sbt Reference Manual

Contents

Preface

sbt is a build tool for Scala, Java, and more. It requires Java 1.8 or later.

Install

See Installing sbt for the setup instructions.

Getting Started

To get started, *please read* the Getting Started Guide. You will save yourself a *lot* of time if you have the right understanding of the big picture up-front. All documentation may be found via the table of contents included at the end of every page.

Use Stack Overflow for questions. Use the sbt-dev mailing list for discussing sbt development. Use [@scala_sbt](https://twitter.com/scala_sbt) for questions and discussions.

Features of sbt

- Little or no configuration required for simple projects
- Scala-based build definition that can use the full flexibility of Scala code
- Accurate incremental recompilation using information extracted from the compiler
- Continuous compilation and testing with triggered execution
- Packages and publishes jars
- Generates documentation with scaladoc
- Supports mixed Scala/Java projects
- Supports testing with ScalaCheck, specs, and ScalaTest. JUnit is supported by a plugin.
- Starts the Scala REPL with project classes and dependencies on the classpath
- Modularization supported with sub-projects
- External project support (list a git repository as a dependency!)
- Parallel task execution, including parallel test execution
- Library management support: inline declarations, external Ivy or Maven configuration files, or manual management

Also

This documentation can be forked on GitHub. Feel free to make corrections and add documentation.

Documentation for 0.13.x has been archived here. This documentation applies to sbt 1.2.1.

See also the API Documentation, and the index of names and types.

Getting Started with sbt

sbt uses a small number of concepts to support flexible and powerful build definitions. There are not that many concepts, but sbt is not exactly like other build systems and there are details you *will* stumble on if you haven't read the documentation.

The Getting Started Guide covers the concepts you need to know to create and maintain an sbt build definition.

It is *highly recommended* to read the Getting Started Guide!

If you are in a huge hurry, the most important conceptual background can be found in build definition, scopes, and task graph. But we don't promise that it's a good idea to skip the other pages in the guide.

It's best to read in order, as later pages in the Getting Started Guide build on concepts introduced earlier.

Thanks for trying out sbt and *have fun*!

Installing sbt

To create an sbt project, you'll need to take these steps:

- Install JDK (We recommend Oracle JDK 8 or OpenJDK 8).
- Install sbt.
- Setup a simple hello world project
- Move on to running to learn how to run sbt.
- Then move on to .sbt build definition to learn more about build definitions.

Ultimately, the installation of sbt boils down to a launcher JAR and a shell script, but depending on your platform, we provide several ways to make the process less tedious. Head over to the installation steps for Mac, Windows, or Linux.

Tips and Notes

If you have any trouble running sbt, see Setup Notes on terminal encodings, HTTP proxies, and JVM options.

Installing sbt on Mac

Install JDK

Follow the link to install Java SE Development Kit 8.

Installing from a universal package

Download ZIP or TGZ package, and expand it.

Installing from a third-party package

> **Note:** Third-party packages may not provide the latest version. Please make sure to report any issues with these packages to the relevant maintainers.

Homebrew

```
$ brew install sbt@1
```

Macports

```
$ port install sbt
```

Installing sbt on Windows

Install JDK

Follow the link to install Java SE Development Kit 8.

Installing from a universal package

Download ZIP or TGZ package and expand it.

Windows installer

Download msi installer and install it.

Installing sbt on Linux

Installing from a universal package

Download ZIP or TGZ package and expand it.

Install JDK

You must first install a JDK. We recommend Oracle JDK 8 or OpenJDK 8. The details around the package names differ from one distribution to another.

For example, Ubuntu xenial (16.04LTS) has openjdk-8-jdk.

Redhat family calls it java-1.8.0-openjdk-devel.

Ubuntu and other Debian-based distributions

DEB package is officially supported by sbt.

Ubuntu and other Debian-based distributions use the DEB format, but usually you don't install your software from a local DEB file. Instead they come with package managers both for the command line (e.g. `apt-get`, `aptitude`) or with a graphical user interface (e.g. Synaptic). Run the following from the terminal to install `sbt` (You'll need superuser privileges to do so, hence the `sudo`).

```
echo "deb https://dl.bintray.com/sbt/debian /" | sudo tee -a /etc/apt/sources.list.d/sbt.list
sudo apt-key adv --keyserver hkp://keyserver.ubuntu.com:80 --recv 2EE0EA64E40A89B84B2DF73499E8
sudo apt-get update
sudo apt-get install sbt
```

Package managers will check a number of configured repositories for packages to offer for installation. sbt binaries are published to Bintray, and conveniently Bintray provides an APT repository. You just have to add the repository to the places your package manager will check.

Once `sbt` is installed, you'll be able to manage the package in `aptitude` or Synaptic after you updated their package cache. You should also be able to see the added repository at the bottom of the list in System Settings -> Software & Updates -> Other Software:

Note: There's been reports about SSL error using Ubuntu: `Server access Error: java.lang.RuntimeException: Unexpected error: java.security.InvalidAlgorithmParameterException: the trustAnchors parameter must be non-empty url=https://repo1.maven.org/maven2/org/scala-sbt/sbt/1.1.0/sbt-1.` which apparently stems from OpenJDK 9 using PKCS12 format for `/etc/ssl/certs/java/cacerts` cert-bug. According to https://stackoverflow.com/a/50103533/3827 it is fixed in Ubuntu Cosmic (18.10), but Ubuntu Bionic LTS (18.04) is still waiting for a release. See the answer for a woraround.

Red Hat Enterprise Linux and other RPM-based distributions

RPM package is officially supported by sbt.

Red Hat Enterprise Linux and other RPM-based distributions use the RPM format. Run the following from the terminal to install `sbt` (You'll need superuser privileges to do so, hence the `sudo`).

```
curl https://bintray.com/sbt/rpm/rpm | sudo tee /etc/yum.repos.d/bintray-sbt-rpm.repo
sudo yum install sbt
```

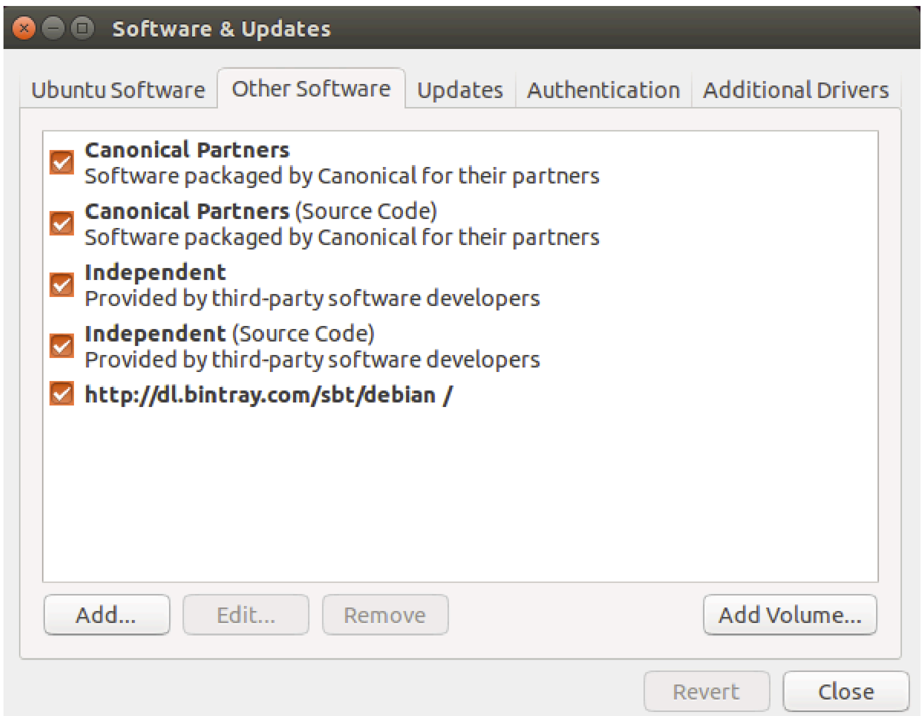


Figure 1: Ubuntu Software & Updates Screenshot

sbt binaries are published to Bintray, and conveniently Bintray provides an RPM repository. You just have to add the repository to the places your package manager will check.

On Fedora, `sbt 0.13.1` available on official repos. If you want to install `sbt 1.1.6` or above, you may need to uninstall `sbt 0.13` (if it's install) and indicate that you want to install the newest version of `sbt` (i.e. `sbt 1.1.6` or above) using `bintray-sbt-rpm.repo` then.

```
sudo dnf remove sbt # uninstalling sbt if sbt 0.13 was installed (may not be necessary)
sudo dnf --enablerepo=bintray--sbt-rpm install sbt
```

> **Note:** Please report any issues with these to the sbt-launcher-package project.

Gentoo

The official tree contains ebuilds for sbt. To install the latest available version do:

```
emerge dev-java/sbt
```

sbt by example

This page assumes you've installed sbt 1.

Let's start with examples rather than explaining how sbt works or why.

Create a minimum sbt build

```
$ mkdir foo-build
$ cd foo-build
$ touch build.sbt
```

Start sbt shell

```
$ sbt
[info] Updated file /tmp/foo-build/project/build.properties: set sbt.version to 1.1.4
[info] Loading project definition from /tmp/foo-build/project
[info] Loading settings from build.sbt ...
[info] Set current project to foo-build (in build file:/tmp/foo-build/)
[info] sbt server started at local:///Users/eed3si9n/.sbt/1.0/server/abc4fb6c89985a00fd95/soc
sbt:foo-build>
```

Exit sbt shell

To leave sbt shell, type `exit` or use Ctrl+D (Unix) or Ctrl+Z (Windows).

```
sbt:foo-build> exit
```

Compile a project

As a convention, we will use the `sbt:...>` or `>` prompt to mean that we're in the sbt interactive shell.

```
$ sbt
sbt:foo-build> compile
```

Recompile on code change

Prefixing the `compile` command (or any other command) with `~` causes the command to be automatically re-executed whenever one of the source files within the project is modified. For example:

```
sbt:foo-build> ~compile
[success] Total time: 0 s, completed May 6, 2018 3:52:08 PM
1. Waiting for source changes... (press enter to interrupt)
```

Create a source file

Leave the previous command running. From a different shell or in your file manager create in the project directory the following nested directories: `src/main/scala/example`. Then, create `Hello.scala` in the `example` directory using your favorite editor as follows:

```scala
package example

object Hello extends App {
  println("Hello")
}
```

This new file should be picked up by the running command:

```
[info] Compiling 1 Scala source to /tmp/foo-build/target/scala-2.12/classes ...
[info] Done compiling.
[success] Total time: 2 s, completed May 6, 2018 3:53:42 PM
2. Waiting for source changes... (press enter to interrupt)
```

Press `Enter` to exit `~compile`.

Run a previous command

From sbt shell, press up-arrow twice to find the `compile` command that you executed at the beginning.

```
sbt:foo-build> compile
```

Getting help

Use the `help` command to get basic help about the available commands.

```
sbt:foo-build> help

  about      Displays basic information about sbt and the build.
  tasks      Lists the tasks defined for the current project.
  settings   Lists the settings defined for the current project.
 reload   (Re)loads the current project or changes to plugins project or returns from it.
  new        Creates a new sbt build.
 projects  Lists the names of available projects or temporarily adds/removes extra builds to th
 project   Displays the current project or changes to the provided `project`.

....
```

Display the description of a specific task:

```
sbt:foo-build> help run
Runs a main class, passing along arguments provided on the command line.
```

Run your app

```
sbt:foo-build> run
[info] Packaging /tmp/foo-build/target/scala-2.12/foo-build_2.12-0.1.0-SNAPSHOT.jar ...
[info] Done packaging.
[info] Running example.Hello
Hello
[success] Total time: 1 s, completed May 6, 2018 4:10:44 PM
```

Set ThisBuild / scalaVersion from sbt shell

```
sbt:foo-build> set ThisBuild / scalaVersion := "2.12.6"
[info] Defining ThisBuild / scalaVersion
```

Check the `scalaVersion` setting:

```
sbt:foo-build> scalaVersion
[info] 2.12.6
```

Save the session to build.sbt

We can save the ad-hoc settings using `session save`.

```
sbt:foo-build> session save
[info] Reapplying settings...
```

`build.sbt` file should now contain:

```
ThisBuild / scalaVersion := "2.12.6"
```

Name your project

Using an editor, change `build.sbt` as follows:

```
ThisBuild / scalaVersion := "2.12.6"
ThisBuild / organization := "com.example"

lazy val hello = (project in file("."))
  .settings(
    name := "Hello"
  )
```

Reload the build

Use the `reload` command to reload the build. The command causes the `build.sbt` file to be re-read, and its settings applied.

```
sbt:foo-build> reload
[info] Loading project definition from /tmp/foo-build/project
[info] Loading settings from build.sbt ...
[info] Set current project to Hello (in build file:/tmp/foo-build/)
sbt:Hello>
```

Note that the prompt has now changed to `sbt:Hello>`.

Add ScalaTest to libraryDependencies

Using an editor, change `build.sbt` as follows:

```
ThisBuild / scalaVersion := "2.12.6"
ThisBuild / organization := "com.example"

lazy val hello = (project in file("."))
  .settings(
    name := "Hello",
    libraryDependencies += "org.scalatest" %% "scalatest" % "3.0.5" % Test,
  )
```

Use the `reload` command to reflect the change in `build.sbt`.

```
sbt:Hello> reload
```

Run tests

```
sbt:Hello> test
```

Run incremental tests continuously

```
sbt:Hello> ~testQuick
```

Write a test

Leaving the previous command running, create a file named `src/test/scala/HelloSpec.scala` using an editor:

```
import org.scalatest._

class HelloSpec extends FunSuite with DiagrammedAssertions {
  test("Hello should start with H") {
    assert("hello".startsWith("H"))
  }
}
```

`~testQuick` should pick up the change:

```
2. Waiting for source changes... (press enter to interrupt)
[info] Compiling 1 Scala source to /tmp/foo-build/target/scala-2.12/test-classes ...
[info] Done compiling.
[info] HelloSpec:
[info] - Hello should start with H *** FAILED ***
[info]   assert("hello".startsWith("H"))
[info]          |       |          |
[info]          "hello" false      "H" (HelloSpec.scala:5)
[info] Run completed in 135 milliseconds.
[info] Total number of tests run: 1
[info] Suites: completed 1, aborted 0
[info] Tests: succeeded 0, failed 1, canceled 0, ignored 0, pending 0
[info] *** 1 TEST FAILED ***
[error] Failed tests:
[error]   HelloSpec
[error] (Test / testQuick) sbt.TestsFailedException: Tests unsuccessful
```

Make the test pass

Using an editor, change `src/test/scala/HelloSpec.scala` to:

```scala
import org.scalatest._

class HelloSpec extends FunSuite with DiagrammedAssertions {
  test("Hello should start with H") {
    // Hello, as opposed to hello
    assert("Hello".startsWith("H"))
  }
}
```

Confirm that the test passes, then press `Enter` to exit the continuous test.

Add a library dependency

Using an editor, change `build.sbt` as follows:

```scala
ThisBuild / scalaVersion := "2.12.6"
ThisBuild / organization := "com.example"

lazy val hello = (project in file("."))
  .settings(
    name := "Hello",
    libraryDependencies += "com.eed3si9n" %% "gigahorse-okhttp" % "0.3.1",
    libraryDependencies += "org.scalatest" %% "scalatest" % "3.0.5" % Test,
  )
```

Use Scala REPL

We can find out the current weather in New York.

```
sbt:Hello> console
[info] Starting scala interpreter...
Welcome to Scala 2.12.6 (Java HotSpot(TM) 64-Bit Server VM, Java 1.8.0_171).
Type in expressions for evaluation. Or try :help.

scala> :paste
// Entering paste mode (ctrl-D to finish)

import gigahorse._, support.okhttp.Gigahorse
import scala.concurrent._, duration._
Gigahorse.withHttp(Gigahorse.config) { http =>
  val r = Gigahorse.url("https://query.yahooapis.com/v1/public/yql").get.
    addQueryString(
      "q" -> """select item.condition
                from weather.forecast where woeid in (select woeid from geo.places(1) where
                and u='c'""",
      "format" -> "json"
    )
  val f = http.run(r, Gigahorse.asString)
  Await.result(f, 10.seconds)
}

// press Ctrl+D

// Exiting paste mode, now interpreting.

import gigahorse._
import support.okhttp.Gigahorse
import scala.concurrent._
import duration._
res0: String = {"query":{"count":1,"created":"2018-05-06T22:49:55Z","lang":"en-US",
"results":{"channel":{"item":{"condition":{"code":"26","date":"Sun, 06 May 2018 06:00 PM EDT
"temp":"16","text":"Cloudy"}}}}}}

scala> :q // to quit
```

Make a subproject

Change `build.sbt` as follows:

```
ThisBuild / scalaVersion := "2.12.6"
ThisBuild / organization := "com.example"

lazy val hello = (project in file("."))
  .settings(
    name := "Hello",
    libraryDependencies += "com.eed3si9n" %% "gigahorse-okhttp" % "0.3.1",
    libraryDependencies += "org.scalatest" %% "scalatest" % "3.0.5" % Test,
  )

lazy val helloCore = (project in file("core"))
  .settings(
    name := "Hello Core",
  )
```

Use the `reload` command to reflect the change in `build.sbt`.

List all subprojects

```
sbt:Hello> projects
[info] In file:/tmp/foo-build/
[info]   * hello
[info]     helloCore
```

Compile the subproject

```
sbt:Hello> helloCore/compile
```

Add ScalaTest to the subproject

Change `build.sbt` as follows:

```
ThisBuild / scalaVersion := "2.12.6"
ThisBuild / organization := "com.example"

val scalaTest = "org.scalatest" %% "scalatest" % "3.0.5"

lazy val hello = (project in file("."))
  .settings(
    name := "Hello",
    libraryDependencies += "com.eed3si9n" %% "gigahorse-okhttp" % "0.3.1",
    libraryDependencies += scalaTest % Test,
  )
```

```
lazy val helloCore = (project in file("core"))
  .settings(
    name := "Hello Core",
    libraryDependencies += scalaTest % Test,
  )
```

Broadcast commands

Set aggregate so that the command sent to `hello` is broadcast to `helloCore` too:

```
ThisBuild / scalaVersion := "2.12.6"
ThisBuild / organization := "com.example"

val scalaTest = "org.scalatest" %% "scalatest" % "3.0.5"

lazy val hello = (project in file("."))
  .aggregate(helloCore)
  .settings(
    name := "Hello",
    libraryDependencies += "com.eed3si9n" %% "gigahorse-okhttp" % "0.3.1",
    libraryDependencies += scalaTest % Test,
  )

lazy val helloCore = (project in file("core"))
  .settings(
    name := "Hello Core",
    libraryDependencies += scalaTest % Test,
  )
```

After `reload`, `~testQuick` now runs on both subprojects:

```
sbt:Hello> ~testQuick
```

Press `Enter` to exit the continuous test.

Make hello depend on helloCore

Use `.dependsOn(...)` to a add dependency on other subprojects. Also let's move the Gigahorse dependency to `helloCore`.

```scala
ThisBuild / scalaVersion := "2.12.6"
ThisBuild / organization := "com.example"

val scalaTest = "org.scalatest" %% "scalatest" % "3.0.5"

lazy val hello = (project in file("."))
  .aggregate(helloCore)
  .dependsOn(helloCore)
  .settings(
    name := "Hello",
    libraryDependencies += scalaTest % Test,
  )

lazy val helloCore = (project in file("core"))
  .settings(
    name := "Hello Core",
    libraryDependencies += "com.eed3si9n" %% "gigahorse-okhttp" % "0.3.1",
    libraryDependencies += scalaTest % Test,
  )
```

Parse JSON using Play JSON

Let's add Play JSON to `helloCore`.

```scala
ThisBuild / scalaVersion := "2.12.6"
ThisBuild / organization := "com.example"

val scalaTest = "org.scalatest" %% "scalatest" % "3.0.5"
val gigahorse = "com.eed3si9n" %% "gigahorse-okhttp" % "0.3.1"
val playJson  = "com.typesafe.play" %% "play-json" % "2.6.9"

lazy val hello = (project in file("."))
  .aggregate(helloCore)
  .dependsOn(helloCore)
  .settings(
    name := "Hello",
    libraryDependencies += scalaTest % Test,
  )

lazy val helloCore = (project in file("core"))
  .settings(
    name := "Hello Core",
    libraryDependencies ++= Seq(gigahorse, playJson),
    libraryDependencies += scalaTest % Test,
  )
```

After reload, add core/src/main/scala/example/core/Weather.scala:

```
package example.core

import gigahorse._, support.okhttp.Gigahorse
import scala.concurrent._
import play.api.libs.json._

object Weather {
  lazy val http = Gigahorse.http(Gigahorse.config)
  def weather: Future[String] = {
    val r = Gigahorse.url("https://query.yahooapis.com/v1/public/yql").get.
      addQueryString(
        "q" -> """select item.condition
from weather.forecast where woeid in (select woeid from geo.places(1) where text='New York,
and u='c'""".stripMargin,
        "format" -> "json"
      )

    import ExecutionContext.Implicits._
    for {
      f <- http.run(r, Gigahorse.asString)
      x <- parse(f)
    } yield x
  }

  def parse(rawJson: String): Future[String] = {
    val js = Json.parse(rawJson)
    (js \\ "text").headOption match {
      case Some(JsString(x)) => Future.successful(x.toLowerCase)
      case _                 => Future.failed(sys.error(rawJson))
    }
  }
}
```

Next, change src/main/scala/example/Hello.scala as follows:

```
package example

import scala.concurrent._, duration._
import core.Weather

object Hello extends App {
  val w = Await.result(Weather.weather, 10.seconds)
  println(s"Hello! The weather in New York is $w.")
```

```
  Weather.http.close()
}
```

Let's run the app to see if it worked:

```
sbt:Hello> run
[info] Compiling 1 Scala source to /tmp/foo-build/core/target/scala-2.12/classes ...
[info] Done compiling.
[info] Compiling 1 Scala source to /tmp/foo-build/target/scala-2.12/classes ...
[info] Packaging /tmp/foo-build/core/target/scala-2.12/hello-core_2.12-0.1.0-SNAPSHOT.jar ...
[info] Done packaging.
[info] Done compiling.
[info] Packaging /tmp/foo-build/target/scala-2.12/hello_2.12-0.1.0-SNAPSHOT.jar ...
[info] Done packaging.
[info] Running example.Hello
Hello! The weather in New York is mostly cloudy.
```

Add sbt-native-packager plugin

Using an editor, create `project/plugins.sbt`:

```
addSbtPlugin("com.typesafe.sbt" % "sbt-native-packager" % "1.3.4")
```

Next change `build.sbt` as follows to add `JavaAppPackaging`:

```
ThisBuild / scalaVersion := "2.12.6"
ThisBuild / organization := "com.example"

val scalaTest = "org.scalatest" %% "scalatest" % "3.0.5"
val gigahorse = "com.eed3si9n" %% "gigahorse-okhttp" % "0.3.1"
val playJson  = "com.typesafe.play" %% "play-json" % "2.6.9"

lazy val hello = (project in file("."))
  .aggregate(helloCore)
  .dependsOn(helloCore)
  .enablePlugins(JavaAppPackaging)
  .settings(
    name := "Hello",
    libraryDependencies += scalaTest % Test,
  )

lazy val helloCore = (project in file("core"))
  .settings(
    name := "Hello Core",
```

```
    libraryDependencies ++= Seq(gigahorse, playJson),
    libraryDependencies += scalaTest % Test,
  )
```

Create a .zip distribution

```
sbt:Hello> dist
[info] Wrote /tmp/foo-build/target/scala-2.12/hello_2.12-0.1.0-SNAPSHOT.pom
[info] Wrote /tmp/foo-build/core/target/scala-2.12/hello-core_2.12-0.1.0-SNAPSHOT.pom
[info] Your package is ready in /tmp/foo-build/target/universal/hello-0.1.0-SNAPSHOT.zip
```

Here's how you can run the packaged app:

```
$ /tmp/someother
$ cd /tmp/someother
$ unzip -o -d /tmp/someother /tmp/foo-build/target/universal/hello-0.1.0-SNAPSHOT.zip
$ ./hello-0.1.0-SNAPSHOT/bin/hello
Hello! The weather in New York is mostly cloudy.
```

Dockerize your app

```
sbt:Hello> Docker/publishLocal
....
[info] Successfully built b6ce1b6ab2c0
[info] Successfully tagged hello:0.1.0-SNAPSHOT
[info] Built image hello:0.1.0-SNAPSHOT
```

Here's how to run the Dockerized app:

```
$ docker run hello:0.1.0-SNAPSHOT
Hello! The weather in New York is mostly cloudy
```

Set the version

Change `build.sbt` as follows:

```
ThisBuild / version      := "0.1.0"
ThisBuild / scalaVersion := "2.12.6"
ThisBuild / organization := "com.example"

val scalaTest = "org.scalatest" %% "scalatest" % "3.0.5"
val gigahorse = "com.eed3si9n" %% "gigahorse-okhttp" % "0.3.1"
```

```scala
val playJson  = "com.typesafe.play" %% "play-json" % "2.6.9"

lazy val hello = (project in file("."))
  .aggregate(helloCore)
  .dependsOn(helloCore)
  .enablePlugins(JavaAppPackaging)
  .settings(
    name := "Hello",
    libraryDependencies += scalaTest % Test,
  )

lazy val helloCore = (project in file("core"))
  .settings(
    name := "Hello Core",
    libraryDependencies ++= Seq(gigahorse, playJson),
    libraryDependencies += scalaTest % Test,
  )
```

Switch scalaVersion temporarily

```
sbt:Hello> ++2.11.12!
[info] Forcing Scala version to 2.11.12 on all projects.
[info] Reapplying settings...
[info] Set current project to Hello (in build file:/tmp/foo-build/)
```

Check the `scalaVersion` setting:

```
sbt:Hello> scalaVersion
[info] helloCore / scalaVersion
[info]  2.11.12
[info] scalaVersion
[info]  2.11.12 scalaVersion
[info] 2.12.6
```

This setting will go away after `reload`.

Inspect the dist task

To find out more about `dist`, try `help` and `inspect`.

```
sbt:Hello> help dist
Creates the distribution packages.
sbt:Hello> inspect dist
```

To call inspect recursively on the dependency tasks use `inspect tree`.

```
sbt:Hello> inspect tree dist
[info] dist = Task[java.io.File]
[info]   +-Universal / dist = Task[java.io.File]
....
```

Batch mode

You can also run sbt in batch mode, passing sbt commands directly from the terminal.

```
$ sbt clean "testOnly HelloSpec"
```

Note: Running in batch mode requires JVM spinup and JIT each time, so **your build will run much slower**. For day-to-day coding, we recommend using the sbt shell or a continuous test like `~testQuick`.

sbt new command

You can use the sbt `new` command to quickly setup a simple "Hello world" build.

```
$ sbt new sbt/scala-seed.g8
....
A minimal Scala project.

name [My Something Project]: hello

Template applied in ./hello
```

When prompted for the project name, type `hello`.

This will create a new project under a directory named `hello`.

Credits

This page is based on the Essential sbt tutorial written by William "Scala William" Narmontas.

Directory structure

This page assumes you've installed sbt and seen the Hello, World example.

Base directory

In sbt's terminology, the "base directory" is the directory containing the project. So if you created a project `hello` containing `hello/build.sbt` as in the Hello, World example, `hello` is your base directory.

Source code

sbt uses the same directory structure as Maven for source files by default (all paths are relative to the base directory):

```
src/
  main/
    resources/
       <files to include in main jar here>
    scala/
       <main Scala sources>
    java/
       <main Java sources>
  test/
    resources
       <files to include in test jar here>
    scala/
       <test Scala sources>
    java/
       <test Java sources>
```

Other directories in `src/` will be ignored. Additionally, all hidden directories will be ignored.

Source code can be placed in the project's base directory as `hello/app.scala`, which may be for small projects, though for normal projects people tend to keep the projects in the `src/main/` directory to keep things neat. The fact that you can place `*.scala` source code in the base directory might seem like an odd trick, but this fact becomes relevant later.

sbt build definition files

The build definition is described in `build.sbt` (actually any files named `*.sbt`) in the project's base directory.

```
build.sbt
```

Build support files

In addition to `build.sbt`, `project` directory can contain `.scala` files that defines helper objects and one-off plugins. See organizing the build for more.

```
build.sbt
project/
  Dependencies.scala
```

You may see `.sbt` files inside `project/` but they are not equivalent to `.sbt` files in the project's base directory. Explaining this will come later, since you'll need some background information first.

Build products

Generated files (compiled classes, packaged jars, managed files, caches, and documentation) will be written to the `target` directory by default.

Configuring version control

Your `.gitignore` (or equivalent for other version control systems) should contain:

```
target/
```

Note that this deliberately has a trailing `/` (to match only directories) and it deliberately has no leading `/` (to match `project/target/` in addition to plain `target/`).

Running

This page describes how to use sbt once you have set up your project. It assumes you've installed sbt and created a Hello, World or other project.

sbt shell

Run sbt in your project directory with no arguments:

```
$ sbt
```

Running sbt with no command line arguments starts sbt shell. sbt shell has a command prompt (with tab completion and history!).

For example, you could type `compile` at the sbt shell:

```
> compile
```

To `compile` again, press up arrow and then enter.

To run your program, type `run`.

To leave sbt shell, type `exit` or use Ctrl+D (Unix) or Ctrl+Z (Windows).

Batch mode

You can also run sbt in batch mode, specifying a space-separated list of sbt commands as arguments. For sbt commands that take arguments, pass the command and arguments as one argument to sbt by enclosing them in quotes. For example,

```
$ sbt clean compile "testOnly TestA TestB"
```

In this example, `testOnly` has arguments, `TestA` and `TestB`. The commands will be run in sequence (`clean`, `compile`, then `testOnly`).

Note: Running in batch mode requires JVM spinup and JIT each time, so **your build will run much slower**. For day-to-day coding, we recommend using the sbt shell or Continuous build and test feature described below.

Beginning in sbt 0.13.16, using batch mode in sbt will issue an informational startup message,

```
$ sbt clean compile
[info] Executing in batch mode. For better performance use sbt's shell
...
```

It will only be triggered for `sbt compile`, and it can also be supressed with `suppressSbtShellNotification := true`.

Continuous build and test

To speed up your edit-compile-test cycle, you can ask sbt to automatically recompile or run tests whenever you save a source file.

Make a command run when one or more source files change by prefixing the command with `~`. For example, in sbt shell try:

```
> ~testQuick
```

Press enter to stop watching for changes.

You can use the ~ prefix with either sbt shell or batch mode.

See Triggered Execution for more details.

Common commands

Here are some of the most common sbt commands. For a more complete list, see Command Line Reference.

clean

Deletes all generated files (in the target directory).

compile

Compiles the main sources (in src/main/scala and src/main/java directories).

test

Compiles and runs all tests.

console

Starts the Scala interpreter with a classpath including the compiled sources and all dependencies. To return to sbt, type :quit, Ctrl+D (Unix), or Ctrl+Z (Windows).

run <argument>*

Runs the main class for the project in the same virtual machine as sbt.

package

Creates a jar file containing the files in src/main/resources and the classes compiled from src/main/scala and src/main/java.

help <command>

Displays detailed help for the specified command. If no command is provided, displays brief descriptions of all commands.

reload

Reloads the build definition (build.sbt, project/*.scala, project/*.sbt files). Needed if you change the build definition.

Tab completion

sbt shell has tab completion, including at an empty prompt. A special sbt convention is that pressing tab once may show only a subset of most likely completions, while pressing it more times shows more verbose choices.

History Commands

sbt shell remembers history, even if you exit sbt and restart it. The simplest way to access history is with the up arrow key. The following commands are also supported:

!

Show history command help.

!!

Execute the previous command again.

!:

Show all previous commands.

!:n

Show the last n commands.

!n

Execute the command with index n, as shown by the !: command.

!-n

Execute the nth command before this one.

!string

Execute the most recent command starting with 'string.'

!?string

Execute the most recent command containing 'string.'

Build definition

This page describes sbt build definitions, including some "theory" and the syntax of `build.sbt`. It assumes you have installed a recent version of sbt, such as sbt 1.2.1, know how to use sbt, and have read the previous pages in the Getting Started Guide.

This page discusses the `build.sbt` build definition.

Specifying the sbt version

As part of your build definition you will specify the version of sbt that your build uses. This allows people with different versions of the sbt launcher to build the same projects with consistent results. To do this, create a file named `project/build.properties` that specifies the sbt version as follows:

```
sbt.version=1.2.1
```

If the required version is not available locally, the `sbt` launcher will download it for you. If this file is not present, the `sbt` launcher will choose an arbitrary version, which is discouraged because it makes your build non-portable.

What is a build definition?

A *build definition* is defined in `build.sbt`, and it consists of a set of projects (of type `Project`). Because the term *project* can be ambiguous, we often call it a *subproject* in this guide.

For instance, in `build.sbt` you define the subproject located in the current directory like this:

```
lazy val root = (project in file("."))
  .settings(
    name := "Hello",
    scalaVersion := "2.12.6"
  )
```

Each subproject is configured by key-value pairs.

For example, one key is `name` and it maps to a string value, the name of your subproject. The key-value pairs are listed under the `.settings(...)` method as follows:

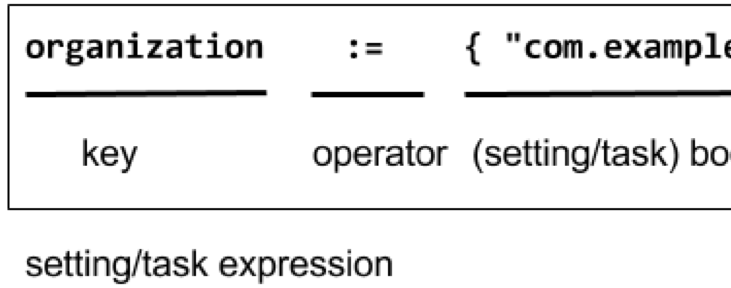
```
lazy val root = (project in file("."))
  .settings(
    name := "Hello",
    scalaVersion := "2.12.6"
  )
```

How build.sbt defines settings

`build.sbt` defines subprojects, which holds a sequence of key-value pairs called *setting expressions* using *build.sbt DSL*.

```
lazy val root = (project in file("."))
  .settings(
    name         := "hello",
    organization := "com.example",
    scalaVersion := "2.12.6",
    version      := "0.1.0-SNAPSHOT"
  )
```

Let's take a closer look at the `build.sbt` DSL:



Each entry is called a *setting expression*. Some among them are also called task expressions. We will see more on the difference later in this page.

A setting expression consists of three parts:

1. Left-hand side is a *key*.
2. *Operator*, which in this case is `:=`
3. Right-hand side is called the *body*, or the *setting body*.

On the left-hand side, `name`, `version`, and `scalaVersion` are *keys*. A key is an instance of `SettingKey[T]`, `TaskKey[T]`, or `InputKey[T]` where `T` is the expected value type. The kinds of key are explained below.

Because key `name` is typed to `SettingKey[String]`, the `:=` operator on `name` is also typed specifically to `String`. If you use the wrong value type, the build definition will not compile:

```
lazy val root = (project in file("."))
  .settings(
    name := 42  // will not compile
  )
```

`build.sbt` may also be interspersed with `val`s, `lazy val`s, and `def`s. Top-level `object`s and `class`es are not allowed in `build.sbt`. Those should go in the `project/` directory as Scala source files.

Keys

Types There are three flavors of key:

- `SettingKey[T]`: a key for a value computed once (the value is computed when loading the subproject, and kept around).
- `TaskKey[T]`: a key for a value, called a *task*, that has to be recomputed each time, potentially with side effects.
- `InputKey[T]`: a key for a task that has command line arguments as input. Check out Input Tasks for more details.

Built-in Keys The built-in keys are just fields in an object called Keys. A `build.sbt` implicitly has an `import sbt.Keys._`, so `sbt.Keys.name` can be referred to as `name`.

Custom Keys Custom keys may be defined with their respective creation methods: `settingKey`, `taskKey`, and `inputKey`. Each method expects the type of the value associated with the key as well as a description. The name of the key is taken from the `val` the key is assigned to. For example, to define a key for a new task called `hello`,

```
lazy val hello = taskKey[Unit]("An example task")
```

Here we have used the fact that an `.sbt` file can contain `val`s and `def`s in addition to settings. All such definitions are evaluated before settings regardless of where they are defined in the file.

> **Note:** Typically, lazy vals are used instead of vals to avoid initialization order problems.

Task vs Setting keys A `TaskKey[T]` is said to define a *task*. Tasks are operations such as `compile` or `package`. They may return `Unit` (`Unit` is Scala for `void`), or they may return a value related to the task, for example `package` is a `TaskKey[File]` and its value is the jar file it creates.

Each time you start a task execution, for example by typing `compile` at the interactive sbt prompt, sbt will re-run any tasks involved exactly once.

sbt's key-value pairs describing the subproject can keep around a fixed string value for a setting such as name, but it has to keep around some executable code for a task such as `compile` – even if that executable code eventually returns a string, it has to be re-run every time.

A given key always refers to either a task or a plain setting. That is, "taskiness" (whether to re-run each time) is a property of the key, not the value.

Defining tasks and settings

Using `:=`, you can assign a value to a setting and a computation to a task. For a setting, the value will be computed once at project load time. For a task, the computation will be re-run each time the task is executed.

For example, to implement the `hello` task from the previous section:

```
lazy val hello = taskKey[Unit]("An example task")

lazy val root = (project in file("."))
  .settings(
    hello := { println("Hello!") }
  )
```

We already saw an example of defining settings when we defined the project's name,

```
lazy val root = (project in file("."))
  .settings(
    name := "hello"
  )
```

Types for tasks and settings From a type-system perspective, the `Setting` created from a task key is slightly different from the one created from a setting key. `taskKey := 42` results in a `Setting[Task[T]]` while `settingKey := 42` results in a `Setting[T]`. For most purposes this makes no difference; the task key still creates a value of type `T` when the task executes.

The `T` vs. `Task[T]` type difference has this implication: a setting can't depend on a task, because a setting is evaluated only once on project load and is not re-run. More on this in task graph.

Keys in sbt shell

In sbt shell, you can type the name of any task to execute that task. This is why typing `compile` runs the `compile` task. `compile` is a task key.

If you type the name of a setting key rather than a task key, the value of the setting key will be displayed. Typing a task key name executes the task but doesn't display the resulting value; to see a task's result, use `show <task name>` rather than plain `<task name>`. The convention for keys names is to use `camelCase` so that the command line name and the Scala identifiers are the same.

To learn more about any key, type `inspect <keyname>` at the sbt interactive prompt. Some of the information `inspect` displays won't make sense yet, but at the top it shows you the setting's value type and a brief description of the setting.

Imports in build.sbt

You can place import statements at the top of `build.sbt`; they need not be separated by blank lines.

There are some implied default imports, as follows:

```
import sbt._
import Keys._
```

(In addition, if you have auto plugins, the names marked under `autoImport` will be imported.)

Bare .sbt build definition

Instead of defining `Projects`, bare `.sbt` build definition consists of a list of `Setting[_]` expressions.

```
name := "hello"
version := "1.0"
scalaVersion := "2.12.6"
```

This syntax is recommended mostly for using plugins. See later section about the plugins.

Adding library dependencies

To depend on third-party libraries, there are two options. The first is to drop jars in `lib/` (unmanaged dependencies) and the other is to add managed dependencies, which will look like this in `build.sbt`:

```
val derby = "org.apache.derby" % "derby" % "10.4.1.3"

lazy val commonSettings = Seq(
  organization := "com.example",
  version := "0.1.0-SNAPSHOT",
  scalaVersion := "2.12.6"
)

lazy val root = (project in file("."))
  .settings(
    commonSettings,
    name := "Hello",
    libraryDependencies += derby
  )
```

This is how you add a managed dependency on the Apache Derby library, version 10.4.1.3.

The `libraryDependencies` key involves two complexities: `+=` rather than `:=`, and the `%` method. `+=` appends to the key's old value rather than replacing it, this is explained in Task Graph. The `%` method is used to construct an Ivy module ID from strings, explained in Library dependencies.

We'll skip over the details of library dependencies until later in the Getting Started Guide. There's a whole page covering it later on.

Task graph

Continuing from build definition, this page explains `build.sbt` definition in more detail.

Rather than thinking of `settings` as key-value pairs, a better analogy would be to think of it as a *directed acyclic graph* (DAG) of tasks where the edges denote **happens-before**. Let's call this the *task graph*.

Terminology

Let's review the key terms before we dive in.

- Setting/Task expression: entry inside `.settings(...)`.
- Key: Left hand side of a setting expression. It could be a `SettingKey[A]`, a `TaskKey[A]`, or an `InputKey[A]`.
- Setting: Defined by a setting expression with `SettingKey[A]`. The value is calculated once during load.
- Task: Defined by a task expression with `TaskKey[A]`. The value is calculated each time it is invoked.

Declaring dependency to other tasks

In `build.sbt` DSL, we use `.value` method to express the dependency to another task or setting. The value method is special and may only be called in the argument to `:=` (or, `+=` or `++=`, which we'll see later).

As a first example, consider defining the `scalacOption` that depends on `update` and `clean` tasks. Here are the definitions of these keys (from Keys).

Note: The values calculated below are nonsensical for `scalaOptions`, and it's just for demonstration purpose only:

```
val scalacOptions = taskKey[Seq[String]]("Options for the Scala compiler.")
val update = taskKey[UpdateReport]("Resolves and optionally retrieves dependencies, producin
val clean = taskKey[Unit]("Deletes files produced by the build, such as generated sources, c
```

Here's how we can rewire `scalacOptions`:

```
scalacOptions := {
  val ur = update.value  // update task happens-before scalacOptions
  val x = clean.value    // clean task happens-before scalacOptions
  // ---- scalacOptions begins here ----
  ur.allConfigurations.take(3)
}
```

`update.value` and `clean.value` declare task dependencies, whereas `ur.allConfigurations.take(3)` is the body of the task.

`.value` is not a normal Scala method call. `build.sbt` DSL uses a macro to lift these outside of the task body. **Both `update` and `clean` tasks are completed by the time task engine evaluates the opening `{` of `scalacOptions` regardless of which line it appears in the body.**

See the following example:

```
lazy val root = (project in file("."))
  .settings(
    name := "Hello",
    organization := "com.example",
    scalaVersion := "2.12.6",
    version := "0.1.0-SNAPSHOT",
    scalacOptions := {
      val out = streams.value // streams task happens-before scalacOptions
      val log = out.log
      log.info("123")
      val ur = update.value   // update task happens-before scalacOptions
      log.info("456")
      ur.allConfigurations.take(3)
    }
  )
```

Next, from sbt shell type `scalacOptions`:

```
> scalacOptions
[info] Updating {file:/xxx/}root...
[info] Resolving jline#jline;2.14.1 ...
[info] Done updating.
[info] 123
[info] 456
[success] Total time: 0 s, completed Jan 2, 2017 10:38:24 PM
```

Even though `val ur = ...` appears in between `log.info("123")` and `log.info("456")` the evaluation of `update` task happens before either of them.

Here's another example:

```
lazy val root = (project in file("."))
  .settings(
    name := "Hello",
    organization := "com.example",
    scalaVersion := "2.12.6",
    version := "0.1.0-SNAPSHOT",
    scalacOptions := {
      val ur = update.value  // update task happens-before scalacOptions
      if (false) {
        val x = clean.value  // clean task happens-before scalacOptions
      }
      ur.allConfigurations.take(3)
    }
  )
```

Next, from sbt shell type `run` then `scalacOptions`:

```
> run
[info] Updating {file:/xxx/}root...
[info] Resolving jline#jline;2.14.1 ...
[info] Done updating.
[info] Compiling 1 Scala source to /Users/eugene/work/quick-test/task-graph/target/scala-2.12/
[info] Running example.Hello
hello
[success] Total time: 0 s, completed Jan 2, 2017 10:45:19 PM
> scalacOptions
[info] Updating {file:/xxx/}root...
[info] Resolving jline#jline;2.14.1 ...
[info] Done updating.
[success] Total time: 0 s, completed Jan 2, 2017 10:45:23 PM
```

Now if you check for `target/scala-2.12/classes/`, it won't exist because `clean` task has run even though it is inside the `if (false)`.

Another important thing to note is that there's no guarantee about the ordering of `update` and `clean` tasks. They might run `update` then `clean`, `clean` then `update`, or both in parallel.

Inlining .value calls

As explained above, `.value` is a special method that is used to express the dependency to other tasks and settings. Until you're familiar with build.sbt, we recommend you put all `.value` calls at the top of the task body.

However, as you get more comfortable, you might wish to inline the `.value` calls because it could make the task/setting more concise, and you don't have to come up with variable names.

We've inlined a few examples:

```
scalacOptions := {
  val x = clean.value
  update.value.allConfigurations.take(3)
}
```

Note whether `.value` calls are inlined, or placed anywhere in the task body, they are still evaluated before entering the task body.

Inspecting the task In the above example, `scalacOptions` has a *dependency* on `update` and `clean` tasks. If you place the above in `build.sbt` and run the sbt interactive console, then type `inspect scalacOptions`, you should see (in part):

```
> inspect scalacOptions
[info] Task: scala.collection.Seq[java.lang.String]
[info] Description:
[info]  Options for the Scala compiler.
....
[info] Dependencies:
[info]  *:clean
[info]  *:update
....
```

This is how sbt knows which tasks depend on which other tasks.

For example, if you `inspect tree compile` you'll see it depends on another key `incCompileSetup`, which it in turn depends on other keys like `dependencyClasspath`. Keep following the dependency chains and magic happens.

```
> inspect tree compile
[info] compile:compile = Task[sbt.inc.Analysis]
[info]   +-compile:incCompileSetup = Task[sbt.Compiler$IncSetup]
[info]   | +-*/*:skip = Task[Boolean]
[info]  | +-compile:compileAnalysisFilename = Task[java.lang.String]
[info]   | | +-*/*:crossPaths = true
[info]   | | +-{.}/*:scalaBinaryVersion = 2.12
```

```
[info]   | |
[info]   | +-*/*:compilerCache = Task[xsbti.compile.GlobalsCache]
[info]   | +-*/*:definesClass = Task[scala.Function1[java.io.File, scala.Function1[java.lang.S
[info]   | +-compile:dependencyClasspath = Task[scala.collection.Seq[sbt.Attributed[java.io.Fi
[info]   | | +-compile:dependencyClasspath::streams = Task[sbt.std.TaskStreams[sbt.Init$Scoped
[info]   | | | +-*/*:streamsManager = Task[sbt.std.Streams[sbt.Init$ScopedKey[_ <: Any]]]
[info]   | | |
[info]   | | +-compile:externalDependencyClasspath = Task[scala.collection.Seq[sbt.Attributed[
[info]   | | | +-compile:externalDependencyClasspath::streams = Task[sbt.std.TaskStreams[sbt.I
[info]   | | | | +-*/*:streamsManager = Task[sbt.std.Streams[sbt.Init$ScopedKey[_ <: Any]]]
[info]   | | | |
[info]   | | | +-compile:managedClasspath = Task[scala.collection.Seq[sbt.Attributed[java.io.F
[info]   | | | | +-compile:classpathConfiguration = Task[sbt.Configuration]
[info]   | | | | | +-compile:configuration = compile
[info]   | | | | | +-*/*:internalConfigurationMap = <function1>
[info]   | | | | | +-*:update = Task[sbt.UpdateReport]
[info]   | | | | |
....
```

When you type `compile` sbt automatically performs an `update`, for example. It Just Works because the values required as inputs to the `compile` computation require sbt to do the `update` computation first.

In this way, all build dependencies in sbt are *automatic* rather than explicitly declared. If you use a key's value in another computation, then the computation depends on that key.

Defining a task that depends on other settings `scalacOptions` is a task key. Let's say it's been set to some values already, but you want to filter out `"-Xfatal-warnings"` and `"-deprecation"` for non-2.12.

```
lazy val root = (project in file("."))
  .settings(
    name := "Hello",
    organization := "com.example",
    scalaVersion := "2.12.6",
    version := "0.1.0-SNAPSHOT",
    scalacOptions := List("-encoding", "utf8", "-Xfatal-warnings", "-deprecation", "-uncheck
    scalacOptions := {
      val old = scalacOptions.value
      scalaBinaryVersion.value match {
        case "2.12" => old
        case _      => old filterNot (Set("-Xfatal-warnings", "-deprecation").apply)
      }
    }
  )
```

Here's how it should look on the sbt shell:

```
> show scalacOptions
[info] * -encoding
[info] * utf8
[info] * -Xfatal-warnings
[info] * -deprecation
[info] * -unchecked
[success] Total time: 0 s, completed Jan 2, 2017 11:44:44 PM
> ++2.11.8!
[info] Forcing Scala version to 2.11.8 on all projects.
[info] Reapplying settings...
[info] Set current project to Hello (in build file:/xxx/)
> show scalacOptions
[info] * -encoding
[info] * utf8
[info] * -unchecked
[success] Total time: 0 s, completed Jan 2, 2017 11:44:51 PM
```

Next, take these two keys (from Keys):

```
val scalacOptions = taskKey[Seq[String]]("Options for the Scala compiler.")
val checksums = settingKey[Seq[String]]("The list of checksums to generate and to verify fo
```

Note: `scalacOptions` and `checksums` have nothing to do with each other. They are just two keys with the same value type, where one is a task.

It is possible to compile a `build.sbt` that aliases `scalacOptions` to `checksums`, but not the other way. For example, this is allowed:

```
// The scalacOptions task may be defined in terms of the checksums setting
scalacOptions := checksums.value
```

There is no way to go the *other* direction. That is, a setting key can't depend on a task key. That's because a setting key is only computed once on project load, so the task would not be re-run every time, and tasks expect to re-run every time.

```
// Bad example: The checksums setting cannot be defined in terms of the scalacOptions task!
checksums := scalacOptions.value
```

Defining a setting that depends on other settings In terms of the execution timing, we can think of the settings as a special tasks that evaluate during loading time.

Consider defining the project organization to be the same as the project name.

```
// name our organization after our project (both are SettingKey[String])
organization := name.value
```

Here's a realistic example. This rewires `scalaSource in Compile` key to a different directory only when `scalaBinaryVersion` is `"2.11"`.

```
scalaSource in Compile := {
  val old = (scalaSource in Compile).value
  scalaBinaryVersion.value match {
    case "2.11" => baseDirectory.value / "src-2.11" / "main" / "scala"
    case _      => old
  }
}
```

What's the point of the build.sbt DSL?

The `build.sbt` DSL is a domain-specific language used construct a DAG of settings and tasks. The setting expressions encode settings, tasks and the dependencies among them.

This structure is common to Make (1976), Ant (2000), and Rake (2003).

Intro to Make The basic Makefile syntax looks like the following:

```
target: dependencies
[tab] system command1
[tab] system command2
```

Given a target (the default target is named `all`),

1. Make checks if the target's dependencies have been built, and builds any of the dependencies that hasn't been built yet.
2. Make runs the system commands in order.

Let's take a look at a `Makefile`:

```
CC=g++
CFLAGS=-Wall

all: hello

hello: main.o hello.o
    $(CC) main.o hello.o -o hello

%.o: %.cpp
    $(CC) $(CFLAGS) -c $< -o $@
```

Running `make`, it will by default pick the target named `all`. The target lists `hello` as its dependency, which hasn't been built yet, so Make will build `hello`.

Next, Make checks if the `hello` target's dependencies have been built yet. `hello` lists two targets: `main.o` and `hello.o`. Once those targets are created using the last pattern matching rule, only then the system command is executed to link `main.o` and `hello.o` to `hello`.

If you're just running `make`, you can focus on what you want as the target, and the exact timing and commands necessary to build the intermediate products are figured out by Make. We can think of this as dependency-oriented programming, or flow-based programming. Make is actually considered a hybrid system because while the DSL describes the task dependencies, the actions are delegated to system commands.

Rake This hybridity is continued for Make successors such as Ant, Rake, and sbt. Take a look at the basic syntax for Rakefile:

```
task name: [:prereq1, :prereq2] do |t|
  # actions (may reference prereq as t.name etc)
end
```

The breakthrough made with Rake was that it used a programming language to describe the actions instead of the system commands.

Benefits of hybrid flow-based programming There are several motivation to organizing the build this way.

First is de-duplication. With flow-based programming, a task is executed only once even when it is depended by multiple tasks. For example, even when multiple tasks along the task graph depend on `compile in Compile`, the compilation will be executed exactly once.

Second is parallel processing. Using the task graph, the task engine can schedule mutually non-dependent tasks in parallel.

Third is the separation of concern and the flexibility. The task graph lets the build user wire the tasks together in different ways, while sbt and plugins can provide various features such as compilation and library dependency management as functions that can be reused.

Summary

The core data structure of the build definition is a DAG of tasks, where the edges denote happens-before relationships. `build.sbt` is a DSL designed to express dependency-oriented programming, or flow-based programming, similar to `Makefile` and `Rakefile`.

The key motivation for the flow-based programming is de-duplication, parallel processing, and customizability.

Scopes

This page describes scopes. It assumes you've read and understood the previous pages, build definition and task graph.

The whole story about keys

Previously we pretended that a key like `name` corresponded to one entry in sbt's map of key-value pairs. This was a simplification.

In truth, each key can have an associated value in more than one context, called a *scope*.

Some concrete examples:

- if you have multiple projects (also called subprojects) in your build definition, a key can have a different value in each project.
- the `compile` key may have a different value for your main sources and your test sources, if you want to compile them differently.
- the `packageOptions` key (which contains options for creating jar packages) may have different values when packaging class files (`packageBin`) or packaging source code (`packageSrc`).

There is no single value for a given key `name`, because the value may differ according to scope.

However, there is a single value for a given *scoped* key.

If you think about sbt processing a list of settings to generate a key-value map describing the project, as discussed earlier, the keys in that key-value map are *scoped* keys. Each setting defined in the build definition (for example in `build.sbt`) applies to a scoped key as well.

Often the scope is implied or has a default, but if the defaults are wrong, you'll need to mention the desired scope in `build.sbt`.

Scope axes

A *scope axis* is a type constructor similar to `Option[A]`, that is used to form a component in a scope.

There are three scope axes:

- The subproject axis
- The dependency configuration axis
- The task axis

If you're not familiar with the notion of *axis*, we can think of the RGB color cube as an example:

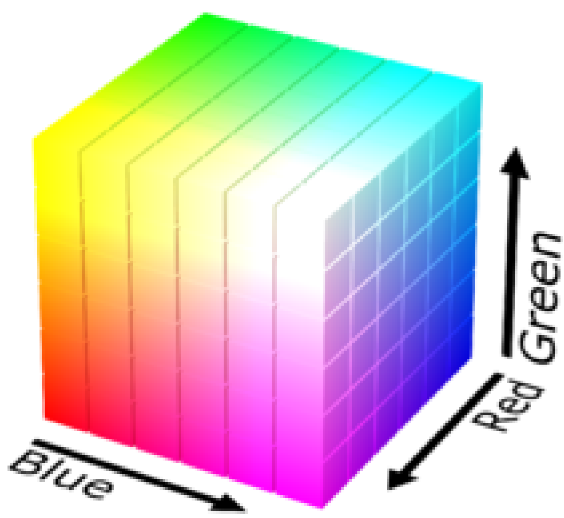


Figure 2: color cube

In the RGB color model, all colors are represented by a point in the cube whose axes correspond to red, green, and blue components encoded by a number.

Similarly, a full scope in sbt is formed by a **tuple** of a subproject, a configuration, and a task value:

```
projA / Compile / console / scalacOptions
```

Which is the slash syntax, introduced in sbt 1.1, for:

```
scalacOptions in (
  Select(projA: Reference),
  Select(Compile: ConfigKey),
  Select(console.key)
)
```

Scoping by the subproject axis If you put multiple projects in a single build, each project needs its own settings. That is, keys can be scoped according to the project.

The project axis can also be set to `ThisBuild`, which means the "entire build", so a setting applies to the entire build rather than a single project. Build-level settings are often used as a fallback when a project doesn't define a project-specific setting. We will discuss more on build-level settings later in this page.

Scoping by the configuration axis A *dependency configuration* (or "configuration" for short) defines a graph of library dependencies, potentially with its own classpath, sources, generated packages, etc. The dependency configuration concept comes from Ivy, which sbt uses for managed dependencies Library Dependencies, and from MavenScopes.

Some configurations you'll see in sbt:

- `Compile` which defines the main build (`src/main/scala`).
- `Test` which defines how to build tests (`src/test/scala`).
- `Runtime` which defines the classpath for the `run` task.

By default, all the keys associated with compiling, packaging, and running are scoped to a configuration and therefore may work differently in each configuration. The most obvious examples are the task keys `compile`, `package`, and `run`; but all the keys which *affect* those keys (such as `sourceDirectories` or `scalacOptions` or `fullClasspath`) are also scoped to the configuration.

Another thing to note about a configuration is that it can extend other configurations. The following figure shows the extension relationship among the most common configurations.

`Test` and `IntegrationTest` extends `Runtime`; `Runtime` extends `Compile`; `CompileInternal` extends `Compile`, `Optional`, and `Provided`.

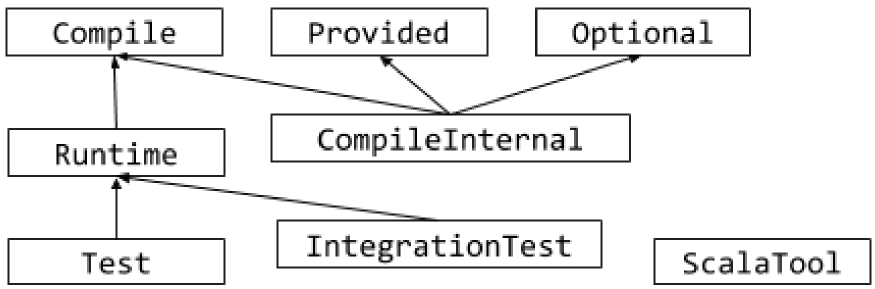


Figure 3: dependency configurations

Scoping by Task axis Settings can affect how a task works. For example, the `packageSrc` task is affected by the `packageOptions` setting.

To support this, a task key (such as `packageSrc`) can be a scope for another key (such as `packageOptions`).

The various tasks that build a package (`packageSrc`, `packageBin`, `packageDoc`) can share keys related to packaging, such as `artifactName` and `packageOptions`. Those keys can have distinct values for each packaging task.

Zero scope component Each scope axis can be filled in with an instance of the axis type (analogous to `Some(_)`), or the axis can be filled in with the special value `Zero`. So we can think of `Zero` as `None`.

`Zero` is a universal fallback for all scope axes, but its direct use should be reserved to sbt and plugin authors in most cases.

`Global` is a scope that sets `Zero` to all axes: `Zero / Zero / Zero`. In other words, `Global / someKey` is a shorthand for `Zero / Zero / Zero / someKey`.

Referring to scopes in a build definition

If you create a setting in `build.sbt` with a bare key, it will be scoped to (current subproject / configuration `Zero` / task `Zero`):

```
lazy val root = (project in file("."))
  .settings(
    name := "hello"
  )
```

Run sbt and `inspect name` to see that it's provided by `ProjectRef(uri("file:/private/tmp/hello/"), "root") / name`, that is, the project is `ProjectRef(uri("file:/Users/xxx/hello/"),` "root"), and neither configuration nor task scope are shown (which means Zero).

A bare key on the right hand side is also scoped to (current subproject / configuration Zero / task Zero):

```
organization := name.value
```

The types of any of the scope axes have been method enriched to have a / operator. The argument to / can be a key or another scope axis. So for example, though there's no good reason to do this, you could have an instance of the name key scoped to the Compile configuration:

```
Compile / name := "hello"
```

or you could set the name scoped to the packageBin task (pointless! just an example):

```
packageBin / name := "hello"
```

or you could set the name with multiple scope axes, for example in the packageBin task in the Compile configuration:

```
Compile / packageBin / name := "hello"
```

or you could use Global:

```
// same as Zero / Zero / Zero / concurrentRestrictions
Global / concurrentRestrictions := Seq(
  Tags.limitAll(1)
)
```

(Global / concurrentRestrictions implicitly converts to Zero / Zero / Zero / concurrentRestrictions, setting all axes to Zero scope component; the task and configuration are already Zero by default, so here the effect is to make the project Zero, that is, define Zero / Zero / Zero / concurrentRestrictions rather than ProjectRef(uri("file:/tmp/hello/"), "root") / Zero / Zero / concurrentRestrictions)

Referring to scoped keys from the sbt shell

On the command line and in the sbt shell, sbt displays (and parses) scoped keys like this:

```
ref / Config / intask / key
```

- `ref` identifies the subproject axis. It could be `<project-id>`, `ProjectRef(uri("file:..."), "id")`, or `ThisBuild` that denotes the "entire build" scope.
- `Config` identifies the configuration axis using the capitalized Scala identifier.
- `intask` identifies the task axis.
- `key` identifies the key being scoped.

`Zero` can appear for each axis.

If you omit part of the scoped key, it will be inferred as follows:

- the current project will be used if you omit the project.
- a key-dependent configuration will be auto-detected if you omit the configuration or task.

For more details, see Interacting with the Configuration System.

Examples of scoped key notation

- `fullClasspath` specifies just a key, so the default scopes are used: current project, a key-dependent configuration, and `Zero` task scope.
- `Test / fullClasspath` specifies the configuration, so this is `fullClasspath` in the `Test` configuration, with defaults for the other two scope axes.
- `root / fullClasspath` specifies the project `root`, where the project is identified with the project id.
- `root / Zero / fullClasspath` specified the project `root`, and specifies `Zero` for the configuration, rather than the default configuration.
- `doc / fullClasspath` specifies the `fullClasspath` key scoped to the `doc` task, with the defaults for the project and configuration axes.
- `ProjectRef(uri("file:/tmp/hello/"), "root") / Test / fullClasspath` specifies a project `ProjectRef(uri("file:/tmp/hello/"), "root")`. Also specifies configurtion Test, leaves the default task axis.
- `ThisBuild / version` sets the subproject axis to "entire build" where the build is `ThisBuild`, with the default configuration.

- `Zero / fullClasspath` sets the subproject axis to `Zero`, with the default configuration.
- `root / Compile / doc / fullClasspath` sets all three scope axes.

Inspecting scopes

In sbt shell, you can use the `inspect` command to understand keys and their scopes. Try `inspect test:fullClasspath`:

```
$ sbt
sbt:Hello> inspect Test / fullClasspath
[info] Task: scala.collection.Seq[sbt.internal.util.Attributed[java.io.File]]
[info] Description:
[info]  The exported classpath, consisting of build products and unmanaged and managed, internal
[info] Provided by:
[info]  ProjectRef(uri("file:/tmp/hello/"), "root") / Test / fullClasspath
[info] Defined at:
[info]  (sbt.Classpaths.classpaths) Defaults.scala:1639
[info] Dependencies:
[info]  Test / dependencyClasspath
[info]  Test / exportedProducts
[info]  Test / fullClasspath / streams
[info] Reverse dependencies:
[info]  Test / testLoader
[info] Delegates:
[info]  Test / fullClasspath
[info]  Runtime / fullClasspath
[info]  Compile / fullClasspath
[info]  fullClasspath
[info]  ThisBuild / Test / fullClasspath
[info]  ThisBuild / Runtime / fullClasspath
[info]  ThisBuild / Compile / fullClasspath
[info]  ThisBuild / fullClasspath
[info]  Zero / Test / fullClasspath
[info]  Zero / Runtime / fullClasspath
[info]  Zero / Compile / fullClasspath
[info]  Global / fullClasspath
[info] Related:
[info]  Compile / fullClasspath
[info]  Runtime / fullClasspath
```

On the first line, you can see this is a task (as opposed to a setting, as explained in .sbt build definition). The value resulting from the task will have type `scala.collection.Seq[sbt.Attributed[java.io.File]]`.

"Provided by" points you to the scoped key that defines the value, in this case `ProjectRef(uri("file:/tmp/hello/"), "root") / Test / fullClasspath` (which is the `fullClasspath` key scoped to the `Test` configuration and the `ProjectRef(uri("file:/tmp/hello/"), "root")` project).

"Dependencies" was discussed in detail in the previous page.

We'll discuss "Delegates" later.

Try `inspect fullClasspath` (as opposed to the above example, inspect `Test / fullClasspath`) to get a sense of the difference. Because the configuration is omitted, it is autodetected as `Compile`. `inspect Compile / fullClasspath` should therefore look the same as `inspect fullClasspath`.

Try `inspect This / Zero / fullClasspath` for another contrast. `fullClasspath` is not defined in the `Zero` configuration scope by default.

Again, for more details, see Interacting with the Configuration System.

When to specify a scope

You need to specify the scope if the key in question is normally scoped. For example, the `compile` task, by default, is scoped to `Compile` and `Test` configurations, and does not exist outside of those scopes.

To change the value associated with the `compile` key, you need to write `Compile / compile` or `Test / compile`. Using plain `compile` would define a new compile task scoped to the current project, rather than overriding the standard compile tasks which are scoped to a configuration.

If you get an error like *"Reference to undefined setting"*, often you've failed to specify a scope, or you've specified the wrong scope. The key you're using may be defined in some other scope. sbt will try to suggest what you meant as part of the error message; look for "Did you mean Compile / compile?"

One way to think of it is that a name is only *part* of a key. In reality, all keys consist of both a name, and a scope (where the scope has three axes). The entire expression `Compile / packageBin / packageOptions` is a key name, in other words. Simply `packageOptions` is also a key name, but a different one (for keys with no in, a scope is implicitly assumed: current project, `Zero` config, `Zero` task).

Build-level settings

An advanced technique for factoring out common settings across subprojects is to define the settings scoped to `ThisBuild`.

If a key that is scoped to a particular subproject is not found, sbt will look for it in `ThisBuild` as a fallback. Using the mechanism, we can define a build-level default setting for frequently used keys such as `version`, `scalaVersion`, and `organization`.

For convenience, there is `inThisBuild(...)` function that will scope both the key and the body of the setting expression to `ThisBuild`. Putting setting expressions in there would be equivalent to appending `in ThisBuild` where possible.

```
lazy val root = (project in file("."))
  .settings(
    inThisBuild(List(
      // Same as:
      // ThisBuild / organization := "com.example"
      organization := "com.example",
      scalaVersion := "2.12.6",
      version      := "0.1.0-SNAPSHOT"
    )),
    name := "Hello",
    publish := (),
    publishLocal := ()
  )

lazy val core = (project in file("core"))
  .settings(
    // other settings
  )

lazy val util = (project in file("util"))
  .settings(
    // other settings
  )
```

Due to the nature of scope delegation that we will cover later, we do not recommend using build-level settings beyond simple value assignments.

Scope delegation

A scoped key may be undefined, if it has no value associated with it in its scope.

For each scope axis, sbt has a fallback search path made up of other scope values. Typically, if a key has no associated value in a more-specific scope, sbt will try to get a value from a more general scope, such as the `ThisBuild` scope.

This feature allows you to set a value once in a more general scope, allowing multiple more-specific scopes to inherit the value. We will discuss scope delegation in detail later.

Appending values

Appending to previous values: `+=` and `++=`

Assignment with `:=` is the simplest transformation, but keys have other methods as well. If the `T` in `SettingKey[T]` is a sequence, i.e. the key's value type is a sequence, you can append to the sequence rather than replacing it.

- `+=` will append a single element to the sequence.
- `++=` will concatenate another sequence.

For example, the key `Compile / sourceDirectories` has a `Seq[File]` as its value. By default this key's value would include `src/main/scala`. If you wanted to also compile source code in a directory called source (since you just have to be nonstandard), you could add that directory:

```
Compile / sourceDirectories += new File("source")
```

Or, using the `file()` function from the sbt package for convenience:

```
Compile / sourceDirectories += file("source")
```

(`file()` just creates a new `File`.)

You could use `++=` to add more than one directory at a time:

```
Compile / sourceDirectories ++= Seq(file("sources1"), file("sources2"))
```

Where `Seq(a, b, c, ...)` is standard Scala syntax to construct a sequence.

To replace the default source directories entirely, you use `:=` of course:

```
Compile / sourceDirectories := Seq(file("sources1"), file("sources2"))
```

When settings are undefined Whenever a setting uses `:=`, `+=`, or `++=` to create a dependency on itself or another key's value, the value it depends on must exist. If it does not, sbt will complain. It might say *"Reference to undefined setting"*, for example. When this happens, be sure you're using the key in the scope that defines it.

It's possible to create cycles, which is an error; sbt will tell you if you do this.

Tasks based on other keys' values You can compute values of some tasks or settings to define or append a value for another task. It's done by using `Def.task` as an argument to `:=`, `+=`, or `++=`.

As a first example, consider appending a source generator using the project base directory and compilation classpath.

```
Compile / sourceGenerators += Def.task {
  myGenerator(baseDirectory.value, (Compile / managedClasspath).value)
}
```

Appending with dependencies: `+=` and `++=`

Other keys can be used when appending to an existing setting or task, just like they can for assigning with `:=`.

For example, say you have a coverage report named after the project, and you want to add it to the files removed by clean:

```
cleanFiles += file("coverage-report-" + name.value + ".txt")
```

Scope delegation (.value lookup)

This page describes scope delegation. It assumes you've read and understood the previous pages, build definition and scopes.

Now that we've covered all the details of scoping, we can explain the `.value` lookup in detail. It's ok to skip this section if this is your first time reading this page.

To summarize what we've learned so far:

- A scope is a tuple of components in three axes: the subproject axis, the configuration axis, and the task axis.
- There's a special scope component `Zero` for any of the scope axes.
- There's a special scope component `ThisBuild` for **the subprojects axis** only.
- `Test` extends `Runtime`, and `Runtime` extends `Compile` configuration.
- A key placed in build.sbt is scoped to `${current subproject} / Zero / Zero` by default.
- A key can scoped using `/` operator.

Now let's suppose we have the following build definition:

```scala
lazy val foo = settingKey[Int]("")
lazy val bar = settingKey[Int]("")

lazy val projX = (project in file("x"))
  .settings(
    foo := {
      (Test / bar).value + 1
    },
    Compile / bar := 1
  )
```

Inside of `foo`'s setting body a dependency on the scoped key `Test / bar` is declared. However, despite `Test / bar` being undefined in `projX`, sbt is still able to resolve `Test / bar` to another scoped key, resulting in `foo` initialized as `2`.

sbt has a well-defined fallback search path called *scope delegation*. This feature allows you to set a value once in a more general scope, allowing multiple more-specific scopes to inherit the value.

Scope delegation rules

Here are the rules for scope delegation:

- Rule 1: Scope axes have the following precedence: the subproject axis, the configuration axis, and then the task axis.
- Rule 2: Given a scope, delegate scopes are searched by substituting the task axis in the following order: the given task scoping, and then `Zero`, which is non-task scoped version of the scope.
- Rule 3: Given a scope, delegate scopes are searched by substituting the configuration axis in the following order: the given configuration, its parents, their parents and so on, and then `Zero` (same as unscoped configuration axis).
- Rule 4: Given a scope, delegate scopes are searched by substituting the subproject axis in the following order: the given subproject, `ThisBuild`, and then `Zero`.
- Rule 5: A delegated scoped key and its dependent settings/tasks are evaluated without carrying the original context.

We will look at each rule in the rest of this page.

Rule 1: Scope axis precedence

- Rule 1: Scope axes have the following precedence: the subproject axis, the configuration axis, and then the task axis.

In other words, given two scope candidates, if one has more specific value on the subproject axis, it will always win regardless of the configuration or the task scoping. Similarly, if subprojects are the same, one with more specific configuration value will always win regardless of the task scoping. We will see more rules to define *more specific*.

Rule 2: The task axis delegation

- Rule 2: Given a scope, delegate scopes are searched by **substituting** the task axis in the following order: the given task scoping, and then `Zero`, which is non-task scoped version of the scope.

Here we have a concrete rule for how sbt will generate delegate scopes given a key. Remember, we are trying to show the search path given an arbitrary `(xxx / yyy).value`.

Exercise A: Given the following build definition:

```
lazy val projA = (project in file("a"))
  .settings(
    name := {
      "foo-" + (packageBin / scalaVersion).value
    },
    scalaVersion := "2.11.11"
  )
```

What is the value of `projA / name`?

1. `"foo-2.11.11"`
2. `"foo-2.12.6"`
3. something else?

The answer is `"foo-2.11.11"`. Inside of `.settings(...)`, `scalaVersion` is automatically scoped to `projA / Zero / Zero`, so `packageBin / scalaVersion` becomes `projA / Zero / packageBin / scalaVersion`. That particular scoped key is undefined. By using Rule 2, sbt will substitute the task axis to `Zero` as `projA / Zero / Zero` (or `projA / scalaVersion`). That scoped key is defined to be `"2.11.11"`.

Rule 3: The configuration axis search path

- Rule 3: Given a scope, delegate scopes are searched by substituting the configuration axis in the following order: the given configuration, its parents, their parents and so on, and then `Zero` (same as unscoped configuration axis).

The example for that is `projX` that we saw earlier:

```
lazy val foo = settingKey[Int]("")
lazy val bar = settingKey[Int]("")

lazy val projX = (project in file("x"))
  .settings(
    foo := {
      (Test / bar).value + 1
    },
    Compile / bar := 1
  )
```

If we write out the full scope again, it's `projX / Test / Zero`. Also recall that `Test` extends `Runtime`, and `Runtime` extends `Compile`.

`Test / bar` is undefined, but due to Rule 3 sbt will look for `bar` scoped in `projX / Test / Zero`, `projX / Runtime / Zero`, and then `projX / Compile / Zero`. The last one is found, which is `Compile / bar`.

Rule 4: The subproject axis search path

- Rule 4: Given a scope, delegate scopes are searched by substituting the subproject axis in the following order: the given subproject, `ThisBuild`, and then `Zero`.

Exercise B: Given the following build definition:

```
ThisBuild / organization := "com.example"

lazy val projB = (project in file("b"))
  .settings(
    name := "abc-" + organization.value,
    organization := "org.tempuri"
  )
```

What is the value of `projB / name`?

1. `"abc-com.example"`
2. `"abc-org.tempuri"`
3. something else?

The answer is `abc-org.tempuri`. So based on Rule 4, the first search path is `organization` scoped to `projB / Zero / Zero`, which is defined in `projB` as `"org.tempuri"`. This has higher precedence than the build-level setting `ThisBuild / organization`.

Scope axis precedence, again **Exercise C**: Given the following build definition:

```
ThisBuild / packageBin / scalaVersion := "2.12.2"

lazy val projC = (project in file("c"))
  .settings(
    name := {
      "foo-" + (packageBin / scalaVersion).value
    },
    scalaVersion := "2.11.11"
  )
```

What is value of `projC / name`?

1. `"foo-2.12.2"`
2. `"foo-2.11.11"`
3. something else?

The answer is `foo-2.11.11`. `scalaVersion` scoped to `projC / Zero / packageBin` is undefined. Rule 2 finds `projC / Zero / Zero`. Rule 4 finds `ThisBuild / Zero / packageBin`. In this case Rule 1 dictates that more specific value on the subproject axis wins, which is `projC / Zero / Zero` that is defined to `"2.11.11"`.

Exercise D: Given the following build definition:

```
ThisBuild / scalacOptions += "-Ywarn-unused-import"

lazy val projD = (project in file("d"))
  .settings(
    test := {
      println((Compile / console / scalacOptions).value)
    },
    console / scalacOptions -= "-Ywarn-unused-import",
    Compile / scalacOptions := scalacOptions.value // added by sbt
  )
```

What would you see if you ran `projD/test`?

1. `List()`
2. `List(-Ywarn-unused-import)`
3. something else?

The answer is `List(-Ywarn-unused-import)`. Rule 2 finds `projD / Compile / Zero`, Rule 3 finds `projD / Zero / console`, and Rule 4 finds `ThisBuild / Zero / Zero`. Rule 1 selects `projD / Compile / Zero` because it has the subproject axis `projD`, and the configuration axis has higher precedence over the task axis.

Next, `Compile / scalacOptions` refers to `scalacOptions.value`, we next need to find a delegate for `projD / Zero / Zero`. Rule 4 finds `ThisBuild / Zero / Zero` and thus it resolves to `List(-Ywarn-unused-import)`.

Inspect command lists the delegates

You might want to look up quickly what is going on. This is where `inspect` can be used.

```
sbt:projd> inspect projD / Compile / console / scalacOptions
[info] Task: scala.collection.Seq[java.lang.String]
[info] Description:
[info]  Options for the Scala compiler.
[info] Provided by:
[info]  ProjectRef(uri("file:/tmp/projd/"), "projD") / Compile / scalacOptions
[info] Defined at:
[info]  /tmp/projd/build.sbt:9
[info] Reverse dependencies:
[info]  projD / test
[info]  projD / Compile / console
[info] Delegates:
[info]  projD / Compile / console / scalacOptions
[info]  projD / Compile / scalacOptions
[info]  projD / console / scalacOptions
[info]  projD / scalacOptions
[info]  ThisBuild / Compile / console / scalacOptions
[info]  ThisBuild / Compile / scalacOptions
[info]  ThisBuild / console / scalacOptions
[info]  ThisBuild / scalacOptions
[info]  Zero / Compile / console / scalacOptions
[info]  Zero / Compile / scalacOptions
[info]  Zero / console / scalacOptions
[info]  Global / scalacOptions
```

Note how "Provided by" shows that `projD / Compile / console / scalacOptions` is provided by `projD / Compile / scalacOptions`. Also under "Delegates", *all* of the possible delegate candidates listed in the order of precedence!

- All the scopes with `projD` scoping on the subproject axis are listed first, then `ThisBuild`, and `Zero`.
- Within a subproject, scopes with `Compile` scoping on the configuration axis are listed first, then falls back to `Zero`.
- Finally, the task axis scoping lists the given task scoping `console /` and the one without.

.value lookup vs dynamic dispatch

- Rule 5: A delegated scoped key and its dependent settings/tasks are evaluated without carrying the original context.

Note that scope delegation feels similar to class inheritance in an object-oriented language, but there's a difference. In an OO language like Scala if there's a method named `drawShape` on a trait `Shape`, its subclasses can override the behavior even when `drawShape` is used by other methods in the `Shape` trait, which is called dynamic dispatch.

In sbt, however, scope delegation can delegate a scope to a more general scope, like a project-level setting to a build-level settings, but that build-level setting cannot refer to the project-level setting.

Exercise E: Given the following build definition:

```
lazy val root = (project in file("."))
  .settings(
    inThisBuild(List(
      organization := "com.example",
      scalaVersion := "2.12.2",
      version      := scalaVersion.value + "_0.1.0"
    )),
    name := "Hello"
  )

lazy val projE = (project in file("e"))
  .settings(
    scalaVersion := "2.11.11"
  )
```

What will `projE / version` return?

1. `"2.12.2_0.1.0"`
2. `"2.11.11_0.1.0"`
3. something else?

