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# The Grails Framework - Reference Documentation

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# 1 Introduction

Java web development as it stands today is dramatically more complicated than it needs to be. Most modern Java space 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 building web applications. Grails builds on these concepts and dramatically reduces the complexity of building web applications. What makes it different, however, is that it does so by building on already established Java technologies like Hibernate.

Grails is a full stack framework and attempts to solve as many pieces of the web development puzzle through its 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 Domain Specific Languages (DSLs)

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

## 1.1 What's new in Grails 2.4?

### Groovy 2.3

Grails 2.4 comes with Groovy 2.3 which includes many new features and enhancements.

For more information on Groovy 2.3, see the [comprehensive release notes](#).

### Spring 4.0

Grails 2.4 comes with Spring 4.0.4 which includes many new features and enhancements. See the [Spring 4.0.4 release notes](#).

### Hibernate 4.3

Grails 2.4 now uses Hibernate 4.3.5 by default (Hibernate 3 is still available as an optional install).

### Standalone GORM and GSP

GORM and GSP can now be used outside of Grails. See the following guides / examples for more information.

- [Accessing Data with GORM](#)
- [Accessing MongoDB Data with GORM](#)
- [GSP in Spring Boot Example Application](#)

## The Asset-Pipeline replaces Resources to serve static assets.

The asset-pipeline provides a new, easier to manage, faster means of managing your JavaScript, CSS bringing compiled client languages in to the fray as first-class citizens (e.g. CoffeeScript, LESS, SASS).

All your assets should now live in the `grails-app/assets` subfolders. Three folders are made for you

- javascript
- stylesheets
- images

Now, defining manifests are done directly in your JavaScript files, or CSS by using require directives!

```
//= require jquery
//= require_self
//= require file_a
//= require_tree .

console.log('some javascript');
```

Easily add your assets to your GSP files:

```
<asset:javascript src="application.js"/>
<asset:stylesheet href="application.css"/>
<asset:image src="grails_logo.png" height="60" />
```

Enjoy developing with on the fly asset processing, asset compiling on WAR, and much more. See the [docs](#)

## Static Compilation

Groovy is a dynamically dispatched, dynamically typed language by default but also has great support for static compilation. See [these notes on Groovy static compilation](#). In general, Grails supports Groovy's static compilation. There are a lot of special situations which are common in a Grails app which cannot be statically compiled. If a code block is marked with `@CompileStatic` contains code which invokes a GORM dynamic finder the code will be statically compiled. The Groovy compiler cannot verify that the dynamic finder is valid. Grails 2.4 improves on this by allowing static compilation and still do things like invoke GORM dynamic finders.

The [grails.compiler.GrailsCompileStatic](#) annotation behaves much like the [groovy.transform.CompileStatic](#) provides special handling to recognize Grails specific constructs.

The following controller is marked with `@GrailsCompileStatic`. All of the code that can be statically compiled. When the compiler encounters code which can not be statically validated, normal compile error. The Grails compiler will allow certain things to be considered valid and dynamically dispatched.

```
// grails-app/controllers/com/demo/PersonController.groovy
package com.demo

import grails.compiler.GrailsCompileStatic

@GrailsCompileStatic
class PersonController {

    def showKids() {
        def kids = Person.findAllByAgeLessThan(16)

        // ...
    }
}
```

There may be situations where most of the code in a class should be statically compiled but a specific dynamic compilation. See the following example.

```
import grails.compiler.GrailsCompileStatic
import groovy.transform.TypeCheckingMode

@GrailsCompileStatic
class SomeClass {

    def update() {
        // this method will be statically compiled
    }

    @GrailsCompileStatic(TypeCheckingMode.SKIP)
    def save() {
        // this method will not be statically compiled
    }

    def delete() {
        // this method will be statically compiled
    }
}
```

The [grails.compiler.GrailsTypeChecked](#) annotation behaves much like the [groovy.transform.TypeChecked](#) provides special handling to recognize Grails specific constructs.

See the [static compilation and type checking](#) section for more details.

## More Advanced Subqueries in GORM

The support for subqueries has been extended. You can now use `in` with nested subqueries:

```
def results = Person.where {
  firstName in where { age < 18 }.firstName
}.list()
```

Criteria and where queries can be seamlessly mixed:

```
def results = Person.withCriteria {
  notIn "firstName", Person.where { age < 18 }.firstName
}
```

Subqueries can be used with projections:

```
def results = Person.where {
  age > where { age > 18 }.avg('age')
}
```

Correlated queries that span two domain classes can be used:

```
def employees = Employee.where {
  region.continent in ['APAC', "EMEA"]
}.id()

def results = Sale.where {
  employee in employees && total > 100000
}.employee.list()
```

And support for aliases (cross query references) using simple variable declarations has been added to wher

```

def query = Employee.where {
  def em1 = Employee
  exists Sale.where {
    def s1 = Sale
    def em2 = employee
    return em2.id == em1.id
  }.id()
}
def results = query.list()

```

## GORM for Hibernate in Unit tests

It is no longer necessary to create integration tests in order to test GORM interactions with Hibernate. You can use `HibernateTestMixin`:

```

import grails.test.mixin.TestMixin
import grails.test.mixin.gorm.Domain
import grails.test.mixin.hibernate.HibernateTestMixin
import spock.lang.Specification

@Domain(Person)
@TestMixin(HibernateTestMixin)
class PersonSpec extends Specification {

  void "Test count people"() {
    expect: "Test execute Hibernate count query"
    Person.count() == 0
    sessionFactory != null
    transactionManager != null
    session != null
  }
}

```

This library dependency is required in `grails-app/conf/BuildConfig.groovy` for adding support for Hibernate

```

dependencies {
  test "org.grails:grails-datastore-test-support:1.0-grails-2.4"
}

```

`HibernateTestMixin` is only supported with `hibernate4` plugin versions `>= 4.3.5.4`.

```
plugins {  
    runtime ':hibernate4:4.3.5.4'  
}
```

## Views For Namespaced Controllers

The views for namespaced controllers may now be defined in the `grails-app/name>/<controller name>/` directory. See the [Models And Views](#) section for more details.

## Improved Programmatic Transactions

Transaction attributes may now be specified when invoking `withTransaction`.

```
// the keys in the Map must correspond to properties  
// of org.springframework.transaction.support.DefaultTransactionDefinition  
Account.withTransaction([propagationBehavior: TransactionDefinition.PROPROPAGATION_R  
                        isolationLevel: TransactionDefinition.ISOLATION_REPEATAB  
    // ...  
})
```

See the [withTransaction](#) docs for more information.

## New Maven Plugin

The Maven plugin has been rewritten to use [Aether for dependency resolution](#) and can now be used with Grails 2.4.x without releasing a new version of the plugin.

This means that the Maven plugin version number is no longer tied to the version number of Grails and no plugin will not come out with each new Grails release. Instead, users can continue to use the 2.4.0 version of Grails going forward.

## Unit Testing improvements

There is a Grails "unit testing runtime" that is based on the previous TestMixin based solution. It now classes and the actual runtime that handles the lifecycle of the Grails unit testing runtime. State of the run fields of the TestMixin classes anymore. The Groovy AST transformation behind the TestMixin annotation Spock test classes by adding JUnit Rule fields to the class. In the previous solution, Before/BeforeClass annotations on AST added mix-in methods were used for the integration.

Some of the main features:

- The programming model remains the same for unit testing of Grails applications
- Setup/teardown method ordering is now deterministic because the integration is now using a single test runtime uses eventing internally to setup and teardown resources
- There are `doWithSpring` and `doWithConfig` callbacks for unit tests - these callback method `grailsApplication` instance in the unit test runtime gets initialized.
- It's possible to register a Spock Mock as a bean to the application context of the Grails unit test runtime to replace a collaborator bean with a mock
- It's possible to reuse a single application context for several test classes and control that so that tests are required
- The Grails unit testing runtime has an event-based plugin architecture. It's possible to add new test runtime plugin classes. The test runtime plugin API is due to change. Changes will be made by the Grails community. The main interfaces of the API are currently documented in the [TestEventInterceptor](#) and [TestEvent](#). Custom test plugins are currently limited since there isn't a standard set of available test plugins. It's now possible to add custom test plugins in a static initialization block call [TestRuntimeFactory.addPluginClass](#).

See the updated [unit testing chapter](#) in the manual for more information of the new features like `doWithSpring`.

## Improved Unit Testing Support For `allowedMethods`

The `allowedMethods` property is now respected in unit tests.

```
// grails-app/controllers/com/demo/DemoController.groovy
package com.demo

class DemoController {
    static allowedMethods = [save: 'POST', update: 'PUT', delete: 'DELETE']

    def save() {
        render 'Save was successful!'
    }

    // ...
}
```



```
// test/unit/com/demo/DemoControllerSpec.groovy
package com.demo

import grails.test.mixin.TestFor
import spock.lang.Specification
import static javax.servlet.http.HttpServletResponse.*

@TestFor(DemoController)
class DemoControllerSpec extends Specification {

    void "test a valid request method"() {
        when:
            request.method = 'POST'
            controller.save()

        then:
            response.status == SC_OK
            response.text == 'Save was successful!'
    }

    void "test an invalid request method"() {
        when:
            request.method = 'DELETE'
            controller.save()

        then:
            response.status == SC_METHOD_NOT_ALLOWED
    }
}
```

## 1.2 What's new in Grails 2.3?

### Improved Dependency Management

The default dependency resolution engine used by Grails has been changed to [Aether](#), the dependency resolution engine from Apache Maven. Which engine you use can be configured in BuildConfig:

```
grails.project.dependency.resolver = "maven" // or ivy
```

Using Aether dependency resolution in Grails results in the same behavior as when using the Maven build system, including snapshot handling, understanding of custom packaging types and so on.

In addition, the [dependency-report](#) command has been updated to print the dependency graph of the project, which is useful for diagnosing dependency resolution failures. See the chapter on [Dependency Resolution](#) for more information.

### Data Binder

Grails 2.3 includes a new data binding mechanism which is more flexible and easier to maintain than previous versions. The new data binder includes numerous enhancements including:

- Custom date formats on a per field basis using [BindingFormat](#)
- User defined data converters using [ValueConverter](#)
- User defined formatted data converters using [BindingFormat](#) and [FormattedValueConverter](#)
- Custom binding on a per class basis using [BindUsing](#)
- Custom binding on a per field basis using [BindUsing](#)
- By default all blank and empty Strings will be converted to null during data binding (configurable)

See the [Data Binding](#) section for details.

The legacy data binder may be used by assigning `true` to the `grails.databinding.useSpring` in `grails-app/conf/Config.groovy`. Note that the legacy binder does not support any of the new data binder.

## Binding Request Body To Command Objects

If a request is made to a controller action which accepts a command object and the request includes a body and used to do data binding to the command object. This simplifies use cases where a request includes a example) that can be bound to a command object. See the [Command Objects](#) documentation for more details.

## Domain Classes As Command Objects

When a domain class is used as a command object and there is an `id` request parameter, the framework will retrieve the domain class from the database using the `id` request parameter. See the [Command Objects](#) documentation for more details.

## Forked Execution

All major commands can now be forked into a separate JVM, thus isolating the build path from the run execution can be controlled via the `BuildConfig`:

```
grails.project.fork = [
  test: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256, daemon:true]
  settings for the test-app JVM
  run: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256], // configure
run-app JVM
  war: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256], // configure
run-war JVM
  console: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256]// configure
the Console UI JVM
]
```

See the documentation on [Forked Mode](#) for more information.

## Test Runner Daemon

To speed up testing when using forked execution a new daemon will start-up in the background to run tests. You can restart the daemon with the `restart-daemon` command from interactive mode:

```
$ grails> restart-daemon
```

## Server-Side REST Improvements

Grails' [REST support](#) has been significantly improved with the addition of the following features:

- Rich [REST URL Mapping support](#) with supports for resource mappings, singular resource mappings, versioning and more
- New extensible response rendering and binding APIs
- Support for HAL, Atom and Hypermedia (HATEOAS)
- Scaffolding for REST controllers

See the [user guide](#) for more information.

## New Scaffolding 2.0 Plugin

Grails' Scaffolding feature has been split into a [separate plugin](#). Version 2.0 of the plugin includes support for REST controllers, Async controllers, and Spock unit tests.

## URL Mappings May Specify A Redirect

URL Mappings may now specify that a redirect should be triggered when the mapping matches an incoming request.

```
class UrlMappings {
    static mappings = {
        "/viewBooks"(redirect: '/books/list')
        "/viewAuthors"(redirect: [controller: 'author', action: 'list'])
        "/viewPublishers"(redirect: [controller: 'publisher', action: 'list', params: {page: 1}])
    }
}
```

See the [user guide](#) for more information.

## Async support

Grails 2.3 features new [Asynchronous Programming APIs](#) that allow for asynchronous processing c seamlessly with GORM. Example:

```
import static grails.async.Promises.*
...
def index() {
    tasks books: Book.async.list(),
          totalBooks: Book.async.count(),
          otherValue: {
              // do hard work
          }
}
```

See [the documentation](#) for further information.

## Encoding / Escaping Improvements

Grails 2.3 features dedicated support for [Cross Site Scripting \(XSS\) prevention](#), including :

- Defaulting to HTML escaping all GSP expressions and scriptlets
- Context sensitive encoding switching for tags
- Double encoding prevention
- Optional automatic encoding of all data in a GSP page not considered safe

See the documentation on [Cross Site Scripting \(XSS\) prevention](#) for more information.

## Hibernate 3 and 4 support

The GORM for Hibernate 3 support for Grails has been extracted into a separate project, allowing new su separate plugin.

## Controller Exception Handling

Controllers may define exception handler methods which will automatically be invoked any time an action throws an exception.

```
// grails-app/controllers/demo/DemoController.groovy
package demo

class DemoController {
    def someAction() {
        // do some work
    }

    def handleSQLException(SQLException e) {
        render 'A SQLException Was Handled'
    }

    def handleBatchUpdateException(BatchUpdateException e) {
        redirect controller: 'logging', action: 'batchProblem'
    }

    def handleNumberFormatException(NumberFormatException nfe) {
        [problemDescription: 'A Number Was Invalid']
    }
}
```

See the [controller exception handling](#) docs for more information.

## Namespaced Controllers

Controllers may now be defined in a namespace which allows for multiple controllers to be defined with the same package.

```
// grails-app/controllers/com/app/reporting/AdminController.groovy
package com.app.reporting

class AdminController {
    static namespace = 'reports'

    // ...
}
```

```
// grails-app/controllers/com/app/security/AdminController.groovy
package com.app.security

class AdminController {
    static namespace = 'users'

    // ...
}
```

```
// grails-app/conf/UrlMappings.groovy
class UrlMappings {

    static mappings = {
        '/userAdmin' {
            controller = 'admin'
            namespace = 'users'
        }

        '/reportAdmin' {
            controller = 'admin'
            namespace = 'reports'
        }

        "$namespace/$controller/$action?"()
    }
}
```

```
<g:link controller="admin" namespace="reports">Click For Report Admin</g:link>
<g:link controller="admin" namespace="users">Click For User Admin</g:link>
```

See the [namespaced controllers](#) docs for more information.

## Command Line

The `create-app` command will now by default generate the command line rails wrapper for newly created apps. The `--skip-wrapper` switch may be used to prevent the wrapper from being generated.

```
rails create-app appname --skip-wrapper
```

## 1.3 What's new in Grails 2.2?

### Namespace Support

Grails 2.2 includes improved support for managing naming conflicts between artifacts provided by an application.

Bean names for Service artifacts provided by a plugin are now prefixed with the plugin name. For example, `com.publishing.AuthorService` is provided by a plugin named `PublishingUtilities` and `com.bookutils.AuthorService` is provided by a plugin named `BookUtilities`, the bean names will be `publishingUtilitiesAuthorService` and `bookUtilitiesAuthorService` respectively. If a Service artifact does not have a name which conflicts with any other Service, then a bean alias will automatically be generated. The alias will not contain the prefix and the alias will refer to the bean referenced by the prefixed name. Service artifact names in application configuration will have no prefix added to the relevant bean name. See the [dependency injection and services](#) docs for more information.

Domain classes provided by a plugin will have their default database table name prefixed with the plugin name. The `grails.gorm.table.prefix.enabled` config property is set to `true`. For example, if the `PublishingUtilities` plugin provides a domain class named `Book`, the default table name for that domain class will be `PUBLISHING_UTILITIES_BOOK` if the `grails.gorm.table.prefix.enabled` config property is set to `true`.

URL Mappings may now include a `plugin` attribute to indicate that the controller referenced in the mapping is provided by a specific plugin.

```
static mappings = {
    // requests to /bookAuthors will be handled by the
    // AuthorController provided by the BookUtilities plugin
    "/bookAuthors" {
        controller = 'author'
        plugin = 'bookUtilities'
    }

    // requests to /publishingAuthors will be handled by the
    // AuthorController provided by the Publishing plugin
    "/publishingAuthors" {
        controller = 'author'
        plugin = 'publishing'
    }
}
```

See the [namespaced controllers](#) docs for more information.

Controller methods and GSP Tags which accept a controller name as a parameter now support an optional `plugin` attribute to indicate that the controller is provided by a specific plugin.

```
<g:link controller="user" plugin="springSecurity">Manage Users</g:link>
```

```
class DemoController {
    def index() {
        redirect controller: 'user', action: 'list', plugin: 'springSecurity'
    }
}
```

## Forked Tomcat Execution

Grails 2.2 supports forked JVM execution of the Tomcat container in development mode. This has several

- Reduced memory consumption, since the Grails build system can exit
- Isolation of the build classpath from the runtime classpath
- The ability to deploy other Grails/Spring applications in parallel without conflicting dependencies

See the [documentation](#) on using forked mode for more information.

## SQL Projections In Criteria Queries

Grails 2.2 adds new functionality to criteria queries to provide access to Hibernate's SQL projection API.

```
// Use SQL projections to retrieve the perimeter and area of all of the Box instances
def c = Box.createCriteria()

def results = c.list {
    projections {
        sqlProjection '(2 * (width + height)) as perimeter, (width * height) as area' as 'area', [INTEGER, INTEGER]
    }
}
```

See the [Criteria](#) section for more information.

## Groovy 2

Grails 2.2 ships with Groovy 2.0, which has a [bunch of new features](#) itself.

## 1.4 What's new in Grails 2.1?

### Maven Improvements / Multi Module Build Support

Grails' Maven support has been improved in a number of significant ways. Firstly it is now possible to specify a `pom.xml` file:



```
<dependency>
  <groupId>org.grails.plugins</groupId>
  <artifactId>hibernate</artifactId>
  <version>2.1.0</version>
  <type>zip</type>
  <scope>compile</scope>
</dependency>
```

The Maven plugin now resolves plugins as well as jar dependencies (previously jar dependencies were plugins by Ivy). Ivy is completely disabled leaving all dependency resolution up to Maven ensuring expected.

There is also a new Grails `create-multi-project-build` script which features initial support for 1 (a future release). This script can be run from a parent directory containing Grails applications and plugins. This is a Maven multi-module build.

Enabling Maven in a project has been made easier with the inclusion of the `create-pom` command:

```
grails create-app myapp
cd myapp
grails create-pom com.mycompany
mvn package
```

To create a multi-module Maven build follow these steps:

```
grails create-app myapp
grails create-plugin plugin-a
grails create-plugin plugin-b
grails create-multi-project-build com.mycompany:parent:1.0-SNAPSHOT
mvn install
```

## Grails Wrapper

The Grails Wrapper allows a Grails application to build without having to install Grails and configure an environment variable. The wrapper includes a small shell script and a couple of small bootstrap jar files checked in to source code control along with the rest of the project. The first time the wrapper is executed it will configure a Grails installation. This wrapper makes it more simple to setup a development environment, upgrade to future versions of Grails. When the application is upgraded to the next version of Grails, the wrapper is checked in to the source code control system and the next time developers update their workspace and run the wrapper it will automatically be using the correct version of Grails.

See the [Wrapper Documentation](#) for more details.

## Debug Option

The `grails` command now supports a `-debug` option which will startup the remote debug agent. `grails-debug` is still available but is deprecated and will be removed in a future release.

```
grails -debug run-app
```

## Grails Command Aliases

The `alias` command may be used to define aliases for grails commands.

The following command creates an alias named `rit` (short for "run integration tests"):

```
grails alias rit test-app integration:
```

See the [alias](#) docs for more info.

## Cache Plugin

Grails 2.1 installs the [cache plugin](#) by default. This plugin provides powerful and easy to use cache function plugins. The main plugin provides basic map backed caching support. For more robust caching options other plugins should be installed and configured. See the [cache-redis docs](#) and the [cache-ehcache docs](#) for details.

See [the main plugin documentation](#) for details on how to configure and use the plugin.

## New GORM Methods

In Grails 2.1.1 domain classes now have static methods named `first` and `last` to retrieve the first and last record in the datastore. See the [first](#) and [last](#) documentation for details.

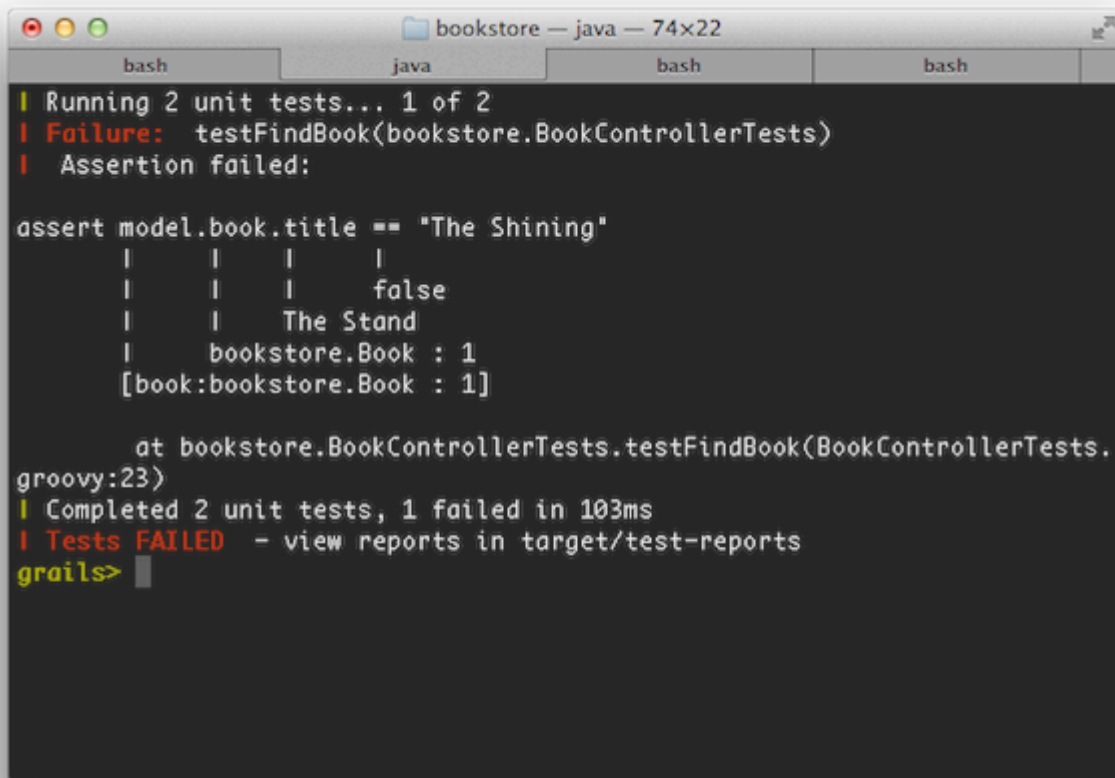
## 1.5 What's new in Grails 2.0?

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

## 1.5.1 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 example when running tests can be seen below:

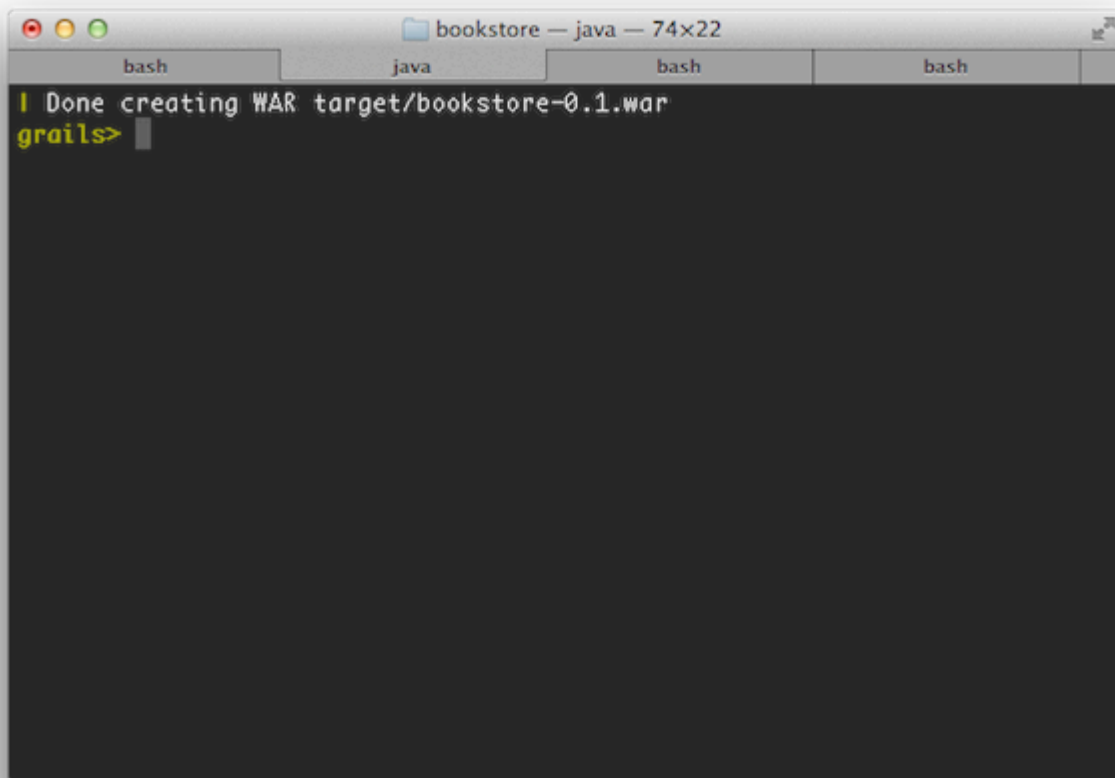
A screenshot of a Grails console window titled 'bookstore — java — 74x22'. The window has four tabs labeled 'bash', 'java', 'bash', and 'bash'. The console output shows the results of running 2 unit tests. The first test, 'testFindBook', failed. The failure message is 'Assertion failed: assert model.book.title == "The Shining"'. The console shows a comparison of 'The Shining' with 'The Stand', resulting in 'false'. The stack trace indicates the failure occurred in 'bookstore.BookControllerTests.testFindBook'. The console also shows that 2 unit tests were completed in 103ms, with 1 failed. The final output is 'Tests FAILED - view reports in target/test-reports' followed by the 'grails>' prompt.

```
| Running 2 unit tests... 1 of 2
| Failure: testFindBook(bookstore.BookControllerTests)
| Assertion failed:

assert model.book.title == "The Shining"
|           |           |           |
|           |           |           | false
|           |           |           | The Stand
|           |           |           | bookstore.Book : 1
|           |           |           | [book:bookstore.Book : 1]

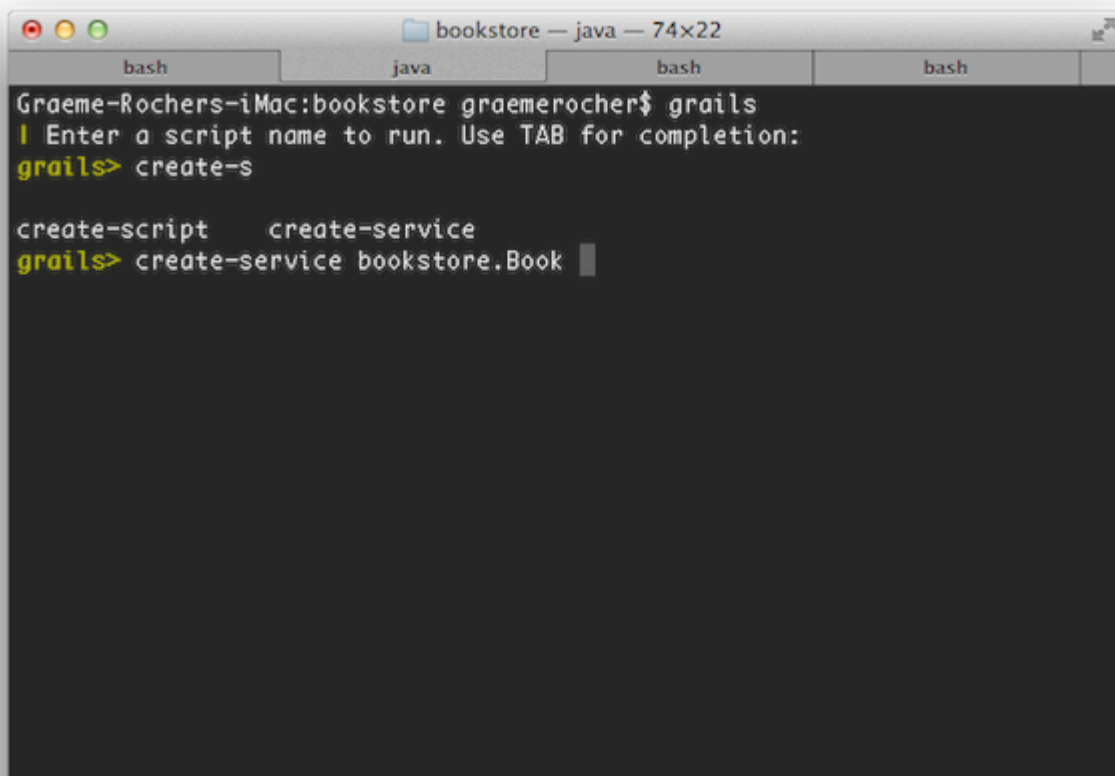
      at bookstore.BookControllerTests.testFindBook(BookControllerTests.
groovy:23)
| Completed 2 unit tests, 1 failed in 103ms
| Tests FAILED - view reports in target/test-reports
grails>
```

In general Grails makes its best effort to display update information on a single line and only present the information when it changes. This means that while in previous versions of Grails the [war](#) command produced many lines of output, in Grails 2.0 the output is produced:

A terminal window titled 'bookstore — java — 74x22' with tabs for 'bash', 'java', 'bash', and 'bash'. The terminal shows the message 'Done creating WAR target/bookstore-0.1.war' and the prompt 'grails>' with a cursor.

```
bookstore — java — 74x22
bash java bash bash
Done creating WAR target/bookstore-0.1.war
grails>
```

In addition simply typing 'grails' at the command line activates the new interactive mode which features command history and keeps the JVM running to ensure commands execute much quicker than otherwise

A terminal window titled 'bookstore — java — 74x22' with tabs for 'bash', 'java', 'bash', and 'bash'. The terminal shows the command 'grails' being entered, followed by the prompt 'Enter a script name to run. Use TAB for completion:', then 'grails> create-s', and finally 'grails> create-service bookstore.Book' with a cursor.

```
bookstore — java — 74x22
bash java bash bash
Graeme-Rochers-iMac:bookstore graemerocher$ grails
Enter a script name to run. Use TAB for completion:
grails> create-s

create-script    create-service
grails> create-service bookstore.Book
```

For more information on the new features of the console refer to the section of the user guide that covers the [mode](#).

## Reloading Agent

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

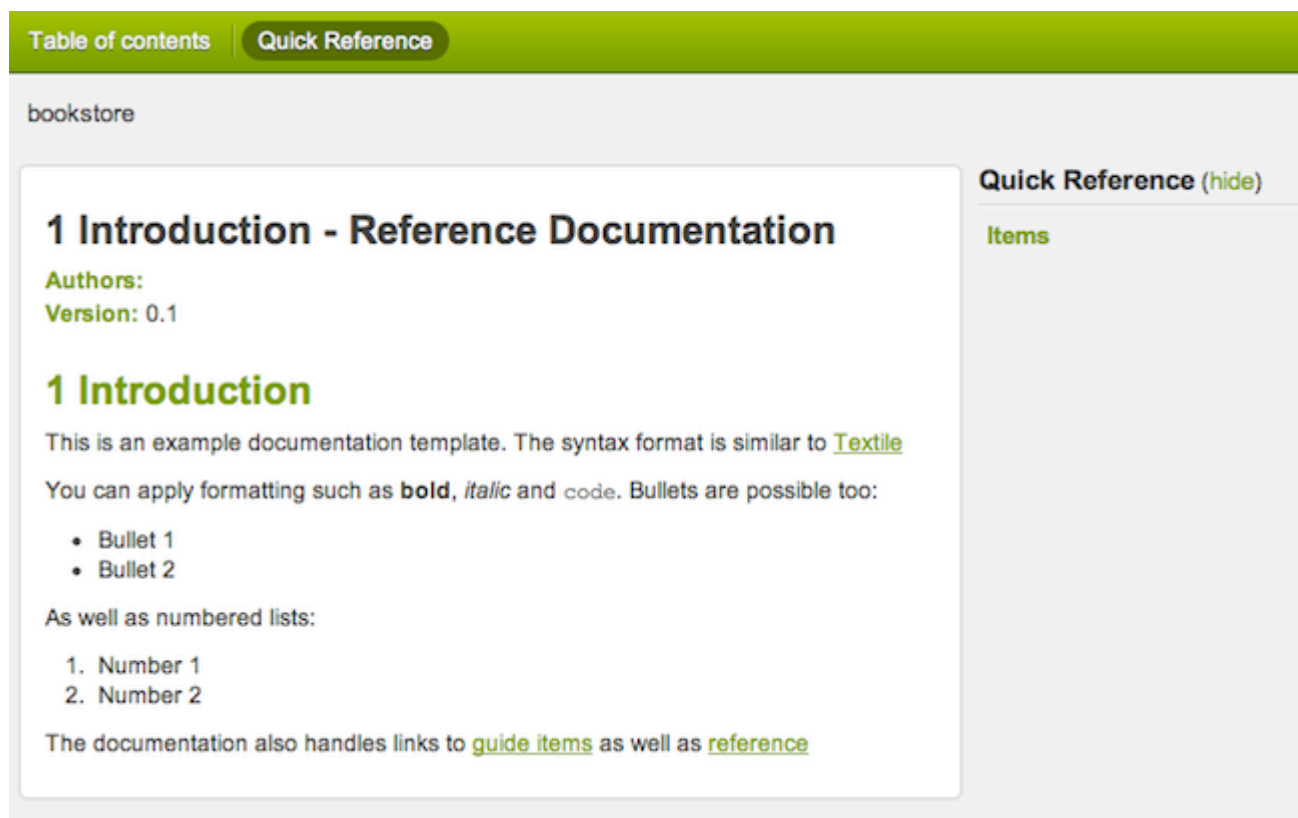
## New Test Report and Documentation Templates

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



The screenshot shows a test report for 'BookControllerTests' under the package 'bookstore'. It indicates that a single test, 'testFindBook', was executed with one failure. The failure message is: 'Assertion failed: assert model.book.title == "The Shining" | | | | | false | | The Stand | bookstore.Book : 1 [book:bookstore.Book : 1]'. The stack trace shows the error occurred in 'BookControllerTests.testFindBook' at line 23.

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



The screenshot shows a documentation page for the 'bookstore' plugin. It features a 'Table of contents' and a 'Quick Reference' section. The main content area is titled '1 Introduction - Reference Documentation' and includes authors, version (0.1), and a detailed introduction. The introduction text describes the documentation template and its syntax, including examples of bold, italic, code, and bulleted/numbered lists. It also mentions that the documentation handles links to 'guide items' and 'reference'.

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. Although it made it difficult to restructure your user guide by inserting new chapters and sections. In addition, a renaming of section titles 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 YAML described in the section on the [documentation engine](#). The logical names appear in the URLs, so as long as your URLs will always 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 analyses stack displays problem areas in your code:

 **GRAILS**

**Error 500: Internal Server Error**

**URI:** /bookstore/book/find  
**Class:** groovy.lang.MissingPropertyException  
**Message:** No such property: titl for class: bookstore.BookService

**Around line 6 of *grails-app/services/bookstore/BookService.groovy***

```
3: class BookService {
4:
5:     Book findByTitle(String title) {
6:         Book.findByTitle(titl)
7:     }
8: }
```

**Around line 10 of *grails-app/controllers/bookstore/BookController.groovy***

```
7:     def bookService
8:     def find() {
9:
10:         def b = bookService.findByTitle(params.title)
11:
12:         [book:b]
13:     }
```

**Trace**

Line	Method
->> 6	findByTitle in BookService.groovy
-----	
10	find in BookController.groovy
886	runTask . . in java.util.concurrent.ThreadPoolExecutor\$Worker
908	run in ''
^ 680	run . . . . in java.lang.Thread

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 development (dbconsole) so that the in-memory database can be easily queried from the browser:

The screenshot displays the H2 Database Console interface. At the top, there is a toolbar with icons for connection, auto-commit, max rows (set to 1000), and auto-complete (set to Normal). Below the toolbar, the left sidebar shows the database structure: jdbc:h2:mem:devDb, BOOK (with fields ID, VERSION, TITLE, and Indexes), INFORMATION\_SCHEMA, Sequences, and Users. The main area shows the SQL statement 'select \* from book;' with a table preview showing columns ID, VERSION, and TITLE, and a message '(no rows, 3 ms)'. Buttons for 'Run (Ctrl+Enter)', 'Clear', and 'Edit' are visible.

## Plugin Usage Tracking

To enhance community awareness of the most popular plugins an opt-in plugin usage tracking system users can 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 support plugins thus 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 `BuildConfig.groovy`.
- Plugins dependencies now appear in the dependency report generated by `grails dependency-report`.
- Plugins published with the release plugin now publish their transitive plugin dependencies in the `grails` later resolved.
- It is now possible to customize the ivy cache directory via `BuildConfig.groovy`

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

- You can change the ivy cache directory for all projects via `settings.groovy`

```
grails.dependency.cache.dir = "${userHome}/.ivy2/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
}
```



## 1.5.2 Core Features

### Binary Plugins

Grails plugins can now be packaged as JAR files and published to standard maven repositories. This even resources (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 example wh Grails environment called "production", a Spring profile of "production" is activated so that you configuration APIs to configure beans for a specific profile.

## 1.5.3 Web Features

### Controller Actions as Methods

It is now possible to define controller actions as methods instead of using closures as in previous version now the 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 For example 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 in automatic 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 the context of a controller. For example if you need to generate links in a service or an asynchronous ba scope of a request:

```
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 scope of a controller, as in a scheduled job or web service. The PageRenderer class features a very similar API to the render methods of the controllers:

```
grails.gsp.PageRenderer groovyPageRenderer

void welcomeUser(User user) {
    def contents = groovyPageRenderer.render(view: "/emails/welcomeLetter", model: user)
    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 which filter should be applied.

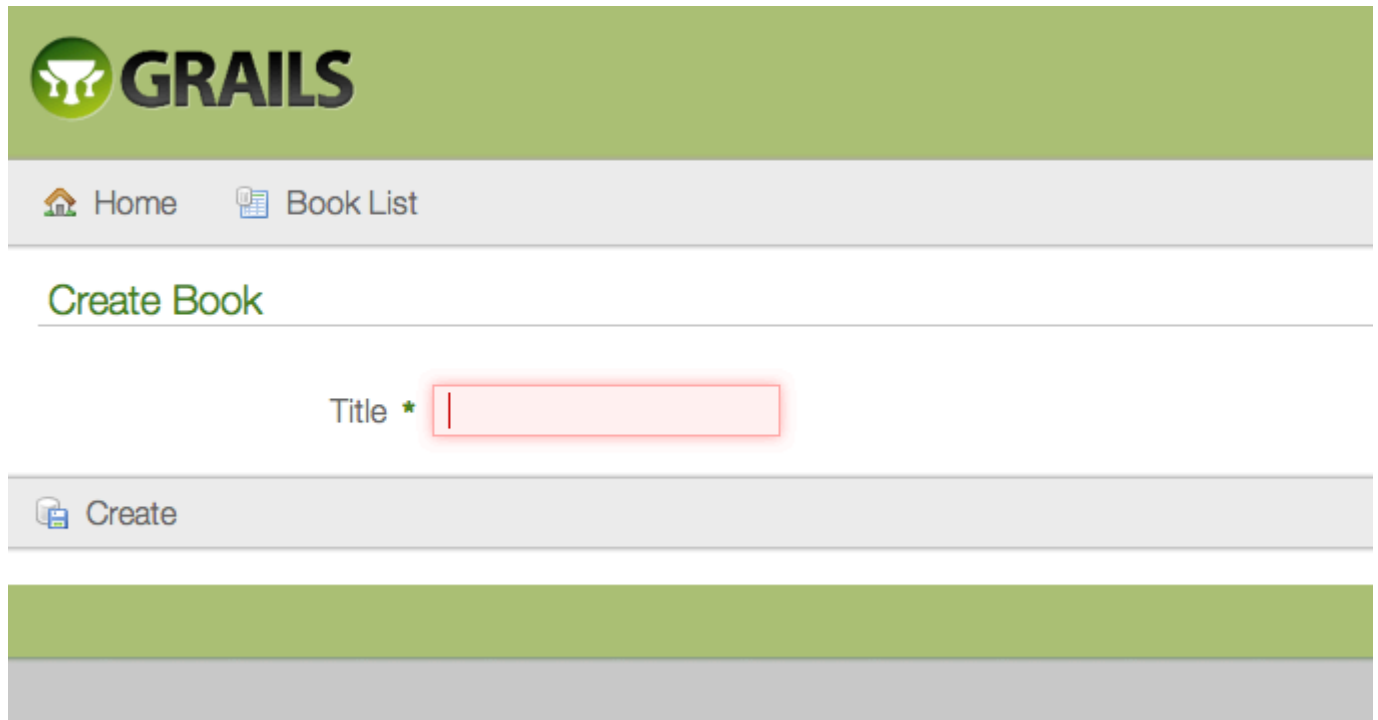
```
filter1(actionExclude: 'log*') {
    before = {
        // ...
    }
}
filter2(controllerExclude: 'auth') {
    before = {
        // ...
    }
}
filter3(uriExclude: '/secure*') {
    before = {
        // ...
    }
}
```

## Performance Improvements

Performance of GSP page rendering has once again been improved by optimizing the GSP compiler to its best possible.

## HTML5 Scaffolding

There is a new HTML5-based scaffolding UI:



The screenshot shows the Grails scaffolding UI for creating a new book. At the top, there is a green header with the Grails logo and the word "GRAILS". Below the header is a navigation bar with two links: "Home" (with a house icon) and "Book List" (with a book icon). The main content area has a green bar with the text "Create Book". Below this is a form with a label "Title \*" and a text input field. At the bottom of the form is a "Create" button with a document icon. The entire form is enclosed in a light gray border.

## jQuery by Default

The jQuery plugin is now the default JavaScript library installed into a Grails application. For backwards compatibility, the [jQuery plugin](#) is available. Refer to the [documentation](#) on the Prototype plugin for installation instructions.

## Easy Date Parsing

A new date method has been added to the params object to allow easy, null-safe parsing of dates:

```
def val = params.date('myDate', 'dd-MM-yyyy')  
  
// or a list for formats  
def val = params.date('myDate', ['yyyy-MM-dd', 'yyyyMMdd', 'yyMMdd'])  
  
// or the format read from messages.properties via the key 'date.myDate.format'  
def val = params.date('myDate')
```

## Customizable URL Formats

The default URL Mapping mechanism supports camel case names in the URLs. The default URL for `addNumbers` in a controller named `MathHelperController` would be something like `/mathHelper/addNumbers`. Grails allows for the customization of this pattern and provides an implementation which replaces the camel hyphenated convention that would support URLs like `/math-helper/add-numbers`. To enable this, set the value of `"hyphenated"` to the `grails.web.url.converter` property in `grails-app/conf/Config.groovy`.

```
// grails-app/conf/Config.groovy
grails.web.url.converter = 'hyphenated'
```

Arbitrary strategies may be plugged in by providing a class which implements the [UrlConverter](#) interface, and registering that class to the Spring application context with the bean name of `grails.web.UrlConverter.BEAN_NAME`. If a bean in the context with that name, it will be used as the default converter and there is no need to set the `grails.web.url.converter` config property.

```
// src/groovy/com/myapplication/MyUrlConverterImpl.groovy
package com.myapplication

class MyUrlConverterImpl implements grails.web.UrlConverter {
    String toUrlElement(String propertyOrClassName) {
        // return some representation of a property or class name that should be
    }
}
```

```
// grails-app/conf/spring/resources.groovy
beans = {
    "${grails.web.UrlConverter.BEAN_NAME}"(com.myapplication.MyUrlConverterImpl)
}
```

## Web Flow input and output

It is now possible to provide input arguments when calling a subflow. Flows can also return output values when calling flow.

## 1.5.4 Persistence Features

### The GORM API

The GORM API has been formalized into a set of classes ( `GormStaticApi`, `GormGormValidationApi`) that get statically wired into every domain class at the byte code level. This provides completion for IDEs, better integration with Java and the potential for more GORM implementations for other languages.

## Detached Criteria and Where Queries

Grails 2.0 features support for [DetachedCriteria](#) which are criteria queries that are not associated with a domain class and thus can be more easily reused and composed:

```
def criteria = new DetachedCriteria(Person).build {
    eq 'lastName', 'Simpson'
}
def results = criteria.list(max:4, sort:"firstName")
```

To support the addition of [DetachedCriteria](#) queries and encourage their use a new `where` method and `DS` greatly reduce the complexity of criteria queries:

```
def query = Person.where {
    (lastName != "Simpson" && firstName != "Fred") || (firstName == "Bart" && age > 10)
}
def results = query.list(sort:"firstName")
```

See the documentation on [DetachedCriteria](#) and [Where Queries](#) for more information.

## New findOrCreate and findOrSave Methods

Domain classes have support for the `findOrCreateWhere`, `findOrSaveWhere`, `findOrCreateBy` and `findOrSaveBy` which behave just like `findWhere` and `findBy` methods except that they should never return null. If a match is found in the database then a new instance is created, populated with values represented in the query parameters. In the case of `findOrSaveWhere` and `findOrSaveBy`, the instance is saved before being returned.

```
def book = Book.findOrCreateWhere(author: 'Douglas Adams', title: "The Hitchhiker's Guide to the Galaxy")
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 linking

```
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 domain uses by 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 as any regular 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 migration changes 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 to generate a domain model from an existing database schema.

## Hibernate 3.6

Grails 2.0 is now built on Hibernate 3.6

## Bag Collections

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

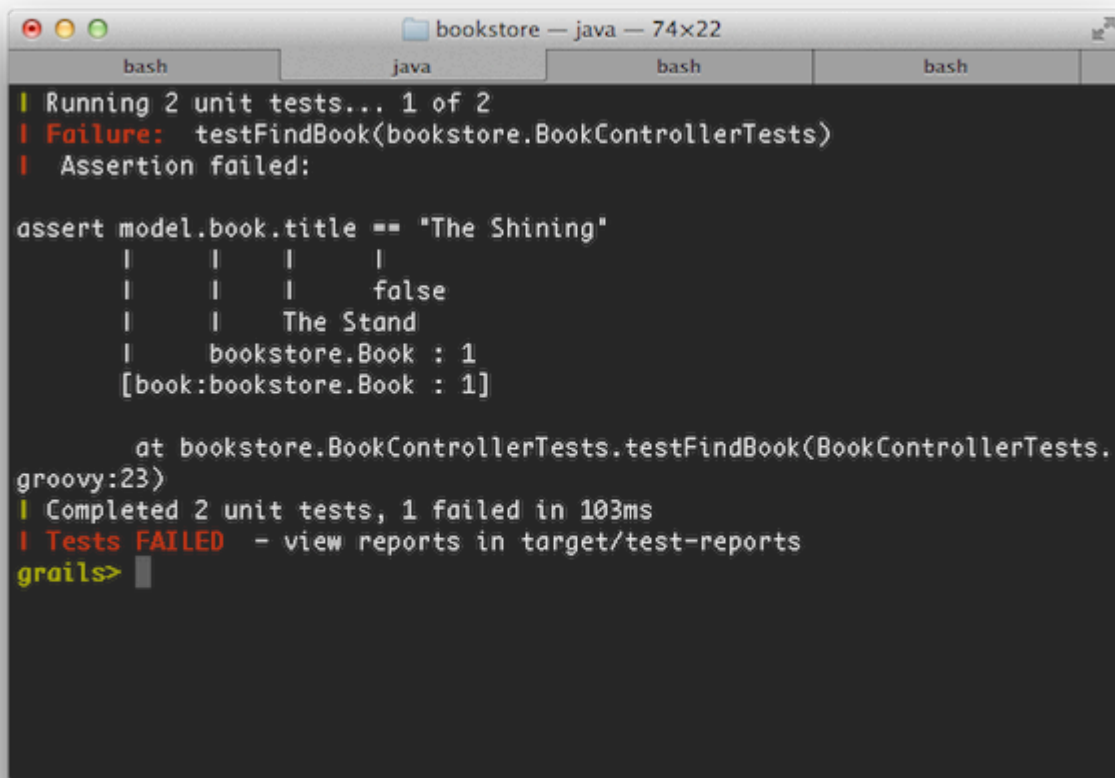
For more information see the section on [Sets, Lists and Maps](#) in the user guide.

## 1.5.5 Testing Features

### New Unit Testing Console Output

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





```
bookstore — java — 74x22
bash java bash bash
| Running 2 unit tests... 1 of 2
| Failure: testFindBook(bookstore.BookControllerTests)
| Assertion failed:
|
| assert model.book.title == "The Shining"
|      |      |      |
|      |      |      false
|      |      The Stand
|      bookstore.Book : 1
|      [book:bookstore.Book : 1]
|
| at bookstore.BookControllerTests.testFindBook(BookControllerTests.
groovy:23)
| Completed 2 unit tests, 1 failed in 103ms
| Tests FAILED - view reports in target/test-reports
grails>
```

## New Unit Testing API

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

```
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: criteria queries, 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 Installation Requirements

Before installing Grails you will need as a minimum a Java Development Kit (JDK) installed version 1.6 appropriate JDK for your operating system, run the installer, and then set up an environment variable call to the location of this installation. If you're unsure how to do this, we recommend the video in [grailsexample.net](http://grailsexample.net):

- [Windows](#)
- [Linux](#)
- [Mac OS X](#)

These will show you how to install Grails too, not just the JDK.

 A JDK is required in your Grails development environment. A JRE is not sufficient.

On some platforms (for example OS X) the Java installation is automatically detected. However in many cases you may need to manually configure the location of Java. For example:

```
export JAVA_HOME=/Library/Java/Home
export PATH="$PATH:$JAVA_HOME/bin"
```

if you're using bash or another variant of the Bourne Shell.

### 2.2 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 something like `GRAILS_HOME=/path/to/grails` to your profile
  - On Windows this is typically a matter of setting an environment variable in the Windows Computer/Advanced/Environment 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_HOME/bin"` to your profile
  - On Windows this is done by modifying the Path environment variable in the Windows Computer/Advanced/Environment Variables

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

```
Grails version: 2.0.0
```

## 2.3 Creating an Application

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

```
cd helloworld
```

## 2.4 A Hello World Example

Let's now take the new project and turn it into the classic "Hello world!" example. First, change into the "helloworld" directory just created and start the Grails interactive console:

```
$ cd helloworld  
$ grails
```

You should see a prompt that looks like this:

```
Graeme-Rochers-iMac:helloworld graemerocher$ grails
| Enter a script name to run. Use TAB for completion:
grails>
```

ctory created in the previous section and activate interactive mode:

What we want is a simple page that just prints the message "Hello World!" to the browser. In Grails, w page you just create a new controller action for it. Since we don't yet have a controller, let's cr [create-controller](#) command:

```
grails> create-controller hello
```

Don't forget that in the interactive console, we have auto-completion on command names. So you can t <tab> to get a list of all `create-*` commands. Type a few more letters of the command name and then <

The above command will create a new [controller](#) in the `grails-app/controllers/hello` `HelloController.groovy`. Why the extra `helloworld` directory? Because in Java land, it's stron classes are placed into packages, so Grails defaults to the application name if you don't provide one. [create-controller](#) provides more detail on this.

We now have a controller so let's add an action to generate the "Hello World!" page. The code looks like tl

```
package helloworld

class HelloController {
    def index() {
        render "Hello World!"
    }
}
```

The action is simply a method. In this particular case, it calls a special method provided by Grails to [rende](#) Job done. To see your application in action, you just need to start up a server with another command called

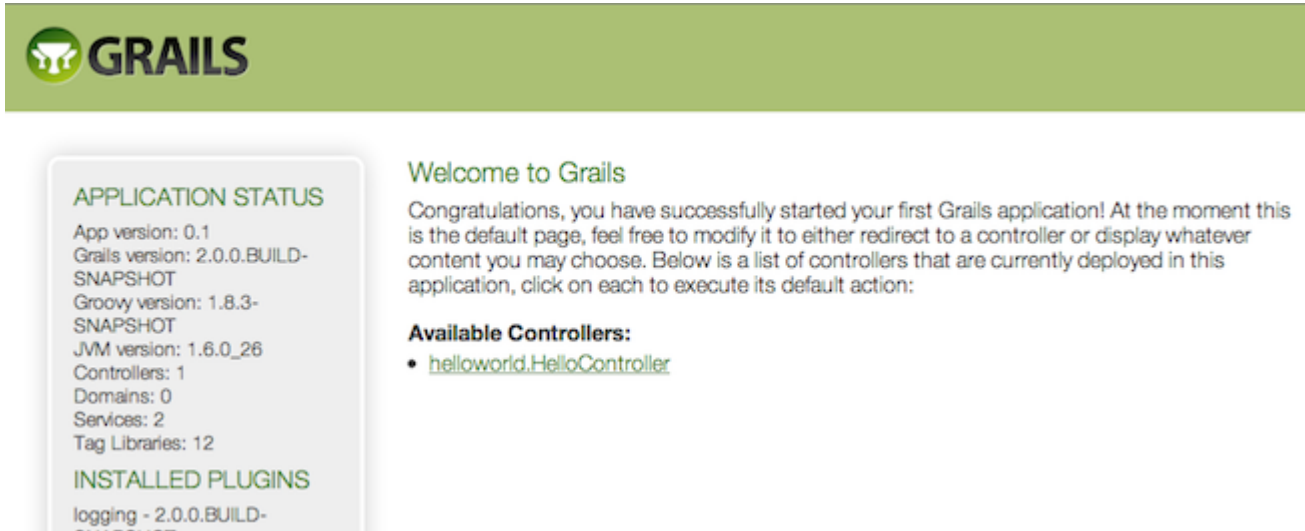
```
grails> run-app
```

This will start an embedded server on port 8080 that hosts your application. You should now be able to a the URL <http://localhost:8080/helloworld/> - try it!



If you see the error "Server failed to start for port 8080: Address already in use", then it means the server is running on that port. You can easily work around this by running your server on a different port using `-Dserver.port=9090 run-app`. '9090' is just an example: you can pretty much use anything within the range 1024 to 49151.

The result will look something like this:

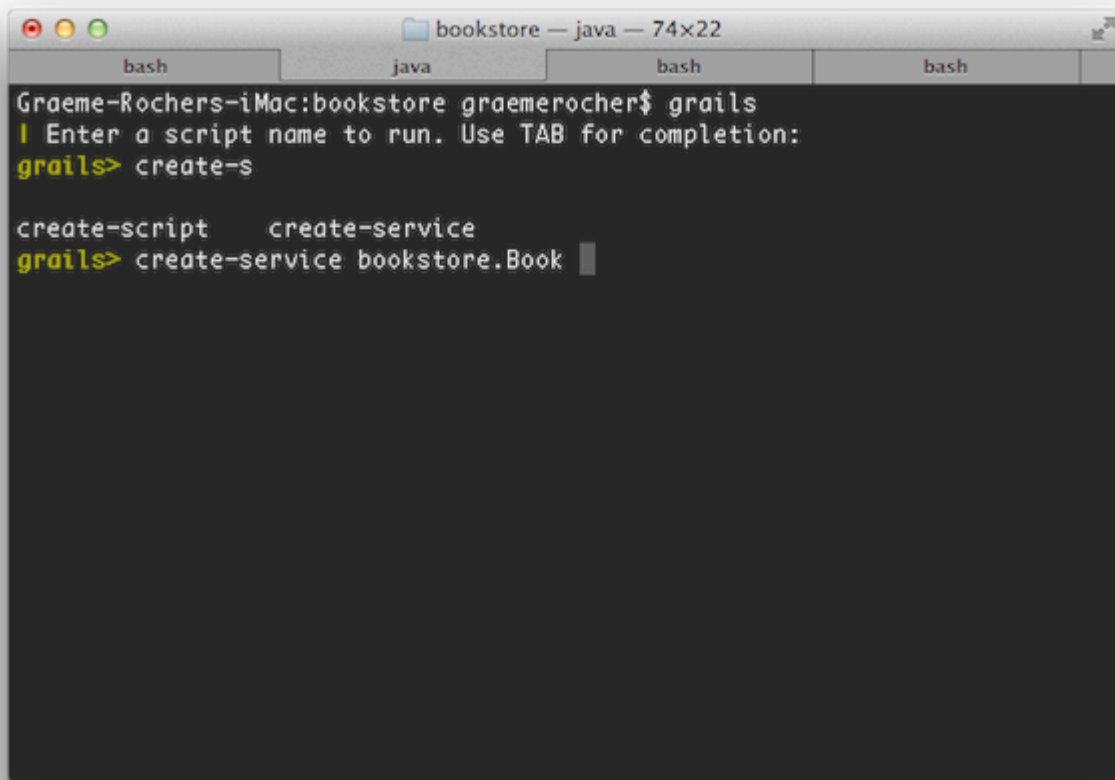


This is the Grails intro page which is rendered by the `grails-app/view/index.gsp` file. It detects available controllers and provides links to them. You can click on the "HelloController" link to see our custom "Hello World!". Voila! You have your first working Grails application.

One final thing: a controller can contain many actions, each of which corresponds to a different page (ignoring the controller name). Each page is accessible via a unique URL that is composed from the controller name, the action name, and the application name: `/<appname>/<controller>/<action>`. This means you can access the Hello World page via [/helloworld/hello](#). The controller name (remove the 'Controller' suffix from the class name and lower-case the first letter) is used for the controller part of the URL. But you can also access the page via the same URL without the action name: this is because 'index' is the default action. See the end of the [controllers and actions](#) section of the user guide to find out more on default actions.

## 2.5 Using Interactive Mode

Grails 2.0 features an interactive mode which makes command execution faster since the JVM doesn't have to start for each command. To use interactive mode simply type 'grails' from the root of any projects and use TAB to cycle through available commands. See the screenshot below for an example:

A screenshot of a terminal window titled 'bookstore — java — 74x22'. The window has four tabs labeled 'bash', 'java', 'bash', and 'bash'. The terminal shows the following commands and output:

```
Graeme-Rochers-iMac:bookstore graemerocher$ grails
! Enter a script name to run. Use TAB for completion:
grails> create-s

create-script    create-service
grails> create-service bookstore.Book
```

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 the [Grails](#) support on the JetBrains website for a feature overview.

IntelliJ IDEA comes in two flavours; the open source "Community Edition" and the commercial "Ultimate Edition". The Community Edition offers support for Groovy, but only Ultimate Edition offers Grails support.

With Ultimate Edition, there is no need to use the `grails integrate-with --intellij` command. IntelliJ IDEA understands Grails projects natively. Just open the project with `File -> New Project -> Create from existing sources`.

You can still use Community Edition for Grails development, but you will miss out on all the Grails specific features like classpath management, GSP editor and quick access to Grails commands. To integrate Grails with IntelliJ IDEA, use 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 [Groovy/Grails](#) built in support for Grails including automatic classpath management, a GSP editor and quick access to [STS Integration](#) page for an overview.

## NetBeans

NetBeans provides a Groovy/Grails plugin that automatically recognizes Grails projects and provides applications in the IDE, code completion and integration with the Glassfish server. For an overview of [Integration](#) guide on the Grails 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 1 Groovy/Grails bundle available from the [TextMate 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 following command from the root of your project:

```
mate .
```

## 2.7 Convention over Configuration

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

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 default:

```
grails run-app
```

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

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

Note that it is better to start up the application in interactive mode since a container restart is much quicker

```
$ grails
grails> run-app
| Server running. Browse to http://localhost:8080/helloworld
| Application loaded in interactive mode. Type 'stop-app' to shutdown.
| Downloading: plugins-list.xml
grails> stop-app
| Stopping Grails server
grails> run-app
| Server running. Browse to http://localhost:8080/helloworld
| Application loaded in interactive mode. Type 'stop-app' to shutdown.
| Downloading: plugins-list.xml
```

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 `test/integration` directory. It is of course up to you to populate these tests with valid test logic, info found in the section on [Testing](#).

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](#) task:

```
grails war
```

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

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

```
grails dev war
```



NEVER deploy Grails using the [run-app](#) command as this command sets Grails up for auto-runtime which has a severe performance and scalability implications

When deploying Grails you should always run your containers JVM with the `-server` option and allocation. A good 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 8
- Jetty 7
- Jetty 6
- Oracle Weblogic 10.3
- Oracle Weblogic 10
- Oracle Weblogic 9
- IBM WebSphere 8.5
- IBM WebSphere 8.0
- IBM WebSphere 7.0
- IBM WebSphere 6.1



It's required to set "-Xverify:none" in "Application servers > server > Process Definition > JVM Arguments" for older versions of WebSphere. This is no longer required for WebSphere version 8 or newer.

Some containers have bugs however, which in most cases can be worked around. A [list of known deployment issues](#) on the Grails wiki.

## 2.12 Creating Artefacts

Grails ships with a few convenience targets such as [create-controller](#), [create-domain-class](#) and so on that will create different artefact types for you.



These are just for your convenience and you can just as easily use an IDE or your favourite text editor.

For example to create the basis of an application you typically need a [domain model](#):

```
grails create-app helloworld
cd helloworld
grails create-domain-class book
```

This will result in the creation of a domain class at `grails-app/domain/helloworld/Book.gro`

```
package helloworld

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.

