iterative Tags

Iterative tags are easy too, since you can invoke the body multiple times:

```
def repeat = { attrs, body ->
    attrs.times?.toInteger()?.times { num ->
        out << body(num)
    }
}
```

In this example we check for a `times` attribute and if it exists convert it to a number, then use Groovy's number of times:

```
<g:repeat times="3">
<p>Repeat this 3 times! Current repeat = ${it}</p>
</g:repeat>
```

Notice how in this example we use the implicit `it` variable to refer to the current number. This works t passed in the current value inside the iteration:

```
out << body(num)
```

That value is then passed as the default variable `it` to the tag. However, if you have nested tags this can instead name the variables that the body uses:

```
def repeat = { attrs, body ->
    def var = attrs.var ?: "num"
    attrs.times?.toInteger()?.times { num ->
        out << body((var):num)
    }
}
```

Here we check if there is a `var` attribute and if there is use that as the name to pass into the body invocatic

```
out << body((var):num)
```

> ⚠ Note the usage of the parenthesis around the variable name. If you omit these Groovy ass String key and not referring to the variable itself.

Now we can change the usage of the tag as follows:

```
<g:repeat times="3" var="j">
<p>Repeat this 3 times! Current repeat = ${j}</p>
</g:repeat>
```

Notice how we use the `var` attribute to define the name of the variable `j` and then we are able to referer tag.

6.3.5 Tag Namespaces

By default, tags are added to the default Grails namespace and are used with the `g:` prefix in GSP pages namespace by adding a static property to your `TagLib` class:

```
class SimpleTagLib {
    static namespace = "my"

def example = { attrs ->
        …
    }
}
```

Here we have specified a `namespace` of `my` and hence the tags in this tag lib must then be referenced fro

```
<my:example name="..." />
```

where the prefix is the same as the value of the static `namespace` property. Namespaces are particularly

Tags within namespaces can be invoked as methods using the namespace as a prefix to the method call:

```
out << my.example(name:"foo")
```

This works from GSP, controllers or tag libraries

6.3.6 Using JSP Tag Libraries

In addition to the simplified tag library mechanism provided by GSP, you can also use JSP tags from G
use with the `taglib` directive:

```
<%@ taglib prefix="fmt" uri="http://java.sun.com/jsp/jstl/fmt" %>
```

Then you can use it like any other tag:

```
<fmt:formatNumber value="${10}" pattern=".00"/>
```

With the added bonus that you can invoke JSP tags like methods:

```
${fmt.formatNumber(value:10, pattern:".00")}
```

6.3.7 Tag return value

Since Grails 1.2, a tag library call returns an instance of `org.codehaus.groovy.grails.web.u`
default. This change improves performance by reducing object creation and optimizing buffering durin
versions, a `java.lang.String` instance was returned.

Tag libraries can also return direct object values to the caller since Grails 1.2.. Object returnir
`returnObjectForTags` property in the tag library class.

Example:

```
class ObjectReturningTagLib {
    static namespace = "cms"
    static returnObjectForTags = ['content']

def content = { attrs, body ->
        CmsContent.findByCode(attrs.code)?.content
    }
}
```

6.4 URL Mappings

Throughout the documentation so far the convention used for URLs has been the default of `/contr`
convention is not hard wired into Grails and is in fact controlled by a URL
`grails-app/conf/UrlMappings.groovy`.

The `UrlMappings` class contains a single property called `mappings` that has been assigned a block of

```
class UrlMappings {
    static mappings = {
    }
}
```

6.4.1 Mapping to Controllers and Actions

To create a simple mapping simply use a relative URL as the method name and specify named parameters

```
"/product"(controller: "product", action: "list")
```

In this case we've mapped the URL `/product` to the `list` action of the `ProductController`. O default action of the controller:

```
"/product"(controller: "product")
```

An alternative syntax is to assign the controller and action to use within a block passed to the method:

```
"/product" {
    controller = "product"
    action = "list"
}
```

Which syntax you use is largely dependent on personal preference. To rewrite one URI onto another expl pair) do something like this:

```
"/hello"(uri: "/hello.dispatch")
```

Rewriting specific URIs is often useful when integrating with other frameworks.

6.4.2 Embedded Variables

Simple Variables

The previous section demonstrated how to map simple URLs with concrete "tokens". In URL mapp characters between each slash, '/'. A concrete token is one which is well defined such as as `/product`. don't know what the value of a particular token will be until runtime. In this case you can use variable plac

```
static mappings = {
  "/product/$id"(controller: "product")
}
```

In this case by embedding a $id variable as the second token Grails will automatically map the second to
params object) called `id`. For example given the URL `/product/MacBook`, the following code will re

```
class ProductController {
     def index() { render params.id }
}
```

You can of course construct more complex examples of mappings. For example the traditional blog URL f

```
static mappings = {
   "/$blog/$year/$month/$day/$id"(controller: "blog", action: "show")
}
```

The above mapping would let you do things like:

```
/graemerocher/2007/01/10/my_funky_blog_entry
```

The individual tokens in the URL would again be mapped into the params object with values available for

Dynamic Controller and Action Names

Variables can also be used to dynamically construct the controller and action name. In fact the default Grai

```
static mappings = {
    "/$controller/$action?/$id?"()
}
```

Here the name of the controller, action and id are implicitly obtained from the variables `controller`,
URL.

You can also resolve the controller name and action name to execute dynamically using a closure:

```
static mappings = {
    "/$controller" {
        action = { params.goHere }
    }
}
```

Optional Variables

Another characteristic of the default mapping is the ability to append a ? at the end of a variable to r
example this technique could be applied to the blog URL mapping to have more flexible linking:

```
static mappings = {
    "/$blog/$year?/$month?/$day?/$id?"(controller:"blog", action:"show")
}
```

With this mapping all of these URLs would match with only the relevant parameters being populated in th

```
/graemerocher/2007/01/10/my_funky_blog_entry
/graemerocher/2007/01/10
/graemerocher/2007/01
/graemerocher/2007
/graemerocher
```

Arbitrary Variables

You can also pass arbitrary parameters from the URL mapping into the controller by just setting them in th

```
"/holiday/win" {
     id = "Marrakech"
     year = 2007
}
```

This variables will be available within the params object passed to the controller.

Dynamically Resolved Variables

The hard coded arbitrary variables are useful, but sometimes you need to calculate the name of the variabl possible by assigning a block to the variable name:

```
"/holiday/win" {
     id = { params.id }
     isEligible = { session.user != null } // must be logged in
}
```

In the above case the code within the blocks is resolved when the URL is actually matched and hence can logic.

6.4.3 Mapping to Views

You can resolve a URL to a view without a controller or action involved. For example to map the r `grails-app/views/index.gsp` you could use:

```
static mappings = {
    "/"(view: "/index")  // map the root URL
}
```

Alternatively if you need a view that is specific to a given controller you could use:

```
static mappings = {
   "/help"(controller: "site", view: "help") // to a view for a controller
}
```

6.4.4 Mapping to Response Codes

Grails also lets you map HTTP response codes to controllers, actions or views. Just use a method name t interested in:

```
static mappings = {
   "403"(controller: "errors", action: "forbidden")
   "404"(controller: "errors", action: "notFound")
   "500"(controller: "errors", action: "serverError")
}
```

Or you can specify custom error pages:

```
static mappings = {
   "403"(view: "/errors/forbidden")
   "404"(view: "/errors/notFound")
   "500"(view: "/errors/serverError")
}
```

Declarative Error Handling

In addition you can configure handlers for individual exceptions:

```
static mappings = {
   "403"(view: "/errors/forbidden")
   "404"(view: "/errors/notFound")
   "500"(controller: "errors", action: "illegalArgument",
         exception: IllegalArgumentException)
   "500"(controller: "errors", action: "nullPointer",
         exception: NullPointerException)
   "500"(controller: "errors", action: "customException",
         exception: MyException)
   "500"(view: "/errors/serverError")
}
```

With this configuration, an `IllegalArgumentException` will be handled by the `illegalArgume` `NullPointerException` will be handled by the `nullPointer` action, and a `MyExce` `customException` action. Other exceptions will be handled by the catch-all rule and use the `/errors`

You can access the exception from your custom error handing view or controller action using the request's

```
class ErrorController {
    def handleError() {
        def exception = request.exception
        // perform desired processing to handle the exception
    }
}
```

If your error-handling controller action throws an exception as well, you'll StackOverflowException.

6.4.5 Mapping to HTTP methods

URL mappings can also be configured to map based on the HTTP method (GET, POST, PUT or DELETE and for restricting mappings based on HTTP method.

As an example the following mappings provide a RESTful API URL mappings for the `ProductContro`

```
static mappings = {
   "/product/$id"(controller:"product") {
       action = [GET:"show", PUT:"update", DELETE:"delete", POST:"save"]
   }
}
```

6.4.6 Mapping Wildcards

Grails' URL mappings mechanism also supports wildcard mappings. For example consider the following m

```
static mappings = {
    "/images/*.jpg"(controller: "image")
}
```

This mapping will match all paths to images such as `/image/logo.jpg`. Of course you can achieve the

```
static mappings = {
    "/images/$name.jpg"(controller: "image")
}
```

However, you can also use double wildcards to match more than one level below:

```
static mappings = {
    "/images/**.jpg"(controller: "image")
}
```

In this cases the mapping will match `/image/logo.jpg` as well as `/image/other/logo.jpg`. Ev variable:

```
static mappings = {
    // will match /image/logo.jpg and /image/other/logo.jpg
    "/images/$name**.jpg"(controller: "image")
}
```

In this case it will store the path matched by the wildcard inside a `name` parameter obtainable from the par

```
def name = params.name
println name // prints "logo" or "other/logo"
```

If you use wildcard URL mappings then you may want to exclude certain URIs from Grails' URL mappi an `excludes` setting inside the `UrlMappings.groovy` class:

```
class UrlMappings {
    static excludes = ["/images/*", "/css/*"]
    static mappings = {
        …
    }
}
```

In this case Grails won't attempt to match any URIs that start with `/images` or `/css`.

6.4.7 Automatic Link Re-Writing

Another great feature of URL mappings is that they automatically customize the behaviour of the link ta require you to go and change all of your links.

This is done through a URL re-writing technique that reverse engineers the links from the URL mapping one from an earlier section:

```
static mappings = {
   "/$blog/$year?/$month?/$day?/$id?"(controller:"blog", action:"show")
}
```

If you use the link tag as follows:

```
<g:link controller="blog" action="show"
        params="[blog:'fred', year:2007]">
    My Blog
</g:link>

<g:link controller="blog" action="show"
        params="[blog:'fred', year:2007, month:10]">
    My Blog - October 2007 Posts
</g:link>
```

Grails will automatically re-write the URL in the correct format:

```
<a href="/fred/2007">My Blog</a>
<a href="/fred/2007/10">My Blog - October 2007 Posts</a>
```

6.4.8 Applying Constraints

URL Mappings also support Grails' unified validation constraints mechanism, which lets you further "c
example, if we revisit the blog sample code from earlier, the mapping currently looks like this:

```
static mappings = {
   "/$blog/$year?/$month?/$day?/$id?"(controller:"blog", action:"show")
}
```

This allows URLs such as:

```
/graemerocher/2007/01/10/my_funky_blog_entry
```

However, it would also allow:

```
/graemerocher/not_a_year/not_a_month/not_a_day/my_funky_blog_entry
```

This is problematic as it forces you to do some clever parsing in the controller code. Luckily, URL M
validate the URL tokens:

```
"/$blog/$year?/$month?/$day?/$id?" {
     controller = "blog"
     action = "show"
     constraints {
          year(matches:/\d{4}/)
          month(matches:/\d{2}/)
          day(matches:/\d{2}/)
     }
}
```

In this case the constraints ensure that the `year`, `month` and `day` parameters match a particular valid pa
later on.

6.4.9 Named URL Mappings

URL Mappings also support named mappings, that is are mappings which have a name associated with th
specific mapping when links are generated.

The syntax for defining a named mapping is as follows:

```
static mappings = {
   name <mapping name>: <url pattern> {
      // …
   }
}
```

For example:

```
static mappings = {
    name personList: "/showPeople" {
        controller = 'person'
        action = 'list'
    }
    name accountDetails: "/details/$acctNumber" {
        controller = 'product'
        action = 'accountDetails'
    }
}
```

The mapping may be referenced in a link tag in a GSP.

```
<g:link mapping="personList">List People</g:link>
```

That would result in:

```
<a href="/showPeople">List People</a>
```

Parameters may be specified using the params attribute.

```
<g:link mapping="accountDetails" params="[acctNumber:'8675309']">
    Show Account
</g:link>
```

That would result in:

```
<a href="/details/8675309">Show Account</a>
```

Alternatively you may reference a named mapping using the link namespace.

```
<link:personList>List People</link:personList>
```

That would result in:

```
<a href="/showPeople">List People</a>
```

The link namespace approach allows parameters to be specified as attributes.

```
<link:accountDetails acctNumber="8675309">Show Account</link:accountDetails>
```

That would result in:

```
<a href="/details/8675309">Show Account</a>
```

To specify attributes that should be applied to the generated `href`, specify a `Map` value to the `attrs` at directly to the href, not passed through to be used as request parameters.

```
<link:accountDetails attrs="[class: 'fancy']" acctNumber="8675309">
    Show Account
</link:accountDetails>
```

That would result in:

```
<a href="/details/8675309" class="fancy">Show Account</a>
```

6.5 Web Flow

Overview

Grails supports the creation of web flows built on the Spring Web Flow project. A web flow is a conver retains state for the scope of the flow. A web flow also has a defined start and end state.

Web flows don't require an HTTP session, but instead store their state in a serialized form, which is then r Grails passes around as a request parameter. This makes flows far more scalable than other forms of state and its inherit memory and clustering concerns.

Web flow is essentially an advanced state machine that manages the "flow" of execution from one state to you, you don't have to be concerned with ensuring that users enter an action in the middle of some multi s you. This makes web flow perfect for use cases such as shopping carts, hotel booking and any application

> From Grails 1.2 onwards Webflow is no longer in Grails core, so you must install the Web feature: `grails install-plugin webflow`

Creating a Flow

To create a flow create a regular Grails controller and add an action that ends with the convention `Flow`. F

```
class BookController {

def index() {
        redirect(action: "shoppingCart")
    }

def shoppingCartFlow() {
        …
    }
}
```

Notice when redirecting or referring to the flow as an action we omit the `Flow` suffix. In other words the r
`shoppingCart`.

6.5.1 Start and End States

As mentioned before a flow has a defined start and end state. A start state is the state which is entered w
(or flow). The start state of a Grails flow is the first method call that takes a block. For example:

```
class BookController {
   …
   def shoppingCartFlow() {
       showCart {
           on("checkout").to "enterPersonalDetails"
           on("continueShopping").to "displayCatalogue"
       }
       …
       displayCatalogue {
           redirect(controller: "catalogue", action: "show")
       }
       displayInvoice()
   }
}
```

Here the `showCart` node is the start state of the flow. Since the showCart state doesn't define an action o
that, by convention, refers to the view `grails-app/views/book/shoppingCart/showCart.gs`

Notice that unlike regular controller actions, the views are stored within a directory that
`grails-app/views/book/shoppingCart`.

The `shoppingCart` flow also has two possible end states. The first is `displayCatalogue` which p
controller and action, thus exiting the flow. The second is `displayInvoice` which is an end state as
render a view called `grails-app/views/book/shoppingCart/displayInvoice.gsp` whils

Once a flow has ended it can only be resumed from the start state, in this case `showCart`, and not from a

6.5.2 Action States and View States

View states

A view state is a one that doesn't define an `action` or a `redirect`. So for example this is a view state:

```
enterPersonalDetails {
   on("submit").to "enterShipping"
   on("return").to "showCart"
}
```

It will look for a view called `grails-app/views/book/shoppingCart/enterPersonalDet` `enterPersonalDetails` state defines two events: `submit` and `return`. The view is responsibl `render` method to change the view to be rendered:

```
enterPersonalDetails {
   render(view: "enterDetailsView")
   on("submit").to "enterShipping"
   on("return").to "showCart"
}
```

Now it will look for `grails-app/views/book/shoppingCart/enterDetailsView.gsp`. S a shared view:

```
enterPersonalDetails {
   render(view: "/shared/enterDetailsView")
   on("submit").to "enterShipping"
   on("return").to "showCart"
}
```

Now it will look for `grails-app/views/shared/enterDetailsView.gsp`

Action States

An action state is a state that executes code but does not render a view. The result of the action is used action state you define an action to to be executed. This is done by calling the `action` method and passin

```
listBooks {
   action {
      [bookList: Book.list()]
   }
   on("success").to "showCatalogue"
   on(Exception).to "handleError"
}
```

As you can see an action looks very similar to a controller action and in fact you can reuse control successfully returns with no errors the `success` event will be triggered. In this case since we return a l and is automatically placed in flow scope.

In addition, in the above example we also use an exception handler to deal with errors on the line:

```
on(Exception).to "handleError"
```

This makes the flow transition to a state called `handleError` in the case of an exception.

You can write more complex actions that interact with the flow request context:

```
processPurchaseOrder {
    action {
        def a =  flow.address
        def p = flow.person
        def pd = flow.paymentDetails
        def cartItems = flow.cartItems
        flow.clear()

def o = new Order(person: p, shippingAddress: a, paymentDetails: pd)
        o.invoiceNumber = new Random().nextInt(9999999)
        for (item in cartItems) { o.addToItems item }
        o.save()
        [order: o]
    }
    on("error").to "confirmPurchase"
    on(Exception).to "confirmPurchase"
    on("success").to "displayInvoice"
}
```

Here is a more complex action that gathers all the information accumulated from the flow scope and creat
order as the model. The important thing to note here is the interaction with the request context and "flow s

Transition Actions

Another form of action is what is known as a *transition* action. A transition action is executed directly pr
been triggered. A simple example of a transition action can be seen below:

```
enterPersonalDetails {
   on("submit") {
       log.trace "Going to enter shipping"
   }.to "enterShipping"
   on("return").to "showCart"
}
```

Notice how we pass a block of the code to `submit` event that simply logs the transition. Transition stat
[validation](), which is covered in a later section.

6.5.3 Flow Execution Events

In order to *transition* execution of a flow from one state to the next you need some way of trigger an *even*
next. Events can be triggered from either view states or action states.

Triggering Events from a View State

As discussed previously the start state of the flow in a previous code listing deals with two possibl
`continueShopping` event:

```
def shoppingCartFlow() {
    showCart {
        on("checkout").to "enterPersonalDetails"
        on("continueShopping").to "displayCatalogue"
    }
    …
}
```

Since the `showCart` event is a view state it will render the view `grails-app/book/shoppingCar`
you need to have components that trigger flow execution. On a form this can be done use the submitButtor

```
<g:form action="shoppingCart">
    <g:submitButton name="continueShopping" value="Continue Shopping" />
    <g:submitButton name="checkout" value="Checkout" />
</g:form>
```

The form must submit back to the `shoppingCart` flow. The name attribute of each submitButton tag s
you don't have a form you can also trigger an event with the link tag as follows:

```
<g:link action="shoppingCart" event="checkout" />
```

Triggering Events from an Action

To trigger an event from an `action` you invoke a method. For example there is the built in `error()` ar
below triggers the `error()` event on validation failure in a transition action:

```
enterPersonalDetails {
   on("submit") {
         def p = new Person(params)
         flow.person = p
         if (!p.validate()) return error()
   }.to "enterShipping"
   on("return").to "showCart"
}
```

In this case because of the error the transition action will make the flow go back to the `enterPersonal`

With an action state you can also trigger events to redirect flow:

```
shippingNeeded {
   action {
       if (params.shippingRequired) yes()
       else no()
   }
   on("yes").to "enterShipping"
   on("no").to "enterPayment"
}
```

6.5.4 Flow Scopes

Scope Basics

You'll notice from previous examples that we used a special object called `flow` to store objects withi
different scopes you can utilize:

- `request` - Stores an object for the scope of the current request
- `flash` - Stores the object for the current and next request only
- `flow` - Stores objects for the scope of the flow, removing them when the flow reaches an end state
- `conversation` - Stores objects for the scope of the conversation including the root flow and neste
- `session` - Stores objects in the user's session

> ⚠ Grails service classes can be automatically scoped to a web flow scope. See the documentatio
> information.

Returning a model Map from an action will automatically result in the model being placed in flow scope.
you can place objects within `flow` scope as follows:

```
enterPersonalDetails {
    on("submit") {
        [person: new Person(params)]
    }.to "enterShipping"
   on("return").to "showCart"
}
```

Be aware that a new request is always created for each state, so an object placed in request scope in an
available in a subsequent view state. Use one of the other scopes to pass objects from one state to another.

1. Moves objects from flash scope to request scope upon transition between states;
2. Merges objects from the flow and conversation scopes into the view model before rendering (so you
   referencing these objects within a view, e.g. GSP pages).