The answer is `2.12.2_0.1.0`. `projD / version` delegates to `ThisBuild / version`, which depends on `ThisBuild / scalaVersion`. Because of this reason, build level setting should be limited mostly to simple value assignments.

Exercise F: Given the following build definition:

```
ThisBuild / scalacOptions += "-D0"
scalacOptions += "-D1"

lazy val projF = (project in file("f"))
  .settings(
    compile / scalacOptions += "-D2",
    Compile / scalacOptions += "-D3",
    Compile / compile / scalacOptions += "-D4",
    test := {
      println("bippy" + (Compile / compile / scalacOptions).value.mkString)
    }
  )
```

What will `projF / test` show?

1. `"bippy-D4"`
2. `"bippy-D2-D4"`
3. `"bippy-D0-D3-D4"`
4. something else?

The answer is `"bippy-D0-D3-D4"`. This is a variation of an exercise originally created by Paul Phillips.

It's a great demonstration of all the rules because `someKey += "x"` expands to

```
someKey := {
  val old = someKey.value
  old :+ "x"
}
```

Retrieving the old value would cause delegation, and due to Rule 5, it will go to another scoped key. Let's get rid of `+=` first, and annotate the delegates for old values:

```
ThisBuild / scalacOptions := {
  // Global / scalacOptions <- Rule 4
  val old = (ThisBuild / scalacOptions).value
  old :+ "-D0"
}
```

```
scalacOptions := {
  // ThisBuild / scalacOptions <- Rule 4
  val old = scalacOptions.value
  old :+ "-D1"
}

lazy val projF = (project in file("f"))
  .settings(
    compile / scalacOptions := {
      // ThisBuild / scalacOptions <- Rules 2 and 4
      val old = (compile / scalacOptions).value
      old :+ "-D2"
    },
    Compile / scalacOptions := {
      // ThisBuild / scalacOptions <- Rules 3 and 4
      val old = (Compile / scalacOptions).value
      old :+ "-D3"
    },
    Compile / compile / scalacOptions := {
      // projF / Compile / scalacOptions <- Rules 1 and 2
      val old = (Compile / compile / scalacOptions).value
      old :+ "-D4"
    },
    test := {
      println("bippy" + (Compile / compile / scalacOptions).value.mkString)
    }
  )
```

This becomes:

```
ThisBuild / scalacOptions := {
  Nil :+ "-D0"
}

scalacOptions := {
  List("-D0") :+ "-D1"
}

lazy val projF = (project in file("f"))
  .settings(
    compile / scalacOptions := List("-D0") :+ "-D2",
    Compile / scalacOptions := List("-D0") :+ "-D3",
    Compile / compile / scalacOptions := List("-D0", "-D3") :+ "-D4",
    test := {
```

```
    println("bippy" + (Compile / compile / scalacOptions).value.mkString)
  }
)
```

Library dependencies

This page assumes you've already read the earlier Getting Started pages, in particular build definition, scopes, and task graph.

Library dependencies can be added in two ways:

- *unmanaged dependencies* are jars dropped into the `lib` directory
- *managed dependencies* are configured in the build definition and downloaded automatically from repositories

Unmanaged dependencies

Most people use managed dependencies instead of unmanaged. But unmanaged can be simpler when starting out.

Unmanaged dependencies work like this: add jars to `lib` and they will be placed on the project classpath. Not much else to it!

You can place test jars such as ScalaCheck, Specs2, and ScalaTest in `lib` as well.

Dependencies in `lib` go on all the classpaths (for `compile`, `test`, `run`, and `console`). If you wanted to change the classpath for just one of those, you would adjust `dependencyClasspath in Compile` or `dependencyClasspath in Runtime` for example.

There's nothing to add to `build.sbt` to use unmanaged dependencies, though you could change the `unmanagedBase` key if you'd like to use a different directory rather than `lib`.

To use `custom_lib` instead of `lib`:

```
unmanagedBase := baseDirectory.value / "custom_lib"
```

`baseDirectory` is the project's root directory, so here you're changing `unmanagedBase` depending on `baseDirectory` using the special `value` method as explained in task graph.

There's also an `unmanagedJars` task which lists the jars from the `unmanagedBase` directory. If you wanted to use multiple directories or do something else complex, you might need to replace the whole `unmanagedJars` task with one that does something else, e.g. empty the list for `Compile` configuration regardless of the files in `lib` directory:

```
Compile / unmanagedJars := Seq.empty[sbt.Attributed[java.io.File]]
```

Managed Dependencies

sbt uses Apache Ivy to implement managed dependencies, so if you're familiar with Ivy or Maven, you won't have much trouble.

The `libraryDependencies` key Most of the time, you can simply list your dependencies in the setting `libraryDependencies`. It's also possible to write a Maven POM file or Ivy configuration file to externally configure your dependencies, and have sbt use those external configuration files. You can learn more about that here.

Declaring a dependency looks like this, where `groupId`, `artifactId`, and `revision` are strings:

```
libraryDependencies += groupID % artifactID % revision
```

or like this, where `configuration` can be a string or Configuration val:

```
libraryDependencies += groupID % artifactID % revision % configuration
```

`libraryDependencies` is declared in Keys like this:

```
val libraryDependencies = settingKey[Seq[ModuleID]]("Declares managed dependencies.")
```

The `%` methods create `ModuleID` objects from strings, then you add those `ModuleID` to `libraryDependencies`.

Of course, sbt (via Ivy) has to know where to download the module. If your module is in one of the default repositories sbt comes with, this will just work. For example, Apache Derby is in the standard Maven2 repository:

```
libraryDependencies += "org.apache.derby" % "derby" % "10.4.1.3"
```

If you type that in `build.sbt` and then `update`, sbt should download Derby to `~/.ivy2/cache/org.apache.derby/`. (By the way, `update` is a dependency of `compile` so there's no need to manually type `update` most of the time.)

Of course, you can also use `++=` to add a list of dependencies all at once:

```
libraryDependencies ++= Seq(
  groupID % artifactID % revision,
  groupID % otherID % otherRevision
)
```

In rare cases you might find reasons to use `:=` with `libraryDependencies` as well.

Getting the right Scala version with %% If you use `groupID %% artifactID % revision` rather than `groupID % artifactID % revision` (the difference is the double `%%` after the `groupID`), sbt will add your project's binary Scala version to the artifact name. This is just a shortcut. You could write this without the `%%`:

```
libraryDependencies += "org.scala-tools" % "scala-stm_2.11" % "0.3"
```

Assuming the `scalaVersion` for your build is `2.11.1`, the following is identical (note the double `%%` after `"org.scala-tools"`):

```
libraryDependencies += "org.scala-tools" %% "scala-stm" % "0.3"
```

The idea is that many dependencies are compiled for multiple Scala versions, and you'd like to get the one that matches your project to ensure binary compatibility.

See Cross Building for some more detail on this.

Ivy revisions The `revision` in `groupID % artifactID % revision` does not have to be a single fixed version. Ivy can select the latest revision of a module according to constraints you specify. Instead of a fixed revision like `"1.6.1"`, you specify `"latest.integration"`, `"2.9.+"`, or `"[1.0,)"`. See the Ivy revisions documentation for details.

Occasionally a Maven "version range" is used to specify a dependency (transitive or otherwise), such as `[1.3.0,)`. If a specific version of the dependency is declared in the build, and it satisfies the range, then sbt will use the specified version. Otherwise, Ivy could go out to the Internet to find the latest version. This would result to a surprising behavior where the effective version keeps changing over time, even though there's a specified version of the library that satisfies the range condition.

Maven version ranges will be replaced with its lower bound if the build so that when a satisfactory version is found in the dependency graph it will be used. You can disable this behavior using the JVM flag `-Dsbt.modversionrange=false`.

Resolvers Not all packages live on the same server; sbt uses the standard Maven2 repository by default. If your dependency isn't on one of the default repositories, you'll have to add a *resolver* to help Ivy find it.

To add an additional repository, use

```
resolvers += name at location
```

with the special at between two strings.

For example:

```
resolvers += "Sonatype OSS Snapshots" at "https://oss.sonatype.org/content/repositories/snap
```

The resolvers key is defined in Keys like this:

```
val resolvers = settingKey[Seq[Resolver]]("The user-defined additional resolvers for automat
```

The at method creates a Resolver object from two strings.

sbt can search your local Maven repository if you add it as a repository:

```
resolvers += "Local Maven Repository" at "file://"+Path.userHome.absolutePath+"/.m2/reposito
```

or, for convenience:

```
resolvers += Resolver.mavenLocal
```

See Resolvers for details on defining other types of repositories.

Overriding default resolvers resolvers does not contain the default resolvers; only additional ones added by your build definition.

sbt combines resolvers with some default repositories to form externalResolvers.

Therefore, to change or remove the default resolvers, you would need to override externalResolvers instead of resolvers.

Per-configuration dependencies Often a dependency is used by your test code (in src/test/scala, which is compiled by the Test configuration) but not your main code.

If you want a dependency to show up in the classpath only for the Test configuration and not the Compile configuration, add % "test" like this:

```
libraryDependencies += "org.apache.derby" % "derby" % "10.4.1.3" % "test"
```

You may also use the type-safe version of Test configuration as follows:

```
libraryDependencies += "org.apache.derby" % "derby" % "10.4.1.3" % Test
```

Now, if you type `show compile:dependencyClasspath` at the sbt interactive prompt, you should not see the derby jar. But if you type `show test:dependencyClasspath`, you should see the derby jar in the list.

Typically, test-related dependencies such as ScalaCheck, Specs2, and ScalaTest would be defined with `% "test"`.

There are more details and tips-and-tricks related to library dependencies on this page.

Multi-project builds

This page introduces multiple subprojects in a single build.

Please read the earlier pages in the Getting Started Guide first, in particular you need to understand build.sbt before reading this page.

Multiple subprojects

It can be useful to keep multiple related subprojects in a single build, especially if they depend on one another and you tend to modify them together.

Each subproject in a build has its own source directories, generates its own jar file when you run package, and in general works like any other project.

A project is defined by declaring a lazy val of type Project. For example, :

```
lazy val util = (project in file("util"))

lazy val core = (project in file("core"))
```

The name of the val is used as the subproject's ID, which is used to refer to the subproject at the sbt shell.

Optionally the base directory may be omitted if it's the same as the name of the val.

```
lazy val util = project

lazy val core = project
```

Common settings To factor out common settings across multiple projects, create a sequence named `commonSettings` and call `settings` method on each project.

```
lazy val commonSettings = Seq(
  organization := "com.example",
  version := "0.1.0-SNAPSHOT",
  scalaVersion := "2.12.6"
)

lazy val core = (project in file("core"))
  .settings(
    commonSettings,
    // other settings
  )

lazy val util = (project in file("util"))
  .settings(
    commonSettings,
    // other settings
  )
```

Now we can bump up `version` in one place, and it will be reflected across subprojects when you reload the build.

Build-wide settings Another a bit advanced technique for factoring out common settings across subprojects is to define the settings scoped to `ThisBuild`. (See Scopes)

Dependencies

Projects in the build can be completely independent of one another, but usually they will be related to one another by some kind of dependency. There are two types of dependencies: aggregate and classpath.

Aggregation Aggregation means that running a task on the aggregate project will also run it on the aggregated projects. For example,

```
lazy val root = (project in file("."))
  .aggregate(util, core)

lazy val util = (project in file("util"))

lazy val core = (project in file("core"))
```

In the above example, the root project aggregates `util` and `core`. Start up sbt with two subprojects as in the example, and try compile. You should see that all three projects are compiled.

In the project doing the aggregating, the root project in this case, you can control aggregation per-task. For example, to avoid aggregating the update task:

```
lazy val root = (project in file("."))
  .aggregate(util, core)
  .settings(
    update / aggregate := false
  )

[...]
```

update / aggregate is the aggregate key scoped to the update task. (See scopes.)

Note: aggregation will run the aggregated tasks in parallel and with no defined ordering between them.

Classpath dependencies A project may depend on code in another project. This is done by adding a dependsOn method call. For example, if core needed util on its classpath, you would define core as:

```
lazy val core = project.dependsOn(util)
```

Now code in core can use classes from util. This also creates an ordering between the projects when compiling them; util must be updated and compiled before core can be compiled.

To depend on multiple projects, use multiple arguments to dependsOn, like dependsOn(bar, baz).

Per-configuration classpath dependencies core dependsOn(util) means that the compile configuration in core depends on the compile configuration in util. You could write this explicitly as dependsOn(util % "compile->compile").

The -> in "compile->compile" means "depends on" so "test->compile" means the test configuration in core would depend on the compile configuration in util.

Omitting the ->config part implies ->compile, so dependsOn(util % "test") means that the test configuration in core depends on the Compile configuration in util.

A useful declaration is "test->test" which means test depends on test. This allows you to put utility code for testing in util/src/test/scala and then use that code in core/src/test/scala, for example.

You can have multiple configurations for a dependency, separated by semicolons. For example, dependsOn(util % "test->test;compile->compile").

Inter-project dependencies

On extremely large projects with many files and many subprojects, sbt can perform less optimally at watching files have changed during interactively and using a lot of disk and system I/O.

sbt has `trackInternalDependencies` and `exportToInternal` settings. These can be used to control whether to trigger compilation of a dependent subprojects when you call `compile`. Both keys will take one of three values: `TrackLevel.NoTracking`, `TrackLevel.TrackIfMissing`, and `TrackLevel.TrackAlways`. By default they are both set to `TrackLevel.TrackAlways`.

When `trackInternalDependencies` is set to `TrackLevel.TrackIfMissing`, sbt will no longer try to compile internal (inter-project) dependencies automatically, unless there are no `*.class` files (or JAR file when `exportJars` is `true`) in the output directory.

When the setting is set to `TrackLevel.NoTracking`, the compilation of internal dependencies will be skipped. Note that the classpath will still be appended, and dependency graph will still show them as dependencies. The motivation is to save the I/O overhead of checking for the changes on a build with many subprojects during development. Here's how to set all subprojects to `TrackIfMissing`.

```
lazy val root = (project in file(".")).
  aggregate(....).
  settings(
    inThisBuild(Seq(
      trackInternalDependencies := TrackLevel.TrackIfMissing,
      exportJars := true
    ))
  )
```

The `exportToInternal` setting allows the dependee subprojects to opt out of the internal tracking, which might be useful if you want to track most subprojects except for a few. The intersection of the `trackInternalDependencies` and `exportToInternal` settings will be used to determine the actual track level. Here's an example to opt-out one project:

```
lazy val dontTrackMe = (project in file("dontTrackMe")).
  settings(
    exportToInternal := TrackLevel.NoTracking
  )
```

Default root project

If a project is not defined for the root directory in the build, sbt creates a default one that aggregates all other projects in the build.

Because project `hello-foo` is defined with `base = file("foo")`, it will be contained in the subdirectory foo. Its sources could be directly under `foo`, like `foo/Foo.scala`, or in `foo/src/main/scala`. The usual sbt directory structure applies underneath `foo` with the exception of build definition files.

Any `.sbt` files in `foo`, say `foo/build.sbt`, will be merged with the build definition for the entire build, but scoped to the `hello-foo` project.

If your whole project is in hello, try defining a different version (`version := "0.6"`) in `hello/build.sbt`, `hello/foo/build.sbt`, and `hello/bar/build.sbt`. Now `show version` at the sbt interactive prompt. You should get something like this (with whatever versions you defined):

```
> show version
[info] hello-foo/*:version
[info]  0.7
[info] hello-bar/*:version
[info]  0.9
[info] hello/*:version
[info]  0.5
```

`hello-foo/*:version` was defined in `hello/foo/build.sbt`, `hello-bar/*:version` was defined in `hello/bar/build.sbt`, and `hello/*:version` was defined in `hello/build.sbt`. Remember the syntax for scoped keys. Each `version` key is scoped to a project, based on the location of the `build.sbt`. But all three `build.sbt` are part of the same build definition.

Each project's settings can go in `.sbt` files in the base directory of that project, while the `.scala` file can be as simple as the one shown above, listing the projects and base directories. *There is no need to put settings in the `.scala` file.*

You may find it cleaner to put everything including settings in `.scala` files in order to keep all build definition under a single project directory, however. It's up to you.

You cannot have a project subdirectory or `project/*.scala` files in the sub-projects. `foo/project/Build.scala` would be ignored.

Navigating projects interactively

At the sbt interactive prompt, type `projects` to list your projects and `project <projectname>` to select a current project. When you run a task like `compile`, it runs on the current project. So you don't necessarily have to compile the root project, you could compile only a subproject.

You can run a task in another project by explicitly specifying the project ID, such as `subProjectID/compile`.

Common code

The definitions in `.sbt` files are not visible in other `.sbt` files. In order to share code between `.sbt` files, define one or more Scala files in the `project/` directory of the build root.

See organizing the build for details.

Using plugins

Please read the earlier pages in the Getting Started Guide first, in particular you need to understand build.sbt, task graph, library dependencies, before reading this page.

What is a plugin?

A plugin extends the build definition, most commonly by adding new settings. The new settings could be new tasks. For example, a plugin could add a `codeCoverage` task which would generate a test coverage report.

Declaring a plugin

If your project is in directory `hello`, and you're adding sbt-site plugin to the build definition, create `hello/project/site.sbt` and declare the plugin dependency by passing the plugin's Ivy module ID to `addSbtPlugin`:

```
addSbtPlugin("com.typesafe.sbt" % "sbt-site" % "0.7.0")
```

If you're adding sbt-assembly, create `hello/project/assembly.sbt` with the following:

```
addSbtPlugin("com.eed3si9n" % "sbt-assembly" % "0.11.2")
```

Not every plugin is located on one of the default repositories and a plugin's documentation may instruct you to also add the repository where it can be found:

```
resolvers += Resolver.sonatypeRepo("public")
```

Plugins usually provide settings that get added to a project to enable the plugin's functionality. This is described in the next section.

Enabling and disabling auto plugins

A plugin can declare that its settings be automatically added to the build definition, in which case you don't have to do anything to add them.

As of sbt 0.13.5, there is a new auto plugins feature that enables plugins to automatically, and safely, ensure their settings and dependencies are on a project. Many auto plugins should have their default settings automatically, however some may require explicit enablement.

If you're using an auto plugin that requires explicit enablement, then you have to add the following to your `build.sbt`:

```
lazy val util = (project in file("util"))
  .enablePlugins(FooPlugin, BarPlugin)
  .settings(
    name := "hello-util"
  )
```

The `enablePlugins` method allows projects to explicitly define the auto plugins they wish to consume.

Projects can also exclude plugins using the `disablePlugins` method. For example, if we wish to remove the `IvyPlugin` settings from `util`, we modify our `build.sbt` as follows:

```
lazy val util = (project in file("util"))
  .enablePlugins(FooPlugin, BarPlugin)
  .disablePlugins(plugins.IvyPlugin)
  .settings(
    name := "hello-util"
  )
```

Auto plugins should document whether they need to be explicitly enabled. If you're curious which auto plugins are enabled for a given project, just run the `plugins` command on the sbt console.

For example:

```
> plugins
In file:/home/jsuereth/projects/sbt/test-ivy-issues/
        sbt.plugins.IvyPlugin: enabled in scala-sbt-org
        sbt.plugins.JvmPlugin: enabled in scala-sbt-org
        sbt.plugins.CorePlugin: enabled in scala-sbt-org
        sbt.plugins.JUnitXmlReportPlugin: enabled in scala-sbt-org
```

Here, the `plugins` output is showing that the sbt default plugins are all enabled. sbt's default settings are provided via three plugins:

1. `CorePlugin`: Provides the core parallelism controls for tasks.
2. `IvyPlugin`: Provides the mechanisms to publish/resolve modules.
3. `JvmPlugin`: Provides the mechanisms to compile/test/run/package Java/Scala projects.

In addition, `JUnitXmlReportPlugin` provides an experimental support for generating junit-xml.

Older non-auto plugins often require settings to be added explicitly, so that multi-project build could have different types of projects. The plugin documentation will indicate how to configure it, but typically for older plugins this involves adding the base settings for the plugin and customizing as necessary.

For example, for the sbt-site plugin, create `site.sbt` with the following content

```
site.settings
```

to enable it for that project.

If the build defines multiple projects, instead add it directly to the project:

```
// don't use the site plugin for the `util` project
lazy val util = (project in file("util"))

// enable the site plugin for the `core` project
lazy val core = (project in file("core"))
  .settings(site.settings)
```

Global plugins

Plugins can be installed for all your projects at once by declaring them in `~/.sbt/1.0/plugins/`. `~/.sbt/1.0/plugins/` is an sbt project whose classpath is exported to all sbt build definition projects. Roughly speaking, any `.sbt` or `.scala` files in `~/.sbt/1.0/plugins/` behave as if they were in the `project/` directory for all projects.

You can create `~/.sbt/1.0/plugins//build.sbt` and put `addSbtPlugin()` expressions in there to add plugins to all your projects at once. Because doing so would increase the dependency on the machine environment, this feature should be used sparingly. See Best Practices.

Available Plugins

There's a list of available plugins.

Some especially popular plugins are:

- those for IDEs (to import an sbt project into your IDE)
- those supporting web frameworks, such as xsbt-web-plugin.

For more details, including ways of developing plugins, see Plugins. For best practices, see Plugins-Best-Practices.

Custom settings and tasks

This page gets you started creating your own settings and tasks.

To understand this page, be sure you've read earlier pages in the Getting Started Guide, especially build.sbt and task graph.

Defining a key

Keys is packed with examples illustrating how to define keys. Most of the keys are implemented in Defaults.

Keys have one of three types. `SettingKey` and `TaskKey` are described in .sbt build definition. Read about `InputKey` on the Input Tasks page.

Some examples from Keys:

```
val scalaVersion = settingKey[String]("The version of Scala used for building.")
val clean = taskKey[Unit]("Deletes files produced by the build, such as generated sources, c
```

The key constructors have two string parameters: the name of the key (`"scalaVersion"`) and a documentation string (`"The version of scala used for building."`).

Remember from .sbt build definition that the type parameter `T` in `SettingKey[T]` indicates the type of value a setting has. `T` in `TaskKey[T]` indicates the type of the task's result. Also remember from .sbt build definition that a setting has a fixed value until project reload, while a task is re-computed for every "task execution" (every time someone types a command at the sbt interactive prompt or in batch mode).

Keys may be defined in an .sbt file, a .scala file, or in an auto plugin. Any `val`s found under `autoImport` object of an enabled auto plugin will be imported automatically into your `.sbt` files.

Implementing a task

Once you've defined a key for your task, you'll need to complete it with a task definition. You could be defining your own task, or you could be planning to redefine an existing task. Either way looks the same; use `:=` to associate some code with the task key:

```
val sampleStringTask = taskKey[String]("A sample string task.")
val sampleIntTask = taskKey[Int]("A sample int task.")

lazy val commonSettings = Seq(
  organization := "com.example",
  version := "0.1.0-SNAPSHOT"
)

lazy val library = (project in file("library"))
  .settings(
    commonSettings,
    sampleStringTask := System.getProperty("user.home"),
    sampleIntTask := {
      val sum = 1 + 2
      println("sum: " + sum)
      sum
    }
  )
```

If the task has dependencies, you'd reference their value using `value`, as discussed in task graph.

The hardest part about implementing tasks is often not sbt-specific; tasks are just Scala code. The hard part could be writing the "body" of your task that does whatever you're trying to do. For example, maybe you're trying to format HTML in which case you might want to use an HTML library (you would add a library dependency to your build definition and write code based on the HTML library, perhaps).

sbt has some utility libraries and convenience functions, in particular you can often use the convenient APIs in IO to manipulate files and directories.

Execution semantics of tasks

When depending on other tasks from a custom task using `value`, an important detail to note is the execution semantics of the tasks. By execution semantics, we mean exactly *when* these tasks are evaluated.

If we take `sampleIntTask` for instance, each line in the body of the task should be strictly evaluated one after the other. That is sequential semantics:

```scala
sampleIntTask := {
  val sum = 1 + 2        // first
  println("sum: " + sum) // second
  sum                    // third
}
```

In reality JVM may inline the `sum` to `3`, but the observable *effect* of the task will remain identical as if each line were executed one after the other.

Now suppose we define two more custom tasks `startServer` and `stopServer`, and modify `sampleIntTask` as follows:

```scala
val startServer = taskKey[Unit]("start server")
val stopServer = taskKey[Unit]("stop server")
val sampleIntTask = taskKey[Int]("A sample int task.")
val sampleStringTask = taskKey[String]("A sample string task.")

lazy val commonSettings = Seq(
  organization := "com.example",
  version := "0.1.0-SNAPSHOT"
)

lazy val library = (project in file("library"))
  .settings(
    commonSettings,
    startServer := {
      println("starting...")
      Thread.sleep(500)
    },
    stopServer := {
      println("stopping...")
      Thread.sleep(500)
    },
    sampleIntTask := {
      startServer.value
      val sum = 1 + 2
      println("sum: " + sum)
      stopServer.value // THIS WON'T WORK
      sum
    },
    sampleStringTask := {
      startServer.value
      val s = sampleIntTask.value.toString
      println("s: " + s)
      s
```

```
    }
  )
```

Running `sampleIntTask` from sbt interactive prompt results to the following:

```
> sampleIntTask
stopping...
starting...
sum: 3
[success] Total time: 1 s, completed Dec 22, 2014 5:00:00 PM
```

To review what happened, let's look at a graphical notation of `sampleIntTask`:

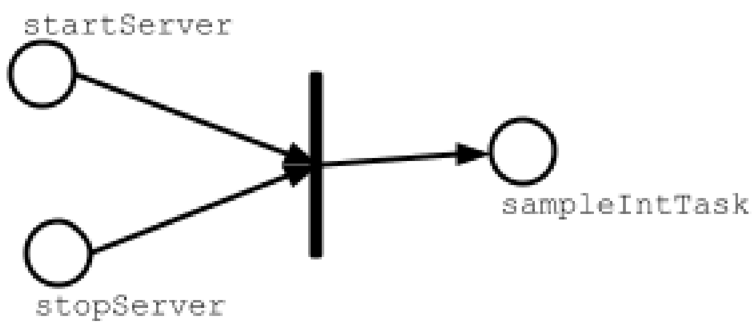


Figure 4: task-dependency

Unlike plain Scala method calls, invoking `value` method on tasks will not be evaluated strictly. Instead, they simply act as placeholders to denote that `sampleIntTask` depends on `startServer` and `stopServer` tasks. When `sampleIntTask` is invoked by you, sbt's tasks engine will:

- evaluate the task dependencies *before* evaluating `sampleIntTask` (partial ordering)
- try to evaluate task dependencies in parallel if they are independent (parallelization)
- each task dependency will be evaluated once and only once per command execution (deduplication)

Deduplication of task dependencies To demonstrate the last point, we can run `sampleStringTask` from sbt interactive prompt.

```
> sampleStringTask
stopping...
```

```
starting...
sum: 3
s: 3
[success] Total time: 1 s, completed Dec 22, 2014 5:30:00 PM
```

Because `sampleStringTask` depends on both `startServer` and `sampleIntTask` task, and `sampleIntTask` also depends on `startServer` task, it appears twice as task dependency. If this was a plain Scala method call it would be evaluated twice, but since `value` is just denoting a task dependency, it will be evaluated once. The following is a graphical notation of `sampleStringTask`'s evaluation:

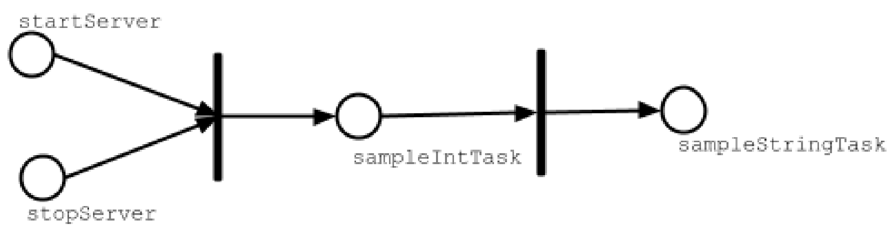


Figure 5: task-dependency

If we did not deduplicate the task dependencies, we will end up compiling test source code many times when `test` task is invoked since `compile in Test` appears many times as a task dependency of `test in Test`.

Cleanup task How should one implement `stopServer` task? The notion of cleanup task does not fit into the execution model of tasks because tasks are about tracking dependencies. The last operation should become the task that depends on other intermediate tasks. For instance `stopServer` should depend on `sampleStringTask`, at which point `stopServer` should be the `sampleStringTask`.

```
lazy val library = (project in file("library"))
  .settings(
    commonSettings,
    startServer := {
      println("starting...")
      Thread.sleep(500)
    },
    sampleIntTask := {
      startServer.value
      val sum = 1 + 2
      println("sum: " + sum)
      sum
```

```
    },
    sampleStringTask := {
      startServer.value
      val s = sampleIntTask.value.toString
      println("s: " + s)
      s
    },
    sampleStringTask := {
      val old = sampleStringTask.value
      println("stopping...")
      Thread.sleep(500)
      old
    }
  )
```

To demonstrate that it works, run `sampleStringTask` from the interactive prompt:

```
> sampleStringTask
starting...
sum: 3
s: 3
stopping...
[success] Total time: 1 s, completed Dec 22, 2014 6:00:00 PM
```

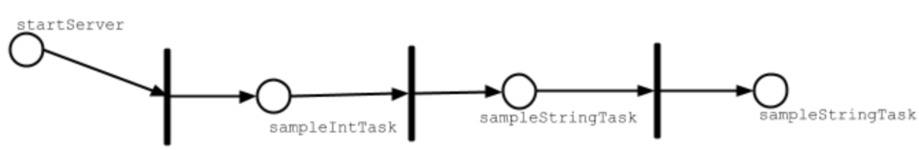


Figure 6: task-dependency

Use plain Scala Another way of making sure that something happens after some other thing is to use Scala. Implement a simple function in `project/ServerUtil.scala` for example, and you can write:

```
sampleIntTask := {
  ServerUtil.startServer
  try {
    val sum = 1 + 2
    println("sum: " + sum)
  } finally {
```

```
    ServerUtil.stopServer
  }
  sum
}
```

Since plain method calls follow sequential semantics, everything happens in order. There's no deduplication, so you have to be careful about that.

Turn them into plugins

If you find you have a lot of custom code, consider moving it to a plugin for re-use across multiple builds.

It's very easy to create a plugin, as teased earlier and discussed at more length here.

This page has been a quick taste; there's much much more about custom tasks on the Tasks page.

Organizing the build

This page discusses the organization of the build structure.

Please read the earlier pages in the Getting Started Guide first, in particular you need to understand build.sbt, task graph, Library dependencies, and Multi-project builds before reading this page.

sbt is recursive

`build.sbt` conceals how sbt really works. sbt builds are defined with Scala code. That code, itself, has to be built. What better way than with sbt?

The `project` directory *is another build inside your build*, which knows how to build your build. To distinguish the builds, we sometimes use the term **proper build** to refer to your build, and **meta-build** to refer to the build in `project`. The projects inside the metabuild can do anything any other project can do. *Your build definition is an sbt project.*

And the turtles go all the way down. If you like, you can tweak the build definition of the build definition project, by creating a `project/project/` directory.

Here's an illustration.

```
hello/                  # your build's root project's base directory

   Hello.scala           # a source file in your build's root project
```

```
                            #   (could be in src/main/scala too)

   build.sbt             # build.sbt is part of the source code for
                       #   meta-build's root project inside project/;
                            #   the build definition for your build

   project/             # base directory of meta-build's root project

     Dependencies.scala # a source file in the meta-build's root project,
                      #   that is, a source file in the build definition
                            #   the build definition for your build

       assembly.sbt       # this is part of the source code for
                     #   meta-meta-build's root project in project/project;
                            #   build definition's build definition

     project/       # base directory of meta-meta-build's root project;
                     #   the build definition project for the build definition

          MetaDeps.scala # source file in the root project of
                            #   meta-meta-build in project/project/
```

Don't worry! Most of the time you are not going to need all that. But understanding the principle can be helpful.

By the way: any time files ending in `.scala` or `.sbt` are used, naming them `build.sbt` and `Dependencies.scala` are conventions only. This also means that multiple files are allowed.

Tracking dependencies in one place

One way of using the fact that `.scala` files under `project` becomes part of the build definition is to create `project/Dependencies.scala` to track dependencies in one place.

```scala
import sbt._

object Dependencies {
  // Versions
  lazy val akkaVersion = "2.3.8"

  // Libraries
  val akkaActor = "com.typesafe.akka" %% "akka-actor" % akkaVersion
  val akkaCluster = "com.typesafe.akka" %% "akka-cluster" % akkaVersion
  val specs2core = "org.specs2" %% "specs2-core" % "2.4.17"
```

```
  // Projects
  val backendDeps =
    Seq(akkaActor, specs2core % Test)
}
```

The `Dependencies` object will be available in `build.sbt`. To use the `val`s under it easier, import `Dependencies._`.

```
import Dependencies._

lazy val commonSettings = Seq(
  version := "0.1.0",
  scalaVersion := "2.12.6"
)

lazy val backend = (project in file("backend"))
  .settings(
    commonSettings,
    libraryDependencies ++= backendDeps
  )
```

This technique is useful when you have a multi-project build that's getting large, and you want to make sure that subprojects to have consistent dependencies.

When to use .scala files

In `.scala` files, you can write any Scala code, including top-level classes and objects.

The recommended approach is to define most settings in a multi-project `build.sbt` file, and using `project/*.scala` files for task implementations or to share values, such as keys. The use of `.scala` files also depends on how comfortable you or your team are with Scala.

Defining auto plugins

For more advanced users, another way of organizing your build is to define one-off auto plugins in `project/*.scala`. By defining triggered plugins, auto plugins can be used as a convenient way to inject custom tasks and commands across all subprojects.

Getting Started summary

This page wraps up the Getting Started Guide.

To use sbt, there are a small number of concepts you must understand. These have some learning curve, but on the positive side, there isn't much to sbt *except* these concepts. sbt uses a small core of powerful concepts to do everything it does.

If you've read the whole Getting Started series, now you know what you need to know.

sbt: The Core Concepts

- the basics of Scala. It's undeniably helpful to be familiar with Scala syntax. Programming in Scala written by the creator of Scala is a great introduction.
- .sbt build definition
- your build definition is a big DAG of tasks and their dependencies.
- to create a `Setting`, call one of a few methods on a key: `:=`, `+=`, or `++=`.
- each setting has a value of a particular type, determined by the key.
- *tasks* are special settings where the computation to produce the key's value will be re-run each time you kick off a task. Non-tasks compute the value once, when first loading the build definition.
- Scopes
- each key may have multiple values, in distinct scopes.
- scoping may use three axes: configuration, project, and task.
- scoping allows you to have different behaviors per-project, per-task, or per-configuration.
- a configuration is a kind of build, such as the main one (`Compile`) or the test one (`Test`).
- the per-project axis also supports "entire build" scope.
- scopes fall back to or *delegate* to more general scopes.
- put most of your configuration in `build.sbt`, but use `.scala` build definition files for defining classes and larger task implementations.
- the build definition is an sbt project in its own right, rooted in the project directory.
- Plugins are extensions to the build definition
- add plugins with the `addSbtPlugin` method in `project/plugins.sbt` (NOT `build.sbt` in the project's base directory).

If any of this leaves you wondering rather than nodding, please ask for help, go back and re-read, or try some experiments in sbt's interactive mode.

Good luck!

Advanced Notes

Since sbt is open source, don't forget you can check out the source code too!

General Information

This part of the documentation has project "meta-information" such as where to get help, find source code and how to contribute.

Credits

sbt was originally created by Mark Harrah ([@harrah][@harrah]) in 2008. Most of the fundamental aspects of sbt, such as the Scala incremental compiler, integration with Maven and Ivy dependencies, and parallel task processing were conceived and initially implemented by Mark.

By 2010, when sbt 0.7 came out, many open-source Scala projects were using sbt as their build tool.

Mark joined Typesafe (now Lightbend) in 2011, the year the company was founded. sbt 0.10.0 shipped that same year. Mark remained the maintainer and most active contributor until March 2014, with sbt 0.13.1 as his last release.

Josh Suereth ([@jsuereth][@jsuereth]) at Typesafe became the next maintainer of sbt.

In 2014, Eugene Yokota ([@eed3si9n][@eed3si9n]) joined Typesafe to co-lead sbt with Josh. This team carried the 0.13 series through 0.13.5 and started the trajectory to 1.0 as technology previews. By the time of Josh's departure in 2015, after sbt 0.13.9, they had shipped `AutoPlugin`, kept sbt 0.13 in shape, and laid groundwork for sbt server.

Grzegorz Kossakowski ([@gkossakowski][@gkossakowski]) worked on a better incremental compiler algorithm called "name hashing" during his time on the Scala team at Typesafe. Name hashing became the default incremental compiler in sbt 0.13.6 (2014). Lightbend later commissioned Grzegorz to refine name hashing using a technique called class-based name hashing, which was adopted by Zinc 1. Another notable contribution from Grzegorz was hosting a series of meetups with @WarszawScaLa, and (with his arm in a sling!) guiding the Warszaw Scala community to fix the infamous blank-line problem.

In May 2015, Dale Wijnand ([@dwijnand][@dwijnand]) became a committer from the community after contributing features such as `inThisBuild` and `-=`.

From June 2015 to early 2016, Martin Duhem ([@Duhemm][@Duhemm]) joined Typesafe as an intern, working on sbt. During this time, Martin worked on crucial components such as making the compiler bridge configurable for Zinc, and code generation for pseudo case classes (which later became Contraband).

Around this time, Eugene, Martin, and Dale started the sbt 1.x codebase, splitting the code base into multiple modules: sbt/sbt, Zinc 1, sbt/librarymanagement, sbt/util, and sbt/io. The aim was to make Zinc 1, an incremental compiler usable by all build tools.

In August 2016, Dale joined the Tooling team at Lightbend. Dale and Eugene oversaw the releases 0.13.12 through 0.13.16, as well as the development of sbt 1.0.

In spring 2017, the Scala Center joined the Zinc 1 development effort. Jorge Vicente Cantero ([@jvican][@jvican]) has contributed a number of improvements including the fix for the "as seen from" bug that had blocked Zinc 1.

According to `git shortlog -sn --no-merges` on sbt/sbt, sbt/zinc, sbt/librarymanagement, sbt/util, sbt/io, sbt/contraband, and sbt/website there were 9151 non-merge commits by 318 contributors.

- Mark Harrah 3852
- Eugene Yokota (eed3si9n) 1760
- Dale Wijnand 524
- Josh Suereth 357
- Grzegorz Kossakowski 349
- Martin Duhem 333
- Jorge Vicente Cantero (jvican) 314
- Eugene Vigdorchik 108
- Kenji Yoshida (xuwei-k) 96
- Indrajit Raychaudhuri 90
- Dan Sanduleac 74
- Benjy Weinberger 52
- Max Peng 52
- Jacek Laskowski 40
- Jason Zaugg 40
- Josh Soref 39
- Krzysztof Romanowski 39
- Pierre DAL-PRA 36
- Andrzej Jozwik 33
- Antonio Cunei 30
- Aaron S. Hawley 29
- Guillaume Martres 25
- James Roper 24
- Chua Chee Seng (cheeseng) 24
- Paolo G. Giarrusso 23
- Matej Urbas 22
- Stu Hood 22
- Adriaan Moors 18

- Jean-Rémi Desjardins 16
- Sanjin Sehic 16
- Fedor Korotkov 14
- Andrew Johnson 13
- David Perez 13
- Havoc Pennington 13
- Liang Tang 12
- Peter Vlugter 12
- Taro L. Saito 10
- Paul Phillips 9
- Roberto Tyley 9
- Vojin Jovanovic 9
- William Benton 9
- (Yang Bo) 9
- Brian Topping 8
- Bruno Bieth 8
- Johannes Rudolph 8
- KAWACHI Takashi 8
- Ken Kaizu (krrrr38) 8
- Artyom Olshevskiy 7
- Eugene Platonov 7
- Matthew Farwell 7
- Michael Allman 7
- David Pratt 6
- Luca Milanesio 6
- Nepomuk Seiler 6
- Peiyu Wang 6
- Simeon H.K. Fitch 6
- Stephen Samuel 6
- Thierry Treyer 6
- James Earl Douglas 5
- Jean-Remi Desjardins 5
- Miles Sabin 5
- Seth Tisue 5
- qgd 5
- Anthony Whitford 4
- Bardur Arantsson 4
- Ches Martin 4
- Chris Birchall 4
- Daniel C. Sobral 4
- Heikki Vesalainen 4
- Krzysztof Nirski 4

- Lloyd Meta 4
- Michael Schmitz 4
- Orr Sella 4
- Philipp Dörfler 4
- Tim Harper 4
- Vasya Novikov 4
- Vincent Munier 4
- Jürgen Keck (j-keck) 4
- Richard Summerhayes (rasummer) 4
- Adam Warski 3
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- Kazuhiro Sera 3
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- Leif Wickland 3
- Lukas Rytz 3
- Max Worgan 3
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- Olli Helenius 3
- Roman Timushev 3
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- daniel-shuy 3
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- Alexey Alekhin 2
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- Alois Cochard 2
- Andreas Flierl 2
- Anthony 2
- Antoine Gourlay 2
- Arnout Engelen 2
- Ben Hutchison 2

- Benjamin Darfler 2
- Brendan W. McAdams 2
- Brennan Saeta 2
- Brian McKenna 2
- Brian Smith 2
- BrianLondon 2
- Charles Feduke 2
- Christian Dedie 2
- Cody Allen 2
- Damien Lecan 2
- David Barri 2
- David Harcombe 2
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- Derek Wickern 2
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- Francois Armand (fanf42) 2
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- Hideki Ikio 2
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- Ismael Juma 2
- Jakob Odersky 2
- Jan Berkel 2
- Jan Niehusmann 2
- Jarek Sacha 2
- Jens Halm 2
- Joachim Hofer 2
- Joe Barnes 2
- Johan Andrén 2
- Jonas Fonseca 2
- Josh Kalderimis 2
- Juan Manuel Caicedo Carvajal 2
- Justin Kaeser 2
- Konrad Malawski 2
- Lex Spoon 2
- Li Haoyi 2
- Lloyd 2
- Lukasz Piepiora 2

- Marcus Lönnberg 2
- Marko Elezovic 2
- Michael Parrott 2
- Mikael Vallerie 2
- Myyk Seok 2
- Ngoc Dao 2
- Nicolas Rémond 2
- Oscar Vargas Torres 2
- Paul Draper 2
- Paulo “JCranky” Siqueira 2
- Petro Verkhogliad 2
- Piotr Kukielka 2
- Robin Green 2
- Roch Delsalle 2
- Roman Iakovlev 2
- Scott Royston 2
- Simon Hafner 2
- Sukant Hajra 2
- Suzanne Hamilton 2
- Tejas Mandke 2
- Thomas Koch 2
- Thomas Lockney 2
- Tobias Neef 2
- Tomasz Bartczak 2
- Travis 2
- Vitalii Voloshyn 2
- Wei Chen 2
- Wojciech Langiewicz 2
- Xin Ren 2
- Zava 2
- amishak 2
- beolnix 2
- ddworak 2
- drdamour 2
- Eric K Richardson (ekrich) 2
- fsi206914 2
- henry 2
- kaatzee 2
- kalmanb 2
- nau 2
- qvaughan 2
- sam 2

- softprops 2
- tbje 2
- timt 2
- Aaron D. Valade 1
- Alexander Buchholtz 1
- Alexandr Nikitin 1
- Alexandre Archambault 1
- Alexey Levan 1
- Anatoly Fayngelerin 1
- Andrea 1
- Andrew D Bate 1
- Andrew Miller 1
- Ashley Mercer 1
- Bruce Mitchener 1
- Cause Cheng 1
- Cause Chung 1
- Christian Krause 1
- Christophe Vidal 1
- Claudio Bley 1
- Daniel Peebles 1
- Denis T 1
- Devis Lucato 1
- Dmitry Melnichenko 1
- EECOLOR 1
- Edward Samson 1
- Erik Bakker 1
- Erik Bruchez 1
- Ethan 1
- Federico Ragona 1
- Felix Leipold 1
- Geoffroy Couprie 1
- Gerolf Seitz 1
- Gilad Hoch 1
- Gregor Heine 1
- HairyFotr 1
- Heiko Seeberger 1
- Holden Karau 1
- Hussachai Puripunpinyo 1
- Jacques 1
- Jakob Grunig 1
- James Koch 1
- Jan Polák 1

- Jan Ziniewicz 1
- Jisoo Park 1
- Joonas Javanainen 1
- Joscha Feth 1
- Josef Vlach 1
- Joseph Earl 1
- João Costa 1
- Justin Ko 1
- Kamil Kloch 1
- Kazuyoshi Kato 1
- Kevin Scaldeferri 1
- Knut Petter Meen 1
- Krzysztof 1
- Kunihiko Ito 1
- LMnet 1
- Luc Bourlier 1
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- Lutz Huehnken 1
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- Stephen Duncan Jr 1
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- Sören Brunk 1
- Thomas Grainger 1
- Tim Sheppard 1
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- Yasuo Nakanishi 1
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- adinath 1
- albuch 1
- cchantep 1
- cdietze 1
- choucri 1
- hokada 1
- joiskov 1
- jozic 1
- jyane 1
- k.bigwheel 1
- kavedaa 1
- mmcbride 1
- pishen tsai 1
- sanjiv sahayam 1
- saturday06 1
- seroperson 1
- slideon 1
- thricejamie 1
- todesking 1
- totem3 1
- upescatore 1
- valydia 1
- walidbenchikha 1
- Wiesław Popielarski 1
- Łukasz Indykiewicz 1

For the details on individual contributions, see Changes.

The following people contributed ideas, documentation, or code to sbt but are not listed above:

- Josh Cough
- Nolan Darilek
- Viktor Klang
- David R. MacIver
- Ross McDonald
- Andrew O'Malley
- Jorge Ortiz
- Mikko Peltonen
- Ray Racine
- Stuart Roebuck
- Harshad RJ
- Tony Sloane
- Francisco Treacy
- Vesa Vilhonen

The sbt ecosystem would not be the same without so many awesome plugins. Here are some of the plugins and their contributors:

- Play Framework by Lightbend (James Roper, Peter Hausel, and many others)
- Scala.js by Sébastien Doeraene, Tobias Schlatter, et al
- sbt-assembly by Eugene Yokota (eed3si9n)
- coursier by Alexandre Archambault
- sbt Native Packager by Nepomuk Seiler (muuki88) and Josh Suereth
- sbt-dependency-graph by Johannes Rudolph
- WartRemover by Claire Neveu and Brian McKenna
- sbt-android by Perry (pfn)
- sbt-revolver by Johannes Rudolph and Mathias (sirthias)
- sbt-docker by Marcus Lönnberg
- tut by Rob Norris (tpolecat)
- sbt-release by Gerolf Seitz
- sbt-jmh by Konrad Malawski (ktoso)
- sbt-updates by Roman Timushev
- xsbt-web-plugin by James Earl Douglas and Artyom Olshevskiy
- sbt-scoverage by Stephen Samuel and Mikko Koponen
- sbt-web by Lightbend (Christopher Hunt, Peter Vlugter, et al)
- sbt-buildinfo by Eugene Yokota (eed3si9n)
- sbt-pack by Taro L. Saito (xerial)
- sbt-onejar by Jason Zaugg (retronym)
- sbt-git by Josh Suereth
- sbt-scalariform by Heiko Seeberger, Daniel Trinh, et al
- ensime-sbt by Sam Halliday (fommil)

- sbt-fresh by Heiko Seeberger
- sbt-web-scalajs by Vincent Munier
- sbt-sonatype by Taro L. Saito (xerial)
- sbt-sublime by Orr Sella
- sbt-errors-summary by Martin Duhem
- sbt-bintray by Doug Tangren (softprops)
- Migration Manager by Lightbend (Mirco Dotta, Seth Tisue, et al)
- sbt-protobuf by Gerolf Seitz and Kenji Yoshida (xuwei-k)
- sbt-site by Jonas Fonseca, Josh Suereth, et al
- sbt-doctest by KAWACHI Takashi
- sbt-robovm by Jan Polák
- scalastyle-sbt-plugin by Matthew Farwell
- sbt-microsites by 47 Degrees (Juan Pedro Moreno, Javier de Silóniz Sandino, et al)
- sbt-header by Heiko Seeberger and Benedikt Ritter
- sbt-groll by Heiko Seeberger
- sbt-ctags by Cody Allen
- sbt-aws-lambda by Gilt (Brendan St John, et al)
- sbt-heroku by Heroku (Joe Kutner)
- sbt-dynver by Dale Wijnand
- sbt-unidoc by Eugene Yokota and Peter Vlugter
- sbt-docker-compose by Tapad (Kurt Kopchik et al)
- sbt-coveralls by Ian Forsey and Stephen Samuel
- gatling-sbt by Pierre Dal-Pra
- sbt-boilerplate by Johannes Rudolph
- fm-sbt-s3-resolver by Tim Underwood
- sbt-reactjs by Dan Di Spaltro
- sbt-scalabuff by Aloïs Cochard
- sbt-pgp by Josh Suereth
- jacoco4sbt by Joachim Hofer
- sbt-s3-resolver by Alexey Alekhin (laughedelic)
- sbt-maven-plugin by Shiva Wu
- sbt-newrelic by Gilt (Gary Coady et al)
- naptime by Coursera (Brennan Saeta, Bryan Kane et al)
- neo-sbt-scalafmt by Lucid Software (Paul Draper et al)
- Courier by Coursera (Joe Betz et al)
- sbt-optimizer by Johannes Rudolph
- sbt-appengine by Eugene Yokota (eed3si9n) and Yasushi Abe
- sbt/sbt-ghpages by Josh Suereth
- kotlin-plugin by Perry (pfn)
- sbt-avro by Juan Manuel Caicedo Carvajal (cavorite), Ben McCann, et al
- sbt-aspectj by Lightbend (Peter Vlugter et al)

- sbt-crossproject Denys Shabalin and Guillaume Massé
- sbt-scapegoat by Stephen Samuel
- sbt-dependency-graph-sugar by Gilt (Brendan St John et al)
- sbt-aether-deploy by Arktekk (Erlend Hamnaberg et al)
- sbt-spark-submit by Forest Fang
- sbt-proguard by Lightbend (Peter Vlugter et al)
- Jenkins CI sbt plugin by Uzi Landsmann
- sbt-quickfix by Dave Cleaver
- sbt-growl-plugin Doug Tangren (softprops)
- sbt-dependency-check by Alexander v. Buchholtz
- sbt-structure by JetBrains (Justin Kaeser et al)
- sbt-typescript by Brandon Arp
- sbt-javacv by Bytedeco (Lloyd Chan et al)
- sbt-stats by Orr Sella
- sbt-rig by Verizon (Timothy Perrett et al)
- sbt-swagger-codegen by UniCredit (Andrea Peruffo, Francesco MDE, et al)
- sbt-pom-reader by Josh Suereth
- sbt-class-diagram by Kenji Yoshida (xuwei-k)

Kudos also to people who have answered questions on Stack Overflow (Jacek Laskowski, Lukasz Piepiora, et al) and sbt Gitter channel, and many who have reported issues and contributed ideas on GitHub.

Thank you all.

Community Plugins

sbt Organization

The sbt organization is available for use by any sbt plugin. Developers who contribute their plugins into the community organization will still retain control over their repository and its access. The goal of the sbt organization is to organize sbt software into one central location.

A side benefit to using the sbt organization for projects is that you can use gh-pages to host websites under the https://www.scala-sbt.org domain.

Community Ivy Repository

Lightbend has provided a freely available Ivy Repository for sbt projects to use. This Ivy repository is mirrored from the freely available Bintray service. If you'd like to submit your plugin, please follow these instructions: Bintray For Plugins.

Cross building plugins from sbt 0.13

See Cross Build Plugins.

Plugins available for sbt 1.0 (including RC-x)

[Edit] this page to submit a pull request that adds your plugin to the list.

Code formatter plugins

- sbt-scalariform: code formatting using Scalariform.
- neo-sbt-scalafmt: code formatting using Scalafmt.
- sbt-java-formatter: code formatting for Java sources.

Documentation plugins

- tut: documentation and tutorial generator.
- Laika: Transform Markdown or reStructuredText into HTML or PDF with Templating.
- sbt-site: site generator.
- sbt-microsites: generate and publish microsites using Jekyll.
- sbt-unidoc: create unified API documentation across subprojects.
- sbt-ghpages: publish generated sites to GitHub pages.
- sbt-class-diagram: generate class diagrams from Scala source code.
- sbt-api-mappings: generate Scaladoc `apiMappings` for common Scala libraries.
- literator: generate literate-style markdown docs from your sources.
- sbt-example: generate ScalaTest test suites from examples in Scaladoc.

One jar plugins

- sbt-assembly: create fat JARs.

Release plugins

- sbt-native-packager (docs): build native packages (RPM, .deb etc) for your projects.
- sbt-pack: create runnable distributions for your projects.
- sbt-bintray: publish artefacts to Bintray.
- sbt-sonatype: publish artefacts to Maven Central.
- sbt-release: create a customizable release process.

- sbt-pgp: sign artefacts using PGP/GPG and manage signing keys.
- sbt-docker: create and push Docker images.
- sbt-aether-deploy: publish artefacts using Eclipse Aether.
- sbt-rig: opinionated common release steps.
- sbt-s3: manage objects on Amazon S3.
- sbt-osgi: create OSGi bundles.
- sbt-github-release: publish Github releases.
- sbt-hadoop: publish artifacts to the Hadoop Distributed File System (HDFS).
- sbt-publish-more: publish artifacts to several repositories
- sbt-deploy: create deployable fat JARs.
- sbt-release-fossil: enhances sbt-release to support Fossil repositories
- sbt-autoversion: automatically set your next version bump based on patterns of your commit messase since last release.
- sbt-gcs: manage objects on Google Cloud Storage.

Deployment integration plugins

- sbt-heroku: deploy applications directly to Heroku.
- sbt-docker-compose: launch Docker images using docker compose.
- sbt-appengine deploy your webapp to Google App Engine.
- sbt-marathon: deploy applications on Apache Mesos using the Marathon framework.

Utility and system plugins

- sbt-revolver: auto-restart forked JVMs on update.
- sbt-conscript (docs): distribute apps using GitHub and Maven Central.
- sbt-git: run git commands from sbt.
- sbt-errors-summary: show a summary of compilation errors.
- MiMa: binary compatibility management for Scala libraries.
- sbt-groll: navigate git history inside sbt.
- sbt-dynver: set project version dynamically from git metadata.
- sbt-prompt: add promptlets and themes to your sbt prompt.
- sbt-crossproject: cross-build Scala, Scala.js and Scala Native.
- sbt-proguard: run ProGuard on compiled sources.
- sbt-structure: extract project structure in XML format.
- sbt-jni: helpers for working with projects that use JNI.
- sbt-jol: inspect OpenJDK Java Object Layout from sbt.
- sbt-musical: control iTunes from sbt (Mac only).
- sbt-travisci: integration with Travis CI.
- horder: cache compilation artefacts for future builds.

- sbt-javaagent: add Java agents to projects.
- sbt-jshell: Java REPL for sbt.
- sbt-check: compile up to, and including, the typer phase.
- sbt-tmpfs: utilize tmpfs to speed up builds.
- sbt-sh: run shell commands from sbt.
- sbt-ammonite-classpath: export classpath for Ammonite and Jupyter Scala.

IDE integration plugins

- sbteclipse: Eclipse project definition generator.
- sbt-sublime: Sublime Text project generator.

Test plugins

- scripted: integration testing for sbt plugins.
- sbt-jmh: run Java Microbenchmark Harness (JMH) benchmarks from sbt.
- sbt-doctest: generate and run tests from Scaladoc comments.
- gatling-sbt: performance and load-testing using Gatling.
- sbt-multi-jvm: run tests using multiple JVMs.
- sbt-scalaprops: scalaprops property-based testing integration.
- sbt-testng: TestNG framework integration.
- sbt-jcstress: Java Concurrency Stress Test (jcstress) integration.

Library dependency plugins

- coursier: pure Scala dependency fetcher.
- sbt-dependency-graph: create dependency graphs using GraphML, graphviz or ASCII.
- sbt-updates: list updated versions of dependencies.
- fm-sbt-s3-resolver: resolve and publish artefacts using Amazon S3.
- sbt-s3-resolver: resolve dependencies using Amazon S3.
- sbt-dependency-check: check dependencies for known vulnerabilities/CVEs.
- sbt-lock: create a lock file containing explicit sbt dependencies.
- sbt-license-report: generate reports of licenses used by dependencies.
- sbt-duplicates-finder: detect class and resources conflicting in your project's classpath.
- sbt-google-cloud-storage: resolver and publisher for Google Cloud Storage.
- sbt-trace: find traces of the client or library usage in other projects.

Web and frontend development plugins

- Play Framework: reactive web framework for Scala and Java.
- Scala.js: Scala to JavaScript compiler.
- xsbt-web-plugin: build and deploy JEE web applications.
- sbt-web: library for building sbt plugins for the web.
- sbt-web-scalajs: use Scala.js with any web server.
- sbt-less: Less CSS compilation support.
- sbt-js-engine: support for sbt plugins that use JavaScript.
- sbt-typescript: TypeScript compilation support.
- sbt-uglify: JavaScript minifier using UglifyJS.
- sbt-digest: generate checksums of assets.
- sbt-scalatra: build and run Scalatra apps.
- sbt-scala-js-map: Configure source mapping for Scala.js projects hosted on Github.
- sbt-gzip: gzip compressor for assets.
- sbt-stylus: Stylus stylesheet compiler.
- sbt-hepek: Render static websites directly from Scala code.
- sbt-puresass: sbt-web plugin for Sass styles compilation.

Database plugins

- scalikejdbc-mapper-generator: Scala code generator from database schema.
- sbt-dynamodb: run a local Amazon DynamoDB test instance from sbt.

Framework-specific plugins

- sbt-newrelic: NewRelic support for artefacts built with sbt-native-packager.
- sbt-spark: Spark application configurator.
- sbt-api-builder: support for ApiBuilder from within sbt's shell.

Code generator plugins

- sbt-buildinfo: generate Scala code from SBT setting keys.
- sbt-scalaxb: generate model classes from XML schemas and WSDL.
- sbt-protobuf: protobuf code generator.
- sbt-header: auto-generate source code file headers (such as copyright notices).
- sbt-boilerplate: TupleX and FunctionX boilerplate code generator.

- sbt-avro: Apache Avro schema and protocol generator.
- sbt-aspectj: AspectJ weaving for sbt.
- sbt-protoc: protobuf code generator using protoc.
- sbt-contraband (docs): generate pseudo-case classes from GraphQL schemas.
- sbt-antlr4: run ANTLR v4 from sbt.
- sbt-sql: generate model classes from SQL.
- sbt-partial-unification: enable partial unification support in Scala (SI-2712).
- sbt-i18n: transform your i18n bundles into Scala code.

Static code analysis plugins

- wartremover: flexible Scala linting tool.
- scalastyle-sbt-plugin: code style checking using Scalastyle.
- sbt-scapegoat: static analysis using Scapegoat.
- sbt-stats: generate source code statistics (lines of code etc).
- sbt-taglist: find tags within source files (such as TODO and FIXME).
- sbt-jcheckstyle: Java code style checking using Checkstyle.
- sbt-sonar: integration with SonarQube.

Code coverage plugins

- sbt-scoverage: Scala code coverage using Scoverage.
- sbt-jacoco: Scala and Java code coverage using JaCoCo.

Create new project plugins

- sbt-fresh: create an opinionated fresh sbt project.

In-house plugins

- sbt-houserules: houserules settings for sbt modules.

Verification plugins

- sbt-stainless: verify Scala or Dotty code using stainless.

Community Repository Policy

The community repository has the following guideline for artifacts published to it:

1. All published artifacts are the authors own work or have an appropriate license which grants distribution rights.
2. All published artifacts come from open source projects, that have an open patch acceptance policy.
3. All published artifacts are placed under an organization in a DNS domain for which you have the permission to use or are an owner (scala-sbt.org is available for sbt plugins).
4. All published artifacts are signed by a committer of the project (coming soon).

Bintray For Plugins

This is currently in Beta mode.

sbt hosts their community plugin repository on Bintray. Bintray is a repository hosting site, similar to github, which allows users to contribute their own plugins, while sbt can aggregate them together in a common repository.

This document walks you through the means to create your own repository for hosting your sbt plugins and then linking them into the sbt shared repository. This will make your plugins available for all sbt users without additional configuration (besides declaring a dependency on your plugin).

To do this, we need to perform the following steps:

Create an Open Source Distribution account on Bintray

First, go to https://bintray.com/signup/oss to create an Open Source Distribution Bintray Account.

If you end up at the Bintray home page, do NOT click on the Free Trial, but click on the link that reads **"For Open Source Distribution Sign Up Here"**.

Create a repository for your sbt plugins

Now, we'll create a repository to host our personal sbt plugins. In bintray, create a generic repository called `sbt-plugins`.

First, go to your user page and click on the `new repository` link:

You should see the following dialog:

Fill it out similarly to the above image, the settings are:

- Name: sbt-plugins
- Type: Generic
- Desc: My sbt plugins
- Tags: sbt

Once this is done, you can begin to configure your sbt-plugins to publish to bintray.

Add the sbt-bintray plugin to your build.

First, add the sbt-bintray to your plugin build.

First, create a `project/bintray.sbt` file

```
addSbtPlugin("org.foundweekends" % "sbt-bintray" % "0.5.2")
```

Next, a make sure your `build.sbt` file has the following settings

```
lazy val commonSettings = Seq(
  version in ThisBuild := "<YOUR PLUGIN VERSION HERE>",
  organization in ThisBuild := "<INSERT YOUR ORG HERE>"
)

lazy val root = (project in file("."))
  .settings(
    commonSettings,
    sbtPlugin := true,
    name := "<YOUR PLUGIN HERE>",
    description := "<YOUR DESCRIPTION HERE>",
    // This is an example.  sbt-bintray requires licenses to be specified
    // (using a canonical name).
    licenses += ("Apache-2.0", url("https://www.apache.org/licenses/LICENSE-2.0.html")),
    publishMavenStyle := false,
    bintrayRepository := "sbt-plugins",
    bintrayOrganization in bintray := None
  )
```

Make sure your project has a valid license specified, as well as unique name and organization.

Make a release

> *Note: bintray does not support snapshots. We recommend using git-revisions supplied by the sbt-git plugin.*

Once your build is configured, open the sbt console in your build and run

```
sbt> publish
```

The plugin will ask you for your credentials. If you don't know where they are, you can find them on Bintray.

1. Login to the website with your credentials.
2. Click on your username
3. Click on edit profile
4. Click on API Key

This will get you your password. The sbt-bintray plugin will save your API key for future use.

NOTE: We have to do this before we can link our package to the sbt org.

Linking your package to the sbt organization

Now that your plugin is packaged on bintray, you can include it in the community sbt repository. To do so, go to the Community sbt repository screen.

1. Click the green `include my package` button and select your plugin.
2. Search for your plugin by name and click on the link.
3. Your request should be automatically filled out, just click send
4. Shortly, one of the sbt repository admins will approve your link request.

From here on, any releases of your plugin will automatically appear in the community sbt repository. Congratulations and thank you so much for your contributions!

Linking your package to the sbt organization (sbt org admins)

If you're a member of the sbt organization on bintray, you can link your package to the sbt organization, but via a different means. To do so, first navigate to the plugin you wish to include and click on the link button:

After clicking this you should see a link like the following:

Click on the `sbt/sbt-plugin-releases` repository and you're done! Any future releases will be included in the sbt-plugin repository.

Summary

After setting up the repository, all new releases will automatically be included the sbt-plugin-releases repository, available for all users. When you create a new plugin, after the initial release you'll have to link it to the sbt community repository, but the rest of the setup should already be completed. Thanks for you contributions and happy hacking.

Setup Notes

Some notes on how to set up your sbt script.

Do not put sbt-launch.jar on your classpath.

Do *not* put sbt-launch.jar in your $SCALA_HOME/lib directory, your project's lib directory, or anywhere it will be put on a classpath. It isn't a library.

Terminal encoding

The character encoding used by your terminal may differ from Java's default encoding for your platform. In this case, you will need to add the option -Dfile.encoding=<encoding> in your sbt script to set the encoding, which might look like:

```
java -Dfile.encoding=UTF8
```

JVM heap, permgen, and stack sizes

If you find yourself running out of permgen space or your workstation is low on memory, adjust the JVM configuration as you would for any application. For example a common set of memory-related options is:

```
java -Xmx1536M -Xss1M -XX:+CMSClassUnloadingEnabled
```

Boot directory

sbt-launch.jar is just a bootstrap; the actual meat of sbt, and the Scala compiler and standard library, are downloaded to the shared directory $HOME/.sbt/boot/.

To change the location of this directory, set the sbt.boot.directory system property in your sbt script. A relative path will be resolved against the current working directory, which can be useful if you want to avoid sharing the boot directory between projects. For example, the following uses the pre-0.11 style of putting the boot directory in `project/boot/`:

```
java -Dsbt.boot.directory=project/boot/
```

HTTP/HTTPS/FTP Proxy

On Unix, sbt will pick up any HTTP, HTTPS, or FTP proxy settings from the standard `http_proxy`, `https_proxy`, and `ftp_proxy` environment variables. If you are behind a proxy requiring authentication, your `sbt` script must also pass flags to set the `http.proxyUser` and `http.proxyPassword` properties for HTTP, `ftp.proxyUser` and `ftp.proxyPassword` properties for FTP, or `https.proxyUser` and `https.proxyPassword` properties for HTTPS.

For example,

```
java -Dhttp.proxyUser=username -Dhttp.proxyPassword=mypassword
```

On Windows, your script should set properties for proxy host, port, and if applicable, username and password. For example, for HTTP:

```
java -Dhttp.proxyHost=myproxy -Dhttp.proxyPort=8080 -Dhttp.proxyUser=username -Dhttp.proxyPas
```

Replace `http` with `https` or `ftp` in the above command line to configure HTTPS or FTP.

Using Sonatype

Deploying to sonatype is easy! Just follow these simple steps:

Sonatype setup

The reference process for configuring and publishing to Sonatype is described in their OSSRH Guide. In short, you need two publicly available URLs:

- the website of the project e.g. https://github.com/sonatype/nexus-public
- the project's source code e.g. https://github.com/sonatype/nexus-public.git

The OSSRH Guide walks you through the required process of setting up the account with Sonatype. It's as simple as creating a Sonatype's JIRA account and then a New Project ticket. When creating the account, try to use the same domain in your email address that the project is hosted on. It makes it easier for Sonatype to validate the relationship with the groupId requested in the ticket, but it is not the only method used to confirm the ownership.

Creation of the *New Project ticket* is as simple as:

- providing the name of the library in the ticket's subject,
- naming the groupId for distributing the library (make sure it matches the root package of your code). Sonatype provides additional hints on choosing the right groupId for publishing your library in Choosing your coordinates guide.
- providing the SCM and Project URLs to the source code and homepage of the library.

After creating your Sonatype account on JIRA, you can log in to the Nexus Repository Manager using the same credentials, although this is not required in the guide, it can be helpful later to check on published artifacts.

> *Note:* Sonatype advises that responding to a **New Project ticket** might take up to two business days, but in my case it was a few minutes.

SBT setup

To address Sonatype's requirements for publishing to the central repository and to simplify the publishing process, you can use two community plugins. The sbt-pgp plugin can sign the files with GPG/PGP and sbt-sonatype can publish to a Sonatype repository.

First - PGP Signatures With the PGP key you want to use, you can sign the artifacts you want to publish to the Sonatype repository with the sbt-pgp plugin. Follow the instructions for the plugin and you'll have PGP signed artifacts in no time.

In short, add the following line to your `~/.sbt/1.0/plugins/gpg.sbt` file to enable it globally for SBT projects:

```
addSbtPlugin("com.jsuereth" % "sbt-pgp" % "1.1.1")
```

> *Note:* The plugin is a jvm-only solution to generate PGP keys and sign artifacts. It can also work with the GPG command line tool.

If you don't have the PGP keys to sign your code with, one of the ways to achieve that is to install the GNU Privacy Guard and:

- use it to generate the keypair you will use to sign your library,
- publish your certificate to enable remote verification of the signatures,
- make sure that the `gpg` command is in PATH available to the sbt,
- add `useGpg := true` to your `build.sbt` to make the plugin `gpg`-aware

PGP Tips'n'tricks If the command to generate your key fails, execute the following commands and remove the displayed files:

```
> show */*:pgpSecretRing
[info] /home/username/.sbt/.gnupg/secring.gpg
> show */*:pgpPublicRing
[info] /home/username/.sbt/.gnupg/pubring.gpg
```

If your PGP key has not yet been distributed to the keyserver pool, e.g., you've just generated it, you'll need to publish it. You can do so using the sbt-pgp plugin:

```
pgp-cmd send-key keyname hkp://pool.sks-keyservers.net
```

Where `keyname` is the name or email address used when creating the key or hexadecimal identifier for the key.

If you see no output from sbt-pgp then the key name specified was not found.

If it fails to run the `SendKey` command you can try another server (for example: hkp://keyserver.ubuntu.com). A list of servers can be found at the status page of sks-keyservers.net.

Second - Configure Sonatype integration

The credentials for your Sonatype OSSRH account need to be stored somewhere safe (*e.g. NOT in the repository*). Common convention is a `~/.sbt/1.0/sonatype.sbt` file, with the following:

```
credentials += Credentials("Sonatype Nexus Repository Manager",
                           "oss.sonatype.org",
                           "<your username>",
                           "<your password>")
```

> *Note:* The first two strings must be `"Sonatype Nexus Repository Manager"` and `"oss.sonatype.org"` for Ivy to use the credentials.

Now, we want to control what's available in the `pom.xml` file. This file describes our project in the maven repository and is used by indexing services for search and discover. This means it's important that `pom.xml` should have all information we wish to advertise as well as required info!

First, let's make sure no repositories show up in the POM file. To publish on maven-central, all *required* artifacts must also be hosted on maven central. However, sometimes we have optional dependencies for special features. If that's the case, let's remove the repositories for optional dependencies in our artifact:

```
pomIncludeRepository := { _ => false }
```

To publish to a maven repository, you'll need to configure a few settings so that the correct metadata is generated. Specifically, the build should provide data for `organization`, `url`, `license`, `scm.url`, `scm.connection` and `developer` keys. For example:

```
licenses := Seq("BSD-style" -> url("http://www.opensource.org/licenses/bsd-license.php"))

homepage := Some(url("http://example.com"))

scmInfo := Some(
  ScmInfo(
    url("https://github.com/your-account/your-project"),
    "scm:git@github.com:your-account/your-project.git"
  )
)

developers := List(
  Developer(
    id    = "Your identifier",
    name  = "Your Name",
    email = "your@email",
    url   = url("http://your.url")
  )
)
```

Maven configuration tips'n'tricks The full format of a `pom.xml` (an end product of the project configuration used by Maven) file is outlined here. You can add more data to it with the `pomExtra` option in `build.sbt`.

To ensure the POMs are generated and pushed:

```
publishMavenStyle := true
```

Setting repositories to publish to:

```
publishTo := {
  val nexus = "https://oss.sonatype.org/"
  if (isSnapshot.value)
    Some("snapshots" at nexus + "content/repositories/snapshots")
  else
    Some("releases"  at nexus + "service/local/staging/deploy/maven2")
}
```

Not publishing the test artifacts (this is the default):

```
publishArtifact in Test := false
```

Third - Publish to the staging repository

> *Note:* sbt-sonatype is a third-party plugin meaning it is not covered by Lightbend subscription.

To simplify the usage of the Sonatype's Nexus, add the following line to `project/plugins.sbt` to import the sbt-sonatype plugin to your project:

```
addSbtPlugin("org.xerial.sbt" % "sbt-sonatype" % "2.0")
```

This plugin will facilitate the publishing process, but in short, these are the main steps for publishing the libraries to the repository:

1. Create a new staging repository: `sonatypeOpen "your groupId" "Some staging name"`
2. Sign and publish the library to the staging repository: `publishSigned`
3. You can and should check the published artifacts in the Nexus Repository Manager (same login as Sonatype's Jira account)
4. Close the staging repository and promote the release to central: `sonatypeRelease`

After publishing you have to follow the release workflow of Nexus.

> *Note:* the sbt-sonatype plugin can also be used to publish to other non-sonatype repositories

Publishing tips'n'tricks Use staged releases to test across large projects of independent releases before pushing the full project.

> *Note:* An error message of `PGPException: checksum mismatch at 0 of 20` indicates that you got the passphrase wrong. We have found at least on OS X that there may be issues with characters outside the 7-bit ASCII range (e.g. Umlauts). If you are absolutely sure that you typed the right phrase and the error doesn't disappear, try changing the passphrase.

Fourth - Integrate with the release process

> *Note:* sbt-release is a third-party plugin meaning it is not covered by Lightbend subscription.

To automate the publishing approach above with the sbt-release plugin, you should simply add the publishing commands as steps in the `releaseProcess` task:

```
...
releaseStepCommand("sonatypeOpen \"your groupId\" \"Some staging name\""),
...
releaseStepCommand("publishSigned"),
...
releaseStepCommand("sonatypeRelease"),
...
```

Contributing to sbt

Below is a running list of potential areas of contribution. This list may become out of date quickly, so you may want to check on the sbt-dev mailing list if you are interested in a specific topic.

1. There are plenty of possible visualization and analysis opportunities.
    - 'compile' produces an Analysis of the source code containing
        - Source dependencies
        - Inter-project source dependencies
        - Binary dependencies (jars + class files)
        - data structure representing the API of the source code There is some code already for generating dot files that isn't hooked up, but graphing dependencies and inheritance relationships is a general area of work.

- 'update' produces an Update Report mapping Configuration/ModuleID/Artifact to the retrieved File
- Ivy produces more detailed XML reports on dependencies. These come with an XSL stylesheet to view them, but this does not scale to large numbers of dependencies. Working on this is pretty straightforward: the XML files are created in `~/.ivy2` and the `.xsl` and `.css` are there as well, so you don't even need to work with sbt. Other approaches described in the email thread
- Tasks are a combination of static and dynamic graphs and it would be useful to view the graph of a run
- Settings are a static graph and there is code to generate the dot files, but isn't hooked up anywhere.

2. There is support for dependencies on external projects, like on GitHub. To be more useful, this should support being able to update the dependencies. It is also easy to extend this to other ways of retrieving projects. Support for svn and hg was a recent contribution, for example.
3. If you like parsers, sbt commands and input tasks are written using custom parser combinators that provide tab completion and error handling. Among other things, the efficiency could be improved.
4. The javap task hasn't been reintegrated
5. Implement enhanced 0.11-style warn/debug/info/error/trace commands. Currently, you set it like any other setting:

```
set logLevel := Level.Warn
```

or set logLevel in Test := Level.Warn

You could make commands that wrap this, like:

```
warn test:run
```

Also, trace is currently an integer, but should really be an abstract data type.

6. Each sbt version has more aggressive incremental compilation and reproducing bugs can be difficult. It would be helpful to have a mode that generates a diff between successive compilations and records the options passed to scalac. This could be replayed or inspected to try to find the cause.

Documentation

1. There's a lot to do with this documentation. If you check it out from git, there's a directory called Dormant with some content that needs going through.

2. the main page mentions external project references (e.g. to a git repo) but doesn't have anything to link to that explains how to use those.
3. API docs are much needed.
4. Find useful answers or types/methods/values in the other docs, and pull references to them up into /faq or /Name-Index so people can find the docs. In general the /faq should feel a bit more like a bunch of pointers into the regular docs, rather than an alternative to the docs.
5. A lot of the pages could probably have better names, and/or little 2-4 word blurbs to the right of them in the sidebar.

Changes

These are changes made in each sbt release.

Migrating from sbt 0.13.x

Migrating case class `.copy(...)`

Many of the case classes are replaced with pseudo case classes generated using Contraband. Migrate `.copy(foo = xxx)` to `withFoo(xxx)`. Suppose you have `m: ModuleID`, and you're currently calling `m.copy(revision = "1.0.1")`. Here how you can migrate it:

```
m.withRevision("1.0.1")
```

sbt version specific source directory

If you are cross building an sbt plugin, one escape hatch we have is sbt version specific source directory `src/main/scala-sbt-0.13` and `src/main/scala-sbt-1.0`. In there you can define an object named `PluginCompat` as follows:

```
package sbtfoo

import sbt._
import Keys._

object PluginCompat {
  type UpdateConfiguration = sbt.librarymanagement.UpdateConfiguration

  def subMissingOk(c: UpdateConfiguration, ok: Boolean): UpdateConfiguration =
    c.withMissingOk(ok)
}
```

Now `subMissingOk(...)` function can be implemented in sbt version specific way.

Migrating to slash syntax

In sbt 0.13 keys were scoped with 2 different syntaxes: one for sbt's shell and one for in code.

- sbt 0.13 shell: `<project-id>/config:intask::key`
- sbt 0.13 code: `key in (<project-id>, Config, intask)`

Starting sbt 1.1.0, the syntax for scoping keys has been unified for both the shell and the build definitions to the **slash syntax** as follows:

- `<project-id> / Config / intask / key`

Here are some examples:

```
lazy val root = (project in file("."))
  .settings(
    name := "hello",
    version in ThisBuild := "1.0.0-SNAPSHOT",
    scalacOptions in Compile += "-Xlint",
    scalacOptions in (Compile, console) --= Seq("-Ywarn-unused", "-Ywarn-unused-import"),
    fork in Test := true
  )
```

They are now written as:

```
lazy val root = (project in file("."))
  .settings(
    name := "hello",
    ThisBuild / version := "1.0.0-SNAPSHOT",
    Compile / scalacOptions += "-Xlint",
    Compile / console / scalacOptions --= Seq("-Ywarn-unused", "-Ywarn-unused-import"),
    Test / fork := true
  )
```

And now the same syntax in sbt's shell:

```
sbt:hello> name
[info] hello
sbt:hello> ThisBuild / version
```

```
[info] 1.0.0-SNAPSHOT
sbt:hello> show Compile / scalacOptions
[info] * -Xlint
sbt:hello> show Compile / console / scalacOptions
[info] * -Xlint
sbt:hello> Test / fork
[info] true
```

Migrating from sbt 0.12 style

Before sbt 0.13 (sbt 0.9 to 0.12) it was very common to see in builds the usage of three aspects of sbt:

- the key dependency operators: `<<=`, `<+=`, `<++=`
- the tuple enrichments (apply and map) for TaskKey's and SettingKey's (eg. `(foo, bar) map { (f, b) => ... }`)
- the use of `Build` trait in `project/Build.scala`

The release of sbt 0.13 (which was over 3 years ago!) introduced the `.value` DSL which allowed for much easier to read and write code, effectively making the first two aspects redundant and they were removed from the official documentation.

Similarly, sbt 0.13's introduction of multi-project `build.sbt` made the `Build` trait redundant. In addition, the auto plugin feature that's now standard in sbt 0.13 enabled automatic sorting of plugin settings and auto import feature, but it made `Build.scala` more difficult to maintain.