## 2.13 Generating an Application

To get started quickly with Grails it is often useful to use a feature called [Scaffolding](#) to generate the skeleton of an application. To do this use one of the `generate-*` commands such as [generate-all](#), which will generate a [controller](#) (and associated [views](#)):

```
grails generate-all helloworld.Book
```

## 3 Upgrading from Grails 2.2

A number of changes need to be considered when upgrading your application from Grails 2.2, some of which are listed below with more detail on each item following after:

- New improved data binding (no Spring property editors)
- Much improved XSS prevention with default HTML encoding
- A new dependency resolution engine
- Must be online to fetch Grails dependencies
- Grails core dependencies rearranged
- Tomcat and Hibernate plugins independently versioned now (breaking!)
- Scaffolding is now a separate plugin
- Spock included by default
- Dependency injection does not work in integration tests by default
- Forked execution for tests
- Reloading in `run-app` won't work by default on upgraded apps
- `grails-debug` doesn't work for forked execution

### New Data Binder

There is a new data binding mechanism written from the ground up to meet Grails' needs. If you wish to use the new data binding then you must set the `grails.databinding.useSpringBinder` property to `false` in `grails-app/conf/Config.groovy`.

### Encoding / Escaping (XSS) Changes

Grails 2.3 includes new features to help prevent XSS attacks. These are enabled by default for new applications. Existing applications will require manual intervention. See the section on [Cross Site Scripting \(XSS\) prevention](#) for more details on how to configure XSS prevention.

### Dependency Resolution changes

Although dependency resolution using Ivy is still supported, the default for Grails 2.3 is to use Aether and Maven. This will be improved upon going forward. You may wish to consider using Aether instead for your existing applications. Configure this in `grails-app/conf/BuildConfig.groovy`:

```
grails.project.dependency.resolver = "maven" // or ivy
```

If you need to authenticate to a maven repository, you will want to change the definition of that repository

```
mavenRepo("http://artifactory.mycompany.com/repo") {
    authentication(username: "myusername", password: "secret")
}
```

## Dependency Metadata Changes

In addition, the POM and dependency metadata for Grails 2.3 has been re-arranged and cleaned up so that are specified for an application and all other dependencies are inherited transitively. This has implications example, Ehcache is now a transitive dependency of the Hibernate plugin, whilst before it was a dir compilation error related to Ehcache, it is most likely that you don't have the Hibernate plugin installed and the Ehcache dependency:

```
compile "net.sf.ehcache:ehcache-core:2.4.6"
```

In addition, excludes may no longer work and may need adjusting when upgrading due to how the metadata is stored. See the [dependency-report](#) to see the new dependency metadata and make adjustments accordingly.

A common error that may occur when upgrading is:

```
| Configuring classpath
:: problems summary ::
::: WARNINGS
      ::::::::::::::::::::::::::::::::::::
      ::                UNRESOLVED DEPENDENCIES                ::
      ::::::::::::::::::::::::::::::::::::::
      :: org.springframework#spring-test;3.2.2.RELEASE: configuration not found in
org.springframework#spring-test;3.2.2.RELEASE: 'compile'. It was required from
org.grails#grails-plugin-testing;2.3.0.BUILD-SNAPSHOT compile
      ::::::::::::::::::::::::::::::::::::::
```

This is caused by a plugin that depends on an old version of `spring-test` (for example the [Mail plugin](#)).  
 grails dependency-report and search for plugins that have a transitive dependency on `spring-test`.  
 For example:

```

plugins {
  compile ':mail:1.0', {
    excludes 'spring-test'
  }
}

```

However, longer term to solve problems like this we recommend that users move away from Ivy and dependency resolution:

```

grails.project.dependency.resolver="maven"

```

## No initial offline mode with Aether

Aether does not support resolving dependencies from a flat file system. This means that the jars in `GRAILS_HOME/lib` are not used for the first resolve, but instead the jars are obtained from Maven central. Once jars are obtained from Maven central then Aether operates fine offline.

If however you do not have the necessary jars in your local Maven repository, then the only way to get them is to enable Ivy via `BuildConfig` (see above).

## Changes to Core plugin versioning schemes and the Upgrade command

Core plugins like `tomcat` and `hibernate` are no longer versioned the same as the Grails version, instead they are versioned according to the Tomcat and Hibernate version they target. If you are upgrading from Grails 2.2 you need to specify the correct Tomcat and Hibernate plugins in `BuildConfig`. The upgrade command will not do this for you.

```

plugins {
  // plugins for the build system only
  build ':tomcat:7.0.42'

  // plugins needed at runtime but not for compilation
  runtime ':hibernate:3.6.10.2'
}

```

Note that the `upgrade` command will be deprecated in 2.3 and replaced with `use-current-grails-version`, which will make no attempts to automatically upgrade Grails plugins.

## Scaffolding moved to a plugin and rewritten



If you have dynamically scaffolded controllers in your application then you will need to configure [Scaffolding plugin](#) in BuildConfig:

```
plugins {  
    compile ':scaffolding:1.0.0'  
}
```

By default for new applications the 2.0 version of the scaffolding plugin is used, which is not backwards compatible.

## Spock included by default

You no longer need to add the Spock plugin to your projects. Simply create Spock specifications as before for unit tests. In fact, don't install the Spock plugin, otherwise your specifications will run twice and potentially the spock test type no longer exists. Specifications and JUnit tests run as the same type now.

## Dependency Injection for Integration Tests

In order to support alternate JUnit4 test runners, Grails 2.3 no longer uses a special test runner to run tests. Tests should no longer extend `GroovyTestCase`.

This change requires that any JUnit integration tests that require dependency injection now need to be annotated.

```
@TestMixin(IntegrationTestMixin)
```

For Spock integration tests, extending `IntegrationSpec` also works.

## Forked Execution for Testing

Tests are now by default executed in a forked JVM (although this can be disabled). One implication of this is that tests are slower to execute when using:

```
grails test-app
```

The reason for this is the need to load a separate JVM to execute tests. To mitigate this Grails interactive runner now loads a background JVM that can be resumed. If you do:

```
$ grails // load interactive mode
$ grails -> test-app
$ grails -> test-app
```

Test execution will be noticeably faster and is the recommended way to run tests in Grails. On older hardware with multiple cores (to run the separate JVMs) it is recommended you disable forked execution for tests to achieve better performance:

```
forkConfig = [maxMemory: 1024, minMemory: 64, debug: false, maxPerm: 256]
grails.project.fork = [
  test: false, // disable forked execution for test-app
  run: forkConfig, // configure settings for the run-app JVM
  ...
]
```

## Forked Execution and the Reloading Agent

In Grails 2.3 the reloading agent is no longer on the build system path unless you pass the `-reloading` command:

```
grails -reloading run-app
```

The reason for this is that the default in Grails 2.3 and above is to load Grails application in a forked JVM. If you do not wish to use forked JVMs then you must ensure that you run Grails with `grails -reloading`. Alternatively, you can enable forking with the following configuration in `BuildConfig`:

```
forkConfig = [maxMemory: 1024, minMemory: 64, debug: false, maxPerm: 256]
grails.project.fork = [
  test: forkConfig, // configure settings for the test-app JVM
  run: forkConfig, // configure settings for the run-app JVM
  war: forkConfig, // configure settings for the run-war JVM
  console: forkConfig // configure settings for the Swing console JVM
]
```

## Forked Execution and Remote Debugging

The `grails-debug` command will no longer work with Grails for remote debugging sessions. The enabled debugging for the build system JVM, but not the JVM used in forked execution. The solution is to use the `debug-fork` command line argument:

```
grails --debug-fork run-app
```

Alternatively you can set the `debug` setting to `true` in `BuildConfig` and use the regular `grails console` command:

```
forkConfig = [maxMemory: 1024, minMemory: 64, debug: true, maxPerm: 256]
grails.project.fork = [
  run: forkConfig, // configure settings for the run-app JVM
  ...
]
```

## Forked Execution and Functional Test plugins

Some existing plugins (Cucumber plugin for example) do not work with 2.3.x forked execution because they are running in the same JVM as the application under tests. For example it is not possible to setup fixture data inside a functional test and have that data visible to the application under test since the application under test is running in a different JVM. The solution to this is to provide the necessary fixture data in the `Bootstrap` of the application (only for development course).

## 4 Upgrading from Grails 2.3

### The upgrade Command

The upgrade command has been removed from Grails 2.4. The procedure for upgrading to the latest is detailed in the user guide from now on. Below are steps that must be taken to upgrade an application from

### The set-grails-version Command

The [set-grails-version](#) command should be run to update the application's metadata to indicate which application is built with.

### Update to latest Plugin versions

You should update your application's BuildConfig to use the latest plugins compatible with Grails 2.3.

```
plugins {
    // plugins for the build system only
    build ':tomcat:7.0.52.1'

    // plugins for the compile step
    compile ':scaffolding:2.1.0'
    compile ':cache:1.1.3'
    compile ':asset-pipeline:1.8.3'

    // plugins needed at runtime but not for compilation
    runtime ':hibernate4:4.3.5.2' // or ':hibernate:3.6.10.14'
    runtime ':database-migration:1.4.0'
    runtime ':jquery:1.11.0.2'
    ...
}
```

You may get compilation errors or incompatibility problems with older versions of the above plugins installed.

### grails-debug Script Has Been Removed

The grails-debug and grails-debug.bat scripts have been removed. To debug the build system use `-debug <command>` and to debug the forked JVM run `grails --debug-fork <command>`.

### New Command Object Data Binding Behavior

The data binding behavior for command objects has changed in Grails 2.4. Request parameter names may now be the name of the controller action argument name that the request parameter should be bound to. For example, in the buy action in the controller below a request parameter named `buyer.name` will be bound to the `name` property of the `buyer` argument and a request parameter named `seller.name` will be bound to the `name` property of the `seller` argument. See [Command Objects](#) documentation for more details.

### New Behavior For Domain Class Command Objects

If a command object's type is a domain class and there is no `id` request parameter then `null` will be passed to the action unless the HTTP request method is "POST", in which case a new instance of the domain class will be created using the domain class constructor. For all of the cases where the domain class instance is non-null, data binding will occur if the HTTP request method is "POST", "PUT" or "PATCH". See the [Command Objects](#) documentation for more details.

## Nullable Command Object Properties

The behavior in Grails 2.3.x is such that constrained properties in command objects and other classes marked `nullable: false` by default. Unconstrained properties were not configured with `nullable: false`. In Grails 2.4 all non-static unconstrained properties in command object classes and other classes marked `nullable: false`.

```
class StoreController {
    def buy(Person buyer, Person seller) {
        // ...
    }
}

class Person {
    String name
}
```

If you wish to retain the old behavior, you can do so on a per-command object basis by using the `nullable: true` argument explicitly and passing the `nullable: true` argument:

```
@Validateable(nullable = true)
class Person {
    String name
}
```

This will cause all properties to be nullable by default unless a constraint is explicitly added (similar to the behavior in Grails 2.4).

See the [Command Objects documentation](#) for more details.

## Ajax Tags Have Been Deprecated

The [formRemote](#), [remoteField](#), [remoteFunction](#) and [remoteLink](#) Ajax tags have been deprecated and will be removed in the next version of Grails. Applications may provide their own Ajax tags and/or Javascript plugins may provide Ajax tags.

## The Spring Data Binder Has Been Deprecated

The `grails.databinding.useSpringBinder` config property may be set to `true` to tell Grails binder instead of the Grails data binder. The Spring data binder has been deprecated and will be removed from Grails. It is recommended that when upgrading to Grails 2.4 that the Grails data binder be used.

## The resources Plugin

As of Grails 2.4 the `resources` plugin has been replaced with the `asset-pipeline` plugin management plugin for newly created applications. See the [static resource abstraction](#) section of the User Guide. When upgrading an application to Grails 2.4 if you choose to continue using the `resources` plugin you will need to use previous versions of the plugin as previous versions of the plugin are not compatible with Grails 2.4.

## Static Holder Classes

The following deprecated classes have been removed from Grails 2.4.x:

- `org.codehaus.groovy.grails.commons.ApplicationHolder`
- `org.codehaus.groovy.grails.commons.ConfigurationHolder`
- `org.codehaus.groovy.grails.plugins.PluginManagerHolder`
- `org.codehaus.groovy.grails.web.context.ServletContextHolder`
- `org.codehaus.groovy.grails.compiler.support.GrailsResourceLoaderHolder`

If you or any plugins you have installed are using these classes you will get a compilation error. The process of updating to new plugins and using `grails.util.Holders` instead.



If your application uses the `jquery` plugin you will need to update to version 1.11.0.2 or later as previous versions of the plugin made use of the `ApplicationHolder` class. If your application uses the `resources` plugin you will need to update to version 1.2.7 or later as previous versions of the plugin made use of the `ConfigurationHolder` class.

## Changes To applicationContext.xml

The `web-app/WEB-INF/applicationContext.xml` file contains a bean definition for a `GrailsApplication` bean which is an instance of `org.codehaus.groovy.grails.commons.GrailsResourceLoader`. That bean definition needs to be removed from the file. The `grailsApplication` bean injected into it as shown below.

```
<bean id="grailsApplication" class=
"org.codehaus.groovy.grails.commons.GrailsApplicationFactoryBean">
  <description>Grails application factory bean</description>
  <property name="grailsDescriptor" value="/WEB-INF/grails.xml" />
  <property name="grailsResourceLoader" ref="grailsResourceLoader" />
</bean>
```

The `grailsApplication` bean definition should be left in the file but the `grailsResourceLoad` be removed as shown below.

```
<bean id="grailsApplication" class=
"org.codehaus.groovy.grails.commons.GrailsApplicationFactoryBean">
  <description>Grails application factory bean</description>
  <property name="grailsDescriptor" value="/WEB-INF/grails.xml" />
</bean>
```

## Changes to web.xml

The Sitemesh servlet filter has been removed and the GSP layout feature is now handled by [GrailsLayout](#). If you are using a customized web.xml should apply the customizations to a web.xml file of Grails 2.4. This applies to applications that have used the "install-templates" to install template files in src/templates folder of the application. It's recommended to rename src/templates to a different name and use a diff tool to apply the possible application specific customizations with Grails 2.4 install-templates command.

## Data Binding Changes

Prior to Grails 2.4 when data binding was performed with the `params` object in a controller, if the request body would be parsed and used for data binding instead of the `params` object. In Grails 2.4 this behavior has changed. If binding is initiated with `params`, the binding will always be done with the `params` object, without regard to whether the request has a body. If binding is done with the `request` object, if the request has a body then the body will be used for data binding, otherwise the request parameters will be used for data binding.

```

class SomeController {
def someAction() {
    // Prior to Grails 2.4 if the request contains a body
    // then obj1 will be populated with values parsed from
    // the body instead of with values in params.

    // With Grails 2.4 obj1 will be populated with values
    // in params.
    def obj1 = new SomeDomainClass(params)

    // the same is true for the following
    def obj2 = new SomeDomainClass()
    obj2.properties = params
}

def someOtherAction() {
    // If the request contains a body then obj1 will be
    // populated with values parsed from the body, otherwise
    // obj1 will be populated with the request parameters.

    // This is not a new change in behavior.
    def obj1 = new SomeDomainClass()
    obj1.properties = request
}
}

```



There is one release in the 2.3.x chain which has the 2.4 behavior described above and that is 2.3.8. None of the 2.3.x releases before or after 2.3.8 have this behavior.

## The allowedMethods Property And Unit Tests

The unit testing environment now respects the [allowedMethods](#) property in controllers. Prior to Grails 2.3.8, if a controller action which is supposed to be restricted to certain request methods could have skipped that request method in the unit test because the allowedMethods property was ignored by the unit test. As of Grails 2.3.8, if an action is limited to be accessed with certain request methods, the unit test must be constructed to deal with

```

// grails-app/controllers/com/demo/DemoController.groovy
package com.demo

class DemoController {

    static allowedMethods = [save: 'POST', update: 'PUT', delete: 'DELETE']

    def save() {
        render 'Save was successful!'
    }

    // ...
}

```



```
// test/unit/com/demo/DemoControllerSpec.groovy
package com.demo

import grails.test.mixin.TestFor
import spock.lang.Specification
import static javax.servlet.http.HttpServletResponse.*

@TestFor(DemoController)
class DemoControllerSpec extends Specification {

    void "test a valid request method"() {
        when:
            request.method = 'POST'
            controller.save()

        then:
            response.status == SC_OK
            response.text == 'Save was successful!'
    }

    void "test an invalid request method"() {
        when:
            request.method = 'DELETE'
            controller.save()

        then:
            response.status == SC_METHOD_NOT_ALLOWED
    }
}
```

## scanning for JSP taglibs has to be configured, no JSTL default dependency

JSP taglib tld files aren't scanned by default any more. This must be configured with the `grails.g` setting. It accepts a comma separated String value. Spring's `PathMatchingResourcePatternResolver` is used

You can get the previous behaviour by adding this setting to `Config.groovy`:

```
grails.gsp.tldScanPattern='classpath*/META-INF/*.tld,/WEB-INF/tld/*.tld'
```

JSTL standard library is no more added as a dependency. In case you are using JSTL, you should also add

```
runtime 'javax.servlet:jstl:1.1.2'
runtime 'taglibs:standard:1.1.2'
```

## 5 Configuration

It may seem odd that in a framework that embraces "convention-over-configuration" that we tackle this default settings you can actually develop an application without doing any configuration whatsoever demonstrates, but it's important to learn where and how to override the conventions when you need to. This guide will mention what configuration settings you can use, but not how to set them. The assumption is that the first section of this chapter!

### 5.1 Basic Configuration

For general configuration Grails provides two files:

- `grails-app/conf/BuildConfig.groovy`
- `grails-app/conf/Config.groovy`

Both of them use Groovy's [ConfigSlurper](#) syntax. The first, `BuildConfig.groovy`, is for settings that affect Grails commands, such as `compile`, `doc`, etc. The second file, `Config.groovy`, is for settings that affect the application when it is running. This means that `Config.groovy` is packaged with your application, but `BuildConfig.groovy` is not. Don't worry if you're not clear on the distinction: the guide will tell you which file to put a particular setting in.

The most basic syntax is similar to that of Java properties files with dot notation on the left-hand side:

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

Note that the value is a Groovy string literal! Those quotes around 'world' are important. In fact, there are many advantages of the ConfigSlurper syntax over properties files: the property values can be any valid Groovy expression, including integers, or arbitrary objects!

Things become more interesting when you have multiple settings with the same base. For example, you could have:

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

both of which have the same base: `foo.bar`. The above syntax works but it's quite repetitive and verbose. One way to reduce that verbosity is by nesting properties at the dots:

```
foo {
  bar {
    hello = "world"
    good = "bye"
  }
}
```

or by only partially nesting them:

```
foo {
  bar.hello = "world"
  bar.good = "bye"
}
```

However, you can't nest after using the dot notation. In other words, this **won't** work:

```
// Won't work!
foo.bar {
  hello = "world"
  good = "bye"
}
```

Within both `BuildConfig.groovy` and `Config.groovy` you can access several implicit variable values:

Variable	Description
<code>userHome</code>	Location of the home directory for the account that is running the Grails application.
<code>grailsHome</code>	Location of the directory where you installed Grails. If the <code>GRAILS_HOME</code> environment variable is set, it will override this value.
<code>appName</code>	The application name as it appears in <code>application.properties</code> .
<code>appVersion</code>	The application version as it appears in <code>application.properties</code> .

For example:

```
my.tmp.dir = "${userHome}/.grails/tmp"
```

In addition, `BuildConfig.groovy` has

Variable	Description
<code>grailsVersion</code>	The version of Grails used to build the project.
<code>grailsSettings</code>	An object containing various build related settings, such as <code>baseDir</code> . It's of type <a href="#">BuildSettings</a>

and `Config.groovy` has

Variable	Description
<code>grailsApplication</code>	The <a href="#">GrailsApplication</a> instance.

Those are the basics of adding settings to the configuration file, but how do you access those settings from your application? That depends on which config you want to read.

The settings in `BuildConfig.groovy` are only available from [command scripts](#) and can be accessed via the `grailsSettings.config` property like so:

```
target(default: "Example command") {
    def maxIterations = grailsSettings.config.myapp.iterations.max
    ...
}
```

If you want to read runtime configuration settings, i.e. those defined in `Config.groovy`, use the `grailsApplication.config` object, which is available as a variable in controllers and tag libraries:

```
class MyController {
    def hello() {
        def recipient = grailsApplication.config.foo.bar.hello
    }
    render "Hello ${recipient}"
}
```

and can be easily injected into services and other Grails artifacts:

```
class MyService {
    def grailsApplication

    String greeting() {
        def recipient = grailsApplication.config.foo.bar.hello
        return "Hello ${recipient}"
    }
}
```

As you can see, when accessing configuration settings you use the same dot notation as when you define the

### 5.1.1 Built in options

Grails has a set of core settings that are worth knowing about. Their defaults are suitable for most projects. Understand what they do because you may need one or more of them later.

## Build settings

Let's start with some important build settings. Although Grails requires JDK 6 when developing your application, you can deploy those applications to JDK 5 containers. Simply set the following in `BuildConfig.groovy`:

```
grails.project.source.level = "1.5"
grails.project.target.level = "1.5"
```

Note that source and target levels are different to the standard public version of JDKs, so JDK 5 -> 1.5, JDK 6 -> 1.6, and JDK 7 -> 1.7.

In addition, Grails supports Servlet versions 2.5 and above but defaults to 2.5. If you wish to use newer features (such as 3.0 async support) you should configure the `grails.servlet.version` setting appropriately:

```
grails.servlet.version = "3.0"
```

## Runtime settings

On the runtime front, i.e. `Config.groovy`, there are quite a few more core settings:

- `grails.config.locations` - The location of properties files or additional Grails Config files to the main configuration. See the [section on externalised config](#).
- `grails.enable.native2ascii` - Set this to false if you do not require native2ascii conversion files (default: true).
- `grails.views.default.codec` - Sets the default encoding regime for GSPs - can be one of (default: 'none'). To reduce risk of XSS attacks, set this to 'html'.
- `grails.views.gsp.encoding` - The file encoding used for GSP source files (default: 'utf-8').
- `grails.mime.file.extensions` - Whether to use the file extension to dictate the mime type (default: true).
- `grails.mime.types` - A map of supported mime types used for [Content Negotiation](#).
- `grails.serverURL` - A string specifying the server URL portion of absolute links, including `grails.serverURL="http://my.yourportal.com"`. See [createLink](#). Also used by redirects.
- `grails.views.gsp.sitemesh.preprocess` - Determines whether SiteMesh preprocessing slows down page rendering, but if you need SiteMesh to parse the generated HTML from a GSP view is the right option. Don't worry if you don't understand this advanced property: leave it set to true.
- `grails.reload.excludes` and `grails.reload.includes` - Configuring these directives controls behavior for project specific source files. Each directive takes a list of strings that are the class names that should be excluded from reloading behavior or included accordingly when running the application with the `run-app` command. If the `grails.reload.includes` directive is configured, then only those files will be reloaded.

## War generation

- `grails.project.war.file` - Sets the name and location of the WAR file generated by the [war](#) task.
- `grails.war.dependencies` - A closure containing Ant builder syntax or a list of JAR file names that specify what libraries are included in the WAR file.
- `grails.war.copyToWebApp` - A closure containing Ant builder syntax that is legal inside an `"fileset()"`. Lets 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 control what resources are included when building the final WAR file.

For more information on using these options, see the section on [deployment](#).

### 5.1.2 Logging

#### The Basics

Grails uses its common configuration mechanism to provide the settings for the underlying [Log4j](#) log system. To add a `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', only messages logged at 'error' level and above will be shown. Loggers with 'org.apache.catalina' logger only show messages at the 'warn' level and above. What does that mean? Let's understand how levels work.

## Logging levels

There 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(msg)` will log a message at the 'error' level. Likewise, `log.debug(msg)` will log it at 'debug'. Each of the above levels have a corresponding log method of the same name.

The logging system uses that *message* level combined with the configuration for the logger (see next section) to decide if the message 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 ignored.

Before we go on to loggers, a quick note about those 'off' and 'all' levels. These are special in that they are not part of the configuration; you can't log messages at these levels. So if you configure a logger with a level of 'off', no messages will be written out. A level of 'all' means 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, shared? How do you configure them?

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

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>'`, where `<type>` is the artifact, for example `'controllers'` or `'services'`, and `<className>` is the fully qualified name of the artifact. For example, if you have this service:

```
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 you can also pass a name to the `getLog()` method, such as `"myLogger"`, but this is less common because it treats names with dots ('.') in a 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 ignore them at a level of 'warn' or lower. But is there a logger with this name in the application? No. So why has it? Because the above rule applies to any logger whose name *begins with* 'org.codehaus.groovy.grails.web.servlet'. For example, the rule applies to both the `org.codehaus.groovy.grails.web.servlet.Grails` class and the `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 would otherwise be.

The most common things that you will want to capture log output from are your controllers, services, and filters. A common convention mentioned earlier to do that is: `grails.app.<artifactType>.<className>`. In particular, the `className` is often package-qualified, i.e. with the package 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` (but excluding `filters`)
- `filters` - For 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 are some Grails 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 et
- `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 have no explicit configuration? Are they 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 provided, any messages that go to that logger are subject to the rules defined for the root logger. In other words, the root logger is the default configuration for the logging system.

Grails automatically configures the root logger to only handle messages at 'error' level and above, and all messages are sent to the console (stdout for those with a C background). You can customise this behaviour by specifying a different logging configuration like so:

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

The above example configures the root logger to log messages at 'info' level and above to the default console appender. You can also configure 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.

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

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

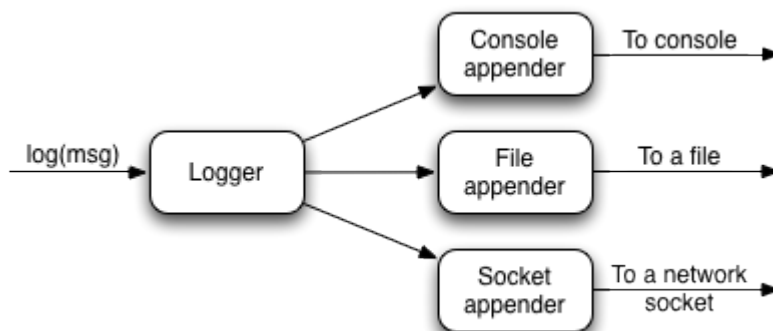
For more information on what you can do with this `Logger` instance, refer to the `Log4j` API documentation.

Those are the basics of logging pretty well covered and they are sufficient if you're happy to only send log messages to the console. But what if you want to send them to a file? How do you make sure that messages from a particular logger are sent to a file, and several others. You can even create your own appender implementations!

## Appenders

Loggers are a useful mechanism for filtering messages, but they don't physically write the messages anywhere. They need an appender, of which there are various types. For example, there is the default one that writes messages to the console, one that writes them to a file, and 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 configuration, the appender named 'stdout' is attached to all loggers through the default root logger configuration. But that's the way that appenders can be done within an '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	<a href="#">JDBCAppender</a>	Logs to a JDBC connection.
console	<a href="#">ConsoleAppender</a>	Logs to the console.
file	<a href="#">FileAppender</a>	Logs to a single file.
rollingFile	<a href="#">RollingFileAppender</a>	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](#) implementation. For example, the above example sets the `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 also have instances of the same 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 not listed above, 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 more.

Once you have declared your extra appenders, you can attach them to specific loggers by passing the name of the logger to the `addAppender` method from the previous section:

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

This will ensure that the 'grails.app.controllers.BookController' logger sends log messages to 'myAppenders' configured for the root logger. To add more than one appender to the logger, then add them to the list:

```
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 appender by using a list.

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 declared for a given logger wins. What you probably want to do is limit what level of messages an appender can log.

An appender that is attached to a logger configured with the 'all' level will generate a lot of logging information in a file, but it makes working at the console difficult. So we configure the console appender to only write messages at the 'info' level or above:

```
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 argument is only used for console appenders, but do 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-specific block. There is a problem with this approach: you have to provide the full logging configuration each time you define an environment. In other words, you cannot 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.controllers"
  }
}

```

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

## Full stacktraces

When exceptions occur, there can be an awful lot of noise in the stacktrace from Java and Groovy internal classes, which typically 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 default writes to `stacktrace.log`. As with other loggers though, you can change its behaviour in the configuration. If you want full stack traces 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 stacktraces are logged. An alternative approach 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 to see the stacktrace in the console.

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

```
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 parameters. To mask out the values of secure request parameters, specify the `grails.exceptionresolver.params.exclude` config property:

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



Request parameter logging may be turned off altogether by `grails.exceptionresolver.logRequestParameters` config property to `false`. The default application is running in `DEVELOPMENT` mode and `false` for all other modes.

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

## Logger inheritance

Earlier, we mentioned that all loggers inherit from the root logger and that loggers are hierarchical based. What this means is that unless you override a parent setting, a logger retains the level and the appenders configuration. So with this configuration:

```
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' appenders. How do you change the level 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 `false`, the logger does not inherit the configuration. The default for all loggers is `true`, i.e. they inherit the configuration. So how do you change this setting? Here is an example:

```
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 configure the 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 contain aren't interesting when diagnosing problems. So Grails uses a implementation of the `org.codehaus.groovy.grails.exceptions.StackTraceFilterer` interface to filter out. To customize the approach used for filtering, implement that interface in a class in `src/groovy` or `src/main/groovy` and register it in `Config.groovy`:

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

In addition, Grails customizes the display of the filtered stacktrace to make the information more readable. To customize the approach used for printing, implement the `org.codehaus.groovy.grails.exceptions.StackTracePrinter` interface in a class in `src/groovy` or `src/main/java` and register it in `Config.groovy`:

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

Finally, to render error information in the error GSP, an HTML-generating printer implementation is registered as a Spring bean. To use your own implementation, either implement the `org.codehaus.groovy.grails.exceptions.StackTracePrinter` interface directly or implement `org.codehaus.groovy.grails.web.errors.ErrorsViewStackTracePrinter` and register it in `grails-app/conf/spring/resources`.

```
import com.yourcompany.yourapp.MyErrorsViewStackTracePrinter

beans = {
  errorsViewStackTracePrinter(MyErrorsViewStackTracePrinter,
                              ref('grailsResourceLocator'))
}
```

## Alternative logging libraries

By default, Grails uses Log4J to do its logging. For most people this is absolutely fine, and many us logging library is used. But if you're not one of those and want to use an alternative, such as the [JDK log](#) you can do so by simply excluding a couple of dependencies from the global set and adding your own:

```
grails.project.dependency.resolution = {
  inherits("global") {
    excludes "grails-plugin-logging", "log4j"
  }
  ...
  dependencies {
    runtime "ch.qos.logback:logback-core:0.9.29"
    ...
  }
  ...
}
```

If you do this, you will get unfiltered, standard Java stacktraces in your log files and you won't be configuration DSL that's just been described. Instead, you will have to use the standard configuration mechanism to choose.

### 5.1.3 GORM

Grails provides the following GORM configuration options:

- `grails.gorm.failOnError` - If set to `true`, causes the `save()` method on domain classes to throw a `grails.validation.ValidationException` if [validation](#) fails during a save. This option is a list of Strings representing package names. If the value is a list of Strings then the `failOnError` behavior applies to domain classes in those 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 flush need to explicitly flush using `save(flush: true)`.

## 5.2 Environments

### Per Environment Configuration

Grails supports the concept of per environment configuration. The `Config.groovy`, `DataSource.groovy` files in the `grails-app/conf` directory can use per-environment configuration provided by [ConfigSlurper](#). As an example consider the following default DataSource definition provided

```

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 sets settings for the `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 environment.

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

In addition, there are 3 preset environments known to Grails: `dev`, `prod`, and `test` for development, production, and testing. For example to create a WAR for the `test` environment you would 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 [Environment](#) class.

```
import grails.util.Environment

...

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

## Per Environment Bootstrapping

It's often desirable to run code when your application starts up on a per-environment basis. To take advantage of the `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 execute environment specific logic. You can also create your own `Environment` class yourself to execute your own environment specific logic:

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

## 5.3 The DataSource

Since Grails is built on Java technology setting up a data source requires some knowledge of JDBC (the stand for Java 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 the dependency resolution to resolve the Maven repository, for example you could add a dependency for the MySQL driver like this:

```
dependencies {
    runtime 'mysql:mysql-connector-java:5.1.29'
}
```

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

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

- `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', 'create', 'drop'
- `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 [org.hibernate.dialect](http://org.hibernate.dialect) package for available dialects.
- `readOnly` - If `true` makes the DataSource read-only, which results in the connection pool calling `Connection.setReadOnly()` on each Connection
- `transactional` - If `false` leaves the DataSource's transactionManager bean outside the container manager implementation. This only applies to additional datasources.
- `persistenceInterceptor` - The default datasource is automatically wired up to the persistence interceptor. Other datasources are not wired up automatically unless this is set to `true`
- `properties` - Extra properties to set on the DataSource bean. See the [Tomcat Pool](http://tomcat.apache.org/tomcat-7.0-doc/pool.html) documentation for format [documentation of the properties](http://tomcat.apache.org/tomcat-7.0-doc/pool.html#properties).
- `jmxExport` - If `false`, will disable registration of JMX MBeans for all DataSources. By default for DataSources with `jmxEnabled = true` in properties.

A typical configuration for MySQL may be something like:



```

dataSource {
    pooled = true
    dbCreate = "update"
    url = "jdbc:mysql://localhost:3306/my_database"
    driverClassName = "com.mysql.jdbc.Driver"
    dialect = org.hibernate.dialect.MySQL5InnoDBDialect
    username = "username"
    password = "password"
    properties {
        jmxEnabled = true
        initialSize = 5
        maxActive = 50
        minIdle = 5
        maxIdle = 25
        maxWait = 10000
        maxAge = 10 * 60000
        timeBetweenEvictionRunsMillis = 5000
        minEvictableIdleTimeMillis = 60000
        validationQuery = "SELECT 1"
        validationQueryTimeout = 3
        validationInterval = 15000
        testOnBorrow = true
        testWhileIdle = true
        testOnReturn = false
        jdbcInterceptors = "ConnectionState;StatementCache(max=200)"
        defaultTransactionIsolation = java.sql.Connection.TRANSACTION_READ_COMMITTED
    }
}

```



When configuring the DataSource do not include the type or the def keyword before configuration settings as Groovy will treat these as local variable definitions and they processed. For example the 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:3306/my_database"
    driverClassName = "com.mysql.jdbc.Driver"
    dialect = org.hibernate.dialect.MySQL5InnoDBDialect
    username = "username"
    password = "password"
    properties {

```

```

// Documentation for Tomcat JDBC Pool
// http://tomcat.apache.org/tomcat-7.0-doc/jdbc-pool.html#Common_Attribute
//
https://tomcat.apache.org/tomcat-7.0-doc/api/org/apache/tomcat/jdbc/pool/PoolConf
jmxEnabled = true
initialSize = 5
maxActive = 50
minIdle = 5
maxIdle = 25
maxWait = 10000
maxAge = 10 * 60000
timeBetweenEvictionRunsMillis = 5000
minEvictableIdleTimeMillis = 60000
validationQuery = "SELECT 1"
validationQueryTimeout = 3
validationInterval = 15000
testOnBorrow = true
testWhileIdle = true
testOnReturn = false
ignoreExceptionOnPreLoad = true
// http://tomcat.apache.org/tomcat-7.0-doc/jdbc-pool.html#JDBC_interceptor
jdbcInterceptors = "ConnectionState;StatementCache(max=200)"
defaultTransactionIsolation = java.sql.Connection.TRANSACTION_READ_COMMITTED
// controls for leaked connections
abandonWhenPercentageFull = 100 // settings are active only when pool is full
removeAbandonedTimeout = 120
removeAbandoned = true
// use JMX console to change this setting at runtime
logAbandoned = false // causes stacktrace recording overhead, use only for
// JDBC driver properties
// Mysql as example
dbProperties {
    // Mysql specific driver properties
    //
http://dev.mysql.com/doc/connector-j/en/connector-j-reference-configuration-properties.html
// let Tomcat JDBC Pool handle reconnecting
autoReconnect=false
// truncation behaviour
jdbcCompliantTruncation=false
// mysql 0-date conversion
zeroDateTimeBehavior='convertToNull'
// Tomcat JDBC Pool's StatementCache is used instead, so disable mysql
cachePrepStmts=false
cacheCallableStmts=false
// Tomcat JDBC Pool's StatementFinalizer keeps track
dontTrackOpenResources=true
// performance optimization: reduce number of SQLExceptions thrown in
holdResultsOpenOverStatementClose=true
// enable MySQL query cache - using server prep stmts will disable query
useServerPrepStmts=false
// metadata caching
cacheServerConfiguration=true
cacheResultSetMetadata=true
metadataCacheSize=100
// timeouts for TCP/IP
connectTimeout=15000
socketTimeout=120000
// timer tuning (disable)
maintainTimeStats=false
enableQueryTimeouts=false
// misc tuning
noDatetimeStringSync=true

```

```

    }
  }
}

```

## More on dbCreate

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

- **create** - Drops the existing schema and creates the schema on startup, dropping existing tables, indexes, and constraints.
- **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 any existing data. This can't properly handle many schema changes like column renames (you're left with the old column names and data).
- **validate** - Makes no changes to your database. Compares the configuration with the existing data and issues warnings.
- any other value - does nothing

You can also remove the `dbCreate` setting completely, which is recommended once your schema is finalized. Database changes are then managed through migrations, either with SQL scripts or a migration tool like [Liquibase](#) (the [Database Migration](#) plugin used in Grails is integrated with Grails and GORM).

### 5.3.1 DataSources and Environments

The previous example configuration assumes you want the same config for all environments: production, test, and development. 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
        }
    }
}

```

### 5.3.2 JNDI DataSources

## Referring to a JNDI DataSource

Most Java EE containers supply DataSource instances via [Java Naming and Directory Interface](#) (JNDI). The definition of 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 DataSource is the same.

## Configuring a Development time JNDI resource

The way in which you configure JNDI data sources at development time is plugin dependent. 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"
    ]
]
```

### 5.3.3 Automatic Database Migration

The `dbCreate` property of the DataSource definition is important as it dictates what Grails should do to automatically generating the database tables from [GORM](#) classes. The options are described in the [Data](#)

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

In [development](#) mode dbCreate is by default set to "create-drop", but at some point in development (and production) 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 code update support is very conservative. It won't make any changes that could result in data loss, and doesn't drop tables, so you'll be left with the old one and will also have the new one.

Grails supports migrations via the [Database Migration](#) plugin which can be installed by editing `grails-app/conf/BuildConfig.groovy`:

```
grails.project.dependency.resolution = {
    ...
    plugins {
        runtime ':database-migration:1.3.1'
    }
}
```

The plugin uses [Liquibase](#) and provides access to all of its functionality, and also has support for GORM (change set by comparing your domain classes to a database).

### 5.3.4 Transaction-aware DataSource Proxy

The actual `dataSource` bean is wrapped in a transaction-aware proxy so you will be given the connection for the current 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 connection able to see changes that haven't been committed yet (assuming you have a sensible transaction isolation level like `READ_COMMITTED` or better).

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

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
```

### 5.3.5 Database Console

The [H2 database console](#) is a convenient feature of H2 that provides a web-based interface to any database driver for, and it's very useful to view the database you're developing against. It's especially useful with an in-memory database.

You can access the console by navigating to **`http://localhost:8080/appname/dbconsole`** in a browser. This is configured using the `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 other environments using the `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 framework.

## Configuration

By default the console is configured for an H2 database which will work with the default settings if you use an external database - you just need to change the JDBC URL to `jdbc:h2:mem:devDB`. If you've configured a different database (e.g. MySQL, Oracle, etc.) then you can use the Saved Settings dropdown to choose a settings template that contains the username/password information from your `DataSource.groovy`.

### 5.3.6 Multiple Datasources

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

## Configuring Additional DataSources

The default `DataSource` configuration in `grails-app/conf/DataSource.groovy` looks something like this:

```
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 another `dataSource` block (at the top level, in an environment block, or both, just like the standard `DataSource`), you can use a custom name, separated by an underscore. For example, this configuration adds a second `DataSource` for the development environment and 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'`. Set the `datasource` property in the mapping block to configure a non-default `DataSource`. For example, if you want to use the ZipCode `'lookup'` `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 than one, for 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 'DEFAULT' DataSource:

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

If a domain class uses all configured DataSources 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 DataSource for GORM calls for a particular DataSource. For example, consider this class which uses two DataSource

```
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 you can call 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.

## Hibernate Mapped Domain Classes

You can also partition annotated Java classes into separate datasources. Classes using the default data sources are defined in `grails-app/conf/hibernate/hibernate.cfg.xml`. To specify that an annotated class uses a different DataSource, create a `hibernate.cfg.xml` file for that DataSource with the file name prefixed with the DataSource name.

For example if the `Book` class is in the default DataSource, you would create `grails-app/conf/hibernate/hibernate.cfg.xml`:

```
<?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>
    <mapping class='org.example.Book' />
  </session-factory>
</hibernate-configuration>
```

and if the `Library` class is in the "ds2" DataSource, you would create `grails-app/conf/hibernate/ds2_hibernate.cfg.xml`:

```
<?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>
        <mapping class='org.example.Library' />
    </session-factory>
</hibernate-configuration>
```

The process is the same for classes mapped with hbm.xml files - just list them in the appropriate hibernate.

## Services

Like Domain classes, by default Services use the default DataSource and PlatformTransactionManager. To 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 which the DataSource is the same as the Service.

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

What you'll see is that if you have a Foo domain class in dataSource1 and a Bar domain class in dataSource2, and a service method that saves a new Foo and a new Bar will only be transactional for dataSource1. The transaction won't affect the Bar instance. If you want both to be transactional you'd need XA datasources for two-phase commit, e.g. with the Atomikos plugin.

## Transactions across multiple datasources

Grails uses the Best Efforts 1PC pattern for handling transactions across multiple datasources.

The [Best Efforts 1PC pattern](#) is fairly general but can fail in some circumstances that the developer must be aware of. It's a non-XA pattern that involves a synchronized single-phase commit of a number of resources. Because it can never be as safe as an XA transaction, but is often good enough if the participants are aware of the compromise.

The basic idea is to delay the commit of all resources as late as possible in a transaction so that the only thing that can fail is an infrastructure failure (not a business-processing error). Systems that rely on Best Efforts 1PC reason that failures are rare enough that they can afford to take the risk in return for higher throughput. If business-processes are designed to be idempotent, then little can go wrong in practice.

The BE1PC implementation was added in Grails 2.3.6. . Before this change additional datasources didn't get transactions initiated in Grails. The transactions in additional datasources were basically in auto commit mode. In some cases, this was unwanted behavior. One reason might be performance: on the start of each new transaction, the BE1PC transaction manager starts a new transaction to each datasource. It's possible to leave an additional datasource out of the BE1PC transaction manager by setting `transactional = false` in the respective configuration block of the additional `DataSource`. Datasources with `transactional = true` will also be left out of the chained transaction manager (since 2.3.7).

By default, the BE1PC implementation will add all beans implementing the Spring [PlatformTransactionManager](#) to the chained BE1PC transaction manager. For example, a possible [JMSTransactionManager](#) bean in the application context would be added to the Grails BE1PC transaction manager's chain of transaction managers.

You can exclude transaction manager beans from the BE1PC implementation with the this configuration option:

```
grails.transaction.chainedTransactionManagerPostProcessor.blacklistPattern = '.*'
```

The exclude matching is done on the name of the transaction manager bean. The transaction managers with `transactional = false` or `readOnly = true` will be skipped and using this configuration option is the preferred case.

## XA and Two-phase Commit

When the Best Efforts 1PC pattern isn't suitable for handling transactions across multiple transactional datasources), there are several options available for adding XA/2PC support to Grails applications.

The [Spring transactions documentation](#) contains information about integrating the JTA/XA transaction manager with application servers. In this case, you can configure a bean with the name `transactionManager` in the `resources.groovy` or `resources.xml` file.

There is also [Atomikos plugin](#) available for XA support in Grails applications. .

## 5.4 Externalized Configuration

Some deployments require that configuration be sourced from more than one place and be changeable without redeploying the application. In order to support deployment scenarios such as these the configuration can be externalized in Grails at the locations of the configuration files that should be used by adding a `grails.config.Config.groovy`, for example:

```
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](#) config files) from the 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 your application. One use for this is re-using configuration provided by plugins across multiple applications.

Ultimately all configuration files get merged into the `config` property of the [GrailsApplication](#) object from there.

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

## Config Defaults

The configuration values contained in the locations described by the `grails.config.locations` property are the values defined in your application `Config.groovy` file which may not be what you want. You may want default values to be loaded that can be overridden in either your application's `Config.groovy` file or in a namespace. In this case you can use the `grails.config.defaults.locations` property.

This property supports the same values as the `grails.config.locations` property (i.e. paths to configuration files or classes), but the config described by `grails.config.defaults.locations` will be loaded before the `grails.config.locations` and can therefore be overridden. Some plugins use this mechanism to supply one or more sets of default configuration values to choose to include in your application config.



Grails also supports the concept of property place holders and property override configurers as described in the [Spring](#) documentation. For more information on these see the section on [Grails and Spring](#).

## 5.5 Versioning

### Versioning Basics

Grails has built in support for application versioning. The version of the application is set to 0.1 when you create an application with the [create-app](#) command. The version is stored in the application meta data file `application.yml` at the root of the project.

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 version to the created WAR file.

## Detecting Versions at Runtime

You can detect the application version using Grails' support for application metadata using the [GrailsApplication](#) class. For example within [controllers](#) there is an implicit [grailsApplication](#) variable that can be used:

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

You can retrieve 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
```

## 5.6 Project Documentation

Since Grails 1.2, the documentation engine that powers the creation of this documentation has been available for all Grails projects.

The documentation engine uses a variation on the [Textile](#) syntax to automatically create project documentation, including formatting etc.

## Creating project documentation

To use the engine you need to follow a few conventions. First, you need to create a `src/docs/guide` directory. All documentation source files will go there. Then, you need to create the source docs themselves. Each chapter should be a separate file as should all numbered 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-sections in sub-directories named after 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 your documentation will be. To do that, you add a `src/docs/guide/toc.yml` file that contains the structure and titles for each section. It is in [YAML](#) format and basically represents the structure of the user guide in tree form. For example, the above structure is 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 section name (without the `.gdoc` extension) followed by a colon. The next line should contain `title:` plus the title of the section. Every sub-section then has its own line after the title. Leaf nodes, i.e. those without any sub-sections, declare their section name as the section name but after the colon.

That's it. You can easily add, remove, and move sections within the `toc.yml` to restructure the documentation. You also make sure that all section names, i.e. the `gdoc` filenames, should be unique since they are used for generating the HTML filenames. Don't 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 belongs to a category which is a directory located in the `src/docs/ref` directory. For example, suppose you have defined a reference item called `renderPDF`. That 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` file that control the output of the documentation such as:

- **grails.doc.title** - The title of the documentation
- **grails.doc.subtitle** - The subtitle of the documentation
- **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 version are pulled from your project itself. If a title is not specified, the application name is used.

You can also customise the look of the documentation and provide images by setting a few other options:

- **grails.doc.css** - The location of a directory containing custom CSS files (type `java.io.File`)
- **grails.doc.js** - The location of a directory containing custom JavaScript files (type `java.io.File`)
- **grails.doc.style** - The location of a directory containing custom HTML templates for the guide (type `java.io.File`)
- **grails.doc.images** - The location of a directory containing image files for use in the style templates (type `java.io.File`)

One of the simplest ways to customise the look of the generated guide is to provide a value for `grails.doc.custom.css` in the corresponding directory. Grails will automatically include this CSS file in the generated `custom-pdf.css` file in that directory. This allows you to override the styles for the PDF version of the guide.

## Generating Documentation

Once you have created some documentation (refer to the syntax guide in the next chapter) you can generate the 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 section covers the syntax basics.

### Basic Formatting

Monospace: `monospace`

```
@monospace@
```

Italic: *italic*

```
_italic_
```

Bold: **bold**

```
*bold*
```

Image:

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

You can also link to internal images like so:

```
!someFolder/my_diagram.png!
```

This will link to an image stored locally within your project. There is currently no default location for specify one with the `grails.doc.images` setting in `Config.groovy` like so:

```
grails.doc.images = new File("src/docs/images")
```

In this example, you would put the `my_diagram.png` file in the directory `'src/docs/images/someFolder'`.

### Linking

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

```
[Pivotal|http://www.pivotal.io/oss]
```

or

```
"Pivotal":http://www.pivotal.io/oss
```

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

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

The section name comes from the corresponding gdoc filename. The documentation engine will warn you your guide break.

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

```
[renderPDF|controllers]
```

In this case the category of the reference item is on the right 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 addi you can 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}
```

## 5.7 Dependency Resolution

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

You can choose to use Aether (since Grails 2.3) or Apache Ivy as the dependency resolution engine. Aether is the default resolution library used by the Maven build tool, so if you are looking for Maven-like behavior then Aether is the way to go. Aether allows more flexibility if you wish to resolve jars from flat file systems or none HTTP repositories. This is the default dependency resolution engine for Grails applications since Grails 2.3.



As of Grails 2.4 the Ivy resolver is considered deprecated and no longer maintained. It is recommended that all users switch to using Aether.

To configure which dependency resolution engine to use you can specify the `grails.project.dependency.resolver` setting in `grails-app/conf/BuildConfig.groovy`. The default setting is shown below:

```
grails.project.dependency.resolver = "maven" // or ivy
```

You can then specify a `grails.project.dependency.resolution` property in the `grails-app/conf/BuildConfig.groovy` file that configures how dependencies are resolved:

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

The default configuration looks like the following:

```

grails.servlet.version = "3.0" // Change depending on target container compliance
grails.project.class.dir = "target/classes"
grails.project.test.class.dir = "target/test-classes"
grails.project.test.reports.dir = "target/test-reports"
grails.project.work.dir = "target/work"
grails.project.target.level = 1.6
grails.project.source.level = 1.6
//grails.project.war.file = "target/${appName}-${appVersion}.war"

grails.project.fork = [
    // configure settings for compilation JVM, note that if you alter the Groovy
    compilation is required
    // compile: [maxMemory: 256, minMemory: 64, debug: false, maxPerm: 256, daem

// configure settings for the test-app JVM, uses the daemon by default
test: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256, daemon:true
// configure settings for the run-app JVM
run: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256, forkReserve:
// configure settings for the run-war JVM
war: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256, forkReserve:
// configure settings for the Console UI JVM
console: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256]
]

grails.project.dependency.resolver = "maven" // or ivy
grails.project.dependency.resolution = {
    // inherit Grails' default dependencies
    inherits("global") {
        // specify dependency exclusions here; for example, uncomment this to dis
        // excludes 'ehcache'
    }
    log "error" // log level of Ivy resolver, either 'error', 'warn', 'info', 'de
    checksums true // Whether to verify checksums on resolve
    legacyResolve false // whether to do a secondary resolve on plugin installati
    and here for backwards compatibility

repositories {
    inherits true // Whether to inherit repository definitions from plugins

grailsPlugins()
    grailsHome()
    mavenLocal()
    grailsCentral()
    mavenCentral()
    // uncomment these (or add new ones) to enable remote dependency resoluti
Maven repositories
    //mavenRepo "http://repository.codehaus.org"
    //mavenRepo "http://download.java.net/maven/2/"
}

dependencies {
    // specify dependencies here under either 'build', 'compile', 'runtime',
    'provided' scopes e.g.
    runtime 'mysql:mysql-connector-java:5.1.24'
    compile 'org.springframework.integration:spring-integration-core:2.2.5.RE
}

plugins {
    // plugins for the build system only
}
}

```

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

## 5.7.1 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
- `optional` (Aether only): Dependencies considered optional and not required for the execution of th

Within the `dependencies` block you can specify a dependency that falls into one of these confi equivalent method. For example if your application requires the MySQL driver to function at `runtime` this:

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

This uses the string syntax: `group:name:version`.

If you are using Aether as the dependency resolution library, the Maven pattern of:

```
<groupId>:<artifactId>[:<extension>[:<classifier>]]:<version>
```

You can also use a Map-based syntax:

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

Possible settings to the map syntax are:



- `group` - The group / organization (or `groupId` in Maven terminology)
- `name` - The dependency name (or `artifactId` in Maven terminology)
- `version` - The version of the dependency
- `extension` (Aether only) - The file extension of the dependency
- `classifier` - The dependency classifier
- `branch` (Ivy only) - The branch of the dependency
- `transitive` (Ivy only) - Whether the dependency has transitive dependencies

As you can see from the list above some dependency configuration settings work only in Aether and some. 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 transitively what you want, but there are occasions where you want a dependency without all its baggage. You can disable transitive dependency 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 conflicts or are unnecessary. For example, many Apache projects have 'commons-logging' as a transitive dependency, but it shouldn't be included in a Grails 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) or by their group and artifact IDs (if you use the Map notation). You may also come across `exclude` as well, but that's a different story.

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

## Dependency Management (Aether Only)

If you are using Aether then you can take advantage of Maven's notion of [Dependency Management](#).