Flow Scopes and Serialization

When placing objects in `flash`, `flow` or `conversation` scope they must implement `java.io.Se`
thrown. This has an impact on domain classes in that domain classes are typically placed within a scope
For example consider the following domain class:

```
class Book {
    String title
}
```

To place an instance of the `Book` class in a flow scope you will need to modify it as follows:

```
class Book implements Serializable {
    String title
}
```

This also impacts associations and closures you declare within a domain class. For example consider this:

```
class Book implements Serializable {
    String title
    Author author
}
```

Here if the `Author` association is not `Serializable` you will also get an error. This also impacts cl `onLoad`, `onSave` and so on. The following domain class will cause an error if an instance is placed in a f

```
class Book implements Serializable {

String title

def onLoad = {
        println "I'm loading"
    }
}
```

The reason is that the assigned block on the `onLoad` event cannot be serialized. To get around this you sh :

```
class Book implements Serializable {

String title

transient onLoad = {
        println "I'm loading"
    }
}
```

or as methods:

```
class Book implements Serializable {

String title

def onLoad() {
        println "I'm loading"
    }
}
```

6.5.5 Data Binding and Validation

In the section on start and end states, the start state in the first example triggered a transition to the `enter` renders a view and waits for the user to enter the required information:

```
enterPersonalDetails {
   on("submit").to "enterShipping"
   on("return").to "showCart"
}
```

The view contains a form with two submit buttons that either trigger the submit event or the return event:

```
<g:form action="shoppingCart">
    <!-- Other fields -->
    <g:submitButton name="submit" value="Continue"></g:submitButton>
    <g:submitButton name="return" value="Back"></g:submitButton>
</g:form>
```

However, what about the capturing the information submitted by the form? To to capture the form info we

```
enterPersonalDetails {
   on("submit") {
      flow.person = new Person(params)
      !flow.person.validate() ? error() : success()
   }.to "enterShipping"
   on("return").to "showCart"
}
```

Notice how we perform data binding from request parameters and place the `Person` instance within `f` perform validation and invoke the `error()` method if validation fails. This signals to the flow that the `enterPersonalDetails` view so valid entries can be entered by the user, otherwise the trans `enterShipping` state.

Like regular actions, flow actions also support the notion of Command Objects by defining the first argum

```
enterPersonalDetails {
   on("submit") { PersonDetailsCommand cmd ->
       flow.personDetails = cmd
      !flow.personDetails.validate() ? error() : success()
   }.to "enterShipping"
   on("return").to "showCart"
}
```

6.5.6 Subflows and Conversations

Grails' Web Flow integration also supports subflows. A subflow is like a flow within a flow. For example

```
def searchFlow() {
    displaySearchForm {
        on("submit").to "executeSearch"
    }
    executeSearch {
        action {
            [results:searchService.executeSearch(params.q)]
        }
        on("success").to "displayResults"
        on("error").to "displaySearchForm"
    }
    displayResults {
        on("searchDeeper").to "extendedSearch"
        on("searchAgain").to "displaySearchForm"
    }
    extendedSearch {
        // Extended search subflow
        subflow(controller: "searchExtensions", action: "extendedSearch")
        on("moreResults").to "displayMoreResults"
        on("noResults").to "displayNoMoreResults"
    }
    displayMoreResults()
    displayNoMoreResults()
}
```

It references a subflow in the `extendedSearch` state. The controller parameter is optional if the subfl
the calling flow.

> ⚠ Prior to 1.3.5, the previous subflow call would look like `subflow(extendedSea`
> requirement that the name of the subflow state be the same as the called subflow (minus `Flo`
> a subflow is deprecated and only supported for backward compatibility.

The subflow is another flow entirely:

```
def extendedSearchFlow() {
    startExtendedSearch {
        on("findMore").to "searchMore"
        on("searchAgain").to "noResults"
    }
    searchMore {
        action {
           def results = searchService.deepSearch(ctx.conversation.query)
           if (!results) return error()
           conversation.extendedResults = results
        }
        on("success").to "moreResults"
        on("error").to "noResults"
    }
    moreResults()
    noResults()
}
```

Notice how it places the `extendedResults` in conversation scope. This scope differs to flow scope
whole conversation not just the flow. Also notice that the end state (either `moreResults` or `noResult`
the main flow:

```
extendedSearch {
    // Extended search subflow
    subflow(controller: "searchExtensions", action: "extendedSearch")
    on("moreResults").to "displayMoreResults"
    on("noResults").to "displayNoMoreResults"
}
```

6.6 Filters

Although Grails [controllers](#) support fine grained interceptors, these are only really useful when applied to to manage with larger applications. Filters on the other hand can be applied across a whole group of cc action. Filters are far easier to plugin and maintain completely separately to your main controller logic anc concerns such as security, logging, and so on.

6.6.1 Applying Filters

To create a filter create a class that ends with the convention `Filters` in the `grails-app/conf` di block called `filters` that contains the filter definitions:

```
class ExampleFilters {
   def filters = {
        // your filters here
   }
}
```

Each filter you define within the `filters` block has a name and a scope. The name is the method name arguments. For example to define a filter that applies to all controllers and all actions you can use wildcard

```
sampleFilter(controller:'*', action:'*') {
  // interceptor definitions
}
```

The scope of the filter can be one of the following things:

- A controller and/or action name pairing with optional wildcards
- A URI, with Ant path matching syntax

Filter rule attributes:

- `controller` - controller matching pattern, by default * is replaced with .* and a regex is compiled
- `controllerExclude` - controller exclusion pattern, by default * is replaced with .* and a regex is
- `action` - action matching pattern, by default * is replaced with .* and a regex is compiled
- `actionExclude` - action exclusion pattern, by default * is replaced with .* and a regex is compiled
- `regex` (`true`/`false`) - use regex syntax (don't replace '*' with '.*')
- `uri` - a uri to match, expressed with as Ant style path (e.g. /book/**)
- `uriExclude` - a uri pattern to exclude, expressed with as Ant style path (e.g. /book/**)
- `find` (`true`/`false`) - rule matches with partial match (see `java.util.regex.Matcher.fin`
- `invert` (`true`/`false`) - invert the rule (NOT rule)

Some examples of filters include:

- All controllers and actions

```
all(controller: '*', action: '*') {
}
```

- Only for the `BookController`

```
justBook(controller: 'book', action: '*') {
}
```

- All controllers except the `BookController`

```
notBook(controller: 'book', invert: true) {
}
```

- All actions containing 'save' in the action name

```
saveInActionName(action: '*save*', find: true) {
}
```

- All actions starting with the letter 'b' except for actions beginning with the phrase 'bad*'

```
actionBeginningWithBButNotBad(action: 'b*', actionExclude: 'bad*', find: true) {
}
```

- Applied to a URI space

```
someURIs(uri: '/book/**') {
}
```

- Applied to all URIs

```
allURIs(uri: '/**') {
}
```

In addition, the order in which you define the filters within the `filters` code block dictates the order in
order of execution between `Filters` classes, you can use the `dependsOn` property discussed in [filter de

Note: When exclude patterns are used they take precedence over the matching patterns. For ex
and actionExclude is 'bad*' then actions like 'best' and 'bien' will have that filter applied bu
'badlands' will not.

6.6.2 Filter Types

Within the body of the filter you can then define one or several of the following interceptor types for the fi

- `before` - Executed before the action. Return `false` to indicate that the response has been handled should not execute
- `after` - Executed after an action. Takes a first argument as the view model to allow modification of
- `afterView` - Executed after view rendering. Takes an Exception as an argument which will be no processing. Note: this Closure is called before the layout is applied.

For example to fulfill the common simplistic authentication use case you could define a filter as follows:

```
class SecurityFilters {
   def filters = {
       loginCheck(controller: '*', action: '*') {
           before = {
              if (!session.user && !actionName.equals('login')) {
                  redirect(action: 'login')
                  return false
               }
           }
       }
   }
}
```

Here the `loginCheck` filter uses a `before` interceptor to execute a block of code that checks if a user
the login action. Note how returning false ensure that the action itself is not executed.

6.6.3 Variables and Scopes

Filters support all the common properties available to controllers and tag libraries, plus the application con

- request - The HttpServletRequest object
- response - The HttpServletResponse object
- session - The HttpSession object
- servletContext - The ServletContext object
- flash - The flash object
- params - The request parameters object
- actionName - The action name that is being dispatched to
- controllerName - The controller name that is being dispatched to
- grailsApplication - The Grails application currently running
- applicationContext - The ApplicationContext object

However, filters only support a subset of the methods available to controllers and tag libraries. These inclu

- redirect - For redirects to other controllers and actions
- render - For rendering custom responses

6.6.4 Filter Dependencies

In a `Filters` class, you can specify any other `Filters` classes that should first be executed using tl when a `Filters` class depends on the behavior of another `Filters` class (e.g. setting up the environme and is defined as an array of `Filters` classes.

Take the following example `Filters` classes:

```
class MyFilters {
    def dependsOn = [MyOtherFilters]

def filters = {
        checkAwesome(uri: "/*") {
            before = {
                if (request.isAwesome) { // do something awesome }
            }
        }

checkAwesome2(uri: "/*") {
            before = {
                if (request.isAwesome) { // do something else awesome }
            }
        }
    }
}
```

```
class MyOtherFilters {
    def filters = {
        makeAwesome(uri: "/*") {
            before = {
                request.isAwesome = true
            }
        }
        doNothing(uri: "/*") {
            before = {
                // do nothing
            }
        }
    }
}
```

MyFilters specifically `dependsOn` MyOtherFilters. This will cause all the filters in MyOtherFilters who be executed before those in MyFilters. For a request of "/test", which will match the scope of every filt would be as follows:

- MyOtherFilters - makeAwesome
- MyOtherFilters - doNothing
- MyFilters - checkAwesome
- MyFilters - checkAwesome2

The filters within the MyOtherFilters class are processed in order first, followed by the filters in the My `Filters` classes are enabled and the execution order of filters within each `Filters` class are preserved

If any cyclical dependencies are detected, the filters with cyclical dependencies will be added to the end continue. Information about any cyclical dependencies that are detected will be written to the logs. Ensure least WARN or configure an appender for the Gra `org.codehaus.groovy.grails.plugins.web.filters.FiltersGrailsPlugin`) when

6.7 Ajax

Ajax is the driving force behind the shift to richer web applications. These types of applications in gen frameworks written in languages like [Groovy] and [Ruby] Grails provides support for building Ajax applica full list of these see the Tag Library Reference.

6.7.1 Ajax Support

By default Grails ships with the [jQuery] library, but through the [Plugin system] provides support for Dojo:http://dojotoolkit.org/, Yahoo UI:http://developer.yahoo.com/yui/ and the [Google Web Toolkit].

This section covers Grails' support for Ajax in general. To get started, add this line to the `<head>` tag of y

```
<g:javascript library="jquery" />
```

You can replace `jQuery` with any other library supplied by a plugin you have installed. This works bec libraries. Thanks to Grails' plugin system there is support for a number of different Ajax libraries including

- jQuery
- Prototype
- Dojo
- YUI
- MooTools

6.7.1.1 Remoting Linking

Remote content can be loaded in a number of ways, the most commons way is through the remoteLink tag anchor tags that perform an asynchronous request and optionally set the response in an element. The sin follows:

```
<g:remoteLink action="delete" id="1">Delete Book</g:remoteLink>
```

The above link sends an asynchronous request to the `delete` action of the current controller with an id of

6.7.1.2 Updating Content

This is great, but usually you provide feedback to the user about what happened:

```
def delete() {
    def b = Book.get(params.id)
    b.delete()
    render "Book ${b.id} was deleted"
}
```

GSP code:

```
<div id="message"></div>
<g:remoteLink action="delete" id="1" update="message">
Delete Book
</g:remoteLink>
```

The above example will call the action and set the contents of the `message` `div` to the response in this c is done by the `update` attribute on the tag, which can also take a Map to indicate what should be updated

```
<div id="message"></div>
<div id="error"></div>
<g:remoteLink update="[success: 'message', failure: 'error']"
              action="delete" id="1">
Delete Book
</g:remoteLink>
```

Here the `error` div will be updated if the request failed.

6.7.1.3 Remote Form Submission

An HTML form can also be submitted asynchronously in one of two ways. Firstly using the formRemote
those for the remoteLink tag:

```
<g:formRemote url="[controller: 'book', action: 'delete']"
              update="[success: 'message', failure: 'error']">
    <input type="hidden" name="id" value="1" />
    <input type="submit" value="Delete Book!" />
</g:formRemote >
```

Or alternatively you can use the submitToRemote tag to create a submit button. This allows some but
depending on the action:

```
<form action="delete">
    <input type="hidden" name="id" value="1" />
    <g:submitToRemote action="delete"
                      update="[success: 'message', failure: 'error']" />
</form>
```

6.7.1.4 Ajax Events

Specific JavaScript can be called if certain events occur, all the events start with the "on" prefix and le
appropriate, or take other action:

```
<g:remoteLink action="show"
              id="1"
              update="success"
              onLoading="showProgress()"
              onComplete="hideProgress()">Show Book 1</g:remoteLink>
```

The above code will execute the "showProgress()" function which may show a progress bar or whatever is

- `onSuccess` - The JavaScript function to call if successful
- `onFailure` - The JavaScript function to call if the call failed
- `on_ERROR_CODE` - The JavaScript function to call to handle specified error codes (eg on404="alert(
- `onUninitialized` - The JavaScript function to call the a Ajax engine failed to initialise
- `onLoading` - The JavaScript function to call when the remote function is loading the response
- `onLoaded` - The JavaScript function to call when the remote function is completed loading the respo
- `onComplete` - The JavaScript function to call when the remote function is complete, including any

If you need a reference to the `XmlHttpRequest` object you can use the implicit event parameter `e` to ob

```
<g:javascript>
    function fireMe(e) {
        alert("XmlHttpRequest = " + e)
    }
}
</g:javascript>
<g:remoteLink action="example"
              update="success"
              onSuccess="fireMe(e)">Ajax Link</g:remoteLink>
```

6.7.2 Ajax with Prototype

Grails features an external plugin to add Prototype support to Grails. To install the plugin type the foll project in a terminal window:

```
grails install-plugin prototype
```

This will download the current supported version of the Prototype plugin and install it into your Grails p following reference to the top of your page:

```
<g:javascript library="prototype" />
```

If you require Scriptaculous too you can do the following instead:

```
<g:javascript library="scriptaculous" />
```

Now all of Grails tags such as remoteLink, formRemote and submitToRemote work with Prototype remoti

6.7.3 Ajax with Dojo

Grails features an external plugin to add Dojo support to Grails. To install the plugin type the following in a terminal window:

```
grails install-plugin dojo
```

This will download the current supported version of Dojo and install it into your Grails project. With reference to the top of your page:

```
<g:javascript library="dojo" />
```

Now all of Grails tags such as remoteLink, formRemote and submitToRemote work with Dojo remoting.

6.7.4 Ajax with GWT

Grails also features support for the Google Web Toolkit through a plugin. There is comprehensive docume

6.7.5 Ajax on the Server

There are a number of different ways to implement Ajax which are typically broken down into:

- Content Centric Ajax - Where you just use the HTML result of a remote call to update the page
- Data Centric Ajax - Where you actually send an XML or JSON response from the server and program
- Script Centric Ajax - Where the server sends down a stream of JavaScript to be evaluated on the fly

Most of the examples in the Ajax section cover Content Centric Ajax where you are updating the pag Centric or Script Centric. This guide covers the different styles of Ajax.

Content Centric Ajax

Just to re-cap, content centric Ajax involves sending some HTML back from the server and is typically render method:

```
def showBook() {
    def b = Book.get(params.id)

render(template: "bookTemplate", model: [book: b])
}
```

Calling this on the client involves using the remoteLink tag:

```
<g:remoteLink action="showBook" id="${book.id}"
              update="book${book.id}">Update Book</g:remoteLink>

<div id="book${book.id}">
   <!--existing book mark-up -->
</div>
```

Data Centric Ajax with JSON

Data Centric Ajax typically involves evaluating the response on the client and updating programmatically would typically use Grails' JSON marshalling capability:

```
import grails.converters.JSON

def showBook() {
    def b = Book.get(params.id)

render b as JSON
}
```

And then on the client parse the incoming JSON request using an Ajax event handler:

```
<g:javascript>
function updateBook(e) {
    var book = eval("("+e.responseText+")") // evaluate the JSON
    $("book" + book.id + "_title").innerHTML = book.title
}
<g:javascript>
<g:remoteLink action="test" update="foo" onSuccess="updateBook(e)">
    Update Book
</g:remoteLink>
<g:set var="bookId">book${book.id}</g:set>
<div id="${bookId}">
    <div id="${bookId}_title">The Stand</div>
</div>
```

Data Centric Ajax with XML

On the server side using XML is equally simple:

```
import grails.converters.XML

def showBook() {
    def b = Book.get(params.id)

render b as XML
}
```

However, since DOM is involved the client gets more complicated:

```
<g:javascript>
function updateBook(e) {
    var xml = e.responseXML
    var id = xml.getElementsByTagName("book").getAttribute("id")
    $("book" + id + "_title") = xml.getElementsByTagName("title")[0].textContent
}
<g:javascript>
<g:remoteLink action="test" update="foo" onSuccess="updateBook(e)">
    Update Book
</g:remoteLink>
<g:set var="bookId">book${book.id}</g:set>
<div id="${bookId}">
    <div id="${bookId}_title">The Stand</div>
</div>
```

Script Centric Ajax with JavaScript

Script centric Ajax involves actually sending JavaScript back that gets evaluated on the client. An example

```
def showBook() {
    def b = Book.get(params.id)

response.contentType = "text/javascript"
    String title = b.title.encodeAsJavascript()
    render "$('book${b.id}_title')='${title}'"
}
```

The important thing to remember is to set the `contentType` to `text/javascript`. If you use
JavaScript will automatically be evaluated due to this `contentType` setting.

Obviously in this case it is critical that you have an agreed client-side API as you don't want changes on th
of the reasons Rails has something like RJS. Although Grails does not currently have a feature such as RJ
that offers similar capabilities.

Responding to both Ajax and non-Ajax requests

It's straightforward to have the same Grails controller action handle both Ajax and non-Ajax requests.
`HttpServletRequest` which can be used to identify Ajax requests. For example you could render a p
requests or the full page for regular HTTP requests:

```
def listBooks() {
    def books = Book.list(params)
    if (request.xhr) {
        render template: "bookTable", model: [books: books]
    } else {
        render view: "list", model: [books: books]
    }
}
```

6.8 Content Negotiation

Grails has built in support for [Content negotiation] using either the HTTP `Accept` header, an explicit for
of a mapped URI.

Configuring Mime Types

Before you can start dealing with content negotiation you need to tell Grails what content types you wi
configured with a number of different content types within `grails-app/conf/Config.groov`
setting:

```
grails.mime.types = [ xml: ['text/xml', 'application/xml'],
                      text: 'text-plain',
                      js: 'text/javascript',
                      rss: 'application/rss+xml',
                      atom: 'application/atom+xml',
                      css: 'text/css',
                      csv: 'text/csv',
                      all: '*/*',
                      json: 'text/json',
                      html: ['text/html','application/xhtml+xml']
                    ]
```

The above bit of configuration allows Grails to detect to format of a request containing either the 'text/x
simply 'xml'. You can add your own types by simply adding new entries into the map.

Content Negotiation using the Accept header

Every incoming HTTP request has a special [Accept] header that defines what media types (or mime types)
this is typically:

```
*/*
```

Which simply means anything. However, on newer browser something all together more useful is sent suc header):

```
text/xml, application/xml, application/xhtml+xml, text/html;q=0.9,
text/plain;q=0.8, image/png, */*;q=0.5
```

Grails parses this incoming format and adds a `property` to the [response](#) object that outlines the pre example the following assertion would pass:

```
assert 'html' == response.format
```

Why? The `text/html` media type has the highest "quality" rating of 0.9, therefore is the highest pri mentioned previously the result is slightly different:

```
assert 'all' == response.format
```

In this case 'all' possible formats are accepted by the client. To deal with different kinds of requests from method that acts as kind of a switch statement:

```
import grails.converters.XML

class BookController {

def list() {
        def books = Book.list()
        withFormat {
            html bookList: books
            js { render "alert('hello')" }
            xml { render books as XML }
        }
    }
}
```

If the preferred format is `html` then Grails will execute the `html()` call only. This causes Gra `grails-app/views/books/list.html.gsp` or `grails-app/views/books/list.gsp`. will be invoked and an XML response rendered.

How do we handle the "all" format? Simply order the content-types within your `withFormat` block so comes first. So in the above example, "all" will trigger the `html` handler.

> When using [withFormat](#) make sure it is the last call in your controller action as the `withFormat` method is used by the action to dictate what happens next.

Request format vs. Response format

As of Grails 2.0, there is a separate notion of the *request* format and the *response* format. The request forr header and is typically used to detect if the incoming request can be parsed into XML or JSON, wh extension, format parameter or ACCEPT header to attempt to deliver an appropriate response to the client.

The [withFormat](#) available on controllers deals specifically with the response format. If you wish to add l then you can do so using a separate `withFormat` method available on the request:

```
request.withFormat {
    xml {
        // read XML
    }
    json {
        // read JSON
    }
}
```

Content Negotiation with the format Request Parameter

If fiddling with request headers if not your favorite activity you can override the format used by specifying

```
/book/list?format=xml
```

You can also define this parameter in the [URL Mappings](#) definition:

```
"/book/list"(controller:"book", action:"list") {
    format = "xml"
}
```

Content Negotiation with URI Extensions

Grails also supports content negotiation using URI extensions. For example given the following URI:

```
/book/list.xml
```

Grails will remove the extension and map it to `/book/list` instead whilst simultaneously setting th extension. This behaviour is enabled by default, so if you wish to turn it off, you must set the `grails.mi` `grails-app/conf/Config.groovy` to `false`:

```
grails.mime.file.extensions = false
```

Testing Content Negotiation

To test content negotiation in a unit or integration test (see the section on Testing) you can either manipula

```
void testJavascriptOutput() {
    def controller = new TestController()
    controller.request.addHeader "Accept",
              "text/javascript, text/html, application/xml, text/xml, */*"

controller.testAction()
    assertEquals "alert('hello')", controller.response.contentAsString
}
```

Or you can set the format parameter to achieve a similar effect:

```
void testJavascriptOutput() {
    def controller = new TestController()
    controller.params.format = 'js'

controller.testAction()
    assertEquals "alert('hello')", controller.response.contentAsString
}
```

7 Validation

Grails validation capability is built on [Spring's Validator API] and data binding capabilities. However G
unified way to define validation "constraints" with its constraints mechanism.