As they are removed in sbt 1.0.0, and here we'll help guide you to how to migrate your code.

Migrating sbt 0.12 style operators With simple expressions such as:

```
a <<= aTaskDef
b <+= bTaskDef
c <++= cTaskDefs
```

it is sufficient to replace them with the equivalent:

```
a := aTaskDef.value
b += bTaskDef.value
c ++= cTaskDefs.value
```

Migrating from the tuple enrichments As mentioned above, there are two tuple enrichments `.apply` and `.map`. The difference used to be for whether you're defining a setting for a `SettingKey` or a `TaskKey`, you use `.apply` for the former and `.map` for the latter:

```
val sett1 = settingKey[String]("SettingKey 1")
val sett2 = settingKey[String]("SettingKey 2")
val sett3 = settingKey[String]("SettingKey 3")

val task1 = taskKey[String]("TaskKey 1")
val task2 = taskKey[String]("TaskKey 2")
val task3 = taskKey[String]("TaskKey 3")
val task4 = taskKey[String]("TaskKey 4")

sett1 := "s1"
sett2 := "s2"
sett3 <<= (sett1, sett2)(_ + _)

task1 := { println("t1"); "t1" }
task2 := { println("t2"); "t2" }
task3 <<= (task1, task2) map { (t1, t2) => println(t1 + t2); t1 + t2 }
task4 <<= (sett1, sett2) map { (s1, s2) => println(s1 + s2); s1 + s2 }
```

(Remember you can define tasks in terms of settings, but not the other way round)

With the `.value` DSL you don't have to know or remember if your key is a `SettingKey` or a `TaskKey`:

```
sett1 := "s1"
sett2 := "s2"
sett3 := sett1.value + sett2.value

task1 := { println("t1"); "t1" }
task2 := { println("t2"); "t2" }
task3 := { println(task1.value + task2.value); task1.value + task2.value }
task4 := { println(sett1.value + sett2.value); sett1.value + sett2.value }
```

Migrating when using `.dependsOn`, `.triggeredBy` or `.runBefore` When instead calling `.dependsOn`, instead of:

```
a <<= a dependsOn b
```

define it as:

```
a := (a dependsOn b).value
```

Note: You'll need to use the <<= operator with .triggeredBy and .runBefore in sbt 0.13.13 and earlier due to issue #1444.

Migrating when you need to set Tasks For keys such as sourceGenerators and resourceGenerators which use sbt's Task type:

```
val sourceGenerators =
  settingKey[Seq[Task[Seq[File]]]]("List of tasks that generate sources")
val resourceGenerators =
  settingKey[Seq[Task[Seq[File]]]]("List of tasks that generate resources")
```

Where you previous would define things as:

```
sourceGenerators in Compile <+= buildInfo
```

for sbt 1, you define them as:

```
Compile / sourceGenerators += buildInfo
```

or in general,

```
Compile / sourceGenerators += Def.task { List(file1, file2) }
```

Migrating with InputKey When using InputKey instead of:

```
run <<= docsRunSetting
```

when migrating you mustn't use .value but .evaluated:

```
run := docsRunSetting.evaluated
```

Migrating from the Build trait

With Build trait based build such as:

```scala
import sbt._
import Keys._
import xyz.XyzPlugin.autoImport._

object HelloBuild extends Build {
  val shared = Defaults.defaultSettings ++ xyz.XyzPlugin.projectSettings ++ Seq(
    organization := "com.example",
    version      := "0.1.0",
    scalaVersion := "2.12.1")

  lazy val hello =
    Project("Hello", file("."),
      settings = shared ++ Seq(
        xyzSkipWrite := true)
    ).aggregate(core)

  lazy val core =
    Project("hello-core", file("core"),
      settings = shared ++ Seq(
        description := "Core interfaces",
        libraryDependencies ++= scalaXml.value)
    )

  def scalaXml = Def.setting {
    scalaBinaryVersion.value match {
      case "2.10" => Nil
      case _      => ("org.scala-lang.modules" %% "scala-xml" % "1.0.6") :: Nil
    }
  }
}
```

You can migrate to `build.sbt`:

```scala
val shared = Seq(
  organization := "com.example",
  version      := "0.1.0",
  scalaVersion := "2.12.1"
)

lazy val helloRoot = (project in file("."))
  .aggregate(core)
  .enablePlugins(XyzPlugin)
  .settings(
    shared,
    name := "Hello",
```

```
    xyzSkipWrite := true
  )

lazy val core = (project in file("core"))
  .enablePlugins(XyzPlugin)
  .settings(
    shared,
    name := "hello-core",
    description := "Core interfaces",
    libraryDependencies ++= scalaXml.value
  )

def scalaXml = Def.setting {
  scalaBinaryVersion.value match {
    case "2.10" => Nil
    case _      => ("org.scala-lang.modules" %% "scala-xml" % "1.0.6") :: Nil
  }
}
```

1. Rename `project/Build.scala` to `build.sbt`.
2. Remove import statements `import sbt._`, `import Keys._`, and any auto imports.
3. Move all of the inner definitions (like `shared`, `helloRoot`, etc) out of the `object HelloBuild`, and remove `HelloBuild`.
4. Change `Project(...)` to `(project in file("x"))` style, and call its `settings(...)` method to pass in the settings. This is so the auto plugins can reorder their setting sequence based on the plugin dependencies. `name` setting should be set to keep the old names.
5. Remove `Defaults.defaultSettings` out of `shared` since these settings are already set by the built-in auto plugins, also remove `xyz.XyzPlugin.projectSettings` out of `shared` and call `enablePlugins(XyzPlugin)` instead.

Note: `Build` traits is deprecated, but you can still use `project/*.scala` file to organize your build and/or define ad-hoc plugins. See Organizing the build.

Migrating from Resolver.withDefaultResolvers

In 0.13.x, you use other repositories instead of the Maven Central repository:

```
externalResolvers := Resolver.withDefaultResolvers(resolvers.value, mavenCentral = false)
```

After 1.x, `withDefaultResolvers` was renamed to `combineDefaultResolvers`. In the meantime, one of the parameters, `userResolvers`, was changed to `Vector` instead of `Seq`.

- You can use `toVector` to help migration.

```
externalResolvers := Resolver.combineDefaultResolvers(resolvers.value.toVector, mavenCe
```

- You can use `Vector` directly too.

sbt 1.1.x releases

sbt 1.1.2

Bug fixes

- Fixes triggered execution's resource leak by caching the watch service. #3999 by [@eatkins][@eatkins]
- Fixes classloader inheriting the dependencies of Scala compiler during `run` zinc#505 by [@eed3si9n][@eed3si9n]
- Fixes forked test concurrency issue. #4030 by [@eatkins][@eatkins]
- Fixes `new` command leaving behind target directory #4033 by [@eed3si9n][@eed3si9n]
- Fixes handling on null Content-Type. lm214 by [@staale][@staale]
- Fixes null handling of `managedChecksums` in `ivySettings` file. lm#218 by [@IanGabes][@IanGabes]
- Adds `sbt.boot.lock` as a JVM property to opt-out of locking. #3927 by [@dwijnand][@dwijnand]
- Provides `SBT_GLOBAL_SERVER_DIR` env var as a workaround to long socket file path on UNIX. #3932 by [@dwijnand][@dwijnand]
- Fixes forked runs reporting noisy "Stream closed" exception. #3970 by [@retronym][@retronym]
- Fixes test compilation not getting included in VS Code save trigger. #4022 by [@tmiyamon][@tmiyamon]
- Fixes sbt server responding with string id when number id passed. #4025 by [@tiqwab][@tiqwab]
- Fixes `getDecoder` in Analysis format zinc#502 by [@jilen][@jilen]
- Fixes equal / hashCode inconsistencies around Array. zinc#513 by [@eed3si9n][@eed3si9n]
- Whitelists `java9-rt-ext-output` in rt export process lp#211 by [@eatkins][@eatkins]
- Fixes JDK version detection for Java 10 friendliness. lp#219 by [@eed3si9n][@eed3si9n] and @2m
- Fixes quoting in Windows bat file. lp#220 by [@ForNeVeR][@ForNeVeR]
- Fixes `-error` not suppressing startup logs. #4036 by [@eed3si9n][@eed3si9n]

Improvements

- Performance optimization around logging. util#152 by [@retronym][@retronym]
- Performance fix by caching the hashCode of `Configuration`. lm#213 by [@retronym][@retronym]
- Returns error code `-33000L` on sbt server when a command fails. #3991 by [@dwijnand][@dwijnand]
- Allows wildcards in organization and artifact. #215 by [@dhs3000][@dhs3000]
- Updates to latest Jsch to support stronger key exchange algorithms. lm#217 by [@ryandbair][@ryandbair]
- Fixes preloading of compiler bridge. lp#222 by [@analytically][@analytically]

Internal

- Updates contribution guide. #3960/#4019 by [@eed3si9n][@eed3si9n] and [@itohiro73][@itohiro73]
- Deletes `buildinfo.BuildInfo` from sbt main that was intended for testing. 3967 by [@dwijnand][@dwijnand] and [@xuwei-k][@xuwei-k]
- Various improvements around Zinc benchmark by [@retronym][@retronym]

Contributors sbt 1.1.2 was brought to you by 23 contributors, according to `git shortlog -sn --no-merges v1.1.1...v1.1.2` on sbt, zinc, librarymanagement, util, io, launcher-packege, and website: Dale Wijnand, Eugene Yokota, Jason Zaugg, Kenji Yoshida (xuwei-k), Ethan Atkins, Martijn Hoekstra, Martynas Mickevičius, Dennis Hörsch, Hosam Aly, Antonio Cunei, Friedrich von Never, Hiroshi Ito, Ian Gabes, Jilen Zhang, Mathias Bogaert, Naohisa Murakami (tiqwab), Philippus Baalman, Ryan Bair, Seth Tisue, Ståle Undheim, Takuya Miyamoto (tmiyamon), Yasuhiro Tatsuno. Thank you!

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sbt 1.1.1

Bug fixes

- Fixes "Modified names for (class) is empty" error. zinc#292 / zinc#484 by [@jvican][@jvican] (Scala Center)
- Fixes tab completion in `console` while running in batch mode as `sbt console`. #3841/#3876 by [@eed3si9n][@eed3si9n]
- Fixes file timestamp retrieval of missing files on Windows. #3871 / io#120 by [@cunei][@cunei]
- Aligns the errors thrown by file timestamp implementations. Fixes #3894 / io#121 by [@j-keck][@j-keck]

- Adds file timestamps native support for FreeBSD. #3894 / io#124 by [@cunei][@cunei]
- Fixes JDK 10 version string parsing. sbt/sbt-launcher-package#209 by @2m

Improvements

- Deprecates `Extracted#append` in favour of `appendWithSession` or `appendWithoutSession`. #3865 by [@dwijnand][@dwijnand]
- Adds a new global `Boolean` setting called `autoStartServer`. See below.
- Upgrades Scala versions used for sbt cross building `^^`. #3923 by [@dwijnand][@dwijnand]
- Many documentation maintenance changes by [@xuwei-k][@xuwei-k].

autoStartServer setting sbt 1.1.1 adds a new global `Boolean` setting called `autoStartServer`, which is set to `true` by default. When set to `true`, sbt shell will automatically start sbt server. Otherwise, it will not start the server until `startSever` command is issued. This could be used to opt out of server for security reasons.

#3922 by [@swaldman][@swaldman]

Contributors sbt 1.1.1 was brought to you by 16 contributors, according to `git shortlog -sn --no-merges v1.1.0 ..v1.1.0` on sbt, zinc, librarymanagement, util, io, and website: Kenji Yoshida (xuwei-k), Eugene Yokota, Dale Wijnand, Antonio Cunei, Steve Waldman, Arnout Engelen, Deokhwan Kim, OlegYch, Robert Walker, Jorge Vicente Cantero (jvican), Claudio Bley, Eric Peters, Lena Brüder, Seiya Mizuno, Seth Tisue, j-keck. Thank you!

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sbt 1.1.0

This is a feature release for sbt 1.0.x series.

Features, fixes, changes with compatibility implications

- sbt server feature is reworked in sbt 1.1.0. See below.
- Changes `version` setting default to `0.1.0-SNAPSHOT` for compatibility with Semantic Versioning. #3577 by [@laughedelic][@laughedelic]

Features

- Unifies sbt shell and build.sbt syntax. See below.

Fixes

- Fixes `ClasspathFilter` that was causing `Class.forName` to not work in `run`. zinc#473 / #3736 / #3733 / #3647 / #3608 by [@ravwojdyla][@ravwojdyla]
- Fixes Java compilation causing `NullPointerException` by making PositionImpl thread-safe. zinc#465 by [@eed3si9n][@eed3si9n]
- Fixes `PollingWatchService` by preventing concurrent modification of `keysWithEvents` map. io#90 by [@mechkg][@mechkg], which fixes ~ related issues #3687, #3695, and #3775.
- Provides workaround for `File#lastModified()` losing millisecond-precision by using native code when possible. io#92/io#106 by [@cunei][@cunei]
- Fixes `IO.relativize` not working with relative path. io#108 by [@dwijnand][@dwijnand]
- Fixes warning message when multiple instances are detected. #3828 by [@eed3si9n][@eed3si9n]
- Fixes over-compilation bug with Java 9. zinc#450 by [@retronym][@retronym]
- Fixes handling of deeply nested Java classes. zinc#423 by [@romanowski][@romanowski]
- Fixes JavaDoc not printing all errors. zinc#415 by [@raboof][@raboof]
- Preserves JAR order in `ScalaInstance.otherJars`. zinc#411 by [@dwijnand][@dwijnand]
- Fixes used name when it contains NL. zinc#449 by [@jilen][@jilen]
- Fixes handling of `ThisProject`. #3609 by [@dwijnand][@dwijnand]
- Escapes imports from sbt files, so if user creates a backquoted definition then task evalution will not fail. #3635 by [@panaeon][@panaeon]
- Removes reference to version 0.14.0 from a warning message. #3693 by [@saniyatech][@saniyatech]
- Fixes screpl throwing "Not a valid key: console-quick". #3762 by [@xuwei-k][@xuwei-k]
- Restores Scala 2.13.0-M1 support. #461 by [@dwijnand][@dwijnand]
- Fixes the encoding of Unix-like file path to use `file:///`. #3805 by [@eed3si9n][@eed3si9n]
- Fixes Log4J2 initialization error during startup. #3814 by [@dwijnand][@dwijnand]

Improvements

- Filters scripted tests based on optional `project/build.properties`. See below.
- Adds `Project#withId` to change a project's id. #3601 by [@dwijnand][@dwijnand]
- Adds `reboot dev` command, which deletes the current artifact from the boot directory. This is useful when working with development versions of sbt. #3659 by [@eed3si9n][@eed3si9n]
- Adds a check for a change in sbt version before `reload`. #1055/#3673 by [@RomanIakovlev][@RomanIakovlev]
- Adds a new setting `insideCI`, which indicates that sbt is likely running in an Continuous Integration environment. #3672 by [@RomanIakovlev][@RomanIakovlev]
- Adds `nameOption` to `Command` trait. #3671 by [@miklos-martin][@miklos-martin]
- Adds POSIX persmission operations in IO, such as `IO.chmod(..)`. io#76 by [@eed3si9n][@eed3si9n]
- Treat sbt 1 modules using Semantic Versioning in the eviction warning. lm#188 by [@eed3si9n][@eed3si9n]
- Uses kind-projector in the code. #3650 by [@dwijnand][@dwijnand]
- Make `displayOnly` etc methods strict in `Completions`. #3763 by [@xuwei-k][@xuwei-k]

Unified slash syntax for sbt shell and build.sbt This adds unified slash syntax for both sbt shell and the build.sbt DSL. Instead of the current `<project-id>/config:intask::key`, this adds `<project-id>/<config-ident>/intask/key` where `<config-ident>` is the Scala identifier notation for the configurations like `Compile` and `Test`. (The old shell syntax will continue to function)

These examples work both from the shell and in build.sbt.

```
Global / cancelable
ThisBuild / scalaVersion
Test / test
root / Compile / compile / scalacOptions
ProjectRef(uri("file:/xxx/helloworld/"),"root")/Compile/scalacOptions
Zero / Zero / name
```

The inspect command now outputs something that can be copy-pasted:

```
> inspect compile
[info] Task: sbt.inc.Analysis
[info] Description:
[info]  Compiles sources.
[info] Provided by:
```

```
[info] ProjectRef(uri("file:/xxx/helloworld/"),"root")/Compile/compile
[info] Defined at:
[info]  (sbt.Defaults) Defaults.scala:326
[info] Dependencies:
[info]  Compile/manipulateBytecode
[info]  Compile/incCompileSetup
....
```

#1812/#3434/#3617/#3620 by [@eed3si9n][@eed3si9n] and [@dwijnand][@dwijnand]

sbt server sbt server feature was reworked to use Language Server Protocol 3.0 (LSP) as the wire protocol, a protocol created by Microsoft for Visual Studio Code.

To discover a running server, sbt 1.1.0 creates a port file at `./project/target/active.json` relative to a build:

```
{"uri":"local:///Users/foo/.sbt/1.0/server/0845deda85cb41abcdef/sock"}
```

`local:` indicates a UNIX domain socket. Here's how we can say hello to the server using `nc`. (`^M` can be sent `Ctrl-V` then `Return`):

```
$ nc -U /Users/foo/.sbt/1.0/server/0845deda85cb41abcdef/sock
Content-Length: 99^M
^M
{ "jsonrpc": "2.0", "id": 1, "method": "initialize", "params": { "initializationOptions": { } }
```

sbt server adds network access to sbt's shell command so, in addition to accepting input from the terminal, server also to accepts input from the network. Here's how we can call `compile`:

```
Content-Length: 93^M
^M
{ "jsonrpc": "2.0", "id": 2, "method": "sbt/exec", "params": { "commandLine": "compile" } }^M
```

The running sbt session should now queue `compile`, and return back with compiler warnings and errors, if any:

```
Content-Length: 296
Content-Type: application/vscode-jsonrpc; charset=utf-8

{"jsonrpc":"2.0","method":"textDocument/publishDiagnostics","params":{"uri":"file:/Users/foo
```

#3524/#3556 by [@eed3si9n][@eed3si9n]

VS Code extension The primary use case we have in mind for the sbt server is tooling integration such as editors and IDEs. As a proof of concept, we created a Visual Studio Code extension called Scala (sbt).

Currently this extension is able to:

- Run `compile` at the root project when `*.scala` files are saved. #3524 by [@eed3si9n][@eed3si9n]
- Display compiler errors.
- Display log messages. #3740 by [@laughedelic][@laughedelic]
- Jump to class definitions. #3660 by [@wpopielarski][@wpopielarski]

Filtering scripted tests using `project/build.properties` For all scripted tests in which `project/build.properties` exist, the value of the `sbt.version` property is read. If its binary version is different from `sbtBinaryVersion in pluginCrossBuild` the test will be skipped and a message indicating this will be logged.

This allows you to define scripted tests that track the minimum supported sbt versions, e.g. 0.13.9 and 1.0.0-RC2. #3564/#3566 by [@jonas][@jonas]

Contributors sbt 1.1.0 was brought to you by 33 contributors, according to `git shortlog -sn --no-merges v1.0.4..v1.1.0` on sbt, zinc, librarymanagement, util, io, and website: Eugene Yokota, Dale Wijnand, Antonio Cunei, Kenji Yoshida (xuwei-k), Alexey Alekhin, Simon Schäfer, Jorge Vicente Cantero (jvican), Miklos Martin, Jeffrey Olchovy, Jonas Fonseca, Andrey Artemov, Arnout Engelen, Dominik Winter, Krzysztof Romanowski, Roman Iakovlev, Wiesław Popielarski, Age Mooij, Allan Timothy Leong, Ivan Poliakov, Jason Zaugg, Jilen Zhang, Long Jinwei, Martin Duhem, Michael Stringer, Michael Wizner, Nud Teeraworamongkol, OlegYch, PanAeon, Philippus Baalman, Pierre Dal-Pra, Rafal Wojdyla, Saniya Tech, Tom Walford, and many others who contributed ideas. Thank you!

sbt 1.0.x releases

sbt 1.0.4

This is a hotfix release for sbt 1.0.x series.

Bug fixes

- Fixes undercompilation of value classes when the underlying type changes. zinc#444 by [@smarter][@smarter]

- Fixes `ArrayIndexOutOfBoundsException` on Ivy when running on Java 9. ivy#27 by [@xuwei-k][@xuwei-k]
- Fixes Java 9 warning by upgrading to launcher 1.0.2. ivy#26/launcher#45 by [@dwijnand][@dwijnand]
- Fixes `-jvm-debug` on Java 9. launcher-package197 by [@mkurz][@mkurz]
- Fixes `run` outputing debug level logs. #3655/#3717 by [@cunei][@cunei]
- Fixes performance regression caused by classpath hashing. zinc#452 by [@jvican][@jvican], [@fommil][@fommil] provided reproduction, and [@eed3si9n][@eed3si9n] fixed https://github.com/sbt/zinc/issues/457
- Fixes performance regression of `testQuick`. #3680/#3720 by [@OlegYch][@OlegYch]
- Disables Ivy log4j caller location calculation for performance regression reported in #3711. util#132 by [@leonardehrenfried][@leonardehrenfried]
- Works around Scala compiler's `templateStats()` not being thread-safe. #3743 by [@cunei][@cunei]
- Fixes "Attempting to overwrite" error message. lm#174 by [@dwijnand][@dwijnand]
- Fixes incorrect eviction warning message. lm#179 by [@xuwei-k][@xuwei-k]
- Registers Ivy protocol only for `http:` and `https:` to be more plugin friendly. lm183 by [@tpunder][@tpunder]
- Fixes script issues related to `bc` by using `expr`. launcher-package#199 by [@thatfulvioguy][@thatfulvioguy]

Enhancement

- Adds Scala 2.13.0-M2 support. zinc#453 by [@eed3si9n][@eed3si9n] and [@jan0sch][@jan0sch]

Internal

- Improves Zinc scripted testing. zinc#440 by [@jvican][@jvican]

Contributors A huge thank you to everyone who's helped improve sbt and Zinc 1 by using them, reporting bugs, improving our documentation, porting builds, porting plugins, and submitting and reviewing pull requests.

This release was brought to you by 17 contributors, according to `git shortlog -sn --no-merges v1.0.3..v1.0.4` on sbt, zinc, librarymanagement, util, io, and website: Eugene Yokota, Kenji Yoshida (xuwei-k), Jorge Vicente Cantero (jvican), Dale Wijnand, Leonard Ehrenfried, Antonio Cunei, Brett Randall, Guillaume Martres, Arnout Engelen, Fulvio Valente, Jens Grassel, Matthias Kurz, OlegYch, Philippus Baalman, Sam Halliday, Tim Underwood, Tom Most. Thank you!

sbt 1.0.3

This is a hotfix release for sbt 1.0.x series.

Bug fixes

- Fixes ~ recompiling in loop (when a source generator or sbt-buildinfo is present). #3501/#3634 by [@dwijnand][@dwijnand]
- Fixes undercompilation on inheritance on same source. zinc#424 by [@eed3si9n][@eed3si9n]
- Fixes the compilation of package-protected objects. zinc#431 by [@jvican][@jvican]
- Workaround for Java returning `null` for `getGenericParameterTypes`. zinc#446 by [@jvican][@jvican]
- Fixes test detection regression. sbt 1.0.3 filters out nested objects/classes from the list, restoring compatibility with 0.13. #3669 by [@cunei][@cunei]
- Uses Scala 2.12.4 for the build definition. This includes fix for runtime reflection of empty package members under Java 9. #3587 by [@eed3si9n][@eed3si9n]
- Fixes extra `/` in Ivy style patterns. lm#170 by [@laughedelic][@laughedelic]
- Fixes "destination file exist" error message by including the file name. lm171 by [@leonardehrenfried][@leonardehrenfried]
- Fixes JDK 9 warning "Illegal reflective access" in library management module and Ivy. lm173 by [@dwijnand][@dwijnand]

Improvements

- Adds `sbt.watch.mode` system property to allow switching back to old polling behaviour for watch. See below for more details.

Alternative watch mode sbt 1.0.0 introduced a new mechanism for watching for source changes based on the NIO `WatchService` in Java 1.7. On some platforms (namely macOS) this has led to long delays before changes are picked up. An alternative `WatchService` for these platforms is planned for sbt 1.1.0 (#3527), in the meantime an option to select which watch service has been added.

The new `sbt.watch.mode` JVM flag has been added with the following supported values:

- `polling`: (default for macOS) poll the filesystem for changes (mechanism used in sbt 0.13).
- `nio` (default for other platforms): use the NIO based `WatchService`.

If you are experiencing long delays on a non-macOS machine then try adding `-Dsbt.watch.mode=polling` to your sbt options.

#3597 by [@stringbean][@stringbean]

Contributors A huge thank you to everyone who's helped improve sbt and Zinc 1 by using them, reporting bugs, improving our documentation, porting builds, porting plugins, and submitting and reviewing pull requests.

This release was brought to you by 15 contributors, according to `git shortlog -sn --no-merges v1.0.2..v1.0.3` on sbt, zinc, librarymanagement, util, io, and website: Eugene Yokota, Dale Wijnand, Michael Stringer, Jorge Vicente Cantero (jvican), Alexey Alekhin, Antonio Cunei, Andrey Artemov, Jeffrey Olchovy, Kenji Yoshida (xuwei-k), Dominik Winter, Long Jinwei, Arnout Engelen, Justin Kaeser, Leonard Ehrenfried, Sakib Hadžiavdić. Thank you!

---

sbt 1.0.2

This is a hotfix release for sbt 1.0.x series.

Bug fixes

- Fixes terminal echo issue. #3507 by [@kczulko][@kczulko]
- Fixes `deliver` task, and adds `makeIvyXml` as a more sensibly named task. #3487 by [@cunei][@cunei]
- Replaces the deprecated use of `OkUrlFactory`, and fixes connection leaks. lm#164 by [@dpratt][@dpratt]
- Refixes false positive in DSL checker for setting keys. #3513 by [@dwijnand][@dwijnand]
- Fixes `run` and `bgRun` not picking up changes to directories in the classpath. #3517 by [@dwijnand][@dwijnand]
- Fixes `++` so it won't change the value of `crossScalaVersion`. #3495/#3526 by [@dwijnand][@dwijnand]
- Fixes sbt server missing some messages. #3523 by [@guillaumebort][@guillaumebort]
- Refixes `consoleProject`. zinc#386 by [@dwijnand][@dwijnand]

- Adds JVM flag `sbt.gigahorse` to enable/disable the internal use of Gigahorse to workaround NPE in `JavaNetAuthenticator` when used in conjunction with `repositories` override. lm#167 by [@cunei][@cunei]
- Adds JVM flag `sbt.server.autostart` to enable/disable the automatic starting of sbt server with the sbt shell. This also adds new `startServer` command to manually start the server. by [@eed3si9n][@eed3si9n]

Internal

- Fixes unused import warnings. #3533 by [@razvan-panda][@razvan-panda]

Contributors A huge thank you to everyone who's helped improve sbt and Zinc 1 by using them, reporting bugs, improving our documentation, porting plugins, and submitting and reviewing pull requests.

This release was brought to you by 19 contributors, according to `git shortlog -sn --no-merges v1.0.1..v1.0.2` on sbt, zinc, librarymanagement, and website: Dale Wijnand, Eugene Yokota, Kenji Yoshida (xuwei-k), Antonio Cunei, David Pratt, Karol Cz (kczulko), Amanj Sherwany, Emanuele Blanco, Eric Peters, Guillaume Bort, James Roper, Joost de Vries, Marko Elezovic, Martynas Mickevičius, Michael Stringer, Răzvan Flavius Panda, Peter Vlugter, Philippus Baalman, and Wiesław Popielarski. Thank you!

---

sbt 1.0.1

This is a hotfix release for sbt 1.0.x series.

Bug fixes

- Fixes command support for cross building `+` command. The `+` added to sbt 1.0 traveres over the subprojects, respecting `crossScalaVersions`; however, it no longer accepted commands as arguments. This brings back the support for it. #3446 by [@jroper][@jroper]
- Fixes `addSbtPlugin` to use the correct version of sbt during cross building. #3442 by [@dwijnand][@dwijnand]
- Fixes `run in Compile` task not including `Runtime` configuration, by reimplementing `run` in terms of `bgRun`. #3477 by [@eed3si9n][@eed3si9n]
- Shows `actual` as a potential option of `inspect` #3335 by [@Duhemm][@Duhemm]
- Includes base directory to watched sources. #3439 by [@Duhemm][@Duhemm]

- Adds an attempt to workaround intermittent `NullPointerException` arround logging. util#121 by [@eed3si9n][@eed3si9n]
- Reverts a bad forward porting. #3481 by [@eed3si9n][@eed3si9n]

WatchSource The watch source feature went through a major change from sbt 0.13 to sbt 1.0 using NIO; however, it did not have clear migration path, so we are rectifying that in sbt 1.0.1.

First, `sbt.WatchSource` is a new alias for `sbt.internal.io.Source`. Hopefully this is easy enough to remember because the key is named `watchSources`. Next, `def apply(base: File)` and `def apply(base: File, includeFilter: FileFilter, excludeFilter: FileFilter)` constructors were added to the companion object of `sbt.WatchSource`.

For backward compatiblity, sbt 1.0.1 adds `+=` support (`Append` instance) from `File` to `Seq[WatchSource]`.

So, if you have a directory you want to watch:

```
watchSources += WatchSource(sourceDirectory.value)
```

If you have a list of files:

```
watchSources ++= (sourceDirectory.value ** "*.scala").get
```

#3438 by [@Duhemm][@Duhemm]; #3478 and io#74 by [@eed3si9n][@eed3si9n]

---

sbt 1.0.0

Features, fixes, changes with compatibility implications See Migrating from sbt 0.13.x also.

- sbt 1.0 uses **Scala 2.12** for build definitions and plugins. This also requires JDK 8.
- Many of the case classes are replaced with pseudo case classes generated using Contraband. Migrate `.copy(foo = xxx)` to `withFoo(xxx)`. For example, `UpdateConfiguration`, `RetrieveConfiguration`, `PublishConfiguration` are refactored to use builder pattern.
- Zinc 1 drops support for Scala 2.9 and earlier. Scala 2.10 must use 2.10.2 and above. Scala 2.11 must use 2.11.2 and above. (latest patch releases are recommended)

- `config("xyz")` must be directly assigned to a *capitalized* `val`, like `val Xyz = config("xyz")`. This captures the lhs identifier into the configuration so we can use it from the shell later.
- Changes `publishTo` and `otherResolvers` from SettingKeys to TaskKeys. #2059/#2662 by [@dwijnand][@dwijnand]
- `Path.relativizeFile(baseFile, file)` is renamed to `IO.relativizeFile(baseFile, file)`.
- `PathFinder`'s `.***` method is renamed to `.allPaths` method.
- `PathFinder.x_!(mapper)` is moved to `def pair` on `PathFinder`.
- A number of the methods on `sbt.Path` (such as `relativeTo` and `rebase` and `flat`) are now no longer in the default namespace by virtue of being mixed into the sbt package object. Use `sbt.io.Path` to access them again.
- sbt 1.0 renames `Global` as scope component to `Zero` to disambiguate from `GlobalScope`. [@eed3si9n][@eed3si9n]
- sbt 1.0 uses `ConfigRef` in places where `String` was used to reference configuration, such as `update.value.configuration(...)`. Pass in `Configuration`, which implicitly converts to `ConfigRef`.
- Changes `sourceArtifactTypes` and `docArtifactTypes` from `Set[String]` to `Seq[String]` settings.
- Renames early command feature from `--<command>` to `early(<command>)`.
- Drops sbt 0.12 style hyphen-separated key names (use `publishLocal` instead of `publish-local`).
- Log options `-error`, `-warn`, `-info`, `-debug` are added as shorthand for `"early(error)"` etc.
- `sbt.Process` and `sbt.ProcessExtra` are dropped. Use `scala.sys.process` instead.
- `incOptions.value.withNameHashing(...)` option is removed because name hashing is always on.
- `TestResult.Value` is now called `TestResult`.
- The scripted plugin is cross-versioned now, so you must use `%%` when depending on it.

Dropped dreprecations:

- sbt 0.12 style `Build` trait that was deprecated in sbt 0.13.12, is removed. Please migrate to build.sbt. Auto plugins and `Build` trait do not work well together, and its feature is now largely subsumed by multi-project build.sbt.
- sbt 0.12 style `Project(...)` constructor is restricted down to two parameters. This is because `settings` parameter does not work well with Auto Plugins. Use `project` instead.
- sbt 0.12 style key dependency operators `<<=`, `<+=`, `<++=` are removed. Please migrate to :=, +=, and ++=. These operators have been sources

of confusion for many users, and have long been removed from 0.13 docs, and have been formally deprecated since sbt 0.13.13.

- Non-auto `sbt.Plugin` trait is dropped. Please migrate to AutoPlugin. Auto plugins are easier to configure, and work better with each other.
- Removes the `settingsSets` method from `Project` (along with `add/setSbtFiles`).
- Drops deprecated `InputTask` `apply` method and `inputTask` DSL method. Use `Def.inputTask` and `Def.spaceDelimited().parsed`.
- Drops deprecated `ProjectReference` implicit lifts. Use `RootProject(<uri>)`, `RootProject(<file>)` or `LocalProject(<string>)`.
- Drops deprecated `seq(..)` DSL method. Use `Seq` or pass in the settings without wrapping.
- Drops deprecated `File`/`Seq[File]` setting enrichments. Use `.value` and `Def.setting`.
- Drops deprecated `SubProcess` `apply` overload. Use `SubProcess(ForkOptions(runJVMOptions = ..))`.
- Drops `toError(opt: Option[String]): Unit` (equivalent to `opt foreach sys.error`); if used to wrap `ScalaRun#run` then the replacement is `scalaRun.run(...).failed foreach (sys error _.getMessage)`

Features

- New incremental compiler called Zinc 1. Details below.
- The interactive shell is adds network API. Details below.

Fixes

- Fixes test content log not showing up. #3198/util#80 by [@eed3si9n][@eed3si9n]
- Fixes confusing log about "Unable to parse". lm#98 by [@jvican][@jvican]
- Fixes `console` task. zinc#295 by [@dwijnand][@dwijnand]
- Fixes spurious recompilations when unrelated constructor changes. zinc#288 by [@smarter][@smarter]
- Fixes restligeist macro for old operators. #3218 by [@eed3si9n][@eed3si9n]
- Fixes task caching of `update` task. #3233 by [@eed3si9n][@eed3si9n]
- Fixes ncurses-JLine issue by updating to JLine 2.14.4. util#81 by [@Rogach][@Rogach]

Improvements

- Scala Center contributed a Java-friendly Zinc API. This was a overhaul of the Zinc internal API for a good Scala integration with other build tools. zinc#304 by [@jvican][@jvican]

- Scala Center contributed a binary format for Zinc's internal storage. See below
- Scala Center contributed static validation of `build.sbt`. See below
- Library management API and parallel artifact download. See below.
- The startup log level is dropped to `-error` in script mode using `scalas`. #840 by [@eed3si9n][@eed3si9n]
- Replace cross building support with sbt-doge. This allows builds with projects that have multiple different combinations of cross scala versions to be cross built correctly. The behaviour of ++ is changed so that it only updates the Scala version of projects that support that Scala version, but the Scala version can be post fixed with ! to force it to change for all projects. A -v argument has been added that prints verbose information about which projects are having their settings changed along with their cross scala versions. #2613 by [@jroper][@jroper]
- `ivyLoggingLevel` is dropped to `UpdateLogging.Quiet` when CI environment is detected. [@eed3si9n][@eed3si9n]
- Add logging of the name of the different `build.sbt` (matching `*.sbt`) files used. #1911 by [@valydia][@valydia]
- Add the ability to call `aggregate` for the current project inside a build sbt file. By [@xuwei-k][@xuwei-k]
- Add new global setting `asciiGraphWidth` that controls the maximum width of the ASCII graphs printed by commands like `inspect tree`. Default value corresponds to the previously hardcoded value of 40 characters. By [@RomanIakovlev][@RomanIakovlev].
- Revamped documentation for Scopes, and added Scope Delegation. [@eed3si9n][@eed3si9n]
- Ports sbt-cross-building's ^ and ^^ commands for plugin cross building. See below.
- Adds support for cross-versioned exclusions. #1518/lm#88 by [@jvican][@jvican]
- Adds new offline mode to the Ivy-based library management. lm#92 by [@jvican][@jvican]
- A number of features related to dependency locking. See below.
- Improved eviction warning presentation. See below.
- A better main class detection. zinc#287 by [@smarter][@smarter]
- For faster startup, sbt will use Java refection to discover `autoImport` . #3115 by [@jvican][@jvican]
- For faster startup, reuse the same global instance for parsing. #3115 by [@jvican][@jvican]
- Adds `InteractionService` from sbt-core-next to keep compatibility with sbt 0.13. #3182 by [@eed3si9n][@eed3si9n]
- Adds new `WatchService` that abstracts `PollingWatchService` and Java NIO. io#47 by [@Duhemm][@Duhemm] on behalf of The Scala Center.
- Adds variants of `IO.copyFile` and `IO.copyDirectory` that accept

sbt.io.CopyOptions(). See below for details.
- Path.directory and Path.contentOf are donated from sbt-native-packager io#38 by [@muuki88][@muuki88]
- ApiDiff feature used to debug Zinc uses Scala implementation borrowed from Dotty. zinc#346 by [@Krever][@Krever]
- In Zinc internal, make ExtractAPI use perRunCaches. zinc#347 by [@gheine][@gheine]

Internals

- Adopted Scalafmt for formatting the source code using neo-scalafmt.
- Scala Center contributed a redesign of the scripted test framework that has batch mode execution. Scripted now reuses the same sbt instance to run sbt tests, which reduces the CI build times by 50% #3151 by [@jvican][@jvican]
- sbt 1.0.0-M6 is built using sbt 1.0.0-M5. #3184 by [@dwijnand][@dwijnand]

Details of major changes

Zinc 1: Class-based name hashing A major improvement brought into Zinc 1.0 by Grzegorz Kossakowski (commissioned by Lightbend) is class-based name hashing, which will speed up the incremental compilation of Scala in large projects.

Zinc 1.0's name hashing tracks your code dependendencies at the class level, instead of at the source file level. The GitHub issue sbt/sbt#1104 lists some comparisons of adding a method to an existing class in some projects:

```
ScalaTest   AndHaveWord class:          Before 49s, After 4s (12x)
Specs2      OptionResultMatcher class:  Before 48s, After 1s (48x)
scala/scala Platform class:            Before 59s, After 15s (3.9x)
scala/scala MatchCodeGen class:        Before 48s, After 17s (2.8x)
```

This depends on some factors such as how your classes are organized, but you can see 3x ~ 40x improvements. The reason for the speedup is because it compiles fewer source files than before by untangling the classes from source files. In the example adding a method to scala/scala's Platform class, sbt 0.13's name hashing used to compile 72 sources, but the new Zinc compiles 6 sources.

Zinc API changes

- Java classes under the xsbti.compile package such as IncOptions hides the constructor. Use the factory method xsbti.compile.Foo.of(...).

- Renames `ivyScala: IvyScala` key to `scalaModuleInfo: ScalaModuleInfo`.
- `xsbti.Reporter#log(...)` takes `xsbti.Problem` as the parameter. Call `log(problem.position, problem.message, problem.severity)` to delegate to the older `log(...)`.
- `xsbi.Maybe`, `xsbti.F0`, and `sxbti.F1` are changed to corresponding Java 8 classes `java.util.Optional`, `java.util.Supplier` and `java.util.Function`.
- Removes unused "resident" option. zinc#345 by [@lukeindykiewicz][@lukeindykiewicz]

sbt server: JSON API for tooling integration sbt 1.0 includes server feature, which allows IDEs and other tools to query the build for settings, and invoke commands via a JSON API. Similar to the way that the interactive shell in sbt 0.13 is implemented with `shell` command, "server" is also just `shell` command that listens to both human input and network input. As a user, there should be minimal impact because of the server.

In March 2016, we rebooted the "server" feature to make it as small as possible. We worked in collaboration with JetBrains' @jastice who works on IntelliJ's sbt interface to narrow down the feature list. sbt 1.0 will not have all the things we originally wanted, but in the long term, we hope to see better integration between IDE and sbt ecosystem using this system. For example, IDEs will be able to issue the compile task and retrieve compiler warning as JSON events:

```
{"type":"xsbti.Problem","message":{"category":"","severity":"Warn","message":"a pure express
```

Another related feature that was added is the `bgRun` task which, for example, enables a server process to be run in the background while you run tests against it.

Static validation of build.sbt sbt 1.0 prohibits `.value` calls inside the bodies of if expressions and anonymous functions in a task, `@sbtUnchecked` annotation can be used to override the check.

The static validation also catches if you forget to call `.value` in a body of a task.

#3216 and #3225 by [@jvican][@jvican]

Eviction warning presentation sbt 1.0 improves the eviction warning presetation.

Before:

```
[warn] There may be incompatibilities among your library dependencies.
[warn] Here are some of the libraries that were evicted:
```

```
[warn]  * com.google.code.findbugs:jsr305:2.0.1 -> 3.0.0
[warn] Run 'evicted' to see detailed eviction warnings
```

After:

```
[warn] Found version conflict(s) in library dependencies; some are suspected to be binary incomp
[warn]
[warn]    * com.typesafe.akka:akka-actor_2.12:2.5.0 is selected over 2.4.17
[warn]       +- de.heikoseeberger:akka-log4j_2.12:1.4.0        (depends on 2.5.0)
[warn]       +- com.typesafe.akka:akka-parsing_2.12:10.0.6      (depends on 2.4.17)
[warn]       +- com.typesafe.akka:akka-stream_2.12:2.4.17 ()     (depends on 2.4.17)
[warn]
[warn] Run 'evicted' to see detailed eviction warnings
```

#3202 by [@eed3si9n][@eed3si9n]

sbt-cross-building [@jrudolph][@jrudolph]'s sbt-cross-building is a plugin author's plugin. It adds cross command `^` and sbtVersion switch command `^^`, similar to `+` and `++`, but for switching between multiple sbt versions across major versions. sbt 0.13.16 merges these commands into sbt because the feature it provides is useful as we migrate plugins to sbt 1.0.

To switch the `sbtVersion in pluginCrossBuild` from the shell use:

```
^^ 1.0.0-M5
```

Your plugin will now build with sbt 1.0.0-M5 (and its Scala version 2.12.2).

If you need to make changes specific to a sbt version, you can now include them into `src/main/scala-sbt-0.13`, and `src/main/scala-sbt-1.0.0-M5`, where the binary sbt version number is used as postfix.

To run a command across multiple sbt versions, set:

```
crossSbtVersions := Vector("0.13.15", "1.0.0-M5")
```

Then, run:

```
^ compile
```

#3133 by [@eed3si9n][@eed3si9n] (forward ported from 0.13.16-M1)

CopyOptions sbt IO 1.0 add variant of `IO.copyFile` and `IO.copyDirectory` that accept `sbt.io.CopyOptions()`. `CopyOptions()` is an example of pseudo case class similar to the builder pattern.

```
import sbt.io.{ IO, CopyOptions }

IO.copyDirectory(source, target)

// The above is same as the following
IO.copyDirectory(source, target, CopyOptions()
  .withOverwrite(false)
  .withPreserveLastModified(true)
  .withPreserveExecutable(true))
```

io#53 by [@dwijnand][@dwijnand]

Library management API and parallel artifact download sbt 1.0 adds Library management API co-authored by Eugene Yokota ([@eed3si9n][@eed3si9n]) from Lightbend and Martin Duhem ([@Duhemm][@Duhemm]) from Scala Center. This API aims to abstract Apache Ivy as well as alternative dependency resolution engines Ivy, cached resolution, and Coursier.

Parallel artifact download for Ivy engine was contributed by Jorge ([@jvican][@jvican]) from Scala Center. It also introduces Gigahorse OkHttp as the Network API, and it uses Square OkHttp for artifact download as well.

lm#124 by [@eed3si9n][@eed3si9n]/[@Duhemm][@Duhemm], lm#90 by [@jvican][@jvican]/[@jsuereth][@jsuereth] and lm#104 by [@eed3si9n][@eed3si9n].

Binary format for Zinc's internal storage Jorge ([@jvican][@jvican]) from Scala Center contributed a binary format for Zinc's internal storage using Google Procol Buffer. The new format provides us with three main advantages:

1. Backwards and forwards binary compatibility at the analysis format level.
2. Faster (1.5 ~ 2x) serialization/deserialization of the analysis file.
3. Provides a better way to make the analysis file machine-independent.

zinc#351 by [@jvican][@jvican]

Dependency locking Dependency locking feature is still in progress, but Jorge ([@jvican][@jvican]) from Scala Center has added a number of related features that would should work together to allow dependency locking.

- Frozen mode to the Ivy-based library management, which makes sure that the resolution is always intransitive. lm#100
- Adds support to specify a resolver for dependencies. lm#97
- Adds "managed checksums", which tells Ivy to skip the checksum process. lm#111

Contributors Too many people to thank here. See Credits

Detailed Topics

This part of the documentation has pages documenting particular sbt topics in detail. Before reading anything in here, you will need the information in the Getting Started Guide as a foundation.

Other resources include the How to and Developer's Guide sections in this reference, and the API Documentation

Using sbt

This part of the documentation has pages documenting particular sbt topics in detail. Before reading anything in here, you will need the information in the Getting Started Guide as a foundation.

Command Line Reference

This page is a relatively complete list of command line options, commands, and tasks you can use from the sbt interactive prompt or in batch mode. See Running in the Getting Started Guide for an intro to the basics, while this page has a lot more detail.

Notes on the command line

- There is a technical distinction in sbt between *tasks*, which are "inside" the build definition, and *commands*, which manipulate the build definition itself. If you're interested in creating a command, see Commands. This specific sbt meaning of "command" means there's no good general term for "thing you can type at the sbt prompt", which may be a setting, task, or command.
- Some tasks produce useful values. The `toString` representation of these values can be shown using `show <task>` to run the task instead of just `<task>`.

- In a multi-project build, execution dependencies and the aggregate setting control which tasks from which projects are executed. See multi-project builds.

Project-level tasks

- `clean` Deletes all generated files (the `target` directory).
- `publishLocal` Publishes artifacts (such as jars) to the local Ivy repository as described in Publishing.
- `publish` Publishes artifacts (such as jars) to the repository defined by the publishTo setting, described in Publishing.
- `update` Resolves and retrieves external dependencies as described in library dependencies.

Configuration-level tasks

Configuration-level tasks are tasks associated with a configuration. For example, `compile`, which is equivalent to `compile:compile`, compiles the main source code (the `compile` configuration). `test:compile` compiles the test source code (test `test` configuration). Most tasks for the `compile` configuration have an equivalent in the `test` configuration that can be run using a `test:` prefix.

- `compile` Compiles the main sources (in the `src/main/scala` directory). `test:compile` compiles test sources (in the src/test/scala/ directory).
- `console` Starts the Scala interpreter with a classpath including the compiled sources, all jars in the lib directory, and managed libraries. To return to sbt, type :quit, Ctrl+D (Unix), or Ctrl+Z (Windows). Similarly, test:console starts the interpreter with the test classes and classpath.
- `consoleQuick` Starts the Scala interpreter with the project's compile-time dependencies on the classpath. test:consoleQuick uses the test dependencies. This task differs from console in that it does not force compilation of the current project's sources.
- `consoleProject` Enters an interactive session with sbt and the build definition on the classpath. The build definition and related values are bound to variables and common packages and values are imported. See the consoleProject documentation for more information.
- `doc` Generates API documentation for Scala source files in `src/main/scala` using scaladoc. `test:doc` generates API documentation for source files in `src/test/scala`.
- `package` Creates a jar file containing the files in `src/main/resources` and the classes compiled from `src/main/scala`. `test:package` creates a jar containing the files in `src/test/resources` and the class compiled from `src/test/scala`.

- `packageDoc` Creates a jar file containing API documentation generated from Scala source files in src/main/scala. test:packageDoc creates a jar containing API documentation for test sources files in src/test/scala.
- `packageSrc`: Creates a jar file containing all main source files and resources. The packaged paths are relative to src/main/scala and src/main/resources. Similarly, test:packageSrc operates on test source files and resources.
- `run <argument>*` Runs the main class for the project in the same virtual machine as sbt. The main class is passed the arguments provided. Please see Running Project Code for details on the use of System.exit and multithreading (including GUIs) in code run by this action. `test:run` runs a main class in the test code.
- `runMain <main-class> <argument>*` Runs the specified main class for the project in the same virtual machine as sbt. The main class is passed the arguments provided. Please see Running Project Code for details on the use of System.exit and multithreading (including GUIs) in code run by this action. `test:runMain` runs the specified main class in the test code.
- `test` Runs all tests detected during test compilation. See Testing for details.
- `testOnly <test>*` Runs the tests provided as arguments. `*` (will be) interpreted as a wildcard in the test name. See Testing for details.
- `testQuick <test>*` Runs the tests specified as arguments (or all tests if no arguments are given) that:
  1. have not been run yet OR
  2. failed the last time they were run OR
  3. had any transitive dependencies recompiled since the last successful run `*` (will be) interpreted as a wildcard in the test name. See Testing for details.

General commands

- `exit` or `quit` End the current interactive session or build. Additionally, Ctrl+D (Unix) or Ctrl+Z (Windows) will exit the interactive prompt.

- `help <command>` Displays detailed help for the specified command. If the command does not exist, help lists detailed help for commands whose name or description match the argument, which is interpreted as a regular expression. If no command is provided, displays brief descriptions of the main commands. Related commands are tasks and settings.

- `projects [add|remove <URI>]` List all available projects if no arguments provided or adds/removes the build at the provided URI. (See multi-project builds for details on multi-project builds.)

- `project <project-id>` Change the current project to the project with ID `<project-id>`. Further operations will be done in the context of the given project. (See multi-project builds for details on multiple project builds.)
- `~ <command>` Executes the project specified action or method whenever source files change. See Triggered Execution for details.
- `< filename` Executes the commands in the given file. Each command should be on its own line. Empty lines and lines beginning with '#' are ignored
- `+ <command>` Executes the project specified action or method for all versions of Scala defined in the crossScalaVersions setting.
- `++ <version|home-directory> <command>` Temporarily changes the version of Scala building the project and executes the provided command. `<command>` is optional. The specified version of Scala is used until the project is reloaded, settings are modified (such as by the set or session commands), or ++ is run again. `<version>` does not need to be listed in the build definition, but it must be available in a repository. Alternatively, specify the path to a Scala installation.
- `; A ; B` Execute A and if it succeeds, run B. Note that the leading semicolon is required.
- `eval <Scala-expression>` Evaluates the given Scala expression and returns the result and inferred type. This can be used to set system properties, as a calculator, to fork processes, etc … For example:

```
> eval System.setProperty("demo", "true")
> eval 1+1
> eval "ls -l" !
```

Commands for managing the build definition

- `reload [plugins|return]` If no argument is specified, reloads the build, recompiling any build or plugin definitions as necessary. reload plugins changes the current project to the build definition project (in project/). This can be useful to directly manipulate the build definition. For example, running clean on the build definition project will force snapshots to be updated and the build definition to be recompiled. reload return changes back to the main project.
- `set <setting-expression>` Evaluates and applies the given setting definition. The setting applies until sbt is restarted, the build is reloaded, or the setting is overridden by another set command or removed by the session command. See .sbt build definition and inspecting settings for details.

- `session <command>` Manages session settings defined by the `set` command. It can persist settings configured at the prompt. See Inspecting-Settings for details.
- `inspect <setting-key>` Displays information about settings, such as the value, description, defining scope, dependencies, delegation chain, and related settings. See Inspecting Settings for details.

Command Line Options

System properties can be provided either as JVM options, or as SBT arguments, in both cases as `-Dprop=value`. The following properties influence SBT execution. Also see sbt launcher.

Property

Values

Default

Meaning

sbt.log.noformat

Boolean

false

If true, disable ANSI color codes. Useful on build servers or terminals that do not support color.

sbt.global.base

Directory

~/.sbt/1.0

The directory containing global settings and plugins

sbt.ivy.home

Directory

~/.ivy2

The directory containing the local Ivy repository and artifact cache

sbt.boot.directory

Directory

~/.sbt/boot

Path to shared boot directory

sbt.main.class

String

xsbt.inc.debug

Boolean

false

sbt.extraClasspath

Classpath Entries

(jar files or directories) that are added to sbt's classpath. Note that the entries are delimінted by comma, e.g.: entry1, entry2,... See also resource in the sbt launcher documentation.

sbt.version

Version

1.2.1

sbt version to use, usually taken from project/build.properties.

sbt.boot.properties

File

The path to find the sbt boot properties file. This can be a relative path, relative to the sbt base directory, the users home directory or the location of the sbt jar file, or it can be an absolute path or an absolute file URI.

sbt.override.build.repos

Boolean

false

If true, repositories configured in a build definition are ignored and the repositories configured for the launcher are used instead. See sbt.repository.config and the sbt launcher documentation.

sbt.repository.config

File

~/.sbt/repositories

A file containing the repositories to use for the launcher. The format is the same as a [repositories] section for a sbt launcher configuration file. This setting is typically used in conjunction with setting sbt.override.build.repos to true (see previous row and the sbt launcher documentation).

Console Project

Description

The `consoleProject` task starts the Scala interpreter with access to your project definition and to `sbt`. Specifically, the interpreter is started up with these commands already executed:

```
import sbt._
import Keys._
import <your-project-definition>._
import currentState._
import extracted._
import cpHelpers._
```

For example, running external processes with sbt's process library (to be included in the standard library in Scala 2.9):

```
> "tar -zcvf project-src.tar.gz src" !
> "find project -name *.jar" !
> "cat build.sbt" #| "grep version" #> new File("sbt-version") !
> "grep -r null src" #|| "echo null-free" !
> uri("http://databinder.net/dispatch/About").toURL #> file("About.html") !
```

`consoleProject` can be useful for creating and modifying your build in the same way that the Scala interpreter is normally used to explore writing code. Note that this gives you raw access to your build. Think about what you pass to `IO.delete`, for example.

Accessing settings

To get a particular setting, use the form:

```
> val value = (<key> in <scope>).eval
```

Examples

```
> IO.delete( (classesDirectory in Compile).eval )
```

Show current compile options:

```
> (scalacOptions in Compile).eval foreach println
```

Show additionally configured repositories.

```
> resolvers.eval foreach println
```

Evaluating tasks

To evaluate a task (and its dependencies), use the same form:

```
> val value = (<key> in <scope>).eval
```

Examples Show all repositories, including defaults.

```
> fullResolvers.eval foreach println
```

Show the classpaths used for compilation and testing:

```
> (fullClasspath in Compile).eval.files foreach println
> (fullClasspath in Test).eval.files foreach println
```

State

The current build State is available as `currentState`. The contents of `currentState` are imported by default and can be used without qualification.

Examples Show the remaining commands to be executed in the build (more interesting if you invoke `consoleProject` like `; consoleProject ; clean ; compile`):

```
> remainingCommands
```

Show the number of currently registered commands:

```
> definedCommands.size
```

Cross-building

Introduction

Different versions of Scala can be binary incompatible, despite maintaining source compatibility. This page describes how to use `sbt` to build and publish your project against multiple versions of Scala and how to use libraries that have done the same.

Publishing Conventions

The underlying mechanism used to indicate which version of Scala a library was compiled against is to append `_<scala-version>` to the library's name. For Scala 2.10.0 and later, the binary version is used. For example, `dispatch-core_2.10` when compiled against 2.10.0, 2.10.1 or any 2.10.x version. This fairly simple approach allows interoperability with users of Maven, Ant and other build tools.

The rest of this page describes how `sbt` handles this for you as part of cross-building.

Using Cross-Built Libraries

To use a library built against multiple versions of Scala, double the first `%` in an inline dependency to be `%%`. This tells `sbt` that it should append the current version of Scala being used to build the library to the dependency's name. For example:

```
libraryDependencies += "net.databinder.dispatch" %% "dispatch-core" % "0.13.3"
```

A nearly equivalent, manual alternative for a fixed version of Scala is:

```
libraryDependencies += "net.databinder.dispatch" % "dispatch-core_2.12" % "0.13.3"
```

Cross-Building a Project

Define the versions of Scala to build against in the `crossScalaVersions` setting. Versions of Scala 2.10.2 or later are allowed. For example, in a `.sbt` build definition:

```
crossScalaVersions := Seq("2.11.11", "2.12.2")
```

To build against all versions listed in `crossScalaVersions`, prefix the action to run with `+`. For example:

```
> + package
```

A typical way to use this feature is to do development on a single Scala version (no `+` prefix) and then cross-build (using `+`) occasionally and when releasing.

You can use `++ <version>` to temporarily switch the Scala version currently being used to build. For example:

```
> ++ 2.12.2
[info] Setting version to 2.12.2
> ++ 2.11.11
[info] Setting version to 2.11.11
> compile
```

`<version>` should be either a version for Scala published to a repository or the path to a Scala home directory, as in `++ /path/to/scala/home`. See Command Line Reference for details.

The ultimate purpose of `+` is to cross-publish your project. That is, by doing:

```
> + publish
```

you make your project available to users for different versions of Scala. See Publishing for more details on publishing your project.

In order to make this process as quick as possible, different output and managed dependency directories are used for different versions of Scala. For example, when building against Scala 2.12.6,

- `./target/` becomes `./target/scala_2.12/`
- `./lib_managed/` becomes `./lib_managed/scala_2.12/`

Packaged jars, wars, and other artifacts have `_<scala-version>` appended to the normal artifact ID as mentioned in the Publishing Conventions section above.

This means that the outputs of each build against each version of Scala are independent of the others. `sbt` will resolve your dependencies for each version separately. This way, for example, you get the version of Dispatch compiled against 2.11 for your 2.11.x build, the version compiled against 2.12 for your 2.12.x builds, and so on. You can have fine-grained control over the behavior for different Scala versions by using the `cross` method on `ModuleID` These are equivalent:

```
"a" % "b" % "1.0"
"a" % "b" % "1.0" cross CrossVersion.Disabled
```

These are equivalent:

```
"a" %% "b" % "1.0"
"a" % "b" % "1.0" cross CrossVersion.binary
```

This overrides the defaults to always use the full Scala version instead of the binary Scala version:

```scala
"a" % "b" % "1.0" cross CrossVersion.full
```

`CrossVersion.patch` sits between `CrossVersion.binary` and `CrossVersion.full` in that it strips off any trailing `-bin-...` suffix which is used to distinguish varaint but binary compatible Scala toolchain builds.

```scala
"a" % "b" % "1.0" cross CrossVersion.patch
```

This uses a custom function to determine the Scala version to use based on the binary Scala version:

```scala
"a" % "b" % "1.0" cross CrossVersion.binaryMapped {
  case "2.9.1" => "2.9.0" // remember that pre-2.10, binary=full
  case "2.10" => "2.10.0" // useful if a%b was released with the old style
  case x => x
}
```

This uses a custom function to determine the Scala version to use based on the full Scala version:

```scala
"a" % "b" % "1.0" cross CrossVersion.fullMapped {
  case "2.9.1" => "2.9.0"
  case x => x
}
```

A custom function is mainly used when cross-building and a dependency isn't available for all Scala versions or it uses a different convention than the default.

Interacting with the Configuration System

Central to sbt is the new configuration system, which is designed to enable extensive customization. The goal of this page is to explain the general model behind the configuration system and how to work with it. The Getting Started Guide (see .sbt files) describes how to define settings; this page describes interacting with them and exploring them at the command line.

Selecting commands, tasks, and settings

A fully-qualified reference to a setting or task looks like:

```
{<build-uri>}<project-id>/config:intask::key
```

This "scoped key" reference is used by commands like `last` and `inspect` and when selecting a task to run. Only `key` is usually required by the parser; the remaining optional pieces select the scope. These optional pieces are individually referred to as scope axes. In the above description, `{<build-uri>}` and `<project-id>/` specify the project axis, `config:` is the configuration axis, and `intask` is the task-specific axis. Unspecified components are taken to be the current project (project axis) or auto-detected (configuration and task axes). An asterisk (`*`) is used to explicitly refer to the `Global` context, as in `*/*:key`.

Selecting the configuration In the case of an unspecified configuration (that is, when the `config:` part is omitted), if the key is defined in `Global`, that is selected. Otherwise, the first configuration defining the key is selected, where order is determined by the project definition's `configurations` member. By default, this ordering is `compile, test, ...`

For example, the following are equivalent when run in a project `root` in the build in `/home/user/sample/`:

```
> compile
> compile:compile
> root/compile
> root/compile:compile
> {file:/home/user/sample/}root/compile:compile
```

As another example, `run` by itself refers to `compile:run` because there is no global `run` task and the first configuration searched, `compile`, defines a `run`. Therefore, to reference the `run` task for the `Test` configuration, the configuration axis must be specified like `test:run`. Some other examples that require the explicit `test:` axis:

```
> test:consoleQuick
> test:console
> test:doc
> test:package
```

Task-specific Settings Some settings are defined per-task. This is used when there are several related tasks, such as `package`, `packageSrc`, and `packageDoc`, in the same configuration (such as `compile` or `test`). For package tasks, their settings are the files to package, the options to use, and the output file to produce. Each package task should be able to have different values for these settings.

This is done with the task axis, which selects the task to apply a setting to. For example, the following prints the output jar for the different package tasks.

```
> package::artifactPath
[info] /home/user/sample/target/scala-2.8.1.final/demo_2.8.1-0.1.jar

> packageSrc::artifactPath
[info] /home/user/sample/target/scala-2.8.1.final/demo_2.8.1-0.1-src.jar

> packageDoc::artifactPath
[info] /home/user/sample/target/scala-2.8.1.final/demo_2.8.1-0.1-doc.jar

> test:package::artifactPath
[info] /home/user/sample/target/scala-2.8.1.final/root_2.8.1-0.1-test.jar
```

Note that a single colon `:` follows a configuration axis and a double colon `::` follows a task axis.

Discovering Settings and Tasks

This section discusses the `inspect` command, which is useful for exploring relationships between settings. It can be used to determine which setting should be modified in order to affect another setting, for example.

Value and Provided By The first piece of information provided by `inspect` is the type of a task or the value and type of a setting. The following section of output is labeled "Provided by". This shows the actual scope where the setting is defined. For example,

```
> inspect libraryDependencies
[info] Setting: scala.collection.Seq[sbt.ModuleID] = List(org.scalaz:scalaz-core:6.0-SNAPSHOT
[info] Provided by:
[info]  {file:/home/user/sample/}root/*:libraryDependencies
...
```

This shows that `libraryDependencies` has been defined on the current project (`{file:/home/user/sample/}root`) in the global configuration (`*:`). For a task like `update`, the output looks like:

```
> inspect update
[info] Task: sbt.UpdateReport
[info] Provided by:
[info]  {file:/home/user/sample/}root/*:update
...
```

Related Settings The "Related" section of `inspect` output lists all of the definitions of a key. For example,

```
> inspect compile
...
[info] Related:
[info]  test:compile
```

This shows that in addition to the requested `compile:compile` task, there is also a `test:compile` task.

Dependencies Forward dependencies show the other settings (or tasks) used to define a setting (or task). Reverse dependencies go the other direction, showing what uses a given setting. `inspect` provides this information based on either the requested dependencies or the actual dependencies. Requested dependencies are those that a setting directly specifies. Actual settings are what those dependencies get resolved to. This distinction is explained in more detail in the following sections.

Requested Dependencies As an example, we'll look at `console`:

```
> inspect console
...
[info] Dependencies:
[info]  compile:console::fullClasspath
[info]  compile:console::scalacOptions
[info]  compile:console::initialCommands
[info]  compile:console::cleanupCommands
[info]  compile:console::compilers
[info]  compile:console::taskTemporary-directory
[info]  compile:console::scalaInstance
[info]  compile:console::streams

...
```

This shows the inputs to the `console` task. We can see that it gets its classpath and options from `fullClasspath` and `scalacOptions(for console)`. The information provided by the `inspect` command can thus assist in finding the right setting to change. The convention for keys, like `console` and `fullClasspath`, is that the Scala identifier is camel case, while the String representation is lowercase and separated by dashes. The Scala identifier for a configuration is uppercase to distinguish it from tasks like `compile` and `test`. For example, we can infer from the previous example how to add code to be run when the Scala interpreter starts up:

```
> set initialCommands in Compile in console := "import mypackage._"
> console
...
import mypackage._
...
```

`inspect` showed that `console` used the setting `compile:console::initialCommands`. Translating the `initialCommands` string to the Scala identifier gives us `initialCommands`. `compile` indicates that this is for the main sources. `console::` indicates that the setting is specific to `console`. Because of this, we can set the initial commands on the `console` task without affecting the `consoleQuick` task, for example.

Actual Dependencies `inspect actual <scoped-key>` shows the actual dependency used. This is useful because delegation means that the dependency can come from a scope other than the requested one. Using `inspect actual`, we see exactly which scope is providing a value for a setting. Combining `inspect actual` with plain `inspect`, we can see the range of scopes that will affect a setting. Returning to the example in Requested Dependencies,

```
> inspect actual console
...
[info] Dependencies:
[info]  compile:scalacOptions
[info]  compile:fullClasspath
[info]  *:scalaInstance
[info]  */*:initialCommands
[info]  */*:cleanupCommands
[info]  */*:taskTemporaryDirectory
[info]  *:console::compilers
[info]  compile:console::streams
...
```

For `initialCommands`, we see that it comes from the global scope (`*/*:`). Combining this with the relevant output from `inspect console`:

```
compile:console::initialCommands
```

we know that we can set `initialCommands` as generally as the global scope, as specific as the current project's `console` task scope, or anything in between. This means that we can, for example, set `initialCommands` for the whole project and will affect `console`:

```
> set initialCommands := "import mypackage._"
...
```

The reason we might want to set it here this is that other console tasks will use this value now. We can see which ones use our new setting by looking at the reverse dependencies output of `inspect actual`:

```
> inspect actual initialCommands
...
[info] Reverse dependencies:
[info]  test:console
[info]  compile:consoleQuick
[info]  compile:console
[info]  test:consoleQuick
[info]  *:consoleProject
...
```

We now know that by setting `initialCommands` on the whole project, we affect all console tasks in all configurations in that project. If we didn't want the initial commands to apply for `consoleProject`, which doesn't have our project's classpath available, we could use the more specific task axis:

```
> set initialCommands in console := "import mypackage._"
> set initialCommands in consoleQuick := "import mypackage._"`
```

or configuration axis:

```
> set initialCommands in Compile := "import mypackage._"
> set initialCommands in Test := "import mypackage._"
```

The next part describes the Delegates section, which shows the chain of delegation for scopes.

Delegates A setting has a key and a scope. A request for a key in a scope A may be delegated to another scope if A doesn't define a value for the key. The delegation chain is well-defined and is displayed in the Delegates section of the `inspect` command. The Delegates section shows the order in which scopes are searched when a value is not defined for the requested key.

As an example, consider the initial commands for `console` again:

```
> inspect console::initialCommands
...
[info] Delegates:
[info]  *:console::initialCommands
[info]  *:initialCommands
[info]  {.}/*:console::initialCommands
```

```
[info]  {.}/*:initialCommands
[info]  */*:console::initialCommands
[info]  */*:initialCommands
...
```

This means that if there is no value specifically for `*:console::initialCommands`, the scopes listed under Delegates will be searched in order until a defined value is found.

Triggered Execution

You can make a command run when certain files change by prefixing the command with `~`. Monitoring is terminated when `enter` is pressed. This triggered execution is configured by the `watch` setting, but typically the basic settings `watchSources` and `pollInterval` are modified.

- `watchSources` defines the files for a single project that are monitored for changes. By default, a project watches resources and Scala and Java sources.
- `watchTransitiveSources` then combines the `watchSources` for the current project and all execution and classpath dependencies (see .scala build definition for details on interProject dependencies).
- `pollInterval` selects the interval between polling for changes in milliseconds. The default value is 500 ms.

Some example usages are described below.

Compile

The original use-case was continuous compilation:

```
> ~ test:compile
```

```
> ~ compile
```

Testing

You can use the triggered execution feature to run any command or task. One use is for test driven development, as suggested by Erick on the mailing list.

The following will poll for changes to your source code (main or test) and run `testOnly` for the specified test.

```
> ~ testOnly example.TestA
```

Running Multiple Commands

Occasionally, you may need to trigger the execution of multiple commands. You can use semicolons to separate the commands to be triggered.

The following will poll for source changes and run `clean` and `test`.

```
> ~ ;clean ;test
```

Scripts, REPL, and Dependencies

sbt has two alternative entry points that may be used to:

- Compile and execute a Scala script containing dependency declarations or other sbt settings
- Start up the Scala REPL, defining the dependencies that should be on the classpath

These entry points should be considered experimental. A notable disadvantage of these approaches is the startup time involved.

Setup

To set up these entry points, you can either use conscript or manually construct the startup scripts. In addition, there is a setup script for the script mode that only requires a JRE installed.

Setup with Conscript Install conscript.

```
$ cs sbt/sbt --branch 1.2.1
```

This will create two scripts: `screpl` and `scalas`.

Manual Setup Duplicate your standard `sbt` script, which was set up according to Setup, as `scalas` and `screpl` (or whatever names you like).

`scalas` is the script runner and should use `sbt.ScriptMain` as the main class, by adding the `-Dsbt.main.class=sbt.ScriptMain` parameter to the `java` command. Its command line should look like:

```
$ java -Dsbt.main.class=sbt.ScriptMain -Dsbt.boot.directory=/home/user/.sbt/boot -jar sbt-lau
```

For the REPL runner `screpl`, use `sbt.ConsoleMain` as the main class:

```
$ java -Dsbt.main.class=sbt.ConsoleMain -Dsbt.boot.directory=/home/user/.sbt/boot -jar sbt-la
```

In each case, `/home/user/.sbt/boot` should be replaced with wherever you want sbt's boot directory to be; you might also need to give more memory to the JVM via `-Xms512M -Xmx1536M` or similar options, just like shown in Setup.

Usage

sbt Script runner The script runner can run a standard Scala script, but with the additional ability to configure sbt. sbt settings may be embedded in the script in a comment block that opens with `/***`.

Example Copy the following script and make it executable. You may need to adjust the first line depending on your script name and operating system. When run, the example should retrieve Scala, the required dependencies, compile the script, and run it directly. For example, if you name it `shout.scala`, you would do on Unix:

```
chmod u+x shout.scala
./shout.scala
```

```
#!/usr/bin/env scalas

/***
scalaVersion := "2.12.6"

libraryDependencies += "org.scala-sbt" %% "io" % "1.2.1"
*/

import sbt.io.IO
import sbt.io.Path._
import sbt.io.syntax._
import java.io.File
import java.net.{URI, URL}
import sys.process._
def file(s: String): File = new File(s)
def uri(s: String): URI = new URI(s)

val targetDir = file("./target/")
val srcDir = file("./src/")
val toTarget = rebase(srcDir, targetDir)
```

```
def processFile(f: File): Unit = {
  val newParent = toTarget(f.getParentFile) getOrElse {sys.error("wat")}
  val file1 = newParent / f.name
  println(s"""$f => $file1""")
  val xs = IO.readLines(f) map { _ + "!" }
  IO.writeLines(file1, xs)
}

val fs: Seq[File] = (srcDir ** "*.scala").get
fs foreach { processFile }
```

This script will take all `*.scala` files under `src/`, append "!" at the end of the line, and write them under `target/`.

sbt REPL with dependencies The arguments to the REPL mode configure the dependencies to use when starting up the REPL. An argument may be either a jar to include on the classpath, a dependency definition to retrieve and put on the classpath, or a resolver to use when retrieving dependencies.

A dependency definition looks like:

```
organization%module%revision
```

Or, for a cross-built dependency:

```
organization%%module%revision
```

A repository argument looks like:

```
"id at url"
```

Example: To add the Sonatype snapshots repository and add Scalaz 7.0-SNAPSHOT to REPL classpath:

```
$ screpl "sonatype-releases at https://oss.sonatype.org/content/repositories/snapshots/" "org
```

This syntax was a quick hack. Feel free to improve it. The relevant class is IvyConsole.

sbt Server

sbt server is a feature that is newly introduced in sbt 1.x, and it's still a work in progress. You might at first imagine server to be something that runs on remote servers, and does great things, but for now sbt server is not that.

Actually, sbt server just adds network access to sbt's shell command so, in addition to accepting input from the terminal, server also to accepts input from the network. This allows multiple clients to connect to a *single session* of sbt. The primary use case we have in mind for the client is tooling integration such as editors and IDEs. As a proof of concept, we created a Visual Studio Code extension called Scala (sbt).

Language Server Protocol 3.0

The wire protocol we use is Language Server Protocol 3.0 (LSP), which in turn is based on JSON-RPC.

The base protocol consists of a header and a content part (comparable to HTTP). The header and content part are separated by a `\r\n`.

Currently the following header fields are supported:

- `Content-Length`: The length of the content part in bytes. If you don't provide this header, we'll read until the end of the line.
- `Content-Type`: Must be set to `application/vscode-jsonrpc; charset=utf-8` or omit it.

Here is an example:

```
Content-Type: application/vscode-jsonrpc; charset=utf-8\r\n
Content-Length: ...\r\n
\r\n
{
  "jsonrpc": "2.0",
  "id": 1,
  "method": "textDocument/didSave",
  "params": {
    ...
  }
}
```

A JSON-RPC request consists of an `id` number, a `method` name, and an optional `params` object. So all LSP requests are pairs of method name and `params` JSON.

An example response to the JSON-RPC request is:

```
Content-Type: application/vscode-jsonrpc; charset=utf-8\r\n
Content-Length: ...\r\n
\r\n
{
  "jsonrpc": "2.0",
  "id": 1,
  "result": {
    ...
  }
}
```

Or the server might return an error response:

```
Content-Type: application/vscode-jsonrpc; charset=utf-8\r\n
Content-Length: ...\r\n
\r\n
{
  "jsonrpc": "2.0",
  "id": 1,
  "error": {
    "code": -32602,
    "message": "some error message"
  }
}
```

In addition to the responses, the server might also send events ("notifications" in LSP terminology).

```
Content-Type: application/vscode-jsonrpc; charset=utf-8\r\n
Content-Length: ...\r\n
\r\n
{
  "jsonrpc": "2.0",
  "method": "textDocument/publishDiagnostics",
  "params": {
    ...
  }
}
```

Server modes

Sbt server can run in two modes, which differ in wire protocol and initialization. The default mode since sbt 1.1.x is *domain socket mode*, which uses either Unix domain sockets (on Unix) or named pipes (on Windows) for data transfer between server and client. In addition, there is a *TCP mode*, which uses TCP for data transfer.

The mode which sbt server starts in is goverened by the key `serverConnectionType`, which can be set to `ConnectionType.Local` for domain socket/named pipe mode, or to `ConnectionType.Tcp` for TCP mode.

Server discovery and authentication

To discover a running server, we use a *port file*.

By default, sbt server will be running when a sbt shell session is active. When the server is up, it will create a file called the port file. The port file is located at `./project/target/active.json`. The port file will look different depending on whether the server is running in TCP mode or domain socket/named pipe mode. They will look something like this:

In domain socket/named pipe mode, on Unix:

```
{"uri":"local:///Users/someone/.sbt/1.0/server/0845deda85cb41abdb9f/sock"}
```

where the `uri` key will contain a string starting with `local://` followed by the socket address sbt server is listening on.

In domain socket/named pipe mode, on Windows, it will look something like

```
{"uri":"local:sbt-server-0845deda85cb41abdb9f"}
```

where the `uri` key will contain a string starting with `local:` followed by the name of the named pipe. In this example, the path of the named pipe will be `\.\pipe\sbt-server-0845deda85cb41abdb9f`.

In TCP mode it will look something like the following:

```
{
  "uri":"tcp://127.0.0.1:5010",
  "tokenfilePath":"/Users/xxx/.sbt/1.0/server/0845deda85cb41abdb9f/token.json",
  "tokenfileUri":"file:/Users/xxx/.sbt/1.0/server/0845deda85cb41abdb9f/token.json"
}
```

In this case, the `uri` key will hold a TCP uri with the address the server is listening on. In this mode, the port file will contain two additional keys, `tokenfilePath` and `tokenfileUri`. These point to the location of a *token file*.

The location of the token file will not change between runs. It's contents will look something like this:

```
{
  "uri":"tcp://127.0.0.1:5010",
  "token":"12345678901234567890123456789012345678"
}
```

The `uri` field is the same, and the `token` field contains a 128-bits non-negative integer.

Initialize request

To initiate communication with sbt server, the client (such as a tool like VS Code) must first send an `initialize` request. This means that the client must send a request with method set to "initialize" and the `InitializeParams` datatype as the `params` field.

If the server is running in TCP mode, to authenticate yourself, you must pass in the token in `initializationOptions` as follows:

```
type InitializationOptionsParams {
  token: String!
}
```

On telnet it would look as follows:

```
$ telnet 127.0.0.1 5010
Content-Type: application/vscode-jsonrpc; charset=utf-8
Content-Length: 149

{ "jsonrpc": "2.0", "id": 1, "method": "initialize", "params": { "initializationOptions": { "tok
```

If the server is running in named pipe mode, no token is needed, and the `initializationOptions` should be the empty object `{}`.

On Unix, using netcat, sending the initialize message in domain socket/named pipe mode will look something like this:

```
$ nc -U /Users/foo/.sbt/1.0/server/0845deda85cb41abcdef/sock
Content-Length: 99^M
^M
{ "jsonrpc": "2.0", "id": 1, "method": "initialize", "params": { "initializationOptions": { } }
```

Connections to the server when it's running in named pipe mode are exclusive to the first process that connects to the socket or pipe.

After sbt receives the request, it will send an `initialized` event.

`textDocument/publishDiagnostics` event

The compiler warnings and errors are sent to the client using the `textDocument/publishDiagnostics` event.

- method: `textDocument/publishDiagnostics`
- params: `PublishDiagnosticsParams`

Here's an example output (with JSON-RPC headers omitted):

```
{
  "jsonrpc": "2.0",
  "method": "textDocument/publishDiagnostics",
  "params": {
    "uri": "file:/Users/xxx/work/hellotest/Hello.scala",
    "diagnostics": [
      {
        "range": {
          "start": {
            "line": 2,
            "character": 0
          },
          "end": {
            "line": 2,
            "character": 1
          }
        },
        "severity": 1,
        "source": "sbt",
        "message": "')' expected but '}' found."
      }
    ]
  }
}
```

`textDocument/didSave` event

As of sbt 1.1.0, sbt will execute the `compile` task upon receiving a `textDocument/didSave` notification. This behavior is subject to change.

`sbt/exec` request

A `sbt/exec` request emulates the user typing into the shell.

- method: `sbt/exec`
- params:

```
type SbtExecParams {
  commandLine: String!
}
```

On telnet it would look as follows:

```
Content-Length: 91

{ "jsonrpc": "2.0", "id": 2, "method": "sbt/exec", "params": { "commandLine": "clean" } }
```

Note that there might be other commands running on the build, so in that case the request will be queued up.