To do so you use a management block, for example:

```
management {
    dependency "commons-logging:commons-logging:1.1.3"
}
```

The above declaration will force all any transitive dependencies on `commons-logging` to use the 1.1.3 version, thus avoiding the need to declare an explicit dependency on `commons-logging` yourself. In addition to the version, you can also specify the scope and exclusion rules of a dependency.

## Where are the JARs?

With all these declarative dependencies, you may wonder where all the JARs end up. They have to go default Grails puts them into a directory, called the dependency cache, that resides on your `user.home/.grails/ivy-cache` or `user.home/.m2/repository` when using Aether. You can change this in the `settings.groovy` file:

```
grails.dependency.cache.dir = "${userHome}/.my-dependency-cache"
```

or in the dependency DSL:

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

The `settings.groovy` option applies to all projects, so it's the preferred approach.

## 5.7.2 Dependency Repositories

### Remote Repositories

Initially your `BuildConfig.groovy` does not use any remote public Maven repositories. There is a default repository that will locate the JAR files Grails needs from your Grails installation. To use a public repository, you need to specify the `repositories` block:

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

In this case the default public Maven repository is specified.

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

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

and even give it a name:

```
repositories {  
    mavenRepo name: "Codehaus", root: "http://repository.codehaus.org"  
}
```

so that you can easily identify it in logs.

## Offline Mode

There are times when it is not desirable to connect to any remote repositories (whilst working on the train) so you can use the `offline` flag to execute Grails commands and Grails will not connect to any remote

```
grails --offline run-app
```



Note that this command will fail if you do not have the necessary dependencies in your local cache

You can also globally configure offline mode by setting `grails.offline.mode=true` in `~/.grails/settings.groovy` or in your project's `BuildConfig.groovy` file:

```
grails.offline.mode=true
```

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

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

## Authentication with Aether

To authenticate with Aether you can either define the credentials on the repository definition:

```
mavenRepo(url:"http://localhost:8082/myrepo") {  
    auth username: "foo", password: "bar"  
}
```

Or you can specify an `id` on the repository:

```
mavenRepo(id:'myrepo', url:"http://localhost:8082/myrepo")
```

And then declare your credentials in `USER_HOME/.grails/settings.groovy`:

```
grails.project.dependency.authentication = {  
    credentials {  
        id = "myrepo"  
        username = "admin"  
        password = "password"  
    }  
}
```

## Authentication with Ivy

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` `grails.project.ivy.authentication` setting:

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

### 5.7.3 Debugging Resolution

If you are having trouble getting a dependency to resolve you can enable more verbose debugging from the `log` method:

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

A common issue is that the checksums for a dependency don't match the associated JAR file, and so Ivy fails to resolve it. This helps ensure that the dependencies are valid. But for a variety of reasons some dependencies have incorrect checksums in the repositories, even if they are valid JARs. To get round this, you can disable Ivy's dependency checksums.

```
grails.project.dependency.resolution = {
    ...
    log "warn"
    checksums false
    ...
}
```

This is a global setting, so only use it if you have to.

### 5.7.4 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 `excludes`

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

### 5.7.5 Providing Default Dependencies

Most Grails applications have runtime dependencies on several jar files that are provided by the Grails framework libraries like Spring, Sitemesh, Hibernate etc. When a war file is created, all of these dependencies will be included in the war. The application may choose to exclude these jar files from the war. This is useful when the jar files will be provided by the container. This would normally be the case if multiple Grails applications are deployed to the same container.

The dependency resolution DSL provides a mechanism to express that all of the default dependencies are provided by the container. This is done by invoking the `defaultDependenciesProvided` method and passing `true`.


```

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 dependencies will be included in the war.

## 5.7.6 Snapshots and Other Changing Dependencies

### Configuration Changing dependencies

Typically, dependencies are constant. That is, for a given combination of group, name and version refers to will never change. The Grails dependency management system uses this fact to cache dependencies having to download them from the source repository each time. Sometimes this is not desirable. For example the convention of a *snapshot* (i.e. a dependency with a version number ending in “-SNAPSHOT”) that changes over time while still retaining the same version number. We call this a “changing dependency”.

Whenever you have a changing dependency, Grails will always check the remote repository for a new version when a changing dependency is encountered during dependency resolution its last modified timestamp compared against the last modified timestamp in the dependency repositories. If the version on the remote is newer than the version in the local cache, the new version will be downloaded and used.

 Be sure to read the next section on “Dependency Resolution Caching” in addition to this one on changing dependencies.

All dependencies (jars and plugins) with a version number ending in -SNAPSHOT are **implicitly** considered changing by Grails. You can also explicitly specify that a dependency is changing by setting the changing flag in the configuration. This is only required for Ivy, Aether does not support the 'changing' flag and treats dependencies that end with -SNAPSHOT as changing.



```
runtime ('org.my:lib:1.2.3') {  
    changing = true  
}
```

## Aether and SNAPSHOT dependencies

The semantics for handling snapshots when using Aether in Grails are the same as those when using the default snapshot check policy is to check once a day for a new version of the dependency. This means published during the day to a remote repository you may not see that change unless you manually clear out

If you wish to change the snapshot update policy you can do so by configuring an `updatePolicy` for snapshot was resolved from, for example:

```
repositories {  
    mavenCentral {  
        updatePolicy "interval:1"  
    }  
}
```

The above example configures an update policy that checks once a minute for changes. Note that that an update above will seriously impact performance of dependency resolution. The possible configuration values are as follows:

- `never` - Never check for new snapshots
- `always` - Always check for new snapshots
- `daily` - Check once a day for new snapshots (the default)
- `interval:x` - Check once every x minutes for new snapshots

## Ivy and Changing dependencies

For those used to Maven snapshot handling, if you use Aether dependency management you can expect Maven. If you choose to use Ivy there is a caveat to the support for changing dependencies that you should stop looking for newer versions of a dependency once it finds a remote repository that has the dependency.

Consider the following setup:

```
grails.project.dependency.resolution = {
  repositories {
    mavenLocal()
    mavenRepo "http://my.org/repo"
  }
  dependencies {
    compile "myorg:mylib:1.0-SNAPSHOT"
  }
}
```

In this example we are using the local maven repository and a remote network maven repository. As dependency and the local Maven cache do not contain the dependency but the remote repository dependency resolution the following actions will occur:

- maven local repository is searched, dependency not found
- maven network repository is searched, dependency is downloaded to the cache and used

Note that the repositories are checked in the order they are defined in the `BuildConfig.groovy` file.

If we perform dependency resolution again without the dependency changing on the remote server, the following actions will occur:

- maven local repository is searched, dependency not found
- maven network repository is searched, dependency is found to be the same "age" as the version in updated (i.e. downloaded)

Later on, a new version of `mylib 1.0-SNAPSHOT` is published changing the version on the server. The next time we perform dependency resolution, the following will happen:

- maven local repository is searched, dependency not found
- maven network repository is searched, dependency is found to be newer than version in the cache (downloaded to the cache)

So far everything is working well.

Now we want to test some local changes to the `mylib` library. To do this we build it locally and install it (how doesn't particularly matter). The next time we perform a dependency resolution, the following will occur:

- maven local repository is searched, dependency is found to be newer than version in the cache (downloaded to the cache)
- maven network repository is NOT searched as we've already found the dependency

This is what we wanted to occur.

Later on, a new version of `mylib 1.0-SNAPSHOT` is published changing the version on the server. The next time we perform dependency resolution, the following will happen:

- maven local repository is searched, dependency is found to be the same "age" as the version in updated (i.e. downloaded)
- maven network repository is NOT searched as we've already found the dependency

This is likely to not be the desired outcome. We are now out of sync with the latest published snapshot and using the version from the local maven repository.

The rule to remember is this: when resolving a dependency, Ivy will stop searching as soon as it finds a dependency at the specified version number. It will **not** continue searching all repositories trying to find a newer instance.

To remedy this situation (i.e. build against the *newer* version of `mylib 1.0-SNAPSHOT` in the repository) you can either:

- Delete the version from the local maven repository, or
- Reorder the repositories in the `BuildConfig.groovy` file

Where possible, prefer deleting the version from the local maven repository. In general, when you have finished locally built SNAPSHOT always try to clear it from the local maven repository.



This changing dependency behaviour is an unmodifiable characteristic of the underlying dependency management system Apache Ivy. It is currently not possible to have Ivy search all repositories for newer versions (in terms of modification date) of the same dependency (i.e. the same coordinates: group, name and version). If you want this behavior consider switching to Aether dependency manager.

## 5.7.7 Dependency Reports

As mentioned in the previous section a Grails application consists of dependencies inherited from the parent project and the 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 the (scope) you want a report for by passing an argument containing the configuration name:

```
grails dependency-report runtime
```

As of Grails 2.3 the `dependency-report` command will also output to the console a graph of the application. Example output is shown below:

```

compile - Dependencies placed on the classpath for compilation (total: 73)
+--- org.codehaus.groovy:groovy-all:2.0.6
+--- org.grails:grails-plugin-codecs:2.3.0
|    --- org.grails:grails-web:2.3.0
|        --- commons-fileupload:commons-fileupload:1.2.2
|        --- xpp3:xpp3_min:1.1.4c
|        --- commons-el:commons-el:1.0
|        --- opensymphony:sitemesh:2.4
|        --- org.springframework:spring-webmvc:3.1.2.RELEASE
|    --- commons-codec:commons-codec:1.5
|    --- org.slf4j:slf4j-api:1.7.2
+--- org.grails:grails-plugin-controllers:2.3.0
|    --- commons-beanutils:commons-beanutils:1.8.3
|    --- org.grails:grails-core:2.3.0
...

```

## 5.7.8 Plugin JAR Dependencies

### Specifying Plugin JAR dependencies

The way in which you specify dependencies for a [plugin](#) is identical to how you specify dependencies if a plugin is 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 use the `export` property of the dependency:

```

compile('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 application dependency if you're using the Map syntax:

```

compile 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 because it's 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 can resolve its 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 excludes method, effectively excluding the javassist library as a dependency.

### 5.7.9 Maven Integration

When using the Grails Maven plugin with the Maven build tool, Grails' dependency resolution mechanism assumed that you will manage dependencies 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 command line to 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.

### 5.7.10 Deploying to a Maven Repository

If you use Maven to build your Grails project, you can use the standard Maven targets `mvn install` and you can deploy a Grails project or plugin to a Maven repository using the [release](#) plugin.

The plugin provides the ability to publish Grails projects and plugins to local and remote Maven repository additional targets 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 already present, in 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 cache.

```
grails maven-install
```

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

## 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 within your `build.gradle` file. You specify the `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 repository specified in your `grails-app/conf/BuildConfig.groovy` file or in your `$USER_HOME/.grails/settings.groovy` file.

```
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 example the 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 (e.g. "http" from to specify a 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 conventions or plugin descriptor.

### Projects

For applications this plugin will use the Grails application name and version provided by Grails when g file. To change 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.groovy`:

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

## Plugins

With a Grails plugin the `groupId` and `version` are taken from the following properties in the `GrailsPlugin` descriptor:

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

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

### 5.7.11 Plugin Dependencies

You can declaratively specify plugins as dependencies via the dependency DSL instead of using the [install](#)



```

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.

## Latest Integration



Only the Ivy dependency manager supports the "latest.integration" version. For Aether you can achieve a similar effect with version ranges.

You can specify to use the latest version of a 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 snapshots use the "latest.release" label:

```

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

```



The "latest.release" label only works with Maven compatible repositories. If you have an SVN-based Grails 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 resolve both plugin and JAR dependencies using exclusions. For

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

Here we have defined a dependency on the "weceem" plugin which transitively depends on the "searchable" plugin. Using the `excludes` method you can tell Grails *not* to transitively install the searchable plugin. You can combine this with specifying an alternative version of a 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
}

```

## 5.7.12 Caching of Dependency Resolution Results

As a performance optimisation, when using Ivy (this does not apply to Aether), Grails does not resolve command invocation. Even with all the necessary dependencies downloaded and cached, resolution may minimise this cost, Grails caches the result of dependency resolution (i.e. the location on the local file system dependencies, typically inside the dependency cache) and reuses this result for subsequent commands expect that nothing has changed.

Grails only performs dependency resolution under the following circumstances:

- The project is clean (i.e. fresh checkout or after `grails clean`)
- The `BuildConfig.groovy` file has changed since the last command was run
- The `--refresh-dependencies` command line switch is provided to the command (any command)
- The `refresh-dependencies` command is the command being executed

Generally, this strategy works well and you can ignore dependency resolution caching. Every time you change a dependency (i.e. modify `BuildConfig.groovy`) Grails will do the right thing and resolve your new dependencies.

However, when you have *changing* or *dynamic* dependencies you will have to consider dependency resolution.

{info} A *changing* dependency is one whose version number does not change, but its contents do (like a `SNAPSHOT` dependency is one that is defined as one of many possible options (like a dependency with a version range like `latest.integration`). {info}

Both *changing* and *dynamic* dependencies are influenced by the environment. With caching active, any changes are effectively ignored. For example, your project may not automatically fetch the very latest version of a `latest.integration`. Or if you declare a `SNAPSHOT` dependency, you may not automatically get the latest from the server.

To ensure you have the correct version of a *changing* or *dynamic* dependency in your project, you can:

- clean the project
- run the `refresh-dependencies` command
- run *any* command with the `--refresh-dependencies` switch; or
- make a change to `BuildConfig.groovy`

If you have your CI builds configured to not perform clean builds, it may be worth adding the `--refresh-dependencies` switch to the command you use to build your projects.

## 6 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 default target, it will throw an error.

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 for more information about individual commands

It's often useful to provide custom arguments to the JVM when running Grails commands, in particular you may for example want to set a higher maximum heap size. The Grails command will use any JVM options specified in the JAVA\_OPTS 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

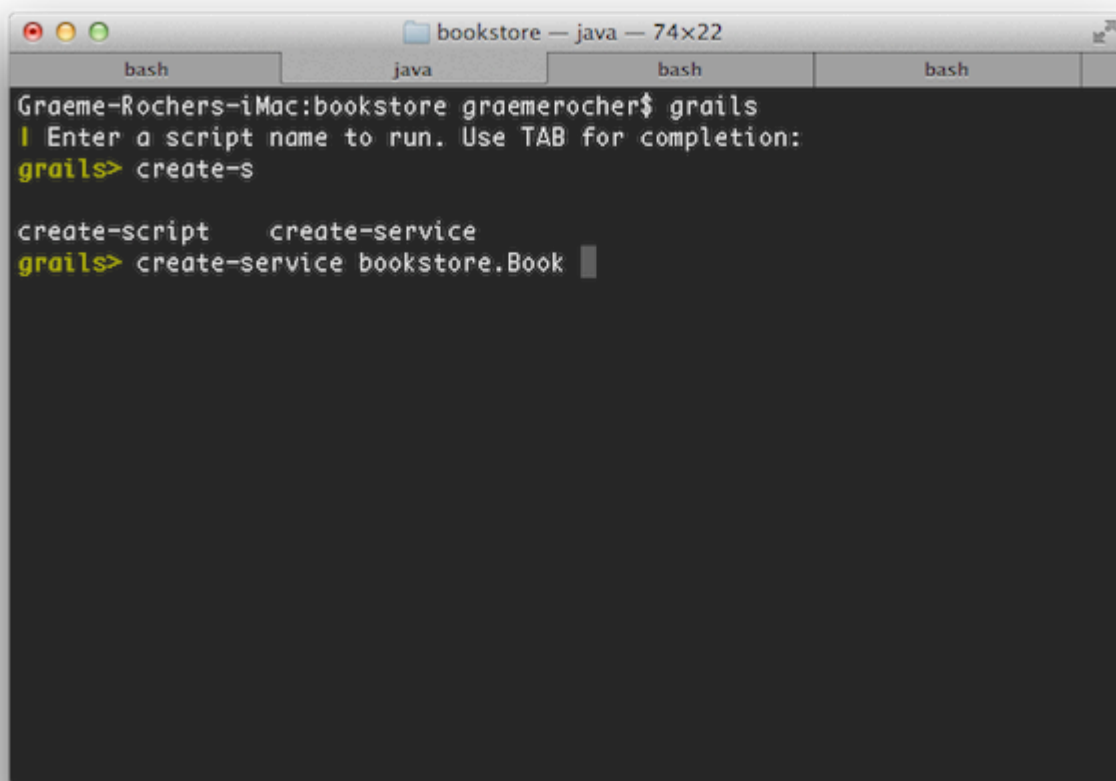
When you run a script manually and it prompts you for information, you can answer the questions and confirm. But when you run a script as part of an automated process, for example a continuous integration build, you need to "answer" the questions. So you can pass the `--non-interactive` switch to the script command to provide a default answer for any questions, for example whether to install a missing plugin.

For example:

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

## 6.1 Interactive Mode

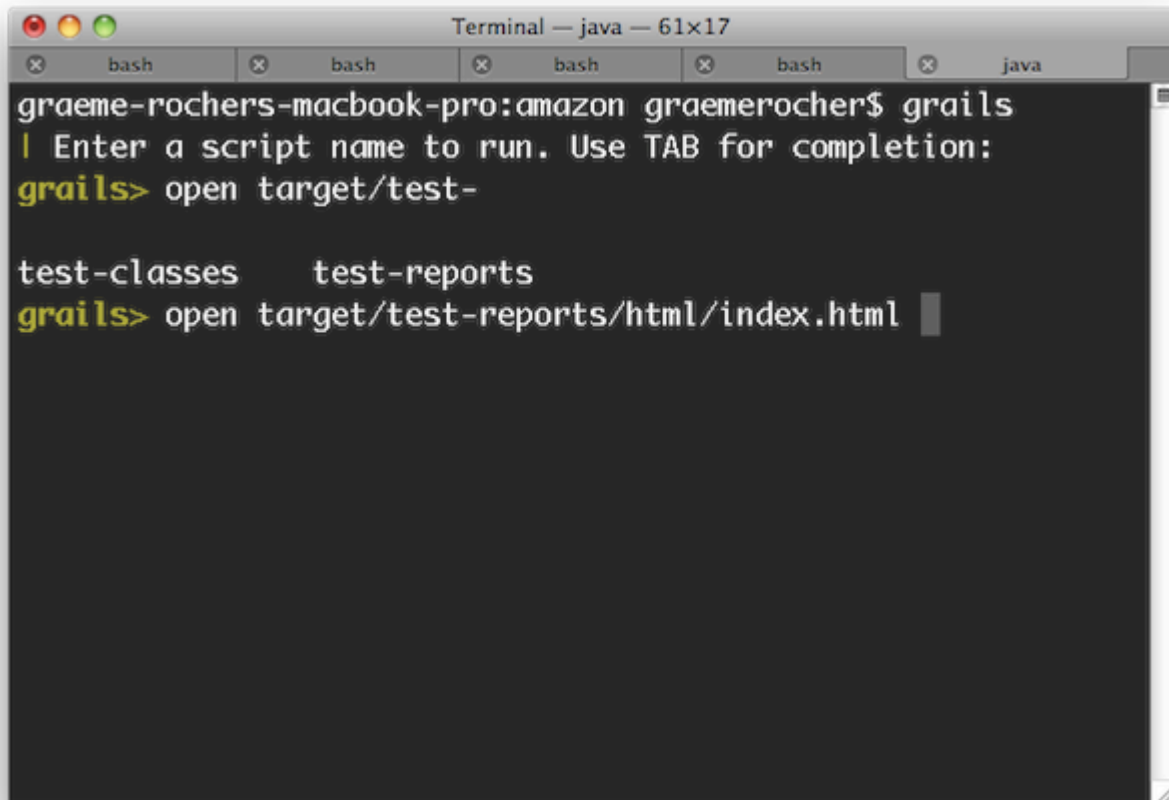
Interactive mode is the a feature of the Grails command line which keeps the JVM running and allows commands. To activate interactive mode type 'grails' at the command line and then use TAB completion to

A screenshot of a macOS terminal window titled 'bookstore — java — 74x22'. The window has four tabs labeled 'bash', 'java', 'bash', and 'bash'. The active tab is 'java'. The terminal shows the following text: 'Graeme-Rochers-iMac:bookstore graemerocher\$ grails', followed by a prompt 'Enter a script name to run. Use TAB for completion:'. The user has entered 'grails> create-s', which has triggered tab completion showing 'create-script' and 'create-service'. The user has then entered 'grails> create-service bookstore.Book', with a cursor at the end of the line.

```
Graeme-Rochers-iMac:bookstore graemerocher$ grails
Enter a script name to run. Use TAB for completion:
grails> create-s

create-script    create-service
grails> create-service bookstore.Book
```

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

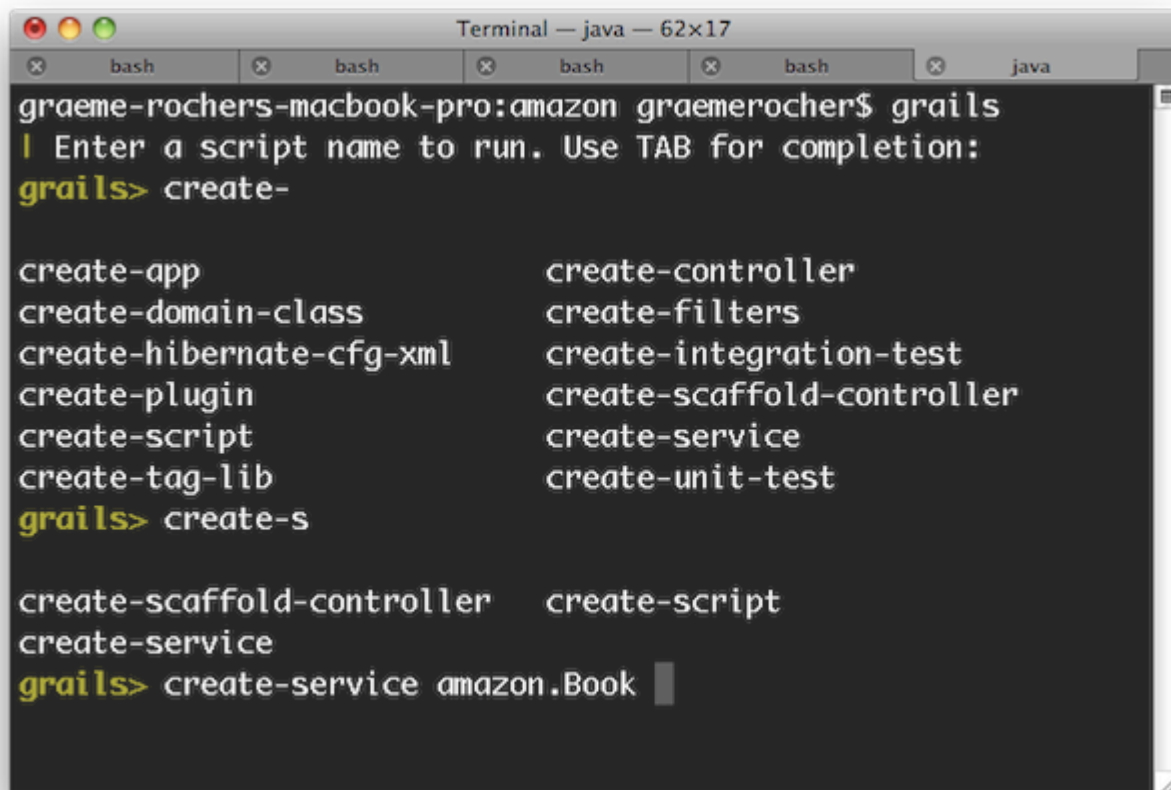
A screenshot of a macOS Terminal window titled "Terminal — java — 61x17". The window has several tabs at the top, including "bash" and "java". The terminal shows a user at the prompt "graeme-rochers-macbook-pro:amazon graemerocher\$" typing the command "grails". The prompt changes to "grails>". The user then types "open target/test-". The terminal displays two suggestions: "test-classes" and "test-reports". The user continues typing "open target/test-reports/html/index.html", and a cursor is visible at the end of the command.

```
graeme-rochers-macbook-pro:amazon graemerocher$ grails
| Enter a script name to run. Use TAB for completion:
grails> open target/test-

test-classes    test-reports
grails> open target/test-reports/html/index.html
```

Even better, the open command understands the logical aliases 'test-report' and 'dep-report', which will open the test report and dependency reports respectively. In other words, to open the test report in a browser simply execute `open test-report`. You can even open multiple files at once: `open test-report test/unit/MyTests.groovy` will open the test report in your browser and the `MyTests.groovy` source file in your text editor.

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

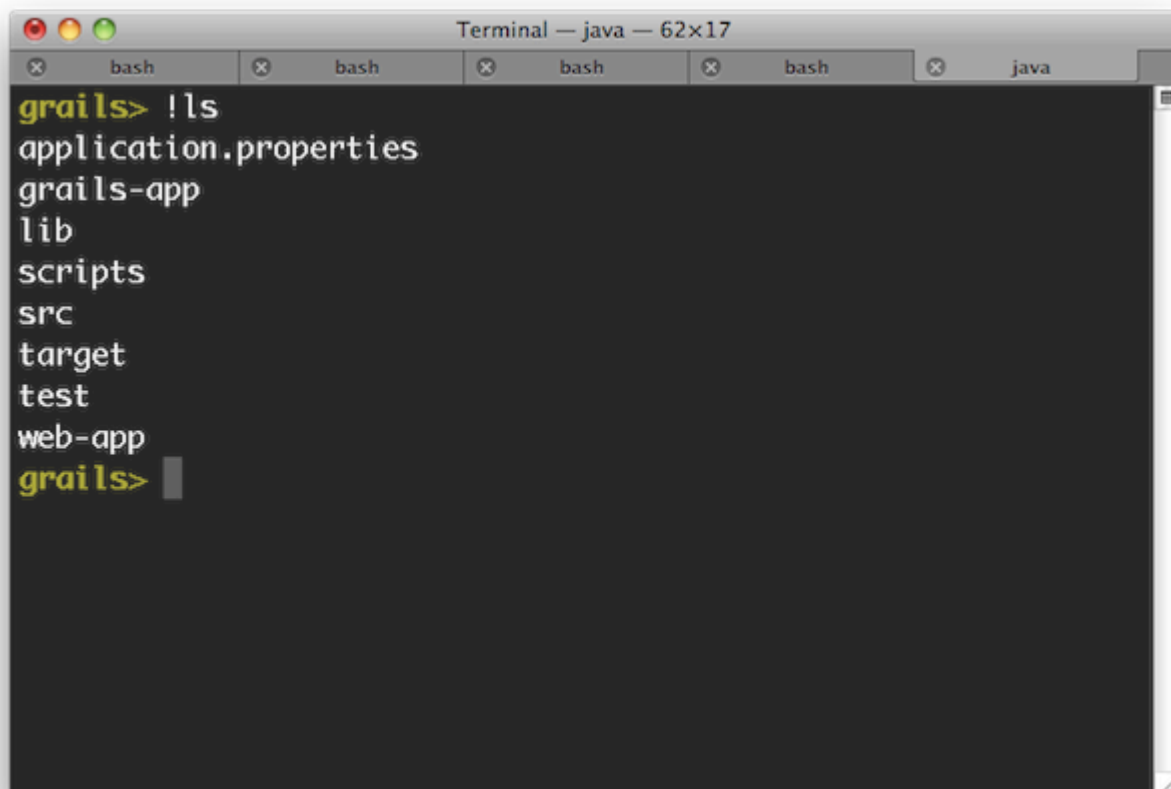


```
Terminal — java — 62x17
graeame-rochers-macbook-pro:amazon graemerocher$ grails
| Enter a script name to run. Use TAB for completion:
grails> create-

create-app                create-controller
create-domain-class       create-filters
create-hibernate-cfg-xml  create-integration-test
create-plugin             create-scaffold-controller
create-script             create-service
create-tag-lib            create-unit-test
grails> create-s

create-scaffold-controller  create-script
create-service
grails> create-service amazon.Book
```

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



```
Terminal — java — 62x17
grails> !ls
application.properties
grails-app
lib
scripts
src
target
test
web-app
grails>
```

Note that with ! (bang) commands, you get file path auto completion - ideal for external commands that c such as 'ls', 'cat', 'git', etc.



The `stop-app` command will stop an application that has been run with the `run-app` command.

To exit interactive mode enter the `exit` command. Note that if the Grails application has been run with `run-app` it will terminate when the interactive mode console exits because the JVM will be terminated. An exception is if the application were running in forked mode which means the application is running in a different JVM. In this case it will be left running after the interactive mode console terminates. If you want to exit interactive mode and the application is running in forked mode, use the `quit` command. The `quit` command will stop the running application and exit interactive mode.

## 6.2 Forked Execution

### Forked Execution

Since Grails 2.3, the `run-app`, `run-war`, `test-app` and `console` commands are now executed in a way that isolates the build classpath from the runtime classpath.

Forked execution is configured via the `grails-app/conf/BuildConfig.groovy` file. The configuration:

```
grails.project.fork = [
  test: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256, daemon:true]
  settings for the test-app JVM
  run: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256], // configure
run-app JVM
  war: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256], // configure
run-war JVM
  console: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256]// configure
the Console UI JVM
]
```

The memory requirements of the forked JVM can be tweaked as per the requirements of the application.

### Forked Test Execution

When running the `test-app` command, a separate JVM is launched to execute these tests. This will have no effect on the execution of the tests when running the command directly:

```
grails test-app
```

To mitigate this, Grails 2.3 and above include a feature that launches a background JVM on standby in interactive mode. In other words, running `test-app` from interactive mode will result in faster test execution.

```
$ grails
$ grails> test-app
```

It is recommended that forked execution is used for tests, however it does require modern hardware and JVMs. You can therefore disable forked execution by setting the `grails.project.fork.test` setting:

```
forkConfig = [maxMemory: 1024, minMemory: 64, debug: false, maxPerm: 256]
grails.project.fork = [
  test: false,
  ...
]
```

## Using the Test Runner Daemon to Speed-up Test Execution

The default configuration for the testing is to activate a daemon to run tests using the `daemon` argument:

```
grails.project.fork = [
  test: [maxMemory: 768, minMemory: 64, debug: false, maxPerm: 256, daemon:true]
  settings for the test-app JVM
  ...
]
```

This only works in interactive mode, so if you start Grails with the 'grails' command and then using `test-app` used:

```
$ grails
$ grails> test-app
```

This has the effect of speeding-up test executions times. You can disable the daemon by setting `daemon` to `false`. If the daemon becomes unresponsive you can restart it with `restart-daemon`:

```
$ grails> restart-daemon
```

## Debugging and Forked Execution (--debug vs --debug-fork)

An important consideration when using forked execution is that the `debug` argument will allow a remote to the build JVM but not the JVM that your application is running in. To debug your application you should use the `--debug-fork` argument:

```
grails test-app --debug-fork
```

Or for `run-app`:

```
grails run-app --debug-fork
```

## Forked Tomcat Execution

Grails 2.2 and above support forked JVM execution of the Tomcat container in development mode. This includes the following:

- Reduced memory consumption, since the Grails build system can exit
- Isolation of the build classpath from the runtime classpath
- The ability to deploy other Grails/Spring applications in parallel without conflicting dependencies

To enable forked execution you can set the `grails.project.fork.run` property to `true`:

```
grails.project.fork.run=true
```

Then just use the regular `run-app` command as per normal. Note that in forked mode the `grails` process is running in the background. To stop the server there is a new `stop-app` command:

```
grails stop-app
```

To customize the JVM arguments passed to the forked JVM you can specify a map instead:

```
grails.project.fork.run= [maxMemory:1024, minMemory:64, debug:false, maxPerm:256,
'..arbitrary JVM arguments..']
```

## Auto-deploying additional WAR files in Forked Mode

Since forked execution isolates classpaths more effectively than embedded execution you can deploy additional Grails or Spring applications to the container.

The easiest way to do so is to drop the WAR files into the `src/autodeploy` directory (if it doesn't exist).

You can customize the location of the autodeploy directory by specifying an alternative location in `BuildConfig.groovy`:

```
grails.project.autodeploy.dir="/path/to/my/war/files"
```

## Customizing the Forked Tomcat instance

If you want to programmatically customize the forked [Tomcat](#) instance you can do so by implementing `org.grails.plugins.tomcat.ForkedTomcatCustomizer` which provides a method with the

```
void customize(Tomcat tomcat) {
    // your code here
}
```

## 6.3 Creating Gant Scripts

You can create your own Gant scripts by running the [create-script](#) command from the root of your project using the following command:

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

This will create a script called `scripts/CompileSources.groovy`. A Gant script itself is similar to a Groovy script except that it 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.Ant`) that provides access to the [Apache Ant API](#).

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

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

### The default target

In the example above, we specified a target with the explicit name "default". This is one way of defining a default target in a Gant script. An 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 set `setDefaultTarget()` at the end of the script in this example, it can go anywhere as long as it comes before the target ("clean-compile" in this case).

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

## 6.4 Re-using Grails scripts

Grails ships with a lot of command line functionality out of the box that you may find useful in your own scripts (see the [command line reference](#) in the reference guide for info on all the commands). Of particular use are the [compile](#), [package](#), and [run](#) scripts.

The [bootstrap](#) script for example lets you bootstrap a Spring [ApplicationContext](#) instance to get access to the application context (the 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 they had been defined in the current script. The mechanism for doing this is the `includeTargets` property or class to it using the 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 the

## Core Grails targets

As you saw in the example at the beginning of this section, you use neither the `File`- nor the `includeTargets` when including core Grails targets. Instead, you should use the special `grailsScript` provided by the Grails command launcher (note that this is not available in normal Gant scripts, just Grails

The syntax for the `grailsScript()` method is pretty straightforward: simply pass it the name of the without any path information. Here is a list of Grails scripts that you could reuse:

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

There are many more scripts provided by Grails, so it is worth digging into the scripts themselves to find out what are available. 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 Grails' convention: a script is *internal*, or in other words that it has not corresponding "command". So you can't run `"grails _grails_test"`. That is also why 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 in your targets into an internal script that can be easily shared, and provide simple command scripts that arguments and delegate to the targets in the internal script. For example if you have a script that runs some split it like this:

```
./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 pass closures.

## 6.5 Hooking into Events

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

The mechanism is deliberately simple and loosely specified. The list of possible events is not fixed in any hook into 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 following locations:

- `USER_HOME/.grails/scripts` - user-specific event handlers
- `PROJECT_HOME/scripts` - application-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 re performed automatically by Grails, so you just need to declare them in the relevant `_Events.groovy` fi

Event handlers are blocks defined in `_Events.groovy`, with a name beginning with "event". The follo in your `/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`, `event` provides some standard events, which are documented in the command line reference guide. For examp fires the following events:

- `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 script
StatusFinal	message	Passed a string indicating the final script status message, target, even if the 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 file is created, not in managed by Grails
Exiting	returnCode	Called when the scripting environment is about to exit cleanly
PluginInstalled	pluginName	Called after a plugin has been installed
CompileStart	kind	Called when compilation starts, passing the kind of compilation
CompileEnd	kind	Called when compilation is finished, passing the kind of compilation
DocStart	kind	Called when documentation generation is about to start - javadoc
DocEnd	kind	Called when documentation generation has ended - javadoc
SetClasspath	rootLoader	Called during classpath initialization so plugins can augment rootLoader.addURL(...). Note that this augments the classpath loaded so you cannot use this to load a class that your environment already has loaded although you can do this if you load the class by name.
PackagingEnd	none	Called at the end of packaging (which is called prior to the application being started and after web.xml is generated)

## 6.6 Customising the build

Grails is most definitely an opinionated framework and it prefers convention to configuration, but this can be configured. In this 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 contains build information. It controls where classes are compiled to, what dependencies the application has, and other such information.

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.
config	The configuration settings defined in the project's <code>BuildConfig.groovy</code> file. same way as you access runtime settings: <code>grailsSettings.config.foo.b</code>
compileDependencies	A list of compile-time project dependencies as <code>File</code> instances.
testDependencies	A list of test-time project dependencies as <code>File</code> instances.
runtimeDependencies	A list of runtime-time project dependencies as <code>File</code> instances.

Of course, these properties aren't much good if you can't get hold of them. Fortunately that's easy `BuildSettings` is available to your scripts as the `grailsSettings` script variable. You can also access using the `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 name. For 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 work.dir would also 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 takes precedence over the 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 former only affects the build, whereas the latter contains those that affect the application at runtime. It's not limited to a single table either: you will find build configuration options dotted around the documentation, such as ones for specifying where the embedded servlet container runs on or 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"). In the absence of this property, the default is 8080.
grails.server.port.https	Port to run the embedded servlet container on for HTTPS ("run-app --https"). In the absence of this property, the default is 8443.
grails.config.base.webXml	Path to a custom web.xml file to use for the application (alternative to using the default web.xml in the grails-app/conf directory).
grails.compiler.dependencies	Legacy approach to adding extra dependencies to the compiler classpath. These entries will be processed by an AntBuildTask. The Groovy form of the corresponding XML elements in an Ant build file is: <code>&lt;include name="\$basedir/lib" includes="**/*.class"/&gt;</code> .
grails.testing.patterns	A list of Ant path patterns that let you control which files are included in the test case. By default, the patterns are <code>test-classes</code> and <code>test-resources</code> . You should not 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 it by setting this 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 the extension. For example, "target/my-app.war".
grails.war.dependencies	A closure containing "fileset()" entries that allows you complete control over the files included in the WAR's "WEB-INF/lib" directory.
grails.war.copyToWebApp	A closure containing "fileset()" entries that allows you complete control over the files copied to the web application directory of the WAR. It overrides the default behaviour of including everything under the staging directory.
grails.war.resources	A closure that takes the location of the staging directory as its first argument and returns a list of files to do anything you like. It is typically used to remove files from the staging directory that directory is jar'd up into a WAR.
grails.project.web.xml	The location to generate Grails' web.xml to

## Reloading Agent Cache Directory

Grails uses an agent based reloading system in the development environment that allows source code changes to be applied while the application is running. This reloading agent caches information needed to carry out the reloading of the application. This cache information is stored under `<USER_HOME_DIR>/grails/.slcache/`. The `GRAILS_AGENT_CACHE` environment variable may be assigned a value to cause this cache information to be stored somewhere else. Note that this is an environment variable, not a JVM system property or a property which may be defined in `BuildConfig.groovy`. It must be defined as an environment variable because the agent cache directory must be configured very early in the process, before any Grails code is executed.

## 6.7 Ant and Maven

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

### Maven Integration

Grails provides integration with [Maven 3](#) with a Maven plugin.

#### Preparation

In order to use the Maven plugin, all you need is Maven 3 installed and set up. This is because **you need Maven 3 separately to use it with Maven!**



The Maven 3 integration for Grails has been designed and tested for Maven 3.1.0 and above and may not work with earlier versions.

### Creating a Grails Maven Project

Using the `create-pom` command you can generate a valid Maven `pom.xml` file for any existing Grails application. This section presents an example:

```
$ grails create-app myapp
$ cd myapp
$ grails create-pom com.mycompany
```

The `create-pom` command expects a group id as an argument. The name and the version of the application are specified in `application.properties` of the application. The Maven plugin will keep the version in the `pom.xml` file in sync with the version in `application.properties`.

The following standard Maven commands are then possible:

- `compile` - Compiles a Grails project
- `package` - Builds a WAR file from the Grails project.
- `install` - Builds a WAR file (or plugin zip/jar if a plugin) and installs it into your local Maven cache
- `test` - Runs the tests of a Grails project
- `clean` - Cleans the Grails project

Other standard Maven commands will likely work too.

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-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

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

## Defining Plugin Dependencies

All Grails plugins are published to a standard Maven repository located at `http://repo.grails.org/grails/`. When using the Maven plugin, ensure that this repository is declared in your list of remote repositories:

```
<repository>
  <id>grails-plugins</id>
  <name>grails-plugins</name>
  <url>http://repo.grails.org/grails/plugins</url>
</repository>
```

With this done you can declare plugin dependencies within your `pom.xml` file:

```
<dependency>
  <groupId>org.grails.plugins</groupId>
  <artifactId>database-migration</artifactId>
  <version>1.1</version>
  <scope>runtime</scope>
  <type>zip</type>
</dependency>
```

Note that the `type` element must be set to `zip`.

## Specifying the Grails Version to Use

The 2.4.0 version of the Maven plugin works with different versions of Grails. By default it tries to auto-detect the version to use from the `grails-dependencies` dependency definition found in the `pom.xml`:

```
<dependency>
  <groupId>org.grails</groupId>
  <artifactId>grails-dependencies</artifactId>
  <version>2.4.0</version>
</dependency>
```

If you change the version of `grails-dependencies` then a different version of Grails will be used. You can explicitly define the Grails version to be used in the plugin configuration:

```
<plugin>
  <groupId>org.grails</groupId>
  <artifactId>grails-maven-plugin</artifactId>
  <version>2.4.0</version>
  <configuration>
    <grailsVersion>2.4.0</grailsVersion>
  </configuration>
  <extensions>true</extensions>
</plugin>
```

## Debugging Grails Execution

The Maven plugin will run Grails commands in a separate process, meaning that the Grails process occupies a separate Maven process.

To debug the Grails process you need to configure the `forkDebug` option in the plugin's configuration.

```
<plugin>
  <groupId>org.grails</groupId>
  <artifactId>grails-maven-plugin</artifactId>
  <version>2.4.0</version>
  <configuration>
    <forkDebug>true</forkDebug>
  </configuration>
  <extensions>true</extensions>
</plugin>
```

With this configuration in place the JVM executed in Maven will load in debug mode.

If you need to customize the memory of the forked process the following elements are available:

- `forkMaxMemory` - The maximum amount of heap (default 1024)
- `forkMinMemory` - The minimum amount of heap (default 512)
- `forkPermGen` - The amount of permgen (default 256)

## Multi Module Maven Builds

The Maven plugin can be used to power multi-module Grails builds. The easiest way to set up a multi-module build is to use the `create-multi-project-build` command:



```
$ grails create-app myapp
$ grails create-plugin plugin1
$ grails create-plugin plugin2
$ grails create-multi-project-build org.mycompany:parent:1.0
```

Running `mvn install` will build all projects together. To enable the 'grails' command to read the `BuildConfig.groovy` to use the POM and resolve dependencies from your Maven local cache:

```
grails.project.dependency.resolution = {
    ...
    pom true
    repositories {
        ...
        mavenLocal()
    }
}
```

By reading the `pom.xml` file you can do an initial `mvn install` from the parent project to build all into your local maven cache and then `cd` into your project and use the regular `grails run-app` application. All previously built plugins will be resolved from the local Maven cache.

## Adding Grails commands to phases

The standard POM created for you by Grails already attaches the appropriate core Grails commands to the phases, so "compile" goes in the "compile" phase and "war" goes in the "package" phase. That doesn't help to attach a plugin's command to a particular phase. The classic example is functional tests. How do you run functional tests (using whichever plugin 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 "exec

```

<plugin>
  <groupId>org.grails</groupId>
  <artifactId>grails-maven-plugin</artifactId>
  <version>2.4.0</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 specify the command as the `command` system property, and optionally specify the arguments with the `args` property.

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

## Raising issues

If you come across any problems with the Maven integration, please raise a [JIRA issue](#).

## Ant Integration

When you create a Grails application with the [create-app](#) command, Grails doesn't automatically create an `ant` target, but you can 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 automatically download the requisite Grails JAR files and other dependencies on demand. You don't even have to install Grails locally, which is particularly useful for 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 task, not just the ones 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`" JAR, so that has to be on the classpath at least. You should also include the "`groovy-all`" JAR. With the task defined, the following table shows you what attributes are available:

Attribute	Description	Required
<code>home</code>	The location of the Grails installation directory to use for the build.	Yes, unless <code>classpathref</code> is set.
<code>classpathref</code>	Classpath to load Grails from. Must include the " <code>grails-bootstrap</code> " JAR artifact and should include " <code>grails-scripts</code> ".	Yes, unless <code>home</code> is set.
<code>script</code>	The name of the Grails script to run, e.g. " <code>TestApp</code> ".	Yes.
<code>args</code>	The arguments to pass to the script, e.g. " <code>-unit -xml</code> ".	No. Default: <code>grails</code> .
<code>environment</code>	The Grails environment to run the script in.	No. Default: <code>development</code> .
<code>includeRuntimeClasspath</code>	Advanced setting: adds the application's runtime classpath to the build classpath if true.	No. Default: <code>false</code> .

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. Typically `@compileClasspath`.
- `testClasspath` - Classpath used to compile and run the tests. Typically includes everything in `runtimeClasspath`.

How you populate these paths is up to you. If you use the `home` attribute and put your own dependencies in `home/lib`, you don't even need to use any of them. For an example of their use, take a look at the generated Ant build file.

## 6.8 Grails Wrapper

The Grails Wrapper allows a Grails application to be built without having to install Grails and configure the `GRAILS_HOME` environment variable. The wrapper includes a small shell script and a couple of small bootstrap jar files checked in to source code control along with the rest of the project. The first time the wrapper is executed it will automatically configure a Grails installation. This wrapper makes it more simple to setup a development environment, upgrade to future versions of Grails. When the application is upgraded to the next version of Grails, the wrapper is updated and checked in to the source code control system and the next time developers update their workspace and run the wrapper, they will automatically be using the correct version of Grails.

### Generating The Wrapper

The [wrapper](#) command can be used to generate the wrapper shell scripts and supporting jar files. Execute the command from the top of an existing Grails project.

```
grails wrapper
```

In order to do this of course Grails must be installed and configured. This is only a requirement for bootstrap. Once the wrapper is generated there is no need to have a Grails installation configured in order to use the wrapper.

See the [wrapper](#) command documentation for details about command line arguments.

By default the wrapper command will generate a `grailsw` shell script and `grailsw.bat` batch file. In addition to those, a `wrapper/` directory (the name of the directory is configurable via command line options) contains some support files which are necessary to run the wrapper. All of these files should be checked in to source code control along with the rest of the project. This allows developers to check the project out of source control and immediately start using the wrapper to execute Grails commands without having to install and configure Grails.

### Using The Wrapper

The wrapper script accepts all of the same arguments as the normal `grails` command.

```
./grailsw create-domain-class com.demo.Person  
./grailsw run-app  
./grailsw test-app unit:  
etc...
```

## 7 Object Relational Mapping (GORM)

Domain classes are core to any business application. They hold state about business processes and behavior. They are 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 (an open source ORM solution) and thanks to the dynamic nature of Groovy with its static and dynamic convention of Grails, there is far 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 write but still use 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()
```

### 7.1 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 name as the 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 `I` Grails will 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

### 7.1.1 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 database in a 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 explicitly call the [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 proxy and throws an exception 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()
```

## 7.2 Domain Modelling in GORM

When building Grails applications you have to consider the problem domain you are trying to solve. If you are building an [Amazon](#)-style bookstore you would be thinking about books, authors, customers and publishers.

These are modeled in GORM as Groovy classes, so a `Book` class may have a title, a release date, an ISBN. The next few 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 can be customized through the [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 underscores. For example `releaseDate` maps onto a column `release_date`. The SQL types are automatic, but can be customized with [Constraints](#) or the [ORM DSL](#).

## 7.2.1 Association in GORM

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

### 7.2.1.1 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 domain class, for example:

#### 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 relationship bidirectional, we need to define the other side as follows (and see the section on controlling the ends of the association just below):

#### 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 that we can attach a `Nose` instance to it and when we save or delete the `Face` instance, GORM will save or delete the `Nose`. Saves and deletes will cascade 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 error:

```
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 example A, so in this case it's stored in the nose table inside a column called `face_id`. Also, `hasOne` only works with bidirectional relationships.

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
}
```

### Controlling the ends of the association

Occasionally you may find yourself with domain classes that have multiple properties of the same type, i.e. the association property has the same type as the domain class it's in. Such situations can arise because Grails may guess incorrectly the type of the association. Consider this simple class:

```
class Person {
    String name
    Person parent

    static belongsTo = [ supervisor: Person ]
    static constraints = { supervisor nullable: true }
}
```

As far as Grails is concerned, the `parent` and `supervisor` properties are two directions of the same : set the `parent` property on a `Person` instance, Grails will automatically set the `supervisor` property on the instance. This may be what you want, but if you look at the class, what we in fact have are two unidirectional

To guide Grails to the correct mapping, you can tell it that a particular association is unidirectional property:

```
class Person {
    String name
    Person parent

    static belongsTo = [ supervisor: Person ]
    static mappedBy = [ supervisor: "none", parent: "none" ]
    static constraints = { supervisor nullable: true }
}
```

You can also replace `"none"` with any property name of the target class. And of course this works for not just self-referential ones. Nor is the `mappedBy` property limited to many-to-one and one-to-one associations, one-to-many and many-to-many associations as you'll see in the next section.



If you have a property called `"none"` on your domain class, this approach won't work currently. The `"none"` property will be treated as the reverse direction of the association (or the `"back"` property). Fortunately, `"none"` is not a common domain class property name.


### 7.2.1.2 One-to-many

A one-to-many relationship is when one class, example `Author`, has many instances of another class, example `Book`. you define 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 with

 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 `hasMany` property. This collection can be used to 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 not be initialized on first 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 `hasMany` association.

The default cascading behaviour is to cascade saves and updates, but not deletes unless a `belongsTo` is also present.

```
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 mapped collection is 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
}
```

### 7.2.1.3 Many-to-many

Grails supports many-to-many relationships by defining a `hasMany` on both sides of the relationship and on the owned 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 relationship takes 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 responsibility for the relationship.



Grails' [Scaffolding](#) feature **does not** currently support many-to-many relationship and hence you have to write the code to manage the relationship yourself

### 7.2.1.4 Basic Collection Types

As well as associations between different domain classes, GORM also supports mapping of basic collections. The following 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 how the association is mapped using the `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

## 7.2.2 Composition in GORM

As well as [association](#), Grails supports the notion of composition. In this case instead of mapping class class can be "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 look 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` directory will also get an address table. If you don't want this to happen use Groovy's ability to define classes per file and include the Address class below the Person class in the `grails-app/domain/Person.groovy` file

## 7.2.3 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 column called `class` (`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 inheritance. An alternative is to use 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 deep queries. In general our advice is if you're going to use inheritance, don't abuse it and don't make your inheritance tree too deep.

## Polymorphic Queries

The upshot of inheritance is that you get the ability to polymorphically query. For example using the [list](#) super class 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
```

## 7.2.4 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 contain duplicates. 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 uniqueness but not order you want. To 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` in your Book 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 sorted by date.

## 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 collection type as 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 in the database:

```

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 index of the collection to retain this order at the database level.

When using a List, elements must be added to the collection before being saved, otherwise Hibernate will throw an 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 Hibernate mapped 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 mapped load of all existing instances from the database, so this approach will perform better and require less memory.

## 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 association the entire associations from the database. If you have a large numbers of entries in the association this performance.

The same behavior is required for List types, since Hibernate needs to load the entire association to maintain recommended that if you anticipate a large numbers of records in the association that you make the association the link can 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 to directly resulting in fewer queries and more efficient code. Given an Author with a large number of associations you were to write 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.

## 7.3 Persistence Basics

A key thing to remember about Grails is that under the surface Grails is using [Hibernate](#) for persistence. In the background of using [ActiveRecord](#) or [iBatis/MyBatis](#), 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 [save](#) as well as other GORM methods transparently.

### Transactional Write-Behind

A useful feature of Hibernate over direct JDBC calls and even other frameworks is that when you call `save()` it does not necessarily perform any SQL operations **at that point**. Hibernate batches up SQL statements and executes them often at the end of the request when flushing and closing the session. This is typically done for you automatically if you use `save()` to manage your Hibernate session.

Hibernate caches database updates where possible, only actually pushing the changes when it knows that a flush is triggered programmatically. One common case where Hibernate will flush cached updates is when you execute a query since the cached information might be included in the query results. But as long as you're doing inserts, updates, and deletes, they'll be batched until the session is flushed. This can be a significant performance benefit if you do a lot of database writes.

Note that flushing is not the same as committing a transaction. If your actions are performed in the context of a transaction, they will execute SQL updates but the database will save the changes in its transaction queue and only final transaction commits.

#### 7.3.1 Saving and Updating

An example of using the [save](#) method can be seen below:

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

This save will not be pushed to the database immediately - it will be pushed when the next flush occurs. When you want to control when those statements are executed or, in Hibernate terminology, when the session is flushed, you can use the flush 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 synchronized to the database. This also lets you catch any exceptions, which is typically useful in highly concurrent scenarios involving `save()`.



```
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 validation fails, the instance will *not* be persisted to the database. By default, `save()` will simply return `null` in this case, but to throw an exception you can 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 [section](#). Remember that when you are saving domain instances that have been bound with data provided by the user, the risk of validation exceptions is quite high 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!

### 7.3.2 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 delete immediately, you can use the `flush` 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 may database constraint, although this is normally down to a programming or schema error. The following example shows a `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 flags/logic.

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"])
```

### 7.3.3 Understanding Cascading Updates and Deletes

It is critical that you understand how cascading updates and deletes work when using GORM. The key `belongsTo` 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 cascade from the owning class to its dependant (the other side of the relationship), and for many-to-many, one-to-one and one-to-many relationships.

If you *do not* define `belongsTo` then no cascades will happen and you will have to manually save each of the 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 `Flights` to it I can save the `Airport` and have the update flight, hence 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 `Flights` 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 understand more about this and other GORM Gotchas, take a look at the summaries below that describe the default behaviour of GORM with regards to specific associations. For a deeper understanding of relationships and cascading, see the GORM Gotchas series of articles.

#### **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 stays on the one side 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 stays on the one side and "SAVE-UPDATE".

#### 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` then the "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 owning side of 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](#).

### 7.3.4 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 then an *iteration* over the `flights` association to get the current flight's destination. In other words you get N+1 queries (N for the flights, 1 for the original one to get the airport).

## Configuring Eager Fetching

An alternative approach that avoids the N+1 queries is to use eager fetching, which can be specified as follows:

```
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, although executed to fetch the collection. You can also use `fetch: 'join'` instead of `lazy: false`, in which you execute a single query to get the airports and their flights. This works well for single-ended associations, but with one-to-manys. Queries will work as you'd expect right up to the moment you add a limit to the number of results. At that point, you will likely end up with fewer results than you were expecting. The reason for this is quite simple: the problem arises from GORM using a left outer join.

So, the recommendation is currently to use `fetch: 'join'` for single-ended associations and `fetch: 'select'` for one-to-manys.

Be careful how and where you use eager loading because you could load your entire database into memory. 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 eagerly fetchable, you could possibly load your entire database into memory resulting in performance and memory problems. An alternative is to use batch fetching. You can 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, Hibernate will fetch flights in batches of 10. For example if you had an `Airport` that had 30 flights, if you didn't configure batch fetching, you would get 1 query to fetch the `Airport` and then 30 queries to fetch each flight. With batch fetching you get 1 query to fetch the `Airport` and 3 queries to fetch each `Flight` in batches of 10. In other words, batch fetching is an optimization of lazy fetching. Batch fetching can also be configured at the class level as follows:

```
class Flight {
    ...
    static mapping = {
        batchSize 10
    }
}
```

Check out [part 3](#) of the GORM Gotchas series for more in-depth coverage of this tricky topic.

## 7.3.5 Pessimistic and Optimistic Locking

### Optimistic Locking

By default GORM classes are configured for optimistic locking. Optimistic locking is a feature of Hibernate that uses a version 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 the object. You can access:

```
def airport = Airport.get(10)
println airport.version
```

When you perform updates Hibernate will automatically check the version property against the version column in the database. If they differ it 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 has a performance penalty. The downside is that you have to deal with this exception if you have highly concurrent writes. Here's an example session:

```
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 merge or inform the user and 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 a row. It has the 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. Here what we are doing is "upgrading" from a regular SELECT to a SELECT..FOR UPDATE and another update of the record in between the 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 `findBy`

```
def airport = Airport.findByName("Heathrow", [lock: true])
```

Or using criteria:

```
def airport = Airport.createCriteria().get {
    eq('name', 'Heathrow')
    lock true
}
```

## 7.3.6 Modification Checking

Once you have loaded and possibly modified a persistent domain class instance, it isn't straightforward to reload the instance using [get](#). Hibernate will return the current modified instance. Reloading using another query would trigger a flush which could cause problems if your data isn't really dirty (GORM provides some methods to retrieve the original values that Hibernate caches when it loads the instance, but this is beyond the scope of this article).

## 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 properties and 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 empty if no fields have been modified.

```
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
    }
}
```

## 7.4 Querying with GORM

GORM supports a number of powerful ways to query from dynamic finders, to criteria to Hibernate language HQL. Depending on the complexity of the query you have the following options in order of flexibility:

- Dynamic Finders
- Where Queries
- Criteria Queries
- Hibernate Query Language (HQL)

In addition, Groovy's ability to manipulate collections with [GPath](#) and methods like `sort`, `findAll` and so on results in a powerful 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 `order` for **ascending** or `desc` for **descending**.

## 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)
```

## 7.4.1 Dynamic Finders

GORM supports the concept of **dynamic finders**. A dynamic finder looks like a static method invocation, but the methods themselves don't 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 of the class. For example the 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 find methods in 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 describes the properties. The 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` comparator like 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
- `InRange` - Between the `from` and `to` values of a Groovy Range
- `Rlike` - Performs a Regexp `LIKE` in MySQL or Oracle otherwise falls back to `Like`
- `Between` - Between two values (requires two arguments)
- `IsNull` - Not a null value (doesn't take an argument)
- `IsNotNull` - 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 demo example:

```
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 n Or or if the number of criteria creates a very long method name, just convert the query to a [Criteria](#) or [HQ](#)

## 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 finders as the final parameter:

```
def books = Book.findAllByTitleLike("Harry Pot%",
    [max: 3, offset: 2, sort: "title", order: "desc"])
```

### 7.4.2 Where Queries

The where method, introduced in Grails 2.0, builds on the support for [Detached Criteria](#) by providing an easy-to-use query DSL for common queries. The where method is more flexible than dynamic finders, less verbose, and provides a powerful mechanism to compose queries.