Constraints in Grails are a way to declaratively specify validation rules. Most commonly they are app
Mappings and Command Objects also support constraints.

7.1 Declaring Constraints

Within a domain class constraints are defined with the constraints property that is assigned a code block:

```
class User {
    String login
    String password
    String email
    Integer age

static constraints = {
      …
    }
}
```

You then use method calls that match the property name for which the constraint applies in combinat
constraints:

```
class User {
    ...

static constraints = {
        login size: 5..15, blank: false, unique: true
        password size: 5..15, blank: false
        email email: true, blank: false
        age min: 18
    }
}
```

In this example we've declared that the `login` property must be between 5 and 15 characters long, it canr
also applied other constraints to the `password`, `email` and `age` properties.

> By default, all domain class properties are not nullable (i.e. they have an implicit `nullable`
> The same is not true for command object properties, which are nullable by default.

A complete reference for the available constraints can be found in the Quick Reference section under the C

A word of warning - referencing domain class properties from constraints

It's very easy to attempt to reference instance variables from the static constraints block, but this isn't lega
will get a `MissingPropertyException` for your trouble. For example, you may try

```
class Response {
    Survey survey
    Answer answer

static constraints = {
        survey blank: false
        answer blank: false, inList: survey.answers
    }
}
```

See how the `inList` constraint references the instance property `survey`? That won't work. Instead, use a

```
class Response {
    …
    static constraints = {
        survey blank: false
        answer blank: false, validator: { val, obj -> val in obj.survey.answers }
    }
}
```

In this example, the `obj` argument to the custom validator is the domain *instance* that is being validated, and return a boolean to indicate whether the new value for the `answer` property, `val`, is valid.

7.2 Validating Constraints

Validation Basics

Call the validate method to validate a domain class instance:

```
def user = new User(params)

if (user.validate()) {
    // do something with user
}
else {
    user.errors.allErrors.each {
        println it
    }
}
```

The `errors` property on domain classes is an instance of the Spring Errors interface. The `Errors` inte
validation errors and also retrieve the original values.

Validation Phases

Within Grails there are two phases of validation, the first one being data binding which occurs when
instance such as:

```
def user = new User(params)
```

At this point you may already have errors in the `errors` property due to type conversion (such as conve
these and obtain the original input value using the `Errors` API:

```
if (user.hasErrors()) {
    if (user.errors.hasFieldErrors("login")) {
        println user.errors.getFieldError("login").rejectedValue
    }
}
```

The second phase of validation happens when you call [validate] or [save]. This is when Grails will validate t
you defined. For example, by default the [save] method calls `validate` before executing, allowing you to

```
if (user.save()) {
    return user
}
else {
    user.errors.allErrors.each {
        println it
    }
}
```

7.3 Validation on the Client

Displaying Errors

Typically if you get a validation error you redirect back to the view for rendering. Once there you need
supports a rich set of tags for dealing with errors. To render the errors as a list you can use [renderErrors]:

```
<g:renderErrors bean="${user}" />
```

If you need more control you can use [hasErrors] and [eachError]:

```
<g:hasErrors bean="${user}">
  <ul>
   <g:eachError var="err" bean="${user}">
       <li>${err}</li>
   </g:eachError>
  </ul>
</g:hasErrors>
```

Highlighting Errors

It is often useful to highlight using a red box or some indicator when a field has been incorrectly input. T
by invoking it as a method. For example:

```
<div class='value ${hasErrors(bean:user,field:'login','errors')}'>
   <input type="text" name="login" value="${fieldValue(bean:user,field:'login')}"
</div>
```

This code checks if the `login` field of the `user` bean has any errors and if so it adds an `errors` CSS CSS rules to highlight the `div`.

Retrieving Input Values

Each error is actually an instance of the FieldError class in Spring, which retains the original input value the error object to restore the value input by the user using the fieldValue tag:

```
<input type="text" name="login" value="${fieldValue(bean:user,field:'login')}"/>
```

This code will check for an existing `FieldError` in the `User` bean and if there is obtain the originally i

7.4 Validation and Internationalization

Another important thing to note about errors in Grails is that error messages are not hard coded anywhere. messages from message bundles using Grails' i18n support.

Constraints and Message Codes

The codes themselves are dictated by a convention. For example consider the constraints we looked at earl

```
package com.mycompany.myapp

class User {
    ...

static constraints = {
        login size: 5..15, blank: false, unique: true
        password size: 5..15, blank: false
        email email: true, blank: false
        age min: 18
    }
}
```

If a constraint is violated Grails will by convention look for a message code of the form:

```
[Class Name].[Property Name].[Constraint Code]
```

In the case of the `blank` constraint this would be `user.login.blank` so you would need a me `grails-app/i18n/messages.properties` file:

```
user.login.blank=Your login name must be specified!
```

The class name is looked for both with and without a package, with the packaged version t com.mycompany.myapp.User.login.blank will be used before user.login.blank. This allows for cases wl clash with a plugin's.

For a reference on what codes are for which constraints refer to the reference guide for each constraint.

Displaying Messages

The renderErrors tag will automatically look up messages for you using the message tag. If you need mc this yourself:

```
<g:hasErrors bean="${user}">
  <ul>
   <g:eachError var="err" bean="${user}">
       <li><g:message error="${err}" /></li>
   </g:eachError>
  </ul>
</g:hasErrors>
```

In this example within the body of the eachError tag we use the message tag in combination with its `erro` given error.

7.5 Validation Non Domain and Command Object Classes

Domain classes and command objects support validation by default. Other classes may be made `constraints` property in the class (as described above) and then telling the framework about them. It i the validateable classes with the framework. Simply defining the `constraints` property is not sufficien

The Validateable Annotation

Classes which define the static `constraints` property and are annotated with @Validateable can be Consider this example:

```
// src/groovy/com/mycompany/myapp/User.groovy
package com.mycompany.myapp

import org.codehaus.groovy.grails.validation.Validateable

@Validateable
class User {
    ...

static constraints = {
        login size: 5..15, blank: false, unique: true
        password size: 5..15, blank: false
        email email: true, blank: false
        age min: 18
    }
}
```

You tell the framework which packages to search for `Validateable` classes in by as `grails.validateable.packages` property in `Config.groovy`:

```
grails.validateable.packages = ['com.mycompany.dto', 'com.mycompany.util']
```

The framework will only search those packages (and child packages of those) for classes annotated with @

Registering Validateable Classes

If a class is not marked with `Validateable`, it may still be made validateable by required to do this are to define the static `constraints` property in the and then telling the framework about the class by assigning a value property in `Config.groovy@`:

```
grails.validateable.classes = [com.mycompany.myapp.User, com.mycompany.dto.Accoun
```

8 The Service Layer

Grails defines the notion of a service layer. The Grails team discourages the embedding of core applicatio
promote reuse and a clean separation of concerns.

Services in Grails are the place to put the majority of the logic in your application, leaving controllers res
redirects and so on.

Creating a Service

You can create a Grails service by running the create-service command from the root of your project in a t

```
grails create-service helloworld.simple
```

> If no package is specified with the create-service script, Grails automatically uses the ap
> package name.

The above example will create a service at the location `grails-app/services/helloworld/Si`
name ends with the convention `Service`, other than that a service is a plain Groovy class:

```
package helloworld

class SimpleService {
}
```

8.1 Declarative Transactions

Default Declarative Transactions

Services are typically involved with coordinating logic between domain classes, and hence often invo
operations. Given the nature of services, they frequently require transactional behaviour. You can use
withTransaction method, however this is repetitive and doesn't fully leverage the power of Spring's underl

Services enable transaction demarcation, which is a declarative way of defining which methods are to l
transactional by default. To disable this set the `transactional` property to `false`:

```
class CountryService {
    static transactional = false
}
```

You may also set this property to `true` to make it clear that the service is intentionally transactional.

> Warning: dependency injection is the **only** way that declarative transactions work. You will
> service if you use the `new` operator such as `new BookService()`

The result is that all methods are wrapped in a transaction and automatic rollback occurs if a method th
extends RuntimeException) or an Error. The propagation level of the transaction is by default set to

> Checked exceptions do **not** roll back transactions. Even though Groovy blurs the distinction
> unchecked exceptions, Spring isn't aware of this and its default behaviour is used, so it's impo
> distinction between checked and unchecked exceptions.

Custom Transaction Configuration

Grails also fully supports Spring's Transactional annotation for cases where you need more fine-
per-method level or need specify an alternative propagation level.

> Annotating a service method with Transactional disables the default Grails transacti
> service (in the same way that adding transactional=false does) so if you use any
> annotate all methods that require transactions.

In this example listBooks uses a read-only transaction, updateBook uses a default read-write
transactional (probably not a good idea given its name).

```
import org.springframework.transaction.annotation.Transactional

class BookService {

@Transactional(readOnly = true)
    def listBooks() {
        Book.list()
    }

@Transactional
    def updateBook() {
        // …
    }

def deleteBook() {
        // …
    }
}
```

You can also annotate the class to define the default transaction behavior for the whole service, and the
example, this service is equivalent to one that has no annotations (since the default is implicitly transac

```
import org.springframework.transaction.annotation.Transactional

@Transactional
class BookService {

def listBooks() {
        Book.list()
    }

def updateBook() {
        // …
    }

def deleteBook() {
        // …
    }
}
```

This version defaults to all methods being read-write transactional (due to the class-level annotation), but
to use a read-only transaction:

```
import org.springframework.transaction.annotation.Transactional

@Transactional
class BookService {

@Transactional(readOnly = true)
    def listBooks() {
        Book.list()
    }

def updateBook() {
        // …
    }

def deleteBook() {
        // …
    }
}
```

Although `updateBook` and `deleteBook` aren't annotated in this example, they inherit the configuratio

For more information refer to the section of the Spring user guide on Using @Transactional.

Unlike Spring you do not need any prior configuration to use `Transactional`; just specify the anno
them up automatically.

8.1.1 Transactions Rollback and the Session

Understanding Transactions and the Hibernate Session

When using transactions there are important considerations you must take into account with regards to ho
handled by Hibernate. When a transaction is rolled back the Hibernate session used by GORM is clear
session become detached and accessing uninitialized lazy-loaded collections will lead to `LazyInitiali`

To understand why it is important that the Hibernate session is cleared. Consider the following example:

```
class Author {
    String name
    Integer age

static hasMany = [books: Book]
}
```

If you were to save two authors using consecutive transactions as follows:

```
Author.withTransaction { status ->
    new Author(name: "Stephen King", age: 40).save()
    status.setRollbackOnly()
}

Author.withTransaction { status ->
    new Author(name: "Stephen King", age: 40).save()
}
```

Only the second author would be saved since the first transaction rolls back the author `save()` by Hibernate session were not cleared then both author instances would be persisted and it would lead to very

It can, however, be frustrating to get `LazyInitializationException`s due to the session being cle

For example, consider the following example:

```
class AuthorService {

void updateAge(id, int age) {
        def author = Author.get(id)
        author.age = age
        if (author.isTooOld()) {
            throw new AuthorException("too old", author)
        }
    }
}
```

```
class AuthorController {

def authorService

def updateAge() {
        try {
            authorService.updateAge(params.id, params.int("age"))
        }
        catch(e) {
            render "Author books ${e.author.books}"
        }
    }
}
```

In the above example the transaction will be rolled back if the `Author`'s age exceeds the maximum valu by throwing an `AuthorException`. The `AuthorException` references the author but when tl `LazyInitializationException` will be thrown because the underlying Hibernate session has beer

To solve this problem you have a number of options. One is to ensure you query eagerly to get the data yo

```
class AuthorService {
    …
    void updateAge(id, int age) {
        def author = Author.findById(id, [fetch:[books:"eager"]])
        ...
```

In this example the `books` association will be queried when retrieving the `Author`.

> This is the optimal solution as it requires fewer queries then the following suggested solutions

Another solution is to redirect the request after a transaction rollback:

```
class AuthorController {

AuthorService authorService

def updateAge() {
        try {
            authorService.updateAge(params.id, params.int("age"))
        }
        catch(e) {
            flash.message "Can't update age"
            redirect action:"show", id:params.id
        }
    }
}
```

In this case a new request will deal with retrieving the `Author` again. And, finally a third solution is to re
make sure the session remains in the correct state:

```
class AuthorController {

def authorService

def updateAge() {
        try {
            authorService.updateAge(params.id, params.int("age"))
        }
        catch(e) {
            def author = Author.read(params.id)
            render "Author books ${author.books}"
        }
    }
}
```

Validation Errors and Rollback

A common use case is to rollback a transaction if there are validation errors. For example consider this ser

```
import grails.validation.ValidationException

class AuthorService {

void updateAge(id, int age) {
        def author = Author.get(id)
        author.age = age
        if (!author.validate()) {
            throw new ValidationException("Author is not valid", author.errors)
        }
    }
}
```

To re-render the same view that a transaction was rolled back in you can re-associate the errors with a refr

```
import grails.validation.ValidationException

class AuthorController {

def authorService

def updateAge() {
        try {
            authorService.updateAge(params.id, params.int("age"))
        }
        catch (ValidationException e) {
            def author = Author.read(params.id)
            author.errors = e.errors
            render view: "edit", model: [author:author]
        }
    }
}
```

8.2 Scoped Services

By default, access to service methods is not synchronised, so nothing prevents concurrent execution of tho is a singleton and may be used concurrently, you should be very careful about storing state in a service. never store state in a service.

You can change this behaviour by placing a service in a particular scope. The supported scopes are:

- `prototype` - A new service is created every time it is injected into another class
- `request` - A new service will be created per request
- `flash` - A new service will be created for the current and next request only
- `flow` - In web flows the service will exist for the scope of the flow
- `conversation` - In web flows the service will exist for the scope of the conversation. ie a root flov
- `session` - A service is created for the scope of a user session
- `singleton` (default) - Only one instance of the service ever exists

> If your service is `flash`, `flow` or `conversation` scoped it must implement `java.io.` can only be used in the context of a Web Flow

To enable one of the scopes, add a static scope property to your class whose value is one of the above, for e

```
static scope = "flow"
```

8.3 Dependency Injection and Services

Dependency Injection Basics

A key aspect of Grails services is the ability to use [Spring Framework](#)'s dependency injection features. Gr convention". In other words, you can use the property name representation of the class name of a ser controllers, tag libraries, and so on.

As an example, given a service called `BookService`, if you define a property called `bookService` in

```
class BookController {
    def bookService
    …
}
```

In this case, the Spring container will automatically inject an instance of that service based on its configu done by name. You can also specify the type as follows:

```
class AuthorService {
    BookService bookService
}
```

> NOTE: Normally the property name is generated by lower casing the first letter of the t instance of the `BookService` class would map to a property named `bookService`.
>
> To be consistent with standard JavaBean conventions, if the first 2 letters of the class nar property name is the same as the class name. For example, the property name of the `JDBCHe` would be `JDBCHelperService`, not `jDBCHelperService` or `jdbcHelperServic`
>
> See section 8.8 of the JavaBean specification for more information on de-capitalization rules.

Dependency Injection and Services

You can inject services in other services with the same technique. If you had an `AuthorService` th declaring the `AuthorService` as follows would allow that:

```
class AuthorService {
    def bookService
}
```

Dependency Injection and Domain Classes / Tag Libraries

You can even inject services into domain classes and tag libraries, which can aid in the development of ric

```
class Book {
    …
    def bookService

def buyBook() {
        bookService.buyBook(this)
    }
}
```

8.4 Using Services from Java

One of the powerful things about services is that since they encapsulate re-usable logic, you can use th classes. There are a couple of ways you can reuse a service from Java. The simplest way is to move y `grails-app/services` directory. The reason this is important is that it is not possible to import clas (the package used when no package declaration is present). So for example the `BookService` below can

```
class BookService {
    void buyBook(Book book) {
        // logic
    }
}
```

However, this can be rectified by placing this class in a package, by moving the clas `grails-app/services/bookstore` and then modifying the package declaration:

```
package bookstore

class BookService {
    void buyBook(Book book) {
        // logic
    }
}
```

An alternative to packages is to instead have an interface within a package that the service implements:

```
package bookstore

interface BookStore {
    void buyBook(Book book)
}
```

And then the service:

```
class BookService implements bookstore.BookStore {
    void buyBook(Book b) {
        // logic
    }
}
```

This latter technique is arguably cleaner, as the Java side only has a reference to the interface and not to always a good idea to use packages). Either way, the goal of this exercise to enable Java to statically re compile time.

Now that this is done you can create a Java class within the `src/java` directory and add a setter that us Spring:

```
// src/java/bookstore/BookConsumer.java
package bookstore;

public class BookConsumer {

private BookStore store;

public void setBookStore(BookStore storeInstance) {
        this.store = storeInstance;
    }
    …
}
```

Once this is done you can configure the Java class as a Spring bean in `grails-app/conf/sp` information see the section on Grails and Spring):

```
<bean id="bookConsumer" class="bookstore.BookConsumer">
    <property name="bookStore" ref="bookService" />
</bean>
```

or in `grails-app/conf/spring/resources.groovy`:

```
import bookstore.BookConsumer

beans = {
    bookConsumer(BookConsumer) {
        bookStore = ref("bookService")
    }
}
```

9 Testing

Automated testing is a key part of Grails. Hence, Grails provides many ways to making testing easier fr
functional tests. This section details the different capabilities that Grails offers for testing.

> Grails 1.3.x and below used the `grails.test.GrailsUnitTestCase` class hierarchy
> style. Grails 2.0.x and above deprecates these test harnesses in favour of mixins that can be
> different kinds of tests (JUnit 3, Junit 4, Spock etc.) without subclassing

The first thing to be aware of is that all of the `create-*` and `generate-*` commands create `unit`
For example if you run the create-controller command as follows:

```
grails create-controller com.acme.app.simple
```

Grails will create a controller at `grails-app/controllers/com/acme/app/SimpleControl`
`test/unit/com/acme/app/SimpleControllerTests.groovy`. What Grails won't do howev
That is left up to you.

> The default class name suffix is `Tests` but as of Grails 1.2.2, the suffix of `Test` is also supp

Running Tests

Test are run with the test-app command:

```
grails test-app
```

Note that you will be able to run unit tests much quicker if you use an IDE or if you use the "interactive m
the need to stop the JVM:

```
grails
…
test-app
```

The `test-app` command will produce output such as:

```
-------------------------------------------------------
Running Unit Tests…
Running test FooTests...FAILURE
Unit Tests Completed in 464ms …
-------------------------------------------------------

Tests failed: 0 errors, 1 failures
```

Whilst reports will have been written out the `target/test-reports` directory.

> ⚠ You can force a clean before running tests by passing `-clean` to the `test-app` command.

Targeting Tests

You can selectively target the test(s) to be run in different ways. To run all tests for a controller named `Si

```
grails test-app SimpleController
```

This will run any tests for the class named `SimpleController`. Wildcards can be used...

```
grails test-app *Controller
```

This will test all classes ending in `Controller`. Package names can optionally be specified...

```
grails test-app some.org.*Controller
```

or to run all tests in a package...

```
grails test-app some.org.*
```

or to run all tests in a package including subpackages...

```
grails test-app some.org.**.*
```

You can also target particular test methods...

```
grails test-app SimpleController.testLogin
```

This will run the `testLogin` test in the `SimpleController` tests. You can specify as many patterns

```
grails test-app some.org.* SimpleController.testLogin BookController
```

Targeting Test Types and/or Phases

In addition to targeting certain tests, you can also target test *types* and/or *phases* by using the `phase:typ

> Grails organises tests by phase and by type. A test phase relates to the state of the Grails appli
> and the type relates to the testing mechanism.
>
> Grails comes with support for 4 test phases (`unit`, `integration`, `functional` and
> types for the `unit` and `integration` phases. These test types have the same name as the p
>
> Testing plugins may provide new test phases or new test types for existing phases.
> documentation.

To execute the JUnit `integration` tests you can run:

```
grails test-app integration:integration
```

Both `phase` and `type` are optional. Their absence acts as a wildcard. The following command will run al

```
grails test-app unit:
```

The Grails Spock Plugin is one plugin that adds new test types to Grails. It adds a `spock` test typ `functional` phases. To run all spock tests in all phases you would run the following:

```
grails test-app :spock
```

To run the all of the spock tests in the `functional` phase you would run...

```
grails test-app functional:spock
```

More than one pattern can be specified...

```
grails test-app unit:spock integration:spock
```

Targeting Tests in Types and/or Phases

Test and type/phase targetting can be applied at the same time:

```
grails test-app integration: unit: some.org.**.*
```

This would run all tests in the `integration` and `unit` phases that are in the package `some.org` or a s

9.1 Unit Testing

Unit testing are tests at the "unit" level. In other words you are testing individual methods or bloc surrounding infrastructure. Unit tests are typically run without the presence of physical resources th connections or files. This is to ensure they run as quick as possible since quick feedback is important.

Since Grails 2.0, a collection of unit testing mixins is provided by Grails that lets you enhance the behavic test. The following sections cover the usage of these mixins.