`sbt/setting` request

A `sbt/setting` request can be used to query settings.

- method: `sbt/setting`
- params:

```
type SettingQuery {
  setting: String!
}
```

On telnet it would look as follows:

```
Content-Length: 102

{ "jsonrpc": "2.0", "id": 3, "method": "sbt/setting", "params": { "setting": "root/scalaVersion
Content-Length: 87
Content-Type: application/vscode-jsonrpc; charset=utf-8

{"jsonrpc":"2.0","id":"3","result":{"value":"2.12.2","contentType":"java.lang.String"}}
```

Unlike the command execution, this will respond immediately.

Understanding Incremental Recompilation

Compiling Scala code with scalac is slow, but sbt often makes it faster. By understanding how, you can even understand how to make compilation even faster. Modifying source files with many dependencies might require recompiling only those source files (which might take 5 seconds for instance) instead of all the dependencies (which might take 2 minutes for instance). Often you can control which will be your case and make development faster with a few coding practices.

Improving the Scala compilation performance is a major goal of sbt, and thus the speedups it gives are one of the major motivations to use it. A significant portion of sbt's sources and development efforts deal with strategies for speeding up compilation.

To reduce compile times, sbt uses two strategies:

Reduce the overhead for restarting Scalac

Implement smart and transparent strategies for incremental recompilation, so that only modified files and the needed dependencies are recompiled.

sbt always runs Scalac in the same virtual machine. If one compiles source code using sbt, keeps sbt alive, modifies source code and triggers a new compilation, this compilation will be faster because (part of) Scalac will have already been JIT-compiled.

Reduce the number of recompiled source.

When a source file A.scala is modified, sbt goes to great effort to recompile other source files depending on A.scala only if required - that is, only if the interface of A.scala was modified. With other build management tools (especially for Java, like ant), when a developer changes a source file in a non-binary-compatible way, she needs to manually ensure that dependencies are also recompiled - often by manually running the clean command to remove existing compilation output; otherwise compilation might succeed even when dependent class files might need to be recompiled. What is worse, the change to one source might make dependencies incorrect, but this is not discovered automatically: One might get a compilation success with incorrect source code. Since Scala compile times are so high, running clean is particularly undesirable.

By organizing your source code appropriately, you can minimize the amount of code affected by a change. sbt cannot determine precisely which dependencies have to be recompiled; the goal is to compute a conservative approximation, so that whenever a file must be recompiled, it will, even though we might recompile extra files.

sbt heuristics

sbt tracks source dependencies at the granularity of source files. For each source file, sbt tracks files which depend on it directly; if the **interface** of classes, objects or traits in a file changes, all files dependent on that source must be recompiled. At the moment sbt uses the following algorithm to calculate source files dependent on a given source file:

- dependencies introduced through inheritance are included *transitively*; a dependency is introduced through inheritance if a class/trait in one file inherits from a trait/class in another file
- all other direct dependencies are considered by name hashing optimization; other dependencies are also called "member reference" dependencies because they are introduced by referring to a member (class, method, type, etc.) defined in some other source file
- name hashing optimization considers all member reference dependencies in context of interface changes of a given source file; it tries to prune irrelevant dependencies by looking at names of members that got modified and checking if dependent source files mention those names

The name hashing optimization is enabled by default since sbt 0.13.6.

How to take advantage of sbt heuristics

The heuristics used by sbt imply the following user-visible consequences, which determine whether a change to a class affects other classes.

1. Adding, removing, modifying `private` methods does not require recompilation of client classes. Therefore, suppose you add a method to a class with a lot of dependencies, and that this method is only used in the declaring class; marking it private will prevent recompilation of clients. However, this only applies to methods which are not accessible to other classes, hence methods marked with private or private[this]; methods which are private to a package, marked with private[name], are part of the API.
2. Modifying the interface of a non-private method triggers name hashing optimization
3. Modifying one class does require recompiling dependencies of other classes defined in the same file (unlike said in a previous version of this guide). Hence separating different classes in different source files might reduce recompilations.
4. Changing the implementation of a method should *not* affect its clients, unless the return type is inferred, and the new implementation leads to a slightly different type being inferred. Hence, annotating the return type of a non-private method explicitly, if it is more general than the type actually

returned, can reduce the code to be recompiled when the implementation of such a method changes. (Explicitly annotating return types of a public API is a good practice in general.)

All the above discussion about methods also applies to fields and members in general; similarly, references to classes also extend to objects and traits.

Implementation of incremental recompilation

This sections goes into details of incremental compiler implementation. It's starts with an overview of the problem incremental compiler tries to solve and then discusses design choices that led to the current implementation.

Overview

The goal of incremental compilation is detect changes to source files or to the classpath and determine a small set of files to be recompiled in such a way that it'll yield the final result identical to the result from a full, batch compilation. When reacting to changes the incremental compiler has to goals that are at odds with each other:

- recompile as little source files as possible cover all changes to type checking and produced
- byte code triggered by changed source files and/or classpath

The first goal is about making recompilation fast and it's a sole point of incremental compiler existence. The second goal is about correctness and sets a lower limit on the size of a set of recompiled files. Determining that set is the core problem incremental compiler tries to solve. We'll dive a little bit into this problem in the overview to understand what makes implementing incremental compiler a challenging task.

Let's consider this very simple example:

```
// A.scala
package a
class A {
  def foo(): Int = 12
}

// B.scala
package b
class B {
  def bar(x: a.A): Int = x.foo()
}
```

Let's assume both of those files are already compiled and user changes `A.scala` so it looks like this:

```scala
// A.scala
package a
class A {
  def foo(): Int = 23 // changed constant
}
```

The first step of incremental compilation is to compile modified source files. That's minimal set of files incremental compiler has to compile. Modified version of `A.scala` will be compiled successfully as changing the constant doesn't introduce type checking errors. The next step of incremental compilation is determining whether changes applied to `A.scala` may affect other files. In the example above only the constant returned by method `foo` has changed and that does not affect compilation results of other files.

Let's consider another change to `A.scala`:

```scala
// A.scala
package a
class A {
  def foo(): String = "abc" // changed constant and return type
}
```

As before, the first step of incremental compilation is to compile modified files. In this case we compile `A.scala` and compilation will finish successfully. The second step is again determining whether changes to `A.scala` affect other files. We see that the return type of the `foo` public method has changed so this might affect compilation results of other files. Indeed, `B.scala` contains call to the `foo` method so has to be compiled in the second step. Compilation of `B.scala` will fail because of type mismatch in `B.bar` method and that error will be reported back to the user. That's where incremental compilation terminates in this case.

Let's identify the two main pieces of information that were needed to make decisions in the examples presented above. The incremental compiler algorithm needs to:

- index source files so it knows whether there were API changes that might affect other source files; e.g. it needs to detect changes to method signatures as in the example above
- track dependencies between source files; once the change to an API is detected the algorithm needs to determine the set of files that might be potentially affected by this change

Both of those pieces of information are extracted from the Scala compiler.

Interaction with the Scala compiler

Incremental compiler interacts with Scala compiler in many ways:

provides three phases additional phases that extract needed information:

api phase extracts public interface of compiled sources by walking trees and indexing types

dependency phase which extracts dependencies between source files (compilation units)

analyzer phase which captures the list of emitted class files

defines a custom reporter which allows sbt to gather errors and warnings

subclasses Global to:

add the api, dependency and analyzer phases

set the custom reporter

manages instances of the custom Global and uses them to compile files it determined that need to be compiled

API extraction phase The API extraction phase extracts information from Trees, Types and Symbols and maps it to incremental compiler's internal data structures described in the api.specification file.Those data structures allow to express an API in a way that is independent from Scala compiler version. Also, such representation is persistent so it is serialized on disk and reused between compiler runs or even sbt runs.

The API extraction phase consist of two major components:

1. mapping Types and Symbols to incremental compiler representation of an extracted API
2. hashing that representation

Mapping Types and Symbols The logic responsible for mapping Types and Symbols is implemented in API.scala. With introduction of Scala reflection we have multiple variants of Types and Symbols. The incremental compiler uses the variant defined in `scala.reflect.internal` package.

Also, there's one design choice that might not be obvious. When type corresponding to a class or a trait is mapped then all inherited members are copied instead of declarations in that class/trait. The reason for doing so is that it greatly simplifies analysis of API representation because all relevant information to a class is stored in one place so there's no need for looking up parent type representation. This simplicity comes at a price: the same information is copied over and over again resulting in a performance hit. For example, every class will have members of `java.lang.Object` duplicated along with full information about their signatures.

Hashing an API representation The incremental compiler (as it's implemented right now) doesn't need very fine grained information about the API. The incremental compiler just needs to know whether an API has changed since the last time it was indexed. For that purpose hash sum is enough and it saves a lot of memory. Therefore, API representation is hashed immediately after single compilation unit is processed and only hash sum is stored persistently.

In earlier versions the incremental compiler wouldn't hash. That resulted in a very high memory consumption and poor serialization/deserialization performance.

The hashing logic is implemented in the HashAPI.scala file.

Dependency phase The incremental compiler extracts all Symbols given compilation unit depends on (refers to) and then tries to map them back to corresponding source/class files. Mapping a Symbol back to a source file is performed by using `sourceFile` attribute that Symbols derived from source files have set. Mapping a Symbol back to (binary) class file is more tricky because Scala compiler does not track origin of Symbols derived from binary files. Therefore simple heuristic is used which maps a qualified class name to corresponding classpath entry. This logic is implemented in dependency phase which has an access to the full classpath.

The set of Symbols given compilation unit depend on is obtained by performing a tree walk. The tree walk examines all tree nodes that can introduce a dependency (refer to another Symbol) and gathers all Symbols assigned to them. Symbols are assigned to tree nodes by Scala compiler during type checking phase.

Incremental compiler used to rely on `CompilationUnit.depends` for collecting dependencies. However, name hashing requires a more precise dependency information. Check #1002 for details.

Analyzer phase Collection of produced class files is extracted by inspecting contents `CompilationUnit.icode` property which contains all ICode classes that backend will emit as JVM class files.

Name hashing algorithm

Motivation Let's consider the following example:

```scala
// A.scala
class A {
  def inc(x: Int): Int = x+1
}

// B.scala
class B {
  def foo(a: A, x: Int): Int = a.inc(x)
}
```

Let's assume both of those files are compiled and user changes `A.scala` so it looks like this:

```scala
// A.scala
class A {
  def inc(x: Int): Int = x+1
  def dec(x: Int): Int = x-1
}
```

Once user hits save and asks incremental compiler to recompile it's project it will do the following:

1. Recompile `A.scala` as the source code has changed (first iteration)
2. While recompiling it will reindex API structure of `A.scala` and detect it has changed
3. It will determine that `B.scala` depends on `A.scala` and since the API structure of `A.scala` has changed `B.scala` has to be recompiled as well (`B.scala` has been invalidated)
4. Recompile `B.scala` because it was invalidated in 3. due to dependency change
5. Reindex API structure of `B.scala` and find out that it hasn't changed so we are done

To summarize, we'll invoke Scala compiler twice: one time to recompile `A.scala` and then to recompile `B.scala` because `A` has a new method `dec`.

However, one can easily see that in this simple scenario recompilation of `B.scala` is not needed because addition of `dec` method to `A` class is irrelevant to the `B` class as its not using it and it is not affected by it in any way.

In case of two files the fact that we recompile too much doesn't sound too bad. However, in practice, the dependency graph is rather dense so one might end up recompiling the whole project upon a change that is irrelevant to almost all files in the whole project. That's exactly what happens in Play projects when routes are modified. The nature of routes and reversed routes is that every template and every controller depends on some methods defined in those two classes (`Routes` and `ReversedRoutes`) but changes to specific route definition usually affects only small subset of all templates and controllers.

The idea behind name hashing is to exploit that observation and make the invalidation algorithm smarter about changes that can possibly affect a small number of files.

Detection of irrelevant dependencies (direct approach) A change to the API of a given source file `X.scala` can be called irrelevant if it doesn't affect the compilation result of file `Y.scala` even if `Y.scala` depends on `X.scala`.

From that definition one can easily see that a change can be declared irrelevant only with respect to a given dependency. Conversely, one can declare a dependency between two source files irrelevant with respect to a given change of API in one of the files if the change doesn't affect the compilation result of the other file. From now on we'll focus on detection of irrelevant dependencies.

A very naive way of solving a problem of detecting irrelevant dependencies would be to say that we keep track of all used methods in `Y.scala` so if a method in `X.scala` is added/removed/modified we just check if it's being used in `Y.scala` and if it's not then we consider the dependency of `Y.scala` on `X.scala` irrelevant in this particular case.

Just to give you a sneak preview of problems that quickly arise if you consider that strategy let's consider those two scenarios.

Inheritance We'll see how a method not used in another source file might affect its compilation result. Let's consider this structure:

```scala
// A.scala
abstract class A

// B.scala
class B extends A
```

Let's add an abstract method to class `A`:

```scala
// A.scala
abstract class A {
  def foo(x: Int): Int
}
```

Now, once we recompile `A.scala` we could just say that since `A.foo` is not used in `B` class then we don't need to recompile `B.scala`. However, this is not true because B doesn't implement a newly introduced, abstract method and an error should be reported.

Therefore, a simple strategy of looking at used methods for determining whether a given dependency is relevant or not is not enough.

Enrichment pattern Here we'll see another case of newly introduced method (that is not used anywhere yet) that affects compilation results of other files. This time, no inheritance will be involved but we'll use enrichment pattern (implicit conversions) instead.

Let's assume we have the following structure:

```scala
// A.scala
class A

// B.scala
class B {
  class AOps(a: A) {
    def foo(x: Int): Int = x+1
  }
  implicit def richA(a: A): AOps = new AOps(a)
  def bar(a: A): Int = a.foo(12) // this is expanded to richA(a).foo so we are calling AOPs
}
```

Now, let's add a `foo` method directly to `A`:

```scala
// A.scala
class A {
  def foo(x: Int): Int = x-1
}
```

Now, once we recompile `A.scala` and detect that there's a new method defined in the `A` class we would need to consider whether this is relevant to the dependency of `B.scala` on `A.scala`. Notice that in `B.scala` we do not use `A.foo` (it didn't exist at the time `B.scala` was compiled) but we use `AOps.foo` and it's not immediately clear that `AOps.foo` has anything to do with `A.foo`. One would need to detect the fact that a call to `AOps.foo` as a result of implicit conversion `richA` that was inserted because we failed to find `foo` on `A` before.

This kind of analysis gets us very quickly to the implementation complexity of Scala's type checker and is not feasible to implement in a general case.

Too much information to track All of the above assumed we actually have full information about the structure of the API and used methods preserved so we can make use of it. However, as described in Hashing an API representation we do not store the whole representation of the API but only its hash sum. Also, dependencies are tracked at source file level and not at class/method level.

One could imagine reworking the current design to track more information but it would be a very big undertaking. Also, the incremental compiler used to preserve the whole API structure but it switched to hashing due to the resulting infeasible memory requirements.

Detection of irrelevant dependencies (name hashing) As we saw in the previous chapter, the direct approach of tracking more information about what's being used in the source files becomes tricky very quickly. One would wish to come up with a simpler and less precise approach that would still yield big improvements over the existing implementation.

The idea is to not track all the used members and reason very precisely about when a given change to some members affects the result of the compilation of other files. We would track just the used *simple names* instead and we would also track the hash sums for all members with the given simple name. The simple name means just an unqualified name of a term or a type.

Let's see first how this simplified strategy addresses the problem with the enrichment pattern. We'll do that by simulating the name hashing algorithm. Let's start with the original code:

```
// A.scala
class A

// B.scala
class B {
  class AOps(a: A) {
    def foo(x: Int): Int = x+1
  }
  implicit def richA(a: A): AOps = new AOps(a)
  def bar(a: A): Int = a.foo(12) // this is expanded to richA(a).foo so we are calling AOPs
}
```

During the compilation of those two files we'll extract the following information:

```
usedNames("A.scala"): A
usedNames("B.scala"): B, AOps, a, A, foo, x, Int, richA, AOps, bar

nameHashes("A.scala"): A -> ...
nameHashes("B.scala"): B -> ..., AOps -> ..., foo -> ..., richA -> ..., bar -> ...
```

The `usedNames` relation track all the names mentioned in the given source file. The `nameHashes` relation gives us a hash sum of the groups of members that are put together in one bucket if they have the same simple name. In addition to the information presented above we still track the dependency of `B.scala` on `A.scala`.

Now, if we add a `foo` method to `A` class:

```scala
// A.scala
class A {
  def foo(x: Int): Int = x-1
}
```

and recompile, we'll get the following (updated) information:

```
usedNames("A.scala"): A, foo
nameHashes("A.scala"): A -> ..., foo -> ...
```

The incremental compiler compares the name hashes before and after the change and detects that the hash sum of `foo` has changed (it's been added). Therefore, it looks at all the source files that depend on `A.scala`, in our case it's just `B.scala`, and checks whether `foo` appears as a used name. It does, therefore it recompiles `B.scala` as intended.

You can see now, that if we added another method to `A` like `xyz` then `B.scala` wouldn't be recompiled because nowhere in `B.scala` is the name `xyz` mentioned. Therefore, if you have reasonably non-clashing names you should benefit from a lot of dependencies between source files marked as irrelevant.

It's very nice that this simple, name-based heuristic manages to withstand the "enrichment pattern" test. However, name-hashing fails to pass the other test of inheritance. In order to address that problem, we'll need to take a closer look at the dependencies introduced by inheritance vs dependencies introduced by member references.

Dependencies introduced by member reference and inheritance The core assumption behind the name-hashing algorithm is that if a user adds/modifies/removes a member of a class (e.g. a method) then the results of compilation of other classes won't be affected unless they are using that particular member. Inheritance with its various override checks makes the whole situation much more complicated; if you combine it with mix-in composition that introduces new fields to classes inheriting from traits then you quickly realize that inheritance requires special handling.

The idea is that for now we would switch back to the old scheme whenever inheritance is involved. Therefore, we track dependencies introduced by member reference separately from dependencies introduced by inheritance. All dependencies introduced by inheritance are *not* subject to name-hashing analysis so they are never marked as irrelevant.

The intuition behind the dependency introduced by inheritance is very simple: it's a dependency a class/trait introduces by inheriting from another class/trait. All other dependencies are called dependencies by member reference because they are introduced by referring (selecting) a member (method, type alias, inner class, val, etc.) from another class. Notice that in order to inherit from a class you need to refer to it so dependencies introduced by inheritance are a strict subset of member reference dependencies.

Here's an example which illustrates the distinction:

```scala
// A.scala
class A {
  def foo(x: Int): Int = x+1
}

// B.scala
class B(val a: A)

// C.scala
trait C

// D.scala
trait D[T]

// X.scala
class X extends A with C with D[B] {
  // dependencies by inheritance: A, C, D
  // dependencies by member reference: A, C, D, B
}

// Y.scala
class Y {
  def test(b: B): Int = b.a.foo(12)
  // dependencies by member reference: B, Int, A
}
```

There are two things to notice:

1. `X` does not depend on `B` by inheritance because `B` is passed as a type parameter to `D`; we consider only types that appear as parents to `X`
2. `Y` *does* depend on `A` even if there's no explicit mention of `A` in the source file; we select a method `foo` defined in `A` and that's enough to introduce a dependency

To sum it up, the way we want to handle inheritance and the problems it introduces is to track all dependencies introduced by inheritance separately and have a much more strict way of invalidating dependencies. Essentially, whenever there's a dependency by inheritance it will react to any (even minor) change in parent types.

Computing name hashes One thing we skimmed over so far is how name hashes are actually computed.

As mentioned before, all definitions are grouped together by their simple name and then hashed as one bucket. If a definition (for example a class) contains other definition then those nested definitions do *not* contribute to a hash sum. The nested definitions will contribute to hashes of buckets selected by their name.

What is included in the interface of a Scala class

It is surprisingly tricky to understand which changes to a class require recompiling its clients. The rules valid for Java are much simpler (even if they include some subtle points as well); trying to apply them to Scala will prove frustrating. Here is a list of a few surprising points, just to illustrate the ideas; this list is not intended to be complete.

1. Since Scala supports named arguments in method invocations, the name of method arguments are part of its interface.
2. Adding a method to a trait requires recompiling all implementing classes. The same is true for most changes to a method signature in a trait.
3. Calls to `super.methodName` in traits are resolved to calls to an abstract method called `fullyQualifiedTraitName$$super$methodName`; such methods only exist if they are used. Hence, adding the first call to `super.methodName` for a specific method name changes the interface. At present, this is not yet handled—see #466.
4. `sealed` hierarchies of case classes allow to check exhaustiveness of pattern matching. Hence pattern matches using case classes must depend on the complete hierarchy - this is one reason why dependencies cannot be easily tracked at the class level (see Scala issue SI-2559 for an example.). Check #1104 for detailed discussion of tracking dependencies at class level.

Debugging an interface representation If you see spurious incremental recompilations or you want to understand what changes to an extracted interface cause incremental recompilation then sbt 0.13 has the right tools for that.

In order to debug the interface representation and its changes as you modify and recompile source code you need to do two things:

1. Enable the incremental compiler's `apiDebug` option.
2. Add diff-utils library to sbt's classpath. Check documentation of `sbt.extraClasspath` system property in the Command-Line-Reference.

   warning

   Enabling the `apiDebug` option increases significantly the memory consumption and degrades the performance of the incremental compiler. The underlying reason is that in order to produce meaningful debugging information about interface differences the incremental compiler has to retain the full representation of the interface instead of just the hash sum as it does by default.

   Keep this option enabled when you are debugging the incremental compiler problem only.

Below is a complete transcript which shows how to enable interface debugging in your project. First, we download the `diffutils` jar and pass it to sbt:

```
curl -O https://java-diff-utils.googlecode.com/files/diffutils-1.2.1.jar
sbt -Dsbt.extraClasspath=diffutils-1.2.1.jar
[info] Loading project definition from /Users/grek/tmp/sbt-013/project
[info] Set current project to sbt-013 (in build file:/Users/grek/tmp/sbt-013/)
> set incOptions := incOptions.value.withApiDebug(true)
[info] Defining *:incOptions
[info] The new value will be used by compile:incCompileSetup, test:incCompileSetup
[info] Reapplying settings...
[info] Set current project to sbt-013 (in build file:/Users/grek/tmp/sbt-013/)
```

Let's suppose you have the following source code in `Test.scala`:

```scala
class A {
  def b: Int = 123
}
```

compile it and then change the `Test.scala` file so it looks like:

```scala
class A {
   def b: String = "abc"
}
```

and run `compile` again. Now if you run `last compile` you should see the following lines in the debugging log

```
> last compile
[...]
[debug] Detected a change in a public API:
[debug] --- /Users/grek/tmp/sbt-013/Test.scala
[debug] +++ /Users/grek/tmp/sbt-013/Test.scala
[debug] @@ -23,7 +23,7 @@
[debug]  ^inherited^ final def ##(): scala.this#Int
[debug]  ^inherited^ final def synchronized[ java.lang.Object.T0 >: scala.this#Nothing <: scala
[debug]  ^inherited^ final def $isInstanceOf[ java.lang.Object.T0 >: scala.this#Nothing <: scal
[debug]  ^inherited^ final def $asInstanceOf[ java.lang.Object.T0 >: scala.this#Nothing <: scal
[debug]  def <init>(): this#A
[debug] -def b: scala.this#Int
[debug] +def b: java.lang.this#String
[debug]  }
```

You can see a unified diff of the two interface textual represetantions. As you can see, the incremental compiler detected a change to the return type of `b` method.

Why changing the implementation of a method might affect clients, and why type annotations help This section explains why relying on type inference for return types of public methods is not always appropriate. However this is an important design issue, so we cannot give fixed rules. Moreover, this change is often invasive, and reducing compilation times is not often a good enough motivation. That is also why we discuss some of the implications from the point of view of binary compatibility and software engineering.

Consider the following source file `A.scala`:

```scala
import java.io._
object A {
  def openFiles(list: List[File]) =
    list.map(name => new FileWriter(name))
}
```

Let us now consider the public interface of trait `A`. Note that the return type of method `openFiles` is not specified explicitly, but computed by type inference to be `List[FileWriter]`. Suppose that after writing this source code, we introduce some client code and then modify `A.scala` as follows:

```scala
import java.io._
object A {
  def openFiles(list: List[File]) =
    Vector(list.map(name => new BufferedWriter(new FileWriter(name))): _*)
}
```

Type inference will now compute the result type as `Vector[BufferedWriter]`; in other words, changing the implementation lead to a change to the public interface, with two undesirable consequences:

1. Concerning our topic, the client code needs to be recompiled, since changing the return type of a method, in the JVM, is a binary-incompatible interface change.
2. If our component is a released library, using our new version requires recompiling all client code, changing the version number, and so on. Often not good, if you distribute a library where binary compatibility becomes an issue.
3. More in general, the client code might now even be invalid. The following code will for instance become invalid after the change:

```
val res: List[FileWriter] = A.openFiles(List(new File("foo.input")))
```

Also the following code will break:

```
val a: Seq[Writer] = new BufferedWriter(new FileWriter("bar.input"))
A.openFiles(List(new File("foo.input")))
```

How can we avoid these problems?

Of course, we cannot solve them in general: if we want to alter the interface of a module, breakage might result. However, often we can remove *implementation details* from the interface of a module. In the example above, for instance, it might well be that the intended return type is more general - namely `Seq[Writer]`. It might also not be the case - this is a design choice to be decided on a case-by-case basis. In this example I will assume however that the designer chooses `Seq[Writer]`, since it is a reasonable choice both in the above simplified example and in a real-world extension of the above code.

The client snippets above will now become

```
val res: Seq[Writer] =
  A.openFiles(List(new File("foo.input")))

val a: Seq[Writer] =
  new BufferedWriter(new FileWriter("bar.input")) +:
  A.openFiles(List(new File("foo.input")))
```

Bytecode Enhancers

sbt added an extension point whereby users can effectively manipulate Java bytecode (`.class` files) *before* the incremental compiler attempts to cache the classfile hashes. This allows libraries like Ebean to function with sbt without corrupting the compiler cache and rerunning compile every few seconds.

This splits the compile task into several subTasks:

1. `previousCompile`: This task returns the previously persisted `Analysis` object for this project.
2. `compileIncremental`: This is the core logic of compiling Scala/Java files together. This task actually does the work of compiling a project incrementally, including ensuring a minimum number of source files are compiled. After this method, all .class files that would be generated by scalac + javac will be available.
3. `manipulateByteCode`: This is a stub task which takes the `compileIncremental` result and returns it. Plugins which need to manipulate bytecode are expected to override this task with their own implementation, ensuring to call the previous behavior.
4. `compile`: This task depends on `manipulateBytecode` and then persists the `Analysis` object containing all incremental compiler information.

Here's an example of how to hook the new `manipulateBytecode` key in your own plugin:

```
manipulateBytecode in Compile := {
  val previous = (manipulateBytecode in Compile).value
  // Note: This must return a new Compiler.CompileResult with our changes.
  doManipulateBytecode(previous)
}
```

Further references

The incremental compilation logic is implemented in https://github.com/sbt/sbt/blob/0.13/compile/inc/src/main/scala/inc/Incremental.scala. Some discussion on the incremental recompilation policies is available in issue #322, #288 and #1010.

Configuration

This part of the documentation has pages documenting particular sbt topics in detail. Before reading anything in here, you will need the information in the Getting Started Guide as a foundation.

Classpaths, sources, and resources

This page discusses how sbt builds up classpaths for different actions, like `compile`, `run`, and `test` and how to override or augment these classpaths.

Basics

In sbt, the classpath includes the Scala library and (when declared as a dependency) the Scala compiler. Classpath-related settings and tasks typically provide a value of type `Classpath`. This is an alias for `Seq[Attributed[File]]`. Attributed is a type that associates a heterogeneous map with each classpath entry. Currently, this allows sbt to associate the `Analysis` resulting from compilation with the corresponding classpath entry and for managed entries, the `ModuleID` and `Artifact` that defined the dependency.

To explicitly extract the raw `Seq[File]`, use the `files` method implicitly added to `Classpath`:

```
val cp: Classpath = ...
val raw: Seq[File] = cp.files
```

To create a `Classpath` from a `Seq[File]`, use `classpath` and to create an `Attributed[File]` from a `File`, use `Attributed.blank`:

```
val raw: Seq[File] = ...
val cp: Classpath = raw.classpath

val rawFile: File = ..
val af: Attributed[File] = Attributed.blank(rawFile)
```

Unmanaged vs managed Classpaths, sources, and resources are separated into two main categories: unmanaged and managed. Unmanaged files are manually created files that are outside of the control of the build. They are the inputs to the build. Managed files are under the control of the build. These include generated sources and resources as well as resolved and retrieved dependencies and compiled classes.

Tasks that produce managed files should be inserted as follows:

```
sourceGenerators in Compile +=
    generate( (sourceManaged in Compile).value / "some_directory")
```

In this example, `generate` is some function of type `File => Seq[File]` that actually does the work. So, we are appending a new task to the list of main source generators (`sourceGenerators in Compile`).

To insert a named task, which is the better approach for plugins:

```scala
val mySourceGenerator = taskKey[Seq[File]](...)

mySourceGenerator in Compile :=
  generate( (sourceManaged in Compile).value / "some_directory")

sourceGenerators in Compile += (mySourceGenerator in Compile)
```

The `task` method is used to refer to the actual task instead of the result of the task.

For resources, there are similar keys `resourceGenerators` and `resourceManaged`.

Excluding source files by name The project base directory is by default a source directory in addition to `src/main/scala`. You can exclude source files by name (`butler.scala` in the example below) like:

```scala
excludeFilter in unmanagedSources := "butler.scala"
```

Read more on How to exclude .scala source file in project folder - Google Groups

External vs internal Classpaths are also divided into internal and external dependencies. The internal dependencies are inter-project dependencies. These effectively put the outputs of one project on the classpath of another project.

External classpaths are the union of the unmanaged and managed classpaths.

Keys For classpaths, the relevant keys are:

- `unmanagedClasspath`
- `managedClasspath`
- `externalDependencyClasspath`
- `internalDependencyClasspath`

For sources:

- `unmanagedSources` These are by default built up from unmanagedSourceDirectories, which consists of scalaSource and javaSource.
- `managedSources` These are generated sources.
- `sources` Combines `managedSources` and `unmanagedSources`.
- `sourceGenerators` These are tasks that generate source files. Typically, these tasks will put sources in the directory provided by sourceManaged.

For resources

- `unmanagedResources` These are by default built up from unmanagedResourceDirectories, which by default is resourceDirectory, excluding files matched by defaultExcludes.
- `managedResources` By default, this is empty for standard projects. sbt plugins will have a generated descriptor file here.
- `resourceGenerators` These are tasks that generate resource files. Typically, these tasks will put resources in the directory provided by resourceManaged.

Use the inspect command for more details.

See also a related StackOverflow answer.

Example You have a standalone project which uses a library that loads xxx.properties from classpath at run time. You put xxx.properties inside directory "config". When you run "sbt run", you want the directory to be in classpath.

```
unmanagedClasspath in Runtime += baseDirectory.value / "config"
```

Compiler Plugin Support

There is some special support for using compiler plugins. You can set `autoCompilerPlugins` to `true` to enable this functionality.

```
autoCompilerPlugins := true
```

To use a compiler plugin, you either put it in your unmanaged library directory (`lib/` by default) or add it as managed dependency in the `plugin` configuration. `addCompilerPlugin` is a convenience method for specifying `plugin` as the configuration for a dependency:

```
addCompilerPlugin("org.scala-tools.sxr" %% "sxr" % "0.3.0")
```

The `compile` and `testCompile` actions will use any compiler plugins found in the `lib` directory or in the `plugin` configuration. You are responsible for configuring the plugins as necessary. For example, Scala X-Ray requires the extra option:

```
// declare the main Scala source directory as the base directory
scalacOptions :=
    scalacOptions.value :+ ("-Psxr:base-directory:" + (scalaSource in Compile).value.getAbso
```

You can still specify compiler plugins manually. For example:

```
scalacOptions += "-Xplugin:<path-to-sxr>/sxr-0.3.0.jar"
```

Continuations Plugin Example

Support for continuations in Scala 2.12 is implemented as a compiler plugin. You can use the compiler plugin support for this, as shown here.

```
val continuationsVersion = "1.0.3"

autoCompilerPlugins := true

addCompilerPlugin("org.scala-lang.plugins" % "scala-continuations-plugin_2.12.2" % continuat

libraryDependencies += "org.scala-lang.plugins" %% "scala-continuations-library" % continuat

scalacOptions += "-P:continuations:enable"
```

Version-specific Compiler Plugin Example

Adding a version-specific compiler plugin can be done as follows:

```
val continuationsVersion = "1.0.3"

autoCompilerPlugins := true

libraryDependencies +=
    compilerPlugin("org.scala-lang.plugins" % ("scala-continuations-plugin_" + scalaVersion.

libraryDependencies += "org.scala-lang.plugins" %% "scala-continuations-library" % continuat

scalacOptions += "-P:continuations:enable"
```

Configuring Scala

sbt needs to obtain Scala for a project and it can do this automatically or you can configure it explicitly. The Scala version that is configured for a project will compile, run, document, and provide a REPL for the project code. When compiling a project, sbt needs to run the Scala compiler as well as provide the compiler with a classpath, which may include several Scala jars, like the reflection jar.

Automatically managed Scala

The most common case is when you want to use a version of Scala that is available in a repository. The only required configuration is the Scala version you want to use. For example,

```
scalaVersion := "2.10.0"
```

This will retrieve Scala from the repositories configured via the `resolvers` setting. It will use this version for building your project: compiling, running, scaladoc, and the REPL.

Configuring the scala-library dependency By default, the standard Scala library is automatically added as a dependency. If you want to configure it differently than the default or you have a project with only Java sources, set:

```
autoScalaLibrary := false
```

In order to compile Scala sources, the Scala library needs to be on the classpath. When `autoScalaLibrary` is true, the Scala library will be on all classpaths: test, runtime, and compile. Otherwise, you need to add it like any other dependency. For example, the following dependency definition uses Scala only for tests:

```
autoScalaLibrary := false

libraryDependencies += "org.scala-lang" % "scala-library" % scalaVersion.value % "test"
```

Configuring additional Scala dependencies When using a Scala dependency other than the standard library, add it as a normal managed dependency. For example, to depend on the Scala compiler,

```
libraryDependencies += "org.scala-lang" % "scala-compiler" % scalaVersion.value
```

Note that this is necessary regardless of the value of the `autoScalaLibrary` setting described in the previous section.

Configuring Scala tool dependencies In order to compile Scala code, run scaladoc, and provide a Scala REPL, sbt needs the `scala-compiler` jar. This should not be a normal dependency of the project, so sbt adds a dependency on `scala-compiler` in the special, private `scala-tool` configuration. It may be desirable to have more control over this in some situations. Disable this automatic behavior with the `managedScalaInstance` key:

```
managedScalaInstance := false
```

This will also disable the automatic dependency on `scala-library`. If you do not need the Scala compiler for anything (compiling, the REPL, scaladoc, etc…), you can stop here. sbt does not need an instance of Scala for your project in that case. Otherwise, sbt will still need access to the jars for the Scala compiler for compilation and other tasks. You can provide them by either declaring a dependency in the `scala-tool` configuration or by explicitly defining `scalaInstance`.

In the first case, add the `scala-tool` configuration and add a dependency on `scala-compiler` in this configuration. The organization is not important, but sbt needs the module name to be `scala-compiler` and `scala-library` in order to handle those jars appropriately. For example,

```
managedScalaInstance := false

// Add the configuration for the dependencies on Scala tool jars
// You can also use a manually constructed configuration like:
//   config("scala-tool").hide
ivyConfigurations += Configurations.ScalaTool

// Add the usual dependency on the library as well on the compiler in the
//  'scala-tool' configuration
libraryDependencies ++= Seq(
   "org.scala-lang" % "scala-library" % scalaVersion.value,
   "org.scala-lang" % "scala-compiler" % scalaVersion.value % "scala-tool"
)
```

In the second case, directly construct a value of type ScalaInstance, typically using a method in the companion object, and assign it to `scalaInstance`. You will also need to add the `scala-library` jar to the classpath to compile and run Scala sources. For example,

```
managedScalaInstance := false
scalaInstance := ...
Compile / unmanagedJars += scalaInstance.value.libraryJar
```

Switching to a local Scala version To use a locally built Scala version, configure Scala home as described in the following section. Scala will still be resolved as before, but the jars will come from the configured Scala home directory.

Using Scala from a local directory

The result of building Scala from source is a Scala home directory `<base>/build/pack/` that contains a subdirectory `lib/` containing the Scala library, compiler, and other jars. The same directory layout is obtained by downloading and extracting a Scala distribution. Such a Scala home directory may be used as the source for jars by setting `scalaHome`. For example,

```
scalaHome := Some(file("/home/user/scala-2.10/"))
```

By default, `lib/scala-library.jar` will be added to the unmanaged classpath and `lib/scala-compiler.jar` will be used to compile Scala sources and provide a Scala REPL. No managed dependency is recorded on `scala-library`. This means that Scala will only be resolved from a repository if you explicitly define a dependency on Scala or if Scala is depended on indirectly via a dependency. In these cases, the artifacts for the resolved dependencies will be substituted with jars in the Scala home `lib/` directory.

Mixing with managed dependencies As an example, consider adding a dependency on `scala-reflect` when `scalaHome` is configured:

```
scalaHome := Some(file("/home/user/scala-2.10/"))

libraryDependencies += "org.scala-lang" % "scala-reflect" % scalaVersion.value
```

This will be resolved as normal, except that sbt will see if `/home/user/scala-2.10/lib/scala-reflect.jar` exists. If it does, that file will be used in place of the artifact from the managed dependency.

Using unmanaged dependencies only Instead of adding managed dependencies on Scala jars, you can directly add them. The `scalaInstance` task provides structured access to the Scala distribution. For example, to add all jars in the Scala home `lib/` directory,

```
scalaHome := Some(file("/home/user/scala-2.10/"))

Compile / unmanagedJars ++= scalaInstance.value.jars
```

To add only some jars, filter the jars from `scalaInstance` before adding them.

sbt's Scala version

sbt needs Scala jars to run itself since it is written in Scala. sbt uses that same version of Scala to compile the build definitions that you write for your project because they use sbt APIs. This version of Scala is fixed for a specific sbt release and cannot be changed. For sbt 1.2.1, this version is Scala 2.12.6. Because this Scala version is needed before sbt runs, the repositories used to retrieve this version are configured in the sbt launcher.

Forking

By default, the `run` task runs in the same JVM as sbt. Forking is required under certain circumstances, however. Or, you might want to fork Java processes when implementing new tasks.

By default, a forked process uses the same Java and Scala versions being used for the build and the working directory and JVM options of the current process. This page discusses how to enable and configure forking for both `run` and `test` tasks. Each kind of task may be configured separately by scoping the relevant keys as explained below.

Enable forking

The `fork` setting controls whether forking is enabled (true) or not (false). It can be set in the `run` scope to only fork `run` commands or in the `test` scope to only fork `test` commands.

To fork all test tasks (`test`, `testOnly`, and `testQuick`) and run tasks (`run`, `runMain`, `Test / run`, and `Test / runMain`),

```
fork := true
```

To only fork `Compile / run` and `Compile / runMain`:

```
Compile / run / fork := true
```

To only fork `Test / run` and `Test / runMain`:

```
Test / run / fork := true
```

Note: `run` and `runMain` share the same configuration and cannot be configured separately.

To enable forking all `test` tasks only, set `fork` to `true` in the `Test` scope:

```
Test / fork := true
```

See Testing for more control over how tests are assigned to JVMs and what options to pass to each group.

Change working directory

To change the working directory when forked, set `baseDirectory in run` or `baseDirectory in test`:

```
// sets the working directory for all `run`-like tasks
run / baseDirectory := file("/path/to/working/directory/")

// sets the working directory for `run` and `runMain` only
Compile / run / baseDirectory := file("/path/to/working/directory/")

// sets the working directory for `Test / run` and `Test / runMain` only
Test / run / baseDirectory := file("/path/to/working/directory/")

// sets the working directory for `test`, `testQuick`, and `testOnly`
Test / baseDirectory := file("/path/to/working/directory/")
```

Forked JVM options

To specify options to be provided to the forked JVM, set `javaOptions`:

```
run / javaOptions += "-Xmx8G"
```

or specify the configuration to affect only the main or test `run` tasks:

```
Test / run / javaOptions += "-Xmx8G"
```

or only affect the `test` tasks:

```
Test / javaOptions += "-Xmx8G"
```

Java Home

Select the Java installation to use by setting the `javaHome` directory:

```
javaHome := Some(file("/path/to/jre/"))
```

Note that if this is set globally, it also sets the Java installation used to compile Java sources. You can restrict it to running only by setting it in the `run` scope:

```
run / javaHome := Some(file("/path/to/jre/"))
```

As with the other settings, you can specify the configuration to affect only the main or test `run` tasks or just the `test` tasks.

Configuring output

By default, forked output is sent to the Logger, with standard output logged at the `Info` level and standard error at the `Error` level. This can be configured with the `outputStrategy` setting, which is of type OutputStrategy.

```
// send output to the build's standard output and error
outputStrategy := Some(StdoutOutput)

// send output to the provided OutputStream `someStream`
outputStrategy := Some(CustomOutput(someStream: OutputStream))

// send output to the provided Logger `log` (unbuffered)
outputStrategy := Some(LoggedOutput(log: Logger))

// send output to the provided Logger `log` after the process terminates
outputStrategy := Some(BufferedOutput(log: Logger))
```

As with other settings, this can be configured individually for main or test `run` tasks or for `test` tasks.

Configuring Input

By default, the standard input of the sbt process is not forwarded to the forked process. To enable this, configure the `connectInput` setting:

```
run / connectInput := true
```

Direct Usage

To fork a new Java process, use the Fork API. The values of interest are `Fork.java`, `Fork.javac`, `Fork.scala`, and `Fork.scalac`. These are of type Fork and provide `apply` and `fork` methods. For example, to fork a new Java process, :

```
val options = ForkOptions(...)
val arguments: Seq[String] = ...
val mainClass: String = ...
val exitCode: Int = Fork.java(options, mainClass +: arguments)
```

ForkOptions defines the Java installation to use, the working directory, environment variables, and more. For example, :

```scala
val cwd: File = ...
val javaDir: File = ...
val options = ForkOptions(
   envVars = Map("KEY" -> "value"),
   workingDirectory = Some(cwd),
   javaHome = Some(javaDir)
)
```

Global Settings

Basic global configuration file

Settings that should be applied to all projects can go in `~/.sbt/1.0/global.sbt` (or any file in `~/.sbt/1.0` with a `.sbt` extension). Plugins that are defined globally in `~/.sbt/1.0/plugins/` are available to these settings. For example, to change the default `shellPrompt` for your projects:

`~/.sbt/1.0/global.sbt`

```scala
shellPrompt := { state =>
  "sbt (%s)> ".format(Project.extract(state).currentProject.id)
}
```

You can also configure plugins globally added in `~/.sbt/1.0/plugins/build.sbt` (see next paragraph) in that file, but you need to use fully qualified names for their properties. For example, for sbt-eclipse property `withSource` documented in https://github.com/sbt/sbteclipse/wiki/Using-sbteclipse, you need to use:

```scala
com.typesafe.sbteclipse.core.EclipsePlugin.EclipseKeys.withSource := true
```

Global Settings using a Global Plugin

The `~/.sbt/1.0/plugins/` directory is a global plugin project. This can be used to provide global commands, plugins, or other code.

To add a plugin globally, create `~/.sbt/1.0/plugins/build.sbt` containing the dependency definitions. For example:

```scala
addSbtPlugin("org.example" % "plugin" % "1.0")
```

To change the default `shellPrompt` for every project using this approach, create a local plugin `~/.sbt/1.0/plugins/ShellPrompt.scala`:

```
import sbt._
import Keys._

object ShellPrompt extends AutoPlugin {
  override def trigger = allRequirements

  override def projectSettings = Seq(
    shellPrompt := { state =>
      "sbt (%s)> ".format(Project.extract(state).currentProject.id) }
  )
}
```

The `~/.sbt/1.0/plugins/` directory is a full project that is included as an external dependency of every plugin project. In practice, settings and code defined here effectively work as if they were defined in a project's `project/` directory. This means that `~/.sbt/1.0/plugins/` can be used to try out ideas for plugins such as shown in the `shellPrompt` example.

Java Sources

sbt has support for compiling Java sources with the limitation that dependency tracking is limited to the dependencies present in compiled class files.

Usage

- `compile` will compile the sources under `src/main/java` by default.
- `testCompile` will compile the sources under `src/test/java` by default.

Pass options to the Java compiler by setting `javacOptions`:

```
javacOptions += "-g:none"
```

As with options for the Scala compiler, the arguments are not parsed by sbt. Multi-element options, such as `-source 1.5`, are specified like:

```
javacOptions ++= Seq("-source", "1.5")
```

You can specify the order in which Scala and Java sources are built with the `compileOrder` setting. Possible values are from the `CompileOrder` enumeration: `Mixed`, `JavaThenScala`, and `ScalaThenJava`. If you have circular dependencies between Scala and Java sources, you need the default, `Mixed`, which passes both Java and Scala sources to `scalac` and then compiles the Java sources with `javac`. If you do not have circular dependencies, you can use one of the other two options to speed up your build by not passing the Java sources to `scalac`. For example, if your Scala sources depend on your Java sources, but your Java sources do not depend on your Scala sources, you can do:

```
compileOrder := CompileOrder.JavaThenScala
```

To specify different orders for main and test sources, scope the setting by configuration:

```
// Java then Scala for main sources
Compile / compileOrder := CompileOrder.JavaThenScala

// allow circular dependencies for test sources
Test / compileOrder := CompileOrder.Mixed
```

Note that in an incremental compilation setting, it is not practical to ensure complete isolation between Java sources and Scala sources because they share the same output directory. So, previously compiled classes not involved in the current recompilation may be picked up. A clean compile will always provide full checking, however.

Known issues in mixed mode compilation

The Scala compiler does not identify compile-time constant variables (Java specification 4.12.4) in Java source code if their definition is not a literal. This issue has several symptoms, described in the Scala ticket SI-5333:

1. The selection of a (non-literal) constant variable is rejected when used as an argument to a Java annotation (a compile-time constant expression is required).
2. The selection of a constant variable is not replaced by its value, but compiled as an actual field load (the Scala specification 4.1 defines that constant expressions should be replaced by their values).

Since Scala 2.11.4, a similar issue arises when using a Java-defined annotation in a Scala class. The Scala compiler does not recognize `@Retention` annotations when parsing the annotation `@interface` from source and therefore emits the annotation with visibility `RUNTIME` (SI-8928).

Ignoring the Scala source directories

By default, sbt includes `src/main/scala` and `src/main/java` in its list of unmanaged source directories. For Java-only projects, the unnecessary Scala directories can be ignored by modifying `unmanagedSourceDirectories`:

```
// Include only src/main/java in the compile configuration
unmanagedSourceDirectories in Compile := (javaSource in Compile).value :: Nil

// Include only src/test/java in the test configuration
unmanagedSourceDirectories in Test := (javaSource in Test).value :: Nil
```

However, there should not be any harm in leaving the Scala directories if they are empty.

Mapping Files

Tasks like `package`, `packageSrc`, and `packageDoc` accept mappings of type `Seq[(File, String)]` from an input file to the path to use in the resulting artifact (jar). Similarly, tasks that copy files accept mappings of type `Seq[(File, File)]` from an input file to the destination file. There are some methods on PathFinder and Path that can be useful for constructing the `Seq[(File, String)]` or `Seq[(File, File)]` sequences.

A common way of making this sequence is to start with a `PathFinder` or `Seq[File]` (which is implicitly convertible to `PathFinder`) and then call the `pair` method. See the PathFinder API for details, but essentially this method accepts a function `File => Option[String]` or `File => Option[File]` that is used to generate mappings.

Relative to a directory

The `Path.relativeTo` method is used to map a `File` to its path `String` relative to a base directory or directories. The `relativeTo` method accepts a base directory or sequence of base directories to relativize an input file against. The first directory that is an ancestor of the file is used in the case of a sequence of base directories.

For example:

```
import Path.relativeTo
val files: Seq[File] = file("/a/b/C.scala") :: Nil
val baseDirectories: Seq[File] = file("/a") :: Nil
val mappings: Seq[(File,String)] = files pair relativeTo(baseDirectories)
```

```scala
val expected = (file("/a/b/C.scala") -> "b/C.scala") :: Nil
assert( mappings == expected )
```

Rebase

The `Path.rebase` method relativizes an input file against one or more base directories (the first argument) and then prepends a base String or File (the second argument) to the result. As with `relativeTo`, the first base directory that is an ancestor of the input file is used in the case of multiple base directories.

For example, the following demonstrates building a `Seq[(File, String)]` using `rebase`:

```scala
import Path.rebase
val files: Seq[File] = file("/a/b/C.scala") :: Nil
val baseDirectories: Seq[File] = file("/a") :: Nil
val mappings: Seq[(File,String)] = files pair rebase(baseDirectories, "pre/")

val expected = (file("/a/b/C.scala") -> "pre/b/C.scala" ) :: Nil
assert( mappings == expected )
```

Or, to build a `Seq[(File, File)]`:

```scala
import Path.rebase
val files: Seq[File] = file("/a/b/C.scala") :: Nil
val baseDirectories: Seq[File] = file("/a") :: Nil
val newBase: File = file("/new/base")
val mappings: Seq[(File,File)] = files pair rebase(baseDirectories, newBase)

val expected = (file("/a/b/C.scala") -> file("/new/base/b/C.scala") ) :: Nil
assert( mappings == expected )
```

Flatten

The `Path.flat` method provides a function that maps a file to the last component of the path (its name). For a File to File mapping, the input file is mapped to a file with the same name in a given target directory. For example:

```scala
import Path.flat
val files: Seq[File] = file("/a/b/C.scala") :: Nil
val mappings: Seq[(File,String)] = files pair flat

val expected = (file("/a/b/C.scala") -> "C.scala" ) :: Nil
assert( mappings == expected )
```

To build a `Seq[(File, File)]` using `flat`:

```
import Path.flat
val files: Seq[File] = file("/a/b/C.scala") :: Nil
val newBase: File = file("/new/base")
val mappings: Seq[(File,File)] = files pair flat(newBase)

val expected = (file("/a/b/C.scala") -> file("/new/base/C.scala") ) :: Nil
assert( mappings == expected )
```

Alternatives

To try to apply several alternative mappings for a file, use `|`, which is implicitly added to a function of type `A => Option[B]`. For example, to try to relativize a file against some base directories but fall back to flattening:

```
import Path.relativeTo
val files: Seq[File] = file("/a/b/C.scala") :: file("/zzz/D.scala") :: Nil
val baseDirectories: Seq[File] = file("/a") :: Nil
val mappings: Seq[(File,String)] = files pair ( relativeTo(baseDirectories) | flat )

val expected = (file("/a/b/C.scala") -> "b/C.scala") ) :: (file("/zzz/D.scala") -> "D.scala"
assert( mappings == expected )
```

Local Scala

To use a locally built Scala version, define the `scalaHome` setting, which is of type `Option[File]`. This Scala version will only be used for the build and not for sbt, which will still use the version it was compiled against.

Example:

```
scalaHome := Some(file("/path/to/scala"))
```

Using a local Scala version will override the `scalaVersion` setting and will not work with cross building.

sbt reuses the class loader for the local Scala version. If you recompile your local Scala version and you are using sbt interactively, run

```
> reload
```

to use the new compilation results.

Macro Projects

Introduction

Some common problems arise when working with macros.

1. The current macro implementation in the compiler requires that macro implementations be compiled before they are used. The solution is typically to put the macros in a subproject or in their own configuration.
2. Sometimes the macro implementation should be distributed with the main code that uses them and sometimes the implementation should not be distributed at all.

The rest of the page shows example solutions to these problems.

Defining the Project Relationships

The macro implementation will go in a subproject in the `macro/` directory. The core project in the `core/` directory will depend on this subproject and use the macro. This configuration is shown in the following build definition. `build.sbt`:

```
lazy val commonSettings = Seq(
  scalaVersion := "2.12.6",
  organization := "com.example"
)
lazy val scalaReflect = Def.setting { "org.scala-lang" % "scala-reflect" % scalaVersion.valu

lazy val core = (project in file("core"))
  .dependsOn(macroSub)
  .settings(
    commonSettings,
    // other settings here
  )

lazy val macroSub = (project in file("macro"))
  .settings(
    commonSettings,
    libraryDependencies += scalaReflect.value
    // other settings here
  )
```

This specifies that the macro implementation goes in `macro/src/main/scala/` and tests go in `macro/src/test/scala/`. It also shows that we need a dependency on the compiler for the macro implementation. As an example macro, we'll use `desugar` from macrocosm. `macro/src/main/scala/demo/Demo.scala`:

```
package demo

import language.experimental.macros
import scala.reflect.macros.Context

object Demo {

  // Returns the tree of `a` after the typer, printed as source code.
  def desugar(a: Any): String = macro desugarImpl

  def desugarImpl(c: Context)(a: c.Expr[Any]) = {
    import c.universe._

    val s = show(a.tree)
    c.Expr(
      Literal(Constant(s))
    )
  }
}
```

`macro/src/test/scala/demo/Usage.scala`:

```
package demo

object Usage {
   def main(args: Array[String]): Unit = {
      val s = Demo.desugar(List(1, 2, 3).reverse)
      println(s)
   }
}
```

This can be then run at the console:

```
$ sbt
> macroSub/test:run
scala.collection.immutable.List.apply[Int](1, 2, 3).reverse
```

Actual tests can be defined and run as usual with `macro/test`.

The main project can use the macro in the same way that the tests do. For example,

`core/src/main/scala/MainUsage.scala`:

```
package demo
```

```scala
object Usage {
   def main(args: Array[String]): Unit = {
      val s = Demo.desugar(List(6, 4, 5).sorted)
      println(s)
   }
}
```

```
$ sbt
> core/run
scala.collection.immutable.List.apply[Int](6, 4, 5).sorted[Int](math.this.Ordering.Int)
```

Common Interface

Sometimes, the macro implementation and the macro usage should share some common code. In this case, declare another subproject for the common code and have the main project and the macro subproject depend on the new subproject. For example, the project definitions from above would look like:

```scala
lazy val commonSettings = Seq(
  scalaVersion := "2.12.6",
  organization := "com.example"
)
lazy val scalaReflect = Def.setting { "org.scala-lang" % "scala-reflect" % scalaVersion.valu

lazy val core = (project in file("core"))
  .dependsOn(macroSub, util)
  .settings(
    commonSettings,
    // other settings here
  )

lazy val macroSub = (project in file("macro"))
  .dependsOn(util)
  .settings(
    commonSettings,
    libraryDependencies += scalaReflect.value
    // other settings here
  )

lazy util = (project in file("util"))
  .settings(
    commonSettings,
    // other setting here
  )
```

Code in `util/src/main/scala/` is available for both the `macroSub` and `main` projects to use.

Distribution

To include the macro code with the core code, add the binary and source mappings from the macro subproject to the core project. And also macro subproject should be removed from core project dependency in publishing. For example, the `core` Project definition above would now look like:

```
lazy val core = (project in file("core"))
  .dependsOn(macroSub % "compile-internal, test-internal")
  .settings(
    commonSettings,
    // include the macro classes and resources in the main jar
    mappings in (Compile, packageBin) ++= mappings.in(macroSub, Compile, packageBin).value,
    // include the macro sources in the main source jar
    mappings in (Compile, packageSrc) ++= mappings.in(macroSub, Compile, packageSrc).value
  )
```

You may wish to disable publishing the macro implementation. This is done by overriding `publish` and `publishLocal` to do nothing:

```
lazy val macroSub = (project in file("macro"))
  .settings(
    commonSettings,
    libraryDependencies += scalaReflect.value,
    publish := {},
    publishLocal := {}
  )
```

The techniques described here may also be used for the common interface described in the previous section.

Paths

This page describes files, sequences of files, and file filters. The base type used is java.io.File, but several methods are augmented through implicits:

- RichFile adds methods to File
- PathFinder adds methods to File and Seq[File]
- Path and IO provide general methods related to files and I/O.

Constructing a File

sbt uses java.io.File to represent a file and defines the type alias `File` for `java.io.File` so that an extra import is not necessary. The `file` method is an alias for the single-argument `File` constructor to simplify constructing a new file from a String:

```
val source: File = file("/home/user/code/A.scala")
```

Additionally, sbt augments File with a `/` method, which is an alias for the two-argument `File` constructor for building up a path:

```
def readme(base: File): File = base / "README"
```

Relative files should only be used when defining the base directory of a `Project`, where they will be resolved properly.

```
val root = Project("root", file("."))
```

Elsewhere, files should be absolute or be built up from an absolute base `File`. The `baseDirectory` setting defines the base directory of the build or project depending on the scope.

For example, the following setting sets the unmanaged library directory to be the "custom_lib" directory in a project's base directory:

```
unmanagedBase := baseDirectory.value /"custom_lib"
```

Or, more concisely:

```
unmanagedBase := baseDirectory.value /"custom_lib"
```

This setting sets the location of the shell history to be in the base directory of the build, irrespective of the project the setting is defined in:

```
historyPath := Some( (ThisBuild / baseDirectory).value / ".history"),
```

Path Finders

A `PathFinder` computes a `Seq[File]` on demand. It is a way to build a sequence of files. There are several methods that augment `File` and `Seq[File]` to construct a `PathFinder`. Ultimately, call `get` on the resulting `PathFinder` to evaluate it and get back a `Seq[File]`.

Selecting descendants The ** method accepts a java.io.FileFilter and selects all files matching that filter.

```
def scalaSources(base: File): PathFinder = (base / "src") ** "*.scala"
```

get This selects all files that end in .scala that are in src or a descendent directory. The list of files is not actually evaluated until get is called:

```
def scalaSources(base: File): Seq[File] = {
  val finder: PathFinder = (base / "src") ** "*.scala"
  finder.get
}
```

If the filesystem changes, a second call to get on the same PathFinder object will reflect the changes. That is, the get method reconstructs the list of files each time. Also, get only returns Files that existed at the time it was called.

Selecting children Selecting files that are immediate children of a subdirectory is done with a single *:

```
def scalaSources(base: File): PathFinder = (base / "src") * "*.scala"
```

This selects all files that end in .scala that are in the src directory.

Existing files only If a selector, such as /, **, or *, is used on a path that does not represent a directory, the path list will be empty:

```
def emptyFinder(base: File) = (base / "lib" / "ivy.jar") * "not_possible"
```

Name Filter The argument to the child and descendent selectors * and ** is actually a NameFilter. An implicit is used to convert a String to a NameFilter that interprets * to represent zero or more characters of any value. See the Name Filters section below for more information.

Combining PathFinders Another operation is concatenation of PathFinders:

```
def multiPath(base: File): PathFinder =
   (base / "src" / "main") +++
   (base / "lib") +++
   (base / "target" / "classes")
```

When evaluated using `get`, this will return `src/main/`, `lib/`, and `target/classes/`. The concatenated finder supports all standard methods. For example,

```
def jars(base: File): PathFinder =
   (base / "lib" +++ base / "target") * "*.jar"
```

selects all jars directly in the "lib" and "target" directories.

A common problem is excluding version control directories. This can be accomplished as follows:

```
def sources(base: File) =
   ( (base / "src") ** "*.scala") --- ( (base / "src") ** ".svn" ** "*.scala")
```

The first selector selects all Scala sources and the second selects all sources that are a descendent of a `.svn` directory. The `---` method removes all files returned by the second selector from the sequence of files returned by the first selector.

Filtering There is a `filter` method that accepts a predicate of type `File => Boolean` and is non-strict:

```
// selects all directories under "src"
def srcDirs(base: File) = ( (base / "src") ** "*") filter { _.isDirectory }

// selects archives (.zip or .jar) that are selected by 'somePathFinder'
def archivesOnly(base: PathFinder) = base filter ClasspathUtilities.isArchive
```

Empty PathFinder `PathFinder.empty` is a `PathFinder` that returns the empty sequence when `get` is called:

```
assert( PathFinder.empty.get == Seq[File]() )
```

PathFinder to String conversions Convert a `PathFinder` to a String using one of the following methods:

- `toString` is for debugging. It puts the absolute path of each component on its own line.
- `absString` gets the absolute paths of each component and separates them by the platform's path separator.
- `getPaths` produces a `Seq[String]` containing the absolute paths of each component

Mappings The packaging and file copying methods in sbt expect values of type `Seq[(File,String)]` and `Seq[(File,File)]`, respectively. These are mappings from the input file to its (String) path in the jar or its (File) destination. This approach replaces the relative path approach (using the `##` method) from earlier versions of sbt.

Mappings are discussed in detail on the `Mapping-Files` page.

File Filters

The argument to `*` and `**` is of type java.io.FileFilter. sbt provides combinators for constructing `FileFilter`s.

First, a String may be implicitly converted to a `FileFilter`. The resulting filter selects files with a name matching the string, with a `*` in the string interpreted as a wildcard. For example, the following selects all Scala sources with the word "Test" in them:

```
def testSrcs(base: File): PathFinder =  (base / "src") * "*Test*.scala"
```

There are some useful combinators added to `FileFilter`. The `||` method declares alternative `FileFilter`s. The following example selects all Java or Scala source files under "src":

```
def sources(base: File): PathFinder  =  (base / "src") ** ("*.scala" || "*.java")
```

The `--` method excludes a files matching a second filter from the files matched by the first:

```
def imageResources(base: File): PathFinder =
   (base/"src"/"main"/"resources") * ("*.png" -- "logo.png")
```

This will get `right.png` and `left.png`, but not `logo.png`, for example.

Parallel Execution

Task ordering

Task ordering is specified by declaring a task's inputs. Correctness of execution requires correct input declarations. For example, the following two tasks do not have an ordering specified:

```
write := IO.write(file("/tmp/sample.txt"), "Some content.")

read := IO.read(file("/tmp/sample.txt"))
```

sbt is free to execute `write` first and then `read`, `read` first and then `write`, or `read` and `write` simultaneously. Execution of these tasks is non-deterministic because they share a file. A correct declaration of the tasks would be:

```
write := {
  val f = file("/tmp/sample.txt")
  IO.write(f, "Some content.")
  f
}

read := IO.read(write.value)
```

This establishes an ordering: `read` must run after `write`. We've also guaranteed that `read` will read from the same file that `write` created.

Practical constraints

Note: The feature described in this section is experimental. The default configuration of the feature is subject to change in particular.

Background Declaring inputs and dependencies of a task ensures the task is properly ordered and that code executes correctly. In practice, tasks share finite hardware and software resources and can require control over utilization of these resources. By default, sbt executes tasks in parallel (subject to the ordering constraints already described) in an effort to utilize all available processors. Also by default, each test class is mapped to its own task to enable executing tests in parallel.

Prior to sbt 0.12, user control over this process was restricted to:

1. Enabling or disabling all parallel execution (parallelExecution := false, for example).
2. Enabling or disabling mapping tests to their own tasks (Test / parallelExecution := false, for example).

(Although never exposed as a setting, the maximum number of tasks running at a given time was internally configurable as well.)

The second configuration mechanism described above only selected between running all of a project's tests in the same task or in separate tasks. Each project still had a separate task for running its tests and so test tasks in separate projects could still run in parallel if overall execution was parallel. There was no way to restriction execution such that only a single test out of all projects executed.

Configuration

sbt 0.12.0 introduces a general infrastructure for restricting task concurrency beyond the usual ordering declarations. There are two parts to these restrictions.

1. A task is tagged in order to classify its purpose and resource utilization. For example, the compile task may be tagged as Tags.Compile and Tags.CPU.
2. A list of rules restrict the tasks that may execute concurrently. For example, Tags.limit(Tags.CPU, 4) would allow up to four computation-heavy tasks to run at a time.

The system is thus dependent on proper tagging of tasks and then on a good set of rules.

Tagging Tasks In general, a tag is associated with a weight that represents the task's relative utilization of the resource represented by the tag. Currently, this weight is an integer, but it may be a floating point in the future. `Initialize[Task[T]]` defines two methods for tagging the constructed Task: `tag` and `tagw`. The first method, `tag`, fixes the weight to be 1 for the tags provided to it as arguments. The second method, `tagw`, accepts pairs of tags and weights. For example, the following associates the `CPU` and `Compile` tags with the `compile` task (with a weight of 1).

```
def myCompileTask = Def.task { ... } tag(Tags.CPU, Tags.Compile)

compile := myCompileTask.value
```

Different weights may be specified by passing tag/weight pairs to `tagw`:

```
def downloadImpl = Def.task { ... } tagw(Tags.Network -> 3)

download := downloadImpl.value
```

Defining Restrictions Once tasks are tagged, the `concurrentRestrictions` setting sets restrictions on the tasks that may be concurrently executed based on the weighted tags of those tasks. This is necessarily a global set of rules, so it must be scoped `Global /`. For example,

```
Global / concurrentRestrictions := Seq(
  Tags.limit(Tags.CPU, 2),
  Tags.limit(Tags.Network, 10),
  Tags.limit(Tags.Test, 1),
  Tags.limitAll( 15 )
)
```

The example limits:

- the number of CPU-using tasks to be no more than 2
- the number of tasks using the network to be no more than 10
- test execution to only one test at a time across all projects
- the total number of tasks to be less than or equal to 15

Note that these restrictions rely on proper tagging of tasks. Also, the value provided as the limit must be at least 1 to ensure every task is able to be executed. sbt will generate an error if this condition is not met.

Most tasks won't be tagged because they are very short-lived. These tasks are automatically assigned the label `Untagged`. You may want to include these tasks in the CPU rule by using the `limitSum` method. For example:

```
...
Tags.limitSum(2, Tags.CPU, Tags.Untagged)
...
```

Note that the limit is the first argument so that tags can be provided as varargs.

Another useful convenience function is `Tags.exclusive`. This specifies that a task with the given tag should execute in isolation. It starts executing only when no other tasks are running (even if they have the exclusive tag) and no other tasks may start execution until it completes. For example, a task could be tagged with a custom tag `Benchmark` and a rule configured to ensure such a task is executed by itself:

```
...
Tags.exclusive(Benchmark)
...
```

Finally, for the most flexibility, you can specify a custom function of type `Map[Tag,Int] => Boolean`. The `Map[Tag,Int]` represents the weighted tags of a set of tasks. If the function returns `true`, it indicates that the set of tasks is allowed to execute concurrently. If the return value is `false`, the set of tasks will not be allowed to execute concurrently. For example, `Tags.exclusive(Benchmark)` is equivalent to the following:

```
...
Tags.customLimit { (tags: Map[Tag,Int]) =>
  val exclusive = tags.getOrElse(Benchmark, 0)
   //  the total number of tasks in the group
  val all = tags.getOrElse(Tags.All, 0)
   // if there are no exclusive tasks in this group, this rule adds no restrictions
```

```
  exclusive == 0 ||
    // If there is only one task, allow it to execute.
    all == 1
}
...
```

There are some basic rules that custom functions must follow, but the main one to be aware of in practice is that if there is only one task, it must be allowed to execute. sbt will generate a warning if the user defines restrictions that prevent a task from executing at all and will then execute the task anyway.

Built-in Tags and Rules Built-in tags are defined in the `Tags` object. All tags listed below must be qualified by this object. For example, `CPU` refers to the `Tags.CPU` value.

The built-in semantic tags are:

- `Compile` - describes a task that compiles sources.
- `Test` - describes a task that performs a test.
- `Publish`
- `Update`
- `Untagged` - automatically added when a task doesn't explicitly define any tags.
- `All`- automatically added to every task.

The built-in resource tags are:

- `Network` - describes a task's network utilization.
- `Disk` - describes a task's filesystem utilization.
- `CPU` - describes a task's computational utilization.

The tasks that are currently tagged by default are:

- `compile` : `Compile`, `CPU`
- `test` : `Test`
- `update` : `Update`, `Network`
- `publish`, `publishLocal` : `Publish`, `Network`

Of additional note is that the default `test` task will propagate its tags to each child task created for each test class.

The default rules provide the same behavior as previous versions of sbt:

```
Global / concurrentRestrictions := {
  val max = Runtime.getRuntime.availableProcessors
  Tags.limitAll(if(parallelExecution.value) max else 1) :: Nil
}
```

As before, `parallelExecution in Test` controls whether tests are mapped to separate tasks. To restrict the number of concurrently executing tests in all projects, use:

```
Global / concurrentRestrictions += Tags.limit(Tags.Test, 1)
```

Custom Tags To define a new tag, pass a String to the `Tags.Tag` method. For example:

```
val Custom = Tags.Tag("custom")
```

Then, use this tag as any other tag. For example:

```
def aImpl = Def.task { ... } tag(Custom)

aCustomTask := aImpl.value

Global / concurrentRestrictions +=
  Tags.limit(Custom, 1)
```

Future work

This is an experimental feature and there are several aspects that may change or require further work.

Tagging Tasks Currently, a tag applies only to the immediate computation it is defined on. For example, in the following, the second compile definition has no tags applied to it. Only the first computation is labeled.

```
def myCompileTask = Def.task { ... } tag(Tags.CPU, Tags.Compile)

compile := myCompileTask.value

compile := {
  val result = compile.value
  ... do some post processing ...
}
```

Is this desirable? expected? If not, what is a better, alternative behavior?

Fractional weighting Weights are currently `ints`, but could be changed to be `doubles` if fractional weights would be useful. It is important to preserve a consistent notion of what a weight of 1 means so that built-in and custom tasks share this definition and useful rules can be written.

Default Behavior User feedback on what custom rules work for what workloads will help determine a good set of default tags and rules.

Adjustments to Defaults Rules should be easier to remove or redefine, perhaps by giving them names. As it is, rules must be appended or all rules must be completely redefined. Also, tags can only be defined for tasks at the original definition site when using the `:=` syntax.

For removing tags, an implementation of `removeTag` should follow from the implementation of `tag` in a straightforward manner.

Other characteristics The system of a tag with a weight was selected as being reasonably powerful and flexible without being too complicated. This selection is not fundamental and could be enhance, simplified, or replaced if necessary. The fundamental interface that describes the constraints the system must work within is `sbt.ConcurrentRestrictions`. This interface is used to provide an intermediate scheduling queue between task execution (`sbt.Execute`) and the underlying thread-based parallel execution service (`java.util.concurrent.CompletionService`). This intermediate queue restricts new tasks from being forwarded to the `j.u.c.CompletionService` according to the `sbt.ConcurrentRestrictions` implementation. See the sbt.ConcurrentRestrictions API documentation for details.

External Processes

Usage

Scala includes a process library to simplify working with external processes. Use `import scala.sys.process._` to bring the implicit conversions into scope.

To run an external command, follow it with an exclamation mark `!`:

```
"find project -name *.jar" !
```

An implicit converts the `String` to `scala.sys.process.ProcessBuilder`, which defines the `!` method. This method runs the constructed command, waits until the command completes, and returns the exit code. Alternatively, the `run` method defined on `ProcessBuilder` runs the command and returns an instance of `scala.sys.process.Process`, which can be used to `destroy` the process before it completes. With no arguments, the `!` method sends output to standard output and standard error. You can pass a `Logger` to the `!` method to send output to the `Logger`:

```
"find project -name *.jar" ! log
```

If you need to set the working directory or modify the environment, call `scala.sys.process.Process` explicitly, passing the command sequence (command and argument list) or command string first and the working directory second. Any environment variables can be passed as a vararg list of key/value String pairs.

```
Process("ls" :: "-l" :: Nil, Path.userHome, "key1" -> value1, "key2" -> value2) ! log
```

Operators are defined to combine commands. These operators start with `#` in order to keep the precedence the same and to separate them from the operators defined elsewhere in `sbt` for filters. In the following operator definitions, `a` and `b` are subcommands.

- `a #&& b` Execute `a`. If the exit code is nonzero, return that exit code and do not execute b. If the exit code is zero, execute b and return its exit code.
- `a #|| b` Execute `a`. If the exit code is zero, return zero for the exit code and do not execute b. If the exit code is nonzero, execute b and return its exit code.
- `a #| b` Execute `a` and `b`, piping the output of `a` to the input of b.

There are also operators defined for redirecting output to `File`s and input from `File`s and `URL`s. In the following definitions, `url` is an instance of `URL` and `file` is an instance of `File`.

- `a #< url` or `url #> a` Use `url` as the input to `a`. `a` may be a File or a command.
- `a #< file` or `file #> a` Use `file` as the input to `a`. a may be a File or a command.
- `a #> file` or `file #< a` Write the output of `a` to `file`. a may be a File, URL, or a command.
- `a #>> file` or `file #<< a` Append the output of `a` to file. a may be a File, URL, or a command.

There are some additional methods to get the output from a forked process into a `String` or the output lines as a `Stream[String]`. Here are some examples, but see the ProcessBuilder API for details.

```
val listed: String = "ls" !!
val lines2: Stream[String] = "ls" lines_!
```

Finally, there is a `cat` method to send the contents of `File`s and `URL`s to standard output.

Examples Download a `URL` to a `File`:

```
url("http://databinder.net/dispatch/About") #> file("About.html") !
// or
file("About.html") #< url("http://databinder.net/dispatch/About") !
```

Copy a `File`:

```
file("About.html") #> file("About_copy.html") !
// or
file("About_copy.html") #< file("About.html") !
```

Append the contents of a `URL` to a `File` after filtering through `grep`:

```
url("http://databinder.net/dispatch/About") #> "grep JSON" #>> file("About_JSON") !
// or
file("About_JSON") #<< ( "grep JSON" #< url("http://databinder.net/dispatch/About") )  !
```

Search for uses of `null` in the source directory:

```
"find src -name *.scala -exec grep null {} ;"  #|  "xargs test -z"  #&&  "echo null-free"  #
```

Use `cat`:

```
val spde = url("http://technically.us/spde/About")
val dispatch = url("http://databinder.net/dispatch/About")
val build = file("project/build.properties")
cat(spde, dispatch, build) #| "grep -i scala" !
```

Running Project Code

The `run` and `console` actions provide a means for running user code in the same virtual machine as sbt.

`run` also exists in a variant called `runMain` that takes an additional initial argument allowing you to specify the fully qualified name of the main class you want to run. `run` and`runMain` share the same configuration and cannot be configured separately.

This page describes the problems with running user code in the same virtual machine as sbt, how sbt handles these problems, what types of code can use this feature, and what types of code must use a forked jvm. Skip to User Code if you just want to see when you should use a forked jvm.

Problems

System.exit User code can call `System.exit`, which normally shuts down the JVM. Because the `run` and `console` actions run inside the same JVM as sbt, this also ends the build and requires restarting sbt.

Threads User code can also start other threads. Threads can be left running after the main method returns. In particular, creating a GUI creates several threads, some of which may not terminate until the JVM terminates. The program is not completed until either `System.exit` is called or all non-daemon threads terminate.

Deserialization and class loading During deserialization, the wrong class loader might be used for various complex reasons. This can happen in many scenarios, and running under SBT is just one of them. This is discussed for instance in issues #163 and #136. The reason is explained here.

sbt's Solutions

System.exit User code is run with a custom `SecurityManager` that throws a custom `SecurityException` when `System.exit` is called. This exception is caught by sbt. sbt then disposes of all top-level windows, interrupts (not stops) all user-created threads, and handles the exit code. If the exit code is nonzero, `run` and `console` complete unsuccessfully. If the exit code is zero, they complete normally.

Threads sbt makes a list of all threads running before executing user code. After the user code returns, sbt can then determine the threads created by the user code. For each user-created thread, sbt replaces the uncaught exception handler with a custom one that handles the custom `SecurityException` thrown by calls to `System.exit` and delegates to the original handler for everything else. sbt then waits for each created thread to exit or for `System.exit` to be called. sbt handles a call to `System.exit` as described above.

A user-created thread is one that is not in the `system` thread group and is not an `AWT` implementation thread (e.g. `AWT-XAWT`, `AWT-Windows`). User-created threads include the `AWT-EventQueue-*` thread(s).

User Code Given the above, when can user code be run with the `run` and `console` actions?

The user code cannot rely on shutdown hooks and at least one of the following situations must apply for user code to run in the same JVM:

1. User code creates no threads.
2. User code creates a GUI and no other threads.
3. The program ends when user-created threads terminate on their own.
4. `System.exit` is used to end the program and user-created threads terminate when interrupted.
5. No deserialization is done, or the deserialization code ensures that the right class loader is used, as in https://github.com/NetLogo/NetLogo/blob/5.x/src/main/org/nlogo/util/ClassLoaderObjectInputStream.scala or https://github.com/scala/scala/blob/2.11.x/src/actors/scala/actors/remote/JavaSerializer.scala#L20.

The requirements on threading and shutdown hooks are required because the JVM does not actually shut down. So, shutdown hooks cannot be run and threads are not terminated unless they stop when interrupted. If these requirements are not met, code must run in a forked jvm.

The feature of allowing `System.exit` and multiple threads to be used cannot completely emulate the situation of running in a separate JVM and is intended for development. Program execution should be checked in a forked jvm when using multiple threads or `System.exit`.

As of sbt 0.13.1, multiple `run` instances can be managed. There can only be one application that uses AWT at a time, however.

Testing

Basics

The standard source locations for testing are:

- Scala sources in `src/test/scala/`
- Java sources in `src/test/java/`
- Resources for the test classpath in `src/test/resources/`

The resources may be accessed from tests by using the getResource methods of java.lang.Class or java.lang.ClassLoader.

The main Scala testing frameworks (ScalaCheck, ScalaTest, and specs2) provide an implementation of the common test interface and only need to be added to the classpath to work with sbt. For example, ScalaCheck may be used by declaring it as a managed dependency:

```
lazy val scalacheck = "org.scalacheck" %% "scalacheck" % "1.13.4"
libraryDependencies += scalacheck % Test
```

Test is the configuration and means that ScalaCheck will only be on the test classpath and it isn't needed by the main sources. This is generally good practice for libraries because your users don't typically need your test dependencies to use your library.

With the library dependency defined, you can then add test sources in the locations listed above and compile and run tests. The tasks for running tests are test and testOnly. The test task accepts no command line arguments and runs all tests:

```
> test
```

testOnly The testOnly task accepts a whitespace separated list of test names to run. For example:

```
> testOnly org.example.MyTest1 org.example.MyTest2
```

It supports wildcards as well:

```
> testOnly org.example.*Slow org.example.MyTest1
```

testQuick The testQuick task, like testOnly, allows to filter the tests to run to specific tests or wildcards using the same syntax to indicate the filters. In addition to the explicit filter, only the tests that satisfy one of the following conditions are run:

- The tests that failed in the previous run
- The tests that were not run before
- The tests that have one or more transitive dependencies, maybe in a different project, recompiled.

Tab completion Tab completion is provided for test names based on the results of the last `test:compile`. This means that a new sources aren't available for tab completion until they are compiled and deleted sources won't be removed from tab completion until a recompile. A new test source can still be manually written out and run using `testOnly`.