#### Basic Querying

The where method accepts a closure that looks very similar to Groovy's regular collection methods. The logical criteria in regular Groovy syntax, for example:

```
def query = Person.where {
    firstName == "Bart"
}
Person bart = query.find()
```

The returned object is a DetachedCriteria instance, which means it is not associated with any particular session. This means you can use the where method to define common queries at the class level:

```
class Person {
    static simpsons = where {
        lastName == "Simpson"
    }
    ...
}
...
Person.simpsons.each {
    println it.firstname
}
```



Query execution is lazy and only happens upon usage of the [DetachedCriteria](#) instance. If you want to execute immediately there are variations of the `findAll` and `find` methods to accomplish this:

```
def results = Person.findAll {
    lastName == "Simpson"
}
def results = Person.findAll(sort:"firstName") {
    lastName == "Simpson"
}
Person p = Person.find { firstName == "Bart" }
```

Each Groovy operator maps onto a regular criteria method. The following table provides a map of Groovy

Operator	Criteria Method	Description
==	eq	Equal to
!=	ne	Not equal to
>	gt	Greater than
<	lt	Less than
>=	ge	Greater than or equal to
<=	le	Less than or equal to
in	inList	Contained within the given list
==~	like	Like a given string
=~	ilike	Case insensitive like

It is possible to use regular Groovy comparison operators and logic to formulate complex queries:

```
def query = Person.where {
    (lastName != "Simpson" && firstName != "Fred") || (firstName == "Bart" && age
}
def results = query.list(sort:"firstName")
```

The Groovy regex matching operators map onto `like` and `ilike` queries unless the expression on the right object, in which case they map onto an `rlike` query:

```
def query = Person.where {  
  firstName =~ ~/B.+/  
}
```



Note that `rlike` queries are only supported if the underlying database supports regular expressions.

A between criteria query can be done by combining the `in` keyword with a range:

```
def query = Person.where {  
  age in 18..65  
}
```

Finally, you can do `isNull` and `isNotNull` style queries by using `null` with regular comparison operators:

```
def query = Person.where {  
  middleName == null  
}
```

## Query Composition

Since the return value of the `where` method is a [DetachedCriteria](#) instance you can compose new queries from existing ones:

```
def query = Person.where {  
  lastName == "Simpson"  
}  
def bartQuery = query.where {  
  firstName == "Bart"  
}  
Person p = bartQuery.find()
```

Note that you cannot pass a closure defined as a variable into the where method unless it has been a `DetachedCriteria` instance. In other words the following will produce an error:

```
def callable = {
    lastName == "Simpson"
}
def query = Person.where(callable)
```

The above must be written as follows:

```
import grails.gorm.DetachedCriteria

def callable = {
    lastName == "Simpson"
} as DetachedCriteria<Person>
def query = Person.where(callable)
```

As you can see the closure definition is cast (using the Groovy `as` keyword) to a [DetachedCriteria](#) instance class.

## Conjunction, Disjunction and Negation

As mentioned previously you can combine regular Groovy logical operators ( `||` and `&&`) to form conjunction

```
def query = Person.where {
    (lastName != "Simpson" && firstName != "Fred") || (firstName == "Bart" && age > 10)
}
```

You can also negate a logical comparison using `!`:

```
def query = Person.where {
    firstName == "Fred" && !(lastName == 'Simpson')
}
```

## Property Comparison Queries

If you use a property name on both the left hand and right side of a comparison expression then the comparison criteria is automatically used:

```
def query = Person.where {  
    firstName == lastName  
}
```

The following table described how each comparison operator maps onto each criteria property comparison

Operator	Criteria Method	Description
==	eqProperty	Equal to
!=	neProperty	Not equal to
>	gtProperty	Greater than
<	ltProperty	Less than
>=	geProperty	Greater than or equal to
<=	leProperty	Less than or equal to

## Querying Associations

Associations can be queried by using the dot operator to specify the property name of the association to be

```
def query = Pet.where {  
    owner.firstName == "Joe" || owner.firstName == "Fred"  
}
```

You can group multiple criterion inside a closure method call where the name of the method matches the a

```
def query = Person.where {  
    pets { name == "Jack" || name == "Joe" }  
}
```

This technique can be combined with other top-level criteria:

```
def query = Person.where {  
    pets { name == "Jack" } || firstName == "Ed"  
}
```

For collection associations it is possible to apply queries to the size of the collection:

```
def query = Person.where {  
    pets.size() == 2  
}
```

The following table shows which operator maps onto which criteria method for each size() comparison:

Operator	Criteria Method	Description
==	sizeEq	The collection size is equal to
!=	sizeNe	The collection size is not equal to
>	sizeGt	The collection size is greater than
<	sizeLt	The collection size is less than
>=	sizeGe	The collection size is greater than or equal to
<=	sizeLe	The collection size is less than or equal to

## Subqueries

It is possible to execute subqueries within where queries. For example to find all the people older than the average age of the people older than them, the following query can be used:

```
final query = Person.where {  
    age > avg(age)  
}
```

The following table lists the possible subqueries:

Method	Description
<b>avg</b>	The average of all values
<b>sum</b>	The sum of all values
<b>max</b>	The maximum value
<b>min</b>	The minimum value
<b>count</b>	The count of all values
<b>property</b>	Retrieves a property of the resulting entities

You can apply additional criteria to any subquery by using the `of` method and passing in a closure contain

```
def query = Person.where {
  age > avg(age).of { lastName == "Simpson" } && firstName == "Homer"
}
```

Since the `property` subquery returns multiple results, the criterion used compares all results. For example, you will find all people younger than people with the surname "Simpson":

```
Person.where {
  age < property(age).of { lastName == "Simpson" }
}
```

## Other Functions

There are several functions available to you within the context of a query. These are summarized in the tab

Method	Description
<b>second</b>	The second of a date property
<b>minute</b>	The minute of a date property
<b>hour</b>	The hour of a date property
<b>day</b>	The day of the month of a date property
<b>month</b>	The month of a date property
<b>year</b>	The year of a date property
<b>lower</b>	Converts a string property to upper case
<b>upper</b>	Converts a string property to lower case
<b>length</b>	The length of a string property
<b>trim</b>	Trims a string property



Currently functions can only be applied to properties or associations of domain classes. You example, use a function on a result of a subquery.

For example the following query can be used to find all pet's born in 2011:

```
def query = Pet.where {
  year(birthDate) == 2011
}
```

You can also apply functions to associations:

```
def query = Person.where {
  year(pets.birthDate) == 2009
}
```

## Batch Updates and Deletes

Since each where method call returns a [DetachedCriteria](#) instance, you can use where queries to execute batch updates and deletes. For example, the following query will update all people with the surname "Bloggs":

```
def query = Person.where {
    lastName == 'Simpson'
}
int total = query.updateAll(lastName: "Bloggs")
```



Note that one limitation with regards to batch operations is that join queries (queries associations) are not allowed.

To batch delete records you can use the `deleteAll` method:

```
def query = Person.where {
    lastName == 'Simpson'
}
int total = query.deleteAll()
```

### 7.4.3 Criteria

Criteria is an advanced way to query that uses a Groovy builder to construct potentially complex queries. It is a more powerful approach than building up query strings using a `StringBuffer`.

Criteria can be used either with the [createCriteria](#) or [withCriteria](#) methods. The builder uses Hibernate's Criteria API. For example, this builder maps 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 in a List 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.

If no records are found with the above criteria, an empty List is returned.

## 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 `Account` Transaction objects:

```
class Account {
  ...
  static hasMany = [transactions: Transaction]
  ...
}
```

We can query this association by using the property name `transactions` 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 last 10 days. We can nest such 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 created.

## Querying with Projections

Projections may be used to customise the results. Define a "projections" node within the criteria builder. There are equivalent methods within the projections node to the methods found in the Hibernate [Projection](#)

```

def c = Account.createCriteria()
def numberOfBranches = c.get {
    projections {
        countDistinct('branch')
    }
}

```

When multiple fields are specified in the projection, a List of values will be returned. A single value will be b

## SQL Projections

The criteria DSL provides access to Hibernate's SQL projection API.

```

// Box is a domain class...
class Box {
    int width
    int height
}

```

```

// Use SQL projections to retrieve the perimeter and area of all of the Box insta
def c = Box.createCriteria()

def results = c.list {
    projections {
        sqlProjection '(2 * (width + height)) as perimeter, (width * height) as are
'area', [INTEGER, INTEGER]
    }
}

```

The first argument to the `sqlProjection` method is the SQL which defines the projections. The second argument is a list of Strings which represent column aliases corresponding to the projected values expressed in the SQL. The third argument is a list of `org.hibernate.type.Type` instances which correspond to the projected values expressed in the SQL. The fourth argument is a list of `org.hibernate.type.Type` objects but constants like `INTEGER`, `LONG`, `FLOAT` etc. are provided. These constants correspond to all of the types defined in `org.hibernate.type.StandardBasicTypes`.

Consider that the following table represents the data in the BOX table.

width	height
2	7
2	8
2	9
4	9

The query above would return results like this:

```
[[18, 14], [20, 16], [22, 18], [26, 36]]
```

Each of the inner lists contains the 2 projected values for each Box, perimeter and area.



Note that if there are other references in scope wherever your criteria query is expressed that conflict with any of the type constants described above, the code in your criteria will resolve references, not the type constants provided by the DSL. In the unlikely event of that happening, disambiguate the conflict by referring to the fully qualified Hibernate type. For `StandardBasicTypes.INTEGER` instead of `INTEGER`.

If only 1 value is being projected, the alias and the type do not need to be included in a list.

```
def results = c.list {
  projections {
    sqlProjection 'sum(width * height) as totalArea', 'totalArea', INTEGER
  }
}
```

That query would return a single result with the value of 84 as the total area of all of the Box instances.

The DSL supports grouped projections with the `sqlGroupProjection` method.

```
def results = c.list {
  projections {
    sqlGroupProjection 'width, sum(height) as combinedHeightsForThisWidth', 'combinedHeightsForThisWidth', [INTEGER, INTEGER]
  }
}
```

The first argument to the `sqlGroupProjection` method is the SQL which defines the projection represents the group by clause that should be part of the query. That string may be single column name or column names. The third argument is a list of Strings which represent column aliases corresponding expressed in the SQL. The fourth argument is a list of `org.hibernate.type.Type` instances which represent projected values expressed in the SQL.

The query above is projecting the combined heights of boxes grouped by width and would return results that

```
[[2, 24], [4, 9]]
```

Each of the inner lists contains 2 values. The first value is a box width and the second value is the sum of boxes which have that width.

## 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"
}
```

SQL Restrictions may be parameterized to deal with SQL injection vulnerabilities related to dynamic restrictions.

```
def c = Person.createCriteria()
def peopleWithShortFirstNames = c.list {
    sqlRestriction "char_length(first_name) < ? AND char_length(first_name) > ?",
    minValuel
}
```



Note that the parameter there is SQL. The `first_name` attribute referenced in the example is from the persistence model, not the object model like in HQL queries. The `Person` property named `first_name` is mapped to the `first_name` column in the database and you must refer to that column in the `sqlRestriction` string.

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 pattern is very similar to the JDBC PreparedStatement / ResultSet pattern and the semantics interface are similar to the similarly 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 the `Criteria` instance. This example calls `setMaxResults` and `setFirstResult` on the `Criteria` instance:

```
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 However, this 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 associations. It's probably best not to use this for one-to-many associations though, because you will most likely get duplicate results. Instead, use the '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 results using the `maxResults` option.



`fetchMode` and `join` are general settings of the query and can only be specified at the top level. You cannot 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 associations will be eagerly 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 explicitly set.

## 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
<b>list</b>	This is the default method. It returns all matching rows.
<b>get</b>	Returns a unique result set, i.e. just one row. The criteria has to be formed that way, that it only returns one row. This method is not to be confused with a limit to just the first row.
<b>scroll</b>	Returns a scrollable result set.
<b>listDistinct</b>	If subqueries or associations are used, one may end up with the same row multiple times in the result set. This method returns only distinct entities and is equivalent to <code>DISTINCT_ROOT_ENTITY</code> of the <a href="#">Criteria API</a> .
<b>count</b>	Returns the number of matching rows.

## Combining Criteria

You can combine multiple criteria closures in the following way:



```

def emeaCriteria = {
  eq "region", "EMEA"
}

def results = Airport.withCriteria {
  emeaCriteria.delegate = delegate
  emeaCriteria()
  flights {
    like "number", "BA%"
  }
}

```

This technique requires that each criteria must refer to the same domain class (i.e. `Airport`). A more flexible approach is to use Detached Criteria, as described in the following section.

## 7.4.4 Detached Criteria

Detached Criteria are criteria queries that are not associated with any given database session/connection. In Grails 2.0, Detached Criteria queries have many uses including allowing you to create common reusable subqueries and execute batch updates/deletes.

### Building Detached Criteria Queries

The primary point of entry for using the Detached Criteria is the `grails.gorm.DetachedCriteria` domain class as the only argument to its constructor:

```

import grails.gorm.*
...
def criteria = new DetachedCriteria(Person)

```

Once you have obtained a reference to a detached criteria instance you can execute [where](#) queries or criteria. To build a normal criteria query you can use the `build` method:

```

def criteria = new DetachedCriteria(Person).build {
  eq 'lastName', 'Simpson'
}

```

Note that methods on the `DetachedCriteria` instance **do not** mutate the original object but instead return a new object. In other words, you have to use the return value of the `build` method to obtain the mutated criteria object:

```
def criteria = new DetachedCriteria(Person).build {
    eq 'lastName', 'Simpson'
}
def bartQuery = criteria.build {
    eq 'firstName', 'Bart'
}
```

## Executing Detached Criteria Queries

Unlike regular criteria, Detached Criteria are lazy, in that no query is executed at the point of definition. Once a query has been constructed then there are a number of useful query methods which are summarized in the table below.

Method	Description
<b>list</b>	List all matching entities
<b>get</b>	Return a single matching result
<b>count</b>	Count all matching records
<b>exists</b>	Return true if any matching records exist
<b>deleteAll</b>	Delete all matching records
<b>updateAll(Map)</b>	Update all matching records with the given properties

As an example the following code will list the first 4 matching records sorted by the `firstName` property

```
def criteria = new DetachedCriteria(Person).build {
    eq 'lastName', 'Simpson'
}
def results = criteria.list(max:4, sort:"firstName")
```

You can also supply additional criteria to the list method:

```
def results = criteria.list(max:4, sort:"firstName") {
    gt 'age', 30
}
```

To retrieve a single result you can use the `get` or `find` methods (which are synonyms):

```
Person p = criteria.find() // or criteria.get()
```

The `DetachedCriteria` class itself also implements the `Iterable` interface which means that it can

```
def criteria = new DetachedCriteria(Person).build {  
    eq 'lastName', 'Simpson'  
}  
criteria.each {  
    println it.firstName  
}
```

In this case the query is only executed when the `each` method is called. The same applies to all other `G` methods.

You can also execute dynamic finders on `DetachedCriteria` just like on domain classes. For example

```
def criteria = new DetachedCriteria(Person).build {  
    eq 'lastName', 'Simpson'  
}  
def bart = criteria.findByFirstName("Bart")
```

## Using Detached Criteria for Subqueries

Within the context of a regular criteria query you can use `DetachedCriteria` to execute subquery. For example, to find all people who are older than the average age the following query will accomplish that:

```
def results = Person.withCriteria {  
    gt "age", new DetachedCriteria(Person).build {  
        projections {  
            avg "age"  
        }  
    }  
    order "firstName"  
}
```

Notice that in this case the subquery class is the same as the original criteria query class (i.e. Person) and shortened to:

```
def results = Person.withCriteria {  
    gt "age", {  
        projections {  
            avg "age"  
        }  
    }  
    order "firstName"  
}
```

If the subquery class differs from the original criteria query then you will have to use the original syntax.

In the previous example the projection ensured that only a single result was returned (the average age). multiple results then there are different criteria methods that need to be used to compare the result. For people older than the ages 18 to 65 a `gtAll` query can be used:

```
def results = Person.withCriteria {  
    gtAll "age", {  
        projections {  
            property "age"  
        }  
        between 'age', 18, 65  
    }  
    order "firstName"  
}
```

The following table summarizes criteria methods for operating on subqueries that return multiple results:

Method	Description
<b>gtAll</b>	greater than all subquery results
<b>geAll</b>	greater than or equal to all subquery results
<b>ltAll</b>	less than all subquery results
<b>leAll</b>	less than or equal to all subquery results
<b>eqAll</b>	equal to all subquery results
<b>neAll</b>	not equal to all subquery results

## Batch Operations with Detached Criteria

The `DetachedCriteria` class can be used to execute batch operations such as batch updates and the following query will update all people with the surname "Simpson" to have the surname "Bloggs":

```
def criteria = new DetachedCriteria(Person).build {
    eq 'lastName', 'Simpson'
}
int total = criteria.updateAll(lastName: "Bloggs")
```



Note that one limitation with regards to batch operations is that join queries (queries with associations) are not allowed within the `DetachedCriteria` instance.

To batch delete records you can use the `deleteAll` method:

```
def criteria = new DetachedCriteria(Person).build {
    eq 'lastName', 'Simpson'
}
int total = criteria.deleteAll()
```

## 7.4.5 Hibernate Query Language (HQL)

GORM classes also support Hibernate's query language HQL, a very complete reference for which can be found in the [documentation](#) of the Hibernate documentation.

GORM provides a number of methods that work with HQL including [find](#), [findAll](#) and [executeQuery](#). As can be seen below:

```
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("\n"  
  "from Book as b, \n"  
  "  Author as a \n"  
  "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 page number at the end of the 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])
```

## 7.5 Advanced GORM Features

The following sections cover more advanced usages of GORM including caching, custom mapping and events.

### 7.5.1 Events and Auto Timestamping

GORM supports the registration of events as methods that get fired when certain events occur such as delete. The following is a list of supported events:

- `beforeInsert` - Executed before an object is initially persisted to the database. If you return `false`, the insert will be cancelled.
- `beforeUpdate` - Executed before an object is updated. If you return `false`, the update will be cancelled.
- `beforeDelete` - Executed before an object is deleted. If you return `false`, the delete will be cancelled.
- `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 method with your domain class.



Do not attempt to flush the session within an event (such as with `obj.save(flush:true)`). Since the event is fired during flushing this will cause a `StackOverflowError`.

## Event types

## The beforeInsert event

Fired before an object is saved to the database

```
class Person {
    private static final Date NULL_DATE = new Date(0)
    String firstName
    String lastName
    Date signupDate = NULL_DATE
    def beforeInsert() {
        if (signupDate == NULL_DATE) {
            signupDate = new Date()
        }
    }
}
```

## The beforeUpdate event

Fired before an existing object is updated

```
class Person {
    def securityService
    String firstName
    String lastName
    String lastUpdatedBy
    static constraints = {
        lastUpdatedBy nullable: true
    }
    def beforeUpdate() {
        lastUpdatedBy = securityService.currentAuthenticatedUsername()
    }
}
```

## The beforeDelete event

Fired before an object is deleted.



```
class Person {
    String name
    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 firing methods like `save()` and `delete()` won't result in objects being saved unless you run your operations within a new session.

Fortunately the `withNewSession` method lets you share the same transactional JDBC connection even across different underlying Sessions.

## 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.



Validation may run more often than you think. It is triggered by the `validate()` and `save()` methods as you'd expect, but it is also typically triggered just before the view is rendered. When writing `beforeValidate()` implementations, make sure that they can handle being called multiple times with the same property values.

GORM supports an overloaded version of `beforeValidate` which accepts a `List` parameter which represents the properties which are about to be validated. This version of `beforeValidate` will be called when `validate()` has been invoked and passed a `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` method, the `validate` method is being invoked with no arguments, not a `List` that includes all of the names.

Either or both versions of `beforeValidate` may be defined in a domain class. GORM will prefer the `List` version if passed to `validate` but will fall back on the no-arg version if the `List` version does not exist. Likewise, it will prefer the no-arg version if no arguments are passed to `validate` but will fall back on the `List` version if the no-arg version does not exist. In that case, `null` is passed to `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

As of Grails 2.0 there is a new API for plugins and applications to register and listen for persistence events. It works with Hibernate and also works for other persistence plugins such as the [MongoDB plugin for GORM](#).

To use this API you need to subclass `AbstractPersistenceEventListener` (`org.grails.datastore.mapping.engine.event`) and implement the methods `onPersistenceEvent` and `onFlushEvent`. You also must provide a reference to the datastore to the listener. The simplest possible implementation can be found in the `GrailsGORMEventListener` class.

```

public MyPersistenceListener(final Datastore datastore) {
    super(datastore)
}

@Override
protected void onPersistenceEvent(final AbstractPersistenceEvent event) {
    switch(event.eventType) {
        case PreInsert:
            println "PRE INSERT ${event.entityObject}"
            break
        case PostInsert:
            println "POST INSERT ${event.entityObject}"
            break
        case PreUpdate:
            println "PRE UPDATE ${event.entityObject}"
            break;
        case PostUpdate:
            println "POST UPDATE ${event.entityObject}"
            break;
        case PreDelete:
            println "PRE DELETE ${event.entityObject}"
            break;
        case PostDelete:
            println "POST DELETE ${event.entityObject}"
            break;
        case PreLoad:
            println "PRE LOAD ${event.entityObject}"
            break;
        case PostLoad:
            println "POST LOAD ${event.entityObject}"
            break;
    }
}

@Override
public boolean supportsEventType(Class<? extends ApplicationEvent> eventType) {
    return true
}

```

The `AbstractPersistenceEvent` class has many subclasses ( `PreInsertEvent`, `PostInsertEvent`, `PreUpdateEvent`, `PostUpdateEvent`, `PreDeleteEvent`, `PostDeleteEvent`, `PreLoadEvent`, `PostLoadEvent` ) further information specific to the event. A `cancel()` method is also provided on the event which allows you to cancel an update or delete operation.

Once you have created your event listener you need to register it with the `ApplicationContext` using `Bootstrap.groovy`:

```

def init = {
    application.mainContext.eventTriggeringInterceptor.datastores.each { k, datas
        applicationContext.addApplicationListener new MyPersistenceListener(datas)
    }
}

```

or use this in a plugin:

```
def doWithApplicationContext = { applicationContext ->
    application.mainContext.eventTriggeringInterceptor.datastores.each { k, datas
        applicationContext.addApplicationListener new MyPersistenceListener(datas
    }
}
```

## Hibernate Events

It is generally encouraged to use the non-Hibernate specific API described above, but if you need access to events then you can define custom Hibernate-specific event listeners.

You can also register event handler classes in an application's `grails-app/conf/spring/resources.groovy` file. You can do this by registering a Spring bean named `hibernateEventListener` in a plugin descriptor by registering a Spring bean named `hibernateEventListener` which has one 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. You can implement all of the required interfaces, or one concrete class per interface, or any combination. The corresponding interfaces are listed here:

Name	Interface
auto-flush	<a href="#">AutoFlushEventListener</a>
merge	<a href="#">MergeEventListener</a>
create	<a href="#">PersistEventListener</a>
create-onflush	<a href="#">PersistEventListener</a>
delete	<a href="#">DeleteEventListener</a>
dirty-check	<a href="#">DirtyCheckEventListener</a>
evict	<a href="#">EvictEventListener</a>
flush	<a href="#">FlushEventListener</a>
flush-entity	<a href="#">FlushEntityEventListener</a>
load	<a href="#">LoadEventListener</a>
load-collection	<a href="#">InitializeCollectionEventListener</a>
lock	<a href="#">LockEventListener</a>
refresh	<a href="#">RefreshEventListener</a>
replicate	<a href="#">ReplicateEventListener</a>
save-update	<a href="#">SaveOrUpdateEventListener</a>
save	<a href="#">SaveOrUpdateEventListener</a>
update	<a href="#">SaveOrUpdateEventListener</a>
pre-load	<a href="#">PreLoadEventListener</a>
pre-update	<a href="#">PreUpdateEventListener</a>
pre-delete	<a href="#">PreDeleteEventListener</a>
pre-insert	<a href="#">PreInsertEventListener</a>
pre-collection-recreate	<a href="#">PreCollectionRecreateEventListener</a>
pre-collection-remove	<a href="#">PreCollectionRemoveEventListener</a>
pre-collection-update	<a href="#">PreCollectionUpdateEventListener</a>
post-load	<a href="#">PostLoadEventListener</a>
post-update	<a href="#">PostUpdateEventListener</a>
post-delete	<a href="#">PostDeleteEventListener</a>
post-insert	<a href="#">PostInsertEventListener</a>
post-commit-update	<a href="#">PostUpdateEventListener</a>
post-commit-delete	<a href="#">PostDeleteEventListener</a>
post-commit-insert	<a href="#">PostInsertEventListener</a>
post-collection-recreate	<a href="#">PostCollectionRecreateEventListener</a>
post-collection-remove	<a href="#">PostCollectionRemoveEventListener</a>
post-collection-update	<a href="#">PostCollectionUpdateEventListener</a>

For example, you could register a class `AuditEventListener` which implements `PostInsertEventListener`, `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

If you define a `dateCreated` property it will be set to the current date for you when you create new in  
define a `lastUpdated` property it will be automatically be updated for you when you change persistent i

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 have `nullable: false` constraints on either `dateCreated` or `lastUpdated` domain instances will fail validation - probably not what you want. Omit constraints properties unless you disable automatic timestamping.

## 7.5.2 Custom ORM Mapping

Grails domain classes can be mapped onto many legacy schemas with an Object Relational Mapping language). The 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 for table and column names and so on. You only need this functionality if you need to tailor the way Grails maps onto legacy schemas or configures caching.

Custom mappings are defined using a static mapping block defined within your domain class:

```
class Person {  
    ...  
    static mapping = {  
        version false  
        autoTimestamp false  
    }  
}
```

You can also configure global mappings in `Config.groovy` (or an external config file) using this setting:

```
grails.gorm.default.mapping = {  
    version false  
    autoTimestamp false  
}
```

It has the same syntax as the standard mapping block but it applies to all your domain classes! You can also override the defaults within the mapping block of a domain class.

### 7.5.2.1 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. Since it maps a domain class persistent field, the parameter values (in this case just "column") are used to configure the mapping property.

## Column type

GORM supports configuration of Hibernate types with the DSL using the `type` attribute. This includes supporting the implementation of the Hibernate [org.hibernate.usertype.UserType](http://org.hibernate.usertype.UserType) interface, which allows complete customization of a type persisted. As an example if you had 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 (CLOB).

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 the one-to-one 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 using `column` we have changed the name of the foreign key column to `Person_Address_Id`.

## One-to-Many Mapping

With a bidirectional one-to-many you can change the foreign key column used by changing the `column` in the association as per the example in the previous section on one-to-one associations. However, with unidirectional foreign key needs to be specified on the association itself. For example given a unidirectional one-to-many `Person` and `Address` the following 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 can use the `joinTable` parameter:

```

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 `person_id` and `group_id` referencing the `person` and `group` tables. To change the column names you can specify a column with class.

```
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'
    }
}
```


## 7.5.2.2 Caching Strategy

### Setting up caching

[Hibernate](#) features a second-level cache with a customizable cache provider. This needs to `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, refer to the [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 collection objects. For 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 mapping as in the 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 read-only cache might be appropriate.
- `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 (i.e. if it is not strictly transactional) and strict transaction isolation is not required, a nonstrict-read-write cache might be appropriate.
- `transactional` - The transactional cache strategy provides support for fully transactional JBoss TreeCache. Such a cache may only be used in a JTA environment and `hibernate.transaction.manager_lookup_class` in the `grails-app/conf/DataSources` hibernate config.

### 7.5.2.3 Inheritance Strategies

By default GORM classes use `table-per-hierarchy` inheritance mapping. This has the disadvantage of having a NOT-NULL constraint applied to them at the database level. If you would prefer to use a `table-per-subclass` inheritance strategy you can 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 classes.

### 7.5.2.4 Custom Database Identity

You can customize how GORM generates identifiers for the database using the DSL. By default GORM uses a database mechanism for generating ids. This is by far the best approach, but there are still many other approaches to identity.

To deal with this Hibernate defines the concept of an id generator. You can customize the id generator and follows:

```

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 documentation](#)

Although you don't typically specify the `id` field (Grails adds it for you) you can still configure its properties. For example to customise the column for the id property you can do:



```

class Person {
    ...
    static mapping = {
        table 'people'
        version false
        id column: 'person_id'
    }
}

```

### 7.5.2.5 Composite Primary Keys

GORM supports the concept of composite identifiers (identifiers composed from 2 or more properties). We don't recommend, but 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.hashCode()
    }

    static mapping = {
        id composite: ['firstName', 'lastName']
    }
}

```

The above will create a composite id of the `firstName` and `lastName` properties of the `Person` class. If you use a 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 `hashCode` methods, using the properties in the composite key for the calculations. The `HashCodeBuilder` for convenience but it's fine to implement it yourself.

Another important consideration when using composite primary keys is associations. If for example you have an association where the foreign keys are stored in the associated table then 2 columns will be present in the 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` and `person_last_name`. If you wish to change the mapping of these columns then you can do so using the following technique:

```
class Address {
    Person person
    static mapping = {
        columns {
            person {
                column name: "FirstName"
                column name: "LastName"
            }
        }
    }
}
```

### 7.5.2.6 Database Indices

To get the best performance out of your queries it is often necessary to tailor the table index definitions to be domain specific and a matter of monitoring usage patterns of your queries. With GORM's DSL you can specify which indexes are used in which indexes:

```

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 `Address_Index` will cause an error.

### 7.5.2.7 Optimistic Locking and Versioning

As discussed in the section on [Optimistic and Pessimistic Locking](#), by default GORM uses optimistic locking. It injects a `version` property into every class which is in turn mapped to a `version` column at the database.

If you're mapping to a legacy schema that doesn't have version columns (or there's some other reason why you can't use versioning) you 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 updates. Updates are open to 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 update occurs. Hibernate also 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 t but this risk is very low. One benefit of using a Timestamp instead of a Long is that you combine the last-updated semantics into a single column.

## 7.5.2.8 Eager and Lazy Fetching

### Lazy Collections

As discussed in the section on [Eager and Lazy fetching](#), GORM collections are lazily loaded by default behaviour with 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 are loaded at the same time with a second `SELECT`. The second option is basically the same, except the collection is loaded with another `SELECT`. Typically you want to reduce the number of queries, so `fetch: 'join'` is the most common. On the other hand, it could feasibly be the more expensive approach if your domain model and data result in more data than would otherwise be necessary.

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 example for `Person`:

```
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 load the four next ones. You can get the same behaviour with eager loading by combining `batchSize` with the `fetch: 'join'` option. You can find out more about these options in the [Hibernate user guide](#) and this [primer on fetching strategies](#). The `subselect` fetching strategy does not currently support the "subselect" fetching strategy.

## Lazy Single-Ended Associations

In GORM, one-to-one and many-to-one associations are by default lazy. Non-lazy single ended associations when you load many entities because each non-lazy association will result in an extra SELECT statement also have non-lazy 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) w loaded.

## Lazy Single-Ended Associations and Proxies

Hibernate uses runtime-generated proxies to facilitate single-ended lazy associations; Hibernate dynamic class to create the proxy.

Consider the previous example but with a lazily-loaded person association: Hibernate will set the per that is a subclass of Person. When you call any of the getters (except for the id property) or setters on t load the entity from 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 Hibernate you load the `Person` instance, Hibernate creates a proxy for its `pet` relation and attaches it to the session whenever you retrieve that `Pet` instance with a query, a `get()`, or the `pet` relation *within the same session* the proxy.

Fortunately for us, GORM automatically unwraps the proxy when you use `get()` and `findBy*`, or the relation. That means you don't have to worry at all about proxies in the majority of cases. But GORM can also be returned with a query that returns a list, such as `list()` and `findAllBy*`. However, if Hibernate has the session, those queries will return the 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 `ClassCastException` if the first pet 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 instance, you can access its `Dog` properties or 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 least an error occurs and be able to work around it.

### 7.5.2.9 Custom Cascade Behaviour

As described in the section on [cascading updates](#), the primary mechanism to control the way updates and association to 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 c association then it 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 persistence](#) better 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 settin

```
class Person {
    String firstName
    static hasMany = [addresses: Address]
    static mapping = {
        addresses cascade: "all-delete-orphan"
    }
}
```

```
class Address {
    String street
    String postCode
}
```

## 7.5.2.10 Custom Hibernate Types

You saw in an earlier section that you can use composition (with the embedded property) to break a ta You can achieve a similar effect with Hibernate's custom user types. These are not domain classes then Groovy classes. Each of these types also has a corresponding "meta-type" class that implements [org.hibernate](#)

The [Hibernate reference manual](#) has some information on custom types, but here we will focus on how to start by taking a look at a simple domain class that uses an old-fashioned (pre-Java 1.5) type-safe enum cla

```

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 corresponding `UserType` implementation. That's all you have to do to start using your custom type. If you want to use the other column settings such as "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 explicitly define in the mapping what columns to use, since Hibernate can only use the property name. Fortunately, Grails lets you map multiple columns to a property using this syntax:

```

class Book {
    String title
    Name author
    Rating rating

    static mapping = {
        author 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 notice you can also use 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 `join`.

One thing to bear in mind with custom types is that they define the *SQL types* for the corresponding data. You take the burden of configuring them yourself, but what happens if you have a legacy database that uses a different set of the columns? In that case, override the column's SQL type using the `sqlType` attribute:

```
class Book {
    String title
    Name author
    Rating rating

    static mapping = {
        author 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 default of `text` with `yes_no` isn't going to work.

### 7.5.2.11 Derived Properties

A derived property is one that takes its value from a SQL expression, often but not necessarily based on other persistent 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 it is probably not a persistent property. The 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 not the object 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 that is will look 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 effect could be achieved by adding a method like `getTax()` to the `Product` class that simply returns the product of the `taxRate` and `price` properties. With an approach like that you would give up the ability query the database based on the value of the derived property. The ability to query the database based on the value of the derived property allows exactly that. To retrieve all `Product` objects that have a `tax` value greater than 21.12f, a query like this:

```
Product.findAllByTaxGreaterThan(21.12f)
```

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 SQL code, derived properties may not have GORM constraints applied to them. If constraints are specified for a derived property, they will be ignored.

### 7.5.2.12 Custom Naming Strategy

By default Grails uses Hibernate's `ImprovedNamingStrategy` to convert domain class `Class` and field and column names by converting from camel-cased Strings to ones that use underscores as word separators. You can override these on a per-class basis in the mapping closure but if there's a consistent pattern you can use a `NamingStrategy` class to use.

Configure the class name to be used in `grails-app/conf/DataSource.groovy` in the `hibernate` block:

```

dataSource {
  pooled = true
  dbCreate = "create-drop"
  ...
}

hibernate {
  cache.use_second_level_cache = true
  ...
  naming_strategy = com.myco.myproj.CustomNamingStrategy
}

```

You can also specify the name of the class and it will be loaded for you:

```
hibernate {
    ...
    naming_strategy = 'com.myco.myproj.CustomNamingStrategy'
}
```

A third option is to provide an instance if there is some configuration required beyond calling the default c

```
hibernate {
    ...
    def strategy = new com.myco.myproj.CustomNamingStrategy()
    // configure as needed
    naming_strategy = strategy
}
```

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)
    }
}
```

### 7.5.3 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 `Airport` instances will by default be sorted by the airport name. To change the sort *order*, use 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 relationships because they involve a join table. See [this issue](#) for more details. Consider using a Sort query with sort parameters to fetch the data you need.

## 7.6 Programmatic Transactions

Grails is built on Spring and uses Spring's Transaction abstraction for dealing with programmatic transactions. Classes have been enhanced to make this simpler with the [withTransaction](#) method. This method has a signature which has a single parameter which is a Spring [TransactionStatus](#) instance.

Here's an example of using `withTransaction` in a controller method:

```
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 unchecked (but not a checked `Exception`, even though Groovy doesn't require that you catch checked exceptions) process the transaction will 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 rollback the transaction. This can 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

## 7.7 GORM and Constraints

Although constraints are covered in the [Validation](#) section, it is important to mention them here as they do affect the way in which the database schema is generated.

Where feasible, Grails uses a domain class's constraints to influence the database columns generated for the class 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 case, we would 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 exceed *before* we persist any records. In Grails, we achieve this validation with [constraints](#). We would add declaration to the domain class.

```
static constraints = {
    description maxSize: 1000
}
```

This constraint would provide both the application-based validation we want and it would also cause the schema shown above. 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 on

In general, it's not advisable to use both constraints on the same domain class property. However, if both `maxSize` and the `size` constraint are defined, then Grails sets the column length to the minimum of the `maxSize` bound of the `size` constraint. (Grails uses the minimum of the two, because any length that exceeds that validation error.)

If the `inList` constraint is defined (and the `maxSize` and the `size` constraints are not defined), then Grails sets the column length based on the length of the longest string in the list of valid values. For example, given a list of valid values: "Groovy", and "C++", Grails would set the column length to 6 (i.e., the number of characters in the string "C++").

## 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 the success of this 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 property. However, if both of these constraints is defined, then Grails uses the minimum precision value from the two, because 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 value for floating point numbers (i.e., `java.lang.Float`, `java.lang.Double`, `java.lang.BigDecimal`, `java.math.BigDecimal`). The success of this attempted influence is largely dependent on how the underlying DBMS handles it.

The constraints define the minimum/maximum numeric values, and Grails derives the maximum number of digits after the decimal point. Keep in mind that specifying only one of `min`/`max` constraints will not affect schema generation. For example, specifying a large negative value of property with `max:100`, for example), unless the specified constraint value requires it, the resulting Hibernate column precision is (19 at the 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
```

## 8 The Web Layer

### 8.1 Controllers

A controller handles requests and creates or prepares the response. A controller can generate the response view. To create a controller, simply create a class whose name ends with `Controller` in the `grails` directory (in a subdirectory if it's in a package).

The default [URL Mapping](#) configuration ensures that the first part of your controller name is mapped to the defined within your controller maps to URIs within the controller name URI.

#### 8.1.1 Understanding Controllers and Actions

##### Creating a controller

Controllers can be created with the [create-controller](#) or [generate-controller](#) command. For example to create a controller from the root of a Grails project:

```
grails create-controller book
```

The command will create a controller at the location `grails-app/controllers/myapp/BookController`.

```
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 convenience; you can just 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 preferred methods.

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.action`
- Methods can be intercepted with standard proxying mechanisms, something that is complicated to do with Closure fields.

If you prefer the Closure syntax or have older controller classes created in earlier versions of Grails and still using methods, you can set the `grails.compile.artefacts.closures.convert` property in `BuildConfig.groovy`:

```
grails.compile.artefacts.closures.convert = true
```

and a compile-time AST transformation will convert your Closures to methods in the generated bytecode.



If a controller class extends some other class which is not defined under `grails-app/controllers/` directory, methods inherited from that class are not converted to controller actions. If the intent is to expose those inherited methods as controller actions then they may be overridden in the subclass and the subclass method may invoke the method in the superclass.

## The Default Action

A controller has the concept of a default URI that maps to the root URI of the controller, for `BookController`. The action that is called when the default URI is requested is dictated by the following:

- 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"
```

## 8.1.2 Controllers and Scopes

### Available Scopes

Scopes are hash-like objects where you can store variables. The following scopes are available to controllers:

- [servletContext](#) - Also known as application scope, this scope lets you share state across the entire application. The `servletContext` is an instance of [ServletContext](#)
- [session](#) - The session allows associating state with a given user and typically uses cookies to associate the user. The session object is an instance of [HttpSession](#)
- [request](#) - The request object allows the storage of objects for the current request only. The request object is an instance of [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 operator `[]` provided by the 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 concise.

```

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 request only. Afterwards 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 a message. The message will be removed 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 a message, but they can be any object type.

## Scoped Controllers

Supported controller scopes are:

- `prototype` (default) - A new controller will be created for each request (recommended for actions as methods)
- `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 listed above.

```
static scope = "singleton"
```

You can define the default strategy under in `Config.groovy` with the `grails.controllers.defaultScope` example:

```
grails.controllers.defaultScope = "singleton"
```

Newly created applications have the `grails.controllers.defaultScope` `grails-app/conf/Config.groovy` with a value of "singleton". You may change this value to any listed above. If the property is not assigned a value at all, controllers will default to "prototype" scope.



Use scoped controllers wisely. For instance, we don't recommend having any prop singleton-scoped controller since they will be shared for *all* requests.

## 8.1.3 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 view. There are a 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 [scaffolding](#) for more details.

A more advanced approach is to return an instance of the Spring [ModelAndView](#) 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 of

## Selecting the View

In both of the previous two examples there was no code that specified which [view](#) to render. So how does it pick? The answer lies in the conventions. Grails will look for a view at the location `grails-app/views` for this `show` action:

```
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` automatically qualifies the view location with the `book` directory of the `grails-app/views` directory. To access shared views you 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/display`. Grails also supports JSPs as views, so if a GSP isn't found in the expected location but a JSP is, it will be used.

## Selecting Views For Namespaced Controllers

If a controller defines a namespace for itself with the [namespace](#) property that will affect the root directory look for views which are specified with a relative path. The default root directory for views rendered by a controller is `grails-app/views/<namespace name>/<controller name>/. If the view is not found in this directory, then Grails will fallback to looking for the view in the non-namespaced directory.`

See the example below.

```
class ReportingController {
  static namespace = 'business'

  def humanResources() {
    // This will render grails-app/views/business/reporting/humanResources.gsp
    // if it exists.

    // If grails-app/views/business/reporting/humanResources.gsp does not
    // exist the fallback will be grails-app/views/reporting/humanResources.gsp.

    // The namespaced GSP will take precedence over the non-namespaced GSP.

    [numberOfEmployees: 9]
  }

  def accountsReceivable() {
    // This will render grails-app/views/business/reporting/accounting.gsp
    // if it exists.

    // If grails-app/views/business/reporting/accounting.gsp does not
    // exist the fallback will be grails-app/views/reporting/accounting.gsp.

    // The namespaced GSP will take precedence over the non-namespaced GSP.

    render view: 'numberCrunch', model: [numberOfEmployees: 13]
  }
}
```

## Rendering a Response

Sometimes it's easier (for example with Ajax applications) to render snippets of text or code to the response. For this, 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, it can cause clashes between 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 MarkupBuilder). To add a <form> element, use the following:

```

def login() {
    // ...
    body {
        h1 'Hello'
        builder.form {
        }
    }
    // ...
}

```

## 8.1.4 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 method:

```
redirect(action: 'myaction', params: [myparam: "myvalue"])
```

These parameters are made available through the [params](#) dynamic property that accesses request parameters. If a parameter specified with the same name as a request parameter, the request parameter is overridden and the controller has access to the new value.

Since the `params` object is a `Map`, you can use it to pass the current request parameters from one action to the next:

```
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 example, in the following 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. This exists in 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"])
```

## 8.1.5 Controller Interceptors

Often it is useful to intercept processing based on either request, session or application state. This can be done using interceptors. There 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 writing a [Filter](#). Filters can be applied to multiple controllers or URIs without the need to duplicate logic of each controller

## Before Interception

The `beforeInterceptor` intercepts processing before the action is executed. If it returns `false` then the action will not be 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 are processed. A 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 an action. The `beforeInterceptor` then defines an interceptor that is used on all actions *except* the `login` action method. The `auth` method is referenced using Groovy's method pointer syntax. Within the method it checks if there is a user in the session, and if not it redirects to the `login` action and returns `false`, causing the interceptor to 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 response.  
An after interceptor may also modify the Spring MVC [ModelAndView](#) object prior to rendering. In this case, the response becomes:

```
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 model is null if the action being intercepted called `redirect` or `render`.

## Interception Conditions

Rails users will be familiar with the authentication example and how the 'except' condition was used when defining filters (interceptors 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 defined:

```
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']]
```

## 8.1.6 Data Binding

Data binding is the act of "binding" incoming request parameters onto the properties of an object or an entity. The data binder should deal with all necessary type conversion since request parameters, which are typically submitted as strings, are always strings whilst the properties of a Groovy or Java object may well not be.

### Map Based Binding

The data binder is capable of converting and assigning values in a Map to properties of an object. The binder uses the keys in the Map to properties of the object using the keys in the Map that have values which correspond to the properties. The following code demonstrates the basics:

```
// grails-app/domain/Person.groovy
class Person {
    String firstName
    String lastName
    Integer age
}
```

```
def bindingMap = [firstName: 'Peter', lastName: 'Gabriel', age: 63]
def person = new Person(bindingMap)

assert person.firstName == 'Peter'
assert person.lastName == 'Gabriel'
assert person.age == 63
```

To update properties of a domain object you may assign a Map to the `properties` property of the domain object.

```
def bindingMap = [firstName: 'Peter', lastName: 'Gabriel', age: 63]

def person = Person.get(someId)
person.properties = bindingMap

assert person.firstName == 'Peter'
assert person.lastName == 'Gabriel'
assert person.age == 63
```

The binder can populate a full graph of objects using Maps of Maps.

```
class Person {
    String firstName
    String lastName
    Integer age
    Address homeAddress
}

class Address {
    String county
    String country
}
```

```
def bindingMap = [firstName: 'Peter', lastName: 'Gabriel', age: 63, homeAddress:
country: 'England'] ]

def person = new Person(bindingMap)

assert person.firstName == 'Peter'
assert person.lastName == 'Gabriel'
assert person.age == 63
assert person.homeAddress.county == 'Surrey'
assert person.homeAddress.country == 'England'
```

## Binding To Collections And Maps

The data binder can populate and update Collections and Maps. The following code shows a simple example of objects in a domain class:

```

class Band {
  String name
  static hasMany = [albums: Album]
  List albums
}

class Album {
  String title
  Integer numberOfTracks
}

```

```

def bindingMap = [name: 'Genesis',
                  'albums[0]': [title: 'Foxtrot', numberOfTracks: 6],
                  'albums[1]': [title: 'Nursery Cryme', numberOfTracks: 7]]

def band = new Band(bindingMap)

assert band.name == 'Genesis'
assert band.albums.size() == 2
assert band.albums[0].title == 'Foxtrot'
assert band.albums[0].numberOfTracks == 6
assert band.albums[1].title == 'Nursery Cryme'
assert band.albums[1].numberOfTracks == 7

```

That code would work in the same way if albums were an array instead of a List.

Note that when binding to a Set the structure of the Map being bound to the Set is the same as that of List but since a Set is unordered, the indexes don't necessarily correspond to the order of elements. In the example above, if albums were a Set instead of a List, the bindingMap could look exactly the same. The first album in the Set or it might be the second. When updating existing elements in a Set the Map must have id elements in it which represent the element in the Set being updated, as in the following example.

```

/*
 * The value of the indexes 0 and 1 in albums[0] and albums[1] are arbitrary
 * values that can be anything as long as they are unique within the Map.
 * They do not correspond to the order of elements in albums because albums
 * is a Set.
 */
def bindingMap = ['albums[0]': [id: 9, title: 'The Lamb Lies Down On Broadway']
                  'albums[1]': [id: 4, title: 'Selling England By The Pound']]

def band = Band.get(someBandId)

/*
 * This will find the Album in albums that has an id of 9 and will set its title
 * to 'The Lamb Lies Down On Broadway' and will find the Album in albums that has
 * an id of 4 and set its title to 'Selling England By The Pound'. In both
 * cases if the Album cannot be found in albums then the album will be retrieved
 * from the database by id, the Album will be added to albums and will be updated
 * with the values described above. If a Album with the specified id cannot be
 * found in the database, then a binding error will be created and associated
 * with the band object. More on binding errors later.
 */
band.properties = bindingMap

```

When binding to a Map the structure of the binding Map is the same as the structure of a Map used for bin and the index inside of square brackets corresponds to the key in the Map being bound to. See the followin

```

class Album {
  String title
  static hasMany = [players: Player]
  Map players
}

class Player {
  String name
}

```

```

def bindingMap = [title: 'The Lamb Lies Down On Broadway',
                  'players[guitar]': [name: 'Steve Hackett'],
                  'players[vocals]': [name: 'Peter Gabriel'],
                  'players[keyboards]': [name: 'Tony Banks']]

def album = new Album(bindingMap)

assert album.title == 'The Lamb Lies Down On Broadway'
assert album.players.size() == 3
assert album.players.guitar.name == 'Steve Hackett'
assert album.players.vocals.name == 'Peter Gabriel'
assert album.players.keyboards.name == 'Tony Banks'

```

When updating an existing Map, if the key specified in the binding Map does not exist in the Map being bound, the key will be created and added to the Map with the specified key as in the following example:

```
def bindingMap = [title: 'The Lamb Lies Down On Broadway',
                  'players[guitar]': [name: 'Steve Hackett'],
                  'players[vocals]': [name: 'Peter Gabriel'],
                  'players[keyboards]': [name: 'Tony Banks']]

def album = new Album(bindingMap)

assert album.title == 'The Lamb Lies Down On Broadway'
assert album.players.size() == 3
assert album.players.guitar == 'Steve Hackett'
assert album.players.vocals == 'Peter Gabriel'
assert album.players.keyboards == 'Tony Banks'

def updatedBindingMap = ['players[drums]': [name: 'Phil Collins'],
                        'players[keyboards]': [name: 'Anthony George Banks']]

album.properties = updatedBindingMap

assert album.title == 'The Lamb Lies Down On Broadway'
assert album.players.size() == 4
assert album.players.guitar.name == 'Steve Hackett'
assert album.players.vocals.name == 'Peter Gabriel'
assert album.players.keyboards.name == 'Anthony George Banks'
assert album.players.drums.name == 'Phil Collins'
```

## Binding Request Data to the Model

The [params](#) object that is available in a controller has special behavior that helps convert dotted request parameters into nested Maps that the data binder can work with. For example, if a request includes request parameters `person.homeAddress.country` and `person.homeAddress.city` with values 'USA' and 'St. Louis', the `params` would include entries like these:

```
[person: [homeAddress: [country: 'USA', city: 'St. Louis']]]
```

There are two ways to bind request parameters onto the properties of a domain class. The first involves the `Map` constructor:

```
def save() {
    def b = new Book(params)
    b.save()
}
```

The data binding happens within the code `new Book(params)`. By passing the [params](#) object to the Grails automatically recognizes that you are trying to bind from request parameters. So if we had an income

```
/book/save?title=The%20Stand&author=Stephen%20King
```

Then the `title` and `author` request parameters would automatically be set on the domain class. You can also use the `update` property to 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.

When binding an empty String (a String with no characters in it, not even spaces), the data binder will convert it to null. This simplifies the most common case where the intent is to treat an empty form field as having the value null. There is also a way to actually submit a null as a request parameter. When this behavior is not desirable the application can be configured to do so directly.

The mass property binding mechanism will by default automatically trim all Strings at binding time. To disable this behavior set the `grails.databinding.trimStrings` property to `false` in `grails-app/conf/Config.groovy`.

```
// the default value is true
grails.databinding.trimStrings = false

// ...
```

The mass property binding mechanism will by default automatically convert all empty Strings to null at binding time. To disable this behavior set the `grails.databinding.convertEmptyStringsToNull` property to `false` in `grails-app/conf/Config.groovy`.

```
// the default value is true
grails.databinding.convertEmptyStringsToNull = false

// ...
```

The order of events is that the String trimming happens and then null conversion happens so if `trim` `convertEmptyStringsToNull` is true, not only will empty Strings be converted to null but also any String such that the `trim()` method returns an empty String.



These forms of data binding in Grails are very convenient, but also indiscriminate. In other words, Grails will bind *all* non-transient, typed instance properties of the target object, including ones that you may not want bound. Just because the form in your UI doesn't submit all the properties, an attacker can still submit malicious data via a raw HTTP request. Fortunately, Grails also makes it easy to protect against such attacks - see the section titled "Data Binding and Security concerns" for more information.

## Data binding and Single-ended Associations

If you have a one-to-one or many-to-one association you can use Grails' data binding capabilities for these relationships too. For 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` instance doing data 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 depending on the type.

If you have a `Set` based association (the default for a `hasMany`) then the simplest way to populate an association is by using a select box. 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 Grails will pass the selected identifiers 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 then the select box is not the best choice. Instead you use 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 defined the association. This is because a `Set` has no concept of order, so although we're referring to `books0` and `books1` it is not guaranteed that the order of the association will be 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 index. This is also true of `Map` based associations.

Note also that if the association you are binding to has a size of two and you refer to an element then the association:

```
<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.

You can bind existing instances of the associated type to a `List` using the same `.id` syntax as you would association. 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"`.

When binding to `Maps`, `Arrays` and `Collections` the data binder will automatically grow the size of the collection default limit to how large the binder will grow a collection is 256. If the data binder encounters an entry that be grown beyond that limit, the entry is ignored. The limit may be configured by assigning `grails.databinding.autoGrowCollectionLimit` property in `Config.groovy`.

```
// grails-app/conf/Config.groovy
// the default value is 256
grails.databinding.autoGrowCollectionLimit = 128
// ...
```

## 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.` or `book.` to isolate which parameters belong to which type. Grails' `params` object is like a multi-dimensional hash and you isolate only a subset of the 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 parameters to bind. We could do 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 controller action arguments. The first category is command objects. Complex types are treated as command objects. See the [Command Objects](#) user guide for details. The other category is basic object types. Supported types are the 8 primitives, wrapper classes and [java.lang.String](#). The default 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 a type conversion is carried out before the request parameter value can be bound to the action argument. The type conversion is done in a case like the example shown above, the `params.accountType` request parameter has to be converted to an `int`. If the conversion fails for any reason, the argument will have its default value per normal Java behavior (null for objects, false for booleans and zero for numbers) and a corresponding error will be added to the `errors` object of the controller.

```
/accounting/displayInvoice?accountNumber=B59786&accountType=bogusValue
```

Since "bogusValue" cannot be converted to type `int`, the value of `accountType` will be `0`. If `errors.hasErrors()` will be true, the controller's `errors.errorCount` will be equal to `errors.getFieldError('accountType')` will contain the corresponding error.

If the argument name does not match the name of the request parameter then the `@grails.web.RequestParameter` annotation may be applied to an argument to express the name of the request parameter which should be bound.

```
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, int accountType) {
    // ...
  }
}
```

## Data binding and type conversion errors

Sometimes when performing data binding it is not possible to convert a particular String into a particular type, resulting in a type conversion error. Grails will retain type conversion errors inside the [errors](#) property of a Grails domain object.

```
class Book {
    ...
    URL publisherURL
}
```

Here we have a domain class `Book` that uses the `java.net.URL` class to represent URLs. Given an incorrect request like this:

```
/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 error occurs for these like 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 type conversion errors we would want a message from the `grails-app/i18n/messages.properties` file to use for the error message handler such 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
```

## The BindUsing Annotation

The [BindUsing](#) annotation may be used to define a custom binding mechanism for a particular field if binding is being applied to the field the closure value of the annotation will be invoked with 2 arguments. object that data binding is being applied to and the second argument is [DataBindingSource](#) which is the binding. The value returned from the closure will be bound to the property. The following example would version of the name value in the source being applied to the name field during data binding.

```
import org.grails.databinding.BindUsing

class SomeClass {
    @BindUsing({obj, source ->
        //source is DataSourceBinding which is similar to a Map
        //and defines getAt operation but source.name cannot be used here.
        //In order to get name from source use getAt instead as shown below.
        source['name']?.toUpperCase()
    })
    String name
}
```



Note that data binding is only possible when the name of the request parameter matches with name in the class. Here, name from request parameters matches with name from SomeClass

The [BindUsing](#) annotation may be used to define a custom binding mechanism for all of the fields on a class. If the annotation is applied to a class, the value assigned to the annotation should be a class which implements the [BindingHelper](#) interface. An instance of that class will be used any time a value is bound to a property in the class that the annotation is applied to.

```
@BindUsing(SomeClassWhichImplementsBindingHelper)
class SomeClass {
    String someProperty
    Integer someOtherProperty
}
```

## Custom Data Converters

The binder will do a lot of type conversion automatically. Some applications may want to define their own custom converters for converting values and a simple way to do this is to write a class which implements [ValueConverter](#) and register the class as a bean in the Spring application context.

```
package com.myapp.converters

import org.grails.databinding.converters.ValueConverter

/**
 * A custom converter which will convert String of the
 * form 'city:state' into an Address object.
 */
class AddressValueConverter implements ValueConverter {

    boolean canConvert(value) {
        value instanceof String
    }

    def convert(value) {
        def pieces = value.split(':')
        new com.myapp.Address(city: pieces[0], state: pieces[1])
    }

    Class<?> getTargetType() {
        com.myapp.Address
    }
}
```

An instance of that class needs to be registered as a bean in the Spring application context. The beans that implemented ValueConverter will be automatically plugged in to the data binding process.

```
// grails-app/conf/spring/resources.groovy

beans = {
    addressConverter com.myapp.converters.AddressValueConverter
    // ...
}
```

```

class Person {
    String firstName
    Address homeAddress
}

class Address {
    String city
    String state
}

def person = new Person()
person.properties = [firstName: 'Jeff', homeAddress: "O'Fallon:Missouri"]
assert person.firstName == 'Jeff'
assert person.homeAddress.city == "O'Fallon"
assert person.homeAddress.state == 'Missouri'

```

## Date Formats For Data Binding

A custom date format may be specified to be used when binding a String to a Date value by applying the [@BindingFormat](#) annotation to a Date field.

```

import org.grails.databinding.BindingFormat

class Person {
    @BindingFormat('MMddyyyy')
    Date birthDate
}

```

A global setting may be configured in `Config.groovy` to define date formats which will be used applied to Date.

```

// grails-app/conf/Config.groovy
grails.databinding.dateFormats = ['MMddyyyy', 'yyyy-MM-dd HH:mm:ss.S', "yyyy-MM-dd'T'HH:mm:ss'Z'"]

```

The formats specified in `grails.databinding.dateFormats` will be attempted in the order in which they are listed. If a property is marked with `@BindingFormat`, the `@BindingFormat` will take precedence over the global `grails.databinding.dateFormats`.