> ⚠ The previous JUnit 3-style `GrailsUnitTestCase` class hierarchy is still present in compatibility, but is now deprecated. The previous documentation on the subject can be fou documentation

9.1.1 Unit Testing Controllers

The Basics

You use the `grails.test.mixin.TestFor` annotation to unit test controllers. Using `Test` `grails.test.mixin.web.ControllerUnitTestMixin` and its associated API. For example:

```
import grails.test.mixin.TestFor

@TestFor(SimpleController)
class SimpleControllerTests {
    void testSomething() {

}
}
```

Adding the `TestFor` annotation to a controller causes a new `controller` field to be automatically cre

> ⚠ The `TestFor` annotation will also automatically annotate any public methods starting wit @Test annotation. If any of your test method don't start with "test" just add this manually

To test the simplest "Hello World"-style example you can do the following:

```
// Test class
class SimpleController {
    def hello() {
        render "hello"
    }
}
```

```
void testHello() {
    controller.hello()

assert response.text == 'hello'
}
```

The response object is an in
`org.codehaus.groovy.grails.plugins.testing.GrailsMockHttpServletRespor`
`org.springframework.mock.web.MockHttpServletResponse` and has a number of useful
response.

For example to test a redirect you can use the `redirectUrl` property:

```
// Test class
class SimpleController {
    def index() {
        redirect action: 'hello'
    }
    …
}
```

```
void testIndex() {
    controller.index()

assert response.redirectedUrl == '/simple/hello'
}
```

Testing View Rendering

To test view rendering you can inspect the state of the controller's `modelAndV`
`org.springframework.web.servlet.ModelAndView`) or you can use the `view` and `model` p

```
// Test class
class SimpleController {
    def home() {
        render view: "homePage", model: [title: "Hello World"]
    }
    …
}
```

```
void testIndex() {
    controller.home()

assert view == "/simple/homePage"
    assert model.title == "Hello World"
}
```

Testing Template Rendering

Unlike view rendering, template rendering will actually attempt to write the template directly to t
`ModelAndView` hence it requires a different approach to testing.

Consider the following controller action:

```
class SimpleController {
    def display() {
        render template:"snippet"
    }
}
```

In this example the controller will look for a template in `grails-app/views/simple/_snippet.`

```
void testDisplay() {
    controller.display()
    assert response.text == 'contents of template'
}
```

However, you may not want to render the real template, but just test that is was rendered. In this case you

```
void testDisplay() {
    views['/simple/_snippet.gsp'] = 'mock contents'
    controller.display()
    assert response.text == 'mock contents'
}
```

Testing XML and JSON Responses

XML and JSON response are also written directly to the response. Grails' mocking capabilities provide so
JSON response. For example consider the following action:

```
def renderXml() {
    render(contentType:"text/xml") {
        book(title:"Great")
    }
}
```

This can be tested using the `xml` property of the response:

```
void testRenderXml() {
    controller.renderXml()
    assert "<book title='Great'/>" == response.text
    assert "Great" == response.xml.@title.text()
}
```

The `xml` property is a parsed result from Groovy's [XmlSlurper](http://groovy.codehaus.org/Reading+XML+using+Groovy's+XmlSlurper) class which is very convenient for parsing

Testing JSON responses is pretty similar, instead you use the `json` property:

```
// controller action
def renderJson() {
    render(contentType:"text/json") {
        book = "Great"
    }
}
```

```
// test
void testRenderJson() {

controller.renderJson()

assert '{"book":"Great"}' == controller.response.text
    assert "Great" == response.json.book
}
```

The `json` property is an instance of `org.codehaus.groovy.grails.web.json.JSONElemen` useful for parsing JSON responses.

Testing XML and JSON Requests

Grails provides various convenient ways to automatically parse incoming XML and JSON packets. For ex XML requests using Grails' data binding:

```
def consumeBook() {
    def b = new Book(params['book'])

render b.title
}
```

To test this Grails provides an easy way to specify an XML or JSON packet via the `xml` or `json` proper be tested by specifying a String containing the XML:

```
void testConsumeBookXml() {
    request.xml = '<book><title>The Shining</title></book>'
    controller.consumeBook()

assert response.text == 'The Shining'
}
```

Or alternatively a domain instance can be specified and it will be auto-converted into the appropriate XML

```
void testConsumeBookXml() {
    request.xml = new Book(title:"The Shining")
    controller.consumeBook()

assert response.text == 'The Shining'
}
```

The same can be done for JSON requests:

```
void testConsumeBookJson() {
    request.json = new Book(title:"The Shining")
    controller.consumeBook()

assert response.text == 'The Shining'
}
```

If you prefer not to use Grails' data binding but instead manually parse the incoming XML or JSON that c
the controller action below:

```
def consume() {
    request.withFormat {
        xml {
            render request.XML.@title
        }
        json {
            render request.JSON.title
        }
    }
}
```

To test the XML request you can specify the XML as a string:

```
void testConsumeXml() {
    request.xml = '<book title="The Stand" />'

controller.consume()

assert response.text == 'The Stand'
}
```

And, of course, the same can be done for JSON:

```
void testConsumeJson() {
    request.json = '{title:"The Stand"}'
    controller.consume()

assert response.text == 'The Stand'
}
```

Testing Spring Beans

When using `TestFor` only a subset of the Spring beans available to a running Grails application are av
beans available you can do so with the `defineBeans` method of `GrailsUnitTestMixin`:

```
class SimpleController {
    SimpleService simpleService
    def hello() {
        render simpleService.sayHello()
    }
}
```

```
void testBeanWiring() {
    defineBeans {
        simpleService(SimpleService)
    }

controller.hello()

assert response.text == "Hello World"
}
```

The controller is auto-wired by Spring just like in a running Grails application. Autowiring even occurs if the controller:

```
void testAutowiringViaNew() {
    defineBeans {
        simpleService(SimpleService)
    }

def controller1 = new SimpleController()
    def controller2 = new SimpleController()

assert controller1.simpleService != null
    assert controller2.simpleService != null
}
```

Testing Mime Type Handling

You can test mime type handling and the `withFormat` method quite simply by setting the response's `fo`

```
// controller action
def sayHello() {
    def data = [Hello:"World"]
    withFormat {
        xml { render data as XML }
        html data
    }
}
```

```
// test
void testSayHello() {
    response.format = 'xml'
    controller.sayHello()

String expected = '<?xml version="1.0" encoding="UTF-8"?>' +
                        '<map><entry key="Hello">World</entry></map>'

assert expected == response.text
}
```

Testing Duplicate Form Submissions

Testing duplicate form submissions is a little bit more involved. For example if you have an action that har

```
def handleForm() {
    withForm {
        render "Good"
    }.invalidToken {
        render "Bad"
    }
}
```

you want to verify the logic that is executed on a good form submission and the logic that is executed on a
submission is simple. Just invoke the controller:

```
void testDuplicateFormSubmission() {
    controller.handleForm()
    assert "Bad" == response.text
}
```

Testing the successful submission requires providing an appropriate `SynchronizerToken`:

```
import org.codehaus.groovy.grails.web.servlet.mvc.SynchronizerToken
...

void testValidFormSubmission() {
    def token = SynchronizerToken.store(session)
    params[SynchronizerToken.KEY] = token.currentToken.toString()

controller.handleForm()
    assert "Good" == response.text
}
```

If you test both the valid and the invalid request in the same test be sure to reset the response between exec

```
controller.handleForm() // first execution
…
response.reset()
…
controller.handleForm() // second execution
```

Testing File Upload

You use the `GrailsMockMultipartFile` class to test file uploads. For example consider the followi

```
def uploadFile() {
    MultipartFile file = request.getFile("myFile")
    file.transferTo(new File("/local/disk/myFile"))
}
```

To test this action you can register a `GrailsMockMultipartFile` with the request:

```
void testFileUpload() {
    final file = new GrailsMockMultipartFile("myFile", "foo".bytes)
    request.addFile(file)
    controller.uploadFile()

assert file.targetFileLocation.path == "/local/disk/myFile"
}
```

The `GrailsMockMultipartFile` constructor arguments are the name and contents of the file. I `transferTo` method that simply records the `targetFileLocation` and doesn't write to disk.

Testing Command Objects

Special support exists for testing command object handling with the `mockCommandObject` methoc action:

```
def handleCommand(SimpleCommand simple) {
    if (simple.hasErrors()) {
        render "Bad"
    }
    else {
        render "Good"
    }
}
```

To test this you mock the command object, populate it and then validate it as follows:

```
void testInvalidCommand() {
    def cmd = mockCommandObject(SimpleCommand)
    cmd.name = '' // doesn't allow blank names

cmd.validate()
    controller.handleCommand(cmd)

assert response.text == 'Bad'
}
```

Testing Calling Tag Libraries

You can test calling tag libraries using `ControllerUnitTestMixin`, although the mechanism for t tag. For example to test a call to the `message` tag, add a message to the `messageSource`. Consider the

```
def showMessage() {
    render g.message(code: "foo.bar")
}
```

This can be tested as follows:

```
void testRenderBasicTemplateWithTags() {
    messageSource.addMessage("foo.bar", request.locale, "Hello World")

controller.showMessage()

assert response.text == "Hello World"
}
```

9.1.2 Unit Testing Tag Libraries

The Basics

Tag libraries and GSP pages can be tested with the `grails.test.mixin.web.GroovyPageUnit` declare which tag library is under test with the `TestFor` annotation:

```
@TestFor(SimpleTagLib)
class SimpleTagLibTests {

}
```

Note that if you are testing invocation of a custom tag from a controller you can combine the `Cont` `GroovyPageUnitTestMixin` using the `Mock` annotation:

```
@TestFor(SimpleController)
@Mock(SimpleTagLib)
class GroovyPageUnitTestMixinTests {

}
```

Testing Custom Tags

The core Grails tags don't need to be enabled during testing, however custom tag libraries do. The `G` provides a `mockTagLib()` method that you can use to mock a custom tag library. For example consider

```
class SimpleTagLib {

static namespace = 's'

def hello = { attrs, body ->
        out << "Hello ${attrs.name ?: 'World'}"
    }
}
```

You can test this tag library by using `TestFor` and supplying the name of the tag library:

```
@TestFor(SimpleTagLib)
class SimpleTagLibTests {
    void testHelloTag() {
        assert applyTemplate('<s:hello />') == 'Hello World'
        assert applyTemplate('<s:hello name="Fred" />') == 'Hello Fred'
    }
}
```

Alternatively, you can use the `TestMixin` annotation and mock multiple tag libraries using the `mockTa`

```
@grails.test.mixin.TestMixin(GroovyPageUnitTestMixin)
class MultipleTagLibraryTests {

@Test
    void testMuliple() {
        mockTagLib(FirstTagLib)
        mockTagLib(SecondTagLib)

…
    }
}
```

The `GroovyPageUnitTestMixin` provides convenience methods for asserting that the template outpu

```
@grails.test.mixin.TestMixin(GroovyPageUnitTestMixin)
class MultipleTagLibraryTests {

@Test
    void testMuliple() {
        mockTagLib(FirstTagLib)
        mockTagLib(SecondTagLib)
        assertOutputEquals ('Hello World', '<s:hello />')
        assertOutputMatches (/.*Fred.*/, '<s:hello name="Fred" />')
    }
}
```

Testing View and Template Rendering

You can test rendering of views and templates in `grails-app/views` via the `renc` `GroovyPageUnitTestMixin`:

```
def result = render(template: "/simple/hello")
assert result == "Hello World"
```

This will attempt to render a template found at the location `grails-app/views/simple/_hello.` on any custom tag libraries you need to call `mockTagLib` as described in the previous section.

9.1.3 Unit Testing Domains

Overview

The mocking support described here is best used when testing non-domain artifacts that use
you focus on testing the artifact without needing a database. But when testing persistence it's
tests which configure Hibernate and use a database.

Domain class interaction can be tested without involving a database connection using `DomainClassUr`
mimics the behavior of GORM against an in-memory `ConcurrentHashMap` implementation. Note tha
GORM implementation. The following features of GORM for Hibernate can only be tested within an integ

- String-based HQL queries
- composite identifiers
- dirty checking methods
- any direct interaction with Hibernate

However a large, commonly-used portion of the GORM API can be mocked using `DomainClassUnitT`

- Simple persistence methods like `save()`, `delete()` etc.
- Dynamic Finders
- Named Queries
- Query-by-example
- GORM Events

If something isn't supported then `GrailsUnitTestMixin`'s `mockFor` method can come in handy to
you can write an integration test which bootstraps the complete Grails environment at a cost of test executi

The Basics

`DomainClassUnitTestMixin` is typically used in combination with testing either a controller, servi
mock collaborator defined by the `Mock` annotation:

```
import grails.test.mixin.*

@TestFor(SimpleController)
@Mock(Simple)
class SimpleControllerTests {

}
```

The example above tests the `SimpleController` class and mocks the behavior of the `Simple` domai
typical scaffolded `save` controller action:

```
class BookController {
    def save() {
        def book = new Book(params)
        if (book.save(flush: true)) {
            flash.message = message(
                    code: 'default.created.message',
                    args: [message(code: 'book.label',
                                   default: 'Book'), book.id])}"
            redirect(action: "show", id: book.id)
        }
        else {
            render(view: "create", model: [bookInstance: book])
        }
    }
}
```

Tests for this action can be written as follows:

```
import grails.test.mixin.*

@TestFor(BookController)
@Mock(Book)
class BookControllerTests {

void testSaveInvalidBook() {
        controller.save()

assert model.bookInstance != null
        assert view == '/book/create'
    }

void testSaveValidBook() {
        params.title = "The Stand"
        params.pages = "500"

controller.save()

assert response.redirectedUrl == '/book/show/1'
        assert flash.message != null
        assert Book.count() == 1
    }
}
```

`Mock` annotation also supports a list of mock collaborators if you have more than one domain to mock:

```
@TestFor(BookController)
@Mock([Book, Author])
class BookControllerTests {
   …
}
```

Alternatively you can also use the `DomainClassUnitTestMixin` directly with the `TestMixin` anno

```
@TestFor(BookController)
@TestMixin(DomainClassUnitTestMixin)
class BookControllerTests {
   …
}
```

And then call the `mockDomain` method to mock domains during your test:

```
void testSave() {
    mockDomain(Author)
    mockDomain(Book)
}
```

The `mockDomain` method also includes an additional parameter that lets you pass a Map of Maps to c
fixture-like data:

```
void testSave() {
    mockDomain(Book, [
            [title: "The Stand", pages: 1000],
            [title: "The Shining", pages: 400],
            [title: "Along Came a Spider", pages: 300] ])
}
```

Testing Constraints

Your constraints contain logic and that logic is highly susceptible to bugs - the kind of bugs that can be t
default `save()` doesn't throw an exception when it fails). If your answer is that it's too hard or fiddly,
`mockForConstraintsTests()` method.

This method is like a much reduced version of the `mockDomain()` method that simply adds a `valida`
All you have to do is mock the class, create an instance with populated data, and then call `validate`
property to determine if validation failed. So if all we are doing is mocking the `validate()` method,
That is so that we can test the `unique` constraint as you will soon see.

So, suppose we have a simple domain class:

```
class Book {
String title
    String author
static constraints = {
        title blank: false, unique: true
        author blank: false, minSize: 5
    }
}
```

Don't worry about whether the constraints are sensible (they're not!), they are for demonstration only. T
following:

```
@TestFor(Book)
class BookTests {
    void testConstraints() {

def existingBook = new Book(
                title: "Misery",
                author: "Stephen King")

mockForConstraintsTests(Book, [existingBook])

// validation should fail if both properties are null
        def book = new Book()

assert !book.validate()
        assert "nullable" == book.errors["title"]
        assert "nullable" == book.errors["author"]

// So let's demonstrate the unique and minSize constraints

book = new Book(title: "Misery", author: "JK")
        assert !book.validate()
        assert "unique" == book.errors["title"]
        assert "minSize" == book.errors["author"]

// Validation should pass!
        book = new Book(title: "The Shining", author: "Stephen King")
        assert book.validate()
    }
}
```

You can probably look at that code and work out what's happening without any further explanation. The o `errors` property is used. First, is a real Spring `Errors` instance, so you can access all the properties an Second, this particular `Errors` object also has map/property access as shown. Simply specify the name c map/property access will return the name of the constraint that was violated. Note that it is the constrai might expect).

That's it for testing constraints. One final thing we would like to say is that testing the constraints in this the "constraints" property name! It is currently one of the hardest bugs to track down normally, and y highlight the problem straight away.

9.1.4 Unit Testing Filters

Unit testing filters is typically a matter of testing a controller where a filter is a mock collaborator. For class:

```
class CancellingFilters {
    def filters = {
        all(controller:"simple", action:"list") {
            before = {
                redirect(controller:"book")
                return false
            }
        }
    }
}
```

This filter interceptors the `list` action of the `simple` controller and redirects to the `book` controller. T that targets the `SimpleController` class and add the `CancellingFilters` as a mock collaborator

```
@TestFor(SimpleController)
@Mock(CancellingFilters)
class SimpleControllerTests {

}
```

You can then implement a test that uses the `withFilters` method to wrap the call to an action in filter e

```
void testInvocationOfListActionIsFiltered() {
    withFilters(action:"list") {
        controller.list()
    }
    assert response.redirectedUrl == '/book'
}
```

Note that the `action` parameter is required because it is unknown what the action to invoke is un `controller` parameter is optional and taken from the controller under test. If it is a another controller y

```
withFilters(controller:"book",action:"list") {
    controller.list()
}
```

9.1.5 Unit Testing URL Mappings

The Basics

Testing URL mappings can be done with the `TestFor` annotation testing a particular URL mappings cla mappings you can do the following:

```
@TestFor(UrlMappings)
class UrlMappingsTests {

}
```

> Note that since the default `UrlMappings` class is in the default package your test must package

With that done there are a number of useful methods that are defined by the `grails.test.mixin.we` for testing URL mappings. These include:

- `assertForwardUrlMapping` - Asserts a URL mapping is forwarded for the given controller cl defined as a mock collaborate for this to work)
- `assertReverseUrlMapping` - Asserts that the given URL is produced when reverse mapping a
- `assertUrlMapping` - Asserts a URL mapping is valid for the given URL. This combines the a `assertReverseUrlMapping` assertions

Asserting Forward URL Mappings

You use `assertForwardUrlMapping` to assert that a given URL maps to a given controller. For mappings:

```
static mappings = {
    "/action1"(controller: "simple", action: "action1")
    "/action2"(controller: "simple", action: "action2")
}
```

The following test can be written to assert these URL mappings:

```
void testUrlMappings() {

assertForwardUrlMapping("/action1", controller: 'simple',
                                    action: "action1")

assertForwardUrlMapping("/action2", controller: 'simple',
                                    action: "action2")

shouldFail {
        assertForwardUrlMapping("/action2", controller: 'simple',
                                            action: "action1")
    }
}
```

Assert Reverse URL Mappings

You use `assertReverseUrlMapping` to check that correct links are produced for your URL mapp views. An example test is largely identical to the previous listing except you use `assertF` `assertForwardUrlMapping`. Note that you can combine these 2 assertions with `assertUrlMapp`

Simulating Controller Mapping

In addition to the assertions to check the validity of URL mappings you can also simulate mapping to a cc as a mock collaborator and the `mapURI` method. For example:

```
@TestFor(SimpleController)
@Mock(UrlMappings)
class SimpleControllerTests {

void testControllerMapping() {

SimpleController controller = mapURI('/simple/list')
        assert controller != null

def model = controller.list()
        assert model != null
    }
}
```

9.1.6 Mocking Collaborators

Beyond the specific targeted mocking APIs there is also an all-purpose `mockFor()` method that is annotation. The signature of `mockFor` is:

```
mockFor(class, loose = false)
```

This is general-purpose mocking that lets you set up either strict or loose demands on a class.

This method is surprisingly intuitive to use. By default it will create a strict mock control object (one for called is important) that you can use to specify demands:

```
def strictControl = mockFor(MyService)
strictControl.demand.someMethod(0..2) { String arg1, int arg2 -> … }
strictControl.demand.static.aStaticMethod {-> … }
```

Notice that you can mock static as well as instance methods by using the "static" property. You then spe with an optional range argument. This range determines how many times you expect the method to be c falls outside of that range (either too few or too many) then an assertion error will be thrown. If no ra assumed, i.e. that the method must be called exactly once.

The last part of a demand is a closure representing the implementation of the mock method. The closure types of the mocked method, but otherwise you are free to add whatever you want in the body.

As we mentioned before, call `mockControl.createMock()` to get an actual mock instance of the cl this multiple times to create as many mock instances as you need. And once you have `mockControl.verify()` to check that the expected methods were called.

Lastly, the call:

```
def looseControl = mockFor(MyService, true)
```

will create a mock control object that has only loose expectations, i.e. the order that methods are invoked d

9.2 Integration Testing

Integration tests differ from unit tests in that you have full access to the Grails environment within t database for integration tests and clears out all the data from the database between tests.

One thing to bear in mind is that logging is enabled for your application classes, but it is different from log like this:

```
class MyServiceTests extends GroovyTestCase {
    void testSomething() {
        log.info "Starting tests"
        …
    }
}
```

the "starting tests" message is logged using a different system than the one used by the application. The `l` instance of `java.util.logging.Logger` (inherited from the base class, not injected by Grails), w the `log` property injected into your application artifacts. For example, it doesn't have `debug()` or `tra` `warn()` is in fact `warning()`.

Transactions

Integration tests run inside a database transaction by default, which is rolled back at the end of the each te test is not persisted to the database. Add a `transactional` property to your test class to check transacti

```
class MyServiceTests extends GroovyTestCase {
    static transactional = false

void testMyTransactionalServiceMethod() {
        …
    }
}
```

Be sure to remove any persisted data from a non-transactional test, for example in the `tearDown` met standard transactional tests that expect a clean database.

Testing Controllers

To test controllers you first have to understand the Spring Mock Library.