Other tasks Tasks that are available for main sources are generally available for test sources, but are prefixed with `Test /` on the command line and are referenced in Scala code with `Test /` as well. These tasks include:

- `Test / compile`
- `Test / console`
- `Test / consoleQuick`
- `Test / run`
- `Test / runMain`

See Running for details on these tasks.

Output

By default, logging is buffered for each test source file until all tests for that file complete. This can be disabled by setting `logBuffered`:

```
Test / logBuffered := false
```

Test Reports By default, sbt will generate JUnit XML test reports for all tests in the build, located in the `target/test-reports` directory for a project. This can be disabled by disabling the `JUnitXmlReportPlugin`

```
val myProject = (project in file(".")).disablePlugins(plugins.JUnitXmlReportPlugin)
```

Options

Test Framework Arguments Arguments to the test framework may be provided on the command line to the `testOnly` tasks following a `--` separator. For example:

```
> testOnly org.example.MyTest -- -verbosity 1
```

To specify test framework arguments as part of the build, add options constructed by `Tests.Argument`:

```
Test / testOptions += Tests.Argument("-verbosity", "1")
```

To specify them for a specific test framework only:

```
Test / testOptions += Tests.Argument(TestFrameworks.ScalaCheck, "-verbosity", "1")
```

Setup and Cleanup Specify setup and cleanup actions using `Tests.Setup` and `Tests.Cleanup`. These accept either a function of type `() => Unit` or a function of type `ClassLoader => Unit`. The variant that accepts a ClassLoader is passed the class loader that is (or was) used for running the tests. It provides access to the test classes as well as the test framework classes.

> **Note**: When forking, the ClassLoader containing the test classes cannot be provided because it is in another JVM. Only use the () => Unit variants in this case.

Examples:

```
Test / testOptions += Tests.Setup( () => println("Setup") )
Test / testOptions += Tests.Cleanup( () => println("Cleanup") )
Test / testOptions += Tests.Setup( loader => ... )
Test / testOptions += Tests.Cleanup( loader => ... )
```

Disable Parallel Execution of Tests By default, sbt runs all tasks in parallel and within the same JVM as sbt itself. Because each test is mapped to a task, tests are also run in parallel by default. To make tests within a given project execute serially: :

```
Test / parallelExecution := false
```

`Test` can be replaced with `IntegrationTest` to only execute integration tests serially. Note that tests from different projects may still execute concurrently.

Filter classes If you want to only run test classes whose name ends with "Test", use `Tests.Filter`:

```
Test / testOptions := Seq(Tests.Filter(s => s.endsWith("Test")))
```

Forking tests The setting:

```
Test / fork := true
```

specifies that all tests will be executed in a single external JVM. See Forking for configuring standard options for forking. By default, tests executed in a forked JVM are executed *sequentially*. More control over how tests are assigned to JVMs and what options to pass to those is available with `testGrouping` key. For example in build.sbt:

```
import Tests._

{
  def groupByFirst(tests: Seq[TestDefinition]) =
    tests groupBy (_.name(0)) map {
      case (letter, tests) =>
        val options = ForkOptions().withRunJVMOptions(Vector("-Dfirst.letter"+letter))
        new Group(letter.toString, tests, SubProcess(options))
    } toSeq

    testGrouping in Test := groupByFirst( (definedTests in Test).value )
}
```

The tests in a single group are run sequentially. Control the number of forked JVMs allowed to run at the same time by setting the limit on `Tags.ForkedTestGroup` tag, which is 1 by default. `Setup` and `Cleanup` actions cannot be provided with the actual test class loader when a group is forked.

In addition, forked tests can optionally be run in parallel within the forked JVM(s), using the following setting:

```
Test / testForkedParallel := true
```

Additional test configurations

You can add an additional test configuration to have a separate set of test sources and associated compilation, packaging, and testing tasks and settings. The steps are:

- Define the configuration
- Add the tasks and settings
- Declare library dependencies
- Create sources
- Run tasks

The following two examples demonstrate this. The first example shows how to enable integration tests. The second shows how to define a customized test configuration. This allows you to define multiple types of tests per project.

Integration Tests The following full build configuration demonstrates integration tests.

```
lazy val commonSettings = Seq(
  scalaVersion := "2.12.6",
  organization := "com.example"
)
lazy val scalatest = "org.scalatest" %% "scalatest" % "3.0.5"

lazy val root = (project in file("."))
  .configs(IntegrationTest)
  .settings(
    commonSettings,
    Defaults.itSettings,
    libraryDependencies += scalatest % "it,test"
    // other settings here
  )
```

- `configs(IntegrationTest)` adds the predefined integration test configuration. This configuration is referred to by the name it.
- `settings(Defaults.itSettings)` adds compilation, packaging, and testing actions and settings in the IntegrationTest configuration.
- `settings(libraryDependencies += scalatest % "it,test")` adds scalatest to both the standard test configuration and the integration test configuration it. To define a dependency only for integration tests, use "it" as the configuration instead of "it,test".

The standard source hierarchy is used:

- `src/it/scala` for Scala sources
- `src/it/java` for Java sources
- `src/it/resources` for resources that should go on the integration test classpath

The standard testing tasks are available, but must be prefixed with `it:`. For example,

```
> IntegrationTest / testOnly org.example.AnIntegrationTest
```

Similarly the standard settings may be configured for the `IntegrationTest` configuration. If not specified directly, most `IntegrationTest` settings delegate to `Test` settings by default. For example, if test options are specified as:

```
Test / testOptions += ...
```

then these will be picked up by the `Test` configuration and in turn by the `IntegrationTest` configuration. Options can be added specifically for integration tests by putting them in the `IntegrationTest` configuration:

```
IntegrationTest / testOptions += ...
```

Or, use `:=` to overwrite any existing options, declaring these to be the definitive integration test options:

```
IntegrationTest / testOptions := Seq(...)
```

Custom test configuration The previous example may be generalized to a custom test configuration.

```
lazy val commonSettings = Seq(
  scalaVersion := "2.12.6",
  organization := "com.example"
)
lazy val scalatest = "org.scalatest" %% "scalatest" % "3.0.5"
lazy val FunTest = config("fun") extend(Test)

lazy val root = (project in file("."))
  .configs(FunTest)
  .settings(
    commonSettings,
    inConfig(FunTest)(Defaults.testSettings),
    libraryDependencies += scalatest % FunTest
    // other settings here
  )
```

Instead of using the built-in configuration, we defined a new one:

```
lazy val FunTest = config("fun") extend(Test)
```

The `extend(Test)` part means to delegate to `Test` for undefined `FunTest` settings. The line that adds the tasks and settings for the new test configuration is:

```
settings(inConfig(FunTest)(Defaults.testSettings))
```

This says to add test and settings tasks in the `FunTest` configuration. We could have done it this way for integration tests as well. In fact, `Defaults.itSettings` is a convenience definition: `val itSettings = inConfig(IntegrationTest)(Defaults.testSettings)`.

The comments in the integration test section hold, except with `IntegrationTest` replaced with `FunTest` and `"it"` replaced with `"fun"`. For example, test options can be configured specifically for `FunTest`:

```
FunTest / testOptions += ...
```

Test tasks are run by prefixing them with `fun`:

```
> FunTest / test
```

Additional test configurations with shared sources An alternative to adding separate sets of test sources (and compilations) is to share sources. In this approach, the sources are compiled together using the same classpath and are packaged together. However, different tests are run depending on the configuration.

```
lazy val commonSettings = Seq(
  scalaVersion := "2.12.6",
  organization := "com.example"
)
lazy val scalatest = "org.scalatest" %% "scalatest" % "3.0.5"
lazy val FunTest = config("fun") extend(Test)

def itFilter(name: String): Boolean = name endsWith "ITest"
def unitFilter(name: String): Boolean = (name endsWith "Test") && !itFilter(name)

lazy val root = (project in file("."))
  .configs(FunTest)
  .settings(
    commonSettings,
    inConfig(FunTest)(Defaults.testTasks),
    libraryDependencies += scalatest % FunTest,
    testOptions in Test := Seq(Tests.Filter(unitFilter)),
    testOptions in FunTest := Seq(Tests.Filter(itFilter))
    // other settings here
  )
```

The key differences are:

- We are now only adding the test tasks (inConfig(FunTest)(Defaults.testTasks)) and not compilation and packaging tasks and settings.
- We filter the tests to be run for each configuration.

To run standard unit tests, run `test` (or equivalently, `Test / test`):

```
> test
```

To run tests for the added configuration (here, `"FunTest"`), prefix it with the configuration name as before:

```
> FunTest / test
> FunTest / testOnly org.example.AFunTest
```

Application to parallel execution One use for this shared-source approach is to separate tests that can run in parallel from those that must execute serially. Apply the procedure described in this section for an additional configuration. Let's call the configuration `serial`:

```
lazy val Serial = config("serial") extend(Test)
```

Then, we can disable parallel execution in just that configuration using:

```
parallelExecution in Serial := false
```

The tests to run in parallel would be run with `test` and the ones to run in serial would be run with `serial:test`.

JUnit

Support for JUnit is provided by junit-interface. To add JUnit support into your project, add the junit-interface dependency in your project's main build.sbt file.

```
libraryDependencies += "com.novocode" % "junit-interface" % "0.11" % Test
```

Extensions

This page describes adding support for additional testing libraries and defining additional test reporters. You do this by implementing `sbt` interfaces (described below). If you are the author of the testing framework, you can depend on the test interface as a provided dependency. Alternatively, anyone can provide support for a test framework by implementing the interfaces in a separate project and packaging the project as an sbt Plugin.

Custom Test Framework The main Scala testing libraries have built-in support for sbt. To add support for a different framework, implement the uniform test interface.

Custom Test Reporters Test frameworks report status and results to test reporters. You can create a new test reporter by implementing either TestReportListener or TestsListener.

Using Extensions To use your extensions in a project definition:

Modify the `testFrameworks` setting to reference your test framework:

```
testFrameworks += new TestFramework("custom.framework.ClassName")
```

Specify the test reporters you want to use by overriding the `testListeners` setting in your project definition.

```
testListeners += customTestListener
```

where `customTestListener` is of type `sbt.TestReportListener`.

Dependency Management

This part of the documentation has pages documenting particular sbt topics in detail. Before reading anything in here, you will need the information in the Getting Started Guide as a foundation.

Artifacts

Selecting default artifacts

By default, the published artifacts are the main binary jar, a jar containing the main sources and resources, and a jar containing the API documentation. You can add artifacts for the test classes, sources, or API or you can disable some of the main artifacts.

To add all test artifacts:

```
publishArtifact in Test := true
```

To add them individually:

```scala
// enable publishing the jar produced by `test:package`
publishArtifact in (Test, packageBin) := true

// enable publishing the test API jar
publishArtifact in (Test, packageDoc) := true

// enable publishing the test sources jar
publishArtifact in (Test, packageSrc) := true
```

To disable main artifacts individually:

```scala
// disable publishing the main jar produced by `package`
publishArtifact in (Compile, packageBin) := false

// disable publishing the main API jar
publishArtifact in (Compile, packageDoc) := false

// disable publishing the main sources jar
publishArtifact in (Compile, packageSrc) := false
```

Modifying default artifacts

Each built-in artifact has several configurable settings in addition to `publishArtifact`. The basic ones are `artifact` (of type `SettingKey[Artifact]`), `mappings` (of type `TaskKey[(File,String)]`), and `artifactPath` (of type `SettingKey[File]`). They are scoped by `(<config>, <task>)` as indicated in the previous section.

To modify the type of the main artifact, for example:

```scala
artifact in (Compile, packageBin) := {
  val previous: Artifact = (artifact in (Compile, packageBin)).value
  previous.withType("bundle")
}
```

The generated artifact name is determined by the `artifactName` setting. This setting is of type `(ScalaVersion, ModuleID, Artifact) => String`. The ScalaVersion argument provides the full Scala version String and the binary compatible part of the version String. The String result is the name of the file to produce. The default implementation is `Artifact.artifactName _`. The function may be modified to produce different local names for artifacts without affecting the published name, which is determined by the `artifact` definition combined with the repository pattern.

For example, to produce a minimal name without a classifier or cross path:

```
artifactName := { (sv: ScalaVersion, module: ModuleID, artifact: Artifact) =>
  artifact.name + "-" + module.revision + "." + artifact.extension
}
```

(Note that in practice you rarely want to drop the classifier.)

Finally, you can get the `(Artifact, File)` pair for the artifact by mapping the `packagedArtifact` task. Note that if you don't need the `Artifact`, you can get just the File from the package task (`package`, `packageDoc`, or `packageSrc`). In both cases, mapping the task to get the file ensures that the artifact is generated first and so the file is guaranteed to be up-to-date.

For example:

```
val myTask = taskKey[Unit]("My task.")

myTask :=  {
  val (art, file) = packagedArtifact.in(Compile, packageBin).value
  println("Artifact definition: " + art)
  println("Packaged file: " + file.getAbsolutePath)
}
```

Defining custom artifacts

In addition to configuring the built-in artifacts, you can declare other artifacts to publish. Multiple artifacts are allowed when using Ivy metadata, but a Maven POM file only supports distinguishing artifacts based on classifiers and these are not recorded in the POM.

Basic `Artifact` construction look like:

```
Artifact("name", "type", "extension")
Artifact("name", "classifier")
Artifact("name", url: URL)
Artifact("name", Map("extra1" -> "value1", "extra2" -> "value2"))
```

For example:

```
Artifact("myproject", "zip", "zip")
Artifact("myproject", "image", "jpg")
Artifact("myproject", "jdk15")
```

See the Ivy documentation for more details on artifacts. See the Artifact API for combining the parameters above and specifying Configurations and extra attributes.

To declare these artifacts for publishing, map them to the task that generates the artifact:

```
val myImageTask = taskKey[File](...)

myImageTask := {
  val artifact: File = makeArtifact(...)
  artifact
}

addArtifact( Artifact("myproject", "image", "jpg"), myImageTask )
```

`addArtifact` returns a sequence of settings (wrapped in a SettingsDefinition). In a full build configuration, usage looks like:

```
...
lazy val proj = Project(...)
  .settings( addArtifact(...).settings )
...
```

Publishing .war files

A common use case for web applications is to publish the `.war` file instead of the `.jar` file.

```
// disable .jar publishing
publishArtifact in (Compile, packageBin) := false

// create an Artifact for publishing the .war file
artifact in (Compile, packageWar) := {
  val previous: Artifact = (artifact in (Compile, packageWar)).value
  previous.withType("war").withExtension("war")
}

// add the .war file to what gets published
addArtifact(artifact in (Compile, packageWar), packageWar)
```

Using dependencies with artifacts

To specify the artifacts to use from a dependency that has custom or multiple artifacts, use the `artifacts` method on your dependencies. For example:

```
libraryDependencies += "org" % "name" % "rev" artifacts(Artifact("name", "type", "ext"))
```

The `from` and `classifer` methods (described on the Library Management page) are actually convenience methods that translate to `artifacts`:

```
def from(url: String) = artifacts( Artifact(name, new URL(url)) )
def classifier(c: String) = artifacts( Artifact(name, c) )
```

That is, the following two dependency declarations are equivalent:

```
libraryDependencies += "org.testng" % "testng" % "5.7" classifier "jdk15"

libraryDependencies += "org.testng" % "testng" % "5.7" artifacts(Artifact("testng", "jdk15")
```

Dependency Management Flow

sbt 0.12.1 addresses several issues with dependency management. These fixes were made possible by specific, reproducible examples, such as a situation where the resolution cache got out of date (gh-532). A brief summary of the current work flow with dependency management in sbt follows.

Background

`update` resolves dependencies according to the settings in a build file, such as `libraryDependencies` and `resolvers`. Other tasks use the output of `update` (an `UpdateReport`) to form various classpaths. Tasks that in turn use these classpaths, such as `compile` or `run`, thus indirectly depend on `update`. This means that before `compile` can run, the `update` task needs to run. However, resolving dependencies on every `compile` would be unnecessarily slow and so `update` must be particular about when it actually performs a resolution.

Caching and Configuration

1. Normally, if no dependency management configuration has changed since the last successful resolution and the retrieved files are still present, sbt does not ask Ivy to perform resolution.
2. Changing the configuration, such as adding or removing dependencies or changing the version or other attributes of a dependency, will automatically cause resolution to be performed. Updates to locally published dependencies should be detected in sbt 0.12.1 and later and will force an update. Dependent tasks like compile and run will get updated classpaths.
3. Directly running the `update` task (as opposed to a task that depends on it) will force resolution to run, whether or not configuration changed. This should be done in order to refresh remote SNAPSHOT dependencies.
4. When `offline := true`, remote SNAPSHOTs will not be updated by a resolution, even an explicitly requested update. This should effectively support working without a connection to remote repositories. Reproducible examples demonstrating otherwise are appreciated. Obviously, update must have successfully run before going offline.

5. Overriding all of the above, `skip in update := true` will tell sbt to never perform resolution. Note that this can cause dependent tasks to fail. For example, compilation may fail if jars have been deleted from the cache (and so needed classes are missing) or a dependency has been added (but will not be resolved because skip is true). Also, update itself will immediately fail if resolution has not been allowed to run since the last clean.

General troubleshooting steps

1. Run `update` explicitly. This will typically fix problems with out of date SNAPSHOTs or locally published artifacts.
2. If a file cannot be found, look at the output of update to see where Ivy is looking for the file. This may help diagnose an incorrectly defined dependency or a dependency that is actually not present in a repository.
3. `last update` contains more information about the most recent resolution and download. The amount of debugging output from Ivy is high, so you may want to use last-grep (run help last-grep for usage).
4. Run `clean` and then `update`. If this works, it could indicate a bug in sbt, but the problem would need to be reproduced in order to diagnose and fix it.
5. Before deleting all of the Ivy cache, first try deleting files in `~/.ivy2/cache` related to problematic dependencies. For example, if there are problems with dependency `"org.example" % "demo" % "1.0"`, delete `~/.ivy2/cache/org.example/demo/1.0/` and retry update. This avoids needing to redownload all dependencies.
6. Normal sbt usage should not require deleting files from `~/.ivy2/cache`, especially if the first four steps have been followed. If deleting the cache fixes a dependency management issue, please try to reproduce the issue and submit a test case.

Plugins

These troubleshooting steps can be run for plugins by changing to the build definition project, running the commands, and then returning to the main project. For example:

```
> reload plugins
> update
> reload return
```

Notes

1. Configure offline behavior for all projects on a machine by putting `offline := true` in `~/.sbt/1.0/global.sbt`. A command that does this for the user would make a nice pull request. Perhaps the setting of offline should go into the output of about or should it be a warning in the output of update or both?
2. The cache improvements in 0.12.1 address issues in the change detection for update so that it will correctly re-resolve automatically in more situations. A problem with an out of date cache can usually be attributed to a bug in that change detection if explicitly running update fixes the problem.
3. A common solution to dependency management problems in sbt has been to remove `~/.ivy2/cache`. Before doing this with 0.12.1, be sure to follow the steps in the troubleshooting section first. In particular, verify that a clean and an explicit update do not solve the issue.
4. There is no need to mark SNAPSHOT dependencies as `changing()` because sbt configures Ivy to know this already.

Library Management

There's now a getting started page about library management, which you may want to read first.

Documentation Maintenance Note: it would be nice to remove the overlap between this page and the getting started page, leaving this page with the more advanced topics such as checksums and external Ivy files.

Introduction

There are two ways for you to manage libraries with sbt: manually or automatically. These two ways can be mixed as well. This page discusses the two approaches. All configurations shown here are settings that go either directly in a .sbt file or are appended to the `settings` of a Project in a .scala file.

Manual Dependency Management

Manually managing dependencies involves copying any jars that you want to use to the `lib` directory. sbt will put these jars on the classpath during compilation, testing, running, and when using the interpreter. You are responsible for adding, removing, updating, and otherwise managing the jars in this directory. No modifications to your project definition are required to use this method unless you would like to change the location of the directory you store the jars in.

To change the directory jars are stored in, change the unmanagedBase setting in your project definition. For example, to use custom_lib/:

```
unmanagedBase := baseDirectory.value / "custom_lib"
```

If you want more control and flexibility, override the unmanagedJars task, which ultimately provides the manual dependencies to sbt. The default implementation is roughly:

```
Compile / unmanagedJars := (baseDirectory.value ** "*.jar").classpath
```

If you want to add jars from multiple directories in addition to the default directory, you can do:

```
Compile / unmanagedJars ++= {
    val base = baseDirectory.value
    val baseDirectories = (base / "libA") +++ (base / "b" / "lib") +++ (base / "libC")
    val customJars = (baseDirectories ** "*.jar") +++ (base / "d" / "my.jar")
    customJars.classpath
}
```

See Paths for more information on building up paths.

Automatic Dependency Management

This method of dependency management involves specifying the direct dependencies of your project and letting sbt handle retrieving and updating your dependencies. sbt supports three ways of specifying these dependencies:

- Declarations in your project definition
- Maven POM files (dependency definitions only: no repositories)
- Ivy configuration and settings files

sbt uses Apache Ivy to implement dependency management in all three cases. The default is to use inline declarations, but external configuration can be explicitly selected. The following sections describe how to use each method of automatic dependency management.

Inline Declarations Inline declarations are a basic way of specifying the dependencies to be automatically retrieved. They are intended as a lightweight alternative to a full configuration using Ivy.

Dependencies Declaring a dependency looks like:

```
libraryDependencies += groupID % artifactID % revision
```

or

```
libraryDependencies += groupID % artifactID % revision % configuration
```

See configurations for details on configuration mappings. Also, several dependencies can be declared together:

```
libraryDependencies ++= Seq(
  groupID %% artifactID % revision,
  groupID %% otherID % otherRevision
)
```

If you are using a dependency that was built with sbt, double the first `%` to be `%%`:

```
libraryDependencies += groupID %% artifactID % revision
```

This will use the right jar for the dependency built with the version of Scala that you are currently using. If you get an error while resolving this kind of dependency, that dependency probably wasn't published for the version of Scala you are using. See Cross Build for details.

Ivy can select the latest revision of a module according to constraints you specify. Instead of a fixed revision like `"1.6.1"`, you specify `"latest.integration"`, `"2.9.+"`, or `"[1.0,)"`. See the Ivy revisions documentation for details.

Resolvers sbt uses the standard Maven2 repository by default.

Declare additional repositories with the form:

```
resolvers += name at location
```

For example:

```
libraryDependencies ++= Seq(
    "org.apache.derby" % "derby" % "10.4.1.3",
    "org.specs" % "specs" % "1.6.1"
)

resolvers += "Sonatype OSS Snapshots" at "https://oss.sonatype.org/content/repositories/snap
```

sbt can search your local Maven repository if you add it as a repository:

```
resolvers += "Local Maven Repository" at "file://"+Path.userHome.absolutePath+"/.m2/reposit
```

See Resolvers for details on defining other types of repositories.

Override default resolvers `resolvers` configures additional, inline user resolvers. By default, `sbt` combines these resolvers with default repositories (Maven Central and the local Ivy repository) to form `externalResolvers`. To have more control over repositories, set `externalResolvers` directly. To only specify repositories in addition to the usual defaults, configure `resolvers`.

For example, to use the Sonatype OSS Snapshots repository in addition to the default repositories,

```
resolvers += "Sonatype OSS Snapshots" at "https://oss.sonatype.org/content/repositories/snap
```

To use the local repository, but not the Maven Central repository:

```
externalResolvers := Resolver.combineDefaultResolvers(resolvers.value, mavenCentral = false)
```

Override all resolvers for all builds The repositories used to retrieve sbt, Scala, plugins, and application dependencies can be configured globally and declared to override the resolvers configured in a build or plugin definition. There are two parts:

1. Define the repositories used by the launcher.
2. Specify that these repositories should override those in build definitions.

The repositories used by the launcher can be overridden by defining `~/.sbt/repositories`, which must contain a `[repositories]` section with the same format as the `Launcher` configuration file. For example:

```
[repositories]
local
my-maven-repo: https://example.org/repo
my-ivy-repo: https://example.org/ivy-repo/, [organization]/[module]/[revision]/[type]s/[arti
```

A different location for the repositories file may be specified by the `sbt.repository.config` system property in the sbt startup script. The final step is to set `sbt.override.build.repos` to true to use these repositories for dependency resolution and retrieval.

Explicit URL If your project requires a dependency that is not present in a repository, a direct URL to its jar can be specified as follows:

```
libraryDependencies += "slinky" % "slinky" % "2.1" from "https://slinky2.googlecode.com/svn/
```

The URL is only used as a fallback if the dependency cannot be found through the configured repositories. Also, the explicit URL is not included in published metadata (that is, the pom or ivy.xml).

Disable Transitivity By default, these declarations fetch all project dependencies, transitively. In some instances, you may find that the dependencies listed for a project aren't necessary for it to build. Projects using the Felix OSGI framework, for instance, only explicitly require its main jar to compile and run. Avoid fetching artifact dependencies with either `intransitive()` or `notTransitive()`, as in this example:

```
libraryDependencies += "org.apache.felix" % "org.apache.felix.framework" % "1.8.0" intransit
```

Classifiers You can specify the classifier for a dependency using the `classifier` method. For example, to get the jdk15 version of TestNG:

```
libraryDependencies += "org.testng" % "testng" % "5.7" classifier "jdk15"
```

For multiple classifiers, use multiple `classifier` calls:

```
libraryDependencies +=
  "org.lwjgl.lwjgl" % "lwjgl-platform" % lwjglVersion classifier "natives-windows" classifie
```

To obtain particular classifiers for all dependencies transitively, run the `updateClassifiers` task. By default, this resolves all artifacts with the `sources` or `javadoc` classifier. Select the classifiers to obtain by configuring the `transitiveClassifiers` setting. For example, to only retrieve sources:

```
transitiveClassifiers := Seq("sources")
```

Exclude Transitive Dependencies To exclude certain transitive dependencies of a dependency, use the `excludeAll` or `exclude` methods. The `exclude` method should be used when a pom will be published for the project. It requires the organization and module name to exclude. For example,

```
libraryDependencies +=
  "log4j" % "log4j" % "1.2.15" exclude("javax.jms", "jms")
```

The `excludeAll` method is more flexible, but because it cannot be represented in a pom.xml, it should only be used when a pom doesn't need to be generated. For example,

```
libraryDependencies +=
  "log4j" % "log4j" % "1.2.15" excludeAll(
    ExclusionRule(organization = "com.sun.jdmk"),
    ExclusionRule(organization = "com.sun.jmx"),
    ExclusionRule(organization = "javax.jms")
  )
```

See ModuleID for API details.

In certain cases a transitive dependency should be excluded from all dependencies. This can be achieved by setting up `ExclusionRules` in `excludeDependencies`.

```
excludeDependencies ++= Seq(
  // commons-logging is replaced by jcl-over-slf4j
  ExclusionRule("commons-logging", "commons-logging")
)
```

Download Sources Downloading source and API documentation jars is usually handled by an IDE plugin. These plugins use the `updateClassifiers` and `updateSbtClassifiers` tasks, which produce an `Update-Report` referencing these jars.

To have sbt download the dependency's sources without using an IDE plugin, add `withSources()` to the dependency definition. For API jars, add `withJavadoc()`. For example:

```
libraryDependencies +=
  "org.apache.felix" % "org.apache.felix.framework" % "1.8.0" withSources() withJavadoc()
```

Note that this is not transitive. Use the `update-*classifiers` tasks for that.

Extra Attributes Extra attributes can be specified by passing key/value pairs to the `extra` method.

To select dependencies by extra attributes:

```
libraryDependencies += "org" % "name" % "rev" extra("color" -> "blue")
```

To define extra attributes on the current project:

```
projectID := {
    val previous = projectID.value
    previous.extra("color" -> "blue", "component" -> "compiler-interface")
}
```

Inline Ivy XML sbt additionally supports directly specifying the configurations or dependencies sections of an Ivy configuration file inline. You can mix this with inline Scala dependency and repository declarations.

For example:

```
ivyXML :=
  <dependencies>
    <dependency org="javax.mail" name="mail" rev="1.4.2">
      <exclude module="activation"/>
    </dependency>
  </dependencies>
```

Ivy Home Directory By default, sbt uses the standard Ivy home directory location `${user.home}/.ivy2/`. This can be configured machine-wide, for use by both the sbt launcher and by projects, by setting the system property `sbt.ivy.home` in the sbt startup script (described in Setup).

For example:

```
java -Dsbt.ivy.home=/tmp/.ivy2/ ...
```

Checksums sbt (through Ivy) verifies the checksums of downloaded files by default. It also publishes checksums of artifacts by default. The checksums to use are specified by the *checksums* setting.

To disable checksum checking during update:

```
update / checksums := Nil
```

To disable checksum creation during artifact publishing:

```
publishLocal / checksums := Nil

publish / checksums := Nil
```

The default value is:

```
checksums := Seq("sha1", "md5")
```

Conflict Management The conflict manager decides what to do when dependency resolution brings in different versions of the same library. By default, the latest revision is selected. This can be changed by setting `conflictManager`, which has type ConflictManager. See the Ivy documentation for details on the different conflict managers. For example, to specify that no conflicts are allowed,

```
conflictManager := ConflictManager.strict
```

With this set, any conflicts will generate an error. To resolve a conflict, you must configure a dependency override, which is explained in a later section.

Eviction warning The following direct dependencies will introduce a conflict on the akka-actor version because banana-rdf requires akka-actor 2.1.4.

```
libraryDependencies ++= Seq(
  "org.w3" %% "banana-rdf" % "0.4",
  "com.typesafe.akka" %% "akka-actor" % "2.3.7",
)
```

The default conflict manager will select the newer version of akka-actor, 2.3.7. This can be confirmed in the output of `show update`, which shows the newer version as being selected and the older version as evicted.

```
> show update
[info] compile:

[info]  com.typesafe.akka:akka-actor_2.10
[info]    - 2.3.7
...
[info]    - 2.1.4
...
[info]      evicted: true
[info]      evictedReason: latest-revision
...
[info]      callers: org.w3:banana-rdf_2.10:0.4
```

Furthermore, the binary version compatibility of the akka-actor 2.1.4 and 2.3.7 are not guaranteed since the second segment has bumped up. sbt 0.13.6+ detects this automatically and prints out the following warning:

```
[warn] There may be incompatibilities among your library dependencies.
[warn] Here are some of the libraries that were evicted:
[warn]  * com.typesafe.akka:akka-actor_2.10:2.1.4 -> 2.3.7
[warn] Run 'evicted' to see detailed eviction warnings
```

Since akka-actor 2.1.4 and 2.3.7 are not binary compatible, the only way to fix this is to downgrade your dependency to akka-actor 2.1.4, or upgrade banana-rdf to use akka-actor 2.3.

Overriding a version For binary compatible conflicts, sbt provides dependency overrides. They are configured with the `dependencyOverrides` setting, which is a set of `ModuleIDs`. For example, the following dependency definitions conflict because spark uses log4j 1.2.16 and scalaxb uses log4j 1.2.17:

```
libraryDependencies ++= Seq(
   "org.spark-project" %% "spark-core" % "0.5.1",
   "org.scalaxb" %% "scalaxb" % "1.0.0"
)
```

The default conflict manager chooses the latest revision of log4j, 1.2.17:

```
> show update
[info] compile:
[info]    log4j:log4j:1.2.17: ...
...
[info]    (EVICTED) log4j:log4j:1.2.16
...
```

To change the version selected, add an override:

```
dependencyOverrides += "log4j" % "log4j" % "1.2.16"
```

This will not add a direct dependency on log4j, but will force the revision to be 1.2.16. This is confirmed by the output of `show update`:

```
> show update
[info] compile:
[info]    log4j:log4j:1.2.16
...
```

> **Note:** this is an Ivy-only feature and will not be included in a published pom.xml.

Unresolved dependencies error Adding the following dependency to your project will result to an unresolved dependencies error of vpp 2.2.1:

```
libraryDependencies += "org.apache.cayenne.plugins" % "maven-cayenne-plugin" % "3.0.2"
```

sbt 0.13.6+ will try to reconstruct dependencies tree when it fails to resolve a managed dependency. This is an approximation, but it should help you figure out where the problematic dependency is coming from. When possible sbt will display the source position next to the modules:

```
[warn]  ::::::::::::::::::::::::::::::::::::::::::::::
[warn]  ::          UNRESOLVED DEPENDENCIES         ::
[warn]  ::::::::::::::::::::::::::::::::::::::::::::::
[warn]  :: foundrylogic.vpp#vpp;2.2.1: not found
[warn]  ::::::::::::::::::::::::::::::::::::::::::::::
[warn]
[warn]  Note: Unresolved dependencies path:
[warn]      foundrylogic.vpp:vpp:2.2.1
[warn]        +- org.apache.cayenne:cayenne-tools:3.0.2
[warn]      +- org.apache.cayenne.plugins:maven-cayenne-plugin:3.0.2 (/foo/some-test/build.sb
[warn]        +- d:d_2.10:0.1-SNAPSHOT
```

Cached resolution See Cached resolution for performance improvement option.

Publishing See Publishing for how to publish your project.

Configurations Ivy configurations are a useful feature for your build when you need custom groups of dependencies, such as for a plugin. Ivy configurations are essentially named sets of dependencies. You can read the Ivy documentation for details.

The built-in use of configurations in sbt is similar to scopes in Maven. sbt adds dependencies to different classpaths by the configuration that they are defined in. See the description of Maven Scopes for details.

You put a dependency in a configuration by selecting one or more of its configurations to map to one or more of your project's configurations. The most common case is to have one of your configurations `A` use a dependency's configuration `B`. The mapping for this looks like `"A->B"`. To apply this mapping to a dependency, add it to the end of your dependency definition:

```
libraryDependencies += "org.scalatest" %% "scalatest" % "2.1.3" % "test->compile"
```

This says that your project's `"test"` configuration uses `ScalaTest`'s `"compile"` configuration. See the Ivy documentation for more advanced mappings. Most projects published to Maven repositories will use the `"compile"` configuration.

A useful application of configurations is to group dependencies that are not used on normal classpaths. For example, your project might use a `"js"` configuration to automatically download jQuery and then include it in your jar by modifying resources. For example:

```
val JS = config("js") hide

ivyConfigurations += JS

libraryDependencies += "jquery" % "jquery" % "3.2.1" % "js->default" from "https://code.jque

Compile / resources ++= update.value.select(configurationFilter("js"))
```

The config method defines a new configuration with name "js" and makes it private to the project so that it is not used for publishing. See Update Report for more information on selecting managed artifacts.

A configuration without a mapping (no "->") is mapped to "default" or "compile". The -> is only needed when mapping to a different configuration than those. The ScalaTest dependency above can then be shortened to:

```
libraryDependencies += "org.scalatest" %% "scalatest" % "2.1.3" % "test"
```

External Maven or Ivy For this method, create the configuration files as you would for Maven (pom.xml) or Ivy (ivy.xml and optionally ivysettings.xml). External configuration is selected by using one of the following expressions.

Ivy settings (resolver configuration)

```
externalIvySettings()
```

or

```
externalIvySettings(baseDirectory.value / "custom-settings-name.xml")
```

or

```
externalIvySettingsURL(url("your_url_here"))
```

Ivy file (dependency configuration)

```
externalIvyFile()
```

or

```
externalIvyFile(Def.setting(baseDirectory.value / "custom-name.xml"))
```

Because Ivy files specify their own configurations, sbt needs to know which configurations to use for the `compile`, `runtime`, and `test` classpaths. For example, to specify that the `Compile` classpath should use the 'default' configuration:

```
Compile / classpathConfiguration := config("default")
```

Maven pom (dependencies only)

```
externalPom()
```

or

```
externalPom(Def.setting(baseDirectory.value / "custom-name.xml"))
```

Full Ivy Example For example, a `build.sbt` using external Ivy files might look like:

```
externalIvySettings()
externalIvyFile(Def.setting(baseDirectory.value / "ivyA.xml"))
Compile / classpathConfiguration := Compile
Test / classpathConfiguration := Test
Runtime / classpathConfiguration := Runtime
```

Forcing a revision (Not recommended) **Note**: Forcing can create logical inconsistencies so it's no longer recommended.

To say that we prefer the version we've specified over the version from indirect dependencies, use `force()`:

```
libraryDependencies ++= Seq(
  "org.spark-project" %% "spark-core" % "0.5.1",
  "log4j" % "log4j" % "1.2.14" force()
)
```

Note: this is an Ivy-only feature and cannot be included in a published pom.xml.

Known limitations Maven support is dependent on Ivy's support for Maven POMs. Known issues with this support:

- Specifying `relativePath` in the `parent` section of a POM will produce an error.
- Ivy ignores repositories specified in the POM. A workaround is to specify repositories inline or in an Ivy `ivysettings.xml` file.

Proxy Repositories

It's often the case that users wish to set up a maven/ivy proxy repository inside their corporate firewall, and have developer sbt instances resolve artifacts through such a proxy. Let's detail what exact changes must be made for this to work.

Overview

The situation arises when many developers inside an organization are attempting to resolve artifacts. Each developer's machine will hit the internet and download an artifact, regardless of whether or not another on the team has already done so. Proxy repositories provide a single point of remote download for an organization. In addition to control and security concerns, Proxy repositories are primarily important for increased speed across a team.

There are many good proxy repository solutions out there, with the big three being (in alphabetical order):

- Archiva
- Artifactory
- Nexus

Once you have a proxy repository installed and configured, then it's time to configure sbt for your needs. Read the note at the bottom about proxy issues with ivy repositories.

sbt Configuration

sbt requires configuration in two places to make use of a proxy repository. The first is the `~/.sbt/repositories` file, and the second is the launcher script.

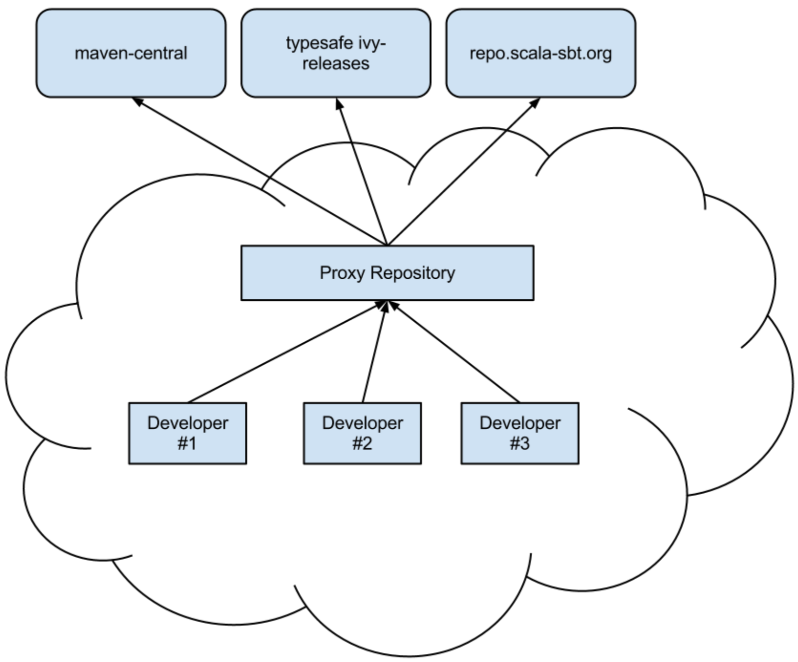


Figure 7: image

`~/.sbt/repositories`

The repositories file is an external configuration for the Launcher. The exact syntax for the configuration file is detailed in the sbt Launcher Configuration.

Here's an example config:

```
[repositories]
  local
 my-ivy-proxy-releases: http://repo.company.com/ivy-releases/, [organization]/[module]/(scal
  my-maven-proxy-releases: http://repo.company.com/maven-releases/
```

This example configuration has three repositories configured for sbt.

The first resolver is `local`, and is used so that artifacts pushed using `publishLocal` will be seen in other sbt projects.

The second resolver is `my-ivy-proxy-releases`. This repository is used to resolve sbt *itself* from the company proxy repository, as well as any sbt plugins that may be required. Note that the ivy resolver pattern is important, make sure that yours matches the one shown or you may not be able to resolve sbt plugins.

The final resolver is `my-maven-proxy-releases`. This repository is a proxy for all standard maven repositories, including maven central.

This repositories file is all that's required to use a proxy repository. These repositories will get included first in any sbt build, however you can add some additional configuration to force the use of the proxy repository instead of other configurations.

Using credentials for the proxy repository

In case you need to define credentials to connect to your proxy repository, define an environment variable `SBT_CREDENTIALS` that points to the file containing your credentials:

```
export SBT_CREDENTIALS="$HOME/.ivy2/.credentials"
```

with file contents

```
  realm=My Nexus Repository Manager
  host=my.artifact.repo.net
  user=admin
  password=admin123
```

Launcher Script The sbt launcher supports two configuration options that allow the usage of proxy repositories. The first is the `sbt.override.build.repos` setting and the second is the `sbt.repository.config` setting.

`sbt.override.build.repos` This setting is used to specify that all sbt project added resolvers should be ignored in favor of those configured in the `repositories` configuration. Using this with a properly configured `~/.sbt/repositories` file leads to only your proxy repository used for builds.

It is specified like so:

```
-Dsbt.override.build.repos=true
```

The value defaults to false and must be explicitly enabled.

`sbt.repository.config` If you are unable to create a `~/.sbt/repositories` file, due to user permission errors or for convenience of developers, you can modify the sbt start script directly with the following:

```
-Dsbt.repository.config=<path-to-your-repo-file>
```

This is only necessary if users do not already have their own default repository file.

Proxying Ivy Repositories

The most common mistake made when setting up a proxy repository for sbt is attempting to *merge* both *maven* and *ivy* repositories into the *same* proxy repository. While some repository managers will allow this, it's not recommended to do so.

Even if your company does not use ivy, sbt uses a custom layout to handle binary compatibility constraints of its own plugins. To ensure that these are resolved correctly, simply set up two virtual/proxy repositories, one for maven and one for ivy.

Here's an example setup:

NOTE: If using Nexus as the proxy repository, then it is very important that you set the layout policy to "permissive" for the proxy mapping that you create to the upstream repository http://repo.scala-sbt.org/scalasbt/sbt-plugin-releases. If you do not, Nexus will stop short of proxying the original request to this url and issue a HTTP 404 in its place and the dependency will not resolve.

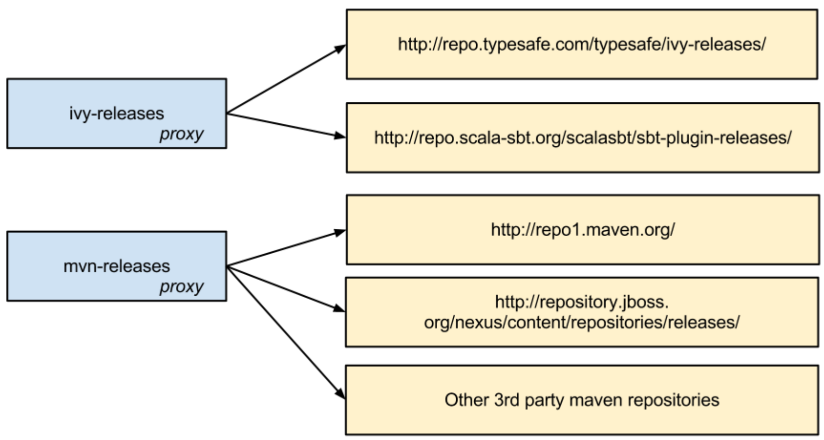


Figure 8: image

Publishing

This page describes how to publish your project. Publishing consists of uploading a descriptor, such as an Ivy file or Maven POM, and artifacts, such as a jar or war, to a repository so that other projects can specify your project as a dependency.

The `publish` action is used to publish your project to a remote repository. To use publishing, you need to specify the repository to publish to and the credentials to use. Once these are set up, you can run `publish`.

The `publishLocal` action is used to publish your project to your Ivy local file repository, which is usually located at `~/.ivy2/local/`. You can then use this project from other projects on the same machine.

Define the repository

To specify the repository, assign a repository to `publishTo` and optionally set the publishing style. For example, to upload to Nexus:

```
publishTo := Some("Sonatype Snapshots Nexus" at "https://oss.sonatype.org/content/repositori
```

To publish to a local repository:

```
publishTo := Some(Resolver.file("file",  new File( "path/to/my/maven-repo/releases" )) )
```

Publishing to the users local maven repository:

```
publishTo := Some(Resolver.file("file",  new File(Path.userHome.absolutePath+"/.m2/reposito
```

If you're using Maven repositories you will also have to select the right repository depending on your artifacts: SNAPSHOT versions go to the /snapshot repository while other versions go to the /releases repository. Doing this selection can be done by using the value of the `isSnapshot` SettingKey:

```
publishTo := {
  val nexus = "https://my.artifact.repo.net/"
  if (isSnapshot.value)
    Some("snapshots" at nexus + "content/repositories/snapshots")
  else
    Some("releases"  at nexus + "service/local/staging/deploy/maven2")
}
```

Credentials

There are two ways to specify credentials for such a repository. The first is to specify them inline:

```
credentials += Credentials("Some Nexus Repository Manager", "my.artifact.repo.net", "admin",
```

The second and better way is to load them from a file, for example:

```
credentials += Credentials(Path.userHome / ".ivy2" / ".credentials")
```

The credentials file is a properties file with keys `realm`, `host`, `user`, and `password`. For example:

```
realm=My Nexus Repository Manager
host=my.artifact.repo.net
user=admin
password=admin123
```

Cross-publishing

To support multiple incompatible Scala versions, enable cross building and do `+ publish` (see Cross Build). See Resolvers for other supported repository types.

Published artifacts

By default, the main binary jar, a sources jar, and a API documentation jar are published. You can declare other types of artifacts to publish and disable or modify the default artifacts. See the Artifacts page for details.

Modifying the generated POM

When `publishMavenStyle` is `true`, a POM is generated by the `makePom` action and published to the repository instead of an Ivy file. This POM file may be altered by changing a few settings. Set `pomExtra` to provide XML (`scala.xml.NodeSeq`) to insert directly into the generated pom. For example:

```
pomExtra :=
  <licenses>
    <license>
      <name>Apache 2</name>
      <url>https://www.apache.org/licenses/LICENSE-2.0.txt</url>
```

```
      <distribution>repo</distribution>
    </license>
</licenses>
```

makePom adds to the POM any Maven-style repositories you have declared. You can filter these by modifying pomRepositoryFilter, which by default excludes local repositories. To instead only include local repositories:

```
pomIncludeRepository := { (repo: MavenRepository) =>
  repo.root.startsWith("file:")
}
```

There is also a pomPostProcess setting that can be used to manipulate the final XML before it is written. It's type is Node => Node.

```
pomPostProcess := { (node: Node) =>
  ...
}
```

Publishing Locally

The publishLocal command will publish to the local Ivy repository. By default, this is in ${user.home}/.ivy2/local. Other projects on the same machine can then list the project as a dependency. For example, if the SBT project you are publishing has configuration parameters like:

```
name := "My Project"

organization := "org.me"

version := "0.1-SNAPSHOT"
```

Then another project can depend on it:

```
libraryDependencies += "org.me" %% "my-project" % "0.1-SNAPSHOT"
```

The version number you select must end with SNAPSHOT, or you must change the version number each time you publish. Ivy maintains a cache, and it stores even local projects in that cache. If Ivy already has a version cached, it will not check the local repository for updates, unless the version number matches a changing pattern, and SNAPSHOT is one such pattern.

Skipping Publishing

To avoid publishing a project, add `skip in publish := true` to its settings. `false` is the default value. Common use case is to prevent publishing of the root project.

Resolvers

Maven

Resolvers for Maven2 repositories are added as follows:

```
resolvers +=
  "Sonatype OSS Snapshots" at "https://oss.sonatype.org/content/repositories/snapshots"
```

This is the most common kind of user-defined resolvers. The rest of this page describes how to define other types of repositories.

Predefined

A few predefined repositories are available and are listed below

- `DefaultMavenRepository` This is the main Maven repository at https://repo1.maven.org/maven2/ and is included by default
- `JavaNet1Repository` This is the Maven 1 repository at http://download.java.net/maven/1/
- `Resolver.sonatypeRepo("public")` (or "snapshots", "releases") This is Sonatype OSS Maven Repository at https://oss.sonatype.org/content/repositories/public
- `Resolver.typesafeRepo("releases")` (or "snapshots") This is Typesafe Repository at https://repo.typesafe.com/typesafe/releases
- `Resolver.typesafeIvyRepo("releases")` (or "snapshots") This is Typesafe Ivy Repository at https://repo.typesafe.com/typesafe/ivy-releases
- `Resolver.sbtPluginRepo("releases")` (or "snapshots") This is sbt Community Repository at https://repo.scala-sbt.org/scalasbt/sbt-plugin-releases
- `Resolver.bintrayRepo("owner", "repo")` This is the Bintray repository at https://dl.bintray.com/{[}owner{]}/{[}repo{]}/
- `Resolver.jcenterRepo` This is the Bintray JCenter repository at https://jcenter.bintray.com/

For example, to use the `java.net` repository, use the following setting in your build definition:

```
resolvers += JavaNet1Repository
```

Predefined repositories will go under Resolver going forward so they are in one place:

```
Resolver.sonatypeRepo("releases")  // Or "snapshots"
```

Custom

sbt provides an interface to the repository types available in Ivy: file, URL, SSH, and SFTP. A key feature of repositories in Ivy is using patterns to configure repositories.

Construct a repository definition using the factory in `sbt.Resolver` for the desired type. This factory creates a `Repository` object that can be further configured. The following table contains links to the Ivy documentation for the repository type and the API documentation for the factory and repository class. The SSH and SFTP repositories are configured identically except for the name of the factory. Use `Resolver.ssh` for SSH and `Resolver.sftp` for SFTP.

Type

Factory

Ivy Docs

Factory API

Repository Class API

Filesystem

Resolver.file

Ivy filesystem

filesystem factory

FileRepository API

SFTP

Resolver.sftp

Ivy sftp

sftp factory

SftpRepository API

SSH

Resolver.ssh

Ivy ssh

ssh factory

SshRepository API

URL

Resolver.url

Ivy url

url factory

URLRepository API

Basic Examples These are basic examples that use the default Maven-style repository layout.

Filesystem Define a filesystem repository in the `test` directory of the current working directory and declare that publishing to this repository must be atomic.

```
resolvers += Resolver.file("my-test-repo", file("test")) transactional()
```

URL Define a URL repository at `"https://example.org/repo-releases/"`.

```
resolvers += Resolver.url("my-test-repo", url("https://example.org/repo-releases/"))
```

To specify an Ivy repository, use:

```
resolvers += Resolver.url("my-test-repo", url)(Resolver.ivyStylePatterns)
```

or customize the layout pattern described in the Custom Layout section below.

SFTP and SSH Repositories The following defines a repository that is served by SFTP from host `"example.org"`:

```
resolvers += Resolver.sftp("my-sftp-repo", "example.org")
```

To explicitly specify the port:

```
resolvers += Resolver.sftp("my-sftp-repo", "example.org", 22)
```

To specify a base path:

```
resolvers += Resolver.sftp("my-sftp-repo", "example.org", "maven2/repo-releases/")
```

Authentication for the repositories returned by `sftp` and `ssh` can be configured by the `as` methods.

To use password authentication:

```
resolvers += Resolver.ssh("my-ssh-repo", "example.org") as("user", "password")
```

or to be prompted for the password:

```
resolvers += Resolver.ssh("my-ssh-repo", "example.org") as("user")
```

To use key authentication:

```
resolvers += {
  val keyFile: File = ...
  Resolver.ssh("my-ssh-repo", "example.org") as("user", keyFile, "keyFilePassword")
}
```

or if no keyfile password is required or if you want to be prompted for it:

```
resolvers += Resolver.ssh("my-ssh-repo", "example.org") as("user", keyFile)
```

To specify the permissions used when publishing to the server:

```
resolvers += Resolver.ssh("my-ssh-repo", "example.org") withPermissions("0644")
```

This is a chmod-like mode specification.

Custom Layout These examples specify custom repository layouts using patterns. The factory methods accept an `Patterns` instance that defines the patterns to use. The patterns are first resolved against the base file or URL. The default patterns give the default Maven-style layout. Provide a different Patterns object to use a different layout. For example:

```
resolvers += Resolver.url("my-test-repo", url)( Patterns("[organisation]/[module]/[revision]
```

You can specify multiple patterns or patterns for the metadata and artifacts separately. You can also specify whether the repository should be Maven compatible (as defined by Ivy). See the patterns API for the methods to use.

For filesystem and URL repositories, you can specify absolute patterns by omitting the base URL, passing an empty `Patterns` instance, and using `ivys` and `artifacts`:

```
resolvers += Resolver.url("my-test-repo") artifacts
        "https://example.org/[organisation]/[module]/[revision]/[artifact].[ext]"
```

Update Report

`update` and related tasks produce a value of type sbt.UpdateReport This data structure provides information about the resolved configurations, modules, and artifacts. At the top level, `UpdateReport` provides reports of type `ConfigurationReport` for each resolved configuration. A `ConfigurationReport` supplies reports (of type `ModuleReport`) for each module resolved for a given configuration. Finally, a `ModuleReport` lists each successfully retrieved `Artifact` and the `File` it was retrieved to as well as the `Artifacts` that couldn't be downloaded. This missing `Arifact` list is always empty for `update`, which will fail if it is non-empty. However, it may be non-empty for `updateClassifiers` and `updateSbtClassifers`.

Filtering a Report and Getting Artifacts

A typical use of `UpdateReport` is to retrieve a list of files matching a filter. A conversion of type `UpdateReport => RichUpdateReport` implicitly provides these methods for `UpdateReport`. The filters are defined by the DependencyFilter, ConfigurationFilter, ModuleFilter, and ArtifactFilter types. Using these filter types, you can filter by the configuration name, the module organization, name, or revision, and the artifact name, type, extension, or classifier.

The relevant methods (implicitly on `UpdateReport`) are:

```
def matching(f: DependencyFilter): Seq[File]

def select(configuration: ConfigurationFilter = ...,
  module: ModuleFilter = ...,
  artifact: ArtifactFilter = ...): Seq[File]
```

Any argument to `select` may be omitted, in which case all values are allowed for the corresponding component. For example, if the `ConfigurationFilter` is not specified, all configurations are accepted. The individual filter types are discussed below.

Filter Basics Configuration, module, and artifact filters are typically built by applying a `NameFilter` to each component of a `Configuration`, `ModuleID`, or `Artifact`. A basic `NameFilter` is implicitly constructed from a String, with `*` interpreted as a wildcard.

```
import sbt._
// each argument is of type NameFilter
val mf: ModuleFilter = moduleFilter(organization = "*sbt*",
  name = "main" | "actions", revision = "1.*" - "1.0")
```

```scala
// unspecified arguments match everything by default
val mf: ModuleFilter = moduleFilter(organization = "net.databinder")

// specifying "*" is the same as omitting the argument
val af: ArtifactFilter = artifactFilter(name = "*", `type` = "source",
  extension = "jar", classifier = "sources")

val cf: ConfigurationFilter = configurationFilter(name = "compile" | "test")
```

Alternatively, these filters, including a `NameFilter`, may be directly defined by an appropriate predicate (a single-argument function returning a Boolean).

```scala
import sbt._

// here the function value of type String => Boolean is implicitly converted to a NameFilte
val nf: NameFilter = (s: String) => s.startsWith("dispatch-")

// a Set[String] is a function String => Boolean
val acceptConfigs: Set[String] = Set("compile", "test")
// implicitly converted to a ConfigurationFilter
val cf: ConfigurationFilter = acceptConfigs

val mf: ModuleFilter = (m: ModuleID) => m.organization contains "sbt"

val af: ArtifactFilter = (a: Artifact) => a.classifier.isEmpty
```

ConfigurationFilter A configuration filter essentially wraps a `NameFilter` and is explicitly constructed by the `configurationFilter` method:

```scala
def configurationFilter(name: NameFilter = ...): ConfigurationFilter
```

If the argument is omitted, the filter matches all configurations. Functions of type `String => Boolean` are implicitly convertible to a `ConfigurationFilter`. As with `ModuleFilter`, `ArtifactFilter`, and `NameFilter`, the `&`, `|`, and `-` methods may be used to combine `ConfigurationFilter`s.

```scala
import sbt._
val a: ConfigurationFilter = Set("compile", "test")
val b: ConfigurationFilter = (c: String) => c.startsWith("r")
val c: ConfigurationFilter = a | b
```

(The explicit types are optional here.)

ModuleFilter A module filter is defined by three `NameFilter`s: one for the organization, one for the module name, and one for the revision. Each component filter must match for the whole module filter to match. A module filter is explicitly constructed by the `moduleFilter` method:

```
def moduleFilter(organization: NameFilter = ..., name: NameFilter = ..., revision: NameFilte
```

An omitted argument does not contribute to the match. If all arguments are omitted, the filter matches all `ModuleID`s. Functions of type `ModuleID => Boolean` are implicitly convertible to a `ModuleFilter`. As with `ConfigurationFilter`, `ArtifactFilter`, and `NameFilter`, the `&`, `|`, and `-` methods may be used to combine `ModuleFilter`s:

```
import sbt._
val a: ModuleFilter = moduleFilter(name = "dispatch-twitter", revision = "0.7.8")
val b: ModuleFilter = moduleFilter(name = "dispatch-*")
val c: ModuleFilter = b - a
```

(The explicit types are optional here.)

ArtifactFilter An artifact filter is defined by four `NameFilter`s: one for the name, one for the type, one for the extension, and one for the classifier. Each component filter must match for the whole artifact filter to match. An artifact filter is explicitly constructed by the `artifactFilter` method:

```
def artifactFilter(name: NameFilter = ..., `type`: NameFilter = ...,
  extension: NameFilter = ..., classifier: NameFilter = ...): ArtifactFilter
```

Functions of type `Artifact => Boolean` are implicitly convertible to an `ArtifactFilter`. As with `ConfigurationFilter`, `ModuleFilter`, and `NameFilter`, the `&`, `|`, and `-` methods may be used to combine `ArtifactFilter`s:

```
import sbt._
val a: ArtifactFilter = artifactFilter(classifier = "javadoc")
val b: ArtifactFilter = artifactFilter(`type` = "jar")
val c: ArtifactFilter = b - a
```

(The explicit types are optional here.)

DependencyFilter A `DependencyFilter` is typically constructed by combining other `DependencyFilter`s together using `&&`, `||`, and `--`. Configuration, module, and artifact filters are `DependencyFilter`s themselves and can be used directly as a `DependencyFilter` or they can build up a `DependencyFilter`. Note that the symbols for the `DependencyFilter` combining methods are doubled up to distinguish them from the combinators of the more specific filters for configurations, modules, and artifacts. These double-character methods will always return a `DependencyFilter`, whereas the single character methods preserve the more specific filter type. For example:

```
import sbt._

val df: DependencyFilter =
  configurationFilter(name = "compile" | "test") &&
  artifactFilter(`type` = "jar") ||
  moduleFilter(name = "dispatch-*")
```

Here, we used `&&` and `||` to combine individual component filters into a dependency filter, which can then be provided to the `UpdateReport.matches` method. Alternatively, the `UpdateReport.select` method may be used, which is equivalent to calling `matches` with its arguments combined with `&&`.

Cached resolution

Cached resolution is an **experimental** feature of sbt added since 0.13.7 to address the scalability performance of dependency resolution.

Setup

To set up cached resolution include the following setting in your project's build:

```
updateOptions := updateOptions.value.withCachedResolution(true)
```

Dependency as a graph

A project declares its own library dependency using `libraryDependencies` setting. The libraries you added also bring in their transitive dependencies. For example, your project may depend on dispatch-core 0.11.2; dispatch-core 0.11.2 depends on async-http-client 1.8.10; async-http-client 1.8.10 depends on netty 3.9.2.Final, and so forth. If we think of each library to be a node with arrows going out to dependent nodes, we can think of the entire dependencies to be a graph – specifically a directed acyclic graph.

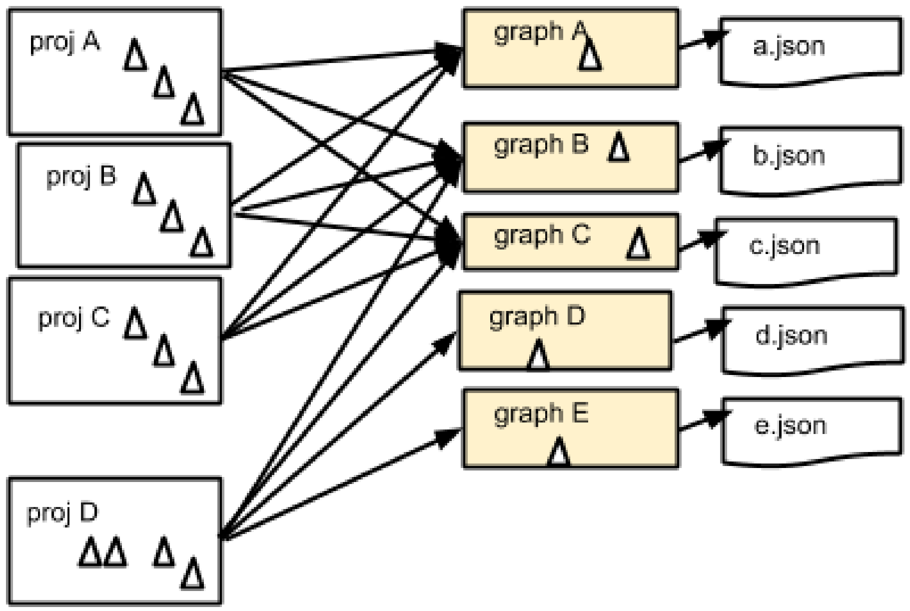
This graph-like structure, which was adopted from Apache Ivy, allows us to define override rules and exclusions transitively, but as the number of the node increases, the time it takes to resolve dependencies grows significantly. See Motivation section later in this page for the full description.

Cached resolution

Cached resolution feature is akin to incremental compilation, which only recompiles the sources that have been changed since the last `compile`. Unlike the Scala compiler, Ivy does not have the concept of separate compilation, so that needed to be implemented.

Instead of resolving the full dependency graph, cached resolution feature creates minigraphs – one for each direct dependency appearing in all related subprojects. These minigraphs are resolved using Ivy's resolution engine, and the result is stored locally under `~/.sbt/1.0/dependency/` (or what's specified by `sbt.dependency.base` flag) shared across all builds. After all minigraphs are resolved, they are stitched together by applying the conflict resolution algorithm (typically picking the latest version).

When you add a new library to your project, cached resolution feature will check for the minigraph files under `~/.sbt/1.0/dependency/` and load the previously resolved nodes, which incurs negligible I/O overhead, and only resolve the newly added library. The intended performance improvement is that the second and third subprojects can take advantage of the resolved minigraphs from the first one and avoid duplicated work. The following figure illustrates the proj A, B, and C all hitting the same set of json file.



The actual speedup will depend case by case, but you should see significant speedup if you have many subprojects. An initial report from a user showed change from 260s to 25s. Your milage may vary.

Caveats and known issues

Cached resolution is an **experimental** feature, and you might run into some issues. When you see them please report to GitHub Issue or sbt-dev list.

First runs The first time you run cached resolution will likely be slow since it needs to resolve all minigraphs and save the result into filesystem. Whenever you add a new node the system has not seen, it will save the minigraph. The second run onwards should be faster, but comparing full-resolution `update` with second run onwards might not be a fair comparison.

Ivy fidelity is not guaranteed Some of the Ivy behavior doesn't make sense, especially around Maven emulation. For example, it seem to treat all transitive dependencies introduced by Maven-published library as `force()` even when the original `pom.xml` doesn't say to:

```
$ cat ~/.ivy2/cache/com.ning/async-http-client/ivy-1.8.10.xml | grep netty
  <dependency org="io.netty" name="netty" rev="3.9.2.Final" force="true" conf="compile->compi
```

There are also some issues around multiple dependencies to the same library with different Maven classifiers. In these cases, reproducing the exact result as normal `update` may not make sense or is downright impossible.

SNAPSHOT and dynamic dependencies When a minigraph contains either a SNAPSHOT or dynamic dependency, the graph is considered dynamic, and it will be invalidated after a single task execution. Therefore, if you have any SNAPSHOT in your graph, your exeperience may degrade. (This could be improved in the future)

A setting key called `updateOptions` customizes the details of managed dependency resolution with the `update` task. One of its flags is called `lastestSnapshots`, which controls the behavior of the chained resolver. Up until 0.13.6, sbt was picking the first `-SNAPSHOT` revision it found along the chain. When `latestSnapshots` is enabled (default: `true`), it will look into all resolvers on the chain, and compare them using the publish date.

The tradeoff is probably a longer resolution time if you have many remote repositories on the build or you live away from the severs. So here's how to disable it:

```
updateOptions := updateOptions.value.withLatestSnapshots(false)
```

Consolidated resolution

`updateOptions` can also be used to enable consolidated resolution for `update` task.

```
updateOptions := updateOptions.value.withConsolidatedResolution(true)
```

This feature is specifically targeted to address Ivy resolution being slow for multi-module projects. Consolidated resolution aims to fix this issue by artificially constructing an Ivy dependency graph for the unique managed dependencies. If two subprojects introduce identical external dependencies, both subprojects should consolidate to the same graph, and therefore resolve immediately for the second `update`.

Motivation

sbt internally uses Apache Ivy to resolve library dependencies. While sbt has benefited from not having to reinvent its own dependency resolution engine all these years, we are increasingly seeing scalability challenges especially for projects with both multiple subprojects and large dependency graph. There are several factors involved in sbt's resolution scalability:

- Number of transitive nodes (libraries) in the graph
- Exclusion and override rules
- Number of subprojects
- Configurations
- Number of repositories and their availability
- Classifiers (additional sources and docs used by IDE)

Of the above factors, the one that has the most impact is the number of transitive nodes.

1. The more nodes there are, the chances of version conflict increases. Conflicts are resolved typically by picking the latest version within the same library.
2. The more nodes there are, the more it needs to backtrack to check for exlusion and override rules.

Exclusion and override rules are applied transitively, so any time a new node is introduced to the graph it needs to check its parent node's rules, its grandparent node's rules, great-grandparent node's rules, etc.

sbt treats configurations and subprojects to be independent dependency graph. This allows us to include arbitrary libraries for different configurations and subprojects, but if the dependency resolution is slow, the linear scaling starts to hurt. There have been prior efforts to cache the result of library dependencies, but it still resulted in full resolution when `libraryDependencies` has changed.

Tasks and Commands

This part of the documentation has pages documenting particular sbt topics in detail. Before reading anything in here, you will need the information in the Getting Started Guide as a foundation.

Tasks

Tasks and settings are introduced in the getting started guide, which you may wish to read first. This page has additional details and background and is intended more as a reference.

Introduction

Both settings and tasks produce values, but there are two major differences between them:

1. Settings are evaluated at project load time. Tasks are executed on demand, often in response to a command from the user.
2. At the beginning of project loading, settings and their dependencies are fixed. Tasks can introduce new tasks during execution, however.

Features

There are several features of the task system:

1. By integrating with the settings system, tasks can be added, removed, and modified as easily and flexibly as settings.
2. Input Tasks use parser combinators to define the syntax for their arguments. This allows flexible syntax and tab-completions in the same way as Commands.
3. Tasks produce values. Other tasks can access a task's value by calling `value` on it within a task definition.
4. Dynamically changing the structure of the task graph is possible. Tasks can be injected into the execution graph based on the result of another task.
5. There are ways to handle task failure, similar to `try/catch/finally`.
6. Each task has access to its own Logger that by default persists the logging for that task at a more verbose level than is initially printed to the screen.

These features are discussed in detail in the following sections.

Defining a Task

Hello World example (sbt) `build.sbt`:

```
lazy val hello = taskKey[Unit]("Prints 'Hello World'")

hello := println("hello world!")
```

Run "sbt hello" from command line to invoke the task. Run "sbt tasks" to see this task listed.

Define the key To declare a new task, define a lazy val of type `TaskKey`:

```
lazy val sampleTask = taskKey[Int]("A sample task.")
```

The name of the `val` is used when referring to the task in Scala code and at the command line. The string passed to the `taskKey` method is a description of the task. The type parameter passed to `taskKey` (here, `Int`) is the type of value produced by the task.

We'll define a couple of other keys for the examples:

```
lazy val intTask = taskKey[Int]("An int task")
lazy val stringTask = taskKey[String]("A string task")
```

The examples themselves are valid entries in a `build.sbt` or can be provided as part of a sequence to `Project.settings` (see .scala build definition).

Implement the task There are three main parts to implementing a task once its key is defined:

1. Determine the settings and other tasks needed by the task. They are the task's inputs.
2. Define the code that implements the task in terms of these inputs.
3. Determine the scope the task will go in.

These parts are then combined just like the parts of a setting are combined.

Defining a basic task A task is defined using `:=`

```
intTask := 1 + 2

stringTask := System.getProperty("user.name")

sampleTask := {
   val sum = 1 + 2
   println("sum: " + sum)
   sum
}
```

As mentioned in the introduction, a task is evaluated on demand. Each time `sampleTask` is invoked, for example, it will print the sum. If the username changes between runs, `stringTask` will take different values in those separate runs. (Within a run, each task is evaluated at most once.) In contrast, settings are evaluated once on project load and are fixed until the next reload.

Tasks with inputs Tasks with other tasks or settings as inputs are also defined using `:=`. The values of the inputs are referenced by the `value` method. This method is special syntax and can only be called when defining a task, such as in the argument to `:=`. The following defines a task that adds one to the value produced by `intTask` and returns the result.

```
sampleTask := intTask.value + 1
```

Multiple settings are handled similarly:

```
stringTask := "Sample: " + sampleTask.value + ", int: " + intTask.value
```

Task Scope As with settings, tasks can be defined in a specific scope. For example, there are separate `compile` tasks for the `compile` and `test` scopes. The scope of a task is defined the same as for a setting. In the following example, `test:sampleTask` uses the result of `compile:intTask`.

```
sampleTask in Test := (intTask in Compile).value * 3
```

On precedence As a reminder, infix method precedence is by the name of the method and postfix methods have lower precedence than infix methods.

1. Assignment methods have the lowest precedence. These are methods with names ending in `=`, except for `!=`, `<=`, `>=`, and names that start with `=`.
2. Methods starting with a letter have the next highest precedence.
3. Methods with names that start with a symbol and aren't included in

    1. have the highest precedence. (This category is divided further according to the specific character it starts with. See the Scala specification for details.)

Therefore, the previous example is equivalent to the following:

```
(sampleTask in Test).:=( (intTask in Compile).value * 3 )
```

Additionally, the braces in the following are necessary:

```
helloTask := { "echo Hello" ! }
```

Without them, Scala interprets the line as `( helloTask.:=("echo Hello") ).!` instead of the desired `helloTask.:=( "echo Hello".! )`.

Separating implementations The implementation of a task can be separated from the binding. For example, a basic separate definition looks like:

```
// Define a new, standalone task implemention
lazy val intTaskImpl: Initialize[Task[Int]] =
   Def.task { sampleTask.value - 3 }

// Bind the implementation to a specific key
intTask := intTaskImpl.value
```

Note that whenever `.value` is used, it must be within a task definition, such as within `Def.task` above or as an argument to `:=`.

Modifying an Existing Task In the general case, modify a task by declaring the previous task as an input.

```
// initial definition
intTask := 3

// overriding definition that references the previous definition
intTask := intTask.value + 1
```

Completely override a task by not declaring the previous task as an input. Each of the definitions in the following example completely overrides the previous one. That is, when `intTask` is run, it will only print `#3`.

```
intTask := {
    println("#1")
    3
}

intTask := {
    println("#2")
    5
}

intTask :=  {
    println("#3")
    sampleTask.value - 3
}
```

Getting values from multiple scopes

Introduction The general form of an expression that gets values from multiple scopes is:

```
<setting-or-task>.all(<scope-filter>).value
```

The `all` method is implicitly added to tasks and settings. It accepts a `ScopeFilter` that will select the `Scopes`. The result has type `Seq[T]`, where `T` is the key's underlying type.

Example A common scenario is getting the sources for all subprojects for processing all at once, such as passing them to scaladoc. The task that we want to obtain values for is `sources` and we want to get the values in all non-root projects and in the `Compile` configuration. This looks like:

```
lazy val core = project

lazy val util = project

lazy val root = project.settings(
   sources := {
      val filter = ScopeFilter( inProjects(core, util), inConfigurations(Compile) )
      // each sources definition is of type Seq[File],
      //   giving us a Seq[Seq[File]] that we then flatten to Seq[File]
      val allSources: Seq[Seq[File]] = sources.all(filter).value
      allSources.flatten
   }
)
```

The next section describes various ways to construct a ScopeFilter.

ScopeFilter A basic `ScopeFilter` is constructed by the `ScopeFilter.apply` method. This method makes a `ScopeFilter` from filters on the parts of a `Scope`: a `ProjectFilter`, `ConfigurationFilter`, and `TaskFilter`. The simplest case is explicitly specifying the values for the parts:

```
val filter: ScopeFilter =
   ScopeFilter(
      inProjects( core, util ),
      inConfigurations( Compile, Test )
   )
```

Unspecified filters If the task filter is not specified, as in the example above, the default is to select scopes without a specific task (global). Similarly, an unspecified configuration filter will select scopes in the global configuration. The project filter should usually be explicit, but if left unspecified, the current project context will be used.

More on filter construction The example showed the basic methods `inProjects` and `inConfigurations`. This section describes all methods for constructing a `ProjectFilter`, `ConfigurationFilter`, or `TaskFilter`. These methods can be organized into four groups:

- Explicit member list (`inProjects`, `inConfigurations`, `inTasks`)
- Global value (`inGlobalProject`, `inGlobalConfiguration`, `inGlobalTask`)
- Default filter (`inAnyProject`, `inAnyConfiguration`, `inAnyTask`)
- Project relationships (`inAggregates`, `inDependencies`)

See the API documentation for details.

Combining ScopeFilters `ScopeFilters` may be combined with the `&&`, `||`, `--`, and `-` methods:

- `a && b` Selects scopes that match both a and b
- `a || b` Selects scopes that match either a or b
- `a -- b` Selects scopes that match a but not b
- `-b` Selects scopes that do not match b

For example, the following selects the scope for the `Compile` and `Test` configurations of the `core` project and the global configuration of the `util` project:

```
val filter: ScopeFilter =
   ScopeFilter( inProjects(core), inConfigurations(Compile, Test)) ||
   ScopeFilter( inProjects(util), inGlobalConfiguration )
```

More operations The `all` method applies to both settings (values of type `Initialize[T]`) and tasks (values of type `Initialize[Task[T]]`). It returns a setting or task that provides a `Seq[T]`, as shown in this table:

Target

Result

Initialize[T]

Initialize[Seq[T]]

Initialize[Task[T]]

Initialize[Task[Seq[T]]]

This means that the `all` method can be combined with methods that construct tasks and settings.

Missing values Some scopes might not define a setting or task. The `?` and `??` methods can help in this case. They are both defined on settings and tasks and indicate what to do when a key is undefined.

?

On a setting or task with underlying type T, this accepts no arguments and returns a setting or task (respectively) of type Option[T]. The result is None if the setting/task is undefined and Some[T] with the value if it is.

??

On a setting or task with underlying type T, this accepts an argument of type T and uses this argument if the setting/task is undefined.

The following contrived example sets the maximum errors to be the maximum of all aggregates of the current project.

```
maxErrors := {
   // select the transitive aggregates for this project, but not the project itself
   val filter: ScopeFilter =
      ScopeFilter( inAggregates(ThisProject, includeRoot=false) )
   // get the configured maximum errors in each selected scope,
   // using 0 if not defined in a scope
   val allVersions: Seq[Int] =
      (maxErrors ?? 0).all(filter).value
   allVersions.max
}
```

Multiple values from multiple scopes The target of `all` is any task or setting, including anonymous ones. This means it is possible to get multiple values at once without defining a new task or setting in each scope. A common use case is to pair each value obtained with the project, configuration, or full scope it came from.

- `resolvedScoped`: Provides the full enclosing ScopedKey (which is a Scope + `AttributeKey[_]`)
- `thisProject`: Provides the Project associated with this scope (undefined at the global and build levels)
- `thisProjectRef`: Provides the ProjectRef for the context (undefined at the global and build levels)

- `configuration`: Provides the Configuration for the context (undefined for the global configuration)

For example, the following defines a task that prints non-Compile configurations that define sbt plugins. This might be used to identify an incorrectly configured build (or not, since this is a fairly contrived example):

```
// Select all configurations in the current project except for Compile
lazy val filter: ScopeFilter = ScopeFilter(
   inProjects(ThisProject),
   inAnyConfiguration -- inConfigurations(Compile)
)

// Define a task that provides the name of the current configuration
//   and the set of sbt plugins defined in the configuration
lazy val pluginsWithConfig: Initialize[Task[ (String, Set[String]) ]] =
   Def.task {
      ( configuration.value.name, definedSbtPlugins.value )
   }

checkPluginsTask := {
   val oddPlugins: Seq[(String, Set[String])] =
      pluginsWithConfig.all(filter).value
   // Print each configuration that defines sbt plugins
   for( (config, plugins) <- oddPlugins if plugins.nonEmpty )
      println(s"$config defines sbt plugins: ${plugins.mkString(", ")}")
}
```

Advanced Task Operations

The examples in this section use the task keys defined in the previous section.

Streams: Per-task logging Per-task loggers are part of a more general system for task-specific data called Streams. This allows controlling the verbosity of stack traces and logging individually for tasks as well as recalling the last logging for a task. Tasks also have access to their own persisted binary or text data.

To use Streams, get the value of the `streams` task. This is a special task that provides an instance of TaskStreams for the defining task. This type provides access to named binary and text streams, named loggers, and a default logger. The default Logger, which is the most commonly used aspect, is obtained by the `log` method:

```
myTask := {
  val s: TaskStreams = streams.value
  s.log.debug("Saying hi...")
  s.log.info("Hello!")
}
```

You can scope logging settings by the specific task's scope:

```
logLevel in myTask := Level.Debug

traceLevel in myTask := 5
```

To obtain the last logging output from a task, use the `last` command:

```
$ last myTask
[debug] Saying hi...
[info] Hello!
```

The verbosity with which logging is persisted is controlled using the `persistLogLevel` and `persistTraceLevel` settings. The `last` command displays what was logged according to these levels. The levels do not affect already logged information.

Dynamic Computations with `Def.taskDyn`

It can be useful to use the result of a task to determine the next tasks to evaluate. This is done using `Def.taskDyn`. The result of `taskDyn` is called a dynamic task because it introduces dependencies at runtime. The `taskDyn` method supports the same syntax as `Def.task` and `:=` except that you return a task instead of a plain value.