The default formats that are used are `"yyyy-MM-dd HH:mm:ss.S"` and `"yyyy-MM-dd'T'hh:mm:ss'Z'"`.

## Custom Formatted Converters



You may supply your own handler for the [BindingFormat](#) annotation by writing a class with [FormattedValueConverter](#) interface and registering an instance of that class as a bean in the Spring application context. Here is an example of a trivial custom String formatter that might convert the case of a String based on the [BindingFormat](#) annotation.

```
package com.myapp.converters

import org.grails.databinding.converters.FormattedValueConverter

class FormattedStringValueConverter implements FormattedValueConverter {
    def convert(value, String format) {
        if('UPPERCASE' == format) {
            value = value.toUpperCase()
        } else if('LOWERCASE' == format) {
            value = value.toLowerCase()
        }
        value
    }
}

Class getTargetType() {
    // specifies the type to which this converter may be applied
    String
}
}
```

An instance of that class needs to be registered as a bean in the Spring application context. The bean name and beans that implemented [FormattedValueConverter](#) will be automatically plugged in to the data binding infrastructure.

```
// grails-app/conf/spring/resources.groovy

beans = {
    formattedStringConverter com.myapp.converters.FormattedStringValueConverter
    // ...
}
```

With that in place the [BindingFormat](#) annotation may be applied to String fields to inform the data binding infrastructure of the custom converter.

```
import org.grails.databinding.BindingFormat

class Person {
    @BindingFormat('UPPERCASE')
    String someUpperCaseString

    @BindingFormat('LOWERCASE')
    String someLowerCaseString

    String someOtherString
}
```

## Localized Binding Formats

The `BindingFormat` annotation supports localized format strings by using the optional `code` attribute. The `code` attribute value will be used as the message code to retrieve the binding format string from a bean in the Spring application context and that lookup will be localized.

```
import org.grails.databinding.BindingFormat

class Person {
    @BindingFormat(code='date.formats.birthdays')
    Date birthDate
}
```

```
# grails-app/conf/i18n/messages.properties
date.formats.birthdays=MMddyyyy
```

```
# grails-app/conf/i18n/messages_es.properties
date.formats.birthdays=ddMMyyyy
```

## Structured Data Binding Editors

A structured data binding editor is a helper class which can bind structured request parameters to a proper for structured binding is binding to a Date object which might be constructed from several smaller pieces in several request parameters with names like birthday\_month, birthday\_date and birthda editor would retrieve all of those individual pieces of information and use them to construct a Date.

The framework provides a structured editor for binding to Date objects. An application may register its c whatever types are appropriate. Consider the following classes:

```
// src/groovy/databinding/Gadget.groovy
package databinding

class Gadget {
    Shape expandedShape
    Shape compressedShape
}
```

```
// src/groovy/databinding/Shape.groovy
package databinding

class Shape {
    int area
}
```

A Gadget has 2 Shape fields. A Shape has an area property. It may be that the application wants to a like width and height and use those to calculate the area of a Shape at binding time. A structur suited for that.

The way to register a structured editor with the data binding process is to add [org.grails.databinding.TypedStructuredBindingEditor](#) interface to the Spring application context. The easie TypedStructuredBindingEditor interface is to exte [org.grails.databinding.converters.AbstractStructuredBindingEditor](#) abstract class and override the getPr as shown below:

```
// src/groovy/databinding/converters/StructuredShapeEditor.groovy
package databinding.converters

import databinding.Shape

import org.grails.databinding.converters.AbstractStructuredBindingEditor

class StructuredShapeEditor extends AbstractStructuredBindingEditor<Shape> {

public Shape getPropertyValue(Map values) {
    // retrieve the individual values from the Map
    def width = values.width as int
    def height = values.height as int

    // use the values to calculate the area of the Shape
    def area = width * height

    // create and return a Shape with the appropriate area
    new Shape(area: area)
}
}
```

An instance of that class needs to be registered with the Spring application context:

```
// grails-app/conf/spring/resources.groovy
beans = {
    shapeEditor databinding.converters.StructuredShapeEditor

    // ...
}
```

When the data binder binds to an instance of the Gadget class it will check to see if there are request parameters `compressedShape` and `expandedShape` which have a value of "struct" and if they do exist, that will be used to instantiate the `StructuredShapeEditor`. The individual components of the structure need to have parameter names `propertyName_structuredElementName`. In the case of the Gadget class above that would mean that the request parameter should have a value of "struct" and the `compressedShape_width` and `compressedShape_height` parameters should have values which represent the width and the height of the compressed shape. Similarly, the `expandedShape` request parameter should have a value of "struct" and the `expandedShape_width` and `expandedShape_height` parameters should have values which represent the width and the height of the expanded shape.

```
// grails-app/controllers/demo/DemoController.groovy
class DemoController {
    def createGadget(Gadget gadget) {
        /*
        /demo/createGadget?expandedShape=struct&expandedShape_width=80&expandedShape_heig
        &compressedShape=struct&compressedShape_width=10&compre

        */
        // with the request parameters shown above gadget.expandedShape.area would be 240
        // and gadget.compressedShape.area would be 30

        // ...
    }
}
```

Typically the request parameters with "struct" as their value would be represented by hidden form fields.

## Data Binding Event Listeners

The [DataBindingListener](#) interface provides a mechanism for listeners to be notified of data binding events this:

```

package org.grails.databinding.events;

import org.grails.databinding.errors.BindingError;

public interface DataBindingListener {

    /**
     * @return true if the listener is interested in events for the specified type
     */
    boolean supports(Class<?> clazz);

    /**
     * Called when data binding is about to start.
     *
     * @param target The object data binding is being imposed upon
     * @param errors the Spring Errors instance (a org.springframework.validation.Errors)
     * @return true if data binding should continue
     */
    Boolean beforeBinding(Object target, Object errors);

    /**
     * Called when data binding is about to be imposed on a property
     *
     * @param target The object data binding is being imposed upon
     * @param propertyName The name of the property being bound to
     * @param value The value of the property being bound
     * @param errors the Spring Errors instance (a org.springframework.validation.Errors)
     * @return true if data binding should continue, otherwise return false
     */
    Boolean beforeBinding(Object target, String propertyName, Object value, Object errors);

    /**
     * Called after data binding has been imposed on a property
     *
     * @param target The object data binding is being imposed upon
     * @param propertyName The name of the property that was bound to
     * @param errors the Spring Errors instance (a org.springframework.validation.Errors)
     */
    void afterBinding(Object target, String propertyName, Object errors);

    /**
     * Called after data binding has finished.
     *
     * @param target The object data binding is being imposed upon
     * @param errors the Spring Errors instance (a org.springframework.validation.Errors)
     */
    void afterBinding(Object target, Object errors);

    /**
     * Called when an error occurs binding to a property
     * @param error encapsulates information about the binding error
     * @param errors the Spring Errors instance (a org.springframework.validation.Errors)
     * @see BindingError
     */
    void bindingError(BindingError error, Object errors);
}

```

Any bean in the Spring application context which implements that interface will automatically be registered. The [DataBindingListenerAdapter](#) class implements the `DataBindingListener` interface and provides implementations for all of the methods in the interface so this class is well suited for subclassing so your listener class can provide implementations for the methods your listener is interested in.

The Grails data binder has limited support for the older [BindEventListener](#) style listeners. `BindEventListener`

```

package org.codehaus.groovy.grails.web.binding;

import org.springframework.beans.MutablePropertyValues;
import org.springframework.beans.TypeConverter;

public interface BindEventListener {

    /**
     * @param target The target to bind to
     * @param source The source of the binding, typically a Map
     * @param typeConverter The type converter to be used
     */
    void doBind(Object target, MutablePropertyValues source, TypeConverter typeCo
}

```

Support for `BindEventListener` is disabled by default. To enable support assign a value to the `grails.databinding.enableSpringEventAdapter` property in `grails-app/conf/Config.groovy`.

```

// grails-app/conf/Config.groovy
grails.databinding.enableSpringEventAdapter=true

...

```

With `enableSpringEventAdapter` set to `true` instances of `BindEventListener` which are in the `grails-web-binding` package will automatically be registered with the data binder. Notice that the `MutablePropertyValues` and `TypeConverter` arguments to the `doBind` method in `BindEventListener` are Spring specific classes. The event adapter will pass null values for those arguments. The only `doBind` method will be the object being bound to. This limited support is provided for backward compatibility for a subset of scenarios. Developers are encouraged to migrate their `BindEventListener` to the `DataBindingListener` model.

## Using The Data Binder Directly

There are situations where an application may want to use the data binder directly. For example, to do binding on an arbitrary object which is not a domain class. The following will not work because the properties property is not a domain class.

```

// src/groovy/bindingdemo/Widget.groovy
package bindingdemo

class Widget {
    String name
    Integer size
}

```

```
// grails-app/services/bindingdemo/WidgetService.groovy
package bindingdemo

class WidgetService {
    def updateWidget(Widget widget, Map data) {
        // this will throw an exception because
        // properties is read-only
        widget.properties = data
    }
}
```

An instance of the data binder is in the Spring application context with a bean name of `grailsWebD` implements the [DataBinder](#) interface. The following code demonstrates using the data binder directly.

```
// grails-app/services/bindingdemo/WidgetService
package bindingdemo

import org.grails.databinding.SimpleMapDataBindingSource

class WidgetService {
    // this bean will be autowired into the service
    def grailsWebDataBinder

    def updateWidget(Widget widget, Map data) {
        grailsWebDataBinder.bind widget, data as SimpleMapDataBindingSource
    }
}
```

See the [DataBinder](#) documentation for more information about overloaded versions of the `bind` method.

## Data Binding and Security Concerns

When batch updating properties from request parameters you need to be careful not to allow clients to update domain classes and be persisted in the database. You can limit what properties are bound to a given subscript operator:

```
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 to use [Command Objects](#) as the target of data binding instead of domain classes, also the 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']])
```



Note that if an empty List is provided as a value for the `include` parameter then all fields are subject to binding if they are not explicitly excluded.

## 8.1.7 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: "application/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>
```

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 with

```
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"
  }
]
```

### 8.1.8 More on JSONBuilder

The previous section on XML and JSON responses covered simplistic examples of rendering XML and the XML builder used by Grails is the standard [XmlSlurper](#) found in Groovy, the JSON builder is a custom to Grails.

## JSONBuilder and Grails versions

JSONBuilder behaves different depending on the version of Grails you use. For version below [grails.web.JSONBuilder](#) class 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 newer/better 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: "application/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: "application/json") {  
    categories = ['a', 'b', 'c']  
}
```

This will produce:

```
{ "categories": [ "a", "b", "c" ] }
```

You can also render lists of complex objects, for example:

```
render(contentType: "application/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: "application/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: "application/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: "application/json") {  
    categories = [ { a = "A" }, { b = "B" } ]  
}
```

You can use the array method to build them up dynamically:

```
def results = Book.list()  
render(contentType: "application/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 direct

```
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
```

## 8.1.9 Uploading Files

### Programmatic File Uploads

Grails supports file uploads using Spring's [MultipartHttpServletRequest](#) interface. The first step for file multipart form 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 do and so on with 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 automatically set the contents as a 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 with a blob size of 255 bytes and can't handle reasonably sized files. For example, both H2 and MySQL default to a blob size of 255 bytes for

It is also possible to set the contents of the file as a string by changing the type of the myFile property type:

```
class Image {  
    String myFile  
}
```

## 8.1.10 Command Objects

Grails controllers support the concept of command objects. A command object is a class that is used [binding](#), usually to allow validation of data that may not fit into an existing domain class.



Note: A class is only considered to be a command object when it is used as a parameter of an annotation.

### Declaring Command Objects

Command object classes are defined just like any other class.

```
@grails.validation.Validateable  
class LoginCommand {  
    String username  
    String password  
  
    static constraints = {  
        username(blank: false, minSize: 6)  
        password(blank: false, minSize: 6)  
    }  
}
```

In this example, the command object is marked with the `Validateable` annotation. The `Validateable` definition of [constraints](#) just like in [domain classes](#). If the command object is defined in the same source file using it, Grails will automatically mark it as `Validateable`. It is not required that command object classes

By default, all `Validateable` object properties are `nullable: false` which matches the behavior of domain objects. If you want a `Validateable` that has `nullable: true` properties by default, you can specify it on the annotation:

```
@grails.validation.Validateable(nullable=true)
class AuthorSearchCommand {
    String name
    Integer age
}
```

In this example, both name and age will allow null values during validation.

## Using Command Objects

To use command objects, controller actions may optionally specify any number of command object parameters. The types must be supplied so that Grails knows what objects to create and initialize.

Before the controller action is executed Grails will automatically create an instance of the command object and bind its properties by binding the request parameters. If the command object class is marked with `Validateable`, the object will be validated. For example:

```
class LoginController {
    def login(LoginCommand cmd) {
        if (cmd.hasErrors()) {
            redirect(action: 'loginForm')
            return
        }

        // work with the command object data
    }
}
```

If the command object's type is that of a domain class and there is an `id` request parameter then instead of calling the class constructor to create a new instance a call will be made to the static `get` method on the domain class. The `id` request parameter will be passed as an argument. Whatever is returned from that call to `get` is what will be passed to the controller action. This means that if there is an `id` request parameter and no corresponding record is found in the database then the command object will be `null`. If an error occurs retrieving the instance from the database then `null` will be passed to the controller action and an error will be added to the controller's `errors` property. If the command object is not a domain class and there is no `id` request parameter then `null` will be passed into the controller action. If the HTTP method is "POST", in which case a new instance of the domain class will be created by invoking the domain class's `save` method. In all of the cases where the domain class instance is non-null, data binding is only performed if the HTTP method is "PUT" or "PATCH".

## Command Objects And Request Parameter Names

Normally request parameter names will be mapped directly to property names in the command object. may be used to bind down the object graph in an intuitive way. In the example below a request parameter bound to the name property of the Person instance and a request parameter named address.city w property of the address property in the Person.

```
class StoreController {
    def buy(Person buyer) {
        // ...
    }
}

class Person {
    String name
    Address address
}

class Address {
    String city
}
```

A problem may arise if a controller action accepts multiple command objects which happen to contain Consider the following example.

```
class StoreController {
    def buy(Person buyer, Product product) {
        // ...
    }
}

class Person {
    String name
    Address address
}

class Address {
    String city
}

class Product {
    String name
}
```

If there is a request parameter named name it isn't clear if that should represent the name of the Product or the Person. Another version of the problem can come up if a controller action accepts 2 command objects as shown below.

```

class StoreController {
    def buy(Person buyer, Person seller, Product product) {
        // ...
    }
}

class Person {
    String name
    Address address
}

class Address {
    String city
}

class Product {
    String name
}

```

To help deal with this the framework imposes special rules for mapping parameter names to command object data binding will treat all parameters that begin with the controller action parameter name as belonging to the command object. For example, the `product.name` request parameter will be bound to the `name` property in the `product` argument, the `buyer.name` request parameter will be bound to the `name` property in the `buyer` argument, the `seller.address.city` request parameter will be bound to the `city` property of the `address` argument, etc...

## Command Objects and Dependency Injection

Command objects can participate in dependency injection. This is useful if your command object has some logic which uses a Grails [service](#):

```

@grails.validation.Validateable
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 injected by `ApplicationContext`.

## Binding The Request Body To Command Objects

When a request is made to a controller action which accepts a command object and the request contains a body, the framework will attempt to parse the body of the request based on the request content type and use the body to do data binding on the following example.

```
// grails-app/controllers/bindingdemo/DemoController.groovy
package bindingdemo

class DemoController {
    def createWidget(Widget w) {
        render "Name: ${w?.name}, Size: ${w?.size}"
    }
}

class Widget {
    String name
    Integer size
}
```

```
$ curl -H "Content-Type: application/json" -d '{"name":"Some Widget","size":"42"}' localhost:8080/myapp/demo/createWidget
Name: Some Widget, Size: 42
~ $
$ curl -H "Content-Type: application/xml" -d '<widget><name>Some Other Widget</name><size>2112</size></widget>' localhost:8080/bodybind/demo/createWidget
Name: Some Other Widget, Size: 2112
~ $
```

Note that the body of the request is being parsed to make that work. Any attempt to read the body of the request manually will fail since the corresponding input stream will be empty. The controller action can either use a command object of the request on its own (either directly, or by referring to something like `request.JSON`), but cannot do both.

```
// grails-app/controllers/bindingdemo/DemoController.groovy
package bindingdemo

class DemoController {
    def createWidget(Widget w) {
        // this will fail because it requires reading the body,
        // which has already been read.
        def json = request.JSON

        // ...
    }
}
```

## 8.1.11 Handling Duplicate Form Submissions

Grails has built-in support for handling duplicate form submissions using the "Synchronizer Token Pattern". To define a token on 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 it will set an invalid token in a `flash.invalidToken` variable and redirect the request back to the original page. You can then check for this in the view:

```
<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 clustered sessions to be used in a cluster.

## 8.1.12 Simple Type Converters

### Type Conversion Methods

If you prefer to avoid the overhead of [Data Binding](#) and simply want to convert incoming parameter names to another more 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`, and `short`. These methods are null-safe and safe from any parsing errors, so you don't have to perform any additional checks.

Each of the conversion methods allows a default value to be passed as an optional second argument. The default value is returned if a corresponding entry cannot be found in the map or if an error occurs during the conversion. For 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 you could have a URL like `?name=Bob&name=Judy`.

In this case dealing with one parameter and dealing with many has different semantics since Groovy's `String` iterates over each character. To avoid this problem the [params](#) object provides a `list` method that returns a list of all values for a given parameter name.

```
for (name in params.list('name')) {  
    println name  
}
```

### 8.1.13 Declarative Controller Exception Handling

Grails controllers support a simple mechanism for declarative exception handling. If a controller declares a `render` method with a single argument and the argument type is `java.lang.Exception` or some subclass of `java.lang.Exception`, the `render` method will be invoked any time an action in that controller throws an exception of that type. See the following example:



```
// grails-app/controllers/demo/DemoController.groovy
package demo

class DemoController {
    def someAction() {
        // do some work
    }

    def handleSQLException(SQLException e) {
        render 'A SQLException Was Handled'
    }

    def handleBatchUpdateException(BatchUpdateException e) {
        redirect controller: 'logging', action: 'batchProblem'
    }

    def handleNumberFormatException(NumberFormatException nfe) {
        [problemDescription: 'A Number Was Invalid']
    }
}
```

That controller will behave as if it were written something like this...

```
// grails-app/controllers/demo/DemoController.groovy
package demo

class DemoController {
    def someAction() {
        try {
            // do some work
        } catch (BatchUpdateException e) {
            return handleBatchUpdateException(e)
        } catch (SQLException e) {
            return handleSQLException(e)
        } catch (NumberFormatException e) {
            return handleNumberFormatException(e)
        }
    }

    def handleSQLException(SQLException e) {
        render 'A SQLException Was Handled'
    }

    def handleBatchUpdateException(BatchUpdateException e) {
        redirect controller: 'logging', action: 'batchProblem'
    }

    def handleNumberFormatException(NumberFormatException nfe) {
        [problemDescription: 'A Number Was Invalid']
    }
}
```

The exception handler method names can be any valid method name. The name is not what makes it a handler, the Exception argument type is the important part.

The exception handler methods can do anything that a controller action can do including invoking rendering a model, etc.

One way to share exception handler methods across multiple controllers is to use inheritance. Exceptions are inherited into subclasses so an application could define the exception handlers in an abstract class that is inherited from. Another way to share exception handler methods across multiple controllers is to use a trait, as shown below.

```
// src/groovy/com/demo/DatabaseExceptionHandler.groovy
package com.demo

trait DatabaseExceptionHandler {
    def handleSQLException(SQLException e) {
        // handle SQLException
    }
    def handleBatchUpdateException(BatchUpdateException e) {
        // handle BatchUpdateException
    }
}
```

```
// grails-app/controllers/com/demo/DemoController.groovy
package com.demo

class DemoController implements DatabaseExceptionHandler {
    // all of the exception handler methods defined
    // in DatabaseExceptionHandler will be added to
    // this class at compile time
}
```

Exception handler methods must be present at compile time. Specifically, exception handler methods metaprogrammed onto a controller class are not supported.

## 8.2 Groovy Server Pages

Groovy Server Pages (or GSP for short) is Grails' view technology. It is designed to be familiar for users of ASP and JSP, but to be far more flexible and intuitive.

GSPs live in the `grails-app/views` directory and are typically rendered automatically (by convention) using a method such as:

```
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 will be this document, the practice is strongly discouraged. Mixing mark-up and code is a **bad** thing. GSP pages 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 model is from a 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 is then used within the GSP view using the name book:

```
${book.title}
```



Embedding data received from user input has the risk of making your application vulnerable to a Site Scripting (XSS) attack. Please read the documentation on [XSS prevention](#) for information on how to prevent XSS attacks.

## 8.2.1 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 cover what users of JSP 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) a demonstrates:

```
<html>
  <body>
    <!-- This is my comment --%>
    <%= "Hello GSP!" %>
  </body>
</html>
```



Embedding data received from user input has the risk of making your application vulnerable Site Scripting (XSS) attack. Please read the documentation on [XSS prevention](#) for information prevent XSS attacks.

### 8.2.1.1 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

### 8.2.1.2 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>
```

### 8.2.1.3 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 [Tags](#):

```
<%@ page import="java.awt.*" %>
```

GSP also supports the contentType directive:

```
<%@ page contentType="application/json" %>
```

The contentType directive allows using GSP to render other formats.

### 8.2.1.4 Expressions

In GSP the `<%= %>` syntax introduced earlier is rarely used due to the support for GSP expressions. A GSP expression is a JSP EL 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.



Embedding data received from user input has the risk of making your application vulnerable to a Cross Site Scripting (XSS) attack. Please read the documentation on [XSS prevention](#) for information on how to prevent XSS attacks.

### 8.2.2 GSP Tags

Now that the less attractive JSP heritage has been set aside, the following sections cover GSP's built-in tag library and the way to 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 automatically 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 String.

```
<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.

### 8.2.2.1 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 `Date` instance). You can 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>
```

The assigned value can also be a bean from the `applicationContext`:

```
<g:set var="bookService" bean="bookService" />
```

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" />
```

### 8.2.2.2 Logic and Iteration

GSP also supports logical and iterative tags out of the box. For logic there are [if](#), [else](#) and [elseif](#) tags for use

```
<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>
```

### 8.2.2.3 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 by class:

```
<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 Groovy. It is a collection of Book instances. Since each Book has a title, you can obtain a list of Book titles by `books.title`. Groovy will auto-magically iterate the collection, obtain each title, and return a new list!

## 8.2.2.4 Links and Resources

GSP also features tags to help you manage linking to controllers and actions. The [link](#) tag lets you specify a name pairing and it will automatically work out the link based on the [URL Mappings](#), even if you change the mappings.

```
<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>
```

## 8.2.2.5 Forms and Fields

### Form Basics

GSP supports many different tags for working with HTML forms and fields, the most basic of which is the `form` tag. It is a controller/action aware version of the regular HTML form tag. The `url` attribute lets you specify which URL mapping to use:

```
<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. Be HTML attributes apply.

## Form Fields

In addition to easy construction of forms, GSP supports custom tags for dealing with different types of field

- [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 [currencySelect](#) 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 using `t` just like a regular submit, but lets you specify an alternative action to submit to:

```
<g:actionSubmit value="Some update label" action="update" />
```

### 8.2.2.6 Tags as Method Calls

One major different between GSP tags and other tagging technologies is that GSP tags can be called as method calls from [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 methods) writing directly 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:

```

```

In view technologies that don't support this feature you have to nest tags within tags, which becomes messy. It's an adverse effect of WYSIWYG tools such as Dreamweaver that attempt to render the mark-up as it is not

```
" />
```

## 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](#) can be called without a prefix and a `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")
```

## 8.2.3 Views and Templates

Grails also has the concept of templates. These are useful for partitioning your views into maintainable chunks. [Layouts](#) 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 template. For example, if you have a 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 books, you can also render 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` in `grails-app/views/book`. 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 it. With the `template` attribute use an absolute location starting with `/` instead of a relative location. For example, a template called `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 a template namespace, called `tmpl`, available that makes it easier to use. Consider for 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](#) generate small HTML or data responses to partially update the current page instead of performing new req

```
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 in template as a 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

## 8.2.4 Layouts with Sitemesh

### Creating Layouts

Grails leverages [Sitemesh](#), a decorator engine, to support view layouts. Layouts a `grails-app/views/layouts` directory. 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 aspects of the page.

## 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 page. The output from the previous section 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" For example, if 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 be app `BookController` delegates to. The value of the "layout" property may contain a directory st `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` template.

## 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 by `BookController` delegates to.

Alternatively, you can create a layout called `grails-app/views/layouts/book/list.gsp` which will be applied by the `list` action within the `BookController`.

If you have both the above mentioned layouts in place the layout specific to the action will take precedence and be executed.

If a layout may not be located using any of those conventions, the convention of last resort is to look for a layout which is `grails-app/views/layouts/application.gsp`. The name of the application can be changed by defining a property 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/myLayout.gsp`.

## Inline Layouts

Grails' also supports Sitemesh's concept of inline layouts with the [applyLayout](#) tag. This can be used to apply a layout to a URL or arbitrary section of content. This lets you even further modularize your view structure by "delegating" includes.

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 include content on the current page 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.

## 8.2.5 Static Resources

Grails 2.0 integrates with the [Asset Pipeline plugin](#) to provide sophisticated static asset management. This is the default in new Grails applications.

The basic way to include a link to a static asset in your application is to use the [resource](#) tag. This simply points to the file.

However modern applications with dependencies on multiple JavaScript and CSS libraries and dependencies on multiple Grails plugins) require something more powerful.

The issues that the Asset-Pipeline plugin tackles are:

- Reduced Dependence - The plugin has compression, minification, and cache-digests built in.
- Easy Debugging - Makes for easy debugging by keeping files separate in development mode.
- Asset Bundling using require [directives](#).
- Web application performance tuning is difficult.
- The need for a standard way to expose static assets in plugins and applications.
- The need for extensible processing to make languages like LESS or Coffee first class citizens.

The asset-pipeline allows you to define your javascript or css requirements right at the top of the file and their creation.

Take a look at the [documentation](#) for the asset-pipeline to get started.

### 8.2.5.1 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 with the `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 the page. The `jquery` plugin sets the 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 at the end of the 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/>` tag to perform the render.

#### Rendering the links to resources with r:layoutResources

When you have declared the resource modules that your GSP page requires, the framework needs to resources at the correct time.

To achieve this correctly, you must include the `r:layoutResources` tag twice in your page, or more common

```
<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 resource should be included.

The default disposition applied depends on the type of resource. All CSS must be rendered in `<head>` in default for all CSS, and will be rendered by the first `r:layoutResources`. Page load times are improved w after the page content, so the default for JavaScript files is "defer", which means it is rendered when the s is invoked.

Note that both your GSP page and your Sitemesh layout (as well as any GSP template fragments) can ca resources. The only limitation is that you must call `r:require` before the `r:layoutResources` that should rende

## 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 reco `r:script` directly 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>` body, based on the 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 demonstrative purposes.

Note that such r:script code fragments **always** load after any modules that you have used, to ensure that all dependencies are loaded.

## Linking to images with r:img

This tag is used to render <img> markup, using the Resources framework to process the resource on the fly (e.g. make it eternally cacheable).

This includes any extra attributes on the <img> tag if the resource has been previously declared in a module.

With this mechanism you can specify the width, height and any other attributes in the resource declaration. These attributes will be pulled 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 static resource. Grails is Resources-aware and will delegate to r:img if found. However it is recommended that you use r:img to ensure the Resources plugin is used.

Alongside the regular Grails [resource](#) tag attributes, this also supports the "uri" attribute for increased brevity.

See [r:resource documentation](#) for full details.

## 8.2.5.2 Other resource tags

### r:resource

This is equivalent to the Grails [resource](#) tag, returning a link to the processed static resource. Grails' delegates to this implementation if found, but if your code requires the Resources plugin, you should use `r`.

Alongside the regular Grails [resource](#) tag attributes, this also supports the "uri" attribute for increased brevity.

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 include a resource such as CSS, JS or a favicon.

See [r:resource documentation](#) for full details.

## 8.2.5.3 Declaring resources

A DSL is provided for declaring resources and modules. This can go either in your `Config.groovy` for application-specific 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 must declare other resources-specific attributes. Any resource that is not declared is called "ad-hoc" and will still be processed by that resource type.

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 auto the box according to the module name, resulting in fewer files. You can override this with `bundle: 'son resource`, or call `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 resource well as 'jquery', all in the correct order.

You'll also notice the `disposition: 'head'` on the `core.js` file. This tells Resources that while it files to the end 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 `r:external` tag when the engine renders the link to the resource, so you can customize the HTML a link.

There is no limit to the number of modules or `xxxResources.groovy` artefacts you can provide, and pl expose modules to applications, which is exactly how the jQuery plugin works.

To define modules like this in your application's `Config.groovy`, you simply assign the `grails.resources.modules` `Config` variable.

For full details of the resource DSL please see the [resources plugin documentation](#).

## 8.2.5.4 Overriding plugin resources

Because a resource module can define the bundle groupings and other attributes of resources, you m provided are not correct for your application.

For example, you may wish to bundle jQuery and some other libraries all together in one file. There is trade-off here, but 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 `defaultBundle` attributes of 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 files required for 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](#).

## 8.2.5.5 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 your own or several 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 also perform 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 default module. 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 boundaries.

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 changes, and 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 them; it also sets the 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 you are serving the static content from your app (e.g. Apache HTTPD), configure it to send caching headers. If you are using a proxy, configure it to request and proxy the resources from your container.

## Zippping 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 already compressed formats 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 code. Some are publicly released but releases are imminent.

## 8.2.5.6 Debugging

When your resources are being moved around, renamed and otherwise mutated, it can be hard to debug. Browsers, especially Safari, Chrome and Firefox have excellent tools that let you view all the resources including the headers and other 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 added to the response. This header contains the source file(s) 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 bypass the normal processing and you can see your original source files.

This also adds a unique timestamp to all your resource URLs, to defeat any caching that browsers may use. This means you should always 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 on globally.

```
grails.resources.debug = true
```

You can of course set this per-environment.

## 8.2.5.7 Preventing processing of resources

Sometimes you do not want a resource to be processed in a particular way, or even at all. Occasionally you may want to disable all resource 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 renames resources to prevent breaking 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 are based on their activity, for example the zipped-resources plugin's "zip" mapper is set to exclude images.

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 replace the default includes/excludes for an additive.

## 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 Grails `(resource, 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 A mappings, which the Resources filter will use to detect such "ad-hoc resource" requests.

By default this is set to:

```
grails.resources.adhoc.patterns = ['images/*', '*.js', '*.css']
```

## 8.2.5.8 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](#)

## 8.2.6 Sitemesh Content Blocks

Although it is useful to decorate an entire page sometimes you may find the need to decorate independent do this you can use content blocks. To get started, partition the page to be decorated using the `<content`

```
<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>

```

## 8.2.7 Making Changes to a Deployed Application

One of the main issues with deploying a Grails application (or typically any servlet-based one) is that it requires that you redeploy your whole application. If all you want to do is fix a typo on a page, or change a link, it can be like a lot of unnecessary work. For such simple requirements, Grails does have a solution: the `grails.reload` configuration setting.

How does this work? The first step is to decide where the GSP files should go. Let's say we want to keep them in `/var/www/grails/my-app` directory. We add these two lines to `grails-app/conf/Config.groovy`:

```

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 line, you'll have to make many changes as you like but they won't be reflected in the running application until you restart. The second line tells Grails where to load the views and layouts from.



The trailing slash on the `grails.gsp.view.dir` value is important! Without it, Grails will look for views in the parent directory.

Setting `"grails.gsp.view.dir"` is optional. If it's not specified, you can update files directly to the application directory. Depending on the application server, these files might get overwritten when the server is restarted. Servers that support "exploded 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 Unix-like system, this 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/views` with the path `/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 permgen space. It will eventually hit "out of permgen space" errors unless you restart the server. So this technique is not recommended for large changes to the views.

There are also some System properties to control GSP reloading:

Name	Description
<code>grails.gsp.enable.reload</code>	alternative system property for enabling the GSP reload mode with <code>Config.groovy</code>
<code>grails.gsp.reload.interval</code>	interval between checking the lastmodified time of the gsp source file, unit is milliseconds
<code>grails.gsp.reload.granularity</code>	the number of milliseconds leeway to give before deciding a file is out of date. Needed because different roundings usually cause a 1000ms difference in times

GSP reloading is supported for precompiled GSPs since Grails 1.3.5 .

## 8.2.8 GSP Debugging

### Viewing the generated source code

- Adding `"?showSource=true"` or `"&showSource=true"` to the url shows the generated Groovy source code of rendering it. 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.showSource"` in `Config.groovy` . It must point to a directory that exists and is writable.
- During "grails war" gsp pre-compilation, the generated source code is stored in `grails.project.work.dir` . It is `~/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 templates render a single page. It might be hard to find out what GSP template actually renders the html seen in the result. The `debugTemplates` feature adds html comments to the output. The comments contain debug information about gsp templates.

Usage is simple: append `"?debugTemplates"` or `"&debugTemplates"` to the url and view the source of the page. `"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.

## 8.3 Tag Libraries

Like [Java Server Pages](#) (JSP), GSP supports the concept of custom tag libraries. Unlike JSP, Grails' tag libraries are simple, elegant and completely reloadable at runtime.

Quite simply, to create a tag library create a Groovy class that ends with the convention `TagLib` in the `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 content.

```
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 when invoked:



```
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 use to write the response. 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 Spring Tool Suite (STS) and others autocomplete tag attributes, you Javadoc comments to your tag closures with @attr descriptions. Since taglibs use Groovy be difficult to reliably 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)  
    }  
}
```

### 8.3.1 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

### 8.3.2 Simple Tags

As demonstrated in the previous example it is easy to write simple tags that have no body and just output content. Here is a `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. Here is how to use it within a GSP as 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 write it directly:

```
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 [render](#)

```
def formatBook = { attrs, body ->
  out << render(template: "bookTemplate", model: [book: attrs.book])
}
```

And then have a separate GSP template that does the actual rendering.

### 8.3.3 Logical Tags

You can also create logical tags where the body of the tag is only output once a set of conditions have been met. For example, you may have a set 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 privileges:

```
<g:isAdmin user='${myUser}'>
  // some restricted content
</g:isAdmin>
```

## 8.3.4 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 the specified 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 because the body we 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 should 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 invocation.

```
out << body((var):num)
```



Note the usage of the parenthesis around the variable name. If you omit these Groovy assurances using a 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 reference body of the tag.

### 8.3.5 Tag Namespaces

By default, tags are added to the default Grails namespace and are used with the `g:` prefix in GSP pages. If a different 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 from

```
<my:example name="..." />
```

where the prefix is the same as the value of the static namespace property. Namespaces are particularly useful in GSPs.

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.

### 8.3.6 Using JSP Tag Libraries

In addition to the simplified tag library mechanism provided by GSP, you can also use JSP tags from GSP. The JSP to use with the `taglib` directive:

```
<%@ taglib prefix="fmt" uri="http://java.sun.com/jsp/jstl/fmt" %>
```

Besides this you have to configure Grails to scan for the JSP tld files. This is done by the `grails.gsp.tldScanPattern` setting. It accepts a comma separated String. A `PathMatchingResourcePatternResolver` is used to resolve the patterns.

For example you could scan for all available tld files by adding this to `Config.groovy`:

```
grails.gsp.tldScanPattern='classpath*/META-INF/*.tld,/WEB-INF/tld/*.tld'
```

JSTL standard library is no more added as a dependency by default. In case you are using JSTL, you need to add the following dependencies to `BuildConfig.groovy`:

```
runtime 'javax.servlet:jstl:1.1.2'
runtime 'taglibs:standard:1.1.2'
```

Then you can use JSP tags 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")}
```

### 8.3.7 Tag return value

A taglib can be used in a GSP as an ordinary tag or it might be used as a function in other taglibs or GSP e.

Internally Grails intercepts calls to taglib closures. The "out" that is available in a taglib is mapped to an implementation that writes to a buffer that "captures" the output of the taglib call. This buffer is the return value when it's used as a function.

If the tag is listed in the library's static `returnObjectForTags` array, then its return value will be written to the buffer. If the tag is not in the array, the return value will be discarded. Using `returnObjectForTags` is not supported.

If the tag is not included in the `returnObjectForTags` array, then its return value will be discarded. Using `returnObjectForTags` is not supported.

Example:

```
class ObjectReturningTagLib {
    static namespace = "cms"
    static returnObjectForTags = ['content']

    def content = { attrs, body ->
        CmsContent.findByCode(attrs.code)?.content
    }
}
```

Given this example `cmd.content(code:'something')` call in another taglib or GSP expression will return `"CmsContent.content"` directly to the caller without wrapping the return value in a buffer. It might be worth noting that for performance optimization reasons. There is no need to wrap the tag return value in an output buffer in such cases.

## 8.4 URL Mappings



Throughout the documentation so far the convention used for URLs has been the default of `/controller/action`. However, this convention is not hard wired into Grails and is in fact controlled by a URL Mapping class in `grails-app/conf/UrlMappings.groovy`.

The `UrlMappings` class contains a single property called `mappings` that has been assigned a block of code:

```
class UrlMappings {
    static mappings = {
    }
}
```

### 8.4.1 Mapping to Controllers and Actions

To create a simple mapping simply use a relative URL as the method name and specify named parameters for the controller and action to map to:

```
"/product"(controller: "product", action: "list")
```

In this case we've mapped the URL `/product` to the `list` action of the `ProductController`. One can also map to the 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.

If you have mappings that all fall under a particular path you can group mappings with the `group` method

```
group "/product", {  
    "/apple"(controller:"product", id:"apple")  
    "/htc"(controller:"product", id:"htc")  
}
```

To rewrite one URI onto another explicit URI (rather than a controller/action pair) do something like this:

```
"/hello"(uri: "/hello.dispatch")
```

Rewriting specific URIs is often useful when integrating with other frameworks.

## 8.4.2 Mapping to REST resources

Since Grails 2.3, it is possible to create RESTful URL mappings that map onto controllers by convention. It follows:

```
"/books"(resources:'book')
```

You define a base URI and the name of the controller to map to using the `resources` parameter. The a in the following URLs:

HTTP Method	URI	Grails Action
GET	/books	index
GET	/books/create	create
POST	/books	save
GET	/books/\${id}	show
GET	/books/\${id}/edit	edit
PUT	/books/\${id}	update
DELETE	/books/\${id}	delete

If you wish to include or exclude any of the generated URL mappings you can do so with the `in` parameter, which accepts the name of the Grails action to include or exclude:

```
"/books"(resources:'book', excludes:['delete', 'update'])  
or  
"/books"(resources:'book', includes:['index', 'show'])
```

## Single resources

A single resource is a resource for which there is only one (possibly per user) in the system. You can create the `resource` parameter (as opposed to `resources`):

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

This results in the following URL mappings:

HTTP Method	URI	Grails Action
GET	/book/create	create
POST	/book	save
GET	/book	show
GET	/book/edit	edit
PUT	/book	update
DELETE	/book	delete

The main difference is that the `id` is not included in the URL mapping.

## Nested Resources

You can nest resource mappings to generate child resources. For example:

```

"/books"(resources:'book') {
  "/authors"(resources:"author")
}

```

The above will result in the following URL mappings:

HTTP Method	URL	Grails Action
GET	/books/\${bookId}/authors	index
GET	/books/\${bookId}/authors/create	create
POST	/books/\${bookId}/authors	save
GET	/books/\${bookId}/authors/\${id}	show
GET	/books/\${bookId}/authors/edit/\${id}	edit
PUT	/books/\${bookId}/authors/\${id}	update
DELETE	/books/\${bookId}/authors/\${id}	delete

You can also nest regular URL mappings within a resource mapping:

```

"/books"(resources: "book") {
  "/publisher"(controller:"publisher")
}

```

This will result in the following URL being available:

HTTP Method	URL	Grails Action
GET	/books/1/publisher	index

## Linking to RESTful Mappings

You can link to any URL mapping created with the `g:link` tag provided by Grails simply by referencing to link to:

```
<g:link controller="book" action="index">My Link</g:link>
```

As a convenience you can also pass a domain instance to the `resource` attribute of the `link` tag:

```
<g:link resource="${book}">My Link</g:link>
```

This will automatically produce the correct link (in this case `/books/1` for an id of `"1"`).

The case of nested resources is a little different as they typically required two identifiers (the id of the parent resource and the id of the nested within). For example given the nested resources:

```
"/books"(resources:'book') {  
  "/authors"(resources:"author")  
}
```

If you wished to link to the `show` action of the `author` controller, you would write:

```
// Results in /books/1/authors/2  
<g:link controller="author" action="show" method="GET" params="[bookId:1]" id="2">  
  Author</g:link>
```

However, to make this more concise there is a `resource` attribute to the `link` tag which can be used instead:

```
// Results in /books/1/authors/2  
<g:link resource="book/author" action="show" bookId="1" id="2">My Link</g:link>
```

The resource attribute accepts a path to the resource separated by a slash (in this case "book/author"). This can be used to specify the necessary `bookId` parameter.

### 8.4.3 Redirects In URL Mappings

Since Grails 2.3, it is possible to define URL mappings which specify a redirect. When a URL mapping matches an incoming request, a redirect is initiated with information provided by the mapping.

When a URL mapping specifies a redirect the mapping must either supply a String representing a URL or provide a Map representing the target of the redirect. That Map is structured just like the Map that may be passed to the `redirect` method in a controller.

```
"/viewBooks"(redirect: '/books/list')
"/viewAuthors"(redirect: [controller: 'author', action: 'list'])
"/viewPublishers"(redirect: [controller: 'publisher', action: 'list', permanent: true])
```

Request parameters that were part of the original request will be included in the redirect.

### 8.4.4 Embedded Variables

#### Simple Variables

The previous section demonstrated how to map simple URLs with concrete "tokens". In URL mappings, a sequence of characters between each slash, '/'. A concrete token is one which is well defined such as `product`. In many circumstances you don't know what the value of a particular token will be until runtime. In this case, you use placeholders within the URL for example:

```
static mappings = {
    "/product/$id"(controller: "product")
}
```

In this case by embedding a `$id` variable as the second token Grails will automatically map the second token (available via the [params](#) object) called `id`. For example given the URL `/product/MacBook`, the framework will map `MacBook` to the response:

```
class ProductController {
    def index() { render params.id }
}
```

You can of course construct more complex examples of mappings. For example the traditional blog URL as follows:

```
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 and so on.

## Dynamic Controller and Action Names

Variables can also be used to dynamically construct the controller and action name. In fact the default C this technique:

```
static mappings = {
    "/$controller/$action?/$id?]()
}
```

Here the name of the controller, action and id are implicitly obtained from the variables `contro` embedded within the 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 make further 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 the

```
/graemerocher/2007/01/10/my_funky_blog_entry  
/graemerocher/2007/01/10  
/graemerocher/2007/01  
/graemerocher/2007  
/graemerocher
```

## Optional File Extensions

If you wish to capture the extension of a particular path, then a special case mapping exists:

```
"/$controller/$action?/$id?(.$format)?"()
```

By adding the ( .\$format ) ? mapping you can access the file extension using the `response.format`

```
def index() {  
    render "extension is ${response.format}"  
}
```

## Arbitrary Variables

You can also pass arbitrary parameters from the URL mapping into the controller by just setting them in the mapping:



```
"/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 variables. This is also 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 work with all sorts of logic.

## 8.4.5 Mapping to Views

You can resolve a URL to a view without a controller or action involved. For example to map the root location `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  
}
```

## 8.4.6 Mapping to Response Codes

Grails also lets you map HTTP response codes to controllers, actions or views. Just use a method name to code you are 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 `illegalArgument` action, a `NullPointerException` will be handled by the `nullPointer` action, and other exceptions will be handled by the `customException` action. Other exceptions will be handled by the `catch` `/errors/serverError` view.

You can access the exception from your custom error handling view or controller action using the request like so:

```
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 end up with a `StackOverflowException`.

## 8.4.7 Mapping to HTTP methods

URL mappings can also be configured to map based on the HTTP method (GET, POST, PUT or DELETE) for RESTful APIs and for restricting mappings based on HTTP method.

As an example the following mappings provide a RESTful API URL mappings for the `ProductController`.

```
static mappings = {  
    "/product/$id"(controller:"product", action: "update", method: "PUT")  
}
```

## 8.4.8 Mapping Wildcards

Grails' URL mappings mechanism also supports wildcard mappings. For example consider the following n

```
static mappings = {  
    "/images/*.jpg"(controller: "image")  
}
```

This mapping will match all paths to images such as `/image/logo.jpg`. Of course you can achieve variable:

```
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`. E double wildcard 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 [params](#)

```
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 mappings. You can provide 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`.

## 8.4.9 Automatic Link Re-Writing

Another great feature of URL mappings is that they automatically customize the behaviour of the [link](#) mappings don't 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 mappings. as the blog 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>
```

## 8.4.10 Applying Constraints

URL Mappings also support Grails' unified [validation constraints](#) mechanism, which lets you further "c" matched. For example, if we revisit the blog sample code from earlier, the mapping currently looks like thi

```
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 Mappings further 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 pattern that burden later on.

### 8.4.11 Named URL Mappings

URL Mappings also support named mappings, that is mappings which have a name associated with them. We refer to a 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` attribute. The value will be applied 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>
```

## 8.4.12 Customizing URL Formats

The default URL Mapping mechanism supports camel case names in the URLs. The default URL for `addNumbers` in a controller named `MathHelperController` would be something like `/mathHelper/addNumbers`. Grails allows for the customization of this pattern and provides an implementation which replaces the camel case with a hyphenated convention that would support URLs like `/math-helper/add-numbers`. To enable this, set the value of `"hyphenated"` to the `grails.web.url.converter` property in `grails-app/conf/Config.groovy`.

```
// grails-app/conf/Config.groovy
grails.web.url.converter = 'hyphenated'
```

Arbitrary strategies may be plugged in by providing a class which implements the [UrlConverter](#) interface. Register that class to the Spring application context with the bean name of `grails.web.UrlConverter.BEAN_NAME`. Once a bean in the context with that name, it will be used as the default converter and there is no need to set the `grails.web.url.converter` config property.

```
// src/groovy/com/myapplication/MyUrlConverterImpl.groovy
package com.myapplication

class MyUrlConverterImpl implements grails.web.UrlConverter {
    String toUrlElement(String propertyOrClassName) {
        // return some representation of a property or class name that should be
    }
}
```

```
// grails-app/conf/spring/resources.groovy
beans = {
    "${grails.web.UrlConverter.BEAN_NAME}"(com.myapplication.MyUrlConverterImpl)
}
```

## 8.4.13 Namespaced Controllers

If an application defines multiple controllers with the same name in different packages, the controller namespace. The way to define a namespace for a controller is to define a static property named `namespace`. assign a `String` to the property that represents the namespace.

```
// grails-app/controllers/com/app/reporting/AdminController.groovy
package com.app.reporting

class AdminController {

    static namespace = 'reports'

    // ...
}
```

```
// grails-app/controllers/com/app/security/AdminController.groovy
package com.app.security

class AdminController {

    static namespace = 'users'

    // ...
}
```

When defining url mappings which should be associated with a namespaced controller, the namespace of the URL mapping.

```
// grails-app/conf/UrlMappings.groovy
class UrlMappings {

    static mappings = {
        '/userAdmin' {
            controller = 'admin'
            namespace = 'users'
        }

        '/reportAdmin' {
            controller = 'admin'
            namespace = 'reports'
        }

        "$namespace/$controller/$action?"()
    }
}
```

Reverse URL mappings also require that the namespace be specified.

```
<g:link controller="admin" namespace="reports">Click For Report Admin</g:link>
<g:link controller="admin" namespace="users">Click For User Admin</g:link>
```

When resolving a URL mapping (forward or reverse) to a namespaced controller, a mapping will only work if a namespace has been provided. If the application provides several controllers with the same name in different packages, they must be defined without a namespace property. If there are multiple controllers with the same name that do not have a namespace property, the framework will not know how to distinguish between them for forward or reverse mapping resolution.

It is allowed for an application to use a plugin which provides a controller with the same name as a controller in the application and for neither of the controllers to define a namespace property as long as the controllers are distinguished by a plugin. For example, an application may include a controller named `com.accounting.ReportingController`. The application may also use a plugin which provides a controller named `com.humanresources.ReportingController`. In this case, the URL mapping for the controller provided by the plugin needs to be explicit in specifying that the `ReportingController` which is provided by the plugin.

See the following example.

```
static mappings = {
    "/accountingReports" {
        controller = "reporting"
    }
    "/humanResourceReports" {
        controller = "reporting"
        plugin = "humanResources"
    }
}
```

With that mapping in place, a request to `/accountingReports` will be handled by the `ReportingController` defined in the application. A request to `/humanResourceReports` will be handled by the `ReportingController` provided by the `humanResources` plugin.

There could be any number of `ReportingController` controllers provided by any number of plugins. The framework can provide more than one `ReportingController` even if they are defined in separate packages.

Assigning a value to the `plugin` variable in the mapping is only required if there are multiple controllers with the same name available at runtime provided by the application and/or plugins. If the `humanResourceReportingController` is the only `ReportingController` available at runtime, the framework will work.

```
static mappings = {  
    "/humanResourceReports" {  
        controller = "reporting"  
    }  
}
```

It is best practice to be explicit about the fact that the controller is being provided by a plugin.

## 8.5 Filters

Although Grails [controllers](#) support fine grained interceptors, these are only really useful when applied become difficult to manage with larger applications. Filters on the other hand can be applied across a whole URI space or to a specific action. Filters are far easier to plugin and maintain completely separately to y and are useful for all sorts of cross cutting concerns such as security, logging, and so on. .

### 8.5.1 Applying Filters

To create a filter create a class that ends with the convention `Filters` in the `grails-app/conf` directory. Define a code 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 using named arguments. For example to define a filter that applies to all controllers and all actions you can

```
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 compiled
- `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.find`)
- `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 which they are executed. To control the order of execution between `Filters` classes, you can use the `dependsOn` property in the [dependencies](#) section.



Note: When exclude patterns are used they take precedence over the matching patterns. For example, if the action is 'b\*' and actionExclude is 'bad\*', then actions like 'best' and 'bien' will have that filter applied, but actions like 'bad' and 'badlands' will not.

## 8.5.2 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 and the action should not execute
- `after` - Executed after an action. Takes a first argument as the view model to allow modification rendering the view
- `afterView` - Executed after view rendering. Takes an Exception as an argument which will be n occurs during 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 is not logged in and redirects to the login action. Note how returning `false` ensures that the action itself is not executed.

Here's a more involved example that demonstrates all three filter types:



```

import java.util.concurrent.atomic.AtomicLong

class LoggingFilters {

private static final AtomicLong REQUEST_NUMBER_COUNTER = new AtomicLong()
    private static final String START_TIME_ATTRIBUTE = 'Controller__START_TIME__'
    private static final String REQUEST_NUMBER_ATTRIBUTE = 'Controller__REQUEST_NU

def filters = {

logFilter(controller: '*', action: '*') {

before = {
    if (!log.debugEnabled) return true

long start = System.currentTimeMillis()
    long currentRequestNumber = REQUEST_NUMBER_COUNTER.incrementAndGet()

request[START_TIME_ATTRIBUTE] = start
    request[REQUEST_NUMBER_ATTRIBUTE] = currentRequestNumber

log.debug "preHandle request #${currentRequestNumber} : " +
    "$request.servletPath/'$request.forwardURI', " +
    "from $request.remoteHost ($request.remoteAddr) " +
    " at ${new Date()}, Ajax: $request.xhr, controller: $controllerNam
    "action: $actionName, params: ${new TreeMap(params)}"

return true
    }

after = { Map model ->

if (!log.debugEnabled) return true

long start = request[START_TIME_ATTRIBUTE]
    long end = System.currentTimeMillis()
    long requestNumber = request[REQUEST_NUMBER_ATTRIBUTE]

def msg = "postHandle request #${requestNumber}: end ${new Date()}, " +
    "controller total time ${end - start}ms"
    if (log.traceEnabled) {
        log.trace msg + "; model: $model"
    }
    else {
        log.debug msg
    }

afterView = { Exception e ->

if (!log.debugEnabled) return true

long start = request[START_TIME_ATTRIBUTE]
    long end = System.currentTimeMillis()
    long requestNumber = request[REQUEST_NUMBER_ATTRIBUTE]

def msg = "afterCompletion request #${requestNumber}: " +
    "end ${new Date()}, total time ${end - start}ms"
    if (e) {
        log.debug "$msg \n\textception: $e.message", e
    }
    else {
        log.debug msg
    }
    }
    }
    }
}

```

In this logging example we just log various request information, but note that the `model` map in the `after` filter. you need to add or remove items from the model map you can do that in the `after` filter.

## 8.5.3 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

## 8.5.4 Filter Dependencies

In a `Filters` class, you can specify any other `Filters` classes that should first be executed using th  
This is used when a `Filters` class depends on the behavior of another `Filters` class (e.g. sett  
modifying the request/session, etc.) 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 v current request to be executed before those in MyFilters. For a request of "/test", which will match the sc example, the execution order 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 M order between Filters classes are enabled and the execution order of filters within each Filters class

If any cyclical dependencies are detected, the filters with cyclical dependencies will be added to the error processing will continue. Information about any cyclical dependencies that are detected will be written to the root logging level is set to at least WARN or configure an appender for the Grails plugin (org.codehaus.groovy.grails.plugins.web.filters.FiltersGrailsPlugin) will handle dependency issues.

## 8.6 Ajax

Ajax is the driving force behind the shift to richer web applications. These types of applications in general use dynamic frameworks written in languages like [Groovy](#) and [Ruby](#). Grails provides support for building Ajax applications using the Ajax tag library. For a full list of these see the Tag Library Reference.

 Note: JavaScript examples use the jQuery library.

### 8.6.1 Ajax Support

By default Grails ships with the [jQuery](#) library, but through the [Plugin system](#) provides support for other [Prototypes](#), [Dojo](#), 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 your application:

```
<g:javascript library="jquery" />
```

You can replace jQuery with any other library supplied by a plugin you have installed. This works because Grails uses adaptive tag libraries. Thanks to Grails' plugin system there is support for a number of different Ajax libraries (limited to):

- jQuery
- Prototype
- Dojo
- YUI
- MooTools

#### 8.6.1.1 Remoting Linking

Remote content can be loaded in a number of ways, the most common way is through the [remoteLink](#) tag. The creation of HTML anchor tags that perform an asynchronous request and optionally set the response in JavaScript. One way to create a remote link is as 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

### 8.6.1.2 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 `deleted`. This is done by the `update` attribute on the tag, which can also take a Map to indicate w/ failure:

```
<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.

### 8.6.1.3 Remote Form Submission

An HTML form can also be submitted asynchronously in one of two ways. Firstly using the [formRemote](#) attributes to 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 button some not depending on the action:

```
<form action="delete">
  <input type="hidden" name="id" value="1" />
  <g:submitToRemote action="delete"
                  update="[success: 'message', failure: 'error']" />
</form>
```

### 8.6.1.4 Ajax Events

Specific JavaScript can be called if certain events occur, all the events start with the "on" prefix and let user where 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 events include:

- `onSuccess` - The JavaScript function to call if successful
- `onFailure` - The JavaScript function to call if the call failed
- `onERROR_CODE` - The JavaScript function to call to handle specified error codes (e.g. `onNotFound` found! ' ) ")
- `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 response
- `onComplete` - The JavaScript function to call when the remote function is complete, including any

You can simply refer to the `XMLHttpRequest` variable to obtain the request:

```
<g:javascript>
  function fireMe(event) {
    alert("XmlHttpRequest = " + event)
  }
</g:javascript>
<g:remoteLink action="example"
              update="success"
              onFailure="fireMe(XMLHttpRequest)">Ajax Link</g:remoteLink>
```

## 8.6.2 Ajax with Prototype

Grails features an external plugin to add [Prototype](#) support to Grails. To install the plugin, list it in `BuildConfig.groovy`:

```
runtime ":prototype:latest.release"
```

This will download the current supported version of the Prototype plugin and install it into your Grails project. You can add the 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

### 8.6.3 Ajax with Dojo

Grails features an external plugin to add [Dojo](#) support to Grails. To install the plugin, list it in BuildConfig

```
compile ":dojo:latest.release"
```

This will download the current supported version of Dojo and install it into your Grails project. With th following 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.

### 8.6.4 Ajax with GWT

Grails also features support for the [Google Web Toolkit](#) through a plugin. There is comprehensive [docun](#) Grails wiki.

### 8.6.5 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 prog page
- 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 page, l use Data 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 done using the [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. With Grails you 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(data) {
    $("#book" + data.id + "_title").html( data.title );
}
</g:javascript>
<g:remoteLink action="showBook" id="${book.id}" onSuccess="updateBook(data)">
    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(data) {
    var id = $(data).find("book").attr("id");
    $("#book" + id + "_title").html( $(data).find("title").text() );
}
</g:javascript>
<g:remoteLink action="showBook" id="${book.id}" onSuccess="updateBook(data)">
    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 below:

```
def showBook() {
  def b = Book.get(params.id)

  response.contentType = "text/javascript"
  String title = b.title.encodeAsJavaScript()
  render "$('#book${b.id}_title').html('${title}');"
}
```

The important thing to remember is to set the `contentType` to `text/javascript`. If you use `render` returned 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 the server. This is one of the reasons Rails has something like RJS. Although Grails does not currently have a [Dynamic JavaScript Plugin](#) 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. Call `isAjaxRequest` method on `HttpServletRequest` which can be used to identify Ajax requests. For example you could use a template for Ajax requests or the full page for regular HTTP requests:

```
def listBooks() {
  def books = Book.list(params)
  if (request.isAjaxRequest()) {
    render template: "bookTable", model: [books: books]
  } else {
    render view: "list", model: [books: books]
  }
}
```

## 8.7 Content Negotiation

Grails has built in support for [Content negotiation](#) using either the HTTP Accept header, an explicit for the extension of a mapped URI.