Grails automatically configures each test with a MockHttpServletRequest, MockHttpServletResponse, an your tests. For example consider the following controller:

```
class FooController {

def text() {
        render "bar"
    }

def someRedirect() {
        redirect(action:"bar")
    }
}
```

The tests for this would be:

```
class FooControllerTests extends GroovyTestCase {

void testText() {
        def fc = new FooController()
        fc.text()
        assertEquals "bar", fc.response.contentAsString
    }

void testSomeRedirect() {
        def fc = new FooController()
        fc.someRedirect()
        assertEquals "/foo/bar", fc.response.redirectedUrl
    }
}
```

In the above case `response` is an instance of `MockHttpServletResponse` which we can use `contentAsString` (when writing to the response) or the redirected URL. These mocked versions of t (unlike the real versions) and hence you can set properties on the request such as the `contextPath` and

Grails **does not** invoke [interceptors](#) or servlet filters when calling actions during integration testing. Yo isolation, using [functional testing](#) if necessary.

Testing Controllers with Services

If your controller references a service (or other Spring beans), you have to explicitly initialise the service f

Given a controller using a service:

```
class FilmStarsController {
    def popularityService

def update() {
        // do something with popularityService
    }
}
```

The test for this would be:

```
class FilmStarsTests extends GroovyTestCase {
    def popularityService

void testInjectedServiceInController () {
        def fsc = new FilmStarsController()
        fsc.popularityService = popularityService
        fsc.update()
    }
}
```

Testing Controller Command Objects

With command objects you just supply parameters to the request and it will automatically do the comma your action with no parameters:

Given a controller using a command object:

```
class AuthenticationController {
    def signup(SignupForm form) {
        …
    }
}
```

You can then test it like this:

```
def controller = new AuthenticationController()
controller.params.login = "marcpalmer"
controller.params.password = "secret"
controller.params.passwordConfirm = "secret"
controller.signup()
```

Grails auto-magically sees your call to `signup()` as a call to the action and populates the comm
parameters. During controller testing, the `params` are mutable with a mocked request supplied by Grails.

Testing Controllers and the render Method

The render method lets you render a custom view at any point within the body of an action. For instance, c

```
def save() {
    def book = Book(params)
    if (book.save()) {
        // handle
    }
    else {
        render(view:"create", model:[book:book])
    }
}
```

In the above example the result of the model of the action is not available as the return value, but insteac
property of the controller. The `modelAndView` property is an instance of Spring MVC's ModelAndViev
result of an action:

```
def bookController = new BookController()
bookController.save()
def model = bookController.modelAndView.model.book
```

Simulating Request Data

You can use the Spring MockHttpServletRequest to test an action that requires request data, for exam
consider this action which performs data binding from an incoming request:

```
def create() {
    [book: new Book(params.book)]
}
```

To simulate the 'book' parameter as an XML request you could do something like the following:

```
void testCreateWithXML() {

def controller = new BookController()

controller.request.contentType = 'text/xml'
    controller.request.content = '''\
            <?xml version="1.0" encoding="ISO-8859-1"?>
            <book>
                <title>The Stand</title>
                …
            </book>
            '''.stripIndent().getBytes() // note we need the bytes

def model = controller.create()
    assert model.book
    assertEquals "The Stand", model.book.title
}
```

The same can be achieved with a JSON request:

```
void testCreateWithJSON() {
def controller = new BookController()
controller.request.contentType = "text/json"
    controller.request.content =
            '{"id":1,"class":"Book","title":"The Stand"}'.getBytes()
def model = controller.create()
    assert model.book
    assertEquals "The Stand", model.book.title
}
```

With JSON don't forget the `class` property to specify the name the target type to bind to. I
within the name of the `<book>` node, but this property is required as part of the JSON packet

For more information on the subject of REST web services see the section on REST.

Testing Web Flows

Testing Web Flows requires a special test harness called `grails.test.WebFlowTestCase` w
AbstractFlowExecutionTests class.

Subclasses of `WebFlowTestCase` **must** be integration tests

For example given this simple flow:

```
class ExampleController {
def exampleFlow() {
        start {
            on("go") {
                flow.hello = "world"
            }.to "next"
        }
        next {
            on("back").to "start"
            on("go").to "subber"
        }
        subber {
            subflow(action: "sub")
            on("end").to("end")
        }
        end()
    }
def subFlow() {
        subSubflowState {
            subflow(controller: "other", action: "otherSub")
            on("next").to("next")
        }
        …
    }
}
```

You need to tell the test harness what to use for the "flow definition". This is done via overriding the abstra

```
import grails.test.WebFlowTestCase

class ExampleFlowTests extends WebFlowTestCase {
    def getFlow() { new ExampleController().exampleFlow }
    …
}
```

You can specify the flow id by overriding the `getFlowId` method, otherwise the default is `test`:

```
import grails.test.WebFlowTestCase

class ExampleFlowTests extends WebFlowTestCase {
    String getFlowId() { "example" }
    …
}
```

If the flow under test calls any subflows, these (or mocks) must be registered before the calling the flow:

```
protected void setUp() {
    super.setUp()

registerFlow("other/otherSub") { // register a simplified mock
        start {
            on("next").to("end")
        }
        end()
    }

// register the original subflow
    registerFlow("example/sub", new ExampleController().subFlow)
}
```

Then you kick off the flow with the `startFlow` method:

```
void testExampleFlow() {
    def viewSelection = startFlow()
    …
}
```

Use the `signalEvent` method to trigger an event:

```
void testExampleFlow() {
    …
    signalEvent("go")
    assert "next" == flowExecution.activeSession.state.id
    assert "world" == flowScope.hello
}
```

Here we have signaled to the flow to execute the event "go" which causes a transition to the "next" state. I
a `hello` variable into the flow scope.

Testing Tag Libraries

Testing tag libraries is simple because when a tag is invoked as a method it returns its result as a string (te this class implements all of the methods of `String`). So for example if you have a tag library like this:

```
class FooTagLib {

def bar = { attrs, body ->
        out << "<p>Hello World!</p>"
    }

def bodyTag = { attrs, body ->
        out << "<${attrs.name}>"
        out << body()
        out << "</${attrs.name}>"
    }
}
```

The tests would look like:

```
class FooTagLibTests extends GroovyTestCase {

void testBarTag() {
        assertEquals "<p>Hello World!</p>",
                     new FooTagLib().bar(null, null).toString()
    }

void testBodyTag() {
        assertEquals "<p>Hello World!</p>",
                     new FooTagLib().bodyTag(name: "p") {
                         "Hello World!"
                     }.toString()
    }
}
```

Notice that for the second example, `testBodyTag`, we pass a block that returns the body of the tag. This as a String.

Testing Tag Libraries with GroovyPagesTestCase

In addition to doing simple testing of tag libraries like in the above examples, you can also use the `grail` class to test tag libraries with integration tests.

The `GroovyPagesTestCase` class is a subclass of the standard `GroovyTestCase` class and adds u GSP rendering.

> ⚠ `GroovyPagesTestCase` can only be used in an integration test.

For example, consider this date formatting tag library:

```
import java.text.SimpleDateFormat

class FormatTagLib {
    def dateFormat = { attrs, body ->
        out << new SimpleDateFormat(attrs.format) << attrs.date
    }
}
```

This can be easily tested as follows:

```
class FormatTagLibTests extends GroovyPagesTestCase {
    void testDateFormat() {
        def template =
                '<g:dateFormat format="dd-MM-yyyy" date="${myDate}" />'

def testDate = … // create the date
        assertOutputEquals('01-01-2008', template, [myDate:testDate])
    }
}
```

You can also obtain the result of a GSP using the `applyTemplate` method of the `GroovyPagesTest`

```
class FormatTagLibTests extends GroovyPagesTestCase {
    void testDateFormat() {
        def template =
                '<g:dateFormat format="dd-MM-yyyy" date="${myDate}" />'

def testDate = … // create the date
        def result = applyTemplate(template, [myDate:testDate])

assertEquals '01-01-2008', result
    }
}
```

Testing Domain Classes

Testing domain classes is typically a simple matter of using the GORM API, but there are a few thing queries you often need to "flush" to ensure the correct state has been persisted to the database. For exampl

```
void testQuery() {
    def books = [
            new Book(title: "The Stand"),
            new Book(title: "The Shining")]
    books*.save()

assertEquals 2, Book.list().size()
}
```

This test will fail because calling save does not actually persist the `Book` instances when called. Calling s some point in the future these instances should be persisted. To commit changes immediately you "flush" t

```
void testQuery() {
    def books = [
            new Book(title: "The Stand"),
            new Book(title: "The Shining")]
    books*.save(flush: true)

assertEquals 2, Book.list().size()
}
```

In this case since we're passing the argument `flush` with a value of `true` the updates will be persisted i to the query later on.

9.3 Functional Testing

Functional tests involve making HTTP requests against the running application and verifying the resulta any support for writing functional tests directly, but there are several plugins available for this.

- `Canoo Webtest` - http://grails.org/plugin/webtest
- `G-Func` - http://grails.org/plugin/functional-test
- `Geb` - http://grails.org/plugin/geb
- `Selenium-RC` - http://grails.org/plugin/selenium-rc
- `WebDriver` - http://grails.org/plugin/webdriver

Consult the documentation for each plugin for its capabilities.

Common Options

There are options that are common to all plugins that control how the Grails application is launched, if at a

inline

The `-inline` option specifies that the grails application should be started inline (i.e. like `run-app`).

This option is implicitly set unless the `baseUrl` or `war` options are set

war

The `-war` option specifies that the grails application should be packaged as a war and started. This is production-like state, but it has a longer startup time than the `-inline` option. It also runs the war in a access any internal application objects.

```
grails test-app functional: -war
```

Note that the same build/config options for the run-war command apply to functional testing against the W

https

The `-https` option results in the application being able to receive https requests as well as http rec `-inline` and `-war` options.

```
grails test-app functional: -https
```

Note that this does not change the test *base url* to be https, it will still be http unless the `-httpsBaseUrl`

httpsBaseUrl

The `-httpsBaseUrl` causes the implicit base url to be used for tests to be a https url.

```
grails test-app functional: -httpsBaseUrl
```

This option is ignored if the `-baseUrl` option is specified.

baseUrl

The `baseUrl` option allows the base url for tests to be specified.

```
grails test-app functional: -baseUrl=http://mycompany.com/grailsapp
```

This option will prevent the local grails application being started unless `-inline` or `-war` are given as test against the local Grails application you **must** specify one of either the `-inline` or `-war` options.

10 Internationalization

Grails supports Internationalization (i18n) out of the box by leveraging the underlying Spring MVC intern
are able to customize the text that appears in a view based on the user's Locale. To quote the javadoc for th

> *A Locale object represents a specific geographical, political, or cultural region. An operation that task is called locale-sensitive and uses the Locale to tailor information for the user. For exa locale-sensitive operation--the number should be formatted according to the customs/conventio region, or culture.*

A Locale is made up of a language code and a country code. For example "en_US" is the code for US en English.

10.1 Understanding Message Bundles

Now that you have an idea of locales, to use them in Grails you create message bundle file containing tl render. Message bundles in Grails are located inside the `grails-app/i18n` directory and are simple Ja

Each bundle starts with the name `messages` by convention and ends with the locale. Grails ships witl range of languages within the `grails-app/i18n` directory. For example:

```
messages.properties
messages_da.properties
messages_de.properties
messages_es.properties
messages_fr.properties
...
```

By default Grails looks in `messages.properties` for messages unless the user has specified a loca bundle by simply creating a new properties file that ends with the locale you are interested. For example `m` British English.

10.2 Changing Locales

By default the user locale is detected from the incoming `Accept-Language` header. However, you ca locales by simply passing a parameter called `lang` to Grails as a request parameter:

```
/book/list?lang=es
```

Grails will automatically switch the user's locale and store it in a cookie so subsequent requests will have t

10.3 Reading Messages

Reading Messages in the View

The most common place that you need messages is inside the view. Use the message tag for this:

```
<g:message code="my.localized.content" />
```

As long as you have a key in your `messages.properties` (with appropriate locale suffix) such as the message:

```
my.localized.content=Hola, Me llamo John. Hoy es domingo.
```

Messages can also include arguments, for example:

```
<g:message code="my.localized.content" args="${ ['Juan', 'lunes'] }" />
```

The message declaration specifies positional parameters which are dynamically specified:

```
my.localized.content=Hola, Me llamo {0}. Hoy es {1}.
```

Reading Messages in Controllers and Tag Libraries

It's simple to read messages in a controller since you can invoke tags as methods:

```
def show() {
    def msg = message(code: "my.localized.content", args: ['Juan', 'lunes'])
}
```

The same technique can be used in tag libraries, but if your tag library uses a custom namespace then you

```
def myTag = { attrs, body ->
    def msg = g.message(code: "my.localized.content", args: ['Juan', 'lunes'])
}
```

10.4 Scaffolding and i18n

Grails scaffolding templates for controllers and views are fully i18n-aware. The GSPs use the message ta `flash` messages use i18n to resolve locale-specific messages.

11 Security

Grails is no more or less secure than Java Servlets. However, Java servlets (and hence Grails) are ext
common buffer overrun and malformed URL exploits due to the nature of the Java Virtual Machine underp

Web security problems typically occur due to developer naivety or mistakes, and there is a little Grails
make writing secure applications easier to write.

What Grails Automatically Does

Grails has a few built in safety mechanisms by default.

1. All standard database access via GORM domain objects is automatically SQL escaped to prevent SQl
2. The default scaffolding templates HTML escape all data fields when displayed
3. Grails link creating tags (link, form, createLink, createLinkTo and others) all use appropriate escaping
4. Grails provides codecs to let you trivially escape data when rendered as HTML, JavaScript and URLs

11.1 Securing Against Attacks

SQL injection

Hibernate, which is the technology underlying GORM domain classes, automatically escapes data when c
issue. However it is still possible to write bad dynamic HQL code that uses unchecked request paramete
vulnerable to HQL injection attacks:

```
def vulnerable() {
    def books = Book.find("from Book as b where b.title ='" + params.title + "'")
}
```

or the analagous call using a GString:

```
def vulnerable() {
    def books = Book.find("from Book as b where b.title ='${params.title}'")
}
```

Do **not** do this. Use named or positional parameters instead to pass in parameters:

```
def safe() {
    def books = Book.find("from Book as b where b.title = ?",
                          [params.title])
}
```

or

```
def safe() {
    def books = Book.find("from Book as b where b.title = :title",
                          [title: params.title])
}
```

Phishing

This really a public relations issue in terms of avoiding hijacking of your branding and a declared comn
Customers need to know how to identify valid emails.

XSS - cross-site scripting injection

It is important that your application verifies as much as possible that incoming requests were originate another site. Ticketing and page flow systems can help this and Grails' support for [Spring Web Flow](#) inclu

It is also important to ensure that all data values rendered into views are escaped correctly. For example you must call [encodeAsHTML](#) on every object to ensure that people cannot maliciously inject JavaSc viewed by others. Grails supplies several [Dynamic Encoding Methods](#) for this purpose and if your outpu can easily write your own codec.

You must also avoid the use of request parameters or data fields for determining the next URL to redirect parameter for example to determine where to redirect a user to after a successful login, attackers can imita site, and then redirect the user back to their own site once logged in, potentially allowing JavaScript code t the site.

Cross-site request forgery

CSRF involves unauthorized commands being transmitted from a user that a website trusts. A typic embedding a link to perform an action on your website if the user is still authenticated.

The best way to decrease risk against these types of attacks is to use the `useToken` attribute on your [Submissions](#) for more information on how to use it. An additional measure would be to not use remember-

HTML/URL injection

This is where bad data is supplied such that when it is later used to create a link in a page, clicking it will may redirect to another site or alter request parameters.

HTML/URL injection is easily handled with the [codecs](#) supplied by Grails, and the tag libraries supplied appropriate. If you create your own tags that generate URLs you will need to be mindful of doing this too.

Denial of service

Load balancers and other appliances are more likely to be useful here, but there are also issues relating to link is created by an attacker to set the maximum value of a result set so that a query could exceed the n system down. The solution here is to always sanitize request parameters before passing them to dynamic fi

```
def safeMax = Math.max(params.max?.toInteger(), 100) // limit to 100 results
return Book.list(max:safeMax)
```

Guessable IDs

Many applications use the last part of the URL as an "id" of some object to retrieve from GORM or elsev these are easily guessable as they are typically sequential integers.

Therefore you must assert that the requesting user is allowed to view the object with the requested id befor

Not doing this is "security through obscurity" which is inevitably breached, just like having a default passv

You must assume that every unprotected URL is publicly accessible one way or another.

11.2 Encoding and Decoding Objects

Grails supports the concept of dynamic encode/decode methods. A set of standard codecs are bundled wi mechanism for developers to contribute their own codecs that will be recognized at runtime.

Codec Classes

A Grails codec class is one that may contain an encode closure, a decode closure or both. When a (framework dynamically loads codecs from the `grails-app/utils/` directory.

The framework looks under `grails-app/utils/` for class names that end with the convention `Co` codecs that ships with Grails is `HTMLCodec`.

If a codec contains an `encode` closure Grails will create a dynamic `encode` method and add that met representing the codec that defined the encode closure. For example, the `HTMLCodec` class defines an with the name `encodeAsHTML`.

The `HTMLCodec` and `URLCodec` classes also define a `decode` closure, so Grails attaches those `decodeURL` respectively. Dynamic codec methods may be invoked from anywhere in a Grails applicatic a report contains a property called 'description' which may contain special characters that must be e document. One way to deal with that in a GSP is to encode the description property using the dynamic enc

```
${report.description.encodeAsHTML()}
```

Decoding is performed using `value.decodeHTML()` syntax.

Standard Codecs

HTMLCodec

This codec performs HTML escaping and unescaping, so that values can be rendered safely in an HTML or damaging the page layout. For example, given a value "Don't you know that 2 > 1?" you wouldn't be ab page because the > will look like it closes a tag, which is especially bad if you render this data within an an input field.

Example of usage:

```
<input name="comment.message" value="${comment.message.encodeAsHTML()}"/>
```

Note that the HTML encoding does not re-encode apostrophe/single quote so you must attribute values to avoid text with apostrophes affecting your page.

URLCodec

URL encoding is required when creating URLs in links or form actions, or any time data is used to crea from getting into the URL and changing its meaning, for example "Apple & Blackberry" is not going request as the ampersand will break parameter parsing.

Example of usage:

```
<a href="/mycontroller/find?searchKey=${lastSearch.encodeAsURL()}">
Repeat last search
</a>
```

Base64Codec

Performs Base64 encode/decode functions. Example of usage:

```
Your registration code is: ${user.registrationCode.encodeAsBase64()}
```

JavaScriptCodec

Escapes Strings so they can be used as valid JavaScript strings. For example:

```
Element.update('${elementId}',
    '${render(template: "/common/message").encodeAsJavaScript()}')
```

HexCodec

Encodes byte arrays or lists of integers to lowercase hexadecimal strings, and can decode hexadecimal stri

```
Selected colour: #${[255,127,255].encodeAsHex()}
```

MD5Codec

Uses the MD5 algorithm to digest byte arrays or lists of integers, or the bytes of a string (in defa hexadecimal string. Example of usage:

```
Your API Key: ${user.uniqueID.encodeAsMD5()}
```

MD5BytesCodec

Uses the MD5 algorithm to digest byte arrays or lists of integers, or the bytes of a string (in default system usage:

```
byte[] passwordHash = params.password.encodeAsMD5Bytes()
```

SHA1Codec

Uses the SHA1 algorithm to digest byte arrays or lists of integers, or the bytes of a string (in defa hexadecimal string. Example of usage:

```
Your API Key: ${user.uniqueID.encodeAsSHA1()}
```

SHA1BytesCodec

Uses the SHA1 algorithm to digest byte arrays or lists of integers, or the bytes of a string (in default syste of usage:

```
byte[] passwordHash = params.password.encodeAsSHA1Bytes()
```

SHA256Codec

Uses the SHA256 algorithm to digest byte arrays or lists of integers, or the bytes of a string (in defa hexadecimal string. Example of usage:

```
Your API Key: ${user.uniqueID.encodeAsSHA256()}
```

SHA256BytesCodec

Uses the SHA256 algorithm to digest byte arrays or lists of integers, or the bytes of a string (in defa Example of usage:

```
byte[] passwordHash = params.password.encodeAsSHA256Bytes()
```

Custom Codecs

Applications may define their own codecs and Grails will load them along with the standard codecs. A cus `grails-app/utils/` directory and the class name must end with `Codec`. The codec may contain a `decode` closure or both. The closure must accept a single argument which will be the object that the Example:

```
class PigLatinCodec {
  static encode = { str ->
    // convert the string to pig latin and return the result
  }
}
```

With the above codec in place an application could do something like this:

```
${lastName.encodeAsPigLatin()}
```

11.3 Authentication

Grails has no default mechanism for authentication as it is possible to implement authentication in many implement a simple authentication mechanism using either interceptors or filters. This is sufficient for sir to use an established security framework, for example by using the Spring Security or the Shiro plugin.

Filters let you apply authentication across all controllers or across a URI space. For example you can crea `grails-app/conf/SecurityFilters.groovy` by running:

```
grails create-filters security
```

and implement your interception logic there:

```
class SecurityFilters {
    def filters = {
        loginCheck(controller: '*', action: '*') {
            before = {
                if (!session.user && actionName != "login") {
                    redirect(controller: "user", action: "login")
                    return false
                }
            }
        }
    }
}
```

Here the `loginCheck` filter intercepts execution *before* all actions except `login` are executed, and redirect to the `login` action.

The `login` action itself is simple too:

```
def login() {
    if (request.get) {
        return // render the login view
    }

def u = User.findByLogin(params.login)
    if (u) {
        if (u.password == params.password) {
            session.user = u
            redirect(action: "home")
        }
        else {
            render(view: "login", model: [message: "Password incorrect"])
        }
    }
    else {
        render(view: "login", model: [message: "User not found"])
    }
}
```

11.4 Security Plugins

If you need more advanced functionality beyond simple authentication such as authorization, roles etc. the available security plugins.