For example,

```
val dynamic = Def.taskDyn {
  // decide what to evaluate based on the value of `stringTask`
  if(stringTask.value == "dev")
    // create the dev-mode task: this is only evaluated if the
    //   value of stringTask is "dev"
    Def.task {
      3
    }
  else
    // create the production task: only evaluated if the value
    //    of the stringTask is not "dev"
```

```
    Def.task {
      intTask.value + 5
    }
}

myTask := {
  val num = dynamic.value
  println(s"Number selected was $num")
}
```

The only static dependency of `myTask` is `stringTask`. The dependency on `intTask` is only introduced in non-dev mode.

> **Note**: A dynamic task cannot refer to itself or a circular dependency will result. In the example above, there would be a circular dependency if the code passed to taskDyn referenced myTask.

Using Def.sequential

sbt 0.13.8 added `Def.sequential` function to run tasks under semi-sequential semantics. This is similar to the dynamic task, but easier to define. To demonstrate the sequential task, let's create a custom task called `compilecheck` that runs `compile in Compile` and then `scalastyle in Compile` task added by scalastyle-sbt-plugin.

```
lazy val compilecheck = taskKey[Unit]("compile and then scalastyle")

lazy val root = (project in file("."))
  .settings(
    compilecheck in Compile := Def.sequential(
      compile in Compile,
      (scalastyle in Compile).toTask("")
    ).value
  )
```

To call this task type in `compilecheck` from the shell. If the compilation fails, `compilecheck` would stop the execution.

```
root> compilecheck
[info] Compiling 1 Scala source to /Users/x/proj/target/scala-2.10/classes...
[error] /Users/x/proj/src/main/scala/Foo.scala:3: Unmatched closing brace '}' ignored here
[error] }
[error] ^
[error] one error found
[error] (compile:compileIncremental) Compilation failed
```

Handling Failure

This section discusses the `failure`, `result`, and `andFinally` methods, which are used to handle failure of other tasks.

`failure` The `failure` method creates a new task that returns the `Incomplete` value when the original task fails to complete normally. If the original task succeeds, the new task fails. Incomplete is an exception with information about any tasks that caused the failure and any underlying exceptions thrown during task execution.

For example:

```
intTask := sys.error("Failed.")

intTask := {
   println("Ignoring failure: " + intTask.failure.value)
   3
}
```

This overrides the `intTask` so that the original exception is printed and the constant `3` is returned.

`failure` does not prevent other tasks that depend on the target from failing. Consider the following example:

```
intTask := if(shouldSucceed) 5 else sys.error("Failed.")

// Return 3 if intTask fails. If intTask succeeds, this task will fail.
aTask := intTask.failure.value - 2

// A new task that increments the result of intTask.
bTask := intTask.value + 1

cTask := aTask.value + bTask.value
```

The following table lists the results of each task depending on the initially invoked task:

invoked task

intTask result

aTask result

bTask result

cTask result

overall result

intTask

failure

not run

not run

not run

failure

aTask

failure

success

not run

not run

success

bTask

failure

not run

failure

not run

failure

cTask

failure

success

failure

failure

failure

intTask

success

not run

not run

not run

success

aTask

success

failure

not run

not run

failure

bTask

success

not run

success

not run

success

cTask

success

failure

success

failure

failure

The overall result is always the same as the root task (the directly invoked task). A `failure` turns a success into a failure, and a failure into an `Incomplete`. A normal task definition fails when any of its inputs fail and computes its value otherwise.

`result` The `result` method creates a new task that returns the full `Result[T]` value for the original task. Result has the same structure as `Either[Incomplete, T]` for a task result of type `T`. That is, it has two subtypes:

- `Inc`, which wraps `Incomplete` in case of failure
- `Value`, which wraps a task's result in case of success.

Thus, the task created by `result` executes whether or not the original task succeeds or fails.

For example:

```
intTask := sys.error("Failed.")

intTask := intTask.result.value match {
   case Inc(inc: Incomplete) =>
      println("Ignoring failure: " + inc)
      3
   case Value(v) =>
      println("Using successful result: " + v)
      v
}
```

This overrides the original `intTask` definition so that if the original task fails, the exception is printed and the constant `3` is returned. If it succeeds, the value is printed and returned.

andFinally The `andFinally` method defines a new task that runs the original task and evaluates a side effect regardless of whether the original task succeeded. The result of the task is the result of the original task. For example:

```
intTask := sys.error("I didn't succeed.")

lazy val intTaskImpl = intTask andFinally { println("andFinally") }

intTask := intTaskImpl.value
```

This modifies the original `intTask` to always print "andFinally" even if the task fails.

Note that `andFinally` constructs a new task. This means that the new task has to be invoked in order for the extra block to run. This is important when calling andFinally on another task instead of overriding a task like in the previous example. For example, consider this code:

```
intTask := sys.error("I didn't succeed.")

lazy val intTaskImpl = intTask andFinally { println("andFinally") }

otherIntTask := intTaskImpl.value
```

If `intTask` is run directly, `otherIntTask` is never involved in execution. This case is similar to the following plain Scala code:

```
def intTask(): Int =
  sys.error("I didn't succeed.")
```

```
def otherIntTask(): Int =
  try { intTask() }
  finally { println("finally") }

intTask()
```

It is obvious here that calling intTask() will never result in "finally" being printed.

Input Tasks

Input Tasks parse user input and produce a task to run. Parsing Input describes how to use the parser combinators that define the input syntax and tab completion. This page describes how to hook those parser combinators into the input task system.

Input Keys

A key for an input task is of type `InputKey` and represents the input task like a `SettingKey` represents a setting or a `TaskKey` represents a task. Define a new input task key using the `inputKey.apply` factory method:

```
// goes in project/Build.scala or in build.sbt
val demo = inputKey[Unit]("A demo input task.")
```

The definition of an input task is similar to that of a normal task, but it can also use the result of a

Parser applied to user input. Just as the special `value` method gets the value of a setting or task, the special `parsed` method gets the result of a `Parser`.

Basic Input Task Definition

The simplest input task accepts a space-delimited sequence of arguments. It does not provide useful tab completion and parsing is basic. The built-in parser for space-delimited arguments is constructed via the `spaceDelimited` method, which accepts as its only argument the label to present to the user during tab completion.

For example, the following task prints the current Scala version and then echoes the arguments passed to it on their own line.

```
import complete.DefaultParsers._

demo := {
  // get the result of parsing
  val args: Seq[String] = spaceDelimited("<arg>").parsed
  // Here, we also use the value of the `scalaVersion` setting
  println("The current Scala version is " + scalaVersion.value)
  println("The arguments to demo were:")
  args foreach println
}
```

Input Task using Parsers

The Parser provided by the `spaceDelimited` method does not provide any flexibility in defining the input syntax. Using a custom parser is just a matter of defining your own `Parser` as described on the Parsing Input page.

Constructing the Parser The first step is to construct the actual `Parser` by defining a value of one of the following types:

- `Parser[I]`: a basic parser that does not use any settings
- `Initialize[Parser[I]]`: a parser whose definition depends on one or more settings
- `Initialize[State => Parser[I]]`: a parser that is defined using both settings and the current state

We already saw an example of the first case with `spaceDelimited`, which doesn't use any settings in its definition. As an example of the third case, the following defines a contrived `Parser` that uses the project's Scala and sbt version settings as well as the state. To use these settings, we need to wrap the Parser construction in `Def.setting` and get the setting values with the special `value` method:

```
import complete.DefaultParsers._
import complete.Parser

val parser: Def.Initialize[State => Parser[(String,String)]] =
Def.setting {
  (state: State) =>
    ( token("scala" <~ Space) ~ token(scalaVersion.value) ) |
    ( token("sbt" <~ Space) ~ token(sbtVersion.value) ) |
    ( token("commands" <~ Space) ~
        token(state.remainingCommands.size.toString) )
}
```

This Parser definition will produce a value of type `(String,String)`. The input syntax defined isn't very flexible; it is just a demonstration. It will produce one of the following values for a successful parse (assuming the current Scala version is 2.12.6, the current sbt version is 1.2.1, and there are 3 commands left to run):

Again, we were able to access the current Scala and sbt version for the project because they are settings. Tasks cannot be used to define the parser.

Constructing the Task Next, we construct the actual task to execute from the result of the `Parser`. For this, we define a task as usual, but we can access the result of parsing via the special `parsed` method on `Parser`.

The following contrived example uses the previous example's output (of type `(String,String)`) and the result of the `package` task to print some information to the screen.

```
demo := {
    val (tpe, value) = parser.parsed
    println("Type: " + tpe)
    println("Value: " + value)
    println("Packaged: " + packageBin.value.getAbsolutePath)
}
```

The InputTask type

It helps to look at the `InputTask` type to understand more advanced usage of input tasks. The core input task type is:

```
class InputTask[T](val parser: State => Parser[Task[T]])
```

Normally, an input task is assigned to a setting and you work with `Initialize[InputTask[T]]`.

Breaking this down,

1. You can use other settings (via Initialize) to construct an input task.
2. You can use the current State to construct the parser.
3. The parser accepts user input and provides tab completion.
4. The parser produces the task to run.

So, you can use settings or `State` to construct the parser that defines an input task's command line syntax. This was described in the previous section. You can then use settings, `State`, or user input to construct the task to run. This is implicit in the input task syntax.

Using other input tasks

The types involved in an input task are composable, so it is possible to reuse input tasks. The `.parsed` and `.evaluated` methods are defined on InputTasks to make this more convenient in common situations:

- Call `.parsed` on an `InputTask[T]` or `Initialize[InputTask[T]]` to get the `Task[T]` created after parsing the command line
- Call `.evaluated` on an `InputTask[T]` or `Initialize[InputTask[T]]` to get the value of type `T` from evaluating that task

In both situations, the underlying `Parser` is sequenced with other parsers in the input task definition. In the case of `.evaluated`, the generated task is evaluated.

The following example applies the `run` input task, a literal separator parser `--`, and `run` again. The parsers are sequenced in order of syntactic appearance, so that the arguments before `--` are passed to the first `run` and the ones after are passed to the second.

```
val run2 = inputKey[Unit](
    "Runs the main class twice with different argument lists separated by --")

val separator: Parser[String] = "--"

run2 := {
   val one = (run in Compile).evaluated
   val sep = separator.parsed
   val two = (run in Compile).evaluated
}
```

For a main class Demo that echoes its arguments, this looks like:

```
$ sbt
> run2 a b -- c d
[info] Running Demo c d
[info] Running Demo a b
c
d
a
b
```

Preapplying input

Because `InputTasks` are built from `Parsers`, it is possible to generate a new `InputTask` by applying some input programmatically. (It is also possible to generate a `Task`, which is covered in the next section.) Two convenience methods are provided on `InputTask[T]` and `Initialize[InputTask[T]]` that accept the String to apply.

- `partialInput` applies the input and allows further input, such as from the command line
- `fullInput` applies the input and terminates parsing, so that further input is not accepted

In each case, the input is applied to the input task's parser. Because input tasks handle all input after the task name, they usually require initial whitespace to be provided in the input.

Consider the example in the previous section. We can modify it so that we:

- Explicitly specify all of the arguments to the first `run`. We use `name` and `version` to show that settings can be used to define and modify parsers.
- Define the initial arguments passed to the second `run`, but allow further input on the command line.

  Note: if the input derives from settings you need to use, for example, `Def.taskDyn { ... }.value`

```
lazy val run2 = inputKey[Unit]("Runs the main class twice: " +
   "once with the project name and version as arguments"
   "and once with command line arguments preceded by hard coded values.")

// The argument string for the first run task is ' <name> <version>'
lazy val firstInput: Initialize[String] =
   Def.setting(s" ${name.value} ${version.value}")

// Make the first arguments to the second run task ' red blue'
lazy val secondInput: String = " red blue"

run2 := {
   val one = (run in Compile).fullInput(firstInput.value).evaluated
   val two = (run in Compile).partialInput(secondInput).evaluated
}
```

For a main class Demo that echoes its arguments, this looks like:

```
$ sbt
> run2 green
[info] Running Demo demo 1.0
[info] Running Demo red blue green
demo
1.0
red
blue
green
```

Get a Task from an InputTask

The previous section showed how to derive a new `InputTask` by applying input. In this section, applying input produces a `Task`. The `toTask` method on `Initialize[InputTask[T]]` accepts the `String` input to apply and produces a task that can be used normally. For example, the following defines a plain task `runFixed` that can be used by other tasks or run directly without providing any input:

```
lazy val runFixed = taskKey[Unit]("A task that hard codes the values to `run`")

runFixed := {
   val _ = (run in Compile).toTask(" blue green").value
   println("Done!")
}
```

For a main class Demo that echoes its arguments, running `runFixed` looks like:

```
$ sbt
> runFixed
[info] Running Demo blue green
blue
green
Done!
```

Each call to `toTask` generates a new task, but each task is configured the same as the original `InputTask` (in this case, `run`) but with different input applied. For example:

```
lazy val runFixed2 = taskKey[Unit]("A task that hard codes the values to `run`")

fork in run := true

runFixed2 := {
```

```
  val x = (run in Compile).toTask(" blue green").value
  val y = (run in Compile).toTask(" red orange").value
  println("Done!")
}
```

The different `toTask` calls define different tasks that each run the project's main class in a new jvm. That is, the `fork` setting configures both, each has the same classpath, and each run the same main class. However, each task passes different arguments to the main class. For a main class Demo that echoes its arguments, the output of running `runFixed2` might look like:

```
$ sbt
> runFixed2
[info] Running Demo blue green
[info] Running Demo red orange
blue
green
red
orange
Done!
```

Commands

What is a "command"?

A "command" looks similar to a task: it's a named operation that can be executed from the sbt console.

However, a command's implementation takes as its parameter the entire state of the build (represented by State) and computes a new State. This means that a command can look at or modify other sbt settings, for example. Typically, you would resort to a command when you need to do something that's impossible in a regular task.

Introduction

There are three main aspects to commands:

1. The syntax used by the user to invoke the command, including:
    - Tab completion for the syntax
    - The parser to turn input into an appropriate data structure
2. The action to perform using the parsed data structure. This action transforms the build State.

3. Help provided to the user

In sbt, the syntax part, including tab completion, is specified with parser combinators. If you are familiar with the parser combinators in Scala's standard library, these are very similar. The action part is a function `(State, T) => State`, where `T` is the data structure produced by the parser. See the Parsing Input page for how to use the parser combinators.

State provides access to the build state, such as all registered `Commands`, the remaining commands to execute, and all project-related information. See States and Actions for details on State.

Finally, basic help information may be provided that is used by the `help` command to display command help.

Defining a Command

A command combines a function `State => Parser[T]` with an action `(State, T) => State`. The reason for `State => Parser[T]` and not simply `Parser[T]` is that often the current `State` is used to build the parser. For example, the currently loaded projects (provided by `State`) determine valid completions for the `project` command. Examples for the general and specific cases are shown in the following sections.

See Command.scala for the source API details for constructing commands.

General commands General command construction looks like:

```
val action: (State, T) => State = ...
val parser: State => Parser[T] = ...
val command: Command = Command("name")(parser)(action)
```

No-argument commands There is a convenience method for constructing commands that do not accept any arguments.

```
val action: State => State = ...
val command: Command = Command.command("name")(action)
```

Single-argument command There is a convenience method for constructing commands that accept a single argument with arbitrary content.

```
// accepts the state and the single argument
val action: (State, String) => State = ...
val command: Command = Command.single("name")(action)
```

Multi-argument command There is a convenience method for constructing commands that accept multiple arguments separated by spaces.

```
val action: (State, Seq[String]) => State = ...

// <arg> is the suggestion printed for tab completion on an argument
val command: Command = Command.args("name", "<arg>")(action)
```

Full Example

The following example is a sample build that adds commands to a project. To try it out:

1. Create `build.sbt` and `project/CommandExample.scala`.
2. Run sbt on the project.
3. Try out the `hello`, `helloAll`, `failIfTrue`, `color`, and printState commands.
4. Use tab-completion and the code below as guidance.

Here's `build.sbt`:

```
import CommandExample._

lazy val commonSettings = Seq(
  scalaVersion := "2.12.6",
)

lazy val root = (project in file("."))
  .settings(
    commonSettings,
    commands ++= Seq(hello, helloAll, failIfTrue, changeColor, printState)
  )
```

Here's `project/CommandExample.scala`:

```
import sbt._
import Keys._

// imports standard command parsing functionality
import complete.DefaultParsers._

object CommandExample {
  // A simple, no-argument command that prints "Hi",
```

```
//  leaving the current state unchanged.
def hello = Command.command("hello") { state =>
  println("Hi!")
  state
}

// A simple, multiple-argument command that prints "Hi" followed by the arguments.
//   Again, it leaves the current state unchanged.
def helloAll = Command.args("helloAll", "<name>") { (state, args) =>
  println("Hi " + args.mkString(" "))
  state
}

// A command that demonstrates failing or succeeding based on the input
def failIfTrue = Command.single("failIfTrue") {
  case (state, "true") => state.fail
  case (state, _) => state
}

// Demonstration of a custom parser.
// The command changes the foreground or background terminal color
//  according to the input.
lazy val change = Space ~> (reset | setColor)
lazy val reset = token("reset" ^^^ "\033[0m")
lazy val color = token( Space ~> ("blue" ^^^ "4" | "green" ^^^ "2") )
lazy val select = token( "fg" ^^^ "3" | "bg" ^^^ "4" )
lazy val setColor = (select ~ color) map { case (g, c) => "\033[" + g + c + "m" }

def changeColor = Command("color")(_ => change) { (state, ansicode) =>
  print(ansicode)
  state
}

// A command that demonstrates getting information out of State.
def printState = Command.command("printState") { state =>
  import state._
  println(definedCommands.size + " registered commands")
  println("commands to run: " + show(remainingCommands))
  println()

  println("original arguments: " + show(configuration.arguments))
  println("base directory: " + configuration.baseDirectory)
  println()

  println("sbt version: " + configuration.provider.id.version)
  println("Scala version (for sbt): " + configuration.provider.scalaProvider.version)
```

```
    println()

    val extracted = Project.extract(state)
    import extracted._
    println("Current build: " + currentRef.build)
    println("Current project: " + currentRef.project)
    println("Original setting count: " + session.original.size)
    println("Session setting count: " + session.append.size)

    state
  }

  def show[T](s: Seq[T]) =
    s.map("'" + _ + "'").mkString("[", ", ", "]")
}
```

Parsing and tab completion

This page describes the parser combinators in sbt. These parser combinators are typically used to parse user input and provide tab completion for Input Tasks and Commands. If you are already familiar with Scala's parser combinators, the methods are mostly the same except that their arguments are strict. There are two additional methods for controlling tab completion that are discussed at the end of the section.

Parser combinators build up a parser from smaller parsers. A `Parser[T]` in its most basic usage is a function `String => Option[T]`. It accepts a `String` to parse and produces a value wrapped in `Some` if parsing succeeds or `None` if it fails. Error handling and tab completion make this picture more complicated, but we'll stick with `Option` for this discussion.

The following examples assume the imports: :

```
import sbt._
import complete.DefaultParsers._
```

Basic parsers

The simplest parser combinators match exact inputs:

```
// A parser that succeeds if the input is 'x', returning the Char 'x'
//  and failing otherwise
val singleChar: Parser[Char] = 'x'

// A parser that succeeds if the input is "blue", returning the String "blue"
```

```
//   and failing otherwise
val litString: Parser[String] = "blue"
```

In these examples, implicit conversions produce a literal `Parser` from a `Char` or `String`. Other basic parser constructors are the `charClass`, `success` and `failure` methods:

```
// A parser that succeeds if the character is a digit, returning the matched Char
//   The second argument, "digit", describes the parser and is used in error messages
val digit: Parser[Char] = charClass( (c: Char) => c.isDigit, "digit")

// A parser that produces the value 3 for an empty input string, fails otherwise
val alwaysSucceed: Parser[Int] = success( 3 )

// Represents failure (always returns None for an input String).
//  The argument is the error message.
val alwaysFail: Parser[Nothing] = failure("Invalid input.")
```

Built-in parsers

sbt comes with several built-in parsers defined in sbt.complete.DefaultParsers. Some commonly used built-in parsers are:

- `Space`, `NotSpace`, `OptSpace`, and `OptNotSpace` for parsing spaces or non-spaces, required or not.
- `StringBasic` for parsing text that may be quoted.
- `IntBasic` for parsing a signed Int value.
- `Digit` and `HexDigit` for parsing a single decimal or hexadecimal digit.
- `Bool` for parsing a `Boolean` value

See the DefaultParsers API for details.

Combining parsers

We build on these basic parsers to construct more interesting parsers. We can combine parsers in a sequence, choose between parsers, or repeat a parser.

```
// A parser that succeeds if the input is "blue" or "green",
//  returning the matched input
val color: Parser[String] = "blue" | "green"

// A parser that matches either "fg" or "bg"
```

```
val select: Parser[String] = "fg" | "bg"

// A parser that matches "fg" or "bg", a space, and then the color, returning the matched va
//   ~ is an alias for Tuple2.
val setColor: Parser[String ~ Char ~ String] =
  select ~ ' ' ~ color

// Often, we don't care about the value matched by a parser, such as the space above
//  For this, we can use ~> or <~, which keep the result of
//  the parser on the right or left, respectively
val setColor2: Parser[String ~ String]  =  select ~ (' ' ~> color)

// Match one or more digits, returning a list of the matched characters
val digits: Parser[Seq[Char]]  =  charClass(_.isDigit, "digit").+

// Match zero or more digits, returning a list of the matched characters
val digits0: Parser[Seq[Char]]  =  charClass(_.isDigit, "digit").*

// Optionally match a digit
val optDigit: Parser[Option[Char]]  =  charClass(_.isDigit, "digit").?
```

Transforming results

A key aspect of parser combinators is transforming results along the way into more useful data structures. The fundamental methods for this are `map` and `flatMap`. Here are examples of `map` and some convenience methods implemented on top of `map`.

```
// Apply the `digits` parser and apply the provided function to the matched
//   character sequence
val num: Parser[Int] = digits map { (chars: Seq[Char]) => chars.mkString.toInt }

// Match a digit character, returning the matched character or return '0' if the input is no
val digitWithDefault: Parser[Char]  =  charClass(_.isDigit, "digit") ?? '0'

// The previous example is equivalent to:
val digitDefault: Parser[Char] =
  charClass(_.isDigit, "digit").? map { (d: Option[Char]) => d getOrElse '0' }

// Succeed if the input is "blue" and return the value 4
val blue = "blue" ^^^ 4

// The above is equivalent to:
val blueM = "blue" map { (s: String) => 4 }
```

Controlling tab completion

Most parsers have reasonable default tab completion behavior. For example, the string and character literal parsers will suggest the underlying literal for an empty input string. However, it is impractical to determine the valid completions for `charClass`, since it accepts an arbitrary predicate. The `examples` method defines explicit completions for such a parser:

```
val digit = charClass(_.isDigit, "digit").examples("0", "1", "2")
```

Tab completion will use the examples as suggestions. The other method controlling tab completion is `token`. The main purpose of `token` is to determine the boundaries for suggestions. For example, if your parser is:

```
("fg" | "bg") ~ ' ' ~ ("green" | "blue")
```

then the potential completions on empty input are: `console fg green fg blue bg green bg blue`

Typically, you want to suggest smaller segments or the number of suggestions becomes unmanageable. A better parser is:

```
token( ("fg" | "bg") ~ ' ') ~ token("green" | "blue")
```

Now, the initial suggestions would be (with _ representing a space): `console fg_ bg_`

Be careful not to overlap or nest tokens, as in `token("green" ~ token("blue"))`. The behavior is unspecified (and should generate an error in the future), but typically the outer most token definition will be used.

Dependent parsers

Sometimes a parser must analyze some data and then more data needs to be parsed, and it is dependent on the previous one.
The key for obtaining this behaviour is to use the `flatMap` function.

As an example, it will shown how to select several items from a list of valid ones with completion, but no duplicates are possible. A space is used to separate the different items.

```
def select1(items: Iterable[String]) =
  token(Space ~> StringBasic.examples(FixedSetExamples(items)))

def selectSome(items: Seq[String]): Parser[Seq[String]] = {
```

```
  select1(items).flatMap { v
  val remaining = items filter { _ != v }
  if (remaining.size == 0)
    success(v :: Nil)
  else
    selectSome(remaining).?.map(v +: _.getOrElse(Seq()))
}
```

As you can see, the `flatMap` function provides the previous value. With this info, a new parser is constructed for the remaining items. The `map` combinator is also used in order to transform the output of the parser.

The parser is called recursively, until it is found the trivial case of no possible choices.

State and actions

State is the entry point to all available information in sbt. The key methods are:

- `definedCommands: Seq[Command]` returns all registered Command definitions
- `remainingCommands: List[Exec]` returns the remaining commands to be run
- `attributes: AttributeMap` contains generic data.

The action part of a command performs work and transforms `State`. The following sections discuss `State => State` transformations. As mentioned previously, a command will typically handle a parsed value as well: `(State, T) => State`.

Command-related data

A Command can modify the currently registered commands or the commands to be executed. This is done in the action part by transforming the (immutable) State provided to the command. A function that registers additional power commands might look like:

```
val powerCommands: Seq[Command] = ...

val addPower: State => State =
  (state: State) =>
    state.copy(definedCommands =
      (state.definedCommands ++ powerCommands).distinct
    )
```

This takes the current commands, appends new commands, and drops duplicates. Alternatively, State has a convenience method for doing the above:

```
val addPower2 = (state: State) => state ++ powerCommands
```

Some examples of functions that modify the remaining commands to execute:

```
val appendCommand: State => State =
  (state: State) =>
    state.copy(remainingCommands = state.remainingCommands :+ "cleanup")

val insertCommand: State => State =
  (state: State) =>
    state.copy(remainingCommands = "next-command" +: state.remainingCommands)
```

The first adds a command that will run after all currently specified commands run. The second inserts a command that will run next. The remaining commands will run after the inserted command completes.

To indicate that a command has failed and execution should not continue, return `state.fail`.

```
(state: State) => {
  val success: Boolean = ...
  if(success) state else state.fail
}
```

Project-related data

Project-related information is stored in `attributes`. Typically, commands won't access this directly but will instead use a convenience method to extract the most useful information:

```
val state: State
val extracted: Extracted = Project.extract(state)
import extracted._
```

Extracted provides:

- Access to the current build and project (`currentRef`)
- Access to initialized project setting data (`structure.data`)
- Access to session `Setting`s and the original, permanent settings from .sbt and .scala files (session.append and session.original, respectively)
- Access to the current Eval instance for evaluating Scala expressions in the build context.

Project data

All project data is stored in `structure.data`, which is of type `sbt.Settings[Scope]`. Typically, one gets information of type `T` in the following way:

```
val key: SettingKey[T]
val scope: Scope
val value: Option[T] = key in scope get structure.data
```

Here, a `SettingKey[T]` is typically obtained from Keys and is the same type that is used to define settings in `.sbt` files, for example. Scope selects the scope the key is obtained for. There are convenience overloads of `in` that can be used to specify only the required scope axes. See Structure.scala for where `in` and other parts of the settings interface are defined. Some examples:

```
import Keys._
val extracted: Extracted
import extracted._

// get name of current project
val nameOpt: Option[String] = name in currentRef get structure.data

// get the package options for the `test:packageSrc` task or Nil if none are defined
val pkgOpts: Seq[PackageOption] = packageOptions in (currentRef, Test, packageSrc) get struc
```

BuildStructure contains information about build and project relationships. Key members are:

```
units: Map[URI, LoadedBuildUnit]
root: URI
```

A `URI` identifies a build and `root` identifies the initial build loaded. LoadedBuildUnit provides information about a single build. The key members of `LoadedBuildUnit` are:

```
// Defines the base directory for the build
localBase: File

// maps the project ID to the Project definition
defined: Map[String, ResolvedProject]
```

ResolvedProject has the same information as the `Project` used in a `project/Build.scala` except that ProjectReferences are resolved to `ProjectRefs`.

Classpaths

Classpaths in sbt are of type `Seq[Attributed[File]]`. This allows tagging arbitrary information to classpath entries. sbt currently uses this to associate an `Analysis` with an entry. This is how it manages the information needed for multi-project incremental recompilation. It also associates the ModuleID and Artifact with managed entries (those obtained by dependency management). When you only want the underlying `Seq[File]`, use `files`:

```
val attributedClasspath: Seq[Attribute[File]] = ...
val classpath: Seq[File] = attributedClasspath.files
```

Running tasks

It can be useful to run a specific project task from a command (*not from another task*) and get its result. For example, an IDE-related command might want to get the classpath from a project or a task might analyze the results of a compilation. The relevant method is `Project.runTask`, which has the following signature:

```
def runTask[T](taskKey: ScopedKey[Task[T]], state: State,
  checkCycles: Boolean = false): Option[(State, Result[T])]
```

For example,

```
val eval: State => State = (state: State) => {

    // This selects the main 'compile' task for the current project.
    //   The value produced by 'compile' is of type inc.Analysis,
    //   which contains information about the compiled code.
    val taskKey = Keys.compile in Compile

    // Evaluate the task
    // None if the key is not defined
    // Some(Inc) if the task does not complete successfully (Inc for incomplete)
    // Some(Value(v)) with the resulting value
    val result: Option[(State, Result[inc.Analysis])] = Project.runTask(taskKey, state)
    // handle the result
    result match
    {
        case None => // Key wasn't defined.
        case Some((newState, Inc(inc))) => // error detail, inc is of type Incomplete, use .
        case Some((newState, Value(v))) => // do something with v: inc.Analysis
    }
}
```

For getting the test classpath of a specific project, use this key:

```
val projectRef: ProjectRef = ...
val taskKey: Task[Seq[Attributed[File]]] =
  Keys.fullClasspath in (projectRef, Test)
```

Using State in a task

To access the current State from a task, use the `state` task as an input. For example,

```
myTask := ... state.value ...
```

Tasks/Settings: Motivation

This page motivates the task and settings system. You should already know how to use tasks and settings, which are described in the getting started guide and on the Tasks page.

An important aspect of the task system is to combine two common, related steps in a build:

1. Ensure some other task is performed.
2. Use some result from that task.

Earlier versions of sbt configured these steps separately using

1. Dependency declarations
2. Some form of shared state

To see why it is advantageous to combine them, compare the situation to that of deferring initialization of a variable in Scala. This Scala code is a bad way to expose a value whose initialization is deferred:

```
// Define a variable that will be initialized at some point
// We don't want to do it right away, because it might be expensive
var foo: Foo = _

// Define a function to initialize the variable
def makeFoo(): Unit = ... initialize foo ...
```

Typical usage would be:

```
makeFoo()
doSomething(foo)
```

This example is rather exaggerated in its badness, but I claim it is nearly the same situation as our two step task definitions. Particular reasons this is bad include:

1. A client needs to know to call `makeFoo()` first.
2. `foo` could be changed by other code. There could be a def makeFoo2(), for example.
3. Access to foo is not thread safe.

The first point is like declaring a task dependency, the second is like two tasks modifying the same state (either project variables or files), and the third is a consequence of unsynchronized, shared state.

In Scala, we have the built-in functionality to easily fix this: `lazy val`.

```
lazy val foo: Foo = ... initialize foo ...
```

with the example usage:

```
doSomething(foo)
```

Here, `lazy val` gives us thread safety, guaranteed initialization before access, and immutability all in one, DRY construct. The task system in sbt does the same thing for tasks (and more, but we won't go into that here) that `lazy val` did for our bad example.

A task definition must declare its inputs and the type of its output. sbt will ensure that the input tasks have run and will then provide their results to the function that implements the task, which will generate its own result. Other tasks can use this result and be assured that the task has run (once) and be thread-safe and typesafe in the process.

The general form of a task definition looks like:

```
myTask := {
  val a: A = aTask.value
  val b: B = bTask.value
  ... do something with a, b and generate a result ...
}
```

(This is only intended to be a discussion of the ideas behind tasks, so see the sbt Tasks page for details on usage.) Here, `aTask` is assumed to produce a result of type `A` and `bTask` is assumed to produce a result of type `B`.

Application

As an example, consider generating a zip file containing the binary jar, source jar, and documentation jar for your project. First, determine what tasks produce the jars. In this case, the input tasks are `packageBin`, `packageSrc`, and `packageDoc` in the main `Compile` scope. The result of each of these tasks is the File for the jar that they generated. Our zip file task is defined by mapping these package tasks and including their outputs in a zip file. As good practice, we then return the File for this zip so that other tasks can map on the zip task.

```
zip := {
    val bin: File = (packageBin in Compile).value
    val src: File = (packageSrc in Compile).value
    val doc: File = (packageDoc in Compile).value
    val out: File = zipPath.value
    val inputs: Seq[(File,String)] = Seq(bin, src, doc) x Path.flat
    IO.zip(inputs, out)
    out
}
```

The `val inputs` line defines how the input files are mapped to paths in the zip. See Mapping Files for details. The explicit types are not required, but are included for clarity.

The `zipPath` input would be a custom task to define the location of the zip file. For example:

```
zipPath := target.value / "out.zip"
```

Plugins and Best Practices

This part of the documentation has pages documenting particular sbt topics in detail. Before reading anything in here, you will need the information in the Getting Started Guide as a foundation.

General Best Practices

This page describes best practices for working with sbt.

`project/` vs. `~/.sbt/`

Anything that is necessary for building the project should go in `project/`. This includes things like the web plugin. `~/.sbt/` should contain local customizations and commands for working with a build, but are not necessary. An example is an IDE plugin.

Local settings

There are two options for settings that are specific to a user. An example of such a setting is inserting the local Maven repository at the beginning of the resolvers list:

```
resolvers := {
  val localMaven = "Local Maven Repository" at "file://"+Path.userHome.absolutePath+"/.m2/re
  localMaven +: resolvers.value
}
```

1. Put settings specific to a user in a global `.sbt` file, such as `~/.sbt/1.0/global.sbt`. These settings will be applied to all projects.
2. Put settings in a `.sbt` file in a project that isn't checked into version control, such as `<project>/local.sbt`. sbt combines the settings from multiple .sbt files, so you can still have the standard `<project>/build.sbt` and check that into version control.

.sbtrc

Put commands to be executed when sbt starts up in a `.sbtrc` file, one per line. These commands run before a project is loaded and are useful for defining aliases, for example. sbt executes commands in `$HOME/.sbtrc` (if it exists) and then `<project>/.sbtrc` (if it exists).

Generated files

Write any generated files to a subdirectory of the output directory, which is specified by the `target` setting. This makes it easy to clean up after a build and provides a single location to organize generated files. Any generated files that are specific to a Scala version should go in `crossTarget` for efficient cross-building.

For generating sources and resources, see Generating Files.

Don't hard code

Don't hard code constants, like the output directory `target/`. This is especially important for plugins. A user might change the `target` setting to point to `build/`, for example, and the plugin needs to respect that. Instead, use the setting, like:

```
myDirectory := target.value / "sub-directory"
```

Don't "mutate" files

A build naturally consists of a lot of file manipulation. How can we reconcile this with the task system, which otherwise helps us avoid mutable state? One approach, which is the recommended approach and the approach used by sbt's default tasks, is to only write to any given file once and only from a single task.

A build product (or by-product) should be written exactly once by only one task. The task should then, at a minimum, provide the Files created as its result. Another task that wants to use Files should map the task, simultaneously obtaining the File reference and ensuring that the task has run (and thus the file is constructed). Obviously you cannot do much about the user or other processes modifying the files, but you can make the I/O that is under the build's control more predictable by treating file contents as immutable at the level of Tasks.

For example:

```
lazy val makeFile = taskKey[File]("Creates a file with some content.")

// define a task that creates a file,
//  writes some content, and returns the File
makeFile := {
    val f: File = file("/tmp/data.txt")
    IO.write(f, "Some content")
    f
}

// The result of makeFile is the constructed File,
//   so useFile can map makeFile and simultaneously
//   get the File and declare the dependency on makeFile
useFile :=
    doSomething( makeFile.value )
```

This arrangement is not always possible, but it should be the rule and not the exception.

Use absolute paths

Construct only absolute Files. Either specify an absolute path

```
file("/home/user/A.scala")
```

or construct the file from an absolute base:

```
base / "A.scala"
```

This is related to the no hard coding best practice because the proper way involves referencing the `baseDirectory` setting. For example, the following defines the myPath setting to be the `<base>/licenses/` directory.

```
myPath := baseDirectory.value / "licenses"
```

In Java (and thus in Scala), a relative File is relative to the current working directory. The working directory is not always the same as the build root directory for a number of reasons.

The only exception to this rule is when specifying the base directory for a Project. Here, sbt will resolve a relative File against the build root directory for you for convenience.

Parser combinators

1. Use `token` everywhere to clearly delimit tab completion boundaries.
2. Don't overlap or nest tokens. The behavior here is unspecified and will likely generate an error in the future.
3. Use `flatMap` for general recursion. sbt's combinators are strict to limit the number of classes generated, so use flatMap like:

```
lazy val parser: Parser[Int] =
  token(IntBasic) flatMap { i =>
    if(i <= 0)
      success(i)
    else
      token(Space ~> parser)
  }
```

   This example defines a parser a whitespace-delimited list of integers, ending with a negative number, and returning that final, negative number.

Plugins

There's a getting started page focused on using existing plugins, which you may want to read first.

A plugin is a way to use external code in a build definition. A plugin can be a library used to implement a task (you might use Knockoff to write a markdown processing task). A plugin can define a sequence of sbt settings that are automatically added to all projects or that are explicitly declared for selected projects. For example, a plugin might add a `proguard` task and associated (overridable) settings. Finally, a plugin can define new commands (via the `commands` setting).

sbt 0.13.5 introduces auto plugins, with improved dependency management among the plugins and explicitly scoped auto importing. Going forward, our recommendation is to migrate to the auto plugins. The Plugins Best Practices page describes the currently evolving guidelines to writing sbt plugins. See also the general best practices.

Using an auto plugin

A common situation is when using a binary plugin published to a repository. If you're adding sbt-assembly, create `project/assembly.sbt` with the following:

```
addSbtPlugin("com.eed3si9n" % "sbt-assembly" % "0.11.2")
```

Alternatively, you can create `project/plugins.sbt` with all of the desired sbt plugins, any general dependencies, and any necessary repositories:

```
addSbtPlugin("org.example" % "plugin" % "1.0")

addSbtPlugin("org.example" % "another-plugin" % "2.0")

// plain library (not an sbt plugin) for use in the build definition
libraryDependencies += "org.example" % "utilities" % "1.3"

resolvers += "Example Plugin Repository" at "https://example.org/repo/"
```

Many of the auto plugins automatically add settings into projects, however, some may require explicit enablement. Here's an example:

```
lazy val util = (project in file("util"))
  .enablePlugins(FooPlugin, BarPlugin)
  .disablePlugins(plugins.IvyPlugin)
  .settings(
    name := "hello-util"
  )
```

See using plugins in the Getting Started guide for more details on using plugins.

By Description

A plugin definition is a project under `project/` folder. This project's classpath is the classpath used for build definitions in `project/` and any `.sbt` files in the project's base directory. It is also used for the `eval` and `set` commands.

Specifically,

1. Managed dependencies declared by the `project/` project are retrieved and are available on the build definition classpath, just like for a normal project.
2. Unmanaged dependencies in `project/lib/` are available to the build definition, just like for a normal project.
3. Sources in the `project/` project are the build definition files and are compiled using the classpath built from the managed and unmanaged dependencies.
4. Project dependencies can be declared in `project/plugins.sbt` (similarly to `build.sbt` file in a normal project) or `project/project/Build.scala` (similarly to `project/Build.scala` in a normal project) and will be available to the build definition sources. Think of project/project/ as the build definition for the build definition (worth to repeat it here again: "sbt is recursive", remember?).

The build definition classpath is searched for `sbt/sbt.autoplugins` descriptor files containing the names of `sbt.AutoPlugin` implementations.

The `reload plugins` command changes the current build to the (root) project's `project/` build definition. This allows manipulating the build definition project like a normal project. `reload return` changes back to the original build. Any session settings for the plugin definition project that have not been saved are dropped.

An auto plugin is a module that defines settings to automatically inject into projects. In addition an auto plugin provides the following feature:

- Automatically import selective names to `.sbt` files and the `eval` and `set` commands.
- Specify plugin dependencies to other auto plugins.
- Automatically activate itself when all dependencies are present.
- Specify `projectSettings`, `buildSettings`, and `globalSettings` as appropriate.

Plugin dependencies

When a traditional plugin wanted to reuse some functionality from an existing plugin, it would pull in the plugin as a library dependency, and then it would either:

1. add the setting sequence from the dependency as part of its own setting sequence, or
2. tell the build users to include them in the right order.

This becomes complicated as the number of plugins increase within an application, and becomes more error prone. The main goal of auto plugin is to alleviate this setting dependency problem. An auto plugin can depend on other auto plugins and ensure these dependency settings are loaded first.

Suppose we have the `SbtLessPlugin` and the `SbtCoffeeScriptPlugin`, which in turn depends on the `SbtJsTaskPlugin`, `SbtWebPlugin`, and `JvmPlugin`. Instead of manually activating all of these plugins, a project can just activate the `SbtLessPlugin` and `SbtCoffeeScriptPlugin` like this:

```
lazy val root = (project in file("."))
  .enablePlugins(SbtLessPlugin, SbtCoffeeScriptPlugin)
```

This will pull in the right setting sequence from the plugins in the right order. The key notion here is you declare the plugins you want, and sbt can fill in the gap.

A plugin implementation is not required to produce an auto plugin, however. It is a convenience for plugin consumers and because of the automatic nature, it is not always appropriate.

Global plugins The `~/.sbt/1.0/plugins/` directory is treated as a global plugin definition project. It is a normal sbt project whose classpath is available to all sbt project definitions for that user as described above for per-project plugins.

Creating an auto plugin

A minimal sbt plugin is a Scala library that is built against the version of Scala that sbt runs (currently, 2.12.6) or a Java library. Nothing special needs to be done for this type of library. A more typical plugin will provide sbt tasks, commands, or settings. This kind of plugin may provide these settings automatically or make them available for the user to explicitly integrate.

To make an auto plugin, create a project and configure `sbtPlugin` to `true`.

```
sbtPlugin := true
```

Then, write the plugin code and publish your project to a repository. The plugin can be used as described in the previous section.

First, in an appropriate namespace, define your auto plugin object by extending `sbt.AutoPlugin`.

projectSettings and buildSettings With auto plugins, all provided settings (e.g. `assemblySettings`) are provided by the plugin directly via the `projectSettings` method. Here's an example plugin that adds a command named hello to sbt projects:

```
package sbthello

import sbt._
import Keys._

object HelloPlugin extends AutoPlugin {
  override lazy val projectSettings = Seq(commands += helloCommand)
  lazy val helloCommand =
    Command.command("hello") { (state: State) =>
      println("Hi!")
      state
    }
}
```

This example demonstrates how to take a `Command` (here, `helloCommand`) and distribute it in a plugin. Note that multiple commands can be included in one plugin (for example, use `commands ++= Seq(a,b)`). See Commands for defining more useful commands, including ones that accept arguments and affect the execution state.

If the plugin needs to append settings at the build-level (that is, in `ThisBuild`) there's a `buildSettings` method. The settings returned here are guaranteed to be added to a given build scope only once regardless of how many projects for that build activate this AutoPlugin.

```
override def buildSettings: Seq[Setting[_]] = Nil
```

The `globalSettings` is appended once to the global settings (`in Global`). These allow a plugin to automatically provide new functionality or new defaults. One main use of this feature is to globally add commands, such as for IDE plugins.

```
override def globalSettings: Seq[Setting[_]] = Nil
```

Use `globalSettings` to define the default value of a setting.

Implementing plugin dependencies Next step is to define the plugin dependencies.

```scala
package sbtless

import sbt._
import Keys._
object SbtLessPlugin extends AutoPlugin {
  override def requires = SbtJsTaskPlugin
  override lazy val projectSettings = ...
}
```

The `requires` method returns a value of type `Plugins`, which is a DSL for constructing the dependency list. The requires method typically contains one of the following values:

- `empty` (No plugins)
- other auto plugins
- `&&` operator (for defining multiple dependencies)

Root plugins and triggered plugins Some plugins should always be explicitly enabled on projects. we call these root plugins, i.e. plugins that are "root" nodes in the plugin dependency graph. An auto plugin is by default a root plugin.

Auto plugins also provide a way for plugins to automatically attach themselves to projects if their dependencies are met. We call these triggered plugins, and they are created by overriding the `trigger` method.

For example, we might want to create a triggered plugin that can append commands automatically to the build. To do this, set the `requires` method to return `empty`, and override the `trigger` method with `allRequirements`.

```scala
package sbthello

import sbt._
import Keys._

object HelloPlugin2 extends AutoPlugin {
  override def trigger = allRequirements
  override lazy val buildSettings = Seq(commands += helloCommand)
  lazy val helloCommand =
    Command.command("hello") { (state: State) =>
      println("Hi!")
      state
    }
}
```

The build user still needs to include this plugin in `project/plugins.sbt`, but it is no longer needed to be included in `build.sbt`. This becomes more interesting when you do specify a plugin with requirements. Let's modify the `SbtLessPlugin` so that it depends on another plugin:

```
package sbtless
import sbt._
import Keys._
object SbtLessPlugin extends AutoPlugin {
  override def trigger = allRequirements
  override def requires = SbtJsTaskPlugin
  override lazy val projectSettings = ...
}
```

As it turns out, `PlayScala` plugin (in case you didn't know, the Play framework is an sbt plugin) lists `SbtJsTaskPlugin` as one of it required plugins. So, if we define a `build.sbt` with:

```
lazy val root = (project in file("."))
  .enablePlugins(PlayScala)
```

then the setting sequence from `SbtLessPlugin` will be automatically appended somewhere after the settings from `PlayScala`.

This allows plugins to silently, and correctly, extend existing plugins with more features. It also can help remove the burden of ordering from the user, allowing the plugin authors greater freedom and power when providing feature for their users.

Controlling the import with autoImport When an auto plugin provides a stable field such as `val` or `object` named `autoImport`, the contents of the field are wildcard imported in `set`, `eval`, and `.sbt` files. In the next example, we'll replace our hello command with a task to get the value of `greeting` easily. In practice, it's recommended to prefer settings or tasks to commands.

```
package sbthello

import sbt._
import Keys._

object HelloPlugin3 extends AutoPlugin {
  object autoImport {
    val greeting = settingKey[String]("greeting")
    val hello = taskKey[Unit]("say hello")
```

```
  }
  import autoImport._
  override def trigger = allRequirements
  override lazy val buildSettings = Seq(
    greeting := "Hi!",
    hello := helloTask.value)
  lazy val helloTask =
    Def.task {
      println(greeting.value)
    }
}
```

Typically, `autoImport` is used to provide new keys - `SettingKeys`, `TaskKeys`, or `InputKeys` - or core methods without requiring an import or qualification.

Example Plugin An example of a typical plugin:

`build.sbt`:

```
sbtPlugin := true

name := "sbt-obfuscate"

organization := "org.example"
```

`ObfuscatePlugin.scala`:

```
package sbtobfuscate

import sbt._
import sbt.Keys._

object ObfuscatePlugin extends AutoPlugin {
  // by defining autoImport, the settings are automatically imported into user's `*.sbt`
  object autoImport {
    // configuration points, like the built-in `version`, `libraryDependencies`, or `compile
    val obfuscate = taskKey[Seq[File]]("Obfuscates files.")
    val obfuscateLiterals = settingKey[Boolean]("Obfuscate literals.")

    // default values for the tasks and settings
    lazy val baseObfuscateSettings: Seq[Def.Setting[_]] = Seq(
      obfuscate := {
        Obfuscate(sources.value, (obfuscateLiterals in obfuscate).value)
      },
      obfuscateLiterals in obfuscate := false
```

```
    )
  }

  import autoImport._
  override def requires = sbt.plugins.JvmPlugin

  // This plugin is automatically enabled for projects which are JvmPlugin.
  override def trigger = allRequirements

  // a group of settings that are automatically added to projects.
  override val projectSettings =
    inConfig(Compile)(baseObfuscateSettings) ++
    inConfig(Test)(baseObfuscateSettings)
}

object Obfuscate {
  def apply(sources: Seq[File], obfuscateLiterals: Boolean): Seq[File] = {
    // TODO obfuscate stuff!
    sources
  }
}
```

Usage example A build definition that uses the plugin might look like. `obfuscate.sbt`:

```
obfuscateLiterals in obfuscate := true
```

Global plugins example The simplest global plugin definition is declaring a library or plugin in `~/.sbt/1.0/plugins/build.sbt`:

```
libraryDependencies += "org.example" %% "example-plugin" % "0.1"
```

This plugin will be available for every sbt project for the current user.

In addition:

- Jars may be placed directly in `~/.sbt/1.0/plugins/lib/` and will be available to every build definition for the current user.
- Dependencies on plugins built from source may be declared in `~/.sbt/1.0/plugins/project/Build.scala` as described at .scala build definition.
- A Plugin may be directly defined in Scala source files in `~/.sbt/1.0/plugins/`, such as `~/.sbt/1.0/plugins/MyPlugin.scala`. `~/.sbt/1.0/plugins//build.sbt` should contain `sbtPlugin := true`. This can be used for quicker turnaround when developing a plugin initially:

1. Edit the global plugin code
2. `reload` the project you want to use the modified plugin in
3. sbt will rebuild the plugin and use it for the project. Additionally, the plugin will be available in other projects on the machine without recompiling again. This approach skips the overhead of `publishLocal` and `clean`ing the plugins directory of the project using the plugin.

These are all consequences of `~/.sbt/1.0/plugins/` being a standard project whose classpath is added to every sbt project's build definition.

Using a library in a build definition example

As an example, we'll add the Grizzled Scala library as a plugin. Although this does not provide sbt-specific functionality, it demonstrates how to declare plugins.

1a) Manually managed

1. Download the jar manually from https://oss.sonatype.org/content/repositories/releases/org/clapper/grizzled-scala_2.8.1/1.0.4/grizzled-scala_2.8.1-1.0.4.jar
2. Put it in `project/lib/`

1b) Automatically managed: direct editing approach Edit `project/plugins.sbt` to contain:

```
libraryDependencies += "org.clapper" %% "grizzled-scala" % "1.0.4"
```

If sbt is running, do `reload`.

1c) Automatically managed: command-line approach We can change to the plugins project in `project/` using `reload plugins`.

```
$ sbt
> reload plugins
[info] Set current project to default (in build file:/Users/sbt/demo2/project/)
>
```

Then, we can add dependencies like usual and save them to `project/plugins.sbt`. It is useful, but not required, to run `update` to verify that the dependencies are correct.

```
> set libraryDependencies += "org.clapper" %% "grizzled-scala" % "1.0.4"
...
> update
...
> session save
...
```

To switch back to the main project use `reload return`:

```
> reload return
[info] Set current project to root (in build file:/Users/sbt/demo2/)
```

1d) Project dependency This variant shows how to use sbt's external project support to declare a source dependency on a plugin. This means that the plugin will be built from source and used on the classpath.

Edit `project/plugins.sbt`

```
lazy val root = (project in file(".")).dependsOn(assemblyPlugin)

lazy val assemblyPlugin = RootProject(uri("git://github.com/sbt/sbt-assembly"))
```

If sbt is running, run `reload`.

Note that this approach can be useful used when developing a plugin. A project that uses the plugin will rebuild the plugin on `reload`. This saves the intermediate steps of `publishLocal` and `update`. It can also be used to work with the development version of a plugin from its repository.

It is however recommended to explicitly specify the commit or tag by appending it to the repository as a fragment:

```
lazy val assemblyPlugin = uri("git://github.com/sbt/sbt-assembly#0.9.1")
```

One caveat to using this method is that the local sbt will try to run the remote plugin's build. It is quite possible that the plugin's own build uses a different sbt version, as many plugins cross-publish for several sbt versions. As such, it is recommended to stick with binary artifacts when possible.

2) Use the library Grizzled Scala is ready to be used in build definitions. This includes the `eval` and `set` commands and `.sbt` and `project/*.scala` files.

```
> eval grizzled.sys.os
```

In a `build.sbt` file:

```
import grizzled.sys._
import OperatingSystem._

libraryDependencies ++=
    if(os == Windows)
        Seq("org.example" % "windows-only" % "1.0")
    else
        Seq.empty
```

Best Practices

If you're a plugin writer, please consult the Plugins Best Practices page; it contains a set of guidelines to help you ensure that your plugin is consistent and plays well with other plugins.

Plugins Best Practices

This page is intended primarily for sbt plugin authors. This page assumes you've read using plugins and Plugins.

A plugin developer should strive for consistency and ease of use. Specifically:

- Plugins should play well with other plugins. Avoiding namespace clashes (in both sbt and Scala) is paramount.
- Plugins should follow consistent conventions. The experiences of an sbt *user* should be consistent, no matter what plugins are pulled in.

Here are some current plugin best practices.

> **Note:** Best practices are evolving, so check back frequently.

Key naming convention: Use prefix

Sometimes, you need a new key, because there is no existing sbt key. In this case, use a plugin-specific prefix.

```
package sbtassembly

import sbt._, Keys._

object AssemblyPlugin extends AutoPlugin {
```

```scala
  object autoImport {
    val assembly                  = taskKey[File]("Builds a deployable fat jar.")
    val assembleArtifact          = settingKey[Boolean]("Enables (true) or disables (false)
    val assemblyOption            = taskKey[AssemblyOption]("Configuration for making a depl
    val assembledMappings         = taskKey[Seq[MappingSet]]("Keeps track of jar origins for

    val assemblyPackageScala      = taskKey[File]("Produces the scala artifact.")
    val assemblyJarName           = taskKey[String]("name of the fat jar")
    val assemblyMergeStrategy     = settingKey[String => MergeStrategy]("mapping from archiv
  }

  import autoImport._

  ....
}
```

In this approach, every `val` starts with `assembly`. A user of the plugin would refer to the settings like this in `build.sbt`:

```scala
assembly / assemblyJarName := "something.jar"
```

Inside sbt shell, the user can refer to the setting in the same way:

```
sbt:helloworld> show assembly/assemblyJarName
[info] helloworld-assembly-0.1.0-SNAPSHOT.jar
```

Avoid sbt 0.12 style key names where the key's Scala identifier and shell uses kebab-casing:

- BAD: `val jarName = SettingKey[String]("assembly-jar-name")`
- BAD: `val jarName = SettingKey[String]("jar-name")`
- GOOD: `val assemblyJarName = taskKey[String]("name of the fat jar")`

Because there's a single namespace for keys both in `build.sbt` and in sbt shell, if different plugins use generic sounding key names like `jarName` and `excludedFiles` they will cause name conflict.

Artifact naming convention

Use the `sbt-$projectname` scheme to name your library and artifact. A plugin ecosystem with a consistent naming convention makes it easier for users to tell whether a project or dependency is an SBT plugin.

If the project's name is `foobar` the following holds:

- BAD: `foobar`
- BAD: `foobar-sbt`
- BAD: `sbt-foobar-plugin`
- GOOD: `sbt-foobar`

If your plugin provides an obvious "main" task, consider naming it `foobar` or `foobar...` to make it more intuitive to explore the capabilities of your plugin within the sbt shell and tab-completion.

(optional) Plugin naming convention

Name your plugin as `FooBarPlugin`.

Don't use default package

Users who have their build files in some package will not be able to use your plugin if it's defined in default (no-name) package.

Get your plugins known

Make sure people can find your plugin. Here are some of the recommended steps:

1. Mention [@scala_sbt](https://twitter.com/scala_sbt) in your announcement, and we will RT it.
2. Send a pull req to sbt/website and add your plugin on the plugins list.

Reuse existing keys

sbt has a number of predefined keys. Where possible, reuse them in your plugin. For instance, don't define:

```
val sourceFiles = settingKey[Seq[File]]("Some source files")
```

Instead, reuse sbt's existing `sources` key.

Use settings and tasks. Avoid commands.

Your plugin should fit in naturally with the rest of the sbt ecosystem. The first thing you can do is to avoid defining commands, and use settings and tasks and task-scoping instead (see below for more on task-scoping). Most of the interesting things in sbt like `compile`, `test` and `publish` are provided using tasks. Tasks can take advantage of duplication reduction and parallel execution by the task engine. With features like ScopeFilter, many of the features that previously required commands are now possible using tasks.

Settings can be composed from other settings and tasks. Tasks can be composed from other tasks and input tasks. Commands, on the other hand, cannot be composed from any of the above. In general, use the minimal thing that you need. One legitimate use of commands may be using plugin to access the build definition itself not the code. sbt-inspectr was implemented using a command before it became `inspect tree`.

Provide core feature in a plain old Scala object

The core feature of sbt's `package` task, for example, is implemented in sbt.Package, which can be called via its `apply` method. This allows greater reuse of the feature from other plugins such as sbt-assembly, which in return implements `sbtassembly.Assembly` object to implement its core feature.

Follow their lead, and provide core feature in a plain old Scala object.

Configuration advices

If your plugin introduces either a new set of source code or its own library dependencies, only then you want your own configuration.

You probably won't need your own configuration Configurations should *not* be used to namespace keys for a plugin. If you're merely adding tasks and settings, don't define your own configuration. Instead, reuse an existing one *or* scope by the main task (see below).

```
package sbtwhatever

import sbt._, Keys._

object WhateverPlugin extends sbt.AutoPlugin {
  override def requires = plugins.JvmPlugin
  override def trigger = allRequirements
```

```
  object autoImport {
    // BAD sample
    lazy val Whatever = config("whatever") extend(Compile)
    lazy val specificKey = settingKey[String]("A plugin specific key")
  }
  import autoImport._
  override lazy val projectSettings = Seq(
    specificKey in Whatever := "another opinion" // DON'T DO THIS
  )
}
```

When to define your own configuration If your plugin introduces either a new set of source code or its own library dependencies, only then you want your own configuration. For instance, suppose you've built a plugin that performs fuzz testing that requires its own fuzzing library and fuzzing source code. `scalaSource` key can be reused similar to `Compile` and `Test` configuration, but `scalaSource` scoped to `Fuzz` configuration (denoted as `scalaSource in Fuzz`) can point to `src/fuzz/scala` so it is distinct from other Scala source directories. Thus, these three definitions use the same *key*, but they represent distinct *values*. So, in a user's `build.sbt`, we might see:

```
scalaSource in Fuzz := baseDirectory.value / "source" / "fuzz" / "scala"

scalaSource in Compile := baseDirectory.value / "source" / "main" / "scala"
```

In the fuzzing plugin, this is achieved with an `inConfig` definition:

```
package sbtfuzz

import sbt._, Keys._

object FuzzPlugin extends sbt.AutoPlugin {
  override def requires = plugins.JvmPlugin
  override def trigger = allRequirements

  object autoImport {
    lazy val Fuzz = config("fuzz") extend(Compile)
  }
  import autoImport._

  lazy val baseFuzzSettings: Seq[Def.Setting[_]] = Seq(
    test := {
      println("fuzz test")
    }
```

```
  )
  override lazy val projectSettings = inConfig(Fuzz)(baseFuzzSettings)
}
```

When defining a new type of configuration, e.g.

```
lazy val Fuzz = config("fuzz") extend(Compile)
```

should be used to create a configuration. Configurations actually tie into dependency resolution (with Ivy) and can alter generated pom files.

Playing nice with configurations Whether you ship with a configuration or not, a plugin should strive to support multiple configurations, including those created by the build user. Some tasks that are tied to a particular configuration can be re-used in other configurations. While you may not see the need immediately in your plugin, some project may and will ask you for the flexibility.

Provide raw settings and configured settings Split your settings by the configuration axis like so:

```
package sbtobfuscate

import sbt._, Keys._

object ObfuscatePlugin extends sbt.AutoPlugin {
  override def requires = plugins.JvmPlugin
  override def trigger = allRequirements

  object autoImport {
    lazy val obfuscate = taskKey[Seq[File]]("obfuscate the source")
    lazy val obfuscateStylesheet = settingKey[File]("obfuscate stylesheet")
  }
  import autoImport._
  lazy val baseObfuscateSettings: Seq[Def.Setting[_]] = Seq(
    obfuscate := Obfuscate((sources in obfuscate).value),
    sources in obfuscate := sources.value
  )
  override lazy val projectSettings = inConfig(Compile)(baseObfuscateSettings)
}

// core feature implemented here
object Obfuscate {
  def apply(sources: Seq[File]): Seq[File] = {
```

```
    sources
  }
}
```

The `baseObfuscateSettings` value provides base configuration for the plugin's tasks. This can be re-used in other configurations if projects require it. The `obfuscateSettings` value provides the default `Compile` scoped settings for projects to use directly. This gives the greatest flexibility in using features provided by a plugin. Here's how the raw settings may be reused:

```
import sbtobfuscate.ObfuscatePlugin

lazy val app = (project in file("app"))
  .settings(inConfig(Test)(ObfuscatePlugin.baseObfuscateSettings))
```

Scoping advices

In general, if a plugin provides keys (settings and tasks) with the widest scoping, and refer to them with the narrowest scoping, it will give the maximum flexibility to the build users.

Provide default values in `globalSettings` If the default value of your settings or task does not transitively depend on a project-level settings (such as `baseDirectory`, `compile`, etc), define it in `globalSettings`.

For example, in `sbt.Defaults` keys related to publishing such as `licenses`, `developers`, and `scmInfo` are all defined at the `Global` scope, typically to empty values like `Nil` and `None`.

```
package sbtobfuscate

import sbt._, Keys._

object ObfuscatePlugin extends sbt.AutoPlugin {
  override def requires = plugins.JvmPlugin
  override def trigger = allRequirements

  object autoImport {
    lazy val obfuscate = taskKey[Seq[File]]("obfuscate the source")
    lazy val obfuscateOption = settingKey[ObfuscateOption]("options to configure obfuscate")
  }
  import autoImport._
  override lazy val globalSettings = Seq(
    obfuscateOption := ObfuscateOption()
```

```
  )

  override lazy val projectSettings = inConfig(Compile)(
    obfuscate := {
      Obfuscate(
        (obfuscate / sources).value,
        (obfuscate / obfuscateOption).value
      )
    },
    obfuscate / sources := sources.value
  )
}

// core feature implemented here
object Obfuscate {
  def apply(sources: Seq[File], opt: ObfuscateOption): Seq[File] = {
    sources
  }
}
```

In the above, `obfuscateOption` is set a default made-up value in the `globalSettings`; but is used as `(obfuscate / obfuscateOption)` in the `projectSettings`. This lets the user either set `obfuscate / obfuscateOption` at a particular subproject level, or scoped to `ThisBuild` affecting all subprojects:

```
ThisBuild / obfuscate / obfuscateOption := ObfuscateOption().withX(true)
```

Giving keys default values in global scope requires knowing that every key (if any) used to define that key must *also* be defined in global scope, otherwise it will fail at load time.

Using a "main" task scope for settings Sometimes you want to define some settings for a particular "main" task in your plugin. In this instance, you can scope your settings using the task itself. See the `baseObfuscateSettings`:

```
  lazy val baseObfuscateSettings: Seq[Def.Setting[_]] = Seq(
    obfuscate := Obfuscate((sources in obfuscate).value),
    sources in obfuscate := sources.value
  )
```

In the above example, `sources in obfuscate` is scoped under the main task, `obfuscate`.

Rewiring existing keys in `globalSettings` There may be times when you need to rewire an existing key in `globalSettings`. The general rule is *be careful what you touch*.

Care should be taken to ensure previous settings from other plugins are not ignored. e.g. when creating a new `onLoad` handler, ensure that the previous `onLoad` handler is not removed.

```
package sbtsomething

import sbt._, Keys._

object MyPlugin extends AutoPlugin {
  override def requires = plugins.JvmPlugin
  override def trigger = allRequirements

  override val globalSettings: Seq[Def.Setting[_]] = Seq(
    onLoad in Global := (onLoad in Global).value andThen { state =>
      ... return new state ...
    }
  )
}
```

Setting up Travis CI with sbt

Travis CI is a hosted continuous integration service for open source and private projects. Many of the OSS projects hosted on GitHub uses open source edition of Travis CI to validate pushes and pull requests. We'll discuss some of the best practices setting up Travis CI.

Set `project/build.properties`

Continuous integration is a great way of checking that your code works outside of your machine. If you haven't created one already, make sure to create `project/build.properties` and explicitly set the `sbt.version` number:

```
sbt.version=1.2.1
```

Your build will now use 1.2.1.

Read the Travis manual

A treasure trove of Travis tricks can be found in the Travis's official documentation. Use this guide as an inspiration, but consult the official source for more details.

Basic setup

Setting up your build for Travis CI is mostly about setting up `.travis.yml`. Scala page says the basic file can look like:

```
language: scala

jdk: oraclejdk8

scala:
   - 2.10.4
   - 2.12.6
```

By default Travis CI executes `sbt ++$TRAVIS_SCALA_VERSION test`. Let's specify that explicitly:

```
language: scala

jdk: oraclejdk8

scala:
   - 2.10.4
   - 2.12.6

script:
   - sbt ++$TRAVIS_SCALA_VERSION test
```

More info on `script` section can be found in Configuring your build.

As noted on the Scala page, Travis CI uses paulp/sbt-extras as the `sbt` command. This becomes relevant when you want to override JVM options, which we'll see later.

Plugin build setup

For sbt plugins, there is no need for cross building on Scala, so the following is all you need:

```
language: scala

jdk: oraclejdk8

script:
   - sbt scripted
```

Another source of good information is to read the output by Travis CI itself to learn about how the virtual environment is set up. For example, from the following output we learn that it is using `JVM_OPTS` environment variable to pass in the JVM options.

```
$ export JVM_OPTS=@/etc/sbt/jvmopts
$ export SBT_OPTS=@/etc/sbt/sbtopts
```

Custom JVM options

The default sbt and JVM options are set by Travis CI people, and it should work for most cases. If you do decide to customize it, read what they currently use as the defaults first. Because Travis is already using the environment variable `JVM_OPTS`, we can instead create a file `travis/jvmopts`:

```
-Dfile.encoding=UTF8
-Xms2048M
-Xmx2048M
-Xss6M
-XX:ReservedCodeCacheSize=256M
```

and then write out the `script` section with `-jvm-opts` option:

```
script:
   - sbt ++$TRAVIS_SCALA_VERSION -jvm-opts travis/jvmopts test
```

After making the change, confirm on the Travis log to see if the flags are taking effect:

```
# Executing command line:
java
-Dfile.encoding=UTF8
-Xms2048M
-Xmx2048M
-Xss6M
-XX:ReservedCodeCacheSize=256M
-jar
/home/travis/.sbt/launchers/1.2.1/sbt-launch.jar
```

It seems to be working. One downside of setting all of the parameters is that we might be left behind when the environment updates and the default values gives us more memory in the future.

Here's how we can add just a few JVM options:

```
script:
  - sbt ++$TRAVIS_SCALA_VERSION -Dfile.encoding=UTF8 -J-XX:ReservedCodeCacheSize=256M -J-Xms1
```

sbt-extra script passes any arguments starting with either `-D` or `-J` directly to JVM.

Again, let's check the Travis log to see if the flags are taking effect:

```
# Executing command line:
java
-Xms2048M
-Xmx2048M
-Xss6M
-Dfile.encoding=UTF8
-XX:ReservedCodeCacheSize=256M
-Xms1024M
-jar
/home/travis/.sbt/launchers/1.2.1/sbt-launch.jar
```

Note: This duplicates the `-Xms` flag as intended, which might not the best thing to do.

Caching

In late 2014, thanks to Travis CI members sending pull requests on GitHub, we learned that Ivy cache can be shared across the Travis builds. The public availability of caching is part of the benefit for trying the new container-based infrastructure.

> Jobs running on container-based infrastructure:
>
> 1. start up faster
> 2. allow the use of caches for public repositories
> 3. disallow the use of `sudo`, setuid and setgid executables

To opt into the container-based infrastructure, put the following in `.travis.yml`:

```
# Use container-based infrastructure
sudo: false
```

Next, we can put `cache` section as follows:

```
# These directories are cached to S3 at the end of the build
cache:
  directories:
    - $HOME/.ivy2/cache
    - $HOME/.sbt
```

Finally, the following a few lines of cleanup script are added:

```
before_cache:
  # Cleanup the cached directories to avoid unnecessary cache updates
  - find $HOME/.ivy2/cache -name "ivydata-*.properties" -print -delete
  - find $HOME/.sbt        -name "*.lock"               -print -delete
```

With the above changes combined Travis CI will tar up the cached directories and uploads them to Amazon S3. Overall, the use of the new infrastructure and caching seems to shave off a few minutes of build time per job.

Note: The Travis documentation states caching features are still experimental.

Build matrix

We've already seen the example of Scala cross building.

```
language: scala

jdk: oraclejdk8

scala:
   - 2.10.4
   - 2.12.6

script:
   - sbt ++$TRAVIS_SCALA_VERSION test
```

We can also form a build matrix using environment variables:

```
env:
  global:
    - SOME_VAR="1"

  # This splits the build into two parts
  matrix:
    - TEST_COMMAND="scripted sbt-assembly/*"
    - TEST_COMMAND="scripted merging/* caching/*"
```

```
script:
   - sbt "$TEST_COMMAND"
```

Now two jobs will be created to build this sbt plugin, simultaneously running different integration tests. This technique is described in Parallelizing your builds across virtual machines.

Notification

You can configure Travis CI to notify you.

> By default, email notifications will be sent to the committer and the commit author, if they are members of the repository[…].
>
> And it will by default send emails when, on the given branch:
>
> - a build was just broken or still is broken
> - a previously broken build was just fixed

The default behavior looks reasonable, but if you want, we can override the `notifications` section to email you on successful builds too, or to use some other channel of communication like IRC.

```
# Email specific recipient all the time
notifications:
  email:
    recipients:
      - one@example.com
  on_success: always # default: change
```

This might also be a good time to read up on encryption using the command line `travis` tool.

```
$ travis encrypt one@example.com
```

Dealing with flaky network or tests

For builds that are more prone to flaky network or tests, Travis CI has created some tricks described in the page My builds is timing out.

Starting your command with `travis_retry` retries the command three times if the return code is non-zero. With caching, hopefully the effect of flaky network is reduced, but it's an interesting one nonetheless. Here are some cautionary words from the documentation:

> We recommend careful use of `travis_retry`, as overusing it can extend your build time when there could be a deeper underlying issue.

Another tidbit about Travis is the output timeout:

> Our builds have a global timeout and a timeout that's based on the output. If no output is received from a build for 10 minutes, it's assumed to have stalled for unknown reasons and is subsequently killed.

There's a function called `travis_wait` that can extend this to 20 minutes.

More things

There are more thing you can do, such as set up databases, installing Ubuntu packages, and deploy continuously.

Travis offers the ability to run tests in parallel, and also imposes time limits on builds. If you have an especially long-running suite of scripted tests for your plugin, you can run a subset of scripted tests in a directory, for example:

```
  - TEST_COMMAND="scripted tests/*1of3"
  - TEST_COMMAND="scripted tests/*2of3"
  - TEST_COMMAND="scripted tests/*3of3"
```

Will create three chunks and run each of the chunks separately for the directory `tests`.

Sample setting

Here's a sample that puts them all together. Remember, most of the sections are optional.

```
# Use container-based infrastructure
sudo: false

language: scala

jdk: oraclejdk8

# These directories are cached to S3 at the end of the build
cache:
```

```
  directories:
    - $HOME/.ivy2/cache
    - $HOME/.sbt/boot/

jdk: oraclejdk8

env:
  # This splits the build into two parts
  matrix:
    - TEST_COMMAND="scripted sbt-assembly/*"
    - TEST_COMMAND="scripted merging/* caching/*"

script:
 - sbt -Dfile.encoding=UTF8 -J-XX:ReservedCodeCacheSize=256M "$TEST_COMMAND"

before_cache:
  # Tricks to avoid unnecessary cache updates
  - find $HOME/.sbt -name "*.lock" | xargs rm
  - find $HOME/.ivy2 -name "ivydata-*.properties" | xargs rm

# Email specific recipient all the time
notifications:
  email:
    recipients:
      secure: "Some/BASE64/STUFF="
    on_success: always # default: change
```

Testing sbt plugins

Let's talk about testing. Once you write a plugin, it turns into a long-term thing. To keep adding new features (or to keep fixing bugs), writing tests makes sense.

scripted test framework

sbt comes with scripted test framework, which lets you script a build scenario. It was written to test sbt itself on complex scenarios – such as change detection and partial compilation:

> Now, consider what happens if you were to delete B.scala but do not update A.scala. When you recompile, you should get an error because B no longer exists for A to reference. [… (really complicated stuff)]

> The scripted test framework is used to verify that sbt handles cases such as that described above.

The framework is made available via scripted-plugin. The rest of this page explains how to include the scripted-plugin into your plugin.

step 1: snapshot

Before you start, set your version to a **-SNAPSHOT** one because scripted-plugin will publish your plugin locally. If you don't use SNAPSHOT, you could get into a horrible inconsistent state of you and the rest of the world seeing different artifacts.

step 2: scripted-plugin

Add scripted-plugin to your plugin build. `project/scripted.sbt`:

```
libraryDependencies += { "org.scala-sbt" %% "scripted-plugin" % sbtVersion.value }
```

Then add the following settings to `build.sbt`:

```
scriptedLaunchOpts := { scriptedLaunchOpts.value ++
  Seq("-Xmx1024M", "-Dplugin.version=" + version.value)
}
scriptedBufferLog := false
```

step 3: src/sbt-test

Make dir structure `src/sbt-test/<test-group>/<test-name>`. For starters, try something like `src/sbt-test/<your-plugin-name>/simple`.

Now ready? Create an initial build in `simple`. Like a real build using your plugin. I'm sure you already have several of them to test manually. Here's an example `build.sbt`:

```
lazy val root = (project in file("."))
  .settings(
    version := "0.1",
    scalaVersion := "2.10.6",
    assemblyJarName in assembly := "foo.jar"
  )
```

In `project/plugins.sbt`:

```scala
sys.props.get("plugin.version") match {
  case Some(x) => addSbtPlugin("com.eed3si9n" % "sbt-assembly" % x)
  case _ => sys.error("""|The system property 'plugin.version' is not defined.
Specify this property using the scriptedLaunchOpts -D.""".stripMargin)
}
```

This a trick I picked up from JamesEarlDouglas/xsbt-web-plugin@feabb2, which allows us to pass version number into the test.

I also have `src/main/scala/hello.scala`:

```scala
object Main extends App {
  println("hello")
}
```

step 4: write a script

Now, write a script to describe your scenario in a file called `test` located at the root dir of your test project.

```
# check if the file gets created
> assembly
$ exists target/scala-2.10/foo.jar
```

Here is the syntax for the script:

1. `#` starts a one-line comment
2. `>` `name` sends a task to sbt (and tests if it succeeds)
3. `$` `name arg*` performs a file command (and tests if it succeeds)
4. `->` `name` sends a task to sbt, but expects it to fail
5. `-$` `name arg*` performs a file command, but expects it to fail

File commands are:

- `touch` `path+` creates or updates the timestamp on the files
- `delete` `path+` deletes the files
- `exists` `path+` checks if the files exist
- `mkdir` `path+` creates dirs
- `absent` `path+` checks if the files don't exist
- `newer` `source target` checks if `source` is newer
- `must-mirror` `source target` checks if `source` is identical
- `pause` pauses until enter is pressed
- `sleep` `time` sleeps

- `exec command args*` runs the command in another process
- `copy-file fromPath toPath` copies the file
- `copy fromPath+ toDir` copies the paths to `toDir` preserving relative structure
- `copy-flat fromPath+ toDir` copies the paths to `toDir` flat

So my script will run `assembly` task, and checks if `foo.jar` gets created. We'll cover more complex tests later.

step 5: run the script

To run the scripts, go back to your plugin project, and run:

```
> scripted
```

This will copy your test build into a temporary dir, and executes the `test` script. If everything works out, you'd see `publishLocal` running, then:

```
Running sbt-assembly / simple
[success] Total time: 18 s, completed Sep 17, 2011 3:00:58 AM
```

step 6: custom assertion

The file commands are great, but not nearly enough because none of them test the actual contents. An easy way to test the contents is to implement a custom task in your test build.

For my hello project, I'd like to check if the resulting jar prints out "hello". I can take advantage of `scala.sys.process.Process` to run the jar. To express a failure, just throw an error. Here's `build.sbt`:

```
import scala.sys.process.Process

lazy val root = (project in file("."))
  .settings(
    version := "0.1",
    scalaVersion := "2.10.6",
    assemblyJarName in assembly := "foo.jar",
    TaskKey[Unit]("check") := {
      val process = Process("java", Seq("-jar", (crossTarget.value / "foo.jar").toString))
      val out = (process!!)
      if (out.trim != "bye") sys.error("unexpected output: " + out)
      ()
    }
  )
```

I am intentionally testing if it matches "bye", to see how the test fails.

Here's `test`:

```
# check if the file gets created
> assembly
$ exists target/foo.jar

# check if it says hello
> check
```

Running `scripted` fails the test as expected:

```
[info] [error] {file:/private/var/folders/Ab/AbC1EFghIj4LMNOPqrStUV+++XX/-Tmp-/sbt_cdd1b3c4/
[info] [error] Total time: 0 s, completed Sep 21, 2011 8:43:03 PM
[error] x sbt-assembly / simple
[error]    {line 6}  Command failed: check failed
[error] {file:/Users/foo/work/sbt-assembly/}default-373f46/*:scripted: sbt-assembly / simple
[error] Total time: 14 s, completed Sep 21, 2011 8:00:00 PM
```

step 7: testing the test

Until you get the hang of it, it might take a while for the test itself to behave correctly. There are several techniques that may come in handy.

First place to start is turning off the log buffering.

```
> set scriptedBufferLog := false
```

This for example should print out the location of the temporary dir:

```
[info] [info] Set current project to default-c6500b (in build file:/private/var/folders/Ab/AbC1
...
```

Add the following line to your `test` script to suspend the test until you hit the enter key:

```
$ pause
```

If you're thinking about going down to the `sbt/sbt-test/sbt-foo/simple` and running `sbt`, don't do it. The right way, is to copy the dir somewhere else and run it.

step 8: get inspired

There are literally 100+ scripted tests under sbt project itself. Browse around to get inspirations.

For example, here's the one called by-name.

```
> compile

# change => Int to Function0
$ copy-file changes/A.scala A.scala

# Both A.scala and B.scala need to be recompiled because the type has changed
-> compile
```

xsbt-web-plugin and sbt-assembly have some scripted tests too.

That's it! Let me know about your experience in testing plugins!

sbt new and Templates

sbt 0.13.13 adds a new command called new, to create new build definitions from a template. The `new` command is extensible via a mechanism called the template resolver.

Trying new command

First, you need sbt's launcher version 0.13.13 or above. Normally the exact version for the `sbt` launcher does not matter because it will use the version specified by `sbt.version` in `project/build.properties`; however for new sbt's launcher 0.13.13 or above is required as the command functions without a `project/build.properties` present.

Next, run:

```
$ sbt new scala/scala-seed.g8
....
name [hello]:

Template applied in ./hello
```

This ran the template scala/scala-seed.g8 using Giter8, prompted for values for "name" (which has a default value of "hello", which we accepted hitting `[Enter]`), and created a build under `./hello`.