### Configuring Mime Types

Before you can start dealing with content negotiation you need to tell Grails what content types you will support. Grails comes configured with a number of different content types within `grails-app/conf/Config.groovy` `grails.mime.types` setting:

```

grails.mime.types = [ // the first one is the default format
  all:                '/*/*', // 'all' maps to '*' or the first available format in w
  atom:               'application/atom+xml',
  css:                'text/css',
  csv:                'text/csv',
  form:               'application/x-www-form-urlencoded',
  html:               ['text/html', 'application/xhtml+xml'],
  js:                 'text/javascript',
  json:               ['application/json', 'text/json'],
  multipartForm:      'multipart/form-data',
  rss:                'application/rss+xml',
  text:               'text/plain',
  hal:                ['application/hal+json', 'application/hal+xml'],
  xml:                ['text/xml', 'application/xml']
]

```

The above bit of configuration allows Grails to detect to format of a request containing either the 'text' media types as simply 'xml'. You can add your own types by simply adding new entries into the map. The format.

## Content Negotiation using the format parameter

Let's say a controller action can return a resource in a variety of formats: HTML, XML, and JSON. What if The easiest and most reliable way for the client to control this is through a `format` URL parameter.

So if you, as a browser or some other client, want a resource as XML, you can use a URL like this:

```
http://my.domain.org/books?format=xml
```

The result of this on the server side is a `format` property on the response object with the value `xml` controller action to return XML based on this property, but you can also make use of the `controller-servlet` method:

```

import grails.converters.JSON
import grails.converters.XML

class BookController {
    def list() {
        def books = Book.list()

        withFormat {
            html bookList: books
            json { render books as JSON }
            xml { render books as XML }
            '*' { render books as JSON }
        }
    }
}

```

In this example, Grails will only execute the block inside `withFormat()` that matches the requested preferred format is `html` then Grails will execute the `html()` call only. Each 'block' can either be a corresponding view (as we are doing for 'html' in the above example) or a closure. The closure can contain code, for example it can return a model or render content directly.

When no format matches explicitly, a **(wildcard) block can be used to handle all other formats.**

**There is a special format, "all", that is handled differently from the explicit formats. If "all" is specified (happens through the Accept header - see below), then the first block of `withFormat()` is executed (wildcard) block available.**

You should not add an explicit "all" block. In this example, a format of "all" will trigger the `html` handler and there is no `*` block).

```

withFormat {
    html bookList: books
    json { render books as JSON }
    xml { render books as XML }
}

```



When using [withFormat](#) make sure it is the last call in your controller action as the return value of the `withFormat` method is used by the action to dictate what happens next.

## Using the Accept header

Every incoming HTTP request has a special [Accept](#) header that defines what media types (or mime types) the client supports. Older browsers typically do not support this header.

```
*/*
```

which simply means anything. However, newer browsers send more interesting values such as this one sent

```
text/xml, application/xml, application/xhtml+xml, text/html;q=0.9,  
text/plain;q=0.8, image/png, */*;q=0.5
```

This particular accept header is unhelpful because it indicates that XML is the preferred response format expecting HTML. That's why Grails ignores the accept header by default for browsers. However, non-browser engines are more specific in their requirements and can send accept headers such as

```
application/json
```

As mentioned the default configuration in Grails is to ignore the accept header for browsers. This is done by setting `grails.mime.disable.accept.header.userAgents`, which is configured to detect browser engines and ignore their ACCEPT headers. This allows Grails' content negotiation to continue to work for

```
grails.mime.disable.accept.header.userAgents = ['Gecko', 'WebKit', 'Presto', 'Trident']
```

For example, if it sees the accept header above ('application/json') it will set `format` to `json` as you'd expect. It works with the `withFormat()` method in just the same way as when the `format` URL parameter is used (the `format` parameter takes precedence).

An accept header of `*/*` results in a value of `all` for the `format` property.



If the accept header is used but contains no registered content types, Grails will assume a browser is making the request and will set the HTML format - note that this is different from how content negotiation modes work as those would activate the "all" format!

## 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 format uses the `CONTENT_TYPE` header and is typically used to detect if the incoming request can be parsed into XML or JSON. The response format uses the file 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 a request format 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 is not your favorite activity you can override the format used by specifying a format parameter:

```
/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
```

This works as a result of the default URL Mapping definition which is:

```
"/$controller/$action?/$id?(.$format)?"{
```

Note the inclusion of the `format` variable in the path. If you do not wish to use content negotiation v simply remove this part of the URL mapping:

```
"/$controller/$action?/$id?"{
```

## Testing Content Negotiation

To test content negotiation in a unit or integration test (see the section on [Testing](#)) you can either manipulate headers:

```
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  
}
```

## 9 Web Services

Web Services are all about providing a web API onto your web application and are typically implemented

### 9.1 REST

REST is not really a technology in itself, but more an architectural pattern. REST is very simple and just uses JSON as a communication medium, combined with URL patterns that are "representational" of the HTTP methods such as GET, PUT, POST and DELETE.

Each HTTP method maps to an action type. For example GET for retrieving data, POST for creating data, on.

Grails includes flexible features that make it easy to create RESTful APIs. Creating a RESTful resource is a single line of code, as demonstrated in the next section.

#### 9.1.1 Domain classes as REST resources

The easiest way to create a RESTful API in Grails is to expose a domain class as a REST resource. This is done using the `grails.rest.Resource` transformation to any domain class:

```
import grails.rest.*

@Resource(uri='/books')
class Book {

    String title

    static constraints = {
        title blank:false
    }
}
```

Simply by adding the `Resource` transformation and specifying a URI, your domain class will automatically become a REST resource in either XML or JSON formats. The transformation will automatically register the [mapping](#) and create a controller called `BookController`.

You can try it out by adding some test data to `Bootstrap.groovy`:

```
def init = { servletContext ->

    new Book(title:"The Stand").save()
    new Book(title:"The Shining").save()
}
```

And then hitting the URL `http://localhost:8080/myapp/books/1`, which will render the response like:

```
<?xml version="1.0" encoding="UTF-8"?>
<book id="1">
  <title>The Stand</title>
</book>
```

If you change the URL to `http://localhost:8080/myapp/books/1.json` you will get a JSON

```
{"id":1,"title":"The Stand"}
```

If you wish to change the default to return JSON instead of XML, you can do this by setting the `format` Resource transformation:

```
import grails.rest.*

@Resource(uri='/books', formats=['json', 'xml'])
class Book {
  ...
}
```

With the above example JSON will be prioritized. The list that is passed should contain the names of the formats that should expose. The names of formats are defined in the `grails.mime.types` setting of `Config.groovy`.

```
grails.mime.types = [
  ...
  json:          ['application/json', 'text/json'],
  ...
  xml:           ['text/xml', 'application/xml']
]
```

See the section on [Configuring Mime Types](#) in the user guide for more information.

Instead of using the file extension in the URI, you can also obtain a JSON response using the `ACCEPT` header using the Unix `curl` tool:

```
$ curl -i -H "Accept: application/json" localhost:8080/myapp/books/1
{"id":1,"title":"The Stand"}
```

This works thanks to Grails' [Content Negotiation](#) features.

You can create a new resource by issuing a POST request:

```
$ curl -i -X POST -H "Content-Type: application/json" -d '{"title":"Along Came A S
localhost:8080/myapp/books
HTTP/1.1 201 Created
Server: Apache-Coyote/1.1
...
```

Updating can be done with a PUT request:

```
$ curl -i -X PUT -H "Content-Type: application/json" -d '{"title":"Along Came A S
localhost:8080/myapp/books/1
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
...
```

Finally a resource can be deleted with DELETE request:

```
$ curl -i -X DELETE localhost:8080/myapp/books/1
HTTP/1.1 204 No Content
Server: Apache-Coyote/1.1
...
```

As you can see, the `Resource` transformation enables all of the HTTP method verbs on the resource. To enable read-only capabilities by setting the `readOnly` attribute to `true`:

```
import grails.rest.*

@Resource(uri='/books', readOnly=true)
class Book {
    ...
}
```

In this case POST, PUT and DELETE requests will be forbidden.

## 9.1.2 Mapping to REST resources

If you prefer to keep the declaration of the URL mapping in your `UrlMappings.groovy` file then s attribute of the `Resource` transformation and adding the following line to `UrlMappings.groovy` wil

```
"/books"(resources:"book")
```

Extending your API to include more end points then becomes trivial:

```
"/books"(resources:"book") {
    "/publisher"(controller:"publisher", method:"GET")
}
```

The above example will expose the URI `/books/1/publisher`.

A more detailed explanation on [creating RESTful URL mappings](#) can be found in the [URL Mappings secti](#)

## 9.1.3 Linking to REST resources

The `link` tag offers an easy way to link to any domain class resource:

```
<g:link resource="${book}">My Link</g:link>
```

However, currently you cannot use `g:link` to link to the DELETE action and most browsers do not support method directly.

The best way to accomplish this is to use a form submit:

```
<form action="/book/2" method="post">
  <input type="hidden" name="_method" value="DELETE"/>
</form>
```

Grails supports overriding the request method via the hidden `_method` parameter. This is for browser compatibility and is useful when using restful resource mappings to create powerful web interfaces. To make a link fire the capture all click events for links with a `data-method` attribute and issue a form submit via javascript.

## 9.1.4 Versioning REST resources

A common requirement with a REST API is to expose different versions at the same time. There are several ways to achieve this in Grails.

### Versioning using the URI

A common approach is to use the URI to version APIs (although this approach is discouraged in favor of content negotiation, you can define the following URL mappings:

```
"/books/v1"(resources:"book", namespace:'v1')
"/books/v2"(resources:"book", namespace:'v2')
```

That will match the following controllers:

```
package myapp.v1

class BookController {
    static namespace = 'v1'
}

package myapp.v2

class BookController {
    static namespace = 'v2'
}
```

This approach has the disadvantage of requiring two different URI namespaces for your API.

## Versioning with the Accept-Version header

As an alternative Grails supports the passing of an `Accept-Version` header from clients. For example, the following URL mappings:

```
"/books"(version:'1.0', resources:"book", namespace:'v1')
"/books"(version:'2.0', resources:"book", namespace:'v2')
```

Then in the client simply pass which version you need using the `Accept-Version` header:

```
$ curl -i -H "Accept-Version: 1.0" -X GET http://localhost:8080/myapp/books
```

## Versioning using Hypermedia / Mime Types

Another approach to versioning is to use Mime Type definitions to declare the version of your custom media. See the section on "Hypermedia as the Engine of Application State" for more information about Hypermedia concepts. In `Config.groovy` you can declare a custom Mime Type for your resource that includes a version parameter:

```
grails.mime.types = [
  all: '*/*',
  book: "application/vnd.books.org.book+json;v=1.0",
  bookv2: "application/vnd.books.org.book+json;v=2.0",
  ...
]
```



It is critical that you place your new mime types after the 'all' Mime Type because if the Content-Type request cannot be established then the first entry in the map is used for the response. If you place your new Mime Type at the top then Grails will always try and send back your new Mime Type and the requested Mime Type cannot be established.

Then override the renderer (see the section on "Customizing Response Rendering" for more information) to send back the custom Mime Type in `grails-app/conf/spring/resources.groovy`:

```
import grails.rest.render.json.*
import org.codehaus.groovy.grails.web.mime.*

beans = {
    bookRendererV1(JsonRenderer, myapp.v1.Book, new MediaType("application/vnd.book+json;v=1.0"))
    bookRendererV2(JsonRenderer, myapp.v2.Book, new MediaType("application/vnd.book+json;v=2.0"))
}
```

Then using the Accept header you can specify which version you need using the Mime Type:

```
$ curl -i -H "Accept: application/vnd.book+json;v=1.0" -X GET
http://localhost:8080/myapp/books
```

## 9.1.5 Implementing REST controllers

The Resource transformation is a quick way to get started, but typically you'll want to customize rendering of the response or extend the API to include additional actions.

### 9.1.5.1 Extending the RestfulController super class

The easiest way to get started doing so is to create a new controller for your resource that extends the `grails.rest.RestfulController` super class. For example:

```
class BookController extends RestfulController {
    static responseFormats = ['json', 'xml']
    BookController() {
        super(Book)
    }
}
```

To customize any logic you can just override the appropriate action. The following table provides the names of the actions and the URIs they map to:



HTTP Method	URI	Controller Action
GET	/books	index
GET	/books/create	create
POST	/books	save
GET	/books/\${id}	show
GET	/books/\${id}/edit	edit
PUT	/books/\${id}	update
DELETE	/books/\${id}	delete



Note that the `create` and `edit` actions are only needed if the controller exposes an HTML interface.

As an example, if you have a [nested resource](#) then you would typically want to query both the parent and the example, given the following URL mapping:

```
"/authors"(resources:'author') {
  "/books"(resources:'book')
}
```

You could implement the nested controller as follows:

```
class BookController extends RestfulController {
  static responseFormats = ['json', 'xml']
  BookController() {
    super(Book)
  }

  @Override
  protected Book queryForResource(Serializable id) {
    Book.where {
      id == id && author.id = params.authorId
    }.find()
  }
}
```

The example above subclasses `RestfulController` and overrides the protected `queryForResource` method. The query for the resource to take into account the parent resource.

## Customizing Data Binding In A RestfulController Subclass

The `RestController` class contains code which does data binding for actions like `save` and `update`. The `getObjectToBind()` method which returns a value which will be used as the source for data binding. An action does something like this...

```
class RestfulController<T> {
  def update() {
    T instance = // retrieve instance from the database...
    instance.properties = getObjectToBind()
    // ...
  }
  // ...
}
```

By default the `getObjectToBind()` method returns the [request](#) object. When the request object is the source, if the request has a body then the body will be parsed and its contents will be used to do the data binding. Subclasses of `RestController` may override the method and return anything that is a valid binding source, including a [Map](#) or a [DataBindingSource](#). For a REST request is appropriate but the `getObjectToBind()` method allows for changing that behavior where de

## Using custom subclass of RestfulController with Resource annotation

You can also customize the behaviour of the controller that backs the `Resource` annotation.

The class must provide a constructor that takes a domain class as its argument. The second constructor is for the `Resource` annotation with `readOnly=true`.

This is a template that can be used for subclassed `RestController` classes used in `Resource` annotations:

```
class SubclassRestController<T> extends RestfulController<T> {
  SubclassRestController(Class<T> domainClass) {
    this(domainClass, false)
  }
  SubclassRestController(Class<T> domainClass, boolean readOnly) {
    super(domainClass, readOnly)
  }
}
```

You can specify the super class of the controller that backs the `Resource` annotation with the `superClass`

```
import grails.rest.*

@Resource(uri='/books', superClass=SubclassRestfulController)
class Book {

    String title

    static constraints = {
        title blank:false
    }
}
```

### 9.1.5.2 Implementing REST Controllers Step by Step

If you don't want to take advantage of the features provided by the `RestfulController` super class, each HTTP verb yourself manually. The first step is to create a controller:

```
$ grails create-controller book
```

Then add some useful imports and enable `readOnly` by default:

```
import grails.transaction.*
import static org.springframework.http.HttpStatus.*
import static org.springframework.http.HttpMethod.*

@Transactional(readOnly = true)
class BookController {
    ...
}
```

Recall that each HTTP verb matches a particular Grails action according to the following conventions:

HTTP Method	URI	Controller Action
GET	/books	index
GET	/books/\${id}	show
GET	/books/create	create
GET	/books/\${id}/edit	edit
POST	/books	save
PUT	/books/\${id}	update
DELETE	/books/\${id}	delete



The 'create' and 'edit' actions are already required if you plan to implement an HTML inter REST resource. They are there in order to render appropriate HTML forms to create and edit If this is not a requirement they can be discarded.

The key to implementing REST actions is the [respond](#) method introduced in Grails 2.3. The `respond` m most appropriate response for the requested content type (JSON, XML, HTML etc.)

## Implementing the 'index' action

For example, to implement the `index` action, simply call the `respond` method passing the list of objects

```
def index(Integer max) {
    params.max = Math.min(max ?: 10, 100)
    respond Book.list(params), model:[bookCount: Book.count()]
}
```

Note that in the above example we also use the `model` argument of the `respond` method to supply the required if you plan to support pagination via some user interface.

The `respond` method will, using [Content Negotiation](#), attempt to reply with the most appropriate respon requested by the client (via the `ACCEPT` header or file extension).

If the content type is established to be HTML then a model will be produced such that the action above w writing:

```
def index(Integer max) {
    params.max = Math.min(max ?: 10, 100)
    [bookList: Book.list(params), bookCount: Book.count()]
}
```

By providing an `index.gsp` file you can render an appropriate view for the given model. If the content type is not HTML then the `respond` method will attempt to lookup an appropriate `grails.rest.render`. `Render` is capable of rendering the passed object. This is done by inspecting the `grails.rest.render.Render`.

By default there are already renderers configured for JSON and XML, to find out how to register a custom renderer see "Customizing Response Rendering".

## Implementing the 'show' action

The `show` action, which is used to display an individual resource by id, can be implemented in `BookController` (excluding the method signature):

```
def show(Book book) {  
    respond book  
}
```

By specifying the domain instance as a parameter to the action Grails will automatically attempt to look up the resource using the `id` parameter of the request. If the domain instance doesn't exist, then `null` will be passed to the `respond` method which will return a 404 error if `null` is passed otherwise once again it will attempt to render an appropriate view. If the format is HTML then an appropriate model will be produced. The following action is functionally equivalent to the one above:

```
def show(Book book) {  
    if(book == null) {  
        render status:404  
    }  
    else {  
        return [book: book]  
    }  
}
```

## Implementing the 'save' action

The `save` action creates new resource representations. To start off, simply define an action that accepts a `Book` object as an argument and mark it as `Transactional` with the `grails.transaction.Transactional` annotation:

```
@Transactional  
def save(Book book) {  
    ...  
}
```

Then the first thing to do is check whether the resource has any [validation errors](#) and if so respond with the

```
if(book.hasErrors()) {
    respond book.errors, view:'create'
}
else {
    ...
}
```

In the case of HTML the 'create' view will be rendered again so the user can correct the invalid input. In (JSON, XML etc.), the errors object itself will be rendered in the appropriate format and (UNPROCESSABLE\_ENTITY) returned.

If there are no errors then the resource can be saved and an appropriate response sent:

```
book.save flush:true
withFormat {
    html {
        flash.message = message(code: 'default.created.message', args: [message(
'book.label', default: 'Book'), book.id])
        redirect book
    }
    '*' { render status: CREATED }
}
```

In the case of HTML a redirect is issued to the originating resource and for other formats a status code is returned.

## Implementing the 'update' action

The update action updates an existing resource representation and is largely similar to the save action signature:

```
@Transactional
def update(Book book) {
    ...
}
```

If the resource exists then Grails will load the resource, otherwise null was passed. In the case of null, you s

```

if(book == null) {
    render status: NOT_FOUND
}
else {
    ...
}

```

Then once again check for errors [validation errors](#) and if so respond with the errors:

```

if(book.hasErrors()) {
    respond book.errors, view:'edit'
}
else {
    ...
}

```

In the case of HTML the 'edit' view will be rendered again so the user can correct the invalid input. In (JSON, XML etc.) the errors object itself will be rendered in the appropriate format and (UNPROCESSABLE\_ENTITY) returned.

If there are no errors then the resource can be saved and an appropriate response sent:

```

book.save flush:true
withFormat {
    html {
        flash.message = message(code: 'default.updated.message', args: [message(c
default: 'Book'), book.id])
        redirect book
    }
    '*' { render status: OK }
}

```

In the case of HTML a redirect is issued to the originating resource and for other formats a status code of 2

## Implementing the 'delete' action

The delete action deletes an existing resource. The implementation is largely similar to the update action, but the `delete()` method is called instead:

```

book.delete flush:true
withFormat {
  html {
    flash.message = message(code: 'default.deleted.message', args: [message(c
default: 'Book'), book.id])
    redirect action:"index", method:"GET"
  }
  '*' { render status: NO_CONTENT }
}

```

Notice that for an HTML response a redirect is issued back to the `index` action, whilst for other content types (NO\_CONTENT) is returned.

### 9.1.5.3 Generating a REST controller using scaffolding

To see some of these concepts in action and help you get going the [Scaffolding plugin](#), version 2.0 and above, will generate a ready controller for you, simply run the command:

```
$ grails generate-controller [Domain Class Name]
```

### 9.1.6 Customizing Response Rendering

There are several ways to customize response rendering in Grails.

#### 9.1.6.1 Customizing the Default Renderers

The default renderers for XML and JSON can be found in the `grails.rest.xml` and `grails.rest.render.json` packages respectively. These use the Grails converters (`grails.converters.XML` and `grails.converters.JSON`) by default for response rendering.

You can easily customize response rendering using these default renderers. A common change you may want to make is to include or exclude certain properties from rendering.

#### Including or Excluding Properties from Rendering

As mentioned previously, Grails maintains a registry of `grails.rest.render.Renderer` instances. You can configure renderers and the ability to register or override renderers for a given domain class or even for all classes. To include a particular property from rendering you need to register a custom renderer in `grails-app/conf/spring/resources.groovy`:



```
import grails.rest.render.xml.*

beans = {
    bookRenderer(XmlRenderer, Book) {
        includes = ['title']
    }
}
```



The bean name is not important (Grails will scan the application context for all registered beans), but for organizational and readability purposes it is recommended you name it meaningful.

To exclude a property, the `excludes` property of the `XmlRenderer` class can be used:

```
import grails.rest.render.xml.*

beans = {
    bookRenderer(XmlRenderer, Book) {
        excludes = ['isbn']
    }
}
```

## Customizing the Converters

As mentioned previously, the default renders use the `grails.converters` package under the covers. Under the covers they essentially do the following:

```
import grails.converters.*

...
render book as XML
// or render book as JSON
```

Why the separation between converters and renderers? Well a renderer has more flexibility to use whatever you chose. When implementing a custom renderer you could use [Jackson](#), [Gson](#) or any Java library to do the rendering. Converters on the other hand are very much tied to Grails' own marshalling implementation.

## 9.1.6.2 Registering Custom Objects Marshallers

Grails' Converters feature the notion of an [ObjectMarshaller](#) and each type can have a registered Object register custom ObjectMarshaller instances to completely customize response rendering. For example, the following in `Bootstrap.init`:

```
XML.registerObjectMarshaller Book, { Book book, XML xml ->
  xml.attribute 'id', book.id
  xml.build {
    title(book.title)
  }
}
```

You can customize the formatting of an individual value this way too. For example the [JodaTime plugin](#) support rendering of JodaTime dates in JSON output:

```
JSON.registerObjectMarshaller(DateTime) {
  return it?.toString("yyyy-MM-dd'T'HH:mm:ss'Z'")
}
```

In the case of JSON it's often simple to use a map to customize output:

```
JSON.registerObjectMarshaller(Book) {
  def map= [:]
  map['titl'] = it.title
  map['auth'] = it.author
  return map
}
```

## Registering Custom Marshallers via Spring

Note that if you have many custom marshallers it is recommended you split the registration of these into a

```

class CustomMarshallerRegistrar {
@javax.annotation.PostConstruct
    void registerMarshallers() {
        JSON.registerObjectMarshaller(DateTime) {
            return it?.toString("yyyy-MM-dd'T'HH:mm:ss'Z'")
        }
    }
}

```

Then define this class as Spring bean in `grails-app/conf/spring/resources.groovy`:

```

beans = {
    myCustomMarshallerRegistrar(CustomMarshallerRegistrar)
}

```

The `PostConstruct` annotation will get triggered on startup of your application.

### 9.1.6.3 Using Named Configurations for Object Marshallers

It is also possible to register named configurations. For example:

```

XML.createNamedConfig('publicApi') {
    it.registerObjectMarshaller(Book) { Book book, XML xml ->
        // do public API
    }
}
XML.createNamedConfig('adminApi') {
    it.registerObjectMarshaller(Book) { Book book, XML xml ->
        // do admin API
    }
}

```

Then when you use either the `render` or `respond` methods you can wrap the call in a named config to customize rendering per request:

```
XML.use( isAdmin ? 'adminApi' : 'publicApi') {  
    render book as XML  
}
```

or

```
XML.use( isAdmin ? 'adminApi' : 'publicApi') {  
    respond book  
}
```

#### 9.1.6.4 Implementing the ObjectMarshaller Interface

For more complex marshallers it is recommended you implement the [ObjectMarshaller](#) interface. For class:

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

By default the output when using:

```
render book as XML
```

Would look like:

```
<book id="1">  
    <title>The Stand</title>  
</book>
```

To write a custom marshaller you can do the following:

```
class BookMarshaller implements ObjectMarshaller<XML> {  
    public boolean supports(Object object) {  
        return object instanceof Book  
    }  
    public void marshalObject(Object object, XML converter) {  
        Book book = (Book)object  
        converter.chars book.title  
    }  
}
```

And then register the marshaller with:

```
XML.registerObjectMarshaller(new BookMarshaller())
```

With the custom ObjectMarshaller in place, the output is now:

```
<book>The Stand</book>
```

## Customizing the Name of the Root Element

If you wish to customize the name of the surrounding element, you can implement [NameAwareMarshaller](#)

```
class BookMarshaller implements ObjectMarshaller<XML>, NameAwareMarshaller {  
    ...  
    String getElementName(Object o) {  
        return 'custom-book'  
    }  
}
```

With the above change the output would now be:

```
<custom-book>The Stand</custom-book>
```

## Outputting Markup Using the Converters API or Builder

With the passed Converter object you can explicitly code to the Converters API to stream markup to the re

```
public void marshalObject(Object object, XML converter) {
    Book book = (Book)object

    converter.attribute 'id', book.id.toString()
    converter.attribute 'date-released', book.dateReleased.toString()

    converter.startNode 'title'
    converter.chars book.title
    converter.end()
}
```

The above code results in:

```
<book id="1" date-released="...">
  <title>The Stand</title>
</book>
```

You can also use a builder notation to achieve a similar result (although the builder notation does not work

```
public void marshalObject(Object object, XML converter) {
    Book b = (Book)object

    converter.build {
        book(id: b.id) {
            title b.title
        }
    }
}
```

## Using the convertAnother Method to Recursively Convert Objects

To create more complex responses you can use the `convertAnother` method to convert associations an

```
public void marshalObject(Object object, XML converter) {
    Book book = (Book)object

    converter.startNode 'title'
    converter.chars book.title
    converter.end()

    if (book.authors) {
        converter.startNode 'authors'
        for(author in book.authors) {
            converter.convertAnother author
        }
        converter.end()
    }
}
```

### 9.1.6.5 Implementing a Custom Renderer

If you want even more control of the rendering or prefer to use your own marshalling techniques then you can create a custom `Renderer` instance. For example below is a simple implementation that customizes the rendering of the `Book` object.

```
package myapp
import grails.rest.render.*
import org.codehaus.groovy.grails.web.mime.MimeType

class BookXmlRenderer extends AbstractRenderer<Book> {
    BookXmlRenderer() {
        super(Book, [MimeType.XML, MimeType.TEXT_XML] as MimeType[])
    }

    void render(Book object, RenderContext context) {
        context.contentType = MimeType.XML.name

        def xml = new groovy.xml.MarkupBuilder(context.writer)
        xml.book(id: object.id, title:object.title)
    }
}
```

The `AbstractRenderer` super class has a constructor that takes the class that it renders and the `MimeType` (via the `ACCEPT` header or file extension) for the renderer.

To configure this renderer, simply add it as a bean to `grails-app/conf/spring/resources.groovy`

```
beans = {  
    bookRenderer(myapp.BookXmlRenderer)  
}
```

The result will be that all `Book` instances will be rendered in the following format:

```
<book id="1" title="The Stand"/>
```



Note that if you change the rendering to a completely different format like the above, then you have to change the binding if you plan to support POST and PUT requests. Grails will not automatically how to bind data from a custom XML format to a domain class otherwise. See the "Customizing Binding of Resources" for further information.

## Container Renderers

A `grails.rest.render.ContainerRenderer` is a renderer that renders responses for container collections etc.). The interface is largely the same as the `Renderer` interface except for `getComponentType()` method, which should return the "contained" type. For example:

```
class BookListRenderer implements ContainerRenderer<List, Book> {  
    Class<List> getTargetType() { List }  
    Class<Book> getComponentType() { Book }  
    MimeType[] getMimeTypes() { [ MimeType.XML ] as MimeType[] }  
    void render(List object, RenderContext context) {  
        ....  
    }  
}
```

### 9.1.6.6 Using GSP to Customize Rendering

You can also customize rendering on a per action basis using Groovy Server Pages (GSP). For example, as mentioned previously:



```
def show(Book book) {  
    respond book  
}
```

You could supply a `show.xml.gsp` file to customize the rendering of the XML:

```
<%@page contentType="application/xml"%>  
<book id="${book.id}" title="${book.title}"/>
```

## 9.1.7 Hypermedia as the Engine of Application State

[HATEOS](#), an abbreviation for Hypermedia as the Engine of Application State, is a common pattern applied that uses hypermedia and linking to define the REST API.

Hypermedia (also called Mime or Media Types) are used to describe the state of a REST resource, and transition to the next state. The format of the response is typically JSON or XML, although standard forms [HAL](#) are frequently used.

### 9.1.7.1 HAL Support

[HAL](#) is a standard exchange format commonly used when developing REST APIs that follow HATEOA. A HAL document representing a list of orders can be seen below:

```

{
  "_links": {
    "self": { "href": "/orders" },
    "next": { "href": "/orders?page=2" },
    "find": {
      "href": "/orders/{id}",
      "templated": true
    },
    "admin": [{
      "href": "/admins/2",
      "title": "Fred"
    }, {
      "href": "/admins/5",
      "title": "Kate"
    }]
  },
  "currentlyProcessing": 14,
  "shippedToday": 20,
  "_embedded": {
    "order": [{
      "_links": {
        "self": { "href": "/orders/123" },
        "basket": { "href": "/baskets/98712" },
        "customer": { "href": "/customers/7809" }
      },
      "total": 30.00,
      "currency": "USD",
      "status": "shipped"
    }, {
      "_links": {
        "self": { "href": "/orders/124" },
        "basket": { "href": "/baskets/97213" },
        "customer": { "href": "/customers/12369" }
      },
      "total": 20.00,
      "currency": "USD",
      "status": "processing"
    }]
  }
}

```

## Exposing Resources Using HAL

To return HAL instead of regular JSON for a resource you can simply override `grails-app/conf/spring/resources.groovy` with an instance of `grails.rest.render.hal.HalJsonRenderer` (or `HalXmlRenderer` for the XML variation):

```

import grails.rest.render.hal.*
beans = {
    halBookRenderer(HalJsonRenderer, rest.test.Book)
}

```

With the bean in place requesting the HAL content type will return HAL:

```
$ curl -i -H "Accept: application/hal+json" http://localhost:8080/myapp/books/1
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Content-Type: application/hal+json;charset=ISO-8859-1

{
  "_links": {
    "self": {
      "href": "http://localhost:8080/myapp/books/1",
      "hreflang": "en",
      "type": "application/hal+json"
    }
  },
  "title": "The Stand"
}
```

To use HAL XML format simply change the renderer:

```
import grails.rest.render.hal.*
beans = {
    halBookRenderer(HalXmlRenderer, rest.test.Book)
}
```

## Rendering Collections Using HAL

To return HAL instead of regular JSON for a list of resources you can simply override `grails-app/conf/spring/resources.groovy` with an instance of `grails.rest.render.hal.HalJsonCollectionRenderer`:

```
import grails.rest.render.hal.*
beans = {
    halBookCollectionRenderer(HalJsonCollectionRenderer, rest.test.Book)
}
```

With the bean in place requesting the HAL content type will return HAL:

```
$ curl -i -H "Accept: application/hal+json" http://localhost:8080/myapp/books
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Content-Type: application/hal+json;charset=UTF-8
Transfer-Encoding: chunked
Date: Thu, 17 Oct 2013 02:34:14 GMT
```

```
{
  "_links": {
    "self": {
      "href": "http://localhost:8080/myapp/books",
      "hreflang": "en",
      "type": "application/hal+json"
    }
  },
  "_embedded": {
    "book": [
      {
        "_links": {
          "self": {
            "href": "http://localhost:8080/myapp/books/1",
            "hreflang": "en",
            "type": "application/hal+json"
          }
        },
        "title": "The Stand"
      },
      {
        "_links": {
          "self": {
            "href": "http://localhost:8080/myapp/books/2",
            "hreflang": "en",
            "type": "application/hal+json"
          }
        },
        "title": "Infinite Jest"
      },
      {
        "_links": {
          "self": {
            "href": "http://localhost:8080/myapp/books/3",
            "hreflang": "en",
            "type": "application/hal+json"
          }
        },
        "title": "Walden"
      }
    ]
  }
}
```

Notice that the key associated with the list of Book objects in the rendered JSON is book which is the name of the objects in the collection, namely Book. In order to customize the value of this key assign a value to the `collectionKey` property on the `HalJsonCollectionRenderer` bean as shown below:

```
import grails.rest.render.hal.*
beans = {
    halBookCollectionRenderer(HalCollectionJsonRenderer, rest.test.Book) {
        collectionName = 'publications'
    }
}
```

With that in place the rendered HAL will look like the following:

```
$ curl -i -H "Accept: application/hal+json" http://localhost:8080/myapp/books
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Content-Type: application/hal+json;charset=UTF-8
Transfer-Encoding: chunked
Date: Thu, 17 Oct 2013 02:34:14 GMT
```

```
{
  "_links": {
    "self": {
      "href": "http://localhost:8080/myapp/books",
      "hreflang": "en",
      "type": "application/hal+json"
    }
  },
  "_embedded": {
    "publications": [
      {
        "_links": {
          "self": {
            "href": "http://localhost:8080/myapp/books/1",
            "hreflang": "en",
            "type": "application/hal+json"
          }
        },
        "title": "The Stand"
      },
      {
        "_links": {
          "self": {
            "href": "http://localhost:8080/myapp/books/2",
            "hreflang": "en",
            "type": "application/hal+json"
          }
        },
        "title": "Infinite Jest"
      },
      {
        "_links": {
          "self": {
            "href": "http://localhost:8080/myapp/books/3",
            "hreflang": "en",
            "type": "application/hal+json"
          }
        },
        "title": "Walden"
      }
    ]
  }
}
```

## Using Custom Media / Mime Types

If you wish to use a custom Mime Type then you first need to declare the `grails-app/conf/Config.groovy`:

```
grails.mime.types = [
    all:      "**/*",
    book:     "application/vnd.books.org.book+json",
    bookList: "application/vnd.books.org.booklist+json",
    ...
]
```



It is critical that place your new mime types after the 'all' Mime Type because if the Content request cannot be established then the first entry in the map is used for the response. If you new Mime Type at the top then Grails will always try and send back your new Mime Type and the requested Mime Type cannot be established.

Then override the renderer to return HAL using the custom Mime Types:

```
import grails.rest.render.hal.*
import org.codehaus.groovy.grails.web.mime.*

beans = {
    halBookRenderer(HalJsonRenderer, rest.test.Book, new MimeType(
        "application/vnd.books.org.book+json", [v:"1.0"]))
    halBookListRenderer(HalJsonCollectionRenderer, rest.test.Book, new MimeType(
        "application/vnd.books.org.booklist+json", [v:"1.0"]))
}
```

In the above example the first bean defines a HAL renderer for a single book instance that returns application/vnd.books.org.book+json. The second bean defines the Mime Type used to render (in this case application/vnd.books.org.booklist+json).

With this in place issuing a request for the new Mime Type returns the necessary HAL:

```
$ curl -i -H "Accept: application/vnd.books.org.book+json" http://localhost:8080/
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Content-Type: application/vnd.books.org.book+json;charset=ISO-8859-1

{
  "_links": {
    "self": {
      "href": "http://localhost:8080/myapp/books/1",
      "hreflang": "en",
      "type": "application/vnd.books.org.book+json"
    }
  },
  "title": "The Stand"
}
```

## Customizing Link Rendering

An important aspect of HATEOAS is the usage of links that describe the transitions the client can use to API. By default the `HalJsonRenderer` will automatically create links for you for associations and to the "self" relationship).

However you can customize link rendering using the `link` method that is added to all domain `grails.rest.Resource` or any class annotated with `grails.rest.Linkable`. For example, modified as follows to provide a new link in the resulting output:

```
def show(Book book) {
  book.link rel:'publisher', href: g.link(resource:"publisher", params:[bookId:
  respond book
}
```

Which will result in output such as:



```

{
  "_links": {
    "self": {
      "href": "http://localhost:8080/myapp/books/1",
      "hreflang": "en",
      "type": "application/vnd.books.org.book+json"
    }
  },
  "publisher": {
    "href": "http://localhost:8080/myapp/books/1/publisher",
    "hreflang": "en"
  },
  "title": "The Stand"
}

```

The `link` method can be passed named arguments that match the properties of the `grails.rest.Link`

### 9.1.7.2 Atom Support

[Atom](#) is another standard interchange format used to implement REST APIs. An example of Atom output is

```

<?xml version="1.0" encoding="utf-8"?>
<feed xmlns="http://www.w3.org/2005/Atom">

<title>Example Feed</title>
<link href="http://example.org/" />
<updated>2003-12-13T18:30:02Z</updated>
<author>
  <name>John Doe</name>
</author>
<id>urn:uuid:60a76c80-d399-11d9-b93C-0003939e0af6</id>

<entry>
  <title>Atom-Powered Robots Run Amok</title>
  <link href="http://example.org/2003/12/13/atom03" />
  <id>urn:uuid:1225c695-cfb8-4ebb-aaaa-80da344efa6a</id>
  <updated>2003-12-13T18:30:02Z</updated>
  <summary>Some text.</summary>
</entry>

</feed>

```

To use Atom rendering again simply define a custom renderer:

```
import grails.rest.render.atom.*
beans = {
    halBookRenderer(AtomRenderer, rest.test.Book)
    halBookListRenderer(AtomCollectionRenderer, rest.test.Book)
}
```

### 9.1.7.3 Vnd.Error Support

[Vnd.Error](#) is a standardised way of expressing an error response.

By default when a validation error occurs when attempting to POST new resources then the errors object with a 422 respond code:

```
$ curl -i -H "Accept: application/json" -H "Content-Type: application/json" -X P
http://localhost:8080/myapp/books

HTTP/1.1 422 Unprocessable Entity
Server: Apache-Coyote/1.1
Content-Type: application/json;charset=ISO-8859-1

{"errors":[{"object":"rest.test.Book", "field":"title", "rejected-value":null, "m
[title] of class [class rest.test.Book] cannot be null"}]}
```

If you wish to change the format to Vnd.Error then si  
 grails.rest.render.errors.VndErrorJsonRenderer bean  
 grails-app/conf/spring/resources.groovy:

```
beans = {
    vndJsonErrorRenderer(grails.rest.render.errors.VndErrorJsonRenderer)
    // for Vnd.Error XML format
    vndXmlErrorRenderer(grails.rest.render.errors.VndErrorXmlRenderer)
}
```

Then if you alter the client request to accept Vnd.Error you get an appropriate response:

```
$ curl -i -H "Accept: application/vnd.error+json,application/json" -H "Content-Type: application/json" -X POST -d "" http://localhost:8080/myapp/books
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Content-Type: application/vnd.error+json;charset=ISO-8859-1

[
  {
    "logref": "book.nullable",
    "message": "Property [title] of class [class rest.test.Book] cannot be null",
    "_links": {
      "resource": {
        "href": "http://localhost:8080/rest-test/books"
      }
    }
  }
]
```

### 9.1.8 Customizing Binding of Resources

The framework provides a sophisticated but simple mechanism for binding REST requests to domain objects. One way to take advantage of this is to bind the request property in a controller to the properties of a domain object. For example, if the following XML as the body of the request, the createBook action will create a new Book and assign "The Stand" to the title property and "Stephen King" to the authorName property.

```
<?xml version="1.0" encoding="UTF-8"?>
<book>
  <title>The Stand</title>
  <authorName>Stephen King</authorName>
</book>
```

```
class BookController {
  def createBook() {
    def book = new Book()
    book.properties = request
  }
}
```

If the root element of the XML document contains an id attribute, the id value will be used to retrieve a persistent instance from the database and then the rest of the document will be bound to the instance. If no id is found in the database, the command object reference will be null.

```
<?xml version="1.0" encoding="UTF-8"?>
<book>
  <title>The Stand</title>
  <authorName>Stephen King</authorName>
</book>
```

Command objects will automatically be bound with the body of the request:

```
class BookController {
  def createBook(BookCommand book) {

  // ...
  }

class BookCommand {
  String title
  String authorName
}
```

If the command object type is a domain class and the root element of the XML document contains an id attribute, the id will be used to retrieve the corresponding persistent instance from the database and then the rest of the data will be used to update the instance. If no corresponding record is found in the database, the command object reference will be null.

```
<?xml version="1.0" encoding="UTF-8"?>
<book id="42">
  <title>Walden</title>
  <authorName>Henry David Thoreau</authorName>
</book>
```

```

class BookController {
    def updateBook(Book book) {
        // The book will have been retrieved from the database and updated
        // by doing something like this:
        //
        // book == Book.get('42')
        // if(book != null) {
        //     book.properties = request
        // }
        //
        // the code above represents what the framework will
        // have done. There is no need to write that code.

    // ...
}
}

```

The data binding depends on an instance of the [DataBindingSource](#) interface created by [DataBindingSourceCreator](#) interface. The specific implementation of DataBindingSourceCreator the contentType of the request. Several implementations are provided to handle common cor implementations will be fine for most use cases. The following table lists the content types which a framework and which DataBindingSourceCreator implementations are used for each. All of the ir in the org.codehaus.groovy.grails.web.binding.bindingsource package.

Content Type(s)	Bean Name	DataBindingSourceCreator Impl.
application/xml, text/xml	xmlDataBindingSourceCreator	XmlDataBindingSourceCreator
application/json, text/json	jsonDataBindingSourceCreator	JsonDataBindingSourceCreator
application/hal+json	halJsonDataBindingSourceCreator	HalJsonDataBindingSourceCreator
application/hal+xml	halXmlDataBindingSourceCreator	HalXmlDataBindingSourceCreator

In order to provide your own DataBindingSourceCreator for any of those content types, write a DataBindingSourceCreator and register an instance of that class in the Spring application context of the existing helpers, use the corresponding bean name from above. If you are providing a helper for those accounted for by the core framework, the bean name may be anything that you like but you should with one of the bean names above.

The DataBindingSourceCreator interface defines just 2 methods:

```

package org.grails.databinding.bindingsource

import org.codehaus.groovy.grails.web.mime.MimeType
import org.grails.databinding.DataBindingSource

/**
 * A factory for DataBindingSource instances
 *
 * @since 2.3
 * @see DataBindingSourceRegistry
 * @see DataBindingSource
 */
interface DataBindingSourceCreator {

    /**
     * return All of the {link MimeType} supported by this helper
     */
    MimeType[] getMimeTypes()

    /**
     * Creates a DataBindingSource suitable for binding bindingSource to bindingTa
     *
     * @param mimeType a mime type
     * @param bindingTarget the target of the data binding
     * @param bindingSource the value being bound
     * @breturn a DataBindingSource
     */
    DataBindingSource createDataBindingSource(MimeType mimeType, Object bindingTa
bindingSource)
}

```

[AbstractRequestBodyDataBindingSourceCreator](#) is an abstract class designed to be extended to `DataBindingSourceCreator` classes. Classes which extend `AbstractRequestBodyDataBindingSourceCreator` need to implement a method named `createBindingSource` which accepts an `InputStream` as argument and returns a `DataBindingSource` as well as implementing the `getMimeTypes` method of the `DataBindingSourceCreator` interface above. The `InputStream` argument to `createBindingSource` provides access to the body of the request.

The code below shows a simple implementation.

```

// MyCustomDataBindingSourceCreator.groovy in
// src/groovy/com/demo/myapp/databinding
package com.demo.myapp.databinding

import org.codehaus.groovy.grails.web.mime.MimeType
import org.grails.databinding.DataBindingSource
import org...databinding.SimpleMapDataBindingSource
import org...databinding.bindingsource.AbstractRequestBodyDataBindingSourceCreato

/**
 * A custom DataBindingSourceCreator capable of parsing key value pairs out of
 * a request body containing a comma separated list of key:value pairs like:
 *
 * name:Herman,age:99,town:STL
 */
class MyCustomDataBindingSourceCreator extends AbstractRequestBodyDataBindingSourceCreato

@Override
    public MimeType[] getMimeTypeTypes() {
        [new MimeType('text/custom+demo+csv')] as MimeType[]
    }

@Override
    protected DataBindingSource createBindingSource(InputStream inputStream) {
        def map = [:]

        def reader = new InputStreamReader(inputStream)

        // this is an obviously naive parser and is intended
        // for demonstration purposes only.

        reader.eachLine { line ->
            def keyValuePairs = line.split(',')
            keyValuePairs.each { keyValuePair ->
                if(keyValuePair?.trim()) {
                    def keyValuePieces = keyValuePair.split(':')
                    def key = keyValuePieces[0].trim()
                    def value = keyValuePieces[1].trim()
                    map[key] = value
                }
            }
        }

        // create and return a DataBindingSource which contains the parsed data
        new SimpleMapDataBindingSource(map)
    }
}

```

An instance of MyCustomDataSourceCreator needs to be registered in the spring application context

```

// grails-app/conf/spring/resources.groovy
beans = {

    myCustomCreator com.demo.myapp.databinding.MyCustomDataBindingSourceCreator

    // ...
}

```

With that in place the framework will use the `myCustomCreator` bean any time a `DataBindingSource` to deal with a request which has a `contentType` of `"text/custom+demo+csv"`.

## 9.2 SOAP

Grails does not feature SOAP support out-of-the-box, but there are several plugins that can help for both and calling SOAP web services.

### SOAP Clients

To call SOAP web services there are generally 2 approaches taken, one is to use a tool to generate client manually construct the SOAP calls. The former can be easier to use, but the latter provides more flexibility

The [CXF client plugin](#) uses the CXF framework, which includes a `wsdl2java` tool for generating a Groovy/Grails specific here in the generated code as it simply provides a Java API which you can in services.

See the documentation on the [CXF client plugin](#) for further information.

Alternatively, if you prefer more control over your SOAP calls the [WS-Lite library](#) is an excellent choice [plugin](#). You have more control over the SOAP requests sent, and since Groovy has fantastic support for it can be very productive approach.

Below is an example of a SOAP call with `wslite`:

```
withSoap(serviceURL: 'http://www.holidaywebservice.com/Holidays/US/Dates/USHolidays') {
    def response = send {
        body {
            GetMothersDay(xmlns: 'http://www.27seconds.com/Holidays/US/Dates/') {
                year(2011)
            }
        }
    }
    println response.GetMothersDayResponse.GetMothersDayResult.text()
}
```

It is not recommended that you use the [GroovyWS](#) library, it pulls in many dependencies which it conflicts. The `WSlite` library provides a far simpler and easier to use solution.

### SOAP Servers

Again, Grails does not have direct support for exposing SOAP web services, however if you wish to expose your application then the [CXF plugin](#) (not to be confused with the `cxf-client` plugin), provides an easy way

Typically it involves taking a Grails service and adding 'expose'-style configuration, such as the below:



```
static expose = EndpointType.JAX_WS_WSDL
//your path (preferred) or url to wsdl
static wsdl = 'org/grails/cxf/test/soap/CustomerService.wsdl'
```

Please refer to the [documentation of the plugin](#) for more information.

## 9.3 RSS and Atom

No direct support is provided for RSS or Atom within Grails. You could construct RSS or ATOM feeds XML capability. There is however a [Feeds plugin](#) available for Grails that provides a RSS and Atom b [ROME](#) library. An example of its usage can be seen below:

```
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
            }
        }
    }
}
```

## 10 Asynchronous Programming

With modern hardware featuring multiple cores, many programming languages have been adding programming APIs, Groovy being no exception.

The excellent [GPar](#)s project features a whole range of different APIs for asynchronous programming techniques, promises, STM and data flow concurrency.

Added Grails 2.3, the Async features of Grails aim to simplify concurrent programming within the framework concept of Promises and a unified event model.

### 10.1 Promises

A Promise is a concept being embraced by many concurrency frameworks. The `java.util.concurrent.Future` instances, but include a more user friendly exception handling mechanism, chaining and the ability to attach listeners.

#### Promise Basics

In Grails the `grails.async.Promises` class provides the entry point to the Promise API:

```
import static grails.async.Promises.*
```

To create promises you can use the `task` method, which returns an instance of the `grails.async.Promise` class:

```
def p1 = task { 2 * 2 }
def p2 = task { 4 * 4 }
def p3 = task { 8 * 8 }
assert [4,16,64] == waitAll(p1, p2, p3)
```

The `waitAll` method waits synchronously, blocking the current thread, for all of the concurrent tasks to complete and return results.

If you prefer not to block the current thread you can use the `onComplete` method:

```
onComplete([p1,p2,p3]) { List results ->
    assert [4,16,64] == results
}
```

The `waitAll` method will throw an exception if an error occurs executing one of the promises. The original `waitAll` method, however, will simply not execute the passed closure if an exception is thrown. The `onComplete` method, however, will simply not execute the passed closure if an exception is thrown. The `onError` listener if you wish to handle exceptions without blocking:

```
onError([p1,p2,p3]) { Throwable t ->
    println "An error occurred ${t.message}"
}
```

If you have just a single long running promise then the `grails.async.Promise` interface provides a `wait` method. For example:

```
import static java.util.concurrent.TimeUnit.*
import static grails.async.Promises.*

Promise p = task {
    // Long running task
}
p.onError { Throwable err ->
    println "An error occurred ${err.message}"
}
p.onComplete { result ->
    println "Promise returned $result"
}
// block until result is called
def result = p.get()
// block for the specified time
def result = p.get(1,MINUTES)
```

## Promise Chaining

It is possible to chain several promises and wait for the chain to complete using the `then` method:

```

final polish = { ... }
final transform = { ... }
final save = { ... }
final notify = { ... }

Promise promise = task {
    // long running task
}
promise.then polish then transform then save then {
    // notify end result
}

```

If an exception occurs at any point in the chain it will be propagated back to the caller and the next step called.

## Promise Lists and Maps

Grails' async API also features the concept of a promise lists and maps. These are `grails.async.PromiseList` and `grails.async.PromiseMap` classes respectively.

The easiest way to create a promise list or map is via the `tasks` method of the `Promises` class:

```

import static grails.async.Promises.*

def promiseList = tasks([ { 2 * 2 }, { 4 * 4 }, { 8 * 8 } ])
assert [4,16,64] == promiseList.get()

```

The `tasks` method, when passed a list of closures, returns a `PromiseList`. You can also construct a `PromiseList` directly:

```

import grails.async.*

def list = new PromiseList()
list << { 2 * 2 }
list << { 4 * 4 }
list << { 8 * 8 }
list.onComplete { List results ->
    assert [4,16,64] == results
}

```



The `PromiseList` class does not implement the `java.util.List` interface, but instead `java.util.List` from the `get()` method

Working with `PromiseMap` instances is largely similar. Again you can either use the `tasks` method:

```
import static grails.async.Promises.*

def promiseList = tasks one:{ 2 * 2 },
                        two:{ 4 * 4 },
                        three:{ 8 * 8 }

assert [one:4,two:16,three:64] == promiseList.get()
```

Or construct a `PromiseMap` manually:

```
import grails.async.*

def map = new PromiseMap()
map['one'] = { 2 * 2 }
map['two'] = { 4 * 4 }
map['three'] = { 8 * 8 }
map.onComplete { Map results ->
    assert [one:4,two:16,three:64] == results
}
```

## Promise Factories

The `Promises` class uses a `grails.async.PromiseFactory` instance to create `Promise` instances.

The default implementation uses the `GPars` concurrency library as `org.grails.async.factory.gpars.GparsPromiseFactory`, however it is possible to switch by setting the `Promises.promiseFactory` variable.

One common use case for this is unit testing, typically you do not want promises to execute asynchronously, this makes tests harder to write. For this purpose Grails ships with `org.grails.async.factory.SynchronousPromiseFactory` instance that makes it easier to

```
import org.grails.async.factory.*
import grails.async.*

Promises.promiseFactory = new SynchronousPromiseFactory()
```

Using the `PromiseFactory` mechanism is theoretically possible to plug in other concurrency framework.

## DelegateAsync Transformation

It is quite common to require both synchronous and asynchronous versions of the same API. Development and maintenance problem as typically the asynchronous API would simply delegate to the synchronous version.

The `DelegateAsync` transformation is designed to mitigate this problem by transforming any synchronous API into an asynchronous one.

For example, consider the following service:

```
class BookService {
    List<Book> findBooks(String title) {
        // implementation
    }
}
```

The `findBooks` method executes synchronously in the same thread as the caller. To make an asynchronous version, you can define another class as follows:

```
import grails.async.*

class AsyncBookService {
    @DelegateAsync BookService bookService
}
```

The `DelegateAsync` transformation will automatically add a new method that looks like the `AsyncBookService` class:

```
Promise<List<Book>> findBooks(String title) {
    Promises.task {
        bookService.findBooks(title)
    }
}
```

As you see the transform adds equivalent methods that return a Promise and execute asynchronously.

The AsyncBookService can then be injected into other controllers and services and used as follows:

```
AsyncBookService asyncBookService
def findBooks(String title) {
    asyncBookService.findBooks(title)
        .onComplete { List results ->
            println "Books = ${results}"
        }
}
```

## 10.2 Asynchronous GORM

Since Grails 2.3, GORM features an asynchronous programming model that works across all supported databases (e.g. MySQL, PostgreSQL, MongoDB etc.).

### Async Namespace

The Asynchronous GORM API is available on every domain class via the `async` namespace.

For example, the following code listing reads 3 objects from the database asynchronously:

```
import static grails.async.Promises.*

def p1 = Person.async.get(1L)
def p2 = Person.async.get(2L)
def p3 = Person.async.get(3L)
def results = waitAll(p1, p2, p3)
```

Using the `async` namespace, all the regular GORM methods are available (even dynamic finders), synchronously, the query is run in the background and a Promise instance is returned.

The following code listing shows a few common examples of GORM queries executed asynchronously:

```
import static grails.async.Promises.*

Person.async.list().onComplete { List results ->
    println "Got people = ${results}"
}
def p = Person.async.getAll(1L, 2L, 3L)
List results = p.get()

def p1 = Person.async.findByFirstName("Homer")
def p2 = Person.async.findByFirstName("Bart")
def p3 = Person.async.findByFirstName("Barney")
results = waitAll(p1, p2, p3)
```

## Async and the Session

When using GORM async each promise is executed in a different thread. Since the Hibernate session is new session is bound per thread.

This is an important consideration when using GORM async (particularly with Hibernate as the persistence layer) because the entities returned from asynchronous queries will be detached entities.

This means you cannot save objects returned from asynchronous queries without first merging them back into the session. The following will not work:

```
def promise = Person.async.findByFirstName("Homer")
def person = promise.get()
person.firstName = "Bart"
person.save()
```

Instead you need to merge the object with the session bound to the calling thread. The above code needs to be changed to:

```
def promise = Person.async.findByFirstName("Homer")
def person = promise.get()
person.merge()
person.firstName = "Bart"
```

Note that `merge()` is called first because it may refresh the object from the cache or database, which would otherwise be lost. In general it is not recommended to read and write objects in different threads and you should only do so unless absolutely necessary.



Finally, another issue with detached objects is that association lazy loading **will not** work and `LazyInitializationException` errors if you do so. If you plan to access the associated object asynchronously you should use eager queries (which is recommended anyway to avoid N+1 problem).

## Multiple Asynchronous GORM calls

As discussed in the previous section you should avoid reading and writing objects in different threads: inefficient.

However, if you wish to do more complex GORM work asynchronously then the GORM `async` namespace provides a method that makes this possible. For example:

```
def promise = Person.async.task {
    withTransaction {
        def person = findByFirstName("Homer")
        person.firstName = "Bart"
        person.save(flush:true)
    }
}

Person updatedPerson = promise.get()
```

Note that the GORM `task` method differs from the static `Promises.task` method in that it deals with the asynchronous thread for you. If you do not use the GORM version and do asynchronous work with GORM manually. Example:

```
import static grails.async.Promises.*

def promise = task {
    Person.withNewSession {
        // your logic here
    }
}
```

## Async DetachedCriteria

The `DetachedCriteria` class also supports the `async` namespace. For example you can do the follow

```
DetachedCriteria query = Person.where {  
    lastName == "Simpson"  
}  
  
def promise = query.async.list()
```

## 10.3 Asynchronous Request Handling

If you are deploying to a Servlet 3.0 container such as Tomcat 7 and above then it is possible asynchronously.

In general for controller actions that execute quickly there is little benefit in handling requests asynchronously. In running controller actions it is extremely beneficial.

The reason being that with an asynchronous / non-blocking response, the one thread == one request == one thread. The container can keep a client response open and active, and at the same time return the thread to deal with another request, improving scalability.

For example, if you have 70 available container threads and an action takes a minute to complete, if the action runs in a non-blocking fashion the likelihood of all 70 threads being occupied and the container not being able to accept new requests. You should consider asynchronous request processing.

Since Grails 2.3, Grails features a simplified API for creating asynchronous responses built on the Promises API previously.

The implementation is based on Servlet 3.0 async so to enable the async features you need to set your server version in `BuildConfig.groovy`:

```
grails.servlet.version = "3.0"
```

## Async Models

A typical activity in a Grails controller is to produce a model (a map of key/value pairs) that can be rendered.