11.4.1 Spring Security

The Spring Security plugins are built on the Spring Security project which provides a flexible, extensil authentication and authorization schemes. The plugins are modular so you can install just the functional The Spring Security plugins are the official security plugins for Grails and are actively maintained and sup

There is a Core plugin which supports form-based authentication, encrypted/salted passwords, HTTP B dependent plugins provide alternate functionality such as OpenID authentication, ACL support, si authentication, Kerberos authentication, and a plugin providing user interface extensions and security worl

See the Core plugin page for basic information and the user guide for detailed information.

11.4.2 Shiro

Shiro is a Java POJO-oriented security framework that provides a default domain model that models real Shiro you extend a controller base class called called `JsecAuthBase` in each controller you `accessControl` block to setup the roles. An example below:

```
class ExampleController extends JsecAuthBase {
    static accessControl = {
        // All actions require the 'Observer' role.
        role(name: 'Observer')

// The 'edit' action requires the 'Administrator' role.
        role(name: 'Administrator', action: 'edit')

// Alternatively, several actions can be specified.
        role(name: 'Administrator', only: [ 'create', 'edit', 'save', 'update' ])
    }
    …
}
```

For more information on the Shiro plugin refer to the documentation.

12 Plugins

Grails is first and foremost a web application framework, but it is also a platform. By exposing a number anything from the command line interface to the runtime configuration engine, Grails can be customised this platform, all you need to do is create a plugin.

Extending the platform may sound complicated, but plugins can range from trivially simple to incredibly Grails application, you'll know how to create a plugin for sharing a data model or some static resources.

12.1 Creating and Installing Plugins

Creating Plugins

Creating a Grails plugin is a simple matter of running the command:

```
grails create-plugin [PLUGIN NAME]
```

This will create a plugin project for the name you specify. For example running `grails create-pl` plugin project called `example`.

The structure of a Grails plugin is very nearly the same as a Grails application project's except that in th find a plugin Groovy file called the "plugin descriptor".

Being a regular Grails project has a number of benefits in that you can immediately test your plugin by run

```
grails run-app
```

The plugin descriptor name ends with the convention `GrailsPlugin` and is found in the root of the plug

```
class ExampleGrailsPlugin {
   def version = "0.1"

…
}
```

All plugins must have this class in the root of their directory structure. The plugin class defines the versio optionally various hooks into plugin extension points (covered shortly).

You can also provide additional information about your plugin using several special properties:

* `title` - short one-sentence description of your plugin
* `version` - The version of your plugin. Valid values include example "0.1", "0.2-SNAPSHOT", "1.1
* `grailsVersion` - The version of version range of Grails that the plugin supports. eg. "1.2 > *" (in
* `author` - plugin author's name
* `authorEmail` - plugin author's contact e-mail
* `description` - full multi-line description of plugin's features
* `documentation` - URL of the plugin's documentation

Here is an example from the [Quartz Grails plugin]:

```
class QuartzGrailsPlugin {
    def version = "0.1"
    def grailsVersion = "1.1 > *"
    def author = "Sergey Nebolsin"
    def authorEmail = "nebolsin@gmail.com"
    def title = "Quartz Plugin"
    def description = '''\
The Quartz plugin allows your Grails application to schedule jobs\
to be executed using a specified interval or cron expression. The\
underlying system uses the Quartz Enterprise Job Scheduler configured\
via Spring, but is made simpler by the coding by convention paradigm.\
'''
    def documentation = "http://grails.org/plugin/quartz"

…
}
```

Installing and Distributing Plugins

To distribute a plugin you navigate to its root directory in a console and run:

```
grails package-plugin
```

This will create a zip file of the plugin starting with `grails-` then the plugin name and version. For ex earlier this would be `grails-example-0.1.zip`. The `package-plugin` command will also contains machine-readable information about plugin's name, version, author, and so on.

Once you have a plugin distribution file you can navigate to a Grails project and run:

```
grails install-plugin /path/to/grails-example-0.1.zip
```

If the plugin is hosted on an HTTP server you can install it with:

```
grails install-plugin http://myserver.com/plugins/grails-example-0.1.zip
```

Notes on excluded Artefacts

Although the [create-plugin] command creates certain files for you so that the plugin can be run as a Grai
included when packaging a plugin. The following is a list of artefacts created, but not included by [package

- `grails-app/conf/BootStrap.groovy`
- `grails-app/conf/BuildConfig.groovy` (although it is used to generate `dependencies`
- `grails-app/conf/Config.groovy`
- `grails-app/conf/DataSource.groovy` (and any other `*DataSource.groovy`)
- `grails-app/conf/UrlMappings.groovy`
- `grails-app/conf/spring/resources.groovy`
- Everything within `/web-app/WEB-INF`
- Everything within `/web-app/plugins/**`
- Everything within `/test/**`
- SCM management files within `**/.svn/**` and `**/CVS/**`

If you need artefacts within `WEB-INF` it is recommended you use the `_Install.groovy` script (co
plugin is installed, to provide such artefacts. In addition, although `UrlMappings.groovy` is exc
`UrlMappings` definition with a different name, such as `MyPluginUrlMappings.groovy`.

Specifying Plugin Locations

An application can load plugins from anywhere on the file system, even if they have not been installed.
plugin in the application's `grails-app/conf/BuildConfig.groovy` file:

```
// Useful to test plugins you are developing.
grails.plugin.location.shiro =
        "/home/dilbert/dev/plugins/grails-shiro"

// Useful for modular applications where all plugins and
// applications are in the same directory.
grails.plugin.location.'grails-ui' = "../grails-grails-ui"
```

This is particularly useful in two cases:

- You are developing a plugin and want to test it in a real application without packaging and installing i
- You have split an application into a set of plugins and an application, all in the same "super-project" c

Global plugins

Plugins can also be installed globally for all applications for a particular version of Grails using the `-glob`

```
grails install-plugin webtest -global
```

The default location is $USER_HOME/.grails/<grailsVersion>/global-plugins but this `grails.global.plugins.dir` setting in `BuildConfig.groovy`.

12.2 Plugin Repositories

Distributing Plugins in the Grails Central Plugins Repository

The preferred way to distribute plugin is to publish to the official Grails Plugins Repository. This will mak command:

```
grails list-plugins
```

which lists all plugins in the Grails Plugin repository, and also the [plugin-info](#) command:

```
grails plugin-info [plugin-name]
```

which outputs more information based on the meta info entered into the plugin descriptor.

> If you have created a Grails plugin and want it to be hosted in the central repository take a which details how release your plugin.

When you have access to the Grails Plugin repository, execute the release-plugin command to release your

```
grails release-plugin
```

This will automatically commit changes to SVN, create tags, and make your changes available to the [list-p](#)

Configuring Additional Repositories

The process for configuring repositories in Grails differs between versions. For version of Grails 1.2 ar [documentation](#) on the subject. The following sections cover Grails 1.3 and above.

Grails 1.3 and above use Ivy under the hood to resolve plugin dependencies. The mechanism for defining the same as [defining repositories for JAR dependencies](#). For example you can define a remote Maven using the following syntax in `grails-app/conf/BuildConfig.groovy`:

```
repositories {
    mavenRepo "http://repository.codehaus.org"
}
```

You can also define a SVN-based Grails repository (such as the one hosted at http://plugins.grails.org) usi

```
repositories {
    grailsRepo "http://myserver/mygrailsrepo"
}
```

There is a shortcut to setup the Grails central repository:

```
repositories {
    grailsCentral()
}
```

The order in which plugins are resolved is based on the ordering of the repositories. So in this case the Gr
last:

```
repositories {
    grailsRepo "http://myserver/mygrailsrepo"
    grailsCentral()
}
```

All of the above examples use HTTP; however you can specify any [Ivy resolver] to resolve plugins with.
resolver:

```
def sshResolver = new SshResolver(user:"myuser", host:"myhost.com")
sshResolver.addArtifactPattern(
        "/path/to/repo/grails-[artifact]/tags/" +
        "LATEST_RELEASE/grails-[artifact]-[revision].[ext]")
sshResolver.latestStrategy =
        new org.apache.ivy.plugins.latest.LatestTimeStrategy()

sshResolver.changingPattern = ".*SNAPSHOT"
sshResolver.setCheckmodified(true)
```

The above example defines an artifact pattern which tells Ivy how to resolve a plugin zip file. For a more d
the relevant section in the Ivy user guide.

Publishing to Maven Compatible Repositories

In general it is recommended for Grails 1.3 and above to use standard Maven-style repositories to self
include the ability for existing tooling and repository managers to interpret the structure of a Maven rep
repositories are not tied to SVN as Grails repositories are.

You use the Maven publisher plugin to publish a plugin to a Maven repository. Please refer to the section o
the subject.

Publishing to Grails Compatible Repositories

Specify the `grails.plugin.repos.distribution.myRepository` setting within the grail
publish a Grails plugin to a Grails-compatible repository:

```
grails.plugin.repos.distribution.myRepository =
        "https://svn.codehaus.org/grails/trunk/grails-test-plugin-repo"
```

You can also provide this settings in the $USER_HOME/.grails/settings.groovy file if you prefer to sl
projects.

Once this is done use the `repository` argument of the `release-plugin` command to specify the rep

```
grails release-plugin -repository = myRepository
```

12.3 Understanding a Plugin's Structure

As as mentioned previously, a plugin is basically a regular Grails application with a plugin descriptor. Ho
plugin differs slightly. For example, take a look at this plugin directory structure:

```
+ grails-app
     + controllers
     + domain
     + taglib
     etc.
 + lib
 + src
     + java
     + groovy
 + web-app
     + js
     + css
```

When a plugin is installed the contents of the `grails-app` directory will g
`plugins/example-1.0/grails-app`. They **will not** be copied into the main source tree. A p
primary source tree.

Dealing with static resources is slightly different. When developing a plugin, just like an application, a
directory. You can then link to static resources just like in an application. This example links to a JavaScri

```
<g:resource dir="js" file="mycode.js" />
```

When you run the plugin in development mode the link to the resource will resolve to something like `/`
plugin is installed into an application the path will automatically change to something like `/plugin/e`
Grails will deal with making sure the resources are in the right place.

There is a special `pluginContextPath` variable that can be used whilst both developing the plugin a
the application to find out what the correct path to the plugin is.

At runtime the `pluginContextPath` variable will either evaluate to an empty string or `/plugins`
plugin is running standalone or has been installed in an application

Java and Groovy code that the plugin provides within the lib and `src/java` and `src/groovy` dire
project's `web-app/WEB-INF/classes` directory so that they are made available at runtime.

12.4 Providing Basic Artefacts

Adding a new Script

A plugin can add a new script simply by providing the relevant Gant script in its scripts directory:

```
+ MyPlugin.groovy
   + scripts     <-- additional scripts here
   + grails-app
        + controllers
        + services
        + etc.
    + lib
```

Adding a new grails-app artifact (Controller, Tag Library, Service, etc.)

A plugin can add new artifacts by creating the relevant file within the `grails-app` tree. Note that the pl
and not copied into the main application tree.

```
+ ExamplePlugin.groovy
   + scripts
   + grails-app
        + controllers  <-- additional controllers here
        + services <-- additional services here
        + etc.  <-- additional XXX here
    + lib
```

Providing Views, Templates and View resolution

When a plugin provides a controller it may also provide default views to be rendered. This is an excelle
through plugins. Grails' view resolution mechanism will first look for the view in the application it is insta
look for the view within the plugin. This means that you can override views provided by a plugin b
application's `grails-app/views` directory.

For example, consider a controller called `BookController` that's provided by an 'amazon' plugin. If the
will first look for a view called `grails-app/views/book/list.gsp` then if that fails it will look fo

However if the view uses templates that are also provided by the plugin then the following syntax may be

```
<g:render template="fooTemplate" plugin="amazon"/>
```

Note the usage of the `plugin` attribute, which contains the name of the plugin where the template resides
look for the template relative to the application.

Excluded Artefacts

By default Grails excludes the following files during the packaging process:

- grails-app/conf/BootStrap.groovy
- grails-app/conf/BuildConfig.groovy (although it is used to generate dependencies
- grails-app/conf/Config.groovy
- grails-app/conf/DataSource.groovy (and any other *DataSource.groovy)
- grails-app/conf/UrlMappings.groovy
- grails-app/conf/spring/resources.groovy
- Everything within /web-app/WEB-INF
- Everything within /web-app/plugins/**
- Everything within /test/**
- SCM management files within **/.svn/** and **/CVS/**

If your plugin requires files under the web-app/WEB-INF directory it is recommende scripts/_Install.groovy Gant script to install these artefacts into the target project's directory tre

In addition, the default UrlMappings.groovy file is excluded to avoid naming conflicts, howeve definition under a different name which **will** be included. For example a file called grails-app/co fine.

The list of excludes is extensible with the pluginExcludes property:

```
// resources that are excluded from plugin packaging
def pluginExcludes = [
    "grails-app/views/error.gsp"
]
```

This is useful for example to include demo or test resources in the plugin repository, but not include them i

12.5 Evaluating Conventions

Before looking at providing runtime configuration based on conventions you first need to understand ho plugin. Every plugin has an implicit application variable which is an instance of the GrailsApplicatio

The GrailsApplication interface provides methods to evaluate the conventions within the project artifact classes within your application.

Artifacts implement the GrailsClass interface, which represents a Grails resource such as a controller o GrailsClass instances you can do:

```
for (grailsClass in application.allClasses) {
    println grailsClass.name
}
```

GrailsApplication has a few "magic" properties to narrow the type of artefact you are interested in can use:

```
for (controllerClass in application.controllerClasses) {
    println controllerClass.name
}
```

The dynamic method conventions are as follows:

- `*Classes` - Retrieves all the classes for a particular artefact name. For example `application.c`
- `get*Class` - Retrieves a named class for a particular `application.getControllerClass("PersonController")`
- `is*Class` - Returns `true` if the given class is of the given a `application.isControllerClass(PersonController)`

The `GrailsClass` interface has a number of useful methods that let you further evaluate and work with

- `getPropertyValue` - Gets the initial value of the given property on the class
- `hasProperty` - Returns `true` if the class has the specified property
- `newInstance` - Creates a new instance of this class.
- `getName` - Returns the logical name of the class in the application without the trailing convention pa
- `getShortName` - Returns the short name of the class without package prefix
- `getFullName` - Returns the full name of the class in the application with the trailing convention pa
- `getPropertyName` - Returns the name of the class as a property name
- `getLogicalPropertyName` - Returns the logical property name of the class in the application applicable
- `getNaturalName` - Returns the name of the property in natural terms (eg. 'lastName' becomes 'Las
- `getPackageName` - Returns the package name

For a full reference refer to the javadoc API.

12.6 Hooking into Build Events

Post-Install Configuration and Participating in Upgrades

Grails plugins can do post-install configuration and participate in application upgrade process (the upgr two specially named scripts under the `scripts` directory of the plugin - `_Install.groovy` and `_Upg`

`_Install.groovy` is executed after the plugin has been installed and `_Upgrade.groovy` is exe application (but not the plugin) with upgrade command.

These scripts are Gant scripts, so you can use the full power of Gant. An addition to the stanc `pluginBasedir` variable which points at the plugin installation basedir.

As an example this `_Install.groovy` script will create a new directory type under the `grails-ap` template:

```
ant.mkdir(dir: "${basedir}/grails-app/jobs")

ant.copy(file: "${pluginBasedir}/src/samples/SamplePluginConfig.groovy",
         todir: "${basedir}/grails-app/conf")
```

Scripting events

It is also possible to hook into command line scripting events. These are events triggered during execution

For example, you can hook into status update output (i.e. "Tests passed", "Server running") and the creatio

A plugin just has to provide an `_Events.groovy` script to listen to the required events. Refer the docu further information.

12.7 Hooking into Runtime Configuration

Grails provides a number of hooks to leverage the different parts of the system and perform runtime config

Hooking into the Grails Spring configuration

First, you can hook in Grails runtime configuration by providing a property called `doWithSpring` v example the following snippet is from one of the core Grails plugins that provides i18n support:

```
import org.springframework.web.servlet.i18n.CookieLocaleResolver
import org.springframework.web.servlet.i18n.LocaleChangeInterceptor
import org.springframework.context.support.ReloadableResourceBundleMessageSource

class I18nGrailsPlugin {

def version = "0.1"

def doWithSpring = {
        messageSource(ReloadableResourceBundleMessageSource) {
            basename = "WEB-INF/grails-app/i18n/messages"
        }
        localeChangeInterceptor(LocaleChangeInterceptor) {
            paramName = "lang"
        }
        localeResolver(CookieLocaleResolver)
    }
}
```

This plugin configures the Grails `messageSource` bean and a couple of other beans to manage Locale Spring Bean Builder syntax to do so.

Participating in web.xml Generation

Grails generates the `WEB-INF/web.xml` file at load time, and although plugins cannot change this f generation of the file. A plugin can provide a `doWithWebDescriptor` property that is assigned `web.xml` as an `XmlSlurper GPathResult`.

Add `servlet` and `servlet-mapping`

Consider this example from the `ControllersPlugin`:

```
def doWithWebDescriptor = { webXml ->

def mappingElement = webXml.'servlet-mapping'

def lastMapping = mappingElement[mappingElement.size() - 1]
    lastMapping + {
        'servlet-mapping' {
            'servlet-name'("grails")
            'url-pattern'("*.dispatch")
        }
    }
}
```

Here the plugin gets a reference to the last `<servlet-mapping>` element and appends Grails' servle
programmatically modify XML using closures and blocks.

Add `filter` and `filter-mapping`

Adding a filter with its mapping works a little differently. The location of the `<filter>` element doesn't
it's simplest to insert your custom filter definition immediately after the last `<context-param>` elemen
the usual approach is to add it immediately after the last `<filter>` element like so:

```
def doWithWebDescriptor = { webXml ->

def contextParam = webXml.'context-param'

contextParam[contextParam.size() - 1] + {
        'filter' {
            'filter-name'('springSecurityFilterChain')
            'filter-class'(DelegatingFilterProxy.name)
        }
    }

def filter = webXml.'filter'
    filter[filter.size() - 1] + {
        'filter-mapping'{
            'filter-name'('springSecurityFilterChain')
            'url-pattern'('/*')
        }
    }
}
```

In some cases you need to ensure that your filter comes after one of the standard Grails filters, such as the
SiteMesh filter. Fortunately you can insert filter mappings immediately after the standard ones (more a
web.xml file) like so:

```
def doWithWebDescriptor = { webXml ->
    ...

// Insert the Spring Security filter after the Spring
    // character encoding filter.
    def filter = webXml.'filter-mapping'.find {
        it.'filter-name'.text() == "charEncodingFilter"
    }

filter + {
        'filter-mapping'{
            'filter-name'('springSecurityFilterChain')
            'url-pattern'('/*')
        }
    }
}
```

Doing Post Initialisation Configuration

Sometimes it is useful to be able do some runtime configuration after the Spring [ApplicationContext](http://static.springsource.org/spring/docs/3.0.x/javadoc-api/org/springframework/context/ApplicationContext.html) has t
`doWithApplicationContext` closure property.

```
class SimplePlugin {

def name = "simple"
    def version = "1.1"

def doWithApplicationContext = { appCtx ->
        def sessionFactory = appCtx.sessionFactory
        // do something here with session factory
    }
}
```

12.8 Adding Dynamic Methods at Runtime

The Basics

Grails plugins let you register dynamic methods with any Grails-managed or other class at
`doWithDynamicMethods` closure.

For Grails-managed classes like controllers, tag libraries and so forth you can add methods, construc
mechanism by accessing each controller's api:http://groovy.codehaus.org/api/groovy/lang/MetaObjectProt

```
class ExamplePlugin {
    def doWithDynamicMethods = { applicationContext ->
        for (controllerClass in application.controllerClasses) {
             controllerClass.metaClass.myNewMethod = {-> println "hello world" }
        }
    }
}
```

In this case we use the implicit application object to get a reference to all of the controller classes' Meta
called `myNewMethod` to each controller. If you know beforehand the class you wish the add a me
`metaClass` property.

For example we can add a new method `swapCase` to `java.lang.String`:

```
class ExamplePlugin {

def doWithDynamicMethods = { applicationContext ->
        String.metaClass.swapCase = {->
             def sb = new StringBuilder()
             delegate.each {
                 sb << (Character.isUpperCase(it as char) ?
                        Character.toLowerCase(it as char) :
                        Character.toUpperCase(it as char))
             }
             sb.toString()
        }

assert "UpAndDown" == "uPaNDdOWN".swapCase()
    }
}
```

Interacting with the ApplicationContext

The `doWithDynamicMethods` closure gets passed the Spring `ApplicationContext` instance. Th objects within it. For example if you were implementing a method to interact with Hibernate you could u combination with a `HibernateTemplate`:

```
import org.springframework.orm.hibernate3.HibernateTemplate

class ExampleHibernatePlugin {

def doWithDynamicMethods = { applicationContext ->

for (domainClass in application.domainClasses) {

domainClass.metaClass.static.load = { Long id->
                def sf = applicationContext.sessionFactory
                def template = new HibernateTemplate(sf)
                template.load(delegate, id)
           }
       }
   }
}
```

Also because of the autowiring and dependency injection capability of the Spring container you ca constructors that use the application context to wire dependencies into your object at runtime:

```
class MyConstructorPlugin {

def doWithDynamicMethods = { applicationContext ->
         for (domainClass in application.domainClasses) {
              domainClass.metaClass.constructor = {->
                  return applicationContext.getBean(domainClass.name)
              }
         }
    }
}
```

Here we actually replace the default constructor with one that looks up prototyped Spring beans instead!