`scala-seed` is the official template for a "minimal" Scala project, but it's definitely not the only one out there.

Giter8 support

Giter8 is a templating project originally started by Nathan Hamblen in 2010, and now maintained by the foundweekends project. The unique aspect of Giter8 is that it uses GitHub (or any other git repository) to host the templates, so it allows anyone to participate in template creation. Here are some of the templates provided by official sources:

- foundweekends/giter8.g8 (A template for Giter8 templates)
- scala/scala-seed.g8 (Seed template for Scala)
- scala/hello-world.g8 (A template to demonstrate a minimal Scala application)
- scala/scalatest-example.g8 (A template for trying out ScalaTest)
- akka/akka-scala-seed.g8 (A minimal seed template for an Akka with Scala build)
- akka/akka-java-seed.g8 (A minimal seed template for an Akka in Java)
- akka/hello-akka.g8 (Simple Akka application)
- playframework/play-scala-seed.g8 (Play Scala Seed Template)
- playframework/play-java-seed.g8 (Play Java Seed template)
- lagom/lagom-scala.g8 (A Lagom Scala seed template for sbt)
- lagom/lagom-java.g8 (A Lagom Java seed template for sbt)
- scala-native/scala-native.g8 (Scala Native)
- scala-native/sbt-crossproject.g8 (sbt-crosspoject)
- http4s/http4s.g8 (http4s services)
- unfiltered/unfiltered.g8 (Unfiltered application)
- scalatra/scalatra-sbt.g8 (Basic Scalatra template using SBT 0.13.x.)

For more, see Giter8 templates on the Giter8 wiki. sbt provides out-of-the-box support for Giter8 templates by shipping with a template resolver for Giter8.

Giter8 parameters You can append Giter8 parameters to the end of the command, so for example to specify a particular branch you can use:

```
$ sbt new scala/scala-seed.g8 --branch myBranch
```

How to create a Giter8 template See Making your own templates for the details on how to create a new Giter8 template.

```
$ sbt new foundweekends/giter8.g8
```

Use CC0 1.0 for template licensing We recommend licensing software templates under CC0 1.0, which waives all copyrights and related rights, similar to the "public domain."

If you reside in a country covered by the Berne Convention, such as the US, copyright will arise automatically without registration. Thus, people won't have legal right to use your template if you do not declare the terms of license. The tricky thing is that even permissive licenses such as MIT License and Apache License will require attribution to your template in the template user's software. To remove all claims to the templated snippets, distribute it under CC0, which is an international equivalent to public domain.

```
License
-------
Written in <YEAR> by <AUTHOR NAME> <AUTHOR E-MAIL ADDRESS>
[other author/contributor lines as appropriate]
To the extent possible under law, the author(s) have dedicated all copyright and related and neig
You should have received a copy of the CC0 Public Domain Dedication along with this software. If
```

How to extend sbt new

The rest of this page explains how to extend the `sbt new` command to provide support for something other than Giter8 templates. You can skip this section if you're not interested in extending `new`.

Template Resolver A template resolver is a partial function that looks at the arguments after `sbt new` and determines whether it can resolve to a particular template. This is analogous to `resolvers` resolving a `ModuleID` from the Internet.

The `Giter8TemplateResolver` takes the first argument that does not start with a hyphen (`-`), and checks whether it looks like a GitHub repo or a git repo that ends in ".g8". If it matches one of the patterns, it will pass the arguments to Giter8 to process.

To create your own template resolver, create a library that has `template-resolver` as a dependency:

```scala
val templateResolverApi = "org.scala-sbt" % "template-resolver" % "0.1"
```

and extend `TemplateResolver`, which is defined as:

```java
package sbt.template;

/** A way of specifying template resolver.
```

```
 */
public interface TemplateResolver {
  /** Returns true if this resolver can resolve the given argument.
   */
  public boolean isDefined(String[] arguments);
  /** Resolve the given argument and run the template.
   */
  public void run(String[] arguments);
}
```

Publish the library to sbt community repo or Maven Central.

templateResolverInfos Next, create an sbt plugin that adds a `TemplateResolverInfo` to `templateResolverInfos`.

```
import Def.Setting
import Keys._

/** An experimental plugin that adds the ability for Giter8 templates to be resolved
 */
object Giter8TemplatePlugin extends AutoPlugin {
  override def requires = CorePlugin
  override def trigger = allRequirements

  override lazy val globalSettings: Seq[Setting[_]] =
    Seq(
      templateResolverInfos +=
        TemplateResolverInfo(ModuleID("org.scala-sbt.sbt-giter8-resolver", "sbt-giter8-reso
          "sbtgiter8resolver.Giter8TemplateResolver")
    )
}
```

This indirecton allows template resolvers to have a classpath independent from the rest of the build.

Cross building plugins

Like we are able to cross build against multiple Scala versions, we can cross build sbt 1.0 plugins while staying on sbt 0.13. This is useful because we can port one plugin at a time.

1. If the plugin depends on libraries, make sure there are Scala 2.12 artifacts for them.

2. Use the latest sbt 0.13.16.
3. Append the following settings to your plugin project (and any other sub-projects that it depends):

```
.settings(
  scalaVersion := "2.12.6",
  sbtVersion in Global := "1.2.1",
  scalaCompilerBridgeSource := {
    val sv = appConfiguration.value.provider.id.version
    ("org.scala-sbt" % "compiler-interface" % sv % "component").sources
  }
)
```

Hopefully the last step will be simplified using @jrudolph's sbt-cross-building in the future. If you run into problems upgrading a plugin, please report to GitHub issue.

How to...

See Detailed Table of Contents for the list of all the how-tos.

Classpaths

Include a new type of managed artifact on the classpath, such as `mar`

The `classpathTypes` setting controls the types of managed artifacts that are included on the classpath by default. To add a new type, such as `mar`,

```
classpathTypes += "mar"
```

Get the classpath used for compilation

See the default types included by running `show classpathTypes` at the sbt prompt.

The `dependencyClasspath` task scoped to `Compile` provides the classpath to use for compilation. Its type is `Seq[Attributed[File]]`, which means that each entry carries additional metadata. The `files` method provides just the raw `Seq[File]` for the classpath. For example, to use the files for the compilation classpath in another task, :

```
example := {
  val cp: Seq[File] = (dependencyClasspath in Compile).value.files
  ...
}
```

> **Note**: This classpath does not include the class directory, which may be necessary for compilation in some situations.

Get the runtime classpath, including the project's compiled classes

The `fullClasspath` task provides a classpath including both the dependencies and the products of project. For the runtime classpath, this means the main resources and compiled classes for the project as well as all runtime dependencies.

The type of a classpath is `Seq[Attributed[File]]`, which means that each entry carries additional metadata. The `files` method provides just the raw `Seq[File]` for the classpath. For example, to use the files for the runtime classpath in another task, :

```
example := {
  val cp: Seq[File] = (fullClasspath in Runtime).value.files
  ...
}
```

Get the test classpath, including the project's compiled test classes

The `fullClasspath` task provides a classpath including both the dependencies and the products of a project. For the test classpath, this includes the main and test resources and compiled classes for the project as well as all dependencies for testing.

The type of a classpath is `Seq[Attributed[File]]`, which means that each entry carries additional metadata. The `files` method provides just the raw `Seq[File]` for the classpath. For example, to use the files for the test classpath in another task, :

```
example := {
  val cp: Seq[File] = (fullClasspath in Test).value.files
  ...
}
```

Use packaged jars on classpaths instead of class directories

By default, `fullClasspath` includes a directory containing class files and resources for a project. This in turn means that tasks like `compile`, `test`, and `run` have these class directories on their classpath. To use the packaged artifact (such as a jar) instead, configure `exportJars` :

```
exportJars := true
```

This will use the result of `packageBin` on the classpath instead of the class directory.

> **Note**: Specifically, fullClasspath is the concatenation of dependencyClasspath and exportedProducts. When exportJars is true, exportedProducts is the output of packageBin. When exportJars is false, exportedProducts is just products, which is by default the directory containing class files and resources.

Get all managed jars for a configuration

The result of the `update` task has type UpdateReport, which contains the results of dependency resolution. This can be used to extract the files for specific types of artifacts in a specific configuration. For example, to get the jars and zips of dependencies in the `Compile` configuration, :

```
example := {
   val artifactTypes = Set("jar", "zip")
   val files =
      Classpaths.managedJars(Compile, artifactTypes, update.value)
   ...
}
```

Get the files included in a classpath

A classpath has type `Seq[Attributed[File]]`, which means that each entry carries additional metadata. The `files` method provides just the raw `Seq[File]` for the classpath. For example, :

```
val cp: Seq[Attributed[File]] = ...
val files: Seq[File] = cp.files
```

Get the module and artifact that produced a classpath entry

A classpath has type `Seq[Attributed[File]]`, which means that each entry carries additional metadata. This metadata is in the form of an AttributeMap. Useful keys for entries in the map are `artifact.key`, `moduleID.key`, and `analysis`. For example,

```
val classpath: Seq[Attributed[File]] = ???
for(entry <- classpath) yield {
   val art: Option[Artifact] = entry.get(artifact.key)
   val mod: Option[ModuleID] = entry.get(moduleID.key)
   val an: Option[inc.Analysis] = entry.get(analysis)
   ...
}
```

> **Note**: Entries may not have some or all metadata. Only entries from source dependencies, such as internal projects, have an incremental compilation Analysis. Only entries for managed dependencies have an Artifact and ModuleID.

Customizing paths

This page describes how to modify the default source, resource, and library directories and what files get included from them.

Change the default Scala source directory

The directory that contains the main Scala sources is by default `src/main/scala`. For test Scala sources, it is `src/test/scala`. To change this, modify `scalaSource` in the `Compile` (for main sources) or `Test` (for test sources). For example,

```
scalaSource in Compile := baseDirectory.value / "src"

scalaSource in Test := baseDirectory.value / "test-src"
```

> **Note**: The Scala source directory can be the same as the Java source directory.

Change the default Java source directory

The directory that contains the main Java sources is by default `src/main/java`. For test Java sources, it is `src/test/java`. To change this, modify `javaSource` in the `Compile` (for main sources) or `Test` (for test sources).

For example,

```
javaSource in Compile := baseDirectory.value / "src"

javaSource in Test := baseDirectory.value / "test-src"
```

> **Note**: The Scala source directory can be the same as the Java source directory.

Change the default resource directory

The directory that contains the main resources is by default `src/main/resources`. For test resources, it is `src/test/resources`. To change this, modify `resourceDirectory` in either the `Compile` or `Test` configuration.

For example,

```
resourceDirectory in Compile := baseDirectory.value / "resources"

resourceDirectory in Test := baseDirectory.value / "test-resources"
```

Change the default (unmanaged) library directory

The directory that contains the unmanaged libraries is by default `lib/`. To change this, modify `unmanagedBase`. This setting can be changed at the project level or in the `Compile`, `Runtime`, or `Test` configurations.

When defined without a configuration, the directory is the default directory for all configurations. For example, the following declares `jars/` as containing libraries:

```
unmanagedBase := baseDirectory.value / "jars"
```

When set for `Compile`, `Runtime`, or `Test`, `unmanagedBase` is the directory containing libraries for that configuration, overriding the default. For example, the following declares `lib/main/` to contain jars only for `Compile` and not for running or testing:

```
unmanagedBase in Compile := baseDirectory.value / "lib" / "main"
```

Disable using the project's base directory as a source directory

By default, sbt includes `.scala` files from the project's base directory as main source files. To disable this, configure `sourcesInBase`:

```
sourcesInBase := false
```

Add an additional source directory

sbt collects `sources` from `unmanagedSourceDirectories`, which by default consists of `scalaSource` and `javaSource`. Add a directory to `unmanagedSourceDirectories` in the appropriate configuration to add a source directory. For example, to add `extra-src` to be an additional directory containing main sources,

```
unmanagedSourceDirectories in Compile += baseDirectory.value / "extra-src"
```

> **Note**: This directory should only contain unmanaged sources, which are sources that are manually created and managed. See Generating Files for working with automatically generated sources.

Add an additional resource directory

sbt collects `resources` from `unmanagedResourceDirectories`, which by default consists of `resourceDirectory`. Add a directory to `unmanagedResourceDirectories` in the appropriate configuration to add another resource directory. For example, to add `extra-resources` to be an additional directory containing main resources,

```
unmanagedResourceDirectories in Compile += baseDirectory.value / "extra-resources"
```

> **Note**: This directory should only contain unmanaged resources, which are resources that are manually created and managed. See Generating Files for working with automatically generated resources.

Include/exclude files in the source directory

When sbt traverses `unmanagedSourceDirectories` for sources, it only includes directories and files that match `includeFilter` and do not match `excludeFilter`. `includeFilter` and `excludeFilter` have type `java.io.FileFilter` and sbt provides some useful combinators for constructing a `FileFilter`. For example, in addition to the default hidden files exclusion, the following also ignores files containing `impl` in their name,

```
excludeFilter in unmanagedSources := HiddenFileFilter || "*impl*"
```

To have different filters for main and test libraries, configure `Compile` and `Test` separately:

```
includeFilter in (Compile, unmanagedSources) := "*.scala" || "*.java"

includeFilter in (Test, unmanagedSources) := HiddenFileFilter || "*impl*"
```

> **Note**: By default, sbt includes `.scala` and `.java` sources, excluding hidden files.

Include/exclude files in the resource directory

When sbt traverses `unmanagedResourceDirectories` for resources, it only includes directories and files that match `includeFilter` and do not match `excludeFilter`. `includeFilter` and `excludeFilter` have type `java.io.FileFilter` and sbt provides some useful combinators for constructing a `FileFilter`. For example, in addition to the default hidden files exclusion, the following also ignores files containing `impl` in their name,

```
excludeFilter in unmanagedResources := HiddenFileFilter || "*impl*"
```

To have different filters for main and test libraries, configure `Compile` and `Test` separately:

```
includeFilter in (Compile, unmanagedResources) := "*.txt"

includeFilter in (Test, unmanagedResources) := "*.html"
```

> **Note**: By default, sbt includes all files that are not hidden.

Include only certain (unmanaged) libraries

When sbt traverses `unmanagedBase` for resources, it only includes directories and files that match `includeFilter` and do not match `excludeFilter`. `includeFilter` and `excludeFilter` have type `java.io.FileFilter` and sbt provides some useful combinators for constructing a `FileFilter`. For example, in addition to the default hidden files exclusion, the following also ignores zips,

```
excludeFilter in unmanagedJars := HiddenFileFilter || "*.zip"
```

To have different filters for main and test libraries, configure `Compile` and `Test` separately:

```
includeFilter in (Compile, unmanagedJars) := "*.jar"

includeFilter in (Test, unmanagedJars) := "*.jar" || "*.zip"
```

> **Note**: By default, sbt includes jars, zips, and native dynamic libraries, excluding hidden files.

Generating files

sbt provides standard hooks for adding source and resource generation tasks.

Generate sources

A source generation task should generate sources in a subdirectory of `sourceManaged` and return a sequence of files generated. The signature of a source generation function (that becomes a basis for a task) is usually as follows:

```
def makeSomeSources(base: File): Seq[File]
```

The key to add the task to is called `sourceGenerators`. Because we want to add the task, and not the value after its execution, we use `taskValue` instead of the usual `value`. `sourceGenerators` should be scoped according to whether the generated files are main (`Compile`) or test (`Test`) sources. This basic structure looks like:

```
sourceGenerators in Compile += <task of type Seq[File]>.taskValue
```

For example, assuming a method `def makeSomeSources(base: File): Seq[File]`,

```
sourceGenerators in Compile += Def.task {
  makeSomeSources((sourceManaged in Compile).value / "demo")
}.taskValue
```

As a specific example, the following source generator generates `Test.scala` application object that once executed, prints `"Hi"` to the console:

```
sourceGenerators in Compile += Def.task {
  val file = (sourceManaged in Compile).value / "demo" / "Test.scala"
  IO.write(file, """object Test extends App { println("Hi") }""")
  Seq(file)
}.taskValue
```

Executing `run` will print `"Hi"`.

```
> run
[info] Running Test
Hi
```

Change `Compile` to `Test` to make it a test source.

NOTE: For the efficiency of the build, `sourceGenerators` should avoid regenerating source files upon each call, and cache based on the input values using `sbt.Tracked.{ inputChanged, outputChanged }` etc instead.

By default, generated sources are not included in the packaged source artifact. To do so, add them as you would other mappings. See Adding files to a package. A source generator can return both Java and Scala sources mixed together in the same sequence. They will be distinguished by their extension later.

Generate resources

A resource generation task should generate resources in a subdirectory of `resourceManaged` and return a sequence of files generated. Like a source generation function, the signature of a resource generation function (that becomes a basis for a task) is usually as follows:

```
def makeSomeResources(base: File): Seq[File]
```

The key to add the task to is called `resourceGenerators`. Because we want to add the task, and not the value after its execution, we use `taskValue` instead of the usual `value`. It should be scoped according to whether the generated files are main (`Compile`) or test (`Test`) resources. This basic structure looks like:

```
resourceGenerators in Compile += <task of type Seq[File]>.taskValue
```

For example, assuming a method `def makeSomeResources(base: File): Seq[File]`,

```
resourceGenerators in Compile += Def.task {
  makeSomeResources((resourceManaged in Compile).value / "demo")
}.taskValue
```

Executing `run` (or `package`, not `compile`) will add a file `demo` to `resourceManaged`, which is `target/scala-*/resource_managed"`. By default, generated resources are not included in the packaged source artifact. To do so, add them as you would other mappings. See Adding files to a package.

As a specific example, the following generates a properties file `myapp.properties` containing the application name and version:

```
resourceGenerators in Compile += Def.task {
  val file = (resourceManaged in Compile).value / "demo" / "myapp.properties"
  val contents = "name=%s\nversion=%s".format(name.value,version.value)
  IO.write(file, contents)
  Seq(file)
}.taskValue
```

Change `Compile` to `Test` to make it a test resource.

NOTE: For the efficiency of the build, `resourceGenerators` should avoid regenerating resource files upon each call, and cache based on the input values using `sbt.Tracked.{ inputChanged, outputChanged }` etc instead.

Inspect the build

Show or search help for a command, task, or setting

The `help` command is used to show available commands and search the help for commands, tasks, or settings. If run without arguments, `help` lists the available commands.

```
> help

 help                    Displays this help message or prints detailed help on
                             requested commands (run 'help <command>').
 about                   Displays basic information about sbt and the build.
 reload                   (Re)loads the project in the current directory
  ...
```

```
> help compile
```

If the argument passed to `help` is the name of an existing command, setting or task, the help for that entity is displayed. Otherwise, the argument is interpreted as a regular expression that is used to search the help of all commands, settings and tasks.

The `tasks` command is like `help`, but operates only on tasks. Similarly, the `settings` command only operates on settings.

See also `help help`, `help tasks`, and `help settings`.

List available tasks

The `tasks` command, without arguments, lists the most commonly used tasks. It can take a regular expression to search task names and descriptions. The verbosity can be increased to show or search less commonly used tasks. See `help tasks` for details.

The `settings` command, without arguments, lists the most commonly used settings. It can take a regular expression to search setting names and descriptions. The verbosity can be increased to show or search less commonly used settings. See `help settings` for details.

List available settings

The `inspect` command displays several pieces of information about a given setting or task, including the dependencies of a task/setting as well as the tasks/settings that depend on the it. For example,

```
> inspect test:compile
...
[info] Dependencies:
[info]  Test / manipulateBytecode
[info]  Test / enableBinaryCompileAnalysis
[info]  Test / compileIncSetup
[info] Reverse dependencies:
[info]  Test / products
[info]  Test / discoveredMainClasses
[info]  Test / printWarnings
[info]  Test / definedTestNames
[info]  Test / definedTests
...
```

See the Inspecting Settings page for details.

Display tree of setting/task dependencies

In addition to displaying immediate forward and reverse dependencies as described in the previous section, the `inspect` command can display the full dependency tree for a task or setting. For example,

```
> inspect tree clean
[info] clean = Task[Unit]
[info]  +-clean / streams = Task[sbt.std.TaskStreams[sbt.internal.util.Init$ScopedKey[_ <: Any
[info]  | +-Global / streamsManager = Task[sbt.std.Streams[sbt.internal.util.Init$ScopedKey[_
[info]  |
[info]   +-cleanFiles = Task[scala.collection.Seq[java.io.File]]
```

```
[info]    | +-cleanKeepFiles = Vector(<project>/target/.history)
[info]    | | +-history = Some(<project>/target/.history)
[info]    | |   +-target = target
[info]    | |     +-baseDirectory =
...
```

For each task, `inspect tree` show the type of the value generated by the task. For a setting, the `toString` of the setting is displayed. See the Inspecting Settings page for details on the `inspect` command.

Display the description and type of a setting or task

While the `help`, `settings`, and `tasks` commands display a description of a task, the `inspect` command also shows the type of a setting or task and the value of a setting. For example:

```
> inspect update
[info] Task: sbt.librarymanagement.UpdateReport
[info] Description:
[info]  Resolves and optionally retrieves dependencies, producing a report.
...

> inspect scalaVersion
[info] Setting: java.lang.String = 2.12.6
[info] Description:
[info]  The version of Scala used for building.
...
```

See the Inspecting Settings page for details.

Display the delegation chain of a setting or task

See the Inspecting Settings page for details.

Display related settings or tasks

The `inspect` command can help find scopes where a setting or task is defined. The following example shows that different options may be specified to the Scala for testing and API documentation generation.

```
> inspect scalacOptions
...
[info] Related:
[info]  Compile / scalacOptions
[info]  Global / scalacOptions
[info]  Test / scalacOptions
```

See the Inspecting Settings page for details.

Show the list of projects and builds

The `projects` command displays the currently loaded projects. The projects are grouped by their enclosing build and the current project is indicated by an asterisk. For example,

```
> projects
[info] In file:/home/user/demo/
[info]   * parent
[info]     sub
[info] In file:/home/user/dep/
[info]     sample
```

Show the current session (temporary) settings

`session list` displays the settings that have been added at the command line for the current project. For example,

```
> session list
  1. maxErrors := 5
  2. scalacOptions += "-explaintypes"
```

`session list-all` displays the settings added for all projects. For details, see `help session`.

Show basic information about sbt and the current build

```
> about
[info] This is sbt 1.1.5
[info] The current project is {file:~/code/sbt.github.com/}default
[info] The current project is built against Scala 2.12.6
[info] Available Plugins: sbt.plugins.IvyPlugin, sbt.plugins.JvmPlugin, sbt.plugins.CorePlugi
[info] sbt, sbt plugins, and build definitions are using Scala 2.12.6
```

Show the value of a setting

The `inspect` command shows the value of a setting as part of its output, but the `show` command is dedicated to this job. It shows the output of the setting provided as an argument. For example,

```
> show organization
[info] com.github.sbt
```

The show command also works for tasks, described next.

Show the result of executing a task

```
> show update
... <output of update> ...
[info] Update report:
[info]  Resolve time: 122 ms, Download time: 5 ms, Download size: 0 bytes
[info]  compile:
[info]      org.scala-lang:scala-library:
[info]              - 2.12.6
[info] ...
```

The show command will execute the task provided as an argument and then print the result. Note that this is different from the behavior of the inspect command (described in other sections), which does not execute a task and thus can only display its type and not its generated value.

```
> show compile:dependencyClasspath
...
[info] ArrayBuffer(Attributed(/Users/foo/.sbt/boot/scala-2.12.6/lib/scala-library.jar))
```

Show the classpath used for compilation or testing

For the test classpath,

```
> show test:dependencyClasspath
...
[info] List(Attributed(/Users/foo/code/sbt.github.com/target/scala-2.12/classes), Attributed
...
```

Show the main classes detected in a project

sbt detects the classes with public, static main methods for use by the run method and to tab-complete the runMain method. The discoveredMainClasses task does this discovery and provides as its result the list of class names. For example, the following shows the main classes discovered in the main sources:

```
> show compile:discoveredMainClasses
... <runs compile if out of date> ...
[info] List(org.example.Main)
```

Show the test classes detected in a project

sbt detects tests according to fingerprints provided by test frameworks. The `definedTestNames` task provides as its result the list of test names detected in this way. For example,

```
> show test:definedTestNames
... < runs test:compile if out of date > ...
[info] List(org.example.TestA, org.example.TestB)
```

Interactive mode

Use tab completion

By default, sbt's interactive mode is started when no commands are provided on the command line or when the `shell` command is invoked.

As the name suggests, tab completion is invoked by hitting the tab key. Suggestions are provided that can complete the text entered to the left of the current cursor position. Any part of the suggestion that is unambiguous is automatically appended to the current text. Commands typically support tab completion for most of their syntax.

As an example, entering `tes` and hitting tab:

```
> tes<TAB>
```

results in sbt appending a `t`:

```
> test
```

To get further completions, hit tab again:

```
> test<TAB>
testFrameworks   testListeners   testLoader     testOnly      testOptions    test:
```

Now, there is more than one possibility for the next character, so sbt prints the available options. We will select `testOnly` and get more suggestions by entering the rest of the command and hitting tab twice:

```
> testOnly<TAB><TAB>
--                sbt.DagSpecification   sbt.EmptyRelationTest  sbt.KeyTest         sbt.Relati
```

The first tab inserts an unambiguous space and the second suggests names of tests to run. The suggestion of `--` is for the separator between test names and options provided to the test framework. The other suggestions are names of test classes for one of sbt's modules. Test name suggestions require tests to be compiled first. If tests have been added, renamed, or removed since the last test compilation, the completions will be out of date until another successful compile.

Show more tab completion suggestions

Some commands have different levels of completion. Hitting tab multiple times increases the verbosity of completions. (Presently, this feature is only used by the `set` command.)

Modify the default JLine keybindings

JLine, used by both Scala and sbt, uses a configuration file for many of its keybindings. The location of this file can be changed with the system property `jline.keybindings`. The default keybindings file is included in the sbt launcher and may be used as a starting point for customization.

Configure the prompt string

By default, sbt only displays `>` to prompt for a command. This can be changed through the `shellPrompt` setting, which has type `State => String`. State contains all state for sbt and thus provides access to all build information for use in the prompt string.

Examples:

```
// set the prompt (for this build) to include the project id.
shellPrompt in ThisBuild := { state => Project.extract(state).currentRef.project + "> " }

// set the prompt (for the current project) to include the username
shellPrompt := { state => System.getProperty("user.name") + "> " }
```

Use history

Interactive mode remembers history even if you exit sbt and restart it. The simplest way to access history is to press the up arrow key to cycle through previously entered commands. Use `Ctrl+r` to incrementally search history backwards. The following commands are supported:

- `!` Show history command help.
- `!!` Execute the previous command again.
- `!:` Show all previous commands.
- `!:n` Show the last n commands.
- `!n` Execute the command with index `n`, as shown by the `!:` command.
- `!-n` Execute the nth command before this one.
- `!string` Execute the most recent command starting with 'string'
- `!?string` Execute the most recent command containing 'string'

Change the location of the interactive history file

By default, interactive history is stored in the `target/` directory for the current project (but is not removed by a `clean`). History is thus separate for each subproject. The location can be changed with the `historyPath` setting, which has type `Option[File]`. For example, history can be stored in the root directory for the project instead of the output directory:

```
historyPath := Some(baseDirectory.value / ".history")
```

The history path needs to be set for each project, since sbt will use the value of `historyPath` for the current project (as selected by the `project` command).

Use the same history for all projects

The previous section describes how to configure the location of the history file. This setting can be used to share the interactive history among all projects in a build instead of using a different history for each project. The way this is done is to set `historyPath` to be the same file, such as a file in the root project's `target/` directory:

```
historyPath :=
  Some( (target in LocalRootProject).value / ".history")
```

The `in LocalRootProject` part means to get the output directory for the root project for the build.

Disable interactive history

If, for whatever reason, you want to disable history, set `historyPath` to `None` in each project it should be disabled in:

```
> historyPath := None
```

Run commands before entering interactive mode

Interactive mode is implemented by the `shell` command. By default, the `shell` command is run if no commands are provided to sbt on the command line. To run commands before entering interactive mode, specify them on the command line followed by `shell`. For example,

```
$ sbt clean compile shell
```

This runs `clean` and then `compile` before entering the interactive prompt. If either `clean` or `compile` fails, sbt will exit without going to the prompt. To enter the prompt whether or not these initial commands succeed, prepend `"onFailure shell"`, which means to run `shell` if any command fails. For example,

```
$ sbt "onFailure shell" clean compile shell
```

Configure and use logging

View the logging output of the previously executed command

When a command is run, more detailed logging output is sent to a file than to the screen (by default). This output can be recalled for the command just executed by running `last`.

For example, the output of `run` when the sources are uptodate is:

```
> run
[info] Running A
Hi!
[success] Total time: 0 s, completed Feb 25, 2012 1:00:00 PM
```

The details of this execution can be recalled by running `last`:

```
> last
[debug] Running task... Cancelable: false, max worker threads: 4, check cycles: false
[debug]
[debug] Initial source changes:
[debug]     removed:Set()
[debug]     added: Set()
[debug]     modified: Set()
[debug] Removed products: Set()
[debug] Modified external sources: Set()
[debug] Modified binary dependencies: Set()
[debug] Initial directly invalidated sources: Set()
```

```
[debug]
[debug] Sources indirectly invalidated by:
[debug]     product: Set()
[debug]     binary dep: Set()
[debug]     external source: Set()
[debug] Initially invalidated: Set()
[debug] Copy resource mappings:
[debug]
[info] Running A
[debug] Starting sandboxed run...
[debug] Waiting for threads to exit or System.exit to be called.
[debug]   Classpath:
[debug]     /tmp/e/target/scala-2.9.2/classes
[debug]    /tmp/e/.sbt/0.12.0/boot/scala-2.9.2/lib/scala-library.jar
[debug] Waiting for thread runMain to exit
[debug]     Thread runMain exited.
[debug] Interrupting remaining threads (should be all daemons).
[debug] Sandboxed run complete..
[debug] Exited with code 0
[success] Total time: 0 s, completed Jan 1, 2012 1:00:00 PM
```

Configuration of the logging level for the console and for the backing file are described in following sections.

View the previous logging output of a specific task

When a task is run, more detailed logging output is sent to a file than to the screen (by default). This output can be recalled for a specific task by running `last <task>`. For example, the first time `compile` is run, output might look like:

```
> compile
[info] Updating {file:/.../demo/}example...
[info] Resolving org.scala-lang#scala-library;2.9.2 ...
[info] Done updating.
[info] Compiling 1 Scala source to .../demo/target/scala-2.9.2/classes...
[success] Total time: 0 s, completed Jun 1, 2012 1:11:11 PM
```

The output indicates that both dependency resolution and compilation were performed. The detailed output of each of these may be recalled individually. For example,

```
> last compile
[debug]
```

```
[debug] Initial source changes:
[debug]     removed:Set()
[debug]     added: Set(/home/mark/tmp/a/b/A.scala)
[debug]     modified: Set()
...
```

and:

```
> last update
[info] Updating {file:/.../demo/}example...
[debug] post 1.3 ivy file: using exact as default matcher
[debug] :: resolving dependencies :: example#example_2.9.2;0.1-SNAPSHOT
[debug]   confs: [compile, runtime, test, provided, optional, compile-internal, runtime-intern
[debug]     validate = true
[debug]     refresh = false
[debug] resolving dependencies for configuration 'compile'
...
```

Show warnings from the previous compilation

The Scala compiler does not print the full details of warnings by default. Compiling code that uses the deprecated `error` method from Predef might generate the following output:

```
> compile
[info] Compiling 1 Scala source to <...>/classes...
[warn] there were 1 deprecation warnings; re-run with -deprecation for details
[warn] one warning found
```

The details aren't provided, so it is necessary to add `-deprecation` to the options passed to the compiler (`scalacOptions`) and recompile. An alternative when using Scala 2.10 and later is to run `printWarnings`. This task will display all warnings from the previous compilation. For example,

```
> printWarnings
[warn] A.scala:2: method error in object Predef is deprecated: Use sys.error(message) instead
[warn]  def x = error("Failed.")
[warn]          ^
```

Change the logging level globally

The quickest way to change logging levels is by using the `error`, `warn`, `info`, or `debug` commands. These set the default logging level for commands and tasks. For example,

```
> warn
```

will by default show only warnings and errors. To set the logging level before any commands are executed on startup, use `--` before the logging level. For example,

```
$ sbt --warn
> compile
[warn] there were 2 feature warning(s); re-run with -feature for details
[warn] one warning found
[success] Total time: 4 s, completed ...
>
```

The logging level can be overridden at a finer granularity, which is described next.

Change the logging level for a specific task, configuration, or project

The amount of logging is controlled by the `logLevel` setting, which takes values from the `Level` enumeration. Valid values are `Error`, `Warn`, `Info`, and `Debug` in order of increasing verbosity. The logging level may be configured globally, as described in the previous section, or it may be applied to a specific project, configuration, or task. For example, to change the logging level for compilation to only show warnings and errors:

```
> set logLevel in compile := Level.Warn
```

To enable debug logging for all tasks in the current project,

```
> set logLevel := Level.Warn
```

A common scenario is that after running a task, you notice that you need more information than was shown by default. A `logLevel` based solution typically requires changing the logging level and running a task again. However, there are two cases where this is unnecessary. First, warnings from a previous compilation may be displayed using `printWarnings` for the main sources or `test:printWarnings` for test sources. Second, output from the previous execution is available either for a single task or for in its entirety. See the section on printWarnings and the sections on previous output.

Configure printing of stack traces

By default, sbt hides the stack trace of most exceptions thrown during execution. It prints a message that indicates how to display the exception. However, you may want to show more of stack traces by default.

The setting to configure is `traceLevel`, which is a setting with an Int value. When `traceLevel` is set to a negative value, no stack traces are shown. When it is zero, the stack trace is displayed up to the first sbt stack frame. When positive, the stack trace is shown up to that many stack frames.

For example, the following configures sbt to show stack traces up to the first sbt frame:

```
> set every traceLevel := 0
```

The `every` part means to override the setting in all scopes. To change the trace printing behavior for a single project, configuration, or task, scope `traceLevel` appropriately:

```
> set traceLevel in Test := 5
> set traceLevel in update := 0
> set traceLevel in ThisProject := -1
```

Print the output of tests immediately instead of buffering

By default, sbt buffers the logging output of a test until the whole class finishes. This is so that output does not get mixed up when executing in parallel. To disable buffering, set the `logBuffered` setting to false:

```
logBuffered := false
```

Add a custom logger

The setting `extraLoggers` can be used to add custom loggers. A custom logger should implement [AbstractLogger]. `extraLoggers` is a function `ScopedKey[_] => Seq[AbstractLogger]`. This means that it can provide different logging based on the task that requests the logger.

```
extraLoggers := {
  val currentFunction = extraLoggers.value
    (key: ScopedKey[_]) => {
        myCustomLogger(key) +: currentFunction(key)
    }
}
```

Here, we take the current function `currentFunction` for the setting and provide a new function. The new function prepends our custom logger to the ones provided by the old function.

Log messages in a task

The special task `streams` provides per-task logging and I/O via a Streams instance. To log, a task uses the `log` member from the `streams` task. Calling `log` provides a Logger.

:

```
myTask := {
  val log = streams.value.log
  log.warn("A warning.")
}
```

Log messages in a setting

Since settings cannot reference tasks, the special task `streams` cannot be used to provide logging during setting initialization. The recommended way is to use `sLog`. Calling `sLog.value` provides a Logger.

```
mySetting := {
  val log = sLog.value
  log.warn("A warning.")
}
```

Project metadata

Set the project name

A project should define `name` and `version`. These will be used in various parts of the build, such as the names of generated artifacts. Projects that are published to a repository should also override `organization`.

```
name := "Your project name"
```

For published projects, this name is normalized to be suitable for use as an artifact name and dependency ID. This normalized name is stored in `normalizedName`.

Set the project version

```
version := "1.0"
```

Set the project organization

```
organization := "org.example"
```

By convention, this is a reverse domain name that you own, typically one specific to your project. It is used as a namespace for projects.

A full/formal name can be defined in the `organizationName` setting. This is used in the generated pom.xml. If the organization has a web site, it may be set in the `organizationHomepage` setting. For example:

```
organizationName := "Example, Inc."

organizationHomepage := Some(url("http://example.org"))
```

Set the project's homepage and other metadata

```
homepage := Some(url("https://www.scala-sbt.org"))

startYear := Some(2008)

description := "A build tool for Scala."

licenses += "GPLv2" -> url("https://www.gnu.org/licenses/gpl-2.0.html")
```

Configure packaging

Use the packaged jar on classpaths instead of class directory

By default, a project exports a directory containing its resources and compiled class files. Set `exportJars` to true to export the packaged jar instead. For example,

```
exportJars := true
```

The jar will be used by `run`, `test`, `console`, and other tasks that use the full classpath.

Add manifest attributes

By default, sbt constructs a manifest for the binary package from settings such as `organization` and `mainClass`. Additional attributes may be added to the `packageOptions` setting scoped by the configuration and package task.

Main attributes may be added with `Package.ManifestAttributes`. There are two variants of this method, once that accepts repeated arguments that map an attribute of type `java.util.jar.Attributes.Name` to a String value and other that maps attribute names (type String) to the String value.

For example,

```
packageOptions in (Compile, packageBin) +=
  Package.ManifestAttributes( java.util.jar.Attributes.Name.SEALED -> "true" )
```

Other attributes may be added with `Package.JarManifest`.

```
packageOptions in (Compile, packageBin) +=  {
  import java.util.jar.{Attributes, Manifest}
  val manifest = new Manifest
  manifest.getAttributes("foo/bar/").put(Attributes.Name.SEALED, "false")
  Package.JarManifest( manifest )
}
```

Or, to read the manifest from a file:

```
packageOptions in (Compile, packageBin) +=  {
  val file = new java.io.File("META-INF/MANIFEST.MF")
  val manifest = Using.fileInputStream(file)( in => new java.util.jar.Manifest(in) )
  Package.JarManifest( manifest )
}
```

Change the file name of a package

The `artifactName` setting controls the name of generated packages. See the Artifacts page for details.

Modify the contents of the package

The contents of a package are defined by the `mappings` task, of type `Seq[(File,String)]`. The `mappings` task is a sequence of mappings from a file to include in the package to the path in the package. See Mapping Files for convenience functions for generating these mappings. For example, to add the file `in/example.txt` to the main binary jar with the path "out/example.txt",

```
mappings in (Compile, packageBin) += {
  (baseDirectory.value / "in" / "example.txt") -> "out/example.txt"
}
```

Note that `mappings` is scoped by the configuration and the specific package task. For example, the mappings for the test source package are defined by the `mappings in (Test, packageSrc)` task.

Running commands

Pass arguments to a command or task in batch mode

sbt interprets each command line argument provided to it as a command together with the command's arguments. Therefore, to run a command that takes arguments in batch mode, quote the command using double quotes, and its arguments. For example,

```
$ sbt "project X" clean "~ compile"
```

Provide multiple commands to run consecutively

Multiple commands can be scheduled at once by prefixing each command with a semicolon. This is useful for specifying multiple commands where a single command string is accepted. For example, the syntax for triggered execution is `~ <command>`. To have more than one command run for each triggering, use semicolons. For example, the following runs `clean` and then `compile` each time a source file changes:

```
> ~ ;clean;compile
```

Read commands from a file

The `<` command reads commands from the files provided to it as arguments. Run `help <` at the sbt prompt for details.

Define an alias for a command or task

The `alias` command defines, removes, and displays aliases for commands. Run `help alias` at the sbt prompt for details.

Example usage:

```
> alias a=about
> alias
    a = about
> a
[info] This is sbt ...
> alias a=
> alias
> a
[error] Not a valid command: a ...
```

Quickly evaluate a Scala expression

The `eval` command compiles and runs the Scala expression passed to it as an argument. The result is printed along with its type. For example,

```
> eval 2+2
4: Int
```

Variables defined by an `eval` are not visible to subsequent `eval`s, although changes to system properties persist and affect the JVM that is running sbt. Use the Scala REPL (`console` and related commands) for full support for evaluating Scala code interactively.

Configure and use Scala

Set the Scala version used for building the project

The `scalaVersion` configures the version of Scala used for compilation. By default, sbt also adds a dependency on the Scala library with this version. See the next section for how to disable this automatic dependency. If the Scala version is not specified, the version sbt was built against is used. It is recommended to explicitly specify the version of Scala.

For example, to set the Scala version to "2.11.1",

```
scalaVersion := "2.11.1"
```

Disable the automatic dependency on the Scala library

sbt adds a dependency on the Scala standard library by default. To disable this behavior, set the `autoScalaLibrary` setting to false.

```
autoScalaLibrary := false
```

Temporarily switch to a different Scala version

To set the Scala version in all scopes to a specific value, use the `++` command. For example, to temporarily use Scala 2.10.4, run:

```
> ++ 2.10.4
```

Use a local Scala installation for building a project

Defining the `scalaHome` setting with the path to the Scala home directory will use that Scala installation. sbt still requires `scalaVersion` to be set when a local Scala version is used. For example,

```
scalaVersion := "2.10.0-local"

scalaHome := Some(file("/path/to/scala/home/"))
```

Build a project against multiple Scala versions

See cross building.

Enter the Scala REPL with a project's dependencies on the classpath, but not the compiled project classes

The `consoleQuick` action retrieves dependencies and puts them on the classpath of the Scala REPL. The project's sources are not compiled, but sources of any source dependencies are compiled. To enter the REPL with test dependencies on the classpath but without compiling test sources, run `test:consoleQuick`. This will force compilation of main sources.

Enter the Scala REPL with a project's dependencies and compiled code on the classpath

The `console` action retrieves dependencies and compiles sources and puts them on the classpath of the Scala REPL. To enter the REPL with test dependencies and compiled test sources on the classpath, run `test:console`.

Enter the Scala REPL with plugins and the build definition on the classpath

```
> consoleProject
```

For details, see the consoleProject page.

Define the initial commands evaluated when entering the Scala REPL

Set `initialCommands in console` to set the initial statements to evaluate when `console` and `consoleQuick` are run. To configure `consoleQuick` separately, use `initialCommands in consoleQuick`. For example,

```
initialCommands in console := """println("Hello from console")"""

initialCommands in consoleQuick := """println("Hello from consoleQuick")"""
```

The `consoleProject` command is configured separately by `initialCommands in consoleProject`. It does not use the value from `initialCommands in console` by default. For example,

```
initialCommands in consoleProject := """println("Hello from consoleProject")"""
```

Define the commands evaluated when exiting the Scala REPL

Set `cleanupCommands in console` to set the statements to evaluate after exiting the Scala REPL started by `console` and `consoleQuick`. To configure `consoleQuick` separately, use `cleanupCommands in consoleQuick`. For example,

```
cleanupCommands in console := """println("Bye from console")"""

cleanupCommands in consoleQuick := """println("Bye from consoleQuick")"""
```

The `consoleProject` command is configured separately by `cleanupCommands in consoleProject`. It does not use the value from `cleanupCommands in console` by default. For example,

```
cleanupCommands in consoleProject := """println("Bye from consoleProject")"""
```

Use the Scala REPL from project code

sbt runs tests in the same JVM as sbt itself and Scala classes are not in the same class loader as the application classes. This is also the case in `console` and when `run` is not forked. Therefore, when using the Scala interpreter, it is important to set it up properly to avoid an error message like:

```
Failed to initialize compiler: class scala.runtime.VolatileBooleanRef not found.
** Note that as of 2.8 scala does not assume use of the java classpath.
** For the old behavior pass -usejavacp to scala, or if using a Settings
** object programmatically, settings.usejavacp.value = true.
```

The key is to initialize the Settings for the interpreter using *embeddedDefaults*. For example:

```
val settings = new Settings
settings.embeddedDefaults[MyType]
val interpreter = new Interpreter(settings, ...)
```

Here, MyType is a representative class that should be included on the interpreter's classpath and in its application class loader. For more background, see the original proposal that resulted in *embeddedDefaults* being added.

Similarly, use a representative class as the type argument when using the *break* and *breakIf* methods of *ILoop*, as in the following example:

```
def x(a: Int, b: Int) = {
  import scala.tools.nsc.interpreter.ILoop
  ILoop.breakIf[MyType](a != b, "a" -> a, "b" -> b )
}
```

Generate API documentation

Select javadoc or scaladoc

sbt will run `javadoc` if there are only Java sources in the project. If there are any Scala sources, sbt will run `scaladoc`. (This situation results from `scaladoc` not processing Javadoc comments in Java sources nor linking to Javadoc.)

Set the options used for generating scaladoc independently of compilation

Scope `scalacOptions` to the `doc` task to configure `scaladoc`. Use `:=` to definitively set the options without appending to the options for `compile`. Scope to `Compile` for main sources or to `Test` for test sources. For example,

```
scalacOptions in (Compile,doc) := Seq("-groups", "-implicits")
```

Add options for scaladoc to the compilation options

Scope `scalacOptions` to the `doc` task to configure `scaladoc`. Use `+=` or `++=` to append options to the base options. To append a single option, use `+=`. To append a `Seq[String]`, use `++=`. Scope to `Compile` for main sources or to `Test` for test sources. For example,

```
scalacOptions in (Compile,doc) ++= Seq("-groups", "-implicits")
```

Set the options used for generating javadoc independently of compilation

Scope `javacOptions` to the `doc` task to configure `javadoc`. Use `:=` to definitively set the options without appending to the options for `compile`. Scope to `Compile` for main sources or to `Test` for test sources.

Add options for javadoc to the compilation options

Scope `javacOptions` to the `doc` task to configure `javadoc`. Use `+=` or `++=` to append options to the base options. To append a single option, use `+=`. To append a `Seq[String]`, use `++=`. Scope to `Compile` for main sources or to `Test` for test sources. For example,

```
javacOptions in (Compile,doc) ++= Seq("-notimestamp", "-linksource")
```

Enable automatic linking to the external Scaladoc of managed dependencies

Set `autoAPIMappings := true` for sbt to tell `scaladoc` where it can find the API documentation for managed dependencies. This requires that dependencies have this information in its metadata and you are using `scaladoc` for Scala 2.10.2 or later.

Enable manual linking to the external Scaladoc of managed dependencies

Add mappings of type `(File, URL)` to `apiMappings` to manually tell `scaladoc` where it can find the API documentation for dependencies. (This requires `scaladoc` for Scala 2.10.2 or later.) These mappings are used in addition to `autoAPIMappings`, so this manual configuration is typically done for unmanaged dependencies. The `File` key is the location of the dependency as passed to the classpath. The `URL` value is the base URL of the API documentation for the dependency. For example,

```
apiMappings += (
  (unmanagedBase.value / "a-library.jar") ->
    url("https://example.org/api/")
)
```

Define the location of API documentation for a library

Set `apiURL` to define the base `URL` for the Scaladocs for your library. This will enable clients of your library to automatically link against the API documentation using `autoAPIMappings`. (This only works for Scala 2.10.2 and later.) For example,

```
apiURL := Some(url("https://example.org/api/"))
```

This information will get included in a property of the published `pom.xml`, where it can be automatically consumed by sbt.

Triggered execution

Run a command when sources change

You can make a command run when certain files change by prefixing the command with `~`. Monitoring is terminated when `enter` is pressed. This triggered execution is configured by the `watch` setting, but typically the basic settings `watchSources` and `pollInterval` are modified as described in later sections.

The original use-case for triggered execution was continuous compilation:

```
> ~ test:compile

> ~ compile
```

You can use the triggered execution feature to run any command or task, however. The following will poll for changes to your source code (main or test) and run `testOnly` for the specified test.

```
> ~ testOnly example.TestA
```

Run multiple commands when sources change

The command passed to `~` may be any command string, so multiple commands may be run by separating them with a semicolon. For example,

```
> ~ ;a ;b
```

This runs `a` and then `b` when sources change.

Configure the sources that are checked for changes

- watchSources defines the files for a single project that are monitored for changes. By default, a project watches resources and Scala and Java sources.
- watchTransitiveSources then combines the watchSources for the current project and all execution and classpath dependencies (see .scala build definition for details on inter-project dependencies).

To add the file demo/example.txt to the files to watch,

```
watchSources += baseDirectory.value / "demo" / "examples.txt"
```

Set the time interval between checks for changes to sources

pollInterval selects the interval between polling for changes in milliseconds. The default value is 500 ms. To change it to 1 s,

```
import scala.concurrent.duration._

pollInterval := 1.second
```

Define Custom Tasks

Define a Task that runs tests in specific sub-projects

Consider a hypothetical multi-build project with 3 subprojects. The following defines a task myTestTask that will run the test Task in specific subprojects core and tools but not client:

```
lazy val core = project.in(file("./core"))
lazy val tools = project.in(file("./tools"))
lazy val client = project.in(file("./client"))

lazy val myTestTask = taskKey[Unit]("my test task")

myTestTask := {
  (test in (core, Test)).value
  (test in (tools, Test)).value
}
```

How to take an action on startup

A global setting `onLoad` is of type `State => State` and is executed once, after all projects are built and loaded. There is a similar hook `onUnload` for when a project is unloaded.

Project unloading typically occurs as a result of a `reload` command or a `set` command. Because the `onLoad` and `onUnload` hooks are global, modifying this setting typically involves composing a new function with the previous value. The following example shows the basic structure of defining `onLoad`.

Suppose you want to run a task named `dependencyUpdates` on start up. Here's what you can do:

```
lazy val dependencyUpdates = taskKey[Unit]("foo")

// This prepends the String you would type into the shell
lazy val startupTransition: State => State = { s: State =>
  "dependencyUpdates" :: s
}

lazy val root = (project in file("."))
  .settings(
    scalaVersion in ThisBuild := "2.12.6",
    organization in ThisBuild := "com.example",
    name := "helloworld",
    dependencyUpdates := { println("hi") },

    // onLoad is scoped to Global because there's only one.
    onLoad in Global := {
      val old = (onLoad in Global).value
      // compose the new transition on top of the existing one
      // in case your plugins are using this hook.
      startupTransition compose old
    }
  )
```

You can use this technique to switch the startup subproject too.

Sequencing

One of the most frequently asked questions is in the form of "how do I do X *and then* do Y in sbt"?

Generally speaking, that's not how sbt tasks are set up. build.sbt is a DSL to define dependency graph of tasks. This is covered in Execution semantics of tasks. So ideally, what you should do is define task Y yourself, and depend on the task X.

```
taskY := {
  val x = taskX.value
  x + 1
}
```

This is more constrained compared to the imperative style plain Scala code with side effects such as the follows:

```
def foo(): Unit = {
  doX()
  doY()
}
```

The benefit of the dependency-oriented programming model is that sbt's task engine is able to reorder the task execution. When possible we run dependent tasks in parallel. Another benefit is that we can deduplicate the graph, and make sure that the task evaluation, such as `compile in Compile`, is called once per command execution, as opposed to compiling the same source many times.

Because task system is generally set up this way, running something sequentially is possible, but you will be fighting the system a bit, and it's not always going to be easy.

- Defining a sequential task with Def.sequential
- Defining a dynamic task with Def.taskDyn
- Doing something after an input task
- Defining a dynamic input task with Def.inputTaskDyn
- How to sequence using commands

Defining a sequential task with Def.sequential

sbt 0.13.8 added `Def.sequential` function to run tasks under semi-sequential semantics. To demonstrate the sequential task, let's create a custom task called `compilecheck` that runs `compile in Compile` and then `scalastyle in Compile` task added by scalastyle-sbt-plugin.

Here's how to set it up

project/build.properties

```
sbt.version=1.2.1
```

project/style.sbt

```
addSbtPlugin("org.scalastyle" %% "scalastyle-sbt-plugin" % "1.0.0")
```

build.sbt

```
lazy val compilecheck = taskKey[Unit]("compile and then scalastyle")

lazy val root = (project in file("."))
  .settings(
    compilecheck in Compile := Def.sequential(
      compile in Compile,
      (scalastyle in Compile).toTask("")
    ).value
  )
```

To call this task type in `compilecheck` from the shell. If the compilation fails, `compilecheck` would stop the execution.

```
root> compilecheck
[info] Compiling 1 Scala source to /Users/x/proj/target/scala-2.10/classes...
[error] /Users/x/proj/src/main/scala/Foo.scala:3: Unmatched closing brace '}' ignored here
[error] }
[error] ^
[error] one error found
[error] (compile:compileIncremental) Compilation failed
```

Looks like we were able to sequence these tasks.

Defining a dynamic task with Def.taskDyn

If sequential task is not enough, another step up is the dynamic task. Unlike `Def.task` which expects you to return pure value `A`, with a `Def.taskDyn` you return a task `sbt.Def.Initialize[sbt.Task[A]]` which the task engine can continue the rest of the computation with.

Let's try implementing a custom task called `compilecheck` that runs `compile in Compile` and then `scalastyle in Compile` task added by scalastyle-sbt-plugin.

project/build.properties

```
sbt.version=1.2.1
```

project/style.sbt

```
addSbtPlugin("org.scalastyle" %% "scalastyle-sbt-plugin" % "1.0.0")
```

build.sbt v1

```
lazy val compilecheck = taskKey[sbt.inc.Analysis]("compile and then scalastyle")

lazy val root = (project in file("."))
  .settings(
    compilecheck := (Def.taskDyn {
      val c = (compile in Compile).value
      Def.task {
        val x = (scalastyle in Compile).toTask("").value
        c
      }
    }).value
  )
```

Now we have the same thing as the sequential task, except we can now return the result `c` from the first task.

build.sbt v2 If we can return the same return type as `compile in Compile`, might actually rewire the key to our dynamic task.

```
lazy val root = (project in file("."))
  .settings(
    compile in Compile := (Def.taskDyn {
      val c = (compile in Compile).value
      Def.task {
        val x = (scalastyle in Compile).toTask("").value
        c
      }
    }).value
  )
```

Now we can actually call `compile in Compile` from the shell and make it do what we want it to do.

Doing something after an input task

Thus far we've mostly looked at tasks. There's another kind of tasks called input tasks that accepts user input from the shell. A typical example for this is the `run in Compile` task. The `scalastyle` task is actually an input task too. See input task for the details of the input tasks.

Now suppose we want to call `run in Compile` task and then open the browser for testing purposes.

src/main/scala/Greeting.scala

```
object Greeting extends App {
  println("hello " + args.toList)
}
```

build.sbt v1

```
lazy val runopen = inputKey[Unit]("run and then open the browser")

lazy val root = (project in file("."))
  .settings(
    runopen := {
      (run in Compile).evaluated
      println("open browser!")
    }
  )
```

Here, I'm faking the browser opening using `println` as the side effect. We can now call this task from the shell:

```
> runopen foo
[info] Compiling 1 Scala source to /x/proj/...
[info] Running Greeting foo
hello List(foo)
open browser!
```

build.sbt v2 We can actually remove `runopen` key, by rewriting the new input task to `run in Compile`:

```
lazy val root = (project in file("."))
  .settings(
    run in Compile := {
      (run in Compile).evaluated
      println("open browser!")
    }
  )
```

Defining a dynamic input task with Def.inputTaskDyn

Let's suppose that there's a task already that does the bowser opening called `openbrowser` because of a plugin. Here's how we can sequence a task after an input tasks.

build.sbt v1

```
lazy val runopen = inputKey[Unit]("run and then open the browser")
lazy val openbrowser = taskKey[Unit]("open the browser")

lazy val root = (project in file("."))
  .settings(
    runopen := (Def.inputTaskDyn {
      import sbt.complete.Parsers.spaceDelimited
      val args = spaceDelimited("<args>").parsed
      Def.taskDyn {
        (run in Compile).toTask(" " + args.mkString(" ")).value
        openbrowser
      }
    }).evaluated,
    openbrowser := {
      println("open browser!")
    }
  )
```

build.sbt v2 Trying to rewire `run in Compile` is going to be complicated. Since the reference to the inner `run in Compile` is already inside the continuation task, simply rewiring `runopen` to `run in Compile` will create a cyclic reference. To break the cycle, we will introduce a clone of `run in Compile` called `actualRun in Compile`:

```
lazy val actualRun = inputKey[Unit]("The actual run task")
lazy val openbrowser = taskKey[Unit]("open the browser")

lazy val root = (project in file("."))
  .settings(
    run in Compile := (Def.inputTaskDyn {
      import sbt.complete.Parsers.spaceDelimited
      val args = spaceDelimited("<args>").parsed
      Def.taskDyn {
        (actualRun in Compile).toTask(" " + args.mkString(" ")).value
        openbrowser
      }
```

```
  }).evaluated,
  actualRun in Compile := Defaults.runTask(
    fullClasspath in Runtime,
    mainClass in (Compile, run),
    runner in (Compile, run)
  ).evaluated,
  openbrowser := {
    println("open browser!")
  }
)
```

* Note that some tasks (ie. `testOnly`) will fail with trailing spaces, so a right trim (`.replaceAll("\s+$", "")`) of the string built for `toTask` might be needed to handle empty `args`.
The `actualRun in Compile`'s implementation was copy-pasted from `run` task's implementation in Defaults.scala.

Now we can call `run foo` from the shell and it will evaluate `actualRun in Compile` with the passed in argument, and then evaluate the `openbrowser` task.

How to sequence using commands

If all you care about is the side effects, and you really just want to emulate humans typing in one command after another, a custom command might be just want you need. This comes in handy for release procedures.

Here's from the build script of sbt itself:

```
commands += Command.command("releaseNightly") { state =>
  "stampVersion" ::
    "clean" ::
    "compile" ::
    "publish" ::
    "bintrayRelease" ::
    state
}
```

Examples

This section of the documentation has example sbt build definitions and code. Contributions are welcome!

You may want to read the Getting Started Guide as a foundation for understanding the examples.

.sbt build examples

Note: As of sbt 0.13.7 blank lines are no longer used to delimit `build.sbt` files. The following example requires sbt 0.13.7+.

Listed here are some examples of settings (each setting is independent). See .sbt build definition for details.

```
import scala.concurrent.duration._

// factor out common settings into a sequence
lazy val commonSettings = Seq(
  organization := "org.myproject",
  version := "0.1.0",
  // set the Scala version used for the project
  scalaVersion := "2.12.6"
)

// define ModuleID for library dependencies
lazy val scalacheck = "org.scalacheck" %% "scalacheck" % "1.13.4"

// define ModuleID using string interpolator
lazy val osmlibVersion = "2.5.2-RC1"
lazy val osmlib = ("net.sf.travelingsales" % "osmlib" % osmlibVersion from
  s"""http://downloads.sourceforge.net/project/travelingsales/libosm/$osmlibVersion/libosm-$

lazy val root = (project in file("."))
  .settings(
    commonSettings,

    // set the name of the project
    name := "My Project",

    // set the main Scala source directory to be <base>/src
    scalaSource in Compile := baseDirectory.value / "src",

    // set the Scala test source directory to be <base>/test
    scalaSource in Test := baseDirectory.value / "test",

    // add a test dependency on ScalaCheck
    libraryDependencies += scalacheck % Test,

    // add compile dependency on osmlib
    libraryDependencies += osmlib,

    // reduce the maximum number of errors shown by the Scala compiler
```

```
    maxErrors := 20,

    // increase the time between polling for file changes when using continuous execution
    pollInterval := 1.second,

    // append several options to the list of options passed to the Java compiler
    javacOptions ++= Seq("-source", "1.5", "-target", "1.5"),

    // append -deprecation to the options passed to the Scala compiler
    scalacOptions += "-deprecation",

    // define the statements initially evaluated when entering 'console', 'consoleQuick', or
    initialCommands := """
import System.{currentTimeMillis => now}
def time[T](f: => T): T = {
  val start = now
  try { f } finally { println("Elapsed: " + (now - start)/1000.0 + " s") }
}""".stripMargin,

    // set the initial commands when entering 'console' or 'consoleQuick', but not 'consoleP
    initialCommands in console := "import myproject._",

    // set the main class for packaging the main jar
    // 'run' will still auto-detect and prompt
    // change Compile to Test to set it for the test jar
    mainClass in (Compile, packageBin) := Some("myproject.MyMain"),

    // set the main class for the main 'run' task
    // change Compile to Test to set it for 'test:run'
    mainClass in (Compile, run) := Some("myproject.MyMain"),

    // add <base>/input to the files that '~' triggers on
    watchSources += baseDirectory.value / "input",

    // add a maven-style repository
    resolvers += "name" at "url",

    // add a sequence of maven-style repositories
    resolvers ++= Seq("name" at "url"),

    // define the repository to publish to
    publishTo := Some("name" at "url"),

    // set Ivy logging to be at the highest level
    ivyLoggingLevel := UpdateLogging.Full,
```

```
// disable updating dynamic revisions (including -SNAPSHOT versions)
offline := true,

// set the prompt (for this build) to include the project id.
shellPrompt in ThisBuild := { state => Project.extract(state).currentRef.project + "> "

// set the prompt (for the current project) to include the username
shellPrompt := { state => System.getProperty("user.name") + "> " },

// disable printing timing information, but still print [success]
showTiming := false,

// disable printing a message indicating the success or failure of running a task
showSuccess := false,

// change the format used for printing task completion time
timingFormat := {
    import java.text.DateFormat
    DateFormat.getDateTimeInstance(DateFormat.SHORT, DateFormat.SHORT)
},

// disable using the Scala version in output paths and artifacts
crossPaths := false,

// fork a new JVM for 'run' and 'test:run'
fork := true,

// fork a new JVM for 'test:run', but not 'run'
fork in Test := true,

// add a JVM option to use when forking a JVM for 'run'
javaOptions += "-Xmx2G",

// only use a single thread for building
parallelExecution := false,

// Execute tests in the current project serially
//   Tests from other projects may still run concurrently.
parallelExecution in Test := false,

// set the location of the JDK to use for compiling Java code.
// if 'fork' is true, this is used for 'run' as well
javaHome := Some(file("/usr/lib/jvm/sun-jdk-1.6")),

// Use Scala from a directory on the filesystem instead of retrieving from a repository
scalaHome := Some(file("/home/user/scala/trunk/")),
```

```scala
// don't aggregate clean (See FullConfiguration for aggregation details)
aggregate in clean := false,

// only show warnings and errors on the screen for compilations.
//  this applies to both test:compile and compile and is Info by default
logLevel in compile := Level.Warn,

// only show warnings and errors on the screen for all tasks (the default is Info)
//  individual tasks can then be more verbose using the previous setting
logLevel := Level.Warn,

// only store messages at info and above (the default is Debug)
//   this is the logging level for replaying logging with 'last'
persistLogLevel := Level.Debug,

// only show 10 lines of stack traces
traceLevel := 10,

// only show stack traces up to the first sbt stack frame
traceLevel := 0,

// add SWT to the unmanaged classpath
unmanagedJars in Compile += Attributed.blank(file("/usr/share/java/swt.jar")),

// publish test jar, sources, and docs
publishArtifact in Test := true,

// disable publishing of main docs
publishArtifact in (Compile, packageDoc) := false,

// change the classifier for the docs artifact
artifactClassifier in packageDoc := Some("doc"),

// Copy all managed dependencies to <build-root>/lib_managed/
//   This is essentially a project-local cache.  There is only one
//   lib_managed/ in the build root (not per-project).
retrieveManaged := true,

/* Specify a file containing credentials for publishing. The format is:
realm=Sonatype Nexus Repository Manager
host=nexus.scala-tools.org
user=admin
password=admin123
*/
credentials += Credentials(Path.userHome / ".ivy2" / ".credentials"),
```

```
    // Directly specify credentials for publishing.
    credentials += Credentials("Sonatype Nexus Repository Manager", "nexus.scala-tools.org",

    // Exclude transitive dependencies, e.g., include log4j without including logging via jd
    libraryDependencies +=
      "log4j" % "log4j" % "1.2.15" excludeAll(
        ExclusionRule(organization = "com.sun.jdmk"),
        ExclusionRule(organization = "com.sun.jmx"),
        ExclusionRule(organization = "javax.jms")
      )
  )
```

.sbt build with .scala files example

`.sbt` builds can be supplemented with `project/*.scala` files. When the build file gets large enough, the first thing to factor out are resolvers and dependencies.

project/Resolvers.scala

```
import sbt._
import Keys._

object Resolvers {
  val sunrepo    = "Sun Maven2 Repo" at "http://download.java.net/maven/2"
  val sunrepoGF  = "Sun GF Maven2 Repo" at "http://download.java.net/maven/glassfish"
  val oraclerepo = "Oracle Maven2 Repo" at "http://download.oracle.com/maven"

  val oracleResolvers = Seq(sunrepo, sunrepoGF, oraclerepo)
}
```

project/Dependencies.scala

```
import sbt._
import Keys._

object Dependencies {
  val logbackVersion = "0.9.16"
  val grizzlyVersion = "1.9.19"

  val logbackcore    = "ch.qos.logback" % "logback-core"     % logbackVersion
  val logbackclassic = "ch.qos.logback" % "logback-classic"  % logbackVersion
```

```
  val jacksonjson = "org.codehaus.jackson" % "jackson-core-lgpl" % "1.7.2"

  val grizzlyframwork = "com.sun.grizzly" % "grizzly-framework" % grizzlyVersion
  val grizzlyhttp     = "com.sun.grizzly" % "grizzly-http"      % grizzlyVersion
  val grizzlyrcm      = "com.sun.grizzly" % "grizzly-rcm"       % grizzlyVersion
  val grizzlyutils    = "com.sun.grizzly" % "grizzly-utils"     % grizzlyVersion
  val grizzlyportunif = "com.sun.grizzly" % "grizzly-portunif"  % grizzlyVersion

  val sleepycat = "com.sleepycat" % "je" % "4.0.92"

  val apachenet   = "commons-net"   % "commons-net"   % "2.0"
  val apachecodec = "commons-codec" % "commons-codec" % "1.4"

  val scalatest = "org.scalatest" %% "scalatest" % "3.0.5"
}
```

These files can be used mange library dependencies in one place.

project/ShellPromptPlugin.scala

When you want to implement custom commands or tasks, you can organize your build by defining an one-off auto plugin.

```
import sbt._
import Keys._
import scala.sys.process._

// Shell prompt which show the current project and git branch
object ShellPromptPlugin extends AutoPlugin {
  override def trigger = allRequirements
  override lazy val projectSettings = Seq(
    shellPrompt := buildShellPrompt
  )
  val devnull: ProcessLogger = new ProcessLogger {
    def out(s: => String): Unit = {}
    def err(s: => String): Unit = {}
    def buffer[T] (f: => T): T = f
  }
  def currBranch =
    ("git status -sb" lineStream_! devnull headOption)
      .getOrElse("-").stripPrefix("## ")
  val buildShellPrompt: State => String = {
    case (state: State) =>
      val currProject = Project.extract (state).currentProject.id
      s"""$currProject:$currBranch> """
```

```
  }
}
```

This auto plugin will display the current project name and the git branch.

build.sbt

Now that we factored out custom settings and dependencies out to `project/*.scala`, we can make use of them in `build.sbt`:

```
import Resolvers._
import Dependencies._

// factor out common settings into a sequence
lazy val buildSettings = Seq(
  organization := "com.example",
  version := "0.1.0",
  scalaVersion := "2.12.6"
)

// Sub-project specific dependencies
lazy val commonDeps = Seq(
  logbackcore,
  logbackclassic,
  jacksonjson,
  scalatest % Test
)

lazy val serverDeps = Seq(
  grizzlyframwork,
  grizzlyhttp,
  grizzlyrcm,
  grizzlyutils,
  grizzlyportunif,
  sleepycat,
  scalatest % Test
)

lazy val pricingDeps = Seq(
  apachenet,
  apachecodec,
  scalatest % Test
)

lazy val cdap2 = (project in file("."))
```

```
  .aggregate(common, server, compact, pricing, pricing_service)
  .settings(buildSettings)

lazy val common = (project in file("cdap2-common"))
  .settings(
    buildSettings,
    libraryDependencies ++= commonDeps
  )

lazy val server = (project in file("cdap2-server"))
  .dependsOn(common)
  .settings(
    buildSettings,
    resolvers := oracleResolvers,
    libraryDependencies ++= serverDeps
  )

lazy val pricing = (project in file("cdap2-pricing"))
  .dependsOn(common, compact, server)
  .settings(
    buildSettings,
    libraryDependencies ++= pricingDeps
  )

lazy val pricing_service = (project in file("cdap2-pricing-service"))
  .dependsOn(pricing, server)
  .settings(buildSettings)

lazy val compatct = (project in file("compact-hashmap"))
  .settings(buildSettings)
```

Advanced configurations example

This is an example .sbt build definition that demonstrates using configurations to group dependencies.

The `utils` module provides utilities for other modules. It uses configurations to group dependencies so that a dependent project doesn't have to pull in all dependencies if it only uses a subset of functionality. This can be an alternative to having multiple utilities modules (and consequently, multiple utilities jars).

In this example, consider a `utils` project that provides utilities related to both Scalate and Saxon. It therefore needs both Scalate and Saxon on the compilation classpath and a project that uses all of the functionality of 'utils' will need these dependencies as well. However, project `a` only needs the utilities related to Scalate, so it doesn't need Saxon. By depending only on the `scalate` configuration of `utils`, it only gets the Scalate-related dependencies.

```
/********* Configurations *******/

// Custom configurations
lazy val Common = config("common") describedAs("Dependencies required in all configurations.
lazy val Scalate = config("scalate") extend(Common) describedAs("Dependencies for using Scal
lazy val Saxon = config("saxon") extend(Common) describedAs("Dependencies for using Saxon ut

// Define a customized compile configuration that includes
//   dependencies defined in our other custom configurations
lazy val CustomCompile = config("compile") extend(Saxon, Common, Scalate)

/********** Projects ************/

// factor out common settings into a sequence
lazy val commonSettings = Seq(
  organization := "com.example",
  version := "0.1.0",
  scalaVersion := "2.10.4"
)

// An example project that only uses the Scalate utilities.
lazy val a = (project in file("a"))
  .dependsOn(utils % "compile->scalate")
  .settings(commonSettings)

// An example project that uses the Scalate and Saxon utilities.
// For the configurations defined here, this is equivalent to doing dependsOn(utils),
//  but if there were more configurations, it would select only the Scalate and Saxon
//  dependencies.
lazy val b = (project in file("b"))
  .dependsOn(utils % "compile->scalate,saxon")
  .settings(commonSettings)

// Defines the utilities project
lazy val utils = (project in file("utils"))
  .settings(
    commonSettings,

    inConfig(Common)(Defaults.configSettings),  // Add the src/common/scala/ compilation con
    addArtifact(artifact in (Common, packageBin), packageBin in Common), // Publish the comm

      // We want our Common sources to have access to all of the dependencies on the classpa
      //   for compile and test, but when depended on, it should only require dependencies i
```

```
    classpathConfiguration in Common := CustomCompile,
      // Modify the default Ivy configurations.
      //   'overrideConfigs' ensures that Compile is replaced by CustomCompile
    ivyConfigurations := overrideConfigs(Scalate, Saxon, Common, CustomCompile)(ivyConfigura
      // Put all dependencies without an explicit configuration into Common (optional)
    defaultConfiguration := Some(Common),
      // Declare dependencies in the appropriate configurations
    libraryDependencies ++= Seq(
       "org.fusesource.scalate" % "scalate-core" % "1.5.0" % Scalate,
       "org.squeryl" %% "squeryl" % "0.9.5-6" % Scalate,
       "net.sf.saxon" % "saxon" % "8.7" % Saxon
    )
  )
```

Advanced command example

This is an advanced example showing some of the power of the new settings system. It shows how to temporarily modify all declared dependencies in the build, regardless of where they are defined. It directly operates on the final `Seq[Setting[_]]` produced from every setting involved in the build.

The modifications are applied by running *canonicalize*. A *reload* or using *set* reverts the modifications, requiring *canonicalize* to be run again.

This particular example shows how to transform all declared dependencies on ScalaCheck to use version 1.8. As an exercise, you might try transforming other dependencies, the repositories used, or the scalac options used. It is possible to add or remove settings as well.

This kind of transformation is possible directly on the settings of Project, but it would not include settings automatically added from plugins or build.sbt files. What this example shows is doing it unconditionally on all settings in all projects in all builds, including external builds.

```
import sbt._
import Keys._

object Canon extends Plugin {
  // Registers the canonicalize command in every project
  override def settings = Seq(commands += canonicalize)

  // Define the command.  This takes the existing settings (including any session settings)
  // and applies 'f' to each Setting[_]
  def canonicalize = Command.command("canonicalize") { (state: State) =>
    val extracted = Project.extract(state)
    import extracted._
```

```
    val transformed = session.mergeSettings map ( s => f(s) )
    appendWithSession(transformed, state)
  }

  // Transforms a Setting[_].
  def f(s: Setting[_]): Setting[_] = s.key.key match {
    // transform all settings that modify libraryDependencies
    case Keys.libraryDependencies.key =>
      // hey scalac.  T == Seq[ModuleID]
      s.asInstanceOf[Setting[Seq[ModuleID]]].mapInit(mapLibraryDependencies)
      // preserve other settings
    case _ => s
  }
  // This must be idempotent because it gets applied after every transformation.
  // That is, if the user does:
  //  libraryDependencies += a
  //  libraryDependencies += b
  // then this method will be called for Seq(a) and Seq(a,b)
  def mapLibraryDependencies(key: ScopedKey[Seq[ModuleID]], value: Seq[ModuleID]): Seq[Modul
    value map mapSingle

  // This is the fundamental transformation.
  // Here we map all declared ScalaCheck dependencies to be version 1.8
  def mapSingle(module: ModuleID): ModuleID =
    if(module.name == "scalacheck") module.withRevision(revision = "1.8")
    else module
}
```

Frequently Asked Questions

Project Information

What does the name "sbt" stand for, and why shouldn't it be written "SBT"? **TL;DR** the name sbt doesn't stand for anything, it's just "sbt", and it should be written that way.

When Mark Harrah ([@harrah][]) first created the project he called it "Simple Build Tool", but in his first public announcement of it he already referred to it as just "sbt". Over time some have re-defined sbt to stand for "Scala Build Tool", but we believe that isn't accurate either given it can be used to build Java-only projects.

Nowadays we just call sbt "sbt", and to reinforce that the name is no longer an initialism we always write it in all lowercase letters. However, we are cool with (subuta) as a nickname.

How do I get help?

- See Support

How do I report a bug?

- See Get Involved

How can I help?

- See Get Involved

Usage

My last command didn't work but I can't see an explanation. Why? sbt 1.2.1 by default suppresses most stack traces and debugging information. It has the nice side effect of giving you less noise on screen, but as a newcomer it can leave you lost for explanation. To see the previous output of a command at a higher verbosity, type `last <task>` where `<task>` is the task that failed or that you want to view detailed output for. For example, if you find that your `update` fails to load all the dependencies as you expect you can enter:

```
> last update
```

and it will display the full output from the last run of the `update` command.

How do I disable ansi codes in the output? Sometimes sbt doesn't detect that ansi codes aren't supported and you get output that looks like:

```
[0m[ [0minfo [0m]  [0mSet current project to root
```

or ansi codes are supported but you want to disable colored output. To completely disable ansi codes, pass `-no-colors` option:

```
$ sbt -no-colors
```

How can I start a Scala interpreter (REPL) with sbt project configuration (dependencies, etc.)? In sbt's shell run `console`.

Build definitions

What are the `:=`, `+=`, and `++=` methods? These are methods on keys used to construct a `Setting` or a `Task`. The Getting Started Guide covers all these methods, see .sbt build definition, task graph, and appending values for example.

What is the `%` method? It's used to create a `ModuleID` from strings, when specifying managed dependencies. Read the Getting Started Guide about library dependencies.

What is `ModuleID`, `Project`, …? To figure out an unknown type or method, have a look at the Getting Started Guide if you have not. Also try the index of commonly used methods, values, and types, the API Documentation and the hyperlinked sources.

How do I add files to a jar package? The files included in an artifact are configured by default by a task `mappings` that is scoped by the relevant package task. The `mappings` task returns a sequence `Seq[(File,String)]` of mappings from the file to include to the path within the jar. See mapping files for details on creating these mappings.

For example, to add generated sources to the packaged source artifact:

```
mappings in (Compile, packageSrc) ++= {
  import Path.{flat, relativeTo}
  val base = (sourceManaged in Compile).value
  val srcs = (managedSources in Compile).value
  srcs pair (relativeTo(base) | flat)
}
```

This takes sources from the `managedSources` task and relativizes them against the `managedSource` base directory, falling back to a flattened mapping. If a source generation task doesn't write the sources to the `managedSource` directory, the mapping function would have to be adjusted to try relativizing against additional directories or something more appropriate for the generator.

How can I generate source code or resources? See Generating Files.

How can a task avoid redoing work if the input files are unchanged? There is basic support for only doing work when input files have changed or when the outputs haven't been generated yet. This support is primitive and subject to change.

The relevant methods are two overloaded methods called FileFunction.cached. Each requires a directory in which to store cached data. Sample usage is:

```
// define a task that takes some inputs
//   and generates files in an output directory
myTask := {
  // wraps a function taskImpl in an uptodate check
  //   taskImpl takes the input files, the output directory,
  //   generates the output files and returns the set of generated files
  val cachedFun = FileFunction.cached(streams.value.cacheDirectory / "my-task") { (in: Set[F
    taskImpl(in, target.value) : Set[File]
  }
  // Applies the cached function to the inputs files
  cachedFun(inputs.value)
}
```

There are two additional arguments for the first parameter list that allow the file tracking style to be explicitly specified. By default, the input tracking style is `FilesInfo.lastModified`, based on a file's last modified time, and the output tracking style is `FilesInfo.exists`, based only on whether the file exists. The other available style is `FilesInfo.hash`, which tracks a file based on a hash of its contents. See the FilesInfo API for details.

A more advanced version of `FileFunction.cached` passes a data structure of type ChangeReport describing the changes to input and output files since the last evaluation. This version of `cached` also expects the set of files generated as output to be the result of the evaluated function.

Extending sbt

How can I add a new configuration? The following example demonstrates adding a new set of compilation settings and tasks to a new configuration called `samples`. The sources for this configuration go in `src/samples/scala/`. Unspecified settings delegate to those defined for the `compile` configuration. For example, if `scalacOptions` are not overridden for `samples`, the options for the main sources are used.

Options specific to `samples` may be declared like:

```
scalacOptions in Samples += "-deprecation"
```

This uses the main options as base options because of `+=`. Use `:=` to ignore the main options:

```
scalacOptions in Samples := "-deprecation" :: Nil
```

The example adds all of the usual compilation related settings and tasks to `samples`:

```
samples:run
samples:runMain
samples:compile
samples:console
samples:consoleQuick
samples:scalacOptions
samples:fullClasspath
samples:package
samples:packageSrc
...
```

How do I add a test configuration? See the Additional test configurations section of Testing.

How can I create a custom run task, in addition to `run`? This answer is extracted from a mailing list discussion.

Read the Getting Started Guide up to custom settings for background.

A basic run task is created by:

```
lazy val myRunTask = taskKey[Unit]("A custom run task.")

// this can go either in a `build.sbt` or the settings member
//   of a Project in a full configuration
fullRunTask(myRunTask, Test, "foo.Foo", "arg1", "arg2")
```

If you want to be able to supply arguments on the command line, replace `TaskKey` with `InputKey` and `fullRunTask` with `fullRunInputTask`. The `Test` part can be replaced with another configuration, such as `Compile`, to use that configuration's classpath.