If the model takes a while to produce then the server could arrive at a blocking state, impacting scalability. You can return the model asynchronously by returning a `grails.async.PromiseMap` via the `Promises.tasks` method.

```
import static grails.async.Promises.*
...
def index() {
    tasks books: Book.async.list(),
           totalBooks: Book.async.count(),
           otherValue: {
               // do hard work
           }
}
```

Grails will handle the response asynchronously, waiting for the promises to complete before rendering synchronous action of the above is:

```
def index() {
    def otherValue = ...
    [ books: Book.list() ,
      totalBooks: Book.count(),
      otherValue: otherValue ]
}
```

You can even render different view by passing the PromiseMap to the model attribute of the render r

```
import static grails.async.Promises.*
...
def index() {
    render view:"myView", model: tasks( one:{ 2 * 2 },
                                         two:{ 3 * 3 } )
}
```

## Async Response Rendering

You can also write to the response asynchronously using promises in Grails 2.3 and above:

```

import static grails.async.Promises.*
class StockController {
    def stock(String ticker) {
        task {
            ticker = ticker ?: 'GOOG'
            def url = new URL(
                "http://download.finance.yahoo.com/d/quotes.csv?s=${ticker}&f=nsllp&e=.csv")
            Double price = url.text.split(',')[ -1] as Double
            render "ticker: $ticker, price: $price"
        }
    }
}

```

The above example using Yahoo Finance to query stock prices, executing asynchronously and only render result has been obtained. This is done by returning a Promise instance from the controller action.

If the Yahoo URL is unresponsive the original request thread will not be blocked and the container will no

## 10.4 Servlet 3.0 Async

In addition to the higher level async features discussed earlier in the section, you can access the raw Servlet 3.0 AsyncContext from a Grails application.

### Servlet 3.0 Asynchronous Rendering

You can render content (templates, binary data etc.) in an asynchronous manner by calling the `startAsync()` method on the `Servlet 3.0 AsyncContext`. Once you have a reference to the `AsyncContext` you can call the `render()` method to render 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 using the `AsyncContext` class:

```
def index() {  
  def ctx = startAsync()  
  ctx.start {  
    // do working  
    ...  
    // render view  
    ctx.dispatch()  
  }  
}
```

# 11 Validation

Grails validation capability is built on [Spring's Validator API](#) and data binding capabilities. However Grails provides a 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 applied to domain classes, however [URL Mappings](#) and [Command Objects](#) also support constraints.

## 11.1 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 combination with the [ConstraintBuilder](#) to specify 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 can be unique. We've 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: false` constraint).

A complete reference for the available constraints can be found in the Quick Reference section under the [Constraints](#) tab.

Note that constraints are only evaluated once which may be relevant for a constraint that relies on a `java.util.Date`.

```
class User {
    ...

    static constraints = {
        // this Date object is created when the constraints are evaluated, not
        // each time an instance of the User class is validated.
        birthDate max: new Date()
    }
}
```

## 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 legal. If you do so, you 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 custom validator:

```
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. The custom validator checks if the `val` argument is in the `survey` property and return a boolean to indicate whether the new value for the `answer` property, `val`, is valid.

## 11.2 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 interface navigates the validation errors and also retrieves the original values.

## Validation Phases

Within Grails there are two phases of validation, the first one being [data binding](#) which occurs when you bind data onto an 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 converting a string to an integer). You can check 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 the [constraints](#) you defined. For example, by default the [save](#) method calls validate before executing further code like:



```

if (user.save()) {
    return user
}
else {
    user.errors.allErrors.each {
        println it
    }
}

```

## 11.3 Sharing Constraints Between Classes

A common pattern in Grails is to use [command objects](#) for validating user-submitted data and then call the command object to the relevant domain classes. This often means that your command objects and domain classes share constraints. You could manually copy and paste the constraints between the two, but that's a very tedious task. Instead, make use of Grails' global constraints and import mechanism.

### Global Constraints

In addition to defining constraints in domain classes, command objects and [other validateable classes](#), you can define global constraints in `grails-app/conf/Config.groovy`:

```

grails.gorm.default.constraints = {
    '*'(nullable: true, size: 1..20)
    myShared(nullable: false, blank: false)
}

```

These constraints are not attached to any particular classes, but they can be easily referenced from any validateable class:

```

class User {
    ...

    static constraints = {
        login shared: "myShared"
    }
}

```

Note the use of the `shared` argument, whose value is the name of one of the constraints defined in `grails.gorm.default.constraints`. Despite the name of the configuration setting, you can use these constraints from any validateable class, such as command objects.

The '\*' constraint is a special case: it means that the associated constraints ('nullable' and 'size' in the applied to all properties in all validateable classes. These defaults can be overridden by the constraints c class.

## Importing Constraints

Grails 2 introduced an alternative approach to sharing constraints that allows you to import a set of const another.

Let's say you have a domain class like so:

```
class User {
    String firstName
    String lastName
    String passwordHash

    static constraints = {
        firstName blank: false, nullable: false
        lastName blank: false, nullable: false
        passwordHash blank: false, nullable: false
    }
}
```

You then want to create a command object, `UserCommand`, that shares some of the properties of t corresponding constraints. You do this with the `importFrom()` method:

```
class UserCommand {
    String firstName
    String lastName
    String password
    String confirmPassword

    static constraints = {
        importFrom User
    }

    password blank: false, nullable: false
    confirmPassword blank: false, nullable: false
}
```

This will import all the constraints from the `User` domain class and apply them to `UserCommand`. Th constraints in the source class ( `User`) that don't have corresponding properties in the importing class ( above example, only the 'firstName' and 'lastName' constraints will be imported into `UserCommand` b properties shared by the two classes.

If you want more control over which constraints are imported, use the `include` and `exclude` argumen list of simple or regular expression strings that are matched against the property names in the source const you only wanted to import the 'lastName' constraint you would use:

```
...
static constraints = {
    importFrom User, include: ["lastName"]
    ...
}
```

or if you wanted all constraints that ended with 'Name':

```
...
static constraints = {
    importFrom User, include: [/.*Name/]
    ...
}
```

Of course, `exclude` does the reverse, specifying which constraints should *not* be imported.

## 11.4 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 errors. Grails 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. This is done using the [hasErrors](#) 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 class to the div. You can then use 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. You can use 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 input value.

## 11.5 Validation and Internationalization

Another important thing to note about errors in Grails is that error messages are not hard coded anywhere. Spring resolves 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 earlier.

```

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 message in your `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 taking precedence. `com.mycompany.myapp.User.login.blank` will be used before `user.login.blank`. This allows for cases where message codes 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 more control you can handle 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 `err` message for the given error.

## 11.6 Applying Validation to Other Classes

[Domain classes](#) and [command objects](#) support validation by default. Other classes may be made validateable by defining the `constraints` property in the class (as described above) and then telling the framework about them. The application registers the validateable classes with the framework. Simply defining the `constraints` property

### The Validateable Annotation

Classes which define the static `constraints` property and are annotated with `@Validateable` can be used by the framework. Consider this example:

```

// src/groovy/com/mycompany/myapp/User.groovy
package com.mycompany.myapp

import 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
    }
}

```

### Registering Validateable Classes

If a class is not marked with `Validateable`, it may still be made validateable by defining the `constraints` property in the class (as described above) and then telling the framework about the class by assigning the `grails.validateable.classes` property in `Config.groovy`:

```
grails.validateable.classes = [com.mycompany.myapp.User, com.mycompany.dto.Account]
```

## 12 The Service Layer

Grails defines the notion of a service layer. The Grails team discourages the embedding of core application logic as it does not 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 to manage request flow with 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 terminal:

```
grails create-service helloworld.simple
```



If no package is specified with the create-service script, Grails automatically uses the application package as the package name.

The above example will create a service at the location `grails-app/services/helloworld/SimpleService.groovy`. A service's name ends with the convention `Service`, other than that a service is a plain Groovy class:

```
package helloworld

class SimpleService {
}
```

### 12.1 Declarative Transactions

#### Default Declarative Transactions


Services are typically involved with coordinating logic between [domain classes](#), and hence often involve large operations. Given the nature of services, they frequently require transactional behaviour. You can manage transactions with the [withTransaction](#) method, however this is repetitive and doesn't fully leverage the power of the transaction abstraction.

Services enable transaction demarcation, which is a declarative way of defining which methods are to be transactional. By default, services are 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 need to create a transactional 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 throws a `RuntimeException` (i.e. one that extends `RuntimeException`) or an `Error`. The propagation level of the transaction is [PROPAGATION\\_REQUIRED](#).

 Checked exceptions do **not** roll back transactions. Even though Groovy blurs the distinction between checked and unchecked exceptions, Spring isn't aware of this and its default behaviour is to not roll back. It is important to understand the distinction between checked and unchecked exceptions.

## Custom Transaction Configuration

Grails also provides `@Transactional` and `@NotTransactional` annotations for cases where you need control over transactions at a per-method level or need to specify an alternative propagation level. The `@NotTransactional` annotation can be used to mark a particular method to be skipped when a `@Transactional` annotation is present.

 The `grails.transaction.Transactional` annotation was first introduced in Grails 2.3, Spring's `@Transactional` annotation was used.

 Annotating a service method with `Transactional` disables the default Grails transaction configuration for that service (in the same way that adding `transactional=false` does) so if you want to use transactions you must annotate all methods that require transactions.

In this example `listBooks` uses a read-only transaction, `updateBook` uses a default read-write transaction and `newBook` is not 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 then override per-method. For example, this service is equivalent to one that has no annotations (since the default is `transactional=true`):

```

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 overrides this 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 configuration annotation.

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 annotation and the compiler will detect them up automatically.

## 12.1.1 Transactions Rollback and the Session

### Understanding Transactions and the Hibernate Session

When using transactions there are important considerations you must take into account with regard to how the persistence session is handled by Hibernate. When a transaction is rolled back the Hibernate session is flushed. This means any objects within the session become detached and accessing uninitialized lazy-loaded objects will result in `LazyInitializationExceptions`.

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 clearing the Hibernate session. If the Hibernate session were not cleared then both author instances would be persisted and it would produce unexpected results.

It can, however, be frustrating to get `LazyInitializationExceptions` due to the session being cleared. 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 `isTooOld()` method by throwing an `AuthorException`. The `AuthorException` references the `books` association is accessed a `LazyInitializationException` will be thrown because the und has been cleared.

To solve this problem you have a number of options. One is to ensure you query eagerly to get the data you

```
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 than 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 `Author` again to 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 rendering:

```

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]
        }
    }
}

```

## 12.2 Scoped Services

By default, access to service methods is not synchronised, so nothing prevents concurrent execution of a service because the service is a singleton and may be used concurrently, you should be very careful about storing state in a service. The easy (and better) road and 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 flow
- **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.Serializable` and 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 example:

```

static scope = "flow"

```



For new Grails apps since 2.3, default controller scope is `singleton`, resulting in prototype services that are effectively per-controller singletons. If non-singleton services are required scope should be changed as well.

## 12.3 Dependency Injection and Services

### Dependency Injection Basics

A key aspect of Grails services is the ability to use [Spring Framework](#)'s dependency injection features. Grails uses "dependency injection by convention". In other words, you can use the property name representation of the class and Grails will automatically inject them into 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 configuration. In this case, the injection is 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 type. For example, an 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 name are in upper case, the property name is the same as the class name. For example, the property name for the `JDBCHelperService` class would be `JDBCHelperService`, not `jdbchelperService`.

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` that depended on `BookService`, 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 views:

```
class Book {
    ...
    def bookService
    def buyBook() {
        bookService.buyBook(this)
    }
}
```

## Service Bean Names

The default bean name which is associated with a service can be problematic if there are multiple services defined in different packages. For example consider the situation where an application defines `com.demo.ReportingService` and the application uses a plugin named `ReportingUtilities` a service class named `com.reporting.util.ReportingService`. The default bean name for `reportingService` so they would conflict with each other. Grails manages this by changing the default provided by plugins by prefixing the bean name with the plugin name. In the scenario described above the bean would be an instance of the `com.demo.ReportingService` class defined in the `reportingUtilitiesReportingService` bean would be an instance of the `com.reporting.util.ReportingService` class provided by the `ReportingUtilities` plugin. If there are no other services with the same name within the application or other plugins, a bean alias will be created which does not include the plugin name and that alias points to the bean reference that does include the plugin name prefix. For example, if the `ReportingUtilities` plugin provides `com.reporting.util.AuthorService` and there is no other `AuthorService` in the application that the application is using then there will be a bean named `reportingUtilitiesAuthorService` that points to this `com.reporting.util.AuthorService` class and there will be a bean alias defined `authorService` which points to that same bean.

## 12.4 Using Services from Java

One of the powerful things about services is that since they encapsulate re-usable logic, you can use them from other languages including Java classes. There are a couple of ways you can reuse a service from Java. The simplest way is to place the service in a package within the `grails-app/services` directory. The reason this is important is that it is not automatically visible to Java from the default package (the package used when no package declaration is present). So for example, the service below cannot be used from Java as it stands:

```
class BookService {
    void buyBook(Book book) {
        // logic
    }
}
```

However, this can be rectified by placing this class in a package, by moving the class into a `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 (although it's always a good idea to use packages). Either way, the goal of this exercise to enable Java to s (or interface) to use, at compile time.

Now that this is done you can create a Java class within the `src/java` directory and add a setter that us of the bean in 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/spring` more 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")
    }
}
```

## 13 Static Type Checking And Compilation

Groovy is a dynamic language and by default Groovy uses a dynamic dispatch mechanism to carry out method access. This dynamic dispatch mechanism provides a lot of flexibility and power to the language. For example, you can dynamically add methods to classes at runtime and it is possible to dynamically replace existing methods. These are important and provide a lot of power to the language. However, there are times when you might want to use dynamic dispatch in favor of a more static dispatch mechanism and Groovy provides a way to do that. The way to tell the compiler that a particular class should be compiled statically is to mark the class with the [groovy.transform.CompileStatic](#) annotation, as shown below.

```
import groovy.transform.CompileStatic

@CompileStatic
class MyClass {

    // this class will be statically compiled...
}
```

See [these notes on Groovy static compilation](#) for more details on how `CompileStatic` works and why you might want to use it.

One limitation of using `CompileStatic` is that when you use it you give up access to the power of dynamic dispatch. For example, in Grails you would not be able to invoke a GORM dynamic finder from within a static method with `CompileStatic` because the compiler cannot verify that the dynamic finder method exists, but only at compile time. It may be that you want to take advantage of Groovy's static compilation benefits with dynamic dispatch for Grails specific things like dynamic finders and this is where [grails.compiler.GrailsCompileStatic](#) behaves just like `CompileStatic` but is aware of certain Grails features and allows specific features to be accessed dynamically.

### 13.1 The GrailsCompileStatic Annotation

#### GrailsCompileStatic

The `GrailsCompileStatic` annotation may be applied to a class or methods within a class.

```

import grails.compiler.GrailsCompileStatic

@GrailsCompileStatic
class SomeClass {

    // all of the code in this class will be statically compiled

    def methodOne() {
        // ...
    }

    def methodTwo() {
        // ...
    }

    def methodThree() {
        // ...
    }
}

```

```

import grails.compiler.GrailsCompileStatic

class SomeClass {

    // methodOne and methodThree will be statically compiled
    // methodTwo will be dynamically compiled

    @GrailsCompileStatic
    def methodOne() {
        // ...
    }

    def methodTwo() {
        // ...
    }

    @GrailsCompileStatic
    def methodThree() {
        // ...
    }
}

```

It is possible to mark a class with `GrailsCompileStatic` and exclude specific methods by using `@GrailsCompileStatic` and specifying that the type checking should be skipped for that particular method.

```

import grails.compiler.GrailsCompileStatic
import groovy.transform.TypeCheckingMode

@GrailsCompileStatic
class SomeClass {

    // methodOne and methodThree will be statically compiled
    // methodTwo will be dynamically compiled

    def methodOne() {
        // ...
    }

    @GrailsCompileStatic(TypeCheckingMode.SKIP)
    def methodTwo() {
        // ...
    }

    def methodThree() {
        // ...
    }
}

```

Code that is marked with `GrailsCompileStatic` will all be statically compiled except for Grails cannot be statically compiled but that `GrailsCompileStatic` can identify as permissible for dynamic things like invoking dynamic finders and DSL code in configuration blocks like constraints and map classes.

Care must be taken when deciding to statically compile code. There are benefits associated with static compilation but you are giving up the power and flexibility of dynamic dispatch. For example, statically compiled code cannot take advantage of runtime metaprogramming enhancements which may be provided by

## 13.2 The `GrailsTypeChecked` Annotation

### `GrailsTypeChecked`

The [grails.compiler.GrailsTypeChecked](#) annotation works a lot like the `GrailsCompileStatic` annotation but enables static type checking, not static compilation. This affords compile time feedback for expressions evaluated statically at compile time while still leaving dynamic dispatch in place for the class.

```
import grails.compiler.GrailsTypeChecked

@GrailsTypeChecked
class SomeClass {

    // all of the code in this class will be statically type
    // checked and will be dynamically dispatched at runtime

    def methodOne() {
        // ...
    }

    def methodTwo() {
        // ...
    }

    def methodThree() {
        // ...
    }
}
```



## 14 Testing

Automated testing is a key part of Grails. Hence, Grails provides many ways to making testing easier from high level 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 in a JUnit 3 style. Grails 2.0.x and above deprecates these test harnesses in favour of mixins applied to a range of 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 automatically. 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/SimpleController` unit test at `test/unit/com/acme/app/SimpleControllerTests.groovy`. What Grails won't do is create the logic inside the test! 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 supported.

### Running Tests

Tests are run with the [test-app](#) command:

```
grails test-app
```

The 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 showing the reason for each test failure.



You can force a clean before running tests by passing `-clean` to the `test-app` command.

Grails writes both plain text and HTML test reports to the `target/test-reports` directory, along with `test-reports` files. The HTML reports are generally the best ones to look at.

Using Grails' [interactive mode](#) confers some distinct advantages when executing tests. First, the tests run faster on the second and subsequent runs. Second, a shortcut is available to open the HTML reports in your

```
open test-report
```

You can also run your unit tests from within most IDEs.

## Targeting Tests

You can selectively target the test(s) to be run in different ways. To run all tests for a controller named `SimpleController` you would run:

```
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 like...

```
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:type`



Grails organises tests by phase and by type. A test phase relates to the state of the Grails during the tests, and the type relates to the testing mechanism.

Grails comes with support for 4 test phases ( `unit`, `integration`, `functional` and `continuousIntegration` ) and 2 JUnit test types for the `unit` and `integration` phases. These test types have the same name as the phase.

Testing plugins may provide new test phases or new test types for existing phases. Refer to the plugin 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 all tests in all phases:

```
grails test-app unit:
```

The Grails [Spock Plugin](#) is one plugin that adds new test types to Grails. It adds a `spock` test type to the `unit` and `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

## 14.1 Unit Testing

Unit testing are tests at the "unit" level. In other words you are testing individual methods or blocks of code for surrounding infrastructure. Unit tests are typically run without the presence of physical resources like databases, socket connections or files. This is to ensure they run as quick as possible since quick feedback

### The Test Mixins

Since Grails 2.0, a collection of unit testing mixins is provided by Grails that lets you enhance the behavior of JUnit 4 or Spock test. The following sections cover the usage of these mixins.



The previous JUnit 3-style `GrailsUnitTestCase` class hierarchy is still present in Grails for backwards compatibility, but is now deprecated. The previous documentation on the subject can be found in the [Grails 1.3.x documentation](#)

You won't normally have to import any of the testing classes because Grails does that for you. But if your IDE can't find the classes, here they all are:

- `grails.test.mixin.TestFor`
- `grails.test.mixin.Mock`
- `grails.test.mixin.TestMixin`
- `grails.test.mixin.support.GrailsUnitTestMixin`
- `grails.test.mixin.domain.DomainClassUnitTestMixin`
- `grails.test.mixin.services.ServiceUnitTestMixin`
- `grails.test.mixin.web.ControllerUnitTestMixin`
- `grails.test.mixin.web.FiltersUnitTestMixin`
- `grails.test.mixin.web.GroovyPageUnitTestMixin`
- `grails.test.mixin.web.UrlMappingsUnitTestMixin`
- `grails.test.mixin.hibernate.HibernateTestMixin`

Note that you're only ever likely to use the first two explicitly. The rest are there for reference.

## Test Mixin Basics

Most testing can be achieved via the `TestFor` annotation in combination with the `Mock` annotation. For example, to test a controller and associated domains you would define the following:

```
@TestFor(BookController)
@Mock([Book, Author, BookService])
```

The `TestFor` annotation defines the class under test and will automatically create a field for the type. In the example above a "controller" field will be present, however if `TestFor` was defined for a domain class a "domain" field would be created and so on.

The `Mock` annotation creates mock versions of any collaborators. There is an in-memory implementation that simulates most interactions with the GORM API. For those interactions that are not automatically mocked, there is support for defining mocks and stubs programmatically. For example:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(BookController)
@Mock(Book)
class BookControllerSpec extends Specification {

    void "test search"() {
        given:
            def searchMock = mockFor(SearchService)
            searchMock.demand.searchWeb { String q -> ['first result', 'second result']
            searchMock.demand.static.logResults { List results -> }
            controller.searchService = searchMock.createMock()

        when:
            controller.search()

        then:
            controller.response.text.contains "Found 2 results"
    }
}

```

## doWithSpring and doWithConfig callback methods, FreshRuntime annotation

The `doWithSpring` callback method can be used to add beans with the BeanBuilder DSL. There is also a callback method for changing the `grailsApplication.config` values before the `grailsApplication` instance is initialized.

```

import grails.test.mixin.support.GrailsUnitTestMixin

import org.junit.ClassRule
import org.junit.rules.TestRule

import spock.lang.Ignore;
import spock.lang.IgnoreRest
import spock.lang.Shared;
import spock.lang.Specification

@TestMixin(GrailsUnitTestMixin)
class StaticCallbacksSpec extends Specification {
    static doWithSpring = {
        myService(MyService)
    }

    static doWithConfig(c) {
        c.myConfigValue = 'Hello'
    }

    def "grailsApplication is not null"() {
        expect:
        grailsApplication != null
    }

    def "doWithSpring callback is executed"() {
        expect:
        grailsApplication.mainContext.getBean('myService') != null
    }

    def "doWithConfig callback is executed"(){
        expect:
        config.myConfigValue == 'Hello'
    }
}

```

You can also use these callbacks without "static" together with the [grails.test.runtime.Fresh](#) this case, a clean application context and grails application instance is initialized for each test method call.



```

import grails.test.mixin.support.GrailsUnitTestMixin
import grails.test.runtime.FreshRuntime;

import org.junit.ClassRule
import org.junit.rules.TestRule

import spock.lang.Ignore;
import spock.lang.IgnoreRest
import spock.lang.Shared;
import spock.lang.Specification

@FreshRuntime
@TestMixin(GrailsUnitTestMixin)
class TestInstanceCallbacksSpec extends Specification {
    def doWithSpring = {
        myService(MyService)
    }

    def doWithConfig(c) {
        c.myConfigValue = 'Hello'
    }

    def "grailsApplication is not null"() {
        expect:
        grailsApplication != null
    }

    def "doWithSpring callback is executed"() {
        expect:
        grailsApplication.mainContext.getBean('myService') != null
    }

    def "doWithConfig callback is executed"(){
        expect:
        config.myConfigValue == 'Hello'
    }
}

```

You can use [org.codehaus.groovy.grails.commons.InstanceFactoryBean](#) together with [FreshRuntime](#) annotation to mock beans in tests.

```

import grails.test.mixin.support.GrailsUnitTestMixin
import grails.test.runtime.FreshRuntime

import org.codehaus.groovy.grails.commons.InstanceFactoryBean
import org.junit.ClassRule

import spock.lang.Shared
import spock.lang.Specification

@FreshRuntime
@TestMixin(GrailsUnitTestMixin)
class MockedBeanSpec extends Specification {
    def myService=Mock(MyService)

    def doWithSpring = {
        myService(InstanceFactoryBean, myService, MyService)
    }

    def "doWithSpring callback is executed"() {
        when:
        def myServiceBean=grailsApplication.mainContext.getBean('myService')
        myServiceBean.prova()
        then:
        1 * myService.prova() >> { true }
    }
}

```

## The DirtiesRuntime annotation

Test methods may be marked with the [grails.test.runtime.DirtiesRuntime](#) annotation modifies the runtime in ways which might be problematic for other tests and as such the runtime should be reset after the method runs.

```

import grails.test.mixin.TestFor
import spock.lang.Specification
import grails.test.runtime.DirtiesRuntime

@TestFor(PersonController)
class PersonControllerSpec extends Specification {

    @DirtiesRuntime
    void "a test method which modifies the runtime"() {
        when:
        Person.metaClass.someMethod = { ... }
        // ...

    then:
        // ...
    }

    void "a test method which should not be affected by the previous test method"() {
        // ...
    }
}

```

## Sharing test runtime grailsApplication instance and beans for several test classes

It's possible to share a single `grailsApplication` instance and beans for several test classes. This feature is enabled by the [SharedRuntime](#) annotation. This annotation takes an optional class parameter implements [Shared](#) interface. All test classes referencing the same `SharedRuntimeConfigurer` implementation class will share a single test run. The value class for `SharedRuntimeConfigurer` annotation can also implement [TestEventInterceptor](#). In this case the instance of the class will be registered as a test event interceptor for the test runtime.

## Loading application beans in unit tests

Adding static `loadExternalBeans = true` field definition to a unit test class makes the Grails bean definitions from `grails-app/conf/spring/resources.groovy` and `grails-app/conf/spring/resources.xml` files.

```
import spock.lang.Issue
import spock.lang.Specification
import grails.test.mixin.support.GrailsUnitTestMixin

@TestMixin(GrailsUnitTestMixin)
class LoadExternalBeansSpec extends Specification {
    static loadExternalBeans = true

    void "should load external beans"() {
        expect:
        applicationContext.getBean('simpleBean') == 'Hello world!'
    }
}
```

### 14.1.1 Unit Testing Controllers

#### The Basics

You use the `grails.test.mixin.TestFor` annotation to unit test controllers. Using `TestFor` in `grails.test.mixin.web.ControllerUnitTestMixin` and its associated API. For example:

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void "test something"() {
        // ...
    }
}
```

Adding the `TestFor` annotation to a controller causes a new controller field to be automatically under test.



The `TestFor` annotation will also automatically annotate any public methods starting with JUnit 4's `@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"
    }
}
```

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void "test hello"() {
        when:
            controller.hello()

        then:
            response.text == 'hello'
    }
}
```

The `response` object is an instance of `GrailsMockHttpServletResponse` (`org.codehaus.groovy.grails.plugins.testing`) which extends Spring's `MockHttpServletResponse` and has a number of useful methods for inspecting the state of the response.

For example to test a redirect you can use the `redirectedUrl` property:

```
class SimpleController {
    def index() {
        redirect action: 'hello'
    }
    ...
}
```

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void 'test index'() {
        when:
            controller.index()

        then:
            response.redirectedUrl == '/simple/hello'
    }
}

```

Many actions make use of the parameter data associated with the request. For example, the 'sort', 'max', a quite common. Providing these in the test is as simple as adding appropriate values to a special `params` variable.

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(PersonController)
class PersonControllerSpec extends Specification {

    void 'test list'() {
        when:
            params.sort = 'name'
            params.max = 20
            params.offset = 0
            controller.list()

        then:
            // ...
    }
}

```

You can even control what type of request the controller action sees by setting the `method` property of the

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(PersonController)
class PersonControllerSpec extends Specification {

    void 'test save'() {
        when:
            request.method = 'POST'
            controller.save()

        then:
            // ...
    }
}

```

This is particularly important if your actions do different things depending on the type of the request. request as AJAX like so:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(PersonController)
class PersonControllerSpec extends Specification {

    void 'test list'() {
        when:
            request.method = 'POST'
            request.makeAjaxRequest()
            controller.getPage()

        then:
            // ...
    }
}

```

You only need to do this though if the code under test uses the `xhr` property on the request.

## Testing View Rendering

To test view rendering you can inspect the state of the controller's `modelAndView` property (`org.springframework.web.servlet.ModelAndView`) or you can use the `view` and `model` properties from the `TestFor` mixin:

```
class SimpleController {
    def home() {
        render view: "homePage", model: [title: "Hello World"]
    }
    ...
}
```

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void 'test home'() {
        when:
            controller.home()

        then:
            view == '/simple/homePage'
            model.title == 'Hello World'
    }
}
```

Note that the view string is the absolute view path, so it starts with a '/' and will include path elements, such as after the action's controller.

## Testing Template Rendering

Unlike view rendering, template rendering will actually attempt to write the template directly to the response's `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`. It follows:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test display'() {
    when:
        controller.display()

    then:
        response.text == 'contents of the template'
}
}

```

However, you may not want to render the real template, but just test that it was rendered. In this case Groovy Pages:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test display with mock template'() {
    when:
        views['/_simple/_snippet.gsp'] = 'mock template contents'
        controller.display()

    then:
        response.text == 'mock template contents'
}
}

```

## Testing Actions Which Return A Map

When a controller action returns a `java.util.Map` that Map may be inspected directly to assert that data:

```

class SimpleController {
    def showBookDetails() {
        [title: 'The Nature Of Necessity', author: 'Alvin Plantinga']
    }
}

```



```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test show book details'() {
    when:
        def model = controller.showBookDetails()

    then:
        model.author == 'Alvin Plantinga'
    }
}

```

## Testing XML and JSON Responses

XML and JSON response are also written directly to the response. Grails' mocking capabilities provide testing XML and 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:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test render xml'() {
    when:
        controller.renderXml()

    then:
        response.text == "<book title='Great'/>"
        response.xml.@title.text() == 'Great'
    }
}

```

The `xml` property is a parsed result from 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:"application/json") {
        book = "Great"
    }
}
```

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void 'test render json'() {
        when:
            controller.renderJson()

        then:
            response.text == '{"book":"Great"}'
            response.json.book == 'Great'
    }
}
```

The `json` property is an instance of `org.codehaus.groovy.grails.web.json.JSONElement` structure that is useful for parsing JSON responses.

## Testing XML and JSON Requests

Grails provides various convenient ways to automatically parse incoming XML and JSON packets. For incoming JSON or XML requests using Grails' data binding:

```
def consumeBook(Book b) {
    render "The title is ${b.title}."
}
```

To test this Grails provides an easy way to specify an XML or JSON packet via the `xml` or `json` properties. The above action can be tested by specifying a String containing the XML:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
@Mock([Book])
class SimpleControllerSpec extends Specification {
    void 'test consume book xml'() {
        when:
            request.xml = '<book><title>Wool</title></book>'
            controller.consumeBook()

        then:
            response.text == 'The title is Wool.'
    }
}

```

Or alternatively a domain instance can be specified and it will be auto-converted into the appropriate XML

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
@Mock([Book])
class SimpleControllerSpec extends Specification {
    void 'test consume book xml'() {
        when:
            request.xml = new Book(title: 'Shift')
            controller.consumeBook()

        then:
            response.text == 'The title is Shift.'
    }
}

```

The same can be done for JSON requests:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
@Mock([Book])
class SimpleControllerSpec extends Specification {

void 'test consume book json'() {
    when:
        request.json = new Book(title: 'Shift')
        controller.consumeBook()

    then:
        response.text == 'The title is Shift.'
    }
}

```

If you prefer not to use Grails' data binding but instead manually parse the incoming XML or JSON then example consider the controller action below:

```

def consume() {
    request.withFormat {
        xml {
            render "The XML Title Is ${request.XML.@title}."
        }
        json {
            render "The JSON Title Is ${request.JSON.title}."
        }
    }
}

```

To test the XML request you can specify the XML as a string:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test consume xml'() {
    when:
        request.xml = '<book title="The Stand"/>'
        controller.consume()

    then:
        response.text == 'The XML Title Is The Stand.'
}

void 'test consume json'() {
    when:
        request.json = '{title:"The Stand"}'
        controller.consume()

    then:
        response.text == 'The JSON Title Is The Stand.'
}
}

```

## Testing Mime Type Handling

You can test mime type handling and the `withFormat` method quite simply by setting the request's con

```

// controller action
def sayHello() {
    def data = [Hello:"World"]
    request.withFormat {
        xml { render data as grails.converters.XML }
        json { render data as grails.converters.JSON }
        html data
    }
}

```

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test say hello xml'() {
    when:
        request.contentType = 'application/xml'
        controller.sayHello()

    then:
        response.text == '<?xml version="1.0" encoding="UTF-8"?><map><entry key="
>World</entry></map>'
}

void 'test say hello json'() {
    when:
        request.contentType = 'application/json'
        controller.sayHello()

    then:
        response.text == '{"Hello":"World"}'
}
}

```

There are constants provided by ControllerUnitTestMixin for all of the common content

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test say hello xml'() {
    when:
        request.contentType = XML_CONTENT_TYPE
        controller.sayHello()

    then:
        response.text == '<?xml version="1.0" encoding="UTF-8"?><map><entry key="
>World</entry></map>'
}

void 'test say hello json'() {
    when:
        request.contentType = JSON_CONTENT_TYPE
        controller.sayHello()

    then:
        response.text == '{"Hello":"World"}'
}
}

```

The defined constants are listed below:

Constant	Value
ALL_CONTENT_TYPE	/*
FORM_CONTENT_TYPE	application/x-www-form-urlencoded
MULTIPART_FORM_CONTENT_TYPE	multipart/form-data
HTML_CONTENT_TYPE	text/html
XHTML_CONTENT_TYPE	application/xhtml+xml
XML_CONTENT_TYPE	application/xml
JSON_CONTENT_TYPE	application/json
TEXT_XML_CONTENT_TYPE	text/xml
TEXT_JSON_CONTENT_TYPE	text/json
HAL_JSON_CONTENT_TYPE	application/hal+json
HAL_XML_CONTENT_TYPE	application/hal+xml
ATOM_XML_CONTENT_TYPE	application/atom+xml

## Testing Duplicate Form Submissions

Testing duplicate form submissions is a little bit more involved. For example if you have an action that has

```
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 bad submission. Testing the bad submission is simple. Just invoke the controller:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test duplicate form submission'() {
    when:
        controller.handleForm()

    then:
        response.text == 'Bad'
    }
}

```

Testing the successful submission requires providing an appropriate SynchronizerToken:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

import org.codehaus.groovy.grails.web.servlet.mvc.SynchronizerTokensHolder

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test valid form submission'() {
    when:
        def tokenHolder = SynchronizerTokensHolder.store(session)

    params[SynchronizerTokensHolder.TOKEN_URI] = '/controller/handleForm'
    params[SynchronizerTokensHolder.TOKEN_KEY] =
        tokenHolder.generateToken(params[SynchronizerTokensHolder.TOKEN_URI])
    controller.handleForm()

    then:
        response.text == 'Good'
    }
}

```

If you test both the valid and the invalid request in the same test be sure to reset the response between exec



```

import grails.test.mixin.TestFor
import spock.lang.Specification

import org.codehaus.groovy.grails.web.servlet.mvc.SynchronizerTokensHolder

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test form submission'() {
    when:
        controller.handleForm()

    then:
        response.text == 'Bad'

    when:
        response.reset()
        def tokenHolder = SynchronizerTokensHolder.store(session)

    params[SynchronizerTokensHolder.TOKEN_URI] = '/controller/handleForm'
    params[SynchronizerTokensHolder.TOKEN_KEY] =
    tokenHolder.generateToken(params[SynchronizerTokensHolder.TOKEN_URI])
    controller.handleForm()

    then:
        response.text == 'Good'
    }
}

```

## Testing File Upload

You use the `GrailsMockMultipartFile` class to test file uploads. For example consider the followin

```

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:

```

import rails.test.mixin.TestFor
import spock.lang.Specification

import org.codehaus.groovy.grails.plugins.testing.GrailsMockMultipartFile

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void 'test file upload'() {
        when:
            def file = new GrailsMockMultipartFile('myFile', 'some file contents'.getBytes())
            request.addFile file
            controller.uploadFile()

        then:
            file.targetFileLocation.path == '/local/disk/myFile'
    }
}

```

The `GrailsMockMultipartFile` constructor arguments are the name and contents of the file. It has the `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` method. In the following action:

```

class SimpleController {
    def handleCommand(SimpleCommand simple) {
        if(simple.hasErrors()) {
            render 'Bad'
        } else {
            render 'Good'
        }
    }
}

class SimpleCommand {
    String name

    static constraints = {
        name blank: false
    }
}

```

To test this you mock the command object, populate it and then validate it as follows:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test valid command object'() {
    given:
        def simpleCommand = new SimpleCommand(name: 'Hugh')
        simpleCommand.validate()

    when:
        controller.handleCommand(simpleCommand)

    then:
        response.text == 'Good'
}

void 'test invalid command object'() {
    given:
        def simpleCommand = new SimpleCommand(name: '')
        simpleCommand.validate()

    when:
        controller.handleCommand(simpleCommand)

    then:
        response.text == 'Bad'
}
}

```

The testing framework also supports allowing Grails to create the command object instance automatically using a no-arg version of the controller action method. Grails will create an instance of the command object, passing the request parameters and validate the object just like it does in when the application is running. See

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test valid command object'() {
    when:
        params.name = 'Hugh'
        controller.handleCommand()

    then:
        response.text == 'Good'
}

void 'test invalid command object'() {
    when:
        params.name = ''
        controller.handleCommand()

    then:
        response.text == 'Bad'
}
}

```

## Testing allowedMethods

The unit testing environment respects the [allowedMethods](#) property in controllers. If a controller action with certain request methods, the unit test must be constructed to deal with that.

```
// grails-app/controllers/com/demo/DemoController.groovypackage com.demo
class DemoController {
    static allowedMethods = [save: 'POST', update: 'PUT', delete: 'DELETE']
    def save() {
        render 'Save was successful!'
    }
    // ...
}
```

```
// test/unit/com/demo/DemoControllerSpec.groovy
package com.demo

import grails.test.mixin.TestFor
import spock.lang.Specification
import static javax.servlet.http.HttpServletResponse.*

@TestFor(DemoController)
class DemoControllerSpec extends Specification {

    void "test a valid request method"() {
        when:
            request.method = 'POST'
            controller.save()

        then:
            response.status == SC_OK
            response.text == 'Save was successful!'
    }

    void "test an invalid request method"() {
        when:
            request.method = 'DELETE'
            controller.save()

        then:
            response.status == SC_METHOD_NOT_ALLOWED
    }
}
```

## Testing Calling Tag Libraries

You can test calling tag libraries using `ControllerUnitTestMixin`, although the mechanism for testing from tag to tag. For example to test a call to the message tag, add a message to the `messageSource` action:

```
def showMessage() {
    render g.message(code: "foo.bar")
}
```

This can be tested as follows:

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void 'test render message tag'() {
        given:
            messageSource.addMessage 'foo.bar', request.locale, 'Hello World'

        when:
            controller.showMessage()

        then:
            response.text == 'Hello World'
    }
}
```

See [unit testing tag libraries](#) for more information.

## 14.1.2 Unit Testing Tag Libraries

### The Basics

Tag libraries and GSP pages can be tested with the `grails.test.mixin.web.GroovyPageUnit`. To use the mixin declare which tag library is under test with the `TestFor` annotation:

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleTagLib)
class SimpleTagLibSpec extends Specification {

    void "test something"() {
    }
}
```

Adding the `TestFor` annotation to a `TagLib` class causes a new `tagLib` field to be automatically created under test. The `tagLib` field can be used to test calling tags as function calls. The return value of a `StreamCharBuffer` instance or the object returned from the tag closure when [returnObjectForTags](#) feature is enabled.

Note that if you are testing invocation of a custom tag from a controller you can combine the `ControllerTestMixin` and the `GroovyPageUnitTestMixin` using the `Mock` annotation:

```
import spock.lang.Specification

@TestFor(SimpleController)
@Mock(SimpleTagLib)
class SimpleControllerSpec extends Specification {

}
```

## Testing Custom Tags

The core Grails tags don't need to be enabled during testing, however custom tag `GroovyPageUnitTestMixin` class provides a `mockTagLib()` method that you can use to mock a tag library. For example consider the following tag library:

```
class SimpleTagLib {
    static namespace = 's'

    def hello = { attrs, body ->
        out << "Hello ${attrs.name ?: 'World'}"
    }

    def bye = { attrs, body ->
        out << "Bye ${attrs.author.name ?: 'World'}"
    }
}
```

You can test this tag library by using `TestFor` and supplying the name of the tag library:

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleTagLib)
class SimpleTagLibSpec extends Specification {

    void "test hello tag"() {
        expect:
        applyTemplate('<s:hello />') == 'Hello World'
        applyTemplate('<s:hello name="Fred" />') == 'Hello Fred'
        applyTemplate('<s:bye author="${author}" />', [author: new Author(name: 'Fred')]) == 'Bye Fred'
    }

    void "test tag calls"() {
        expect:
        tagLib.hello().toString() == 'Hello World'
        tagLib.hello(name: 'Fred').toString() == 'Hello Fred'
        tagLib.bye(author: new Author(name: 'Fred')).toString() == 'Bye Fred'
    }
}
```

Alternatively, you can use the `TestMixin` annotation and mock multiple tag libraries using the `mockTagLib` method.

```
import spock.lang.Specification
import grails.test.mixin.TestMixin
import grails.test.mixin.web.GroovyPageUnitTestMixin

@TestMixin(GroovyPageUnitTestMixin)
class MultipleTagLibSpec extends Specification {

    void "test multiple tags"() {
        given:
        mockTagLib(SomeTagLib)
        mockTagLib(SomeOtherTagLib)

        expect:
        // ...
    }
}
```

The `GroovyPageUnitTestMixin` provides convenience methods for asserting that the template output matches the expected value.

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleTagLib)
class SimpleTagLibSpec extends Specification {

void "test hello tag"() {
    expect:
    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 `render(Map GroovyPageUnitTestMixin)`:

```

import spock.lang.Specification
import grails.test.mixin.TestMixin
import grails.test.mixin.web.GroovyPageUnitTestMixin

@TestMixin(GroovyPageUnitTestMixin)
class RenderingSpec extends Specification {

void "test rendering template"() {
    when:
    def result = render(template: '/simple/hello')

    then:
    result == 'Hello World!'
}
}

```

This will attempt to render a template found at the location `grails-app/views/simple/_hello`. The template depends on any custom tag libraries you need to call `mockTagLib` as described in the previous :

Some core tags use the active controller and action as input. In `GroovyPageUnitTestMixin` tests, you can set the controller and action name by setting `controllerName` and `actionName` properties on the `webRequest` object:

```

webRequest.controllerName = 'simple'
webRequest.actionName = 'hello'

```



## 14.1.3 Unit Testing Domains

### Overview

Domain class interaction can be tested without involving a real database connection using `DomainClassUnitTestMixin` by using the `HibernateTestMixin`.

The GORM implementation in `DomainClassUnitTestMixin` is using a simple in-memory `ConcurrentHashMap`. Note that this has limitations compared to a real GORM implementation.

A large, commonly-used portion of the GORM API can be mocked using `DomainClassUnitTestMixin`:

- Simple persistence methods like `save()`, `delete()` etc.
- Dynamic Finders
- Named Queries
- Query-by-example
- GORM Events

`HibernateTestMixin` uses Hibernate 4 and a H2 in-memory database. This makes it possible to use a Grails unit tests.

All features of GORM for Hibernate can be tested within a `HibernateTestMixin` unit test including:

- String-based HQL queries
- composite identifiers
- dirty checking methods
- any direct interaction with Hibernate

The implementation behind `HibernateTestMixin` takes care of setting up the Hibernate with the in-memory database and only configures the given domain classes for use in a unit test. The `@Domain` annotation is used to test domain classes that should be configured.

### DomainClassUnitTestMixin Basics

`DomainClassUnitTestMixin` is typically used in combination with testing either a controller, service or domain. A mock collaborator defined by the `Mock` annotation:

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(BookController)
@Mock(Book)
class BookControllerSpec extends Specification {
    // ...
}
```

The example above tests the SimpleController class and mocks the behavior of the Simple domain object. In this example consider a 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
import spock.lang.Specification

@TestFor(BookController)
@Mock(Book)
class BookControllerSpec extends Specification {
  void "test saving an invalid book"() {
    when:
      controller.save()

    then:
      model.bookInstance != null
      view == '/book/create'
  }

  void "test saving a valid book"() {
    when:
      params.title = "The Stand"
      params.pages = "500"

    controller.save()

    then:
      response.redirectedUrl == '/book/show/1'
      flash.message != null
      Book.count() == 1
  }
}
```

Mock annotation also supports a list of mock collaborators if you have more than one domain to mock:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(BookController)
@Mock([Book, Author])
class BookControllerSpec extends Specification {
    // ...
}

```

Alternatively you can also use the `DomainClassUnitTestMixin` directly with the `TestMixin` and `mockDomain` method to mock domains during your test:

```

import grails.test.mixin.TestFor
import grails.test.mixin.TestMixin
import spock.lang.Specification
import grails.test.mixin.domain.DomainClassUnitTestMixin

@TestFor(BookController)
@TestMixin(DomainClassUnitTestMixin)
class BookControllerSpec extends Specification {

    void setupSpec() {
        mockDomain(Book)
    }

    void "test saving an invalid book"() {
        when:
            controller.save()

        then:
            model.bookInstance != null
            view == '/book/create'
    }

    void "test saving a valid book"() {
        when:
            params.title = "The Stand"
            params.pages = "500"

        controller.save()

        then:
            response.redirectedUrl == '/book/show/1'
            flash.message != null
            Book.count() == 1
    }
}

```

The `mockDomain` method also includes an additional parameter that lets you pass a Map of Maps to contain useful for fixture-like data:

```
mockDomain(Book, [
    [title: "The Stand", pages: 1000],
    [title: "The Shining", pages: 400],
    [title: "Along Came a Spider", pages: 300] ])
```

## Testing Constraints

There are 4 types of validateable classes:

1. Domain classes
2. Classes marked with the `Validateable` annotation
3. Command Objects which have been made validateable automatically
4. Classes configured to be validateable via the `grails.validateable.classes` property in `Config.groovy`

The first 3 are easily testable in a unit test with no special configuration necessary as long as the test class extends `TestFor` or explicitly applies the `GrailsUnitTestMixin` using `TestMixin`. See the examples below.

```
// src/groovy/com/demo/MyValidateable.groovy
package com.demo

@grails.validation.Validateable
class MyValidateable {
    String name
    Integer age

    static constraints = {
        name matches: /[A-Z].*/
        age range: 1..99
    }
}
```

```
// grails-app/domain/com/demo/Person.groovy
package com.demo

class Person {
    String name

    static constraints = {
        name matches: /[A-Z].*/
    }
}
```

```
// grails-app/controllers/com/demo/DemoController.groovy
package com.demo

class DemoController {
    def addItem(MyCommandObject co) {
        if(co.hasErrors()) {
            render 'something went wrong'
        } else {
            render 'items have been added'
        }
    }
}

class MyCommandObject {
    Integer numberOfItems

    static constraints = {
        numberOfItems range: 1..10
    }
}
```

```
// test/unit/com/demo/PersonSpec.groovy
package com.demo

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(Person)
class PersonSpec extends Specification {

    void "Test that name must begin with an upper case letter"() {
        when: 'the name begins with a lower letter'
            def p = new Person(name: 'jeff')

        then: 'validation should fail'
            !p.validate()

        when: 'the name begins with an upper case letter'
            p = new Person(name: 'Jeff')

        then: 'validation should pass'
            p.validate()
    }
}
```

```
// test/unit/com/demo/DemoControllerSpec.groovy
package com.demo

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(DemoController)
class DemoControllerSpec extends Specification {

    void 'Test an invalid number of items'() {
        when:
            params.numberOfItems = 42
            controller.addItem()

        then:
            response.text == 'something went wrong'
    }

    void 'Test a valid number of items'() {
        when:
            params.numberOfItems = 8
            controller.addItem()

        then:
            response.text == 'items have been added'
    }
}
```

```

// test/unit/com/demo/MyValidateableSpec.groovy
package com.demo

import grails.test.mixin.TestMixin
import grails.test.mixin.support.GrailsUnitTestMixin
import spock.lang.Specification

@TestMixin(GrailsUnitTestMixin)
class MyValidateableSpec extends Specification {

void 'Test validate can be invoked in a unit test with no special configuration'(
    when: 'an object is valid'
    def validateable = new MyValidateable(name: 'Kirk', age: 47)

then: 'validate() returns true and there are no errors'
    validateable.validate()
    !validateable.hasErrors()
    validateable.errors.errorCount == 0

when: 'an object is invalid'
    validateable.name = 'kirk'

then: 'validate() returns false and the appropriate error is created'
    !validateable.validate()
    validateable.hasErrors()
    validateable.errors.errorCount == 1
    validateable.errors['name'].code == 'matches.invalid'

when: 'the clearErrors() is called'
    validateable.clearErrors()

then: 'the errors are gone'
    !validateable.hasErrors()
    validateable.errors.errorCount == 0

when: 'the object is put back in a valid state'
    validateable.name = 'Kirk'

then: 'validate() returns true and there are no errors'
    validateable.validate()
    !validateable.hasErrors()
    validateable.errors.errorCount == 0
    }
}

```

```

// test/unit/com/demo/MyCommandObjectSpec.groovy
package com.demo

import grails.test.mixin.TestMixin
import grails.test.mixin.support.GrailsUnitTestMixin
import spock.lang.Specification

@TestMixin(GrailsUnitTestMixin)
class MyCommandObjectSpec extends Specification {

void 'Test that numberOfItems must be between 1 and 10'() {
    when: 'numberOfItems is less than 1'
        def co = new MyCommandObject()
        co.numberOfItems = 0

    then: 'validation fails'
        !co.validate()
        co.hasErrors()
        co.errors['numberOfItems'].code == 'range.toosmall'

    when: 'numberOfItems is greater than 10'
        co.numberOfItems = 11

    then: 'validation fails'
        !co.validate()
        co.hasErrors()
        co.errors['numberOfItems'].code == 'range.toobig'

    when: 'numberOfItems is greater than 1'
        co.numberOfItems = 1

    then: 'validation succeeds'
        co.validate()
        !co.hasErrors()

    when: 'numberOfItems is greater than 10'
        co.numberOfItems = 10

    then: 'validation succeeds'
        co.validate()
        !co.hasErrors()
    }
}

```

For validateable classes which are not one of the first 3 types listed above but are `grails.validateable.classes` property in `Config.groovy`, one additional step is required. `GrailsUnitTestMixin` provides a method named `mockForConstraintsTests` that will mock these classes. See the example below.



```
// src/groovy/com/demo/Book.groovy
package com.demo

class Book {
    String title
    String author

    static constraints = {
        author minSize: 5
    }
}
```

```
// grails-app/conf/Config.groovy
grails.validateable.classes = [com.demo.Book]

// ...
```

```
// test/unit/com/demo/BookSpec.groovy
package com.demo

import grails.test.mixin.TestMixin
import grails.test.mixin.support.GrailsUnitTestMixin
import spock.lang.Specification

@TestMixin(GrailsUnitTestMixin)
class BookSpec extends Specification {

    void 'Test validation'() {
        given:
            mockForConstraintsTests Book

        when: 'the author name has only 4 characters'
            def book = new Book()
            book.author = 'Jeff'

        then: 'validation should fail'
            !book.validate()
            book.hasErrors()
            book.errors['author'] == 'minSize'

        when: 'the author name has 5 characters'
            book.author = 'Jacob'

        then: 'validation should pass'
            book.validate()
            !book.hasErrors()
    }
}
```

Note that the `mockForConstraintsTests` method changes the behavior of the errors object so `book.errors['author']` will evaluate to the name of the failed constraint, `org.springframework.validation.FieldError` object. This is convenient for unit tests. If you want a reference to the `org.springframework.validation.FieldError` object `book.errors.getFieldError('author')`.

That's it for testing constraints. One final thing we would like to say is that testing the constraints in this error: typos in the "constraints" property name which is a mistake that is easy to make and equally easy to fix. Your constraints will highlight the problem straight away.

## HibernateTestMixin Basics

`HibernateTestMixin` allows Hibernate 4 to be used in Grails unit tests. It uses a H2 in-memory database.

```
import grails.test.mixin.TestMixin
import grails.test.mixin.gorm.Domain
import grails.test.mixin.hibernate.HibernateTestMixin
import spock.lang.Specification

@Domain(Person)
@TestMixin(HibernateTestMixin)
class PersonSpec extends Specification {

    void "Test count people"() {
        expect: "Test execute Hibernate count query"
        Person.count() == 0
        sessionFactory != null
        transactionManager != null
        session != null
    }
}
```

This library dependency is required in `grails-app/conf/BuildConfig.groovy` for adding support for Hibernate.

```
dependencies {
    test 'org.grails:grails-datastore-test-support:1.0-grails-2.4'
}
```

`HibernateTestMixin` is only supported with `hibernate4` plugin versions `>= 4.3.5.4`.

```
plugins {
    runtime ':hibernate4:4.3.5.4'
}
```

## Configuring domain classes for HibernateTestMixin tests

The `grails.test.mixin.gorm.Domain` annotation is used to configure the list of domain classes that the `SessionFactory` instance that gets configured when the unit test runtime is initialized.

Domain annotations will be collected from several locations:

- the annotations on the test class
- the package annotations in the `package-info.java/package-info.groovy` file in the package of the test class
- each super class of the test class and their respective package annotations
- the possible [SharedRuntime](#) class

Domain annotations can be shared by adding them as package annotations to `package-info.java/package-info.groovy` or by adding them to a [SharedRuntime](#) class which has been added for the test.

It's not possible to use `DomainClassUnitTestMixin`'s `Mock` annotation in `HibernateTestMixin` tests. Use the `Mock` annotation in `HibernateTestMixin` tests.

### 14.1.4 Unit Testing Filters

Unit testing filters is typically a matter of testing a controller where a filter is a mock collaborator. The following filters class:

```
class CancellingFilters {
    def filters = {
        all(controller:"simple", action:"list") {
            before = {
                redirect(controller:"book")
                return false
            }
        }
    }
}
```

This filter intercepts the `list` action of the `simple` controller and redirects to the `book` controller. To test this, write a test that targets the `SimpleController` class and add the `CancellingFilters` as a mock.

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
@Mock(CancellingFilters)
class SimpleControllerSpec extends Specification {

    // ...

}
```

You can then implement a test that uses the `withFilters` method to wrap the call to an action in filter e

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
@Mock(CancellingFilters)
class SimpleControllerSpec extends Specification {

    void "test list action is filtered"() {
        when:
            withFilters(action:"list") {
                controller.list()
            }

        then:
            response.redirectedUrl == '/book'
    }
}
```

Note that the `action` parameter is required because it is unknown what the action to invoke is until the The controller parameter is optional and taken from the controller under test. If it is another controller can specify it:

```
withFilters(controller:"book",action:"list") {
    controller.list()
}
```

## 14.1.5 Unit Testing URL Mappings


### The Basics

Testing URL mappings can be done with the `TestFor` annotation testing a particular URL mappings class. For default URL mappings you can do the following:

```
import com.demo.SimpleController
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(UrlMappings)
@Mock(SimpleController)
class UrlMappingsSpec extends Specification {
    // ...
}
```

As you can see, any controller that is the target of a URL mapping that you're testing *must* be added to the

 Note that since the default `UrlMappings` class is in the default package your test must also be in the default package

With that done there are a number of useful methods that are available in `grails.test.mixin.web.UrlMappingsUnitTestMixin` for testing URL mappings. These include:

- `assertForwardUrlMapping` - Asserts a URL mapping is forwarded for the given controller (a mock of `SimpleController` will need to be defined as a mock collaborator for this to work)
- `assertReverseUrlMapping` - Asserts that the given URL is produced when reverse mapping a controller and action
- `assertUrlMapping` - Asserts a URL mapping is valid for the given URL. This method uses `assertForwardUrlMapping` and `assertReverseUrlMapping` assertions

## Asserting Forward URL Mappings

You use `assertForwardUrlMapping` to assert that a given URL maps to a given controller. For the following URL mappings:

```
static mappings = {
    "/actionOne"(controller: "simple", action: "action1")
    "/actionTwo"(controller: "simple", action: "action2")
}
```

The following test can be written to assert these URL mappings:

```

import com.demo.SimpleController
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(UrlMappings)
@Mock(SimpleController)
class UrlMappingsSpec extends Specification {

    void "test forward mappings"() {
        expect:
        assertForwardUrlMapping("/actionOne", controller: 'simple', action: "acti
        assertForwardUrlMapping("/actionTwo", controller: 'simple', action: "acti
    }
}

```

## Assert Reverse URL Mappings

You use `assertReverseUrlMapping` to check that correct links are produced for your URL mapping tag in GSP views. An example test is largely identical to the previous listing except you use `assertReverseUrlMapping` instead of `assertForwardUrlMapping`. Note that you can combine these 2 assertions with `assertUrlMapping`.

### 14.1.6 Mocking Collaborators

The Spock Framework manual has a chapter on [Interaction Based Testing](#) which also explains mocking collaborators.

### 14.1.7 Mocking Codecs

The `GrailsUnitTestMixin` provides a `mockCodec` method for mocking [custom codecs](#) which may be used during a unit test is running.

```
mockCodec(MyCustomCodec)
```

Failing to mock a codec which is invoked while a unit test is running may result in a `MissingMethodException`.

### 14.1.8 Unit Test Metaprogramming

If runtime metaprogramming needs to be done in a unit test it needs to be done early in the process environment is fully initialized. This should be done when the unit test class is being initialized. For a Spock test this should be done in the `setUpSpec()` method. For a JUnit test this should be done in a method marked with `@Before`.