12.9 Participating in Auto Reload Events

Monitoring Resources for Changes

Often it is valuable to monitor resources for changes and perform some action when they occur. Thi reloading of application state at runtime. For example, consider this simplified snippet from the Grails Se

```
class ServicesGrailsPlugin {
    …
    def watchedResources = "file:./grails-app/services/*Service.groovy"

…
    def onChange = { event ->
        if (event.source) {
            def serviceClass = application.addServiceClass(event.source)
            def serviceName = "${serviceClass.propertyName}"
            def beans = beans {
                "$serviceName"(serviceClass.getClazz()) { bean ->
                    bean.autowire =  true
                }
            }
            if (event.ctx) {
                event.ctx.registerBeanDefinition(
                        serviceName,
                        beans.getBeanDefinition(serviceName))
            }
        }
    }
}
```

First it defines `watchedResources` as either a String or a List of strings that contain either the ref watch. If the watched resources specify a Groovy file, when it is changed it will automatically be relo closure in the `event` object.

The `event` object defines a number of useful properties:

- `event.source` - The source of the event, either the reloaded `Class` or a Spring `Resource`
- `event.ctx` - The Spring `ApplicationContext` instance
- `event.plugin` - The plugin object that manages the resource (usually `this`)
- `event.application` - The `GrailsApplication` instance
- `event.manager` - The `GrailsPluginManager` instance

These objects are available to help you apply the appropriate changes based on what changed. In the "S bean is re-registered with the `ApplicationContext` when one of the service classes changes.

Influencing Other Plugins

In addition to reacting to changes, sometimes a plugin needs to "influence" another.

Take for example the Services and Controllers plugins. When a service is reloaded, unless you reload tl when you try to auto-wire the reloaded service into an older controller Class.

To get around this, you can specify which plugins another plugin "influences". This means that when one itself and then reload its influenced plugins. For example consider this snippet from the `ServicesGrai`

```
def influences = ['controllers']
```

Observing other plugins

If there is a particular plugin that you would like to observe for changes but not necessary watch the res "observe" property:

```
def observe = ["controllers"]
```

In this case when a controller is changed you will also receive the event chained from the controllers plugi

It is also possible for a plugin to observe all loaded plugins by using a wildcard:

```
def observe = ["*"]
```

The Logging plugin does exactly this so that it can add the `log` property back to *any* artefact that changes

12.10 Understanding Plugin Load Order

Controlling Plugin Dependencies

Plugins often depend on the presence of other plugins and can adapt depending on the presence of properties. The first is called `dependsOn`. For example, take a look at this snippet from the Hibernate plu

```
class HibernateGrailsPlugin {
def version = "1.0"
def dependsOn = [dataSource: "1.0",
                 domainClass: "1.0",
                 i18n: "1.0",
                 core: "1.0"]
}
```

The Hibernate plugin is dependent on the presence of four plugins: the `dataSource`, `domainClass`, `i`

The dependencies will be loaded before the Hibernate plugin and if all dependencies do not load, then the

The `dependsOn` property also supports a mini expression language for specifying version ranges. A fe below:

```
def dependsOn = [foo: "* > 1.0"]
def dependsOn = [foo: "1.0 > 1.1"]
def dependsOn = [foo: "1.0 > *"]
```

When the wildcard * character is used it denotes "any" version. The expression syntax also excludes any so for example the expression "1.0 > 1.1" would match any of the following versions:

- 1.1
- 1.0
- 1.0.1
- 1.0.3-SNAPSHOT
- 1.1-BETA2

Controlling Load Order

Using `dependsOn` establishes a "hard" dependency in that if the dependency is not resolved, the plu possible though to have a weaker dependency using the `loadAfter` property:

```
def loadAfter = ['controllers']
```

Here the plugin will be loaded after the `controllers` plugin if it exists, otherwise it will just be loa presence of the other plugin, for example the Hibernate plugin has this code in its `doWithSpring` closu

```
if (manager?.hasGrailsPlugin("controllers")) {
    openSessionInViewInterceptor(OpenSessionInViewInterceptor) {
        flushMode = HibernateAccessor.FLUSH_MANUAL
        sessionFactory = sessionFactory
    }
    grailsUrlHandlerMapping.interceptors << openSessionInViewInterceptor
}
```

Here the Hibernate plugin will only register an `OpenSessionInViewInterceptor` if the `contr` `manager` variable is an instance of the GrailsPluginManager interface and it provides methods to interact

Scopes and Environments

It's not only plugin load order that you can control. You can also specify which environments your plugin (stages of a build). Simply declare one or both of these properties in your plugin descriptor:

```
def environments = ['development', 'test', 'myCustomEnv']
def scopes = [excludes:'war']
```

In this example, the plugin will only load in the 'development' and 'test' environments. Nor will it be pa excluded from the 'war' phase. This allows `development-only` plugins to not be packaged for product

The full list of available scopes are defined by the enum BuildScope, but here's a summary:

- `test` - when running tests
- `functional-test` - when running functional tests
- `run` - for run-app and run-war
- `war` - when packaging the application as a WAR file
- `all` - plugin applies to all scopes (default)

Both properties can be one of:

- a string - a sole inclusion
- a list - a list of environments or scopes to include
- a map - for full control, with 'includes' and/or 'excludes' keys that can have string or list values

For example,

```
def environments = "test"
```

will only include the plugin in the test environment, whereas

```
def environments = ["development", "test"]
```

will include it in both the development *and* test environments. Finally,

```
def environments = [includes: ["development", "test"]]
```

will do the same thing.

12.11 The Artefact API

You should by now understand that Grails has the concept of artefacts: special types of classes that it kno normal Groovy and Java classes, for example by enhancing them with extra properties and methods. classes and controllers. What you may not be aware of is that Grails allows application and plugir infrastructure for artefacts, which means you can find out what artefacts are available and even enhance your own custom artefact types.

12.11.1 Asking About Available Artefacts

As a plugin developer, it can be important for you to find out about what domain classes, controllers, or ot application. For example, the [Searchable plugin] needs to know what domain classes exist so it can check and index the appropriate ones. So how does it do it? The answer lies with the `grailsApplication` ol that's available automatically in controllers and GSPs and can be [injected] everywhere else.

The `grailsApplication` object has several important properties and methods for querying artefacts. that gives you all the classes of a particular artefact type:

```
for (cls in grailsApplication.<artefactType>Classes) {
    …
}
```

In this case, `artefactType` is the property name form of the artefact type. With core Grails you have:

- domain
- controller
- tagLib
- service
- codec
- bootstrap
- urlMappings

So for example, if you want to iterate over all the domain classes, you use:

```
for (cls in grailsApplication.domainClasses) {
    …
}
```

and for URL mappings:

```
for (cls in grailsApplication.urlMappingsClasses) {
    …
}
```

You need to be aware that the objects returned by these properties are not instances of [Class](). Instead, th
some particularly useful properties and methods, including one for the underlying `Class`:

- `shortName` - the class name of the artefact without the package (equivalent of `Class.simpleNa`
- `logicalPropertyName` - the artefact name in property form without the 'type' suffix. So `MyGre`
- `siAbstract()` - a boolean indicating whether the artefact class is abstract or not.
- `getPropertyValue(name)` - returns the value of the given property, whether it's a static or a property is initialised on declaration, e.g. `static transactional = true`.

The artefact API also allows you to fetch classes by name and check whether a class is an artefact:

- get<type>Class(String name)
- is<type>Class(Class clazz)

The first method will retrieve the `GrailsClass` instance for the given name, e.g. 'MyGreatController'. is a particular type of artefact. For example, `grailsApplication.isControllerClass(org.example.MyGreatController)` to chec in fact a controller.

12.11.2 Adding Your Own Artefact Types

Plugins can easily provide their own artefacts so that they can easily find out what implementations are a you need to do is create an `ArtefactHandler` implementation and register it in your main plugin class

```
class MyGrailsPlugin {
    def artefacts = [ org.somewhere.MyArtefactHandler ]
    …
}
```

The `artefacts` list can contain either handler classes (as above) or instances of handlers.

So, what does an artefact handler look like? Well, put simply it is an implementation of the ArtefactHanc there is a skeleton implementation that can readily be extended: ArtefactHandlerAdapter.

In addition to the handler itself, every new artefact needs a corresponding wrapper class that imp implementations are available such as AbstractInjectableGrailsClass, which is particularly useful as it tur is auto-wired, just like controllers and services.

The best way to understand how both the handler and wrapper classes work is to look at the Quartz plugin:

- GrailsJobClass
- DefaultGrailsJobClass
- JobArtefactHandler

Another example is the Shiro plugin which adds a realm artefact.

12.12 Binary Plugins

Regular Grails plugins are packaged as zip files containing the full source of the plugin. This has some distribution system (anyone can see the source), in addition to avoiding problems with the source compatib

As of Grails 2.0 you can pre-compile Grails plugins into regular JAR files known as "binary plugins". T disadvantages as discussed in the advantages of source plugins above) including:

- Binary plugins can be published as standard JAR files to a Maven repository
- Binary plugins can be declared like any other JAR dependency
- Commercial plugins are more viable since the source isn't published
- IDEs have a better understanding since binary plugins are regular JAR files containing classes

Packaging

To package a plugin in binary form you can use the package-plugin command and the `--binary` flag:

```
grails package-plugin --binary
```

Supported artefacts include:

- Grails artifact classes such as controllers, domain classes and so on
- I18n Message bundles
- GSP Views, layouts and templates

You can also specify the packaging in the plugin descriptor:

```
def packaging = "binary"
```

in which case the packaging will default to binary.

Using Binary Plugins

The packaging process creates a JAR file in the `target` directory of the plugin, for example `target.` two ways to incorporate a binary plugin into an application.

One is simply placing the plugin JAR file in your application's `lib` directory. The other is to publish t repository and declare it as a dependency in `grails-app/conf/BuildConfig.groovy`:

```
dependencies {
    compile "mycompany:myplugin:0.1"
}
```

> Since binary plugins are packaged as JAR files, they are declared as dependencies in the `de` *not* in the `plugins` block as you may be naturally inclined to do. The `plugins` block traditional source plugins packaged as zip files

13 Web Services

Web services are all about providing a web API onto your web application and are typically implemented i

13.1 REST

REST Architectural Pattern REST XML JSON URL patterns representational HTTP methods GE

HTTP method action type GET PUT POST REST CRUD

URL patterns

REST Grails RESTful URL mappings:

```
static mappings = {
   "/product/$id?"(resource:"product")
}
```

URI `/product` onto a `ProductController` HTTP method GET, PUT, POST DELETE action

Method	Action
`GET`	`show`
`PUT`	`update`
`POST`	`save`
`DELETE`	`delete`

Grails XML JSON

HTTP methods URL Mappings map to HTTP methods:

```
"/product/$id"(controller: "product") {
    action = [GET: "show", PUT: "update", DELETE: "delete", POST: "save"]
}
```

`resource` Grails XML JSON XML JSON `parseRequest`

```
"/product/$id"(controller: "product", parseRequest: true) {
    action = [GET: "show", PUT: "update", DELETE: "delete", POST: "save"]
}
```

HTTP Methods

URL mappings HTTP methods action REST client HTTP method (example in Groovy's HTTPBuild

```
import groovyx.net.http.*
import static groovyx.net.http.ContentType.JSON

def http = new HTTPBuilder("http://localhost:8080/amazon")

http.request(Method.GET, JSON) {
     url.path = '/book/list'
     response.success = { resp, json ->
         for (book in json.books) {
             println book.title
         }
     }
 }
```

request method `GET` POST `Grails` [`form`]() DELETE@

```
<g:form controller="book" method="DELETE">
    ..
</g:form>
```

Grails will send a hidden parameter called `_method`, which will be used as the request's HTTP metho method for non-browser clients is to use the `X-HTTP-Method-Override` to specify the alternative me

XML Marshalling - Reading

The controller can use Grails' [XML marshalling]() support to implement the GET method:

```
import grails.converters.XML

class ProductController {
    def show() {
        if (params.id && Product.exists(params.id)) {
            def p = Product.findByName(params.id)
            render p as XML
        }
        else {
            def all = Product.list()
            render all as XML
        }
    }
    ..
}
```

If there is an `id` we search for the `Product` by name and return it, otherwise we return all Products. Thi all products, otherwise if we go to `/product/MacBook` we only get a MacBook.

XML Marshalling - Updating

To support updates such as `PUT` and `POST` you can use the [params]() object which Grails enhances with packet. Given an incoming XML packet of:

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<product>
    <name>MacBook</name>
    <vendor id="12">
        <name>Apple</name>
     </vender>
</product>
```

you can read this XML packet using the same techniques described in the Data Binding section, using the

```
def save() {
    def p = new Product(params.product)
if (p.save()) {
        render p as XML
    }
    else {
        render p.errors
    }
}
```

In this example by indexing into the `params` object using the `product` key we can automatically `Product` constructor. An interesting aspect of the line:

```
def p = new Product(params.product)
```

is that it requires no code changes to deal with a form submission that submits form data, or an XML reque

> ⚠ If you require different responses to different clients (REST, HTML etc.) you can use content

The `Product` object is then saved and rendered as XML, otherwise an error message is produced usi form:

```
<error>
   <message>The property 'title' of class 'Person' must be specified</message>
</error>
```

REST with JAX-RS

There also is a JAX-RS Plugin which can be used to build web services based on the Java API for RESTfu

13.2 SOAP

SOAP Grails Spring WS plugin SOAP API Grails services

- CXF plugin which uses the CXF SOAP stack
- Axis2 plugin which uses Axis2
- Metro plugin which uses the Metro framework (and can also be used for Contract First)

SOAP Grails Grails services via the `exposes` static property CXF plugin:

```
class BookService {
static expose = ['cxf']
Book[] getBooks() {
        Book.list() as Book[]
    }
}
```

WSDL `http://127.0.0.1:8080/your_grails_app/services/book?wsdl`

CXF Plugin the documentation

13.3 RSS and Atom

RSS Atom Grails RSS ATOM feeds render XML Feeds plugin Grails RSS Atom ROME library

```
def feed() {
    render(feedType: "rss", feedVersion: "2.0") {
        title = "My test feed"
        link = "http://your.test.server/yourController/feed"
for (article in Article.list()) {
            entry(article.title) {
                link = "http://your.test.server/article/${article.id}"
                article.content // return the content
            }
        }
    }
}
```

14 Grails and Spring

This section is for advanced users and those who are interested in how Grails integrates with and builds on
for plugin developers considering doing runtime configuration Grails.

14.1 The Underpinnings of Grails

Grails is actually a Spring MVC application in disguise. Spring MVC is the Spring framework's built
Although Spring MVC suffers from some of the same difficulties as frameworks like Struts in terms of its
architected and was, for Grails, the perfect framework to build another framework on top of.

Grails leverages Spring MVC in the following areas:

- Basic controller logic - Grails subclasses Spring's DispatcherServlet and uses it to delegate to Grails c
- Data Binding and Validation - Grails' validation and data binding capabilities are built on those provi
- Runtime configuration - Grails' entire runtime convention based system is wired together by a Spring
- Transactions - Grails uses Spring's transaction management in GORM

In other words Grails has Spring embedded running all the way through it.

The Grails ApplicationContext

Spring developers are often keen to understand how the Grails `ApplicationContext` instance is cons

- Grails constructs a parent `ApplicationContext` from the `web-app/WEB-INF/appli` `ApplicationContext` configures the GrailsApplication instance and the GrailsPluginManager.
- Using this `ApplicationContext` as a parent Grails' analyses the conventions with the `GrailsA` a child `ApplicationContext` that is used as the root `ApplicationContext` of the web appli

Configured Spring Beans

Most of Grails' configuration happens at runtime. Each plugin may configure Spring beans that are regist
For a reference as to which beans are configured, refer to the reference guide which describes each of th
configure.

14.2 Configuring Additional Beans

Using the Spring Bean DSL

You can easily register new (or override existing) beans by configuring them in `grails-app/conf/s`
uses the Grails Spring DSL. Beans are defined inside a `beans` property (a Closure):

```
beans = {
    // beans here
}
```

As a simple example you can configure a bean with the following syntax:

```
import my.company.MyBeanImpl

beans = {
    myBean(MyBeanImpl) {
        someProperty = 42
        otherProperty = "blue"
    }
}
```

Once configured, the bean can be auto-wired into Grails artifacts and other classes that support `BootStrap.groovy` and integration tests) by declaring a public field whose name is your bean's name

```
class ExampleController {

def myBean
    …
}
```

Using the DSL has the advantage that you can mix bean declarations and logic, for example based on the e

```
import grails.util.Environment
import my.company.mock.MockImpl
import my.company.MyBeanImpl

beans = {
    switch(Environment.current) {
        case Environment.PRODUCTION:
            myBean(MyBeanImpl) {
                someProperty = 42
                otherProperty = "blue"
            }
            break

case Environment.DEVELOPMENT:
            myBean(MockImpl) {
                someProperty = 42
                otherProperty = "blue"
            }
            break
    }
}
```

The `GrailsApplication` object can be accessed with the `application` variable and can be u (amongst other things):

```
import grails.util.Environment
import my.company.mock.MockImpl
import my.company.MyBeanImpl

beans = {
    if (application.config.my.company.mockService) {
        myBean(MockImpl) {
            someProperty = 42
            otherProperty = "blue"
        }
    } else {
        myBean(MyBeanImpl) {
            someProperty = 42
            otherProperty = "blue"
        }
    }
}
```

If you define a bean in `resources.groovy` with the same name as one previously regi installed plugin, your bean will replace the previous registration. This is a convenient way without resorting to editing plugin code or other approaches that would affect maintainability.

Using XML

Beans can also be configured using a `grails-app/conf/spring/resources.xml`. In ear automatically generated for you by the `run-app` script, but the DSL in `resources.groovy` is t automatically generated now. But it is still supported - you just need to create it yourself.

This file is typical Spring XML file and the Spring documentation has an [excellent reference] on how to co

The `myBean` bean that we configured using the DSL would be configured with this syntax in the XML fil

```
<bean id="myBean" class="my.company.MyBeanImpl">
    <property name="someProperty" value="42" />
    <property name="otherProperty" value="blue" />
</bean>
```

Like the other bean it can be auto-wired into any class that supports dependency injection:

```
class ExampleController {

def myBean
}
```

Referencing Existing Beans

Beans declared in `resources.groovy` or `resources.xml` can reference other beans by con `BookService` class its Spring bean name would be `bookService`, so your bean would reference it lik

```
beans = {
    myBean(MyBeanImpl) {
        someProperty = 42
        otherProperty = "blue"
        bookService = ref("bookService")
    }
}
```

or like this in XML:

```
<bean id="myBean" class="my.company.MyBeanImpl">
    <property name="someProperty" value="42" />
    <property name="otherProperty" value="blue" />
    <property name="bookService" ref="bookService" />
</bean>
```

The bean needs a public setter for the bean reference (and also the two simple properties), which in Groovy

```
package my.company

class MyBeanImpl {
    Integer someProperty
    String otherProperty
    BookService bookService // or just "def bookService"
}
```

or in Java like this:

```
package my.company;

class MyBeanImpl {

private BookService bookService;
    private Integer someProperty;
    private String otherProperty;

public void setBookService(BookService theBookService) {
        this.bookService = theBookService;
    }

public void setSomeProperty(Integer someProperty) {
        this.someProperty = someProperty;
    }

public void setOtherProperty(String otherProperty) {
        this.otherProperty = otherProperty;
    }
}
```

Using `ref` (in XML or the DSL) is very powerful since it configures a runtime reference, so the referen long as it's in place when the final application context configuration occurs, everything will be resolved co

For a full reference of the available beans see the plugin reference in the reference guide.

14.3 Runtime Spring with the Beans DSL

This Bean builder in Grails aims to provide a simplified way of wiring together dependencies that uses Spr

In addition, Spring's regular way of configuration (via XML and annotations) is static and difficult to mod programmatic XML creation which is both error prone and verbose. Grails' [BeanBuilder] change programmatically wire together components at runtime, allowing you to adapt the logic based on system p

This enables the code to adapt to its environment and avoids unnecessary duplication of code (hav development and production environments)

The BeanBuilder class

Grails provides a grails.spring.BeanBuilder class that uses dynamic Groovy to construct bean definitions. T

```
import org.apache.commons.dbcp.BasicDataSource
import org.codehaus.groovy.grails.orm.hibernate.ConfigurableLocalSessionFactoryBe
import org.springframework.context.ApplicationContext
import grails.spring.BeanBuilder

def bb = new BeanBuilder()

bb.beans {

dataSource(BasicDataSource) {
        driverClassName = "org.h2.Driver"
        url = "jdbc:h2:mem:grailsDB"
        username = "sa"
        password = ""
    }

sessionFactory(ConfigurableLocalSessionFactoryBean) {
        dataSource = ref('dataSource')
        hibernateProperties = ["hibernate.hbm2ddl.auto": "create-drop",
                               "hibernate.show_sql":     "true"]
    }
}

ApplicationContext appContext = bb.createApplicationContext()
```

> Within plugins and the grails-app/conf/spring/resources.groovy file you don't need to crea `BeanBuilder`. Instead the DSL is implicitly available inside the `doWithSpring` respectively.

This example shows how you would configure Hibernate with a data source with the `BeanBuilder` clas

Each method call (in this case `dataSource` and `sessionFactory` calls) maps to the name of the be method is the bean's class, whilst the last argument is a block. Within the body of the block you can set Groovy syntax.

Bean references are resolved automatically using the name of the bean. This can be seen in the `sessionFactory` bean resolves the `dataSource` reference.

Certain special properties related to bean management can also be set by the builder, as seen in the followi