```

package myapp

import grails.test.mixin.*
import spock.lang.Specification

@TestFor(SomeController)
class SomeControllerSpec extends Specification {

    def setupSpec() {
        SomeClass.metaClass.someMethod = { ->
            // do something here
        }
    }

    // ...
}

```

```

package myapp

import grails.test.mixin.*
import org.junit.*

@TestFor(SomeController)
class SomeControllerTests {

    @BeforeClass
    static void metaProgramController() {
        SomeClass.metaClass.someMethod = { ->
            // do something here
        }
    }

    // ...
}

```

## 14.2 Integration Testing

Integration tests differ from unit tests in that you have full access to the Grails environment within in-memory H2 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 log4j. You can have something 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 example above is an instance of `java.util.logging.Logger` (inherited from the base class, not injected), which doesn't have the same methods as the `log` property injected into your application artifacts. For example, it doesn't have `info()` or `trace()` methods, and the equivalent of `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 test. Any data saved during a test is not persisted to the database. Add a `transactional` property to your test class to change this behaviour:

```
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` method, to avoid interfering with 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](#), and [MockMvc](#), which you can use in 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 to obtain content as a string (when writing to the response) or the redirected URL. These mocked versions are completely mutable (unlike the real versions) and hence you can set properties on the response such as the status code.

Grails **does not** invoke [interceptors](#) or servlet filters when calling actions during integration testing. You can use [interceptors](#) and filters in 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 fixture. 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 command when you call 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 command request parameters. During controller testing, the params are mutable with a mocked request supplied by

## 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 below:

```
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 instead the `modelAndView` property of the controller. The `modelAndView` property is an instance of Spring `ModelAndView` and you can use it to test the 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 example 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 = "application/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. It is implicit within the name of the <book> node, but this property is required as part of the JS

For more information on the subject of REST web services see the section on [REST](#).

## Testing Tag Libraries

Testing tag libraries is simple because when a tag is invoked as a method it returns its result as `StreamCharBuffer` but this class implements all of the methods of `String`). So for example if you h

```
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, representing the body as a `String`.

## Testing Tag Libraries with `GroovyPagesTestCase`

In addition to doing simple testing of tag libraries like in the above examples, you can use the `grails.test.GroovyPagesTestCase` class to test tag libraries with integration tests.

The `GroovyPagesTestCase` class is a subclass of the standard `GroovyTestCase` class and adds support for testing the output of 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
        assertEquals('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 things to be aware of when testing queries you often need to "flush" to ensure the correct state has been persisted to the database. The following example:

```
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 Hibernate that at some point in the future these instances should be persisted. To commit changes immediately

```
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 and will be available to the query later on.

## 14.3 Functional Testing

Functional tests involve making HTTP requests against the running application and verifying the results. The functional testing phase differs from the integration phase in that the Grails application is now listening for HTTP requests. This is useful for end-to-end testing scenarios, such as making REST calls against a JSON API.

Grails does not ship with any support for writing functional tests directly, but there are several plugins available:

- 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 all.

## 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 application is in a production-like state, but it has a longer startup time than the `-inline` option. It also JVM, meaning that you cannot 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 requests. ] the `-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 : base url but still test against the local Grails application you **must** specify one of either the `-inline` or `-`

## 15 Internationalization

Grails supports Internationalization (i18n) out of the box by leveraging the underlying Spring MVC infrastructure. With Grails you are able to customize the text that appears in a view based on the user's Locale. To query the [Locale](#) class:

*A Locale object represents a specific geographical, political, or cultural region. An operation that requires localization to perform its task is called locale-sensitive and uses the Locale to tailor information for the user. For example, displaying a number is a locale-sensitive operation--the number should be formatted according to the customs/conventions of the user's native country, 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 English and "en\_GB" is the code for British English.

### 15.1 Understanding Message Bundles

Now that you have an idea of locales, to use them in Grails you create message bundle files containing the messages you wish to render. Message bundles in Grails are located inside the `grails-app/i18n` directory and are named `messages_<locale>.properties` files.

Each bundle starts with the name `messages` by convention and ends with the locale. Grails ships with message bundles for a whole 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 locale. You can create your own message bundle by simply creating a new properties file that ends with the locale you are interested in. For example, `messages_en_GB.properties` for British English.

### 15.2 Changing Locales

By default the user locale is detected from the incoming `Accept-Language` header. However, you can change the locale capability to switch 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 the same locale.

## 15.3 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 `my.localized.content` it will look up 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 g.:

```
def myTag = { attrs, body ->
  def msg = g.message(code: "my.localized.content", args: ['Juan', 'lunes'])
}
```

## 15.4 Scaffolding and i18n

Grails [scaffolding](#) templates for controllers and views are fully i18n-aware. The GSPs use the [message](#) tag and controller flash messages use i18n to resolve locale-specific messages.

The scaffolding includes locale specific labels for domain classes and domain fields. For example, if you have a class with a title field:

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

The scaffolding will use labels with the following keys:

```
book.label = Libro
book.title.label = Título del libro
```

You can use this property pattern if you'd like or come up with one of your own. There is nothing special about the label as part of the key other than it's the convention used by the scaffolding.

# 16 Security

Grails is no more or less secure than Java Servlets. However, Java servlets (and hence Grails) are extremely immune to common buffer overrun and malformed URL exploits due to the nature of the Java Virtual Machine code.

Web security problems typically occur due to developer naivety or mistakes, and there is a little Grails magic to help you avoid these mistakes and 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 injection.
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 to prevent code injection
4. Grails provides [codecs](#) to let you trivially escape data when rendered as HTML, JavaScript and URL strings to prevent attacks here.

## 16.1 Securing Against Attacks

### SQL injection

Hibernate, which is the technology underlying GORM domain classes, automatically escapes data when creating SQL queries. This is not an issue. However it is still possible to write bad dynamic HQL code that uses unchecked string concatenation. An example doing the following is vulnerable to HQL injection attacks:

```
def vulnerable() {
    def books = Book.find("from Book as b where b.title = '" + params.title + "'")
}
```

or the analogous 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 community of customers. 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 originated from not from another site. It is also important to ensure that all data values rendered into views are escaped correctly. When rendering to HTML or XHTML you must ensure that people cannot maliciously inject JavaScript or other code that is viewed by others.

Grails 2.3 and above include special support for automatically encoded data placed into GSP pages. See [Cross Site Scripting \(XSS\) prevention](#) for further information.

You must also avoid the use of request parameters or data fields for determining the next URL to redirect to. The `successURL` parameter for example to determine where to redirect a user to after a successful login, a login procedure using your own site, and then redirect the user back to their own site once logged in. Do not use JavaScript code to then exploit the logged-in account on the site.

## Cross-site request forgery

CSRF involves unauthorized commands being transmitted from a user that a website trusts. A typical example is a website 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 forms. See [Duplicate Form Submissions](#) for more information on how to use it. An additional measure would be to use cookies.

## 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 have a different behaviour, and 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 support [encodeAsURL](#) where appropriate. If you create your own tags that generate URLs you will need to be min

## Denial of service

Load balancers and other appliances are more likely to be useful here, but there are also issues relating to example where a link is created by an attacker to set the maximum value of a result set so that a query exceeds the limits of the server or slow the system down. The solution here is to always sanitize request parameter dynamic finders or other GORM query methods:

```
int limit = 100
def safeMax = Math.min(params.max?.toInteger() ?: limit, limit) // limit to 100 or less
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 elsewhere. In the case of GORM 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 before returning it to the user.

Not doing this is "security through obscurity" which is inevitably breached, just like having a default password on.

You must assume that every unprotected URL is publicly accessible one way or another.

## 16.2 Cross Site Scripting (XSS) Prevention

Cross Site Scripting (XSS) attacks are a common attack vector for web applications. They typically involve injecting Javascript code in a form such that when that code is displayed, the browser does something nasty. It could be as simple as an alert box, or it could be much worse. The solution is to escape all untrusted user input when it is used in HTML. For example,

```
<script>alert('Got ya!');</script>
```

will become

```
<script>alert('Got ya!');</script>
```

when rendered, nullifying the effects of the malicious input.

By default, Grails plays it safe and escapes all content in `${ }` expressions in GSPs. All the standard C default, escaping any relevant attribute values.

So what happens when you want to stop Grails from escaping some content? There are valid use cases for database and rendering it as-is, as long as that content is **trusted**. In such cases, you can tell Grails that the be rendered raw, i.e. without any escaping:

```
<section>${raw(page.content)}</section>
```

The `raw( )` method you see here is available from controllers, tag libraries and GSP pages.

### **XSS prevention is hard and requires a lot of developer attention**



Although Grails plays it safe by default, that is no guarantee that your application will be inv an XSS-style attack. Such an attack is less likely to succeed than would otherwise be th developers should always be conscious of potential attack vectors and attempt to uncover vul in the application during testing. It's also easy to switch to an unsafe default, thereby increas of a vulnerability being introduced.

There are more details about the XSS in [OWASP - XSS prevention rules](#) and [OWASP - Types of Cross XSS](#) are: [Stored XSS](#), [Reflected XSS](#) and [DOM based XSS](#). [DOM based XSS prevention](#) is coming more popularity of Javascript client side templating and Single Page Apps.

Grails codecs are mainly for preventing stored and reflected XSS type of attacks. Grails 2.4 includes HTM preventing some DOM based XSS attacks.

It's difficult to make a solution that works for everyone, and so Grails provides a lot of flexibility with r escaping works, allowing you to keep most of your application safe while switching off default escapir used for pages, tags, page fragments, and more.

## **Configuration**

It is recommended that you review the configuration of a newly created Grails application to garner a prevention works in Grails.

GSP features the ability to automatically HTML encode GSP expressions, and as of Grails 2.3 this is the d default configuration (found in `Config.groovy`) for a newly created Grails application can be seen belc



```

grails {
  views {
    gsp {
      encoding = 'UTF-8'
      htmlcodec = 'xml' // use xml escaping instead of HTML4 escaping
      codecs {
        expression = 'html' // escapes values inside ${}
        scriptlet = 'html' // escapes output from scriptlets in GSPs
        taglib = 'none' // escapes output from taglibs
        staticparts = 'none' // escapes output from static template p
      }
    }
    // escapes all not-encoded output at final stage of outputting
    // filteringCodecForContentType.'text/html' = 'html'
  }
}

```

GSP features several codecs that it uses when writing the page to the response. The codecs are configured and are described below:

- **expression** - The expression codec is used to encode any code found within `${..}` expression created application is html encoding.
- **scriptlet** - Used for output from GSP scriptlets (`<% %>`, `<%= %>` blocks). The default for new html encoding
- **taglib** - Used to encode output from GSP tag libraries. The default is none for new application responsibility of the tag author to define the encoding of a given tag and by specifying none G compatible with older tag libraries.
- **staticparts** - Used to encode the raw markup output by a GSP page. The default is none.

## Double Encoding Prevention

Versions of Grails prior to 2.3, included the ability to set the default codec to `html`, however enabling proved problematic when using existing plugins due to encoding being applied twice (once by the `html` codec plugin manually called `encodeAsHTML()`).

Grails 2.3 includes double encoding prevention so that when an expression is evaluated, it will not be encoded (Example `${foo.encodeAsHTML() }`).

## Raw Output

If you are 100% sure that the value you wish to present on the page has not been received from user input value to be encoded then you can use the `raw` method:

```
${raw(book.title)}
```

The 'raw' method is available in tag libraries, controllers and GSP pages.

## Per Plugin Encoding

Grails also features the ability to control the codecs used on a per plugin basis. For example if you have the `html` plugin installed, then placing the following configuration in your application's `Config.groovy` will disable encoding for the `html` plugin

```
foo.grails.views.gsp.codecs.expression = "none"
```

## Per Page Encoding

You can also control the various codecs used to render a GSP page on a per page basis, using a page directive

```
<%@page expressionCodec="none" %>
```

## Per Tag Library Encoding

Each tag library created has the opportunity to specify a default codec used to encode output from the `render` method using the `"defaultEncodeAs"` property:

```
static defaultEncodeAs = 'html'
```

Encoding can also be specified on a per tag basis using `"encodeAsForTags"`:

```
static encodeAsForTags = [tagName: 'raw']
```

## Context Sensitive Encoding Switching

Certain tags require certain encodings and Grails features the ability to enable a codec only a certain part of the "withCodec" method. Consider for example the "<g:javascript>" tag which allows you to embed JavaScript. This tag requires JavaScript encoding, not HTML coding for the execution of the body of the tag (but not the output):

```
out.println '<script type="text/javascript">'
    withCodec("JavaScript") {
        out << body()
    }
out.println()
out.println '</script>'
```

## Forced Encoding for Tags

If a tag specifies a default encoding that differs from your requirements you can force the encoding for a tag with the optional 'encodeAs' attribute:

```
<g:message code="foo.bar" encodeAs="JavaScript" />
```

## Default Encoding for All Output

The default configuration for new applications is fine for most use cases, and backwards compatible with existing applications. However, you can also make your application even more secure by configuring Grails to always encode the output of a response. This is done using the `filteringCodecForContentType` configuration in `Config.groovy`:

```
grails.views.gsp.filteringCodecForContentType.'text/html' = 'html'
```

Note that, if activated, the `staticparts` codec typically needs to be set to `raw` so that static markup is 1

```
codecs {
    expression = 'html' // escapes values inside ${}
    scriptlet = 'html' // escapes output from scriptlets in GSPs
    taglib = 'none' // escapes output from taglibs
    staticparts = 'raw' // escapes output from static template parts
}
```

## 16.3 Encoding and Decoding Objects

Grails supports the concept of dynamic encode/decode methods. A set of standard codecs are bundled and supports a simple 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 Grails application starts, the Grails 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 `Codec`. One of the standard codecs that ships with Grails is `HTMLCodec`.

If a codec contains an encode closure Grails will create a dynamic encode method and add that method to the class with a name representing the codec that defined the encode closure. For example, the `HTMLCodec` class contains an encode closure, so Grails attaches it with the name `encodeAsHTML`.

The `HTMLCodec` and `URLCodec` classes also define a decode closure, so Grails attaches those with the names `decodeHTML` and `decodeURL` respectively. Dynamic codec methods may be invoked from anywhere in a Grails application. Consider a case where a report contains a property called 'description' which may contain special characters. To be presented in an HTML document. One way to deal with that in a GSP is to encode the description property using the `encodeAsHTML` method as shown below:

```
${report.description.encodeAsHTML() }
```

Decoding is performed using `value.decodeHTML()` syntax.

### Encoder and Decoder interfaces for statically compiled code

A preferred way to use codecs is to use the `codecLookup` bean to get hold of `Encoder` and `Decoder` instances.

```
package org.codehaus.groovy.grails.support.encoding;

public interface CodecLookup {
    public Encoder lookupEncoder(String codecName);
    public Decoder lookupDecoder(String codecName);
}
```

example of using CodecLookup and Encoder interface

```
import org.codehaus.groovy.grails.support.encoding.CodecLookup

class CustomTagLib {
    CodecLookup codecLookup

    def myTag = { Map attrs, body ->
        out << codecLookup.lookupEncoder('HTML').encode(attrs.something)
    }
}
```

## Standard Codecs

### HTMLCodec

This codec performs HTML escaping and unescaping, so that values can be rendered safely in an HTML page without breaking HTML tags or damaging the page layout. For example, given a value "Don't you know that 2 > 1?" you can render this safely within an HTML page because the > will look like it closes a tag, which is especially bad if you use it as an attribute, such as the value attribute of 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 use double quotes on attribute values to avoid text with apostrophes affecting your page.

HTMLCodec defaults to HTML4 style escaping (legacy HTMLCodec implementation in Grails version 2.0) which escapes non-ascii characters.

You can use plain XML escaping instead of HTML4 escaping by setting this config property in Config.groovy:

```
grails.views.gsp.htmlcodec = 'xml'
```

## XMLCodec

This codec performs XML escaping and unescaping. It escapes & , < , > , " , ' , \ , @ , ` , non break separator (\u2028) and paragraph separator (\u2029).

## HTMLJSCodec

This codec performs HTML and JS encoding. It is used for preventing some DOM-XSS vulnerabilities. See [XSS Prevention Cheat Sheet](#) for guidelines of preventing DOM based XSS attacks.

## URLCodec

URL encoding is required when creating URLs in links or form actions, or any time data is used to create characters from getting into the URL and changing its meaning, for example "Apple & Blackberry" is no parameter in a GET 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 strings. Example of usage:

```
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 default system charset). 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 charset). Example of 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 default system charset). 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 system array). Example 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 default system lowercase 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 default system array). 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 custom codec is defined in the `grails-app/utils/` directory and the class name must end with `Codec`. The codec must implement an `encode` closure, a `static decode` closure or both. The closure must accept a single argument which is the value the dynamic method was invoked on. For 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() }
```

## 16.4 Authentication

Grails has no default mechanism for authentication as it is possible to implement authentication in many ways, however, easy to implement a simple authentication mechanism using either [interceptors](#) or [filters](#). This is the case but it's highly preferable to use an established security framework, for example by using the [Spring Security](#) plugin.

Filters let you apply authentication across all controllers or across a URI space. For example you can create a class called `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 session then 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"])
}
}

```

## 16.5 Security Plugins

If you need more advanced functionality beyond simple authentication such as authorization, roles etc. try using one of the available security plugins.

### 16.5.1 Spring Security

The Spring Security plugins are built on the [Spring Security](#) project which provides a flexible, extensible all sorts of authentication and authorization schemes. The plugins are modular so you can install just the features for your application. The Spring Security plugins are the official security plugins for Grails and are supported.

There is a [Core plugin](#) which supports form-based authentication, encrypted/salted passwords, HTTP Basic authentication. Secondary dependent plugins provide alternate functionality such as [OpenID authentication](#), [ACL support](#), [CAS](#), [LDAP authentication](#), [Kerberos authentication](#), and a plugin providing [user interface extensions](#) and

See the [Core plugin page](#) for basic information and the [user guide](#) for detailed information.

## 16.5.2 Shiro

[Shiro](#) is a Java POJO-oriented security framework that provides a default domain model that models permissions. With Shiro you extend a controller base class called `JsecAuthBase` in each controller you provide an `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](#).

## 17 Plugins

Grails is first and foremost a web application framework, but it is also a platform. By exposing a number of ways you can extend anything from the command line interface to the runtime configuration engine, Grails can be customized to meet any needs. To hook into 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 complex. Once you know how to build a Grails application, you'll know how to create a plugin for [sharing a data model](#) or some static content.

### 17.1 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-plugin example` will create a new plugin project called `example`.

Make sure the plugin name does not contain more than one capital in a row, or it won't work. Camel case is fine.

The structure of a Grails plugin is very nearly the same as a Grails application project's except that in the `src` directory you will find a plugin Groovy file called the "plugin descriptor".



The only plugins included in a new plugin project are Tomcat and Release. Hibernate is not included by default.

Being a regular Grails project has a number of benefits in that you can immediately test your plugin by running the application.

```
grails run-app
```



Plugin projects don't provide an `index.gsp` by default since most plugins don't need it. So, if you view the plugin running in a browser right after creating it, you will receive a page not found error. You can easily create a `grails-app/views/index.gsp` for your plugin if you'd like.

The plugin descriptor name ends with the convention `GrailsPlugin` and is found in the root of the plugin project.

```
class ExampleGrailsPlugin {
    def version = "0.1"

    ...
}
```

All plugins must have this class in the root of their directory structure. The plugin class defines the version metadata, and 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 or version range of Grails that the plugin supports. eg. "1.2 > \*" (inclusive)
- `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 Local Plugins

To make your plugin available for use in a Grails application run the `maven-install` command:

```
grails maven-install
```

This will install the plugin into your local Maven cache. Then to use the plugin within an application declare the plugin in your `grails-app/conf/BuildConfig.groovy` file:

```
compile "org.quartz-scheduler:quartz:0.1"
```

## Notes on excluded Artefacts

Although the [create-plugin](#) command creates certain files for you so that the plugin can be run as a Grails application, these files are not included when packaging a plugin. The following is a list of artefacts created, but not included:

- `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 (located in `grails-app/scripts`) which is executed when a plugin is installed, to provide such artefacts. In addition, although `UrlMappings.groovy` is not included, you are allowed to include a `UrlMappings` definition with a different name, such as `MyPluginUrlMappings.groovy`.

## Customizing the plugin contents

You can specify what to exclude in addition to the default excludes by adding elements to the `plugin.excludes` property (described below). In addition, there are two ways to configure the contents of the plugin ZIP or JAR.

One is to create an event handler for the `CreatePluginArchiveStart` event, which is fired after the plugin has been copied to the staging directory. By adding an event handler you can add, modify, or delete files as needed. For example, in `_Events.groovy` in the `scripts` directory, for example:

```
eventCreatePluginArchiveStart = { stagingDir ->
    // update staging directory contents here
}
```

You can customize the location of the staging directory with the `grails.project.plugin.stagingDir` property in `BuildConfig.groovy` or as a system property.

Note that there is also a `CreatePluginArchiveEnd` event which is fired after the ZIP or JAR is packed.

You can also do this work in a Closure in `BuildConfig.groovy` with the property `grails.plugin.resources`, analogous to the `grails.war.resources` property, e.g.

```
grails.plugin.resources = { stagingDir ->
    // update staging directory contents here
}
```

## Specifying Plugin Locations

An application can load plugins from anywhere on the file system, even if they have not been installed. Specify an (unpacked) 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 it.
- You have split an application into a set of plugins and an application, all in the same "super-project" directory.



The Artifactory repository for Grails now includes all the dependencies for published plugins. If you are using inline plugins that have dependencies, it is necessary to do a secondary resolve because dependencies might not be in the repository. Therefore, you should set `legacyResolve` in your `BuildConfig.groovy` if you are using inline plugins with dependencies.

## 17.2 Plugin Repositories

### Distributing Plugins in the Grails Central Plugin Repository

The preferred way to distribute plugin is to publish to the official Grails Central Plugin Repository. The command `grails list-plugins` is visible to the `list-plugins` command:

```
grails list-plugins
```

which lists all plugins that are in the central repository. Your plugin will also be available to the `plugin-info` command:

```
grails plugin-info [plugin-name]
```

which prints extra information about it, such as its description, who wrote, etc.



If you have created a Grails plugin and want it to be hosted in the central repository, see the instructions for getting an account on [this wiki page](#).

When you have access to the Grails Plugin repository, install the [Release Plugin](#) by declaring it as a 'build' dependency in your `grails-app/conf/BuildConfig.groovy` file:

```
grails.project.dependency.resolution = {
    ...
    plugins {
        build ':release:3.0.0'
    }
}
```

And execute the `publish-plugin` command to release your plugin:



```
grails publish-plugin
```

This will automatically publish the plugin to the central repository. If the command is successful, it will be on the plugin portal at <http://grails.org/plugin/<pluginName>>. You can find out more about the Release plugin in [its user guide](#).

## Configuring Additional Repositories

The process for configuring repositories in Grails differs between versions. For version of Grails 1.2 and earlier see [Grails 1.2 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 repositories is largely the same as [defining repositories for JAR dependencies](#). For example you can define a repository that contains Grails plugins using the following syntax in `grails-app/conf/BuildConfig.groovy`:

```
repositories {
    mavenRepo "http://repository.codehaus.org"
    // ...or with a name
    mavenRepo name: "myRepo",
              root: "http://myserver:8081/artifactory/plugins-snapshots-local"
}
```

You can also define a SVN-based Grails repository (such as the one hosted at <http://plugins.grails.org>) using the following method:

```
repositories {
    grailsRepo "http://myserver/mygrailsrepo"
    // ...or with a name
    grailsRepo "http://myserver/svn/grails-plugins", "mySvnRepo"
}
```

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 GrailsCentral repository will be searched last:

```
repositories {  
    grailsRepo "http://myserver/mygrailsrepo"  
    grailsCentral()  
}
```

## Publishing to Maven Compatible Repositories

In general it is recommended for Grails 1.3 and above to use standard Maven-style repositories to self host. Doing so includes the ability for existing tooling and repository managers to interpret the structure of a Maven repository.

You use the Release plugin to publish a plugin to a Maven repository. Please refer to the section of the guide on the subject.

## 17.3 Understanding a Plugin's Structure

As mentioned previously, a plugin is basically a regular Grails application with a plugin descriptor. However, the structure of a 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 go into `plugins/example-1.0/grails-app`. They **will not** be copied into the main source tree. A plugin's primary source tree.

Dealing with static resources is slightly different. When developing a plugin, just like an application, all static resources go into the `web-app` directory. You can then link to static resources just like in an application. This example links to

```
<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/example-0.1/js/mycode.js`. However, when the plugin is installed into an application the path will automatically change to `/plugin/example-0.1/js/mycode.js` and Grails will deal with making sure the resources are in the correct place.

There is a special `pluginContextPath` variable that can be used whilst both developing the plugin and when it is installed into 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/` depending on whether the 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` directories will be copied into the main project's `web-app/WEB-INF/classes` directory so that they are made available at runtime.

## 17.4 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 file is copied into the application tree where it is installed 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 excellent application through plugins. Grails' view resolution mechanism will first look for the view in the application, if that fails will attempt to look for the view within the plugin. This means that you can override views by creating corresponding GSPs in the application's `grails-app/views` directory.

For example, consider a controller called `BookController` that's provided by an 'amazon' plugin. If the `list` action is called, Grails will first look for a view called `grails-app/views/book/list.gsp` then if that fails, it will look for a view relative to the plugin.

However if the view uses templates that are also provided by the plugin then the following syntax may be used:

```
<g:render template="fooTemplate" plugin="amazon"/>
```

Note the usage of the `plugin` attribute, which contains the name of the plugin where the template resides. If not specified, then Grails will 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 recommended that you create a `scripts/_Install.groovy` Gant script to install these artefacts into the target project's directory tree.

In addition, the default `UrlMappings.groovy` file is excluded to avoid naming conflicts, however, your own `UrlMappings` definition under a different name which **will** be included. For example, `grails-app/conf/BlogUrlMappings.groovy` is 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 in the application.

## 17.5 Evaluating Conventions

Before looking at providing runtime configuration based on conventions you first need to understand the conventions from a plugin. Every plugin has an implicit `application` variable which is an instance of the `GrailsApplication` interface.

The `GrailsApplication` interface provides methods to evaluate the conventions within the project and return references to all artifact classes within your application.

Artifacts implement the [GrailsClass](#) interface, which represents a Grails resource such as a controller or a service. To get all `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. Here are some of the controllers you 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.controllerClasses`.
- `get*Class` - Retrieves a named class for a particular artefact. For example `application.getControllerClass("PersonController")`.
- `is*Class` - Returns true if the given class is of the given artefact type. For example `application.isControllerClass(PersonController)`.

The GrailsClass interface has a number of useful methods that let you further evaluate and work with classes. Here are some of the methods it includes:

- `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 part.
- `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 part.
- `getPropertyName` - Returns the name of the class as a property name.
- `getLogicalPropertyName` - Returns the logical property name of the class in the application convention part if applicable.
- `getNaturalName` - Returns the name of the property in natural terms (e.g. 'lastName' becomes 'Last Name').
- `getPackageName` - Returns the package name.

For a full reference refer to the [javadoc API](#).

## 17.6 Hooking into Build Events

### Post-Install Configuration and Participating in Upgrades

Grails plugins can do post-install configuration. This is achieved using a specially named script under the plugin - `_Install.groovy`.

`_Install.groovy` is executed after the plugin has been installed.

This script is a [Gant](#) script, so you can use the full power of Gant. An addition to the standard Gant `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-app` configuration template:

```
ant.mkdir(dir: "${basedir}/grails-app/jobs")
ant.copy(file: "${pluginBasedir}/src/samples/SamplePluginConfig.groovy",
        todir: "${basedir}/grails-app/conf")
```

The `pluginBasedir` variable is not available in custom scripts, but you can use `fooPluginDir`, within your plugin.

### Scripting events

It is also possible to hook into command line scripting events. These are events triggered during execution of plugin scripts.

For example, you can hook into status update output (i.e. "Tests passed", "Server running") and the creation of new resources.

A plugin just has to provide an `_Events.groovy` script to listen to the required events. Refer the [do into Events](#) for further information.

## 17.7 Hooking into Runtime Configuration

Grails provides a number of hooks to leverage the different parts of the system and perform runtime configuration.

### Hooking into the Grails Spring configuration

First, you can hook in Grails runtime configuration by providing a property called `doWithSpring` within your plugin. For 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. It uses the [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, they can participate in the generation of the file. A plugin can provide a `doWithWebDescriptor` property that gets passed the `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' servlet ability to 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 matter, so it's simplest to insert your custom filter definition immediately after the last `<context-param>` element. It's not important for mappings, but the usual approach is to add it immediately after the last `<filter>` element.

```
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 character encoding filter or the SiteMesh filter. Fortunately you can insert filter mappings immediately after the last filter mapping (or, more accurately, any that are in the template 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 to do some runtime configuration after the Spring [ApplicationContext](#) has been created. You can define a `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
  }
}

```

## 17.8 Adding Dynamic Methods at Runtime

### The Basics

Grails plugins let you register dynamic methods with any Grails-managed or other class at runtime. `doWithDynamicMethods` closure.

For Grails-managed classes like controllers, tag libraries and so forth you can add methods, constants using the [ExpandoMetaClass](#) mechanism by accessing each controller's [MetaClass](#):

```

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' `MetaClass` and add a new method called `myNewMethod` to each controller. If you know beforehand the class you wish to add the method to, you can simply reference its `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. To interact with objects within it. For example if you were implementing a method to interact with `HibernateSessionFactory` instance in 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 can in dynamic 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!

## 17.9 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. This is advanced reloading of application state at runtime. For example, consider this simplified sni ServicesPlugin:

```

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 resources to watch. If the watched resources specify a Groovy file, when it is changed it will automatically trigger the `onChange` 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 "Service" new service 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 the controllers, an error will occur 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 plugin is reloaded it will reload itself and then reload its influenced plugins. For example consider this snippet from the Services plugin:

```
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 resource it manages, you can use the "observe" property:

```
def observe = ["controllers"]
```

In this case when a controller is changed you will also receive the event chained from the controllers plugin.

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 change running.

## 17.10 Understanding Plugin Load Order

### Controlling Plugin Dependencies

Plugins often depend on the presence of other plugins and can adapt depending on the presence of others. They have two properties. The first is called `dependsOn`. For example, take a look at this snippet from the Hibernate plugin:

```
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`, `i18n`, and `core`.

The dependencies will be loaded before the Hibernate plugin and if all dependencies do not load, then the plugin will not load.

The `dependsOn` property also supports a mini expression language for specifying version ranges. A few examples can be seen 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 pre-release versions (e.g. -ALPHA etc.) 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 plugin load. It is possible though to have a weaker dependency using the `loadAfter` and `loadBefore` properties.

```
def loadAfter = ['controllers']
```

Here the plugin will be loaded after the `controllers` plugin if it exists, otherwise it will just be loaded. To adapt to the presence of the other plugin, for example the `Hibernate` plugin has this code in its `doWithSpring`:

```
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 `controllers` plugin is loaded. The `manager` variable is an instance of the [GrailsPluginManager](#) interface and it provides methods to check if other plugins are loaded.

You can also use the `loadBefore` property to specify one or more plugins that your plugin should load before.

```
def loadBefore = ['rabbitmq']
```

## Scopes and Environments

It's not only plugin load order that you can control. You can also specify which environments your plugin should run in, and which scopes (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 packaged because it's excluded from the 'war' phase. This allows development-only plugins to not be packaged

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.

## 17.11 The Artefact API



You should by now understand that Grails has the concept of artefacts: special types of classes that it knows differently from normal Groovy and Java classes, for example by enhancing them with extra properties and methods. Artefacts include domain classes and controllers. What you may not be aware of is that Grails allows developers access to the underlying infrastructure for artefacts, which means you can find out what artefact types are available and enhance them yourself. You can even provide your own custom artefact types.

### 17.11.1 Asking About Available Artefacts

As a plugin developer, it can be important for you to find out about what domain classes, controllers, or other artefacts are available in an application. For example, the [Searchable plugin](#) needs to know what domain classes exist and index the appropriate ones. So how does it do it? The `grailsApplication` object, and instance of [GrailsApplication](#) that's available automatically in controllers, can be [injected](#) everywhere else.

The `grailsApplication` object has several important properties and methods for querying artefacts. The most common is the one 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, they are instances of [GrailsClass](#) that has 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.simpleName`)
- `logicalPropertyName` - the artefact name in property form without the 'type' suffix. So `myGreatController` becomes 'myGreat'.
- `isAbstract()` - 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 an instance property. It's best if the 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`. The second method will check whether a class is a particular type of artefact. For example, `grailsApplication.isControllerClass(org.example.MyGreatController)` to check if `MyGreatController` is in fact a controller.

## 17.11.2 Adding Your Own Artefact Types

Plugins can easily provide their own artefacts so that they can easily find out what implementations are available at runtime. All you need to do is create an `ArtefactHandler` implementation and register it in your manifest.

```
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 [ArtefactHandler](#) interface. To make it a bit easier, 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 implements skeleton implementations are available such as [AbstractInjectableGrailsClass](#), which is particularly useful into a Spring bean that 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.

## 17.12 Binary Plugins

Regular Grails plugins are packaged as zip files containing the full source of the plugin. This has some being an open distribution system (anyone can see the source), in addition to avoiding problems with the source used for compilation.

As of Grails 2.0 you can pre-compile Grails plugins into regular JAR files known as "binary plugins". This (and some 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/f`. There are 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 it to a compatible Maven 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 `dependencies` block, *not* in the `plugins` block as you may be naturally inclined to do. The `plugins` block is used for declaring traditional source plugins packaged as zip files.

## 18 Grails and Spring

This section is for advanced users and those who are interested in how Grails integrates with and builds on Spring. It is also useful for [plugin developers](#) considering doing runtime configuration in Grails.

### 18.1 The Underpinnings of Grails

Grails is actually a [Spring MVC](#) application in disguise. Spring MVC is the Spring framework's built-in framework. Although Spring MVC suffers from some of the same difficulties as frameworks like Struts in the past, it is superbly designed and architected and was, for Grails, the perfect framework to build another framework.

Grails leverages Spring MVC in the following areas:

- Basic controller logic - Grails subclasses Spring's [DispatcherServlet](#) and uses it to delegate to Grails controllers.
- Data Binding and Validation - Grails' [validation](#) and [data binding](#) capabilities are built on those provided by Spring.
- Runtime configuration - Grails' entire runtime convention based system is wired together by a Spring [ApplicationContext](#).
- 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 constructed and how it is configured. The details are as follows.

- Grails constructs a parent `ApplicationContext` from the `web-app/WEB-INF/applicationContext.xml`. This `ApplicationContext` configures the [GrailsApplication](#) instance and the [GrailsPluginManager](#).
- Using this `ApplicationContext` as a parent Grails' analyses the conventions with the `GrailsConvention` and constructs a child `ApplicationContext` that is used as the root `ApplicationContext` of the application.

#### Configured Spring Beans

Most of Grails' configuration happens at runtime. Each [plugin](#) may configure Spring beans that are registered in the `ApplicationContext`. For a reference as to which beans are configured, refer to the reference guide for the Grails plugins and which beans they configure.

### 18.2 Configuring Additional Beans

#### Using the Spring Bean DSL

You can easily register new (or override existing) beans by configuring `grails-app/conf/spring/resources.groovy` which uses the Grails [Spring DSL](#). Beans are registered using the `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 dependency injection (e.g. `Bootstrap.groovy` and integration tests) by declaring a public field whose name is your bean's name (e.g. `myBean`):

```
class ExampleController {  
    def myBean  
    ...  
}
```

Using the DSL has the advantage that you can mix bean declarations and logic, for example based on the [environment](#):

```

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 used for configuration (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 registered by Grails or an installed plugin, your bean will replace the previous registration. This is a convenient way to customize behavior without resorting to editing plugin code or other approaches that would reduce maintainability.

## Using XML

Beans can also be configured using a `grails-app/conf/spring/resources.xml`. In earlier versions it was automatically generated for you by the `run-app` script, but the DSL in `resources.groovy` is the reason so it isn'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 configure beans.

The `myBean` bean that we configured using the DSL would be configured with this syntax in the XML file:

```
<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 convention. For example, if you have a `BookService` class its Spring bean name would be `bookService`, so your bean would reference it like this:

```
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 this:

```
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 referent must exist yet. As long as it's in place when the final application context configuration occurs, everything will be fine.

For a full reference of the available beans see the plugin reference in the reference guide.

## 18.3 Runtime Spring with the Beans DSL

This Bean builder in Grails aims to provide a simplified way of wiring together dependencies that uses Spring.

In addition, Spring's regular way of configuration (via XML and annotations) is static and difficult to change at runtime, other than programmatic XML creation which is both error prone and verbose. Grails' [BeanBuilder](#) DSL makes it possible to programmatically wire together components at runtime, allowing you to adapt the configuration to different properties or environment variables.

This enables the code to adapt to its environment and avoids unnecessary duplication of code (having different code for test, development and production environments).

### The BeanBuilder class

Grails provides a [grails.spring.BeanBuilder](#) class that uses dynamic Groovy to construct bean definitions. [1]

```
import org.apache.commons.dbcp.BasicDataSource
import org.codehaus.groovy.grails.orm.hibernate.ConfigurableLocalSessionFactoryBean
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 create an instance of `BeanBuilder`. Instead the DSL is implicitly available inside the `doWithSpring` and `beans` blocks respectively.

This example shows how you would configure Hibernate with a data source with the `BeanBuilder` class.

Each method call (in this case `dataSource` and `sessionFactory` calls) maps to the name of the bean. The last argument to the method is a block. Within the body of the block you can refer to the bean using standard Groovy syntax.

Bean references are resolved automatically using the name of the bean. This can be seen in the example where 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 following:

```
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 Grails application. Then add the 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 syntax defined here. For 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` and loads their bean definitions. An example script can be seen below:

```
import org.apache.commons.dbcp.BasicDataSource
import org.codehaus.groovy.grails.orm.hibernate.ConfigurableLocalSessionFactoryBean

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.

## 18.4 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 c and invoke 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 instance of these factories. In this case the bean has no Class argument and instead you must pass the name of the defining method:

```
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. This can named 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 `myBean`.

## 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 string to define a bean 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. The value could also be a constant, but would work just as well with a name that is generated programmatically based on configuration.

Furthermore, because sometimes bean names are not known until runtime you may need to reference other 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`. The `ref` method is used to refer to beans from a parent `ApplicationContext` that is provided in the constructor of the `BeanBuilder`.

```
ApplicationContext parent = ...//
def 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 that creates an inner bean.

```
bb.beans {
  marge(Person) {
    name = "Marge"
    husband = { Person p ->
      name = "Homer"
      age = 45
      props = [overweight: true, height: "1.8m"]
    }
    children = [ref('bart'), ref('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 `r`. If you have a factory bean you can omit the type and just use the specified bean definition instead to setup the



```

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 = [ref('bart'), ref('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 parent of 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 other properties on the 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 argument. Later we define 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 use `BeanBuilder` 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 attribute:

```
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. With Spring namespaces you also get full access to all of the powerful AOP support in Spring from `BeanBuilder` given these two classes:

```
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)"
    }
  }
}

```

## 18.5 Property Placeholder Configuration

Grails supports the notion of property placeholder configuration through an extended [PropertyPlaceholderConfigurer](#), which is typically useful in combination with [externalized configuration](#).

Settings defined in either [ConfigSlurper](#) scripts or Java properties files can be used as placeholder values in `grails-app/conf/spring/resources.xml` and `grails-app/conf/spring/resources.groovy`, for example given the following entries in `grails-app/conf/Config.groovy` (or an externalized configuration file):

```

database.driver="com.mysql.jdbc.Driver"
database.dbname="mysql:mysqldb"

```

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>
```

To specify placeholders in `resources.groovy` you need to use single quotes:

```
dataSource(org.springframework.jdbc.datasource.DriverManagerDataSource) {
  driverClassName = '${database.driver}'
  url = 'jdbc:${database.dbname}'
}
```

This sets the property value to a literal string which is later resolved against the config by Spring's PropertyPlaceholderConfigurer. A better option for `resources.groovy` is to access properties through the `grailsApplication` variable.

```
dataSource(org.springframework.jdbc.datasource.DriverManagerDataSource) {
  driverClassName = grailsApplication.config.database.driver
  url = "jdbc:${grailsApplication.config.database.dbname}"
}
```

Using this approach will keep the types as defined in your config.

## 18.6 Property Override Configuration

Grails supports setting of bean properties via [configuration](#). This is often useful when used in combination with [configuration](#).

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
```

## 19 Grails and Hibernate

If [GORM](#) (Grails Object Relational Mapping) is not flexible enough for your liking you can alternatively use Hibernate, either with XML mapping files or JPA annotations. You will be able to map Grails domain objects to a range of legacy systems and have more flexibility in the creation of your database schema. Best of all, you can use all of the dynamic persistent and query methods provided by GORM!

### 19.1 Using Hibernate XML Mapping Files

Mapping your domain classes with XML is pretty straightforward. Simply create a `hibernate.cfg.xml` in the `grails-app/conf/hibernate` directory, either manually or with the [create-hibernate-cfg-xml](#) command as follows:

```
<?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, should be placed in the `grails-app/conf/hibernate` directory. To find out how to map domain classes with XML, check out the [Hibernate documentation](#).

If the default location of the `hibernate.cfg.xml` file doesn't suit you, you can change it by specifying the `hibernate.config.location` property in `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 place the mapping files into `grails-app/conf/hibernate` and either put the Java files in `src/java` project's `lib` directory if the domain model is packaged as a JAR. You still need the `hibernate.cfg.xml`.

## 19.2 Mapping with Hibernate Annotations

To map a domain class with annotations, create a new class in `src/java` and use the annotations defined in the [Hibernate Annotations Docs](#):

```
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 relevant `grails-app/conf/hibernate/hibernate.cfg.xml` file as follows:

```
<!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 can do with the domain class see the section on [Scaffolding](#).

## 19.3 Adding Constraints

You can still use GORM validation even if you use a Java domain model. Grails lets you define constraints in the `src/java` directory. The script must be in a directory that matches the package of the corresponding domain class. The script name must have a *Constraints* suffix. For example, if you had a domain class `org.example.Book`, the script would be `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!

## 20 Scaffolding

Scaffolding lets you generate some basic CRUD interfaces for a domain class, including:

- The necessary [views](#)
- Controller actions for create/read/update/delete (CRUD) operations

As of Grails 2.3, the scaffolding feature has been moved to a plugin. By default this is configured in applications, but if you are upgrading from a previous version of Grails you will need to add the following `BuildConfig.groovy` file:

```
plugins {  
    ...  
    compile ":%scaffolding:2.0.0"  
    ...  
}
```

Version 1.0.0 of the plugin provides the same scaffolding seen in Grails 2.2.x and below. Version 2.0.x includes different scaffolding templates that are aligned with the new REST APIs introduced in Grails 2.3.

### Dynamic Scaffolding

The simplest way to get started with scaffolding is to enable it with the `scaffold` property. Set the `scaffold` property to `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 class. For a different domain class 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 at actions are dynamically implemented by default by the runtime scaffolding mechanism:

- index
- show
- edit
- delete
- create
- save
- update

A CRUD interface will also be generated. To access this open `http://localhost:8080/app/book`

If you prefer to keep your domain model in Java and [mapped with Hibernate](#) you can still use scaffold domain class and set 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 index() {
    [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 'row' attributes will have no effect.

Also, the standard scaffold views expect model variables of the `<propertyName>InstanceList` for collections and `<propertyName>Instance` instances. It's tempting to use properties like 'books' and '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 re-ordering the 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 view

```
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 customize. Grails lets you generate a controller and the views used to create the above interface from the command line:

```
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 include the package name:

```
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 the [install-templates](#) command.

## 21 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 development phase. An embedded Tomcat server is launched that loads the web application from the disk, allowing it to pick up any changes to application files.

This approach is not recommended at all for production deployment because the performance is poor. Cold-starts place a sizable overhead on the server. Having said that, `grails prod run-app` removes the overhead and lets you fine tune how frequently the regular check takes place.

Setting the system property "disable.auto.recompile" to `true` disables this regular check completely. "recompile.frequency" controls the frequency. This latter property should be set to the number of seconds between checks. The default is currently 3.

### "grails run-war"

This is very similar to the previous option, but Tomcat runs against the packaged WAR file rather than the application files. Hot-reloading is disabled, so you get good performance without the hassle of having to deploy the WAR file.

## WAR file

When it comes down to it, current Java infrastructures almost mandate that web applications are deployed as WAR files. This is by far the most common approach to Grails application deployment in production. Creating a WAR file is done with the [war](#) command:

```
grails war
```

There are also many ways in which you can customise the WAR file that is created. For example, you can specify an absolute or relative path 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 default filename:

```
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 in the `lib` directory. The default behavior is to include in the WAR file all libraries required by Grails, plus any libraries in the `lib` directories, plus any libraries contained in the application's `lib` directory. As an alternative to the default, you can explicitly specify the complete list of libraries to include in the WAR file by setting the property `grails.war.dependencies` in `BuildConfig.groovy` to either a list of Ant include patterns or closures containing AntBuilder syntax. Closures are only used within an Ant `"copy"` step, so only elements like `"fileset"` can be included, whereas each item in a pattern list or closure assigned to the latter property will be included in addition to `grails.war.dependencies`.

Be careful with these properties: if any of the libraries Grails depends on are missing, the application will fail. Here is an 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 your application, it will probably not work. You can find a list of dependencies required by Grails in the `dependencies` directory of the unpacked distribution. You can also find a list of the default dependencies included in the `War.groovy` script - see the `DEFAULT_DEPS` and `DEFAULT_J5_DEPS` variables.

The remaining two configuration options available to you are `grails.war.copyToWebApp` and `grails.war.preProcessResources`. The first of these lets you customise what files are included in the WAR file from the `"web-app"` directory, and the second lets you perform any extra processing you 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 anywhere. However, things are rarely ever this simple. The [Grails website](#) contains a list of application servers tested with, along with any additional steps required to get a Grails WAR file working.

## 22 Contributing to Grails

Grails is an open source project with an active community and we rely heavily on that community to help. As such, there are various ways in which people can contribute to Grails. One of these is by [writing useful](#) publicly available. In this chapter, we'll look at some of the other options.

### 22.1 Report Issues in JIRA

Grails uses [JIRA](#) to track issues in the core framework, its documentation, its website, and many of the plugins. If you find a bug or wish to see a particular feature added, this is the place to start. You'll need to create a (free) JIRA account. You can either submit an issue or comment on an existing one.

When submitting issues, please provide as much information as possible and in the case of bugs, make sure you specify the versions of Grails and various plugins you are using. Also, an issue is much more likely to be dealt with if you provide a sample application (which can be packaged up using the `grails bug-report` command).

### Reviewing issues

There are quite a few old issues in JIRA, some of which may no longer be valid. The core team can't track every issue. A very simple contribution that you can make is to verify one or two issues occasionally.

Which issues need verification? A shared [JIRA filter](#) will display all issues that haven't been resolved and are older than 6 months. Just pick one or two of them and check whether they are still relevant.

Once you've verified an issue, simply edit it and set the "Last Reviewed" field to today. If you think the issue is no longer relevant, also check the "Flagged" field and add a short comment explaining why. Once those changes are saved, they will appear in the results of the above filter. If you've flagged it, the core team will review and close it if it really is no longer relevant.

One last thing: you can easily set the above filter as a favourite on [this JIRA screen](#) so that it appears in your favourites. Just click on the star next to a filter to make it a favourite.

### 22.2 Build From Source and Run Tests

If you're interested in contributing fixes and features to the core framework, you will have to learn how to build from source, build it and test it with your own applications. Before you start, make sure you have:

- A JDK (1.6 or above)
- A git client

Once you have all the pre-requisite packages installed, the next step is to download the Grails source code from [GitHub](#) in several repositories owned by the ["grails" GitHub user](#). This is a simple case of cloning the repositories. For example, to get the core framework run:

```
git clone http://github.com/grails/grails-core.git
```

This will create a "grails-core" directory in your current working directory containing all the project source code. You can then get a Grails installation from the source.

## Creating a Grails installation

If you look at the project structure, you'll see that it doesn't look much like a standard `GRAILS_HOME` installation. It's, however, simple to turn it into one. Just run this from the root directory of the project:

```
./gradlew install
```

This will fetch all the standard dependencies required by Grails and then build a `GRAILS_HOME` installation. It skips the extensive collection of Grails test classes, which can take some time to complete.

Once the above command has finished, simply set the `GRAILS_HOME` environment variable to the check "bin" directory to your path. When you next type run the `grails` command, you'll be using the version you

## Running the test suite

All you have to do to run the full suite of tests is:

```
./gradlew test
```

These will take a while (15-30 mins), so consider running individual tests using the command line. For example, to run `BinaryPluginSpec` simply execute the following command:

```
./gradlew :grails-core:test --tests *.BinaryPluginSpec
```

Note that you need to specify the sub-project that the test case resides in, because the top-level "test" target

## Developing in IntelliJ IDEA

You need to run the following gradle task:

```
./gradlew idea
```

Then open the project file which is generated in IDEA. Simple!

## Developing in STS / Eclipse

You need to run the following gradle task:

```
./gradlew cleanEclipse eclipse
```

Before importing projects to STS do the following action:

- Edit grails-scripts/.classpath and remove the line "<classpathentry kind="src" path="../scripts"/>".

Use "Import->General->Existing Projects into Workspace" to import all projects to STS. There will be a warning, click "Yes" and then do the following:

- Add the springloaded-core JAR file in \$GRAILS\_HOME/lib/org.springframework.springsloaded/springloaded-core's classpath.
- Remove "src/test/groovy" from grails-plugin-testing's source path GRECLIPSE-1067
- Add the jsp-api JAR file in \$GRAILS\_HOME/lib/javax.servlet.jsp/jsp-api/jars to the classpath of grails-core
- Fix the source path of grails-scripts. Add linked source folder linking to "../scripts". If you get build error, run the command `./gradlew cleanEclipse eclipse` in that directory and edit the .classpath file again (remove the line `<classpathentry kind="src" path="../scripts"/>`). Remove possible empty "scripts" directory under grails-scripts if you have a linked folder.
- Do a clean build for the whole workspace.
- To use Eclipse GIT scm team provider: Select all projects (except "Servers") in the navigation area, right-click and select "Share project" (not "Share projects"). Choose "Git". Then check "Use or create repository in parent folder location" and click "Finish".
- Get the recommended code style settings from the [mailing list thread](#) (final style not decided yet). Import the code style xml file to STS in Window->Preferences->Java->Code Style->Formatter->Import Defaults. Select "Spaces" instead of tabs for indenting.

## Debugging Grails or a Grails application

To enable debugging, run:

```
grails --debug-fork run-app
```

By default Grails forks a JVM to run the application in. The `--debug-fork` argument causes the debug the forked JVM. In order to instead attach the debugger to the build system which is going to fork the option:

```
grails -debug run-app
```

## 22.3 Submit Patches to Grails Core

If you want to submit patches to the project, you simply need to fork the repository on GitHub rather than you will commit your changes to your fork and send a pull request for a core team member to review.

### Forking and Pull Requests

One of the benefits of [GitHub](#) is the way that you can easily contribute to a project by [forking the repository](#) with your changes.

What follows are some guidelines to help ensure that your pull requests are speedily dealt with and processed. They will also make your life easier!

### Create a local branch for your changes

Your life will be greatly simplified if you create a local branch to make your changes on. For example, if you have a repository and clone the fork locally, execute

```
git checkout -b mine
```

This will create a new local branch called "mine" based off the "master" branch. Of course, you can name the branch like - you don't have to use "mine".

### Create JIRAs for non-trivial changes

For any non-trivial changes, raise a JIRA issue if one doesn't already exist. That helps us keep track of what's new in the new version of Grails.

## Include JIRA issue ID in commit messages

This may not seem particularly important, but having a JIRA issue ID in a commit message means that you can date why a change was made. Include the ID in any and all commits that relate to that issue. If a commit doesn't relate to an issue then there's no need to include an issue ID.

## Make sure your fork is up to date

Since the core developers must merge your commits into the main repository, it makes life much easier if you make sure your fork is up to date before you send a pull request.

Let's say you have the main repository set up as a remote called "upstream" and you want to submit a pull request. Your changes are currently on the local "mine" branch but not on "master". The first step involves pulling updates from the upstream repository that have been added since you last fetched and merged:

```
git checkout master
git pull upstream
```

This should complete without any problems or conflicts. Next, rebase your local branch against the now up-to-date master:

```
git checkout mine
git rebase master
```

What this does is rearrange the commits such that all of your changes come after the most recent one in master. It's like putting all your new cards to the top of a deck rather than shuffling them into the pack.

You'll now be able to do a clean merge from your local branch to master:

```
git checkout master
git merge mine
```

Finally, you must push your changes to your remote repository on GitHub, otherwise the core developers won't see them up:

```
git push
```

You're now ready to send the pull request from the GitHub user interface.

## Say what your pull request is for

A pull request can contain any number of commits and it may be related to any number of issues. In the pull request, please specify the IDs of all issues that the request relates to. Also give a brief description of the work you did. For example, "I refactored the data binder and added support for custom number editors (GRAILS-xxxx)".

## 22.4 Submit Patches to Grails Documentation

Contributing to the documentation is simpler for the core framework because there is a <http://github.com/grails/grails-doc> project that anyone can request commit access to. So, if you want to contribute to the documentation, simply request commit access to the following repository <http://github.com/pledbrook/grails-doc>. Send a GitHub message to 'pledbrook' and then commit your patches just as you would to any other GitHub repository.

## Building the Guide

To build the documentation, simply type:

```
./gradlew docs
```

Be warned: this command can take a while to complete and you should probably increase your Gradle memory with the `GRADLE_OPTS` environment variable a value like

```
export GRADLE_OPTS="-Xmx512m -XX:MaxPermSize=384m"
```

Fortunately, you can reduce the overall build time with a couple of useful options. The first allows you to specify the Grails source to use:

```
./gradlew -Dgrails.home=/home/user/projects/grails-core docs
```

The Grails source is required because the guide links to its API documentation and the build needs to ensure that if you don't specify a `grails.home` property, then the build will fetch the Grails source - a download of 10s or so and compile the Grails source which can take a while too.

Additionally you can create a `local.properties` file with this variable set:

```
grails.home=/home/user/projects/grails-core
```

or

```
grails.home=../grails-core
```

The other useful option allows you to disable the generation of the API documentation, since you only need the user guide.

```
./gradlew -Ddisable.groovydocs=true docs
```

Again, this can save a significant amount of time and memory.

The main English user guide is generated in the `build/docs` directory, with the `guide` sub-directory containing the user guide part and the `ref` folder containing the reference material. To view the user guide, simply open `build/docs/guide`.

## Publishing

The publishing system for the user guide is the same as [the one for Grails projects](#). You write your content in the `src/<lang>/guide` directory in the `gdoc` wiki format which is then converted to HTML for the final guide. Each chapter is a top-level directory. Sections and sub-sections then go into sub-directories with the same name as the section without the suffix.

The structure of the user guide is defined in the `src/<lang>/guide/toc.yml` file, which is a YAML file that defines the (language-specific) section titles. If you add or remove a `gdoc` file, you must update the TOC as well.



The `src/<lang>/ref` directory contains the source for the reference sidebar. Each directory is the name of a language and also appears in the docs. Hence the directories need different names for the different languages. Inside these are the files, whose names match the names of the methods, commands, properties or whatever that the files describe.

## Translations

This project can host multiple translations of the user guide, with `src/en` being the main one. To add another new language directory under `src` and copy into it all the files under `src/en`. The build will take care of

Once you have a copy of the original guide, you can use the `{hidden}` macro to wrap the English text rather than remove it. This makes it easier to compare changes to the English guide against your translation

```
{hidden}
When you create a Grails application with the [create-app|commandLine] command,
Grails doesn't automatically create an Ant build.xml file but you can generate
one with the [integrate-with|commandLine] command:
{hidden}

Quando crias uma aplicacao Grails com o comando [create-app|commandLine], Grails
no cria automaticamente um ficheiro de construo Ant build.xml mas podes gerar
um com o comando [integrate-with|commandLine]:
```

Because the English text remains in your gdoc files, `diff` will show differences on the English lines. You can use `diff` to see which bits of your translation need updating. On top of that, the `{hidden}` macro ensures the text is not displayed in the browser, although you can display it by adding this URL `javascript:toggleHidden()`; (requires you to build the user guide with Grails 2.0 M2 or later).

Even better, you can use the `left_to_do.groovy` script in the root of the project to see what still needs to be done like so:

```
./left_to_do.groovy es
```

This will then print out a recursive diff of the given translation against the reference English user guide. Blocks that haven't changed since being translated will *not* appear in the diff output. In other words, all content that hasn't been translated yet and content that has changed since it was translated. Note that `{code}` blocks need to include them inside `{hidden}` macros.

To provide translations for the headers, such as the user guide title and subtitle, just add a language-specific `'resources/doc.properties'` file like so:

```
es.title=El Grails Framework  
es.subtitle=...
```

For each language translation, properties beginning `<lang>.` will override the standard ones. In the above example, the title will be El Grails Framework for the Spanish translation. Also, translators can be credited by adding the `translators` property:

```
fr.translators=Stphane Maldini
```

This should be a comma-separated list of names (or the native language equivalent) and it will be displayed in the header in the user guide itself.

You can build specific translations very easily using the `publishGuide_*` and `publishPdf_*` tasks. To build both the French HTML and PDF user guides, simply execute

```
./gradlew publishPdf_fr
```

Each translation is generated in its own directory, so for example the French guide will end up in `build/docs/fr/`. To view the translated guide by opening `build/docs/<lang>/index.html`.

All translations are created as part of the [Hudson CI build for the grails-doc](#) project, so you can easily see the build status without having to build the docs yourself.

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