```
sessionFactory(ConfigurableLocalSessionFactoryBean) { bean ->
    // Autowiring behaviour. The other option is 'byType'. [autowire]
    bean.autowire = 'byName'
    // Sets the initialisation method to 'init'. [init-method]
    bean.initMethod = 'init'
    // Sets the destruction method to 'destroy'. [destroy-method]
    bean.destroyMethod = 'destroy'
    // Sets the scope of the bean. [scope]
    bean.scope = 'request'
    dataSource = ref('dataSource')
    hibernateProperties = ["hibernate.hbm2ddl.auto": "create-drop",
                           "hibernate.show_sql":     "true"]
}
```

The strings in square brackets are the names of the equivalent bean attributes in Spring's XML definition.

Using BeanBuilder with Spring MVC

Include the `grails-spring-<version>.jar` file in your classpath to use BeanBuilder in a regular following `<context-param>` values to your `/WEB-INF/web.xml` file:

```
<context-param>
    <param-name>contextConfigLocation</param-name>
    <param-value>/WEB-INF/applicationContext.groovy</param-value>
</context-param>

<context-param>
    <param-name>contextClass</param-name>
    <param-value>
      org.codehaus.groovy.grails.commons.spring.GrailsWebApplicationContext
    </param-value>
</context-param>
```

Then create a `/WEB-INF/applicationContext.groovy` file that does the rest:

```
import org.apache.commons.dbcp.BasicDataSource

beans {
    dataSource(BasicDataSource) {
        driverClassName = "org.h2.Driver"
        url = "jdbc:h2:mem:grailsDB"
        username = "sa"
        password = ""
    }
}
```

Loading Bean Definitions from the File System

You can use the `BeanBuilder` class to load external Groovy scripts that define beans using the same example:

```
def bb = new BeanBuilder()
bb.loadBeans("classpath:*SpringBeans.groovy")

def applicationContext = bb.createApplicationContext()
```

Here the BeanBuilder loads all Groovy files on the classpath ending with SpringBeans.groovy
An example script can be seen below:

```
import org.apache.commons.dbcp.BasicDataSource
import org.codehaus.groovy.grails.orm.hibernate.ConfigurableLocalSessionFactoryBe

beans {

dataSource(BasicDataSource) {
        driverClassName = "org.h2.Driver"
        url = "jdbc:h2:mem:grailsDB"
        username = "sa"
        password = ""
    }

sessionFactory(ConfigurableLocalSessionFactoryBean) {
        dataSource = dataSource
        hibernateProperties = ["hibernate.hbm2ddl.auto": "create-drop",
                               "hibernate.show_sql":     "true"]
    }
}
```

Adding Variables to the Binding (Context)

If you're loading beans from a script you can set the binding to use by creating a Groovy Binding:

```
def binding = new Binding()
binding.maxSize = 10000
binding.productGroup = 'finance'

def bb = new BeanBuilder()
bb.binding = binding
bb.loadBeans("classpath:*SpringBeans.groovy")

def ctx = bb.createApplicationContext()
```

Then you can access the maxSize and productGroup properties in your DSL files.

14.4 The BeanBuilder DSL Explained

Using Constructor Arguments

Constructor arguments can be defined using parameters to each bean-defining method. Put them after the f

```
bb.beans {
    exampleBean(MyExampleBean, "firstArgument", 2) {
        someProperty = [1, 2, 3]
    }
}
```

This configuration corresponds to a MyExampleBean with a constructor that looks like this:

```
MyExampleBean(String foo, int bar) {
   …
}
```

Configuring the BeanDefinition (Using factory methods)

The first argument to the closure is a reference to the bean configuration instance, which you can use to any method on the AbstractBeanDefinition class:

```
bb.beans {
    exampleBean(MyExampleBean) { bean ->
        bean.factoryMethod = "getInstance"
        bean.singleton = false
        someProperty = [1, 2, 3]
    }
}
```

As an alternative you can also use the return value of the bean defining method to configure the bean:

```
bb.beans {
    def example = exampleBean(MyExampleBean) {
        someProperty = [1, 2, 3]
    }
    example.factoryMethod = "getInstance"
}
```

Using Factory beans

Spring defines the concept of factory beans and often a bean is created not directly from a new insta factories. In this case the bean has no Class argument and instead you must pass the name of the factory be

```
bb.beans {

myFactory(ExampleFactoryBean) {
        someProperty = [1, 2, 3]
    }

myBean(myFactory) {
        name = "blah"
    }
}
```

Another common approach is provide the name of the factory method to call on the factory bean. Th parameter syntax:

```
bb.beans {

myFactory(ExampleFactoryBean) {
        someProperty = [1, 2, 3]
    }

myBean(myFactory: "getInstance") {
        name = "blah"
    }
}
```

Here the `getInstance` method on the `ExampleFactoryBean` bean will be called to create the `myBe`

Creating Bean References at Runtime

Sometimes you don't know the name of the bean to be created until runtime. In this case you can use a
defining method dynamically:

```
def beanName = "example"
bb.beans {
    "${beanName}Bean"(MyExampleBean) {
        someProperty = [1, 2, 3]
    }
}
```

In this case the beanName variable defined earlier is used when invoking a bean defining method. Th
would work just as well with a name that is generated programmatically based on configuration, system pr

Furthermore, because sometimes bean names are not known until runtime you may need to reference the
beans, in this case using the ref method:

```
def beanName = "example"
bb.beans {

"${beanName}Bean"(MyExampleBean) {
        someProperty = [1, 2, 3]
    }

anotherBean(AnotherBean) {
        example = ref("${beanName}Bean")
    }
}
```

Here the example property of AnotherBean is set using a runtime reference to the exampleBean. Th
to beans from a parent ApplicationContext that is provided in the constructor of the BeanBuilde

```
ApplicationContext parent = ...//
der bb = new BeanBuilder(parent)
bb.beans {
    anotherBean(AnotherBean) {
        example = ref("${beanName}Bean", true)
    }
}
```

Here the second parameter true specifies that the reference will look for the bean in the parent context.

Using Anonymous (Inner) Beans

You can use anonymous inner beans by setting a property of the bean to a block that takes an argument tha

```
bb.beans {

marge(Person) {
        name = "Marge"
        husband = { Person p ->
            name = "Homer"
            age = 45
            props = [overweight: true, height: "1.8m"]
        }
        children = [bart, lisa]
    }

bart(Person) {
        name = "Bart"
        age = 11
    }

lisa(Person) {
        name = "Lisa"
        age = 9
    }
}
```

In the above example we set the `marge` bean's husband property to a block that creates an inner bean factory bean you can omit the type and just use the specified bean definition instead to setup the factory:

```
bb.beans {

personFactory(PersonFactory)

marge(Person) {
        name = "Marge"
        husband = { bean ->
            bean.factoryBean = "personFactory"
            bean.factoryMethod = "newInstance"
            name = "Homer"
            age = 45
            props = [overweight: true, height: "1.8m"]
        }
        children = [bart, lisa]
    }
}
```

Abstract Beans and Parent Bean Definitions

To create an abstract bean definition define a bean without a `Class` parameter:

```
class HolyGrailQuest {
    def start() { println "lets begin" }
}
```

```
class KnightOfTheRoundTable {

String name
    String leader
    HolyGrailQuest quest

KnightOfTheRoundTable(String name) {
        this.name = name
    }

def embarkOnQuest() {
        quest.start()
    }
}
```

```
import grails.spring.BeanBuilder

def bb = new BeanBuilder()
bb.beans {
    abstractBean {
        leader = "Lancelot"
    }
    …
}
```

Here we define an abstract bean that has a `leader` property with the value of `"Lancelot"`. To use the child bean:

```
bb.beans {
    …
    quest(HolyGrailQuest)

knights(KnightOfTheRoundTable, "Camelot") { bean ->
        bean.parent = abstractBean
        quest = ref('quest')
    }
}
```

> When using a parent bean you must set the parent property of the bean before setting any c
> bean!

If you want an abstract bean that has a `Class` specified you can do it this way:

```
import grails.spring.BeanBuilder

def bb = new BeanBuilder()
bb.beans {

abstractBean(KnightOfTheRoundTable) { bean ->
        bean.'abstract' = true
        leader = "Lancelot"
    }

quest(HolyGrailQuest)

knights("Camelot") { bean ->
        bean.parent = abstractBean
        quest = quest
    }
}
```

In this example we create an abstract bean of type `KnightOfTheRoundTable` and use the bean argum a knights bean that has no `Class` defined, but inherits the `Class` from the parent bean.

Using Spring Namespaces

Since Spring 2.0, users of Spring have had easier access to key features via XML namespaces. You can u by declaring it with this syntax:

```
xmlns context:"http://www.springframework.org/schema/context"
```

and then invoking a method that matches the names of the Spring namespace tag and its associated attribut

```
context.'component-scan'('base-package': "my.company.domain")
```

You can do some useful things with Spring namespaces, such as looking up a JNDI resource:

```
xmlns jee:"http://www.springframework.org/schema/jee"

jee.'jndi-lookup'(id: "dataSource", 'jndi-name': "java:comp/env/myDataSource")
```

This example will create a Spring bean with the identifier `dataSource` by performing a JNDI lookup namespaces you also get full access to all of the powerful AOP support in Spring from BeanBuilder. For e:

```
class Person {

int age
    String name

void birthday() {
        ++age;
    }
}
```

```
class BirthdayCardSender {
List peopleSentCards = []
void onBirthday(Person person) {
        peopleSentCards << person
    }
}
```

You can define an aspect that uses a pointcut to detect whenever the `birthday()` method is called:

```
xmlns aop:"http://www.springframework.org/schema/aop"
fred(Person) {
    name = "Fred"
    age = 45
}
birthdayCardSenderAspect(BirthdayCardSender)
aop {
    config("proxy-target-class": true) {
        aspect(id: "sendBirthdayCard", ref: "birthdayCardSenderAspect") {
            after method: "onBirthday",
            pointcut: "execution(void ..Person.birthday()) and this(person)"
        }
    }
}
```

14.5 Property Placeholder Configuration

Grails supports the notion of property placeholder configuration through an extended version of Spring's is typically useful in combination with externalized configuration.

Settings defined in either ConfigSlurper scripts or Java properties files can be used as placeholde `grails-app/conf/spring/resources.xml`. For example given the following entries in `grail` an externalized config):

```
database.driver="com.mysql.jdbc.Driver"
database.dbname="mysql:mydb"
```

You can then specify placeholders in `resources.xml` as follows using the familiar ${..} syntax:

```
<bean id="dataSource"
      class="org.springframework.jdbc.datasource.DriverManagerDataSource">
    <property name="driverClassName">
        <value>${database.driver}</value>
    </property>
    <property name="url">
        <value>jdbc:${database.dbname}</value>
    </property>
 </bean>
```

14.6 Property Override Configuration

Grails supports setting of bean properties via configuration. This is often useful when used in combination

You define a `beans` block with the names of beans and their values:

```
beans {
    bookService {
        webServiceURL = "http://www.amazon.com"
    }
}
```

The general format is:

```
[bean name].[property name] = [value]
```

The same configuration in a Java properties file would be:

```
beans.bookService.webServiceURL=http://www.amazon.com
```

15 Grails and Hibernate

If GORM (Grails Object Relational Mapping) is not flexible enough for your liking you can alternat
Hibernate, either with XML mapping files or JPA annotations. You will be able to map Grails domain
systems and have more flexibility in the creation of your database schema. Best of all, you will still be al
and query methods provided by GORM!

15.1 Using Hibernate XML Mapping Files

Mapping your domain classes with XML is pretty straightforward. Simply create a `hibernat`
`grails-app/conf/hibernate` directory, either manually or with the create-hibernate-cfg-xml comm

```
<?xml version='1.0' encoding='UTF-8'?>
<!DOCTYPE hibernate-configuration PUBLIC
        "-//Hibernate/Hibernate Configuration DTD 3.0//EN"
        "http://hibernate.sourceforge.net/hibernate-configuration-3.0.dtd">
<hibernate-configuration>
    <session-factory>
        <!-- Example mapping file inclusion -->
        <mapping resource="org.example.Book.hbm.xml"/>
        …
    </session-factory>
</hibernate-configuration>
```

The individual mapping files, like 'org.example.Book.hbm.xml' in the above example, also go into the
directory. To find out how to map domain classes with XML, check out the Hibernate manual.

If the default location of the `hibernate.cfg.xml` file doesn't suit you, you can change it by
`grails-app/conf/DataSource.groovy`:

```
hibernate {
    config.location = "file:/path/to/my/hibernate.cfg.xml"
}
```

or even a list of locations:

```
hibernate {
    config.location = ["file:/path/to/one/hibernate.cfg.xml",
                       "file:/path/to/two/hibernate.cfg.xml"]
}
```

Grails also lets you write your domain model in Java or reuse an existing one that already has Hibernate m
files into `grails-app/conf/hibernate` and either put the Java files in `src/java` or the classe
domain model is packaged as a JAR. You still need the `hibernate.cfg.xml` though!

15.2 Mapping with Hibernate Annotations

To map a domain class with annotations, create a new class in `src/java` and use the annotations define
info on this see the Hibernate Annotations Docs):

```java
package com.books;

import javax.persistence.Entity;
import javax.persistence.GeneratedValue;
import javax.persistence.Id;

@Entity
public class Book {
    private Long id;
    private String title;
    private String description;
    private Date date;

@Id
    @GeneratedValue
    public Long getId() {
        return id;
    }

public void setId(Long id) {
        this.id = id;
    }

public String getTitle() {
        return title;
    }

public void setTitle(String title) {
        this.title = title;
    }

public String getDescription() {
        return description;
    }

public void setDescription(String description) {
        this.description = description;
    }
}
```

Then register the class with the Hibernate `sessionFactory` by adding `grails-app/conf/hibernate/hibernate.cfg.xml` file as follows:

```xml
<!DOCTYPE hibernate-configuration SYSTEM
  "http://hibernate.sourceforge.net/hibernate-configuration-3.0.dtd">
<hibernate-configuration>
    <session-factory>
        <mapping package="com.books" />
        <mapping class="com.books.Book" />
    </session-factory>
</hibernate-configuration>
```

See the previous section for more information on the `hibernate.cfg.xml` file.

When Grails loads it will register the necessary dynamic methods with the class. To see what else you ca the section on Scaffolding.

15.3 Adding Constraints

You can still use GORM validation even if you use a Java domain model. Grails lets you define cons `src/java` directory. The script must be in a directory that matches the package of the corresponding d *Constraints* suffix. For example, if you had a domain class `org.example.Book`, the `src/java/org/example/BookConstraints.groovy`.

Add a standard GORM `constraints` block to the script:

```
constraints = {
    title blank: false
    author blank: false
}
```

Once this is in place you can validate instances of your domain class!

16 Scaffolding

Scaffolding lets you auto-generate a whole application for a given domain class including:

- The necessary views
- Controller actions for create/read/update/delete (CRUD) operations

Dynamic Scaffolding

The simplest way to get started with scaffolding is to enable it with the `scaffold` property. Set the `sc` `true` for the `Book` domain class:

```
class BookController {
    static scaffold = true
}
```

This works because the `BookController` follows the same naming convention as the `Book` domain cl we could reference the class directly in the scaffold property:

```
class SomeController {
    static scaffold = Author
}
```

With this configured, when you start your application the actions and views will be auto-generated dynamically implemented by default by the runtime scaffolding mechanism:

- list
- show
- edit
- delete
- create
- save
- update

A CRUD interface will also be generated. To access this open `http://localhost:8080/app/boo`

If you prefer to keep your domain model in Java and mapped with Hibernate you can still use scaffolding, its name as the `scaffold` argument.

You can add new actions to a scaffolded controller, for example:

```
class BookController {
static scaffold = Book
def changeAuthor() {
        def b = Book.get(params.id)
        b.author = Author.get(params["author.id"])
        b.save()
// redirect to a scaffolded action
        redirect(action:show)
    }
}
```

You can also override the scaffolded actions:

```
class BookController {
static scaffold = Book
// overrides scaffolded action to return both authors and books
    def list() {
        [bookInstanceList: Book.list(),
         bookInstanceTotal: Book.count(),
         authorInstanceList: Author.list()]
    }
def show() {
        def book = Book.get(params.id)
        log.error(book)
        [bookInstance : book]
    }
}
```

All of this is what is known as "dynamic scaffolding" where the CRUD interface is generated dynamically

> By default, the size of text areas in scaffolded views is defined in the CSS, so adding 'rows' a
> have no effect.
>
> Also, the standard scaffold views expect model variables of the form `<propertyName>`
> collections and `<propertyName>Instance` for single instances. It's tempting to use pro
> 'book', but those won't work.

Customizing the Generated Views

The views adapt to Validation constraints. For example you can change the order that fields appear i
constraints in the builder:

```
def constraints = {
    title()
    releaseDate()
}
```

You can also get the generator to generate lists instead of text inputs if you use the `inList` constraint:

```
def constraints = {
    title()
    category(inList: ["Fiction", "Non-fiction", "Biography"])
    releaseDate()
}
```

Or if you use the `range` constraint on a number:

```
def constraints = {
    age(range:18..65)
}
```

Restricting the size with a constraint also effects how many characters can be entered in the generated viev

```
def constraints = {
    name(size:0..30)
}
```

Static Scaffolding

Grails also supports "static" scaffolding.

The above scaffolding features are useful but in real world situations it's likely that you will want to cus you generate a controller and the views used to create the above interface from the command line. To gene

```
grails generate-controller Book
```

or to generate the views:

```
grails generate-views Book
```

or to generate everything:

```
grails generate-all Book
```

If you have a domain class in a package or are generating from a Hibernate mapped class remember to incl

```
grails generate-all com.bookstore.Book
```

Customizing the Scaffolding templates

The templates used by Grails to generate the controller and views can be customized by installing th
command.

17 Deployment

Grails applications can be deployed in a number of ways, each of which has its pros and cons.

"grails run-app"

You should be very familiar with this approach by now, since it is the most common method of running phase. An embedded Tomcat server is launched that loads the web application from the development s changes to application files.

This approach is not recommended at all for production deployment because the performance is poor. Che sizable overhead on the server. Having said that, `grails prod run-app` removes the per-request frequently the regular check takes place.

Setting the system property "disable.auto.recompile" to `true` disables this regular check completely, wh controls the frequency. This latter property should be set to the number of seconds you want between each

"grails run-war"

This is very similar to the previous option, but Tomcat runs against the packaged WAR file rather than the disabled, so you get good performance without the hassle of having to deploy the WAR file elsewhere.

WAR file

When it comes down to it, current java infrastructures almost mandate that web applications are deployed common approach to Grails application deployment in production. Creating a WAR file is as simple as exe

```
grails war
```

There are also many ways in which you can customise the WAR file that is created. For example, you relative) to the command that instructs it where to place the file and what name to give it:

```
grails war /opt/java/tomcat-5.5.24/foobar.war
```

Alternatively, you can add a line to `grails-app/conf/BuildConfig.groovy` that changes the de

```
grails.project.war.file = "foobar-prod.war"
```

Any command line argument that you provide overrides this setting.

It is also possible to control what libraries are included in the WAR file, for example to avoid conflicts v default behavior is to include in the WAR file all libraries required by Grails, plus any libraries contain libraries contained in the application's "lib" directory. As an alternative to the default behavior you can libraries to include in the WAR file by setting the property `grails.war.dependencies` in BuildCon patterns or closures containing AntBuilder syntax. Closures are invoked from within an Ant "copy" step included, whereas each item in a pattern list is included. Any closure or pattern assigned to the latter pı `grails.war.dependencies`.

Be careful with these properties: if any of the libraries Grails depends on are missing, the applicatior example that includes a small subset of the standard Grails dependencies:

```
def deps = [
    "hibernate3.jar",
    "groovy-all-*.jar",
    "standard-${servletVersion}.jar",
    "jstl-${servletVersion}.jar",
    "oscache-*.jar",
    "commons-logging-*.jar",
    "sitemesh-*.jar",
    "spring-*.jar",
    "log4j-*.jar",
    "ognl-*.jar",
    "commons-*.jar",
    "xstream-1.2.1.jar",
    "xpp3_min-1.1.3.4.O.jar" ]

grails.war.dependencies = {
    fileset(dir: "libs") {
        for (pattern in deps) {
            include(name: pattern)
        }
    }
}
```

This example only exists to demonstrate the syntax for the properties. If you attempt to use it as is in you probably not work. You can find a list of dependencies required by Grails in the "dependencies.txt" file distribution. You can also find a list of the default dependencies included in WAR generation ir `DEFAULT_DEPS` and `DEFAULT_J5_DEPS` variables.

The remaining two configuration options available to you are `grails.war.copyToWebApp` and `gra` these lets you customise what files are included in the WAR file from the "web-app" directory. The secor want before the WAR file is finally created.

```
// This closure is passed the command line arguments used to start the
// war process.
grails.war.copyToWebApp = { args ->
    fileset(dir:"web-app") {
        include(name: "js/**")
        include(name: "css/**")
        include(name: "WEB-INF/**")
    }
}

// This closure is passed the location of the staging directory that
// is zipped up to make the WAR file, and the command line arguments.
// Here we override the standard web.xml with our own.
grails.war.resources = { stagingDir, args ->
    copy(file: "grails-app/conf/custom-web.xml",
         tofile: "${stagingDir}/WEB-INF/web.xml")
}
```

Application servers

Ideally you should be able to simply drop a WAR file created by Grails into any application server and i things are rarely ever this simple. The Grails website contains an up-to-date list of application servers that any additional steps required to get a Grails WAR file working.