This run task can be configured individually by specifying the task key in the scope. For example:

```
fork in myRunTask := true

javaOptions in myRunTask += "-Xmx6144m"
```

How should I express a dependency on an outside tool such as proguard? Tool dependencies are used to implement a task and are not needed by project source code. These dependencies can be declared in their own configuration and classpaths. These are the steps:

1. Define a new configuration.
2. Declare the tool dependencies in that configuration.
3. Define a classpath that pulls the dependencies from the Update Report produced by `update`.
4. Use the classpath to implement the task.

As an example, consider a `proguard` task. This task needs the ProGuard jars in order to run the tool. First, define and add the new configuration:

```
val ProguardConfig = config("proguard") hide

ivyConfigurations += ProguardConfig
```

Then,

```
// Add proguard as a dependency in the custom configuration.
//  This keeps it separate from project dependencies.
libraryDependencies +=
   "net.sf.proguard" % "proguard" % "4.4" % ProguardConfig.name

// Extract the dependencies from the UpdateReport.
managedClasspath in proguard := {
    // these are the types of artifacts to include
    val artifactTypes: Set[String] = (classpathTypes in proguard).value
    Classpaths.managedJars(proguardConfig, artifactTypes, update.value)
}

// Use the dependencies in a task, typically by putting them
//  in a ClassLoader and reflectively calling an appropriate
//  method.
proguard := {
    val cp: Seq[File] = (managedClasspath in proguard).value
  // ... do something with , which includes proguard ...
}
```

Defining the intermediate classpath is optional, but it can be useful for debugging or if it needs to be used by multiple tasks. It is also possible to specify artifact types inline. This alternative `proguard` task would look like:

```
proguard := {
   val artifactTypes = Set("jar")
    val cp =
      Classpaths.managedJars(proguardConfig, artifactTypes, update.value)
  // ... do something with , which includes proguard ...
}
```

How would I change sbt's classpath dynamically? It is possible to register additional jars that will be placed on sbt's classpath. Through State, it is possible to obtain a xsbti.ComponentProvider, which manages application components. Components are groups of files in the `~/.sbt/boot/` directory and, in this case, the application is sbt. In addition to the base classpath, components in the "extra" component are included on sbt's classpath.

(Note: the additional components on an application's classpath are declared by the `components` property in the `[main]` section of the launcher configuration file `boot.properties`.)

Because these components are added to the `~/.sbt/boot/` directory and `~/.sbt/boot/` may be read-only, this can fail. In this case, the user has generally intentionally set sbt up this way, so error recovery is not typically necessary (just a short error message explaining the situation.)

Example of dynamic classpath augmentation The following code can be used where a `State => State` is required, such as in the `onLoad` setting (described below) or in a command. It adds some files to the "extra" component and reloads sbt if they were not already added. Note that reloading will drop the user's session state.

```
def augment(extra: Seq[File])(s: State): State = {
    // Get the component provider
  val cs: xsbti.ComponentProvider = s.configuration.provider.components()

    // Adds the files in 'extra' to the "extra" component
    //   under an exclusive machine-wide lock.
    //   The returned value is 'true' if files were actually copied and 'false'
    //   if the target files already exists (based on name only).
  val copied: Boolean = s.locked(cs.lockFile, cs.addToComponent("extra", extra.toArray))

    // If files were copied, reload so that we use the new classpath.
  if(copied) s.reload else s
}
```

How can I take action when the project is loaded or unloaded? See How to take an action on startup.

Example of project load/unload hooks The following example maintains a count of the number of times a project has been loaded and prints that number:

```
{
  // the key for the current count
  val key = AttributeKey[Int]("loadCount")
  // the State transformer
  val f = (s: State) => {
    val previous = s get key getOrElse 0
    println("Project load count: " + previous)
    s.put(key, previous + 1)
  }
  onLoad in Global := {
    val previous = (onLoad in Global).value
    f compose previous
  }
}
```

Errors

On project load, "Reference to uninitialized setting" Setting initializers are executed in order. If the initialization of a setting depends on other settings that has not been initialized, sbt will stop loading.

In this example, we try to append a library to `libraryDependencies` before it is initialized with an empty sequence.

```
libraryDependencies += "commons-io" % "commons-io" % "1.4" % "test"

disablePlugins(plugins.IvyPlugin)
```

To correct this, include the IvyPlugin plugin settings, which includes `libraryDependencies := Seq()`. So, we just drop the explicit disabling.

```
libraryDependencies += "commons-io" % "commons-io" % "1.4" % "test"
```

A more subtle variation of this error occurs when using scoped settings.

```
// error: Reference to uninitialized setting
settings = Seq(
  libraryDependencies += "commons-io" % "commons-io" % "1.2" % "test",
  fullClasspath := fullClasspath.value.filterNot(_.data.name.contains("commons-io"))
)
```

This setting varies between the test and compile scopes. The solution is use the scoped setting, both as the input to the initializer, and the setting that we update.

```
fullClasspath in Compile := (fullClasspath in Compile).value.filterNot(_.data.name.contains(
```

Dependency Management

How do I resolve a checksum error? This error occurs when the published checksum, such as a sha1 or md5 hash, differs from the checksum computed for a downloaded artifact, such as a jar or pom.xml. An example of such an error is:

```
[warn]  problem while downloading module descriptor:
https://repo1.maven.org/maven2/commons-fileupload/commons-fileupload/1.2.2/commons-fileuploa
invalid sha1: expected=ad3fda4adc95eb0d061341228cc94845ddb9a6fe computed=0ce5d4a03b07c8b00ab6
```

The invalid checksum should generally be reported to the repository owner (as was done for the above error). In the meantime, you can temporarily disable checking with the following setting:

```
checksums in update := Nil
```

See library management for details.

I've added a plugin, and now my cross-compilations fail! This problem crops up frequently. Plugins are only published for the Scala version that sbt uses (currently, 2.12). You can still *use* plugins during cross-compilation, because sbt only looks for a 2.12 version of the plugin.

… unless you specify the plugin in the wrong place!

A typical mistake is to put global plugin definitions in `~/.sbt/plugins.sbt`. **THIS IS WRONG.** `.sbt` files in `~/.sbt` are loaded for *each* build–that is, for *each* cross-compilation. So, if you build for Scala 2.9.0, sbt will try to find a version of the plugin that's compiled for 2.9.0–and it usually won't. That's because it doesn't *know* the dependency is a plugin.

To tell sbt that the dependency is an sbt plugin, make sure you define your global plugins in a `.sbt` file in `~/.sbt/plugins/`. sbt knows that files in `~/.sbt/plugins` are only to be used by sbt itself, not as part of the general build definition. If you define your plugins in a file under *that* directory, they won't foul up your cross-compilations. Any file name ending in `.sbt` will do, but most people use `~/.sbt/plugins/build.sbt` or `~/.sbt/plugins/plugins.sbt`.

Miscellaneous

Where can I find plugins for 1.2.1? See Community Plugins for a list of currently available plugins.

Index

This is an index of common methods, types, and values you might find in an sbt build definition. For command names, see Running. For available plugins, see the plugins list.

Values and Types

Dependency Management

- ModuleID is the type of a dependency definition. See Library Management.
- Artifact represents a single artifact (such as a jar or a pom) to be built and published. See Library Management and Artifacts.
- A Resolver can resolve and retrieve dependencies. Many types of Resolvers can publish dependencies as well. A repository is a closely linked idea that typically refers to the actual location of the dependencies. However, sbt is not very consistent with this terminology and repository and resolver are occasionally used interchangeably.
- A ModuleConfiguration defines a specific resolver to use for a group of dependencies.
- A Configuration is a useful Ivy construct for grouping dependencies. See ivy-configurations. It is also used for scoping settings.
- `Compile`, `Test`, `Runtime`, `Provided`, and `Optional` are predefined configurations.

Settings and Tasks

- A Setting describes how to initialize a specific setting in the build. It can use the values of other settings or the previous value of the setting being initialized.
- A SettingsDefinition is the actual type of an expression in a build.sbt. This allows either a single Setting or a sequence of settings (SettingList) to be defined at once. The types in a .scala build definition always use just a plain Setting.
- Initialize describes how to initialize a setting using other settings, but isn't bound to a particular setting yet. Combined with an initialization method and a setting to initialize, it produces a full Setting.

- TaskKey, SettingKey, and InputKey are keys that represent a task or setting. These are not the actual tasks, but keys that are used to refer to them. They can be scoped to produce ScopedTask, ScopedSetting, and ScopedInput. These form the base types that provide the Settings methods.
- InputTask parses and tab completes user input, producing a task to run.
- Task is the type of a task. A task is an action that runs on demand. This is in contrast to a setting, which is run once at project initialization.

Build Structure

- AutoPlugin is the trait implemented for sbt plugins.
- Project is both a trait and a companion object that declares a single module in a build. See .scala build definition.
- Keys is an object that provides all of the built-in keys for settings and tasks.
- State contains the full state for a build. It is mainly used by Commands and sometimes Input Tasks. See also State and Actions.

Methods

Settings and Tasks See the Getting Started Guide for details.

- `:=`, `+=`, `++=` These construct a Setting, which is the fundamental type in the settings system.
- `value` This uses the value of another setting or task in the definition of a new setting or task. This method is special (it is a macro) and cannot be used except in the argument of one of the setting definition methods above (:=, …) or in the standalone construction methods Def.setting and Def.task. See Task-Graph for details.
- `in` specifies the Scope or part of the Scope of a setting being referenced. See scopes.

File and IO See RichFile, PathFinder, and Paths for the full documentation.

- `/` When called on a single File, this is `new File(x,y)`. For Seq[File], this is applied for each member of the sequence..
- `*` and `**` are methods for selecting children (`*`) or descendants (`**`) of a File or Seq[File] that match a filter.
- `|`, `||`, `&&`, `&`, `-`, and `--` are methods for combining filters, which are often used for selecting Files. See NameFilter and FileFilter. Note that methods with these names also exist for other types, such as collections (like Seq) and Parser (see Parsing Input).

- `pair` Used to construct mappings from a `File` to another `File` or to a String. See Mapping Files.
- `get` forces a PathFinder (a call-by-name data structure) to a strict `Seq[File]` representation. This is a common name in Scala, used by types like Option.

Dependency Management See Library Management for full documentation.

- `%` This is used to build up a ModuleID.
- `%%` This is similar to `%` except that it identifies a dependency that has been cross built.
- `from` Used to specify the fallback URL for a dependency
- `classifier` Used to specify the classifier for a dependency.
- `at` Used to define a Maven-style resolver.
- `intransitive` Marks a dependency or Configuration as being intransitive.
- `hide` Marks a Configuration as internal and not to be included in the published metadata.

Parsing These methods are used to build up Parsers from smaller Parsers. They closely follow the names of the standard library's parser combinators. See Parsing Input for the full documentation. These are used for Input Tasks and Commands.

- `~`, `~>`, `<~` Sequencing methods.
- `??`, `?` Methods for making a Parser optional. `?` is postfix.
- `id` Used for turning a Char or String literal into a Parser. It is generally used to trigger an implicit conversion to a Parser.
- `|`, `||` Choice methods. These are common method names in Scala.
- `^^^` Produces a constant value when a Parser matches.
- `+`, `*` Postfix repetition methods. These are common method names in Scala.
- `map`, `flatMap` Transforms the result of a Parser. These are common method names in Scala.
- `filter` Restricts the inputs that a Parser matches on. This is a common method name in Scala.
- `-` Prefix negation. Only matches the input when the original parser doesn't match the input.
- `examples`, `token` Tab completion
- `!!!` Provides an error message to use when the original parser doesn't match the input.

Developer's Guide (Work in progress)

This is the set of documentation about the future architecture of sbt. The target audience of this document is the sbt plugin authors and sbt developers. See also How can I help?

Towards sbt 1.0

On 2008-12-18, Mark Harrah announced sbt 0.3.2 as the initial release of sbt. Mark remained the primary author of sbt until sbt 0.13.1 (2013-12-11). In 2014, sbt project was handed over to the authors of this document Josh Suereth and Eugene Yokota.

As we move towards sbt 1.0, we wish to stabilize what's already stable and innovate where it matters. There are several levels of stability:

- conceptual stability
- source compatibility of the build definition
- binary compatibility of the plugins

Concepts Conceptually, sbt has been stable on what it does:

1. incremental compilation that supports Scala
2. dependency management that's aware of Scala's binary compatibility
3. task and plugins system that's extensible using Scala
4. a text-based interactive shell

The only thing that we plan to change is the last point. In sbt 1.0, we will replace the interactive shell with sbt server that's accessible via JSON API and a text-based client.

Source compatibility of the build definition Source compatibility means that a build source that worked for sbt version A works for another version B without modification. Our goal for sbt 1.0 is to adopt Semantic Versioning, and maintain source compatibility of the build during 1.x.y.

Binary compatibility of the plugins Binary compatibility ("bincompat") of the plugins means that a plugin that was published for sbt version A works for another version B without recompilation. sbt 0.13 has kept binary compatibility for 18 months as of March 2015. The stability here helps maintain the sbt plugin ecosystem. Our goal for sbt 1.0 is to adopt Semantic Versioning, and maintain binary compatibility of the build during 1.x.y.

From the development perspective, maintaining binary compatibility becomes an additional constraint that we need to worry about whenever we make changes. The root of the problem is that sbt 0.13 does not distinguish between public API and internal implementation. Most things are open to plugins.

Modularization

The process we aim to take for sbt 1.0 is to disassemble sbt into smaller modules and layers. To be clear, sbt 0.13's codebase already does consist of numerous subprojects.

Layers are more coarse-grained sets of subproject(s) that can be used independently. Another purpose of the modularization is to distinguish between public API and internal implementation. Reducing the surface area of the sbt code base has several benefits:

- It makes it easier for the build users and the plugin authors to learn the APIs.
- It makes it easier for us to maintain binary and semantic compatibilities.
- It encourages the reuse of the modules.

The following is a conceptual diagram of the layers:

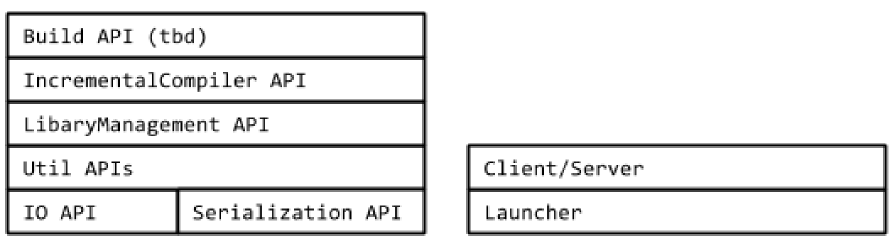


Figure 9: Module diagram

We'll discuss the details in the next page.

Module summary

The following is a conceptual diagram of the modular layers:

This diagram is arranged such that each layer depends only on the layers underneath it.

IO API (sbt/io) IO API is a low level API to deal with files and directories.

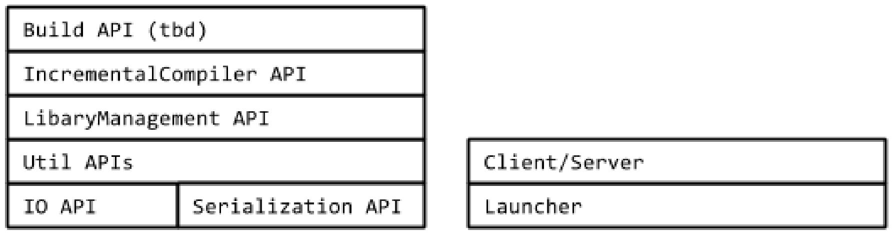


Figure 10: Module diagram

Serialization API (sbt/serialization) Serialization API is an opinionated wrapper around Scala Pickling. The responsibility of the serialization API is to turn values into JSON.

Util APIs (sbt/util) Util APIs provide commonly used features like logging and internal datatypes used by sbt.

LibraryManagement API (sbt/librarymanagement) sbt's library management system is based on Apache Ivy, and as such the concepts and terminology around the library management system are also influenced by Ivy. The responsibility of the library management API is to calculate the transitive dependency graph, and download artifacts from the given repositories.

IncrementalCompiler API (sbt/zinc) Incremental compilation of Scala is so fundamental that we now seldom think of it as a feature of sbt. There are number of subprojects/classes involved that are actually internal details, and we should use this opportunity to hide them.

Build API (tbd) This is the part that's exposed to `build.sbt`. The responsibility of the module is to load the build files and plugins, and provide a way for commands to be executed on the state.

This might remain at sbt/sbt.

sbt Launcher (sbt/launcher) The sbt launcher provides a generic container that can load and run programs resolved using the Ivy dependency manager. sbt uses this as the deployment mechanism, but it can be used for other purposes.

See foundweekends/conscript and Launcher for more details.

Client/Server (tbd) Currently developed in sbt/sbt-remote-control. sbt Server provides a JSON-based API wrapping functionality of the command line experience.

One of the clients will be the "terminal client", which subsumes the command line sbt shell. Other clients that are planned are IDE integrations.

Website (sbt/website) This website's source.

sbt Coding Guideline

This page discusses the coding style and other guidelines for sbt 1.0.

General goal

sbt 1.0 will primarily target Scala 2.12. We will cross-build against Scala 2.10.

Clean up old deprecation Before 1.0 is release, we should clean up deprecations.

Aim for zero warnings (except deprecation) On Scala 2.12 we should aim for zero warnings. One exception may be deprecation if it's required for cross-building.

Documentation

> It is often useful to start with the Scaladoc before fleshing out a trait/class implementation by forcing you to consider the need for its existance.

All newly introduced **public** traits and classes and, to a lesser extent, functions and methods, should have Scaladoc. A significant amount of existing sbt code lacks documentation and we need to repair this situation over time. If you see an opportunity to add some documentation, or improve existing documentation then this will also help.

Package level documentation is a great place to describe how various components interact, so please consider adding/enhancing that where possible.

For more information on good Scaladoc style, please refer to the Scaladoc Style Guide

Modular design

Aim small The fewer methods we can expose to the build user, the easier sbt becomes to maintain.

Public APIs should be coded against "interfaces" Code against interfaces.

Hide implementation details The implementation details should be hidden behind `sbt.internal.x` packages, where `x` could be the name of the main package (like `io`).

Less interdependence Independent modules with fewer dependent libraries are easier to reuse.

Hide external classes Avoid exposing external classes in the API, except for standard Scala and Java classes.

Hide internal modules A module may be declared internal if it has no use to the public.

Compiler flags

```
-encoding utf8
-deprecation
-feature
-unchecked
-Xlint
-language:higherKinds
-language:implicitConversions
-Xfuture
-Yinline-warnings
-Yno-adapted-args
-Ywarn-dead-code
-Ywarn-numeric-widen
-Ywarn-value-discard
-Xfatal-warnings
```

The `-Xfatal-warnings` may be removed if there are unavoidable warnings.

Package name and organization name Use the package name appended with the layer name, such as `sbt.io` for IO layer. The organization name for published artifacts should remain `org.scala-sbt`.

Binary resiliency

A good overview on the topic of binary resiliency is Josh's 2012 talk on Binary resiliency. The guideline here applies mostly to publicly exposed APIs.

MiMa Use MiMa.

Public traits should contain `def` declarations only

- `val` or `var` in a `trait` results in code generated at subclass and in the artificial `Foo$class.$init$`
- `lazy val` results in code generated at subclass

Abstract classes are also useful To trait, or not to trait?. Abstract classes are less flexible than traits, but traits pose more problems for binary compatibility. Abstract classes also have better Java interoperability.

Seal traits and abstract classes If there's no need to keep a class open, seal it.

Finalize the leaf classes If there's no need to keep a class open, finalize it.

Typeclass and subclass inheritance The typeclass pattern with pure traits might ease maintaining binary compatibility more so than subclassing.

Avoid case classes, use sbt-datatype Case classes involve code generation that makes it harder to maintain binary compatibility over time.

Prefer method overloading over default parameter values Default parameter values are effectively code generation, which makes them difficult to maintain.

Other public API matters

Here are other guidelines about the sbt public API.

Avoid Stringly-typed programming Define datatypes.

Avoid overuse of `def apply` `def apply` should be reserved for factory methods in a companion object that returns type `T`.

Use specific datatypes (`Vector`, `List`, or `Array`), rather than `Seq` `scala.Seq` is `scala.collection.Seq`, which is not immutable. Default to `Vector`. Use `List` if constant prepending is needed. Use `Array` if Java interoperability is needed. Note that using mutable collections is perfectly fine within the implementation.

Avoid calling `toSeq` or anything with side-effects on `Set` `Set` is fine if you stick to set operations, like `contains` and `subsetOf`. More often than not, `toSeq` is called explicitly or implicitly, or some side-effecting method is called from `map`. This introduces non-determinism to the code.

Avoid calling `toSeq` on `Map` Same as above. This will introduce non-determinism.

Avoid functions and tuples in the signature, if Java interoperability is needed Instead of functions and tuples, turn them into a trait. This applies where interoperability is a concern, like implementing incremental compilation.

Style matters

Use scalafmt sbt-houserules comes with scalafmt for formatting source code consistently.

Avoid procedure syntax Declare an explicit `Unit` return.

Define instances of typeclasses in their companion objects, when possible This style is encouraged:

```scala
final class FooID {}
object FooID {
  implicit val fooIdPicklerUnpicker: PicklerUnpickler[FooID] = ???
}
```

Implicit conversions for syntax (enrich-my-library pattern) should be imported Avoid defining implicit converters in companion objects and package objects.

Suppose the IO module introduces a `URL` enrichment called `RichURI`, and LibraryManagement introduces a `String` enrichment called `GroupID` (for `ModuleID` syntax). These implicit conversions should be defined in an object named `syntax` in the respective package:

```
package sbt.io

object syntax {
  implicit def uriToRichURI(uri: URI): RichURI = new RichURI(uri)
}
```

When all the layers are available, the `sbt` package should also define an object called `syntax` which forwards implicit conversions from all the layers:

```
package sbt

object syntax {
  implicit def uriToRichURI(uri: URI): io.RichURI = io.syntax.uriToRichURI(uri)
  ....
}
```

sbt-datatype

sbt-datatype is a code generation library and an sbt autoplugin that generates growable datatypes and helps developers avoid breakage of binary compatibility.

Unlike standard Scala case classes, the datatypes (or pseudo case classes) generated by this library allow the developer to add new fields to the defined datatypes without breaking binary compatibility, while offering (almost) the same functionality as plain case classes. The only difference is that datatype doesn't generate `unapply` or `copy` methods, because they would break binary compatibility.

In addition, sbt-datatype is also able to generate JSON codec for sjson-new, which can work against various JSON backends.

Our plugin takes as input a datatype schema in the form of a `JSON` object, whose format is based on the format defined by Apache Avro, and generates the corresponding code in Java or Scala along with the boilerplate code that will allow the generated classes to remain binary-compatible with previous versions of the datatype.

The source code of the library and autoplugin can be found on GitHub.

Using the plugin

To enable the plugin for your build, put the following line in `project/datatype.sbt`:

```
addSbtPlugin("org.scala-sbt" % "sbt-datatype" % "0.2.2")
```

Your datatype definitions should be placed by default in `src/main/datatype` and `src/test/datatype`. Here's how your build should be configured:

```
lazy val library = (project in file("library"))
  .enablePlugins(DatatypePlugin)
  .settings(
    name := "foo library",
  )
```

Datatype schema

Datatype is able to generate three kinds of types:

1. Records
2. Interfaces
3. Enums

Records Records are mapped to Java or Scala `classes`, corresponding to the standard case classes in Scala.

```
{
  "types": [
    {
      "name": "Person",
      "type": "record",
      "target": "Scala",
      "fields": [
        {
          "name": "name",
          "type": "String"
        },
        {
          "name": "age",
          "type": "int"
        }
      ]
    }
  ]
}
```

This schema will produce the following Scala class:

```scala
final class Person(
  val name: String,
  val age: Int) extends Serializable {
  override def equals(o: Any): Boolean = o match {
    case x: Person => (this.name == x.name) && (this.age == x.age)
    case _ => false
  }
  override def hashCode: Int = {
    37 * (37 * (17 + name.##) + age.##)
  }
  override def toString: String = {
    "Person(" + name + ", " + age + ")"
  }
  private[this] def copy(name: String = name, age: Int = age): Person = {
    new Person(name, age)
  }
  def withName(name: String): Person = {
    copy(name = name)
  }
  def withAge(age: Int): Person = {
    copy(age = age)
  }
}
object Person {
  def apply(name: String, age: Int): Person = new Person(name, age)
}
```

Or the following Java code (after changing the `target` property to `"Java"`):

```java
public final class Person implements java.io.Serializable {
    private String name;
    private int age;
    public Person(String _name, int _age) {
        super();
        name = _name;
        age = _age;
    }
    public String name() {
        return this.name;
    }
    public int age() {
        return this.age;
    }
```

```java
    public boolean equals(Object obj) {
        if (this == obj) {
            return true;
        } else if (!(obj instanceof Person)) {
            return false;
        } else {
            Person o = (Person)obj;
            return name().equals(o.name()) && (age() == o.age());
        }
    }
    public int hashCode() {
        return 37 * (37 * (17 + name().hashCode()) + (new Integer(age())).hashCode());
    }
    public String toString() {
        return "Person("  + "name: " + name() + ", " + "age: " + age() + ")";
    }
}
```

Interfaces Interfaces are mapped to Java `abstract classes` or Scala `abstract classes`. They can be extended by other interfaces or records.

```json
{
  "types": [
    {
      "name": "Greeting",
      "namespace": "com.example",
      "target": "Scala",
      "type": "interface",
      "fields": [
        {
          "name": "message",
          "type": "String"
        }
      ],
      "types": [
        {
          "name": "SimpleGreeting",
          "namespace": "com.example",
          "target": "Scala",
          "type": "record"
        }
      ]
    }
  ]
}
```

This generates abstract class named `Greeting` and a class named `SimpleGreeting` that extends `Greeting`.

In addition, interfaces can define `messages`, which generates abstract method declarations.

```
{
  "types": [
    {
      "name": "FooService",
      "target": "Scala",
      "type": "interface",
      "messages": [
        {
          "name": "doSomething",
          "response": "int*",
          "request": [
            {
              "name": "arg0",
              "type": "int*",
              "doc": [
                "The first argument of the message.",
              ]
            }
          ]
        }
      ]
    }
  ]
}
```

Enums Enums are mapped to Java enumerations or Scala case objects.

```
{
  "types": [
    {
      "name": "Weekdays",
      "type": "enum",
      "target": "Java",
      "symbols": [
        "Monday", "Tuesday", "Wednesday", "Thursday",
        "Friday", "Saturday", "Sunday"
      ]
    }
  ]
}
```

This schema will generate the following Java code:

```
public enum Weekdays {
    Monday,
    Tuesday,
    Wednesday,
    Thursday,
    Friday,
    Saturday,
    Sunday
}
```

Or the following Scala code (after changing the `target` property to):

```
sealed abstract class Weekdays extends Serializable
object Weekdays {
  case object Monday extends Weekdays
  case object Tuesday extends Weekdays
  case object Wednesday extends Weekdays
  case object Thursday extends Weekdays
  case object Friday extends Weekdays
  case object Saturday extends Weekdays
  case object Sunday extends Weekdays
}
```

Using datatype to retain binary compatibility

By using the `since` and `default` parameters, it is possible to grow existing datatypes while remaining binary compatible with classes that have been compiled against an earlier version of your datatype definition.

Consider the following initial version of a datatype:

```
{
  "types": [
    {
      "name": "Greeting",
      "type": "record",
      "target": "Scala",
      "fields": [
        {
          "name": "message",
          "type": "String"
        }
      ]
```

```
    }
  ]
}
```

The generated code could be used in a Scala program using the following code:

```scala
val greeting = Greeting("hello")
```

Imagine now that you would like to extend your datatype to include a date to the `Greeting`s. The datatype can be modified accordingly:

```json
{
  "types": [
    {
      "name": "Greeting",
      "type": "record",
      "target": "Scala",
      "fields": [
        {
          "name": "message",
          "type": "String"
        },
        {
          "name": "date",
          "type": "java.util.Date"
        }
      ]
    }
  ]
}
```

Unfortunately, the code that used `Greeting` would no longer compile, and classes that have been compiled against the previous version of the datatype would crash with a `NoSuchMethodError`.

To circumvent this problem and allow you to grow your datatypes, it is possible to indicate the version `since` the field exists and a `default` value in the datatype definition:

```json
{
  "types": [
    {
      "name": "Greeting",
      "type": "record",
      "target": "Scala",
```

```
      "fields": [
        {
          "name": "message",
          "type": "String"
        },
        {
          "name": "date",
          "type": "java.util.Date",
          "since": "0.2.0",
          "default": "new java.util.Date()"
        }
      ]
    }
  ]
}
```

Now the code that was compiled against previous definitions of the datatype will still run.

JSON codec generation

Adding `JsonCodecPlugin` to the subproject will generate sjson-new JSON codes for the datatypes.

lazy val root = (project in file(".")) .enablePlugins(DatatypePlugin, JsonCodecPlugin) .settings(scalaVersion := "2.11.8", libraryDependencies += "com.eed3si9n" %% "sjson-new-scalajson" % "0.4.1")

`codecNamespace` can be used to specify the package name for the codecs.

```
{
  "codecNamespace": "com.example.codec",
  "fullCodec": "CustomJsonProtocol",
  "types": [
    {
      "name": "Person",
      "namespace": "com.example",
      "type": "record",
      "target": "Scala",
      "fields": [
        {
          "name": "name",
          "type": "String"
        },
        {
          "name": "age",
```

```
          "type": "int"
        }
      ]
    }
  ]
}
```

JsonFormat traits will be generated under `com.example.codec` package, along with a full codec named `CustomJsonProtocol` that mixes in all the traits.

```
scala> import sjsonnew.support.scalajson.unsafe.{ Converter, CompactPrinter, Parser }
import sjsonnew.support.scalajson.unsafe.{Converter, CompactPrinter, Parser}

scala> import com.example.codec.CustomJsonProtocol._
import com.example.codec.CustomJsonProtocol._

scala> import com.example.Person
import com.example.Person

scala> val p = Person("Bob", 20)
p: com.example.Person = Person(Bob, 20)

scala> val j = Converter.toJsonUnsafe(p)
j: scala.json.ast.unsafe.JValue = JObject([Lscala.json.ast.unsafe.JField;@6731ad72)

scala> val s = CompactPrinter(j)
s: String = {"name":"Bob","age":20}

scala> val x = Parser.parseUnsafe(s)
x: scala.json.ast.unsafe.JValue = JObject([Lscala.json.ast.unsafe.JField;@7331f7f8)

scala> val q = Converter.fromJsonUnsafe[Person](x)
q: com.example.Person = Person(Bob, 20)

scala> assert(p == q)
```

Existing parameters for protocols, records, etc.

All the elements of the schema definition accept a number of parameters that will influence the generated code. These parameters are not available for every node of the schema. Please refer to the syntax summary to see whether a parameters can be defined for a node.

`name`

This parameter defines the name of a field, record, field, etc.

`target`

This parameter determines whether the code will be generated in Java or Scala.

`namespace`

This parameter exists only for `Definition`s. It determines the package in which the code will be generated.

`doc`

The Javadoc that will accompany the generated element.

`fields`

For a `protocol` or a `record` only, it describes all the fields that compose the generated entity.

`types`

For a `protocol`, it defines the child `protocol`s and `record`s that extend it.

For an `enumeration`, it defines the values of the enumeration.

`since`

This parameter exists for `field`s only. It indicates the version in which the field has been added to its parent `protocol` or `record`.

When this parameter is defined, `default` must also be defined.

`default`

This parameter exists for `field`s only. It indicates what the default value should be for this field, in case it is used by a class that has been compiled against an earlier version of this datatype.

It must contain an expression which is valid in the `target` language of the parent `protocol` or `record`.

`type` for `fields`

It indicates what is the underlying type of the field.

Always use the type that you want to see in Scala. For instance, if your field will contain an integer value, use `Int` rather than Java's `int`. `datatype` will automatically use Java's primitive types if they are available.

For non-primitive types, it is recommended to write the fully-qualified type.

`type` for other definitions

It simply indicates the kind of entity that you want to generate: `protocol`, `record` or `enumeration`.

Settings

This location can be changed by setting a new location in your build definition:

```
datatypeSource in generateDatatypes := file("some/location")
```

The plugin exposes other settings for Scala code generation:

1. `datatypeScalaFileNames in (Compile, generateDatatypes)` This setting accepts a function `Definition => File` which will determine the filename for every generated Scala definition.
2. `datatypeScalaSealInterfaces in (Compile, generateDatatypes)` This setting accepts a boolean value, and will determine whether interfaces should be `seal`ed or not.

Syntax summary

```
Schema           := {   "types": [ Definition* ]
                    (, "codecNamespace": string constant)?
                    (, "fullCodec": string constant)? }

Definition       := Record | Interface | Enumeration

Record           := {   "name": ID,
                        "type": "record",
                        "target": ("Scala" | "Java")
                    (, "namespace": string constant)?
                    (, "doc": string constant)?
                    (, "fields": [ Field* ])? }

Interface        := {   "name": ID,
                        "type": "interface",
                        "target": ("Scala" | "Java")
                    (, "namespace": string constant)?
                    (, "doc": string constant)?
                    (, "fields": [ Field* ])?
                    (, "messages": [ Message* ])?
                    (, "types": [ Definition* ])? }

Enumeration      := {   "name": ID,
                        "type": "enum",
                        "target": ("Scala" | "Java")
                    (, "namespace": string constant)?
                    (, "doc": string constant)?
```

```
                     (, "symbols": [ Symbol* ])? }

Symbol           := ID
 {   "name": ID
                     (, "doc": string constant)? }

Field            := {   "name": ID,
                        "type": ID
                     (, "doc": string constant)?
                     (, "since": version number string)?
                     (, "default": string constant)? }

Message          := {   "name": ID,
                        "response": ID
                     (, "request": [ Request* ])?
                     (, "doc": string constant)? }

Request          := {   "name": ID,
                        "type": ID
                     (, "doc": string constant)? }
```

Compiler Interface

The compiler interface is the communication link between sbt and the Scala compiler.

It is used to get information from the Scala compiler, and must therefore be compiled against the Scala version in use for the configured projects.

The code for this project can be found in the directory internal/compiler-bridge.

Fetching the most specific sources

Because the compiler interface is recompiled against each Scala version in use in your project, its source must stay compatible with all the Scala versions that sbt supports (from Scala 2.8 to the latest version of Scala).

This comes at great cost for both the sbt maintainers and the Scala compiler authors:

1. The compiler authors cannot remove old and deprecated public APIs from the Scala compiler.
2. sbt cannot use new APIs defined in the Scala compiler.
3. sbt must implement all kinds of hackery to remain source-compatible with all versions of the Scala compiler and support new features.

To circumvent this problem, a new mechanism that allows sbt to fetch the version of the sources for the compiler interface that are the most specific for the Scala version in use has been implemented in sbt.

For instance, for a project that is compiled using Scala 2.11.8-M2, sbt will look for the following version of the sources for the compiler interface, in this order:

1. 2.11.8-M2
2. 2.11.8
3. 2.11
4. The default sources.

This new mechanism allows both the Scala compiler and sbt to move forward and enjoy new APIs while being certain than users of older versions of Scala will still be able to use sbt.

Finally, another advantage of this technique is that it relies on Ivy to retrieve the sources of the compiler bridge, but can be easily ported for use with Maven, which is the distribution mechanism that the sbt maintainers would like to use to distribute sbt's modules.

sbt Launcher

The sbt launcher provides a generic container that can load and run programs resolved using the Ivy dependency manager. Sbt uses this as its own deployment mechanism.

The code is hosted at sbt/launcher.

Getting Started with the sbt launcher

The sbt launcher provides two parts:

1. An interface for launched applications to interact with the launcher code
2. A minimal sbt-launch.jar that can launch applications by resolving them through ivy.

The sbt launcher component is a self-contained jar that boots a Scala application or server without Scala or the application already existing on the system. The only prerequisites are the launcher jar itself, an optional configuration file, and a Java runtime version 1.6 or greater.

Overview

A user downloads the launcher jar and creates a script to run it. In this documentation, the script will be assumed to be called `launch`. For Unix, the script would look like: `java -jar sbt-launcher.jar "$@"`

The user can now launch servers and applications which provide sbt launcher configuration.

Alternatively, you can repackage the launcher with a launcher configuration file. For example, sbt/sbt pulls in the raw JAR and injects the appropriate boot.properties files for sbt.

Applications To launch an application, the user then downloads the configuration file for the application (call it `my.app.configuration`) and creates a script to launch it (call it `myapp`):

```
launch @my.app.configuration "$@"
```

The user can then launch the application using `myapp arg1 arg2 ...`

More on launcher configuration can be found at Launcher Configuration

Servers The sbt launcher can be used to launch and discover running servers on the system. The launcher can be used to launch servers similarly to applications. However, if desired, the launcher can also be used to ensure that only one instance of a server is running at time. This is done by having clients always use the launcher as a *service locator*.

To discover where a server is running (or launch it if it is not running), the user downloads the configuration file for the server (call it `my.server.configuration`) and creates a script to discover the server (call it `find-myserver`):

```
launch --locate @my.server.properties.
```

This command will print out one string, the URI at which to reach the server, e.g. `sbt://127.0.0.1:65501`. Clients should use the IP/port to connect to to the server and initiate their connection.

When using the `locate` feature, the sbt launcher makes the following restrictions to servers:

- The Server must have a starting class that extends the `xsbti.ServerMain` class

- The Server must have an entry point (URI) that clients can use to detect the server
- The server must have defined a lock file which the launcher can use to ensure that only one instance is running at a time
- The filesystem on which the lock file resides must support locking.
- The server must allow the launcher to open a socket against the port without sending any data. This is used to check if a previous server is still alive.

Resolving Applications/Servers Like the launcher used to distribute `sbt`, the downloaded launcher jar will retrieve Scala and the application according to the provided configuration file. The versions may be fixed or read from a different configuration file (the location of which is also configurable). The location to which the Scala and application jars are downloaded is configurable as well. The repositories searched are configurable. Optional initialization of a properties file on launch is configurable.

Once the launcher has downloaded the necessary jars, it loads the application/server and calls its entry point. The application is passed information about how it was called: command line arguments, current working directory, Scala version, and application ID (organization, name, version). In addition, the application can ask the launcher to perform operations such as obtaining the Scala jars and a `ClassLoader` for any version of Scala retrievable from the repositories specified in the configuration file. It can request that other applications be downloaded and run. When the application completes, it can tell the launcher to exit with a specific exit code or to reload the application with a different version of Scala, a different version of the application, or different arguments.

There are some other options for setup, such as putting the configuration file inside the launcher jar and distributing that as a single download. The rest of this documentation describes the details of configuring, writing, distributing, and running the application.

Creating a Launched Application This section shows how to make an application that is launched by this launcher. First, declare a dependency on the `launcher-interface`. Do not declare a dependency on the launcher itself. The launcher interface consists strictly of Java interfaces in order to avoid binary incompatibility between the version of Scala used to compile the launcher and the version used to compile your application. The launcher interface class will be provided by the launcher, so it is only a compile-time dependency. If you are building with sbt, your dependency definition would be:

```
libraryDependencies += "org.scala-sbt" % "launcher-interface" % "1.0.0" % "provided"

resolvers += sbtResolver.value
```

Make the entry point to your class implement `xsbti.AppMain`. An example that uses some of the information:

```scala
package com.acme.launcherapp

class Main extends xsbti.AppMain
{
    def run(configuration: xsbti.AppConfiguration) =
    {
        // get the version of Scala used to launch the application
        val scalaVersion = configuration.provider.scalaProvider.version

        // Print a message and the arguments to the application
        println("Hello world!  Running Scala " + scalaVersion)
        configuration.arguments.foreach(println)

        // demonstrate the ability to reboot the application into different versions of Sca
        // and how to return the code to exit with
        scalaVersion match
        {
            case "2.10.6" =>
                new xsbti.Reboot {
                    def arguments = configuration.arguments
                    def baseDirectory = configuration.baseDirectory
                    def scalaVersion = "2.11.8"
                    def app = configuration.provider.id
                }
            case "2.11.8" => new Exit(1)
            case _ => new Exit(0)
        }
    }
    class Exit(val code: Int) extends xsbti.Exit
}
```

Next, define a configuration file for the launcher. For the above class, it might look like:

```
[scala]
  version: 2.11.8
[app]
  org: com.acme
  name: launcherapp
  version: 0.0.1
  class: com.acme.launcherapp.Main
  cross-versioned: true
```

```
[repositories]
  local
  maven-central
[boot]
 directory: ${user.home}/.myapp/boot
```

Then, `publishLocal` or `+publishLocal` the application in sbt's shell to make it available. For more information, see Launcher Configuration.

Running an Application As mentioned above, there are a few options to actually run the application. The first involves providing a modified jar for download. The second two require providing a configuration file for download.

- Replace the `/sbt/sbt.boot.properties` file in the launcher jar and distribute the modified jar. The user would need a script to run `java -jar your-launcher.jar arg1 arg2 ....`
- The user downloads the launcher jar and you provide the configuration file.
  - The user needs to run `java -Dsbt.boot.properties=your.boot.properties -jar launcher.jar`.
  - The user already has a script to run the launcher (call it 'launch'). The user needs to run `launch @your.boot.properties your-arg-1 your-arg-2`

Execution Let's review what's happening when the launcher starts your application.

On startup, the launcher searches for its configuration and then parses it. Once the final configuration is resolved, the launcher proceeds to obtain the necessary jars to launch the application. The `boot.directory` property is used as a base directory to retrieve jars to. Locking is done on the directory, so it can be shared system-wide. The launcher retrieves the requested version of Scala to

```
${boot.directory}/${scala.version}/lib/
```

If this directory already exists, the launcher takes a shortcut for startup performance and assumes that the jars have already been downloaded. If the directory does not exist, the launcher uses Apache Ivy to resolve and retrieve the jars. A similar process occurs for the application itself. It and its dependencies are retrieved to

```
${boot.directory}/${scala.version}/${app.org}/${app.name}/.
```

Once all required code is downloaded, the class loaders are set up. The launcher creates a class loader for the requested version of Scala. It then creates a child class loader containing the jars for the requested `app.components` and with the paths specified in `app.resources`. An application that does not use components will have all of its jars in this class loader.

The main class for the application is then instantiated. It must be a public class with a public no-argument constructor and must conform to `xsbti.AppMain`. The `run` method is invoked and execution passes to the application. The argument to the 'run' method provides configuration information and a callback to obtain a class loader for any version of Scala that can be obtained from a repository in [repositories]. The return value of the run method determines what is done after the application executes. It can specify that the launcher should restart the application or that it should exit with the provided exit code.

Sbt Launcher Architecture

The sbt launcher is a mechanism whereby modules can be loaded from Ivy and executed within a JVM. It abstracts the mechanism of grabbing and caching jars, allowing users to focus on what application they want, and control its versions.

The launcher's primary goal is to take configuration for applications— mostly Ivy coordinates and a main class—and start the application. The launcher resolves the Ivy module, caches the required runtime jars, and starts the application.

The sbt launcher provides the application with the means to load a different application when it completes, exit normally, or load additional applications from inside another.

The sbt launcher provides these core functions:

- Module Resolution
- Classloader Caching and Isolation
- File Locking
- Service Discovery and Isolation

Module Resolution

The primary purpose of the sbt launcher is to resolve applications and run them. This is done through the `[app]` configuration section. See launcher configuration for more information on how to configure module resolution.

Module resolution is performed using the Ivy dependency management library. This library supports loading artifacts from Maven repositories as well.

Classloader Caching and Isolation

The sbt launcher's classloading structure is different than just starting an application in the standard Java mechanism. Every application loaded by the launcher is given its own classloader. This classloader is a child of the Scala classloader used by the application. The Scala classloader can see all of the `xsbti.*` classes from the launcher itself.

Here's an example classloader layout from an sbt-launched application.

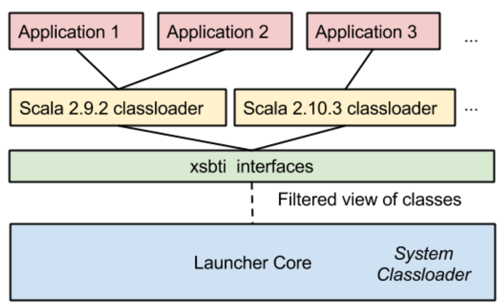


Figure 11: image

In this diagram, three different applications were loaded. Two of these use the same version of Scala (2.9.2). In this case, sbt can share the same classloader for these applications. This has the benefit that any JIT optimisations performed on Scala classes can be re-used between applications thanks to the shared classloader.

Caching

The sbt launcher creates a secondary cache on top of Ivy's own cache. This helps isolate applications from errors resulting from unstable revisions, like `-SNAPSHOT`.

For any launched application, the launcher creates a directory to store all its jars. Here's an example layout.

Locking

In addition to providing a secondary cache, the launcher also provides a mechanism of safely doing file-based locks. This is used in two places directly by the launcher:

1. Locking the boot directory.
2. Ensuring located servers have at most one active process.

This feature requires a filesystem which supports locking. It is exposed via the `xsbti.GlobalLock` interface.

Note: This is both a thread and file lock. Not only are we limiting access to a single process, but also a single thread within that process.

Service Discovery and Isolation

The launcher also provides a mechanism to ensure that only one instance of a server is running, while dynamically starting it when a client requests. This is done through the `--locate` flag on the launcher. When the launcher is started with the `--locate` flag it will do the following:

1. Lock on the configured server lock file.
2. Read the server properties to find the URI of the previous server.
3. If the port is still listening to connection requests, print this URI on the command line.
4. If the port is not listening, start a new server and write the URI on the command line.
5. Release all locks and shutdown.

The configured `server.lock` file is thus used to prevent multiple servers from running. sbt itself uses this to prevent more than one server running on any given project directory by configuring `server.lock` to be `${user.dir}/.sbtserver`.

sbt Launcher Configuration

The launcher may be configured in one of the following ways in increasing order of precedence:

- Replace the `/sbt/sbt.boot.properties` file in the launcher jar

- Put a configuration file named `sbt.boot.properties` on the classpath. Put it in the classpath root without the /sbt prefix.
- Specify the location of an alternate configuration on the command line, either as a path or an absolute URI. This can be done by either specifying the location as the system property sbt.boot.properties or as the first argument to the launcher prefixed by `@`. The system property has lower precedence. Resolution of a relative path is first attempted against the current working directory, then against the user's home directory, and then against the directory containing the launcher jar.

An error is generated if none of these attempts succeed.

Example

The default configuration file for sbt as an application looks like:

```
[scala]
  version: ${sbt.scala.version-auto}

[app]
  org: ${sbt.organization-org.scala-sbt}
  name: sbt
  version: ${sbt.version-read(sbt.version)[0.13.5]}
  class: ${sbt.main.class-sbt.xMain}
  components: xsbti,extra
  cross-versioned: ${sbt.cross.versioned-false}

[repositories]
  local
 typesafe-ivy-releases: http://repo.typesafe.com/typesafe/ivy-releases/, [organization]/[mod
  maven-central
 sonatype-snapshots: https://oss.sonatype.org/content/repositories/snapshots

[boot]
 directory: ${sbt.boot.directory-${sbt.global.base-${user.home}/.sbt}/boot/}

[ivy]
  ivy-home: ${sbt.ivy.home-${user.home}/.ivy2/}
  checksums: ${sbt.checksums-sha1,md5}
  override-build-repos: ${sbt.override.build.repos-false}
 repository-config: ${sbt.repository.config-${sbt.global.base-${user.home}/.sbt}/repositorie
```

Let's look at all the launcher configuration sections in detail:

1. Scala Configuration The `[scala]` section is used to configure the version of Scala. It has one property:

- `version` - The version of Scala an application uses, or `auto` if the application is not cross-versioned.
- `classifiers` - The (optional) list of additional Scala artifacts to resolve, e.g. sources.

2. Application Identification The `[app]` section configures how the launcher will look for your application using the Ivy dependency manager. It consists of the following properties:

- `org` - The organization associated with the Ivy module. (`groupId` in Maven vernacular)
- `name` - The name of the Ivy module. (`artifactId` in Maven vernacular)
- `version` - The revision of the Ivy module.
- `class` - The name of the "entry point" into the application. An entry point must be a class which meets one of the following criteria
  - Extends the `xsbti.AppMain` interface.
  - Extends the `xsbti.ServerMain` interfaces.
  - Contains a method with the signature `static void main(String[])`
  - Contains a method with the signature `static int main(String[])`
  - Contains a method with the signature `static xsbti.Exit main(String[])`
- `components` - An optional list of additional components that Ivy should resolve.
- `cross-versioned` - An optional string denoting how this application is published. If `app.cross-versioned` is binary, the resolved module ID is `{app.name+'_'+CrossVersion.binaryScalaVersion(scala.version)}`. If `app.cross-versioned` is `true` or `full`, the resolved module ID is `{app.name+'_'+scala.version}`. The `scala.version` property must be specified and cannot be `auto` when cross-versioned.
- `resources` - An optional list of jar files that should be added to the application's classpath.
- `classifiers` - An optional list of additional classifiers that should be resolved with this application, e.g. sources.

3. Repositories Section The `[repositories]` section configures where and how Ivy will look for your application. Each line denotes a repository where Ivy will look.

Note: This section configured the default location where Ivy will look, but this can be overridden via user configuration.

There are several built-in strings that can be used for common repositories:

- `local` - the local Ivy repository `~/.ivy2/local`.
- `maven-local` - The local Maven repository `~/.m2/repository`.
- `maven-central` - The Maven Central repository `repo.maven.org`.

Besides built in repositories, other repositories can be configured using the following syntax:

> name: url(, pattern)(,descriptorOptional)(,skipConsistencyCheck)

The `name` property is an identifier which Ivy uses to cache modules resolved from this location. The `name` should be unique across all repositories.

The `url` property is the base `url` where Ivy should look for modules.

The `pattern` property is an optional specification of *how* Ivy should look for modules. By default, the launcher assumes repositories are in the maven style format.

The `skipConsistencyCheck` string is used to tell Ivy not to validate checksums and signatures of files it resolves.

4. The Boot section The `[boot]` section is used to configure where the sbt launcher will store its cache and configuration information. It consists of the following properties:

- `directory` - The directory defined here is used to store all cached JARs resolved launcher.
- `properties` - (optional) A properties file to use for any `read` variables.

5. The Ivy section The `[ivy]` section is used to configure the Ivy dependency manager for resolving applications. It consists of the following properties:

- `ivy-home` - The home directory for Ivy. This determines where the ivy-local repository is located, and also where the Ivy cache is stored. Defaults to `~/.ivy2`
- `checksums` - The comma-separated list of checksums that Ivy should use to verify artifacts have correctly resolved, e.g. md5 or sha1.
- `override-build-repos` - If this is set, then the `isOverrideRepositories` method on `xsbti.Launcher` interface will return its value. The use of this method is application-specific, but in the case of sbt denotes that the configuration of repositories in the launcher should override those used by any build. Applications should respect this convention if they can.
- `repository-config` - This specifies a configuration location where Ivy repositories can also be configured. If this file exists, then its contents override the `[repositories]` section.

6. The Server Section When using the `--locate` feature of the launcher, this section configures how a server is started. It consists of the following properties:

- `lock` - The file that controls access to the running server. This file will contain the active port used by a server and must be located on a filesystem that supports locking.
- `jvmargs` - A file that contains line-separated JVM arguments that were used when starting the server.
- `jvmprops` - The location of a properties file that will define override properties in the server. All properties defined in this file will be set as `-D` Java properties.

Variable Substitution

Property values may include variable substitutions. A variable substitution has one of these forms:

- `${variable.name}`
- `${variable.name-default}`

where `variable.name` is the name of a system property. If a system property by that name exists, the value is substituted. If it does not exists and a default is specified, the default is substituted after recursively substituting variables in it. If the system property does not exist and no default is specified, the original string is not substituted.

There is also a special variable substitution:

```
read(property.name)[default]
```

This will look in the file configured by `boot.properties` for a value. If there is no `boot.properties` file configured, or the property does not exist, then the default value is chosen.

Syntax

The configuration file is line-based, read as UTF-8 encoded, and defined by the following grammar. `'nl'` is a newline or end of file and `'text'` is plain text without newlines or the surrounding delimiters (such as parentheses or square brackets):

```
configuration: scala app repositories boot log appProperties
scala: "[" "scala" "]" nl version nl classifiers nl
app: "[" "app" "]" nl org nl name nl version nl components nl class nl crossVersioned nl res
repositories: "[" "repositories" "]" nl (repository nl)*
boot: "[" "boot" "]" nl directory nl bootProperties nl search nl promptCreate nl promptFill
log: "[" "log" "]" nl logLevel nl
appProperties: "[" "app-properties" "]" nl (property nl)*
ivy: "[" "ivy" "]" nl homeDirectory nl checksums nl overrideRepos nl repoConfig nl
directory: "directory" ":" path
bootProperties: "properties" ":" path
search: "search" ":" ("none" | "nearest" | "root-first" | "only" ) ("," path)*
logLevel: "level" ":" ("debug" | "info" | "warn" | "error")
promptCreate: "prompt-create"  ":"  label
promptFill: "prompt-fill" ":" boolean
quickOption: "quick-option" ":" boolean
version: "version" ":" versionSpecification
versionSpecification: readProperty | fixedVersion
readProperty: "read"  "(" propertyName ")"  "[" default "]"
fixedVersion: text
classifiers: "classifiers" ":" text ("," text)*
homeDirectory: "ivy-home" ":" path
checksums: "checksums" ":" checksum ("," checksum)*
overrideRepos: "override-build-repos" ":" boolean
repoConfig: "repository-config" ":" path
org: "org" ":" text
name: "name" ":" text
class: "class" ":" text
components: "components" ":" component ("," component)*
crossVersioned: "cross-versioned" ":"  ("true" | "false" | "none" | "binary" | "full")
resources: "resources" ":" path ("," path)*
repository: ( predefinedRepository | customRepository ) nl
predefinedRepository: "local" | "maven-local" | "maven-central"
customRepository: label ":" url [ ["," ivyPattern] ["," artifactPattern] [", mavenCompatible
property: label ":" propertyDefinition ("," propertyDefinition)*
propertyDefinition: mode "=" (set | prompt)
mode: "quick" | "new" | "fill"
set: "set" "(" value ")"
prompt: "prompt"  "(" label ")" ("[" default "]")?
boolean: "true" | "false"
nl: "\r\n" | "\n" | "\r"
path: text
propertyName: text
label: text
default: text
checksum: text
ivyPattern: text
```

```
artifactPattern: text
url: text
component: text
```

Notes

Here are some more docs that used to be part of Developer Guide.

Core Principles

This document details the core principles overarching sbt's design and code style. sbt's core principles can be stated quite simply:

1. Everything should have a `Type`, enforced as much as is practical.
2. Dependencies should be **explicit**.
3. Once learned, a concept should hold throughout **all** parts of sbt.
4. Parallel is the default.

With these principles in mind, let's walk through the core design of sbt.

Introduction to build state

This is the first piece you hit when starting sbt. sbt's command engine is the means by which it processes user requests using the build state. The command engine is essentially a means of applying **state transformations** on the build state, to execute user requests.

In sbt, commands are functions that take the current build state (`sbt.State`) and produce the next state. In other words, they are essentially functions of `sbt.State => sbt.State`. However, in reality, Commands are actually string processors which take some string input and act on it, returning the next build state.

So, the entirety of sbt is driven off the `sbt.State` class. Since this class needs to be resilient in the face of custom code and plugins, it needs a mechanism to store the state from any potential client. In dynamic languages, this can be done directly on objects.

A naive approach in Scala is to use a `Map<String,Any>`. However, this violates tenant #1: Everything should have a `Type`. So, sbt defines a new type of map called an `AttributeMap`. An `AttributeMap` is a key-value storage mechanism where keys are both strings *and* expected `Type`s for their value.

Here is what the type-safe `AttributeKey` key looks like :

```
sealed trait AttributeKey[T] {
 /** The label is the identifier for the key and is camelCase by convention. */
  def label: String
  /** The runtime evidence for ``T`` */
  def manifest: Manifest[T]
}
```

These keys store both a `label` (`string`) and some runtime type information (`manifest`). To put or get something on the `AttributeMap`, we first need to construct one of these keys. Let's look at the basic definition of the `AttributeMap`:

```
trait AttributeMap {
  /** Gets the value of type ``T`` associated with the key ``k`` or ``None`` if no value is
  * If a key with the same label but a different type is defined, this method will return `
  def get[T](k: AttributeKey[T]): Option[T]

  /** Adds the mapping ``k -> value`` to this map, replacing any existing mapping for ``k``
  * Any mappings for keys with the same label but different types are unaffected. */
  def put[T](k: AttributeKey[T], value: T): AttributeMap
}
```

Now that there's a definition of what build state is, there needs to be a way to dynamically construct it. In sbt, this is done through the `Setting[_]` sequence.

Settings Architecture

A Setting represents the means of constructing the value of one particular `AttributeKey[_]` in the `AttributeMap` of build state. A setting consists of two pieces:

1. The `AttributeKey[T]` where the value of the setting should be assigned.
2. An `Initialize[T]` object which is able to construct the value for this setting.

sbt's initialization time is basically just taking a sequence of these `Setting[_]` objects and running their initialization objects and then storing the value into the `AttributeMap`. This means overwriting an existing value at a key is as easy as appending a `Setting[_]` to the end of the sequence which does so.

Where it gets interesting is that `Initialize[T]` can depend on other `AttributeKey[_]`s in the build state. Each `Initialize[_]` can pull values from any `AttributeKey[_]` in the build state's `AttributeMap` to compute its value. sbt ensures a few things when it comes to `Initialize[_]` dependencies:

1. There can be no circular dependencies
2. If one `Initialize[_]` depends on another `Initialize[_]` key, then *all* associated `Initialize[_]` blocks for that key must have run before we load the value.

Let's look at what gets stored for the setting :

```
normalizedName := normalize(name.value)
```

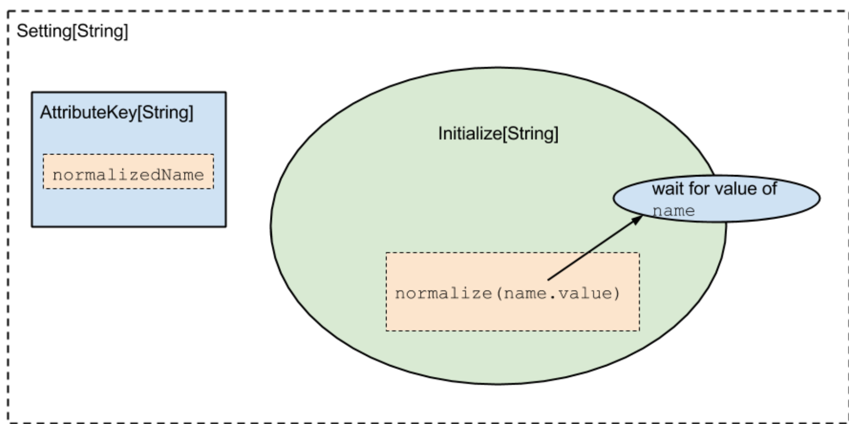


Figure 12: image

Here, a `Setting[_]` is constructed that understands it depends on the value in the `name` `AttributeKey`. Its initialize block first grabs the value of the `name` key, then runs the function `normalize` on it to compute its value.

This represents the core mechanism of how to construct sbt's build state. Conceptually, at some point we have a graph of dependencies and initialization functions which we can use to construct the first build state. Once this is completed, we can then start to process user requests.

Task Architecture

The next layer in sbt is around these user requests, or tasks. When a user configures a build, they are defining a set of repeatable tasks that they can run on their project. Things like `compile` or `test`. These tasks *also* have a dependency graph, where e.g. the `test` task requires that `compile` has run before it can successfully execute.

sbt defines a class `Task[T]`. The `T` type parameter represents the type of data returned by a task. Remember the tenets of sbt? "All things have types" and "Dependencies are explicit" both hold true for tasks. sbt promotes a style of task dependencies that is closer to functional programming: return data for your users rather than using shared mutable state.

Most build tools communicate over the filesystem, and indeed by necessity sbt does some of this. However, for stable parallelization it is far better to keep tasks isolated on the filesystem and communicate directly through types.

Similarly to how a `Setting[_]` stores both dependencies and an initialization function, a `Task[_]` stores both its `Task[_]`dependencies and its behavior (a function).

TODO - More on `Task[_]`

TODO - Transition into `InputTask[_]`, rehash Command

TODO - Transition into Scope.

Settings Core

This page describes the core settings engine a bit. This may be useful for using it outside of sbt. It may also be useful for understanding how sbt works internally.

The documentation is comprised of two parts. The first part shows an example settings system built on top of the settings engine. The second part comments on how sbt's settings system is built on top of the settings engine. This may help illuminate what exactly the core settings engine provides and what is needed to build something like the sbt settings system.

Example

Setting up To run this example, first create a new project with the following build.sbt file:

```
libraryDependencies += "org.scala-sbt" %% "collections" % sbtVersion.value

resolvers += sbtResolver.value
```

Then, put the following examples in source files `SettingsExample.scala` and `SettingsUsage.scala`. Finally, run sbt and enter the REPL using `console`. To see the output described below, enter `SettingsUsage`.

Example Settings System The first part of the example defines the custom settings system. There are three main parts:

1. Define the `Scope` type.
2. Define a function that converts that `Scope` (plus an `AttributeKey`) to a `String`.
3. Define a delegation function that defines the sequence of `Scope`s in which to look up a value.

There is also a fourth, but its usage is likely to be specific to sbt at this time. The example uses a trivial implementation for this part.

`SettingsExample.scala`:

```
import sbt._

/** Define our settings system */

// A basic scope indexed by an integer.
final case class Scope(index: Int)

// Extend the Init trait.
//  (It is done this way because the Scope type parameter is used everywhere in Init.
//  Lots of type constructors would become binary, which as you may know requires lots of ty
//  when you want a type function with only one parameter.
//  That would be a general pain.)
object SettingsExample extends Init[Scope]
{
    // Provides a way of showing a Scope+AttributeKey[_]
    val showFullKey: Show[ScopedKey[_]] = new Show[ScopedKey[_]] {
        def apply(key: ScopedKey[_]) = key.scope.index + "/" + key.key.label
    }

    // A sample delegation function that delegates to a Scope with a lower index.
    val delegates: Scope => Seq[Scope] = { case s @ Scope(index) =>
        s +: (if(index <= 0) Nil else delegates(Scope(index-1)) )
    }

    // Not using this feature in this example.
    val scopeLocal: ScopeLocal = _ => Nil
```

```
    // These three functions + a scope (here, Scope) are sufficient for defining our settin
}
```

Example Usage This part shows how to use the system we just defined. The end result is a `Settings[Scope]` value. This type is basically a mapping `Scope -> AttributeKey[T] -> Option[T]`. See the Settings API documentation for details.

`SettingsUsage.scala`:

```scala
/** Usage Example **/

import sbt._
import SettingsExample._
import Types._

object SettingsUsage {

      // Define some keys
   val a = AttributeKey[Int]("a")
   val b = AttributeKey[Int]("b")

      // Scope these keys
   val a3 = ScopedKey(Scope(3), a)
   val a4 = ScopedKey(Scope(4), a)
   val a5 = ScopedKey(Scope(5), a)

   val b4 = ScopedKey(Scope(4), b)

      // Define some settings
   val mySettings: Seq[Setting[_]] = Seq(
      setting( a3, value( 3 ) ),
      setting( b4, map(a4)(_ * 3)),
      update(a5)(_ + 1)
   )

      // "compiles" and applies the settings.
      //  This can be split into multiple steps to access intermediate results if desired.
      //  The 'inspect' command operates on the output of 'compile', for example.
   val applied: Settings[Scope] = make(mySettings)(delegates, scopeLocal, showFullKey)

   // Show results.
   for(i <- 0 to 5; k <- Seq(a, b)) {
      println( k.label + i + " = " + applied.get( Scope(i), k) )
   }
}
```

This produces the following output when run:

```
a0 = None
b0 = None
a1 = None
b1 = None
a2 = None
b2 = None
a3 = Some(3)
b3 = None
a4 = Some(3)
b4 = Some(9)
a5 = Some(4)
b5 = Some(9)
```

- For the `None` results, we never defined the value and there was no value to delegate to.
- For `a3`, we explicitly defined it to be 3.
- `a4` wasn't defined, so it delegates to `a3` according to our `delegates` function.
- `b4` gets the value for `a4` (which delegates to `a3`, so it is 3) and multiplies by 3
- `a5` is defined as the previous value of `a5` + 1 and since no previous value of `a5` was defined, it delegates to `a4`, resulting in 3+1=4.
- `b5` isn't defined explicitly, so it delegates to `b4` and is therefore equal to 9 as well

sbt Settings Discussion

Scopes sbt defines a more complicated scope than the one shown here for the standard usage of settings in a build. This scope has four components: the project axis, the configuration axis, the task axis, and the extra axis. Each component may be Zero (no specific value), This (current context), or Select (containing a specific value). sbt resolves `This_` to either Zero or Select depending on the context.

For example, in a project, a This project axis becomes a Select referring to the defining project. All other axes that are This are translated to Zero. Functions like `inConfig` and `inTask` transform `This` into a Select for a specific value. For example, `inConfig(Compile)(someSettings)` translates the configuration axis for all settings in *someSettings* to be `Select(Compile)` if the axis value is This.

So, from the example and from sbt's scopes, you can see that the core settings engine does not impose much on the structure of a scope. All it requires is a `delegates` function `Scope => Seq[Scope]` and a `display` function. You can choose a scope type that makes sense for your situation.

Constructing settings The `app`, `value`, `update`, and related methods are the core methods for constructing settings. This example obviously looks rather different from sbt's interface because these methods are not typically used directly, but are wrapped in a higher-level abstraction.

With the core settings engine, you work with `HLists` to access other settings. In sbt's higher-level system, there are wrappers around `HList` for `TupleN` and `FunctionN` for N = 1-9 (except `Tuple1` isn't actually used). When working with arbitrary arity, it is useful to make these wrappers at the highest level possible. This is because once wrappers are defined, code must be duplicated for every N. By making the wrappers at the top-level, this requires only one level of duplication.

Additionally, sbt uniformly integrates its task engine into the settings system. The underlying settings engine has no notion of tasks. This is why sbt uses a `SettingKey` type and a `TaskKey` type. Methods on an underlying `TaskKey[T]` are basically translated to operating on an underlying `SettingKey[Task[T]]` (and they both wrap an underlying `AttributeKey`).

For example, `a := 3` for a SettingKey *a* will very roughly translate to `setting(a, value(3))`. For a TaskKey *a*, it will roughly translate to `setting(a, value( task { 3 } ) )`. See main/Structure.scala for details.

Settings definitions sbt also provides a way to define these settings in a file (`build.sbt` and `Build.scala`). This is done for `build.sbt` using basic parsing and then passing the resulting chunks of code to `compile/Eval.scala`. For all definitions, sbt manages the classpaths and recompilation process to obtain the settings. It also provides a way for users to define project, task, and configuration delegation, which ends up being used by the `delegates` function.

Setting Initialization

This page outlines the mechanisms by which sbt loads settings for a particular build, including the hooks where users can control the ordering of everything.

As stated elsewhere, sbt constructs its initialization graph and task graph via `Setting[_]` objects. A setting is something which can take the values stored at other `Keys` in the build state, and generates a new value for a particular build key. sbt converts all registered `Setting[_]` objects into a giant linear sequence and *compiles* them into a task graph. This task graph is then used to execute your build.

All of sbt's loading semantics are contained within the Load.scala file. It is approximately the following:

The blue circles represent actions happening when sbt loads a project. We can see that sbt performs the following actions in load:

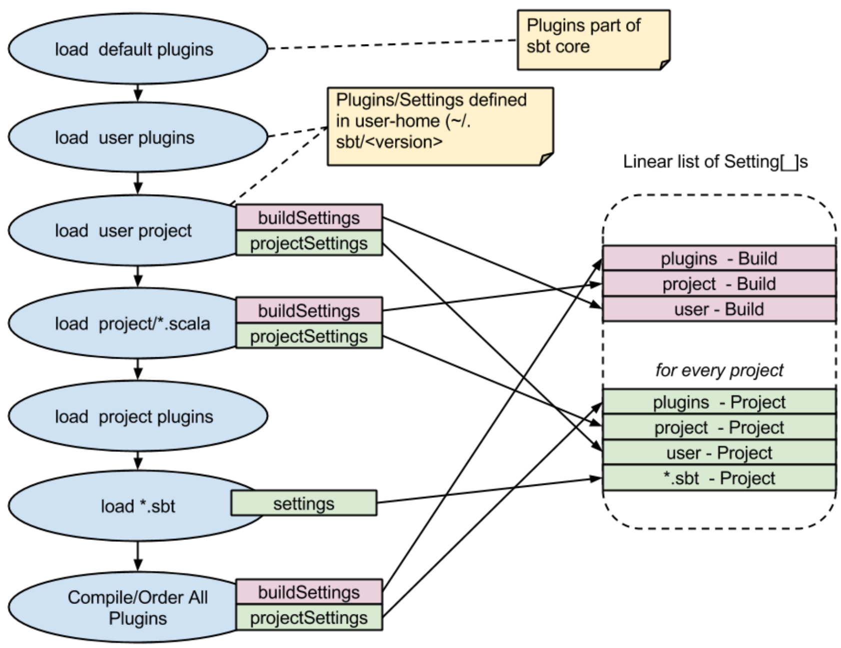


Figure 13: image

1. Compile the user-level project (~/.sbt/<version>/)

    a. Load any plugins defined by this project (~/.sbt/<version>/plugins/*.sbt and ~/.sbt/<version>/plugins/project/*.scala)
    b. Load all settings defined (~/.sbt/<version>/*.sbt and ~/.sbt/<version>/plugins/*.scala)

2. Compile the current project (<working-directory/project)

    a. Load all defined plugins (project/plugins.sbt and project/project/*.scala)
    b. Load/Compile the project (project/*.scala)

3. Load project *.sbt files (build.sbt and friends).

Each of these loads defines several sequences of settings. The diagram shows the two most important:

- `buildSettings` - These are settings defined to be `in ThisBuild` or directly against the `Build` object. They are initialized *once* for the build. You can add these, e.g. in `project/build.scala` :

  ```
  object MyBuild extends Build {
    override val settings = Seq(foo := "hi")
  }
  ```

  or in a `build.sbt` file:

  ```
  foo in ThisBuild := "hi"
  ```

- `projectSettings` - These are settings specific to a project. They are specific to a *particular subproject* in the build. A plugin may be contributing its settings to more than on project, in which case the values are duplicated for each project. You add project specific settings, eg. in `project/build.scala`:

  ```
  object MyBuild extends Build {
    val test = project.in(file(".")).settings(...)
  }
  ```

After loading/compiling all the build definitions, sbt has a series of `Seq[Setting[_]]` that it must order. As shown in the diagram, the default inclusion order for sbt is:

1. All AutoPlugin settings
2. All settings defined in `project/Build.scala`
3. All settings defined in the user directory (~/.sbt/<version>/*.sbt)
4. All local configurations (`build.sbt`)

Controlling Initialization

The order which sbt uses to load settings is configurable at a *project* level. This means that we can't control the order of settings added to Build/Global namespace, but we can control how each project loads, e.g. plugins and `.sbt` files. To do so, use the `AddSettings` class:

```
import sbt._
import Keys._

import AddSettings._

object MyOwnOrder extends Build {
  // here we load config from a txt file.
  lazy val root = project.in(file(".")).settingSets( autoPlugins, buildScalaFiles, sbtFiles(
}
```

In the above project, we've modified the order of settings to be:

1. All AutoPlugin settings.
2. All settings defined in the `project/Build.scala` file (shown above).
3. All settings found in the `silly.txt` file.

What we've excluded:

- All settings from the user directory (`~/.sbt/<version>`)
- All `*.sbt` settings.

The `AddSettings` object provides the following "groups" of settings you can use for ordering:

- `autoPlugins` All the ordered settings of plugins after they've gone through dependency resolution
- `buildScalaFiles` The full sequence of settings defined directly in `project/*.scala` builds.
- `sbtFiles(*)` Specifies the exact setting DSL files to include (files must use the `.sbt` file format)
- `userSettings` All the settings defined in the user directory `~/.sbt/<version>/`.
- `defaultSbtFiles` Include all local `*.sbt` file settings.

> *Note: Be very careful when reordering settings. It's easy to accidentally remove core functionality.*

For example, let's see what happens if we move the `build.sbt` files *before* the `buildScalaFile`.

Let's create an example project the following definition. `project/build.scala`:

```
object MyTestBuild extends Build {
  val testProject = project.in(file(".")).settingSets(autoPlugins, defaultSbtFiles, buildSca
    version := scalaBinaryVersion.value match {
      case "2.10" => "1.0-SNAPSHOT"
      case v => "1.0-for-${v}-SNAPSHOT"
    }
  )
}
```

This build defines a version string which appends the Scala version if the current Scala version is not the in the `2.10.x` series. Now, when issuing a release we want to lock down the version. Most tools assume this can happen by writing a `version.sbt` file. `version.sbt`:

```
version := "1.0.0"
```

However, when we load this new build, we find that the `version` in `version.sbt` has been **overridden** by the one defined in `project/Build.scala` because of the order we defined for settings, so the new `version.sbt` file has no effect.

Build Loaders

Build loaders are the means by which sbt resolves, builds, and transforms build definitions. Each aspect of loading may be customized for special applications. Customizations are specified by overriding the *buildLoaders* methods of your build definition's Build object. These customizations apply to external projects loaded by the build, but not the (already loaded) Build in which they are defined. Also documented on this page is how to manipulate inter-project dependencies from a setting.

Custom Resolver

The first type of customization introduces a new resolver. A resolver provides support for taking a build URI and retrieving it to a local directory on the filesystem. For example, the built-in resolver can checkout a build using git based on a git URI, use a build in an existing local directory, or download and extract a build packaged in a jar file. A resolver has type:

```
ResolveInfo => Option[() => File]
```

The resolver should return None if it cannot handle the URI or Some containing a function that will retrieve the build. The ResolveInfo provides a staging directory that can be used or the resolver can determine its own target directory. Whichever is used, it should be returned by the loading function. A resolver is registered by passing it to *BuildLoader.resolve* and overriding *Build.buildLoaders* with the result:

```
...
object Demo extends Build {
  ...
  override def buildLoaders =
    BuildLoader.resolve(demoResolver) ::
    Nil

  def demoResolver: BuildLoader.ResolveInfo => Option[() => File] = ...

}
```

API Documentation Relevant API documentation for custom resolvers:

- ResolveInfo
- BuildLoader

Full Example

```
import sbt._
import Keys._

object Demo extends Build
{
  // Define a project that depends on an external project with a custom URI
  lazy val root = Project("root", file(".")).dependsOn(
    uri("demo:a")
  )

  // Register the custom resolver
  override def buildLoaders =
    BuildLoader.resolve(demoResolver) ::
    Nil

  // Define the custom resolver, which handles the 'demo' scheme.
  // The resolver's job is to produce a directory containing the project to load.
  // A subdirectory of info.staging can be used to create new local
  //   directories, such as when doing 'git clone ...'
```

```
  def demoResolver(info: BuildLoader.ResolveInfo): Option[() => File] =
    if(info.uri.getScheme != "demo")
      None
    else
    {
      // Use a subdirectory of the staging directory for the new local build.
      // The subdirectory name is derived from a hash of the URI,
      //   and so identical URIs will resolve to the same directory (as desired).
      val base = RetrieveUnit.temporary(info.staging, info.uri)

      // Return a closure that will do the actual resolution when requested.
      Some(() => resolveDemo(base, info.uri.getSchemeSpecificPart))
    }

  // Construct a sample project on the fly with the name specified in the URI.
  def resolveDemo(base: File, ssp: String): File =
  {
    // Only create the project if it hasn't already been created.
    if(!base.exists)
      IO.write(base / "build.sbt", template.format(ssp))
    base
  }

  def template =  """
name := "%s"

version := "1.0"
"""
}
```

Custom Builder

Once a project is resolved, it needs to be built and then presented to sbt as an instance of `sbt.BuildUnit`. A custom builder has type:

```
BuildInfo => Option[() => BuildUnit]
```

A builder returns None if it does not want to handle the build identified by the `BuildInfo`. Otherwise, it provides a function that will load the build when evaluated. Register a builder by passing it to *BuildLoader.build* and overriding *Build.buildLoaders* with the result:

```
...
object Demo extends Build {
```

```
  ...
  override def buildLoaders =
    BuildLoader.build(demoBuilder) ::
    Nil

  def demoBuilder: BuildLoader.BuildInfo => Option[() => BuildUnit] = ...

}
```

API Documentation Relevant API documentation for custom builders:

- BuildInfo
- BuildLoader
- BuildUnit

Example This example demonstrates the structure of how a custom builder could read configuration from a pom.xml instead of the standard .sbt files and project/ directory.

```
... imports ...

object Demo extends Build
{
  lazy val root = Project("root", file(".")) dependsOn( file("basic-pom-project") )

  override def buildLoaders =
    BuildLoader.build(demoBuilder) ::
    Nil

  def demoBuilder: BuildInfo => Option[() => BuildUnit] = info =>
    if(pomFile(info).exists)
      Some(() => pomBuild(info))
    else
      None

  def pomBuild(info: BuildInfo): BuildUnit =
  {
    val pom = pomFile(info)
    val model = readPom(pom)

    val n = Project.normalizeProjectID(model.getName)
    val base = Option(model.getProjectDirectory) getOrElse info.base
    val root = Project(n, base) settings( pomSettings(model) )
    val build = new Build { override def projects = Seq(root) }
```

```
    val loader = this.getClass.getClassLoader
    val definitions = new LoadedDefinitions(info.base, Nil, loader, build :: Nil, Nil)
    val plugins = new LoadedPlugins(info.base / "project", Nil, loader, Nil, Nil)
    new BuildUnit(info.uri, info.base, definitions, plugins)
  }

  def readPom(file: File): Model = ...
  def pomSettings(m: Model): Seq[Setting[_]] = ...
  def pomFile(info: BuildInfo): File = info.base / "pom.xml"
```

Custom Transformer

Once a project has been loaded into an `sbt.BuildUnit`, it is transformed by all registered transformers. A custom transformer has type:

```
TransformInfo => BuildUnit
```

A transformer is registered by passing it to *BuildLoader.transform* and overriding *Build.buildLoaders* with the result:

```
...
object Demo extends Build {
  ...
  override def buildLoaders =
    BuildLoader.transform(demoTransformer) ::
    Nil

  def demoTransformer: BuildLoader.TransformInfo => BuildUnit = ...

}
```

API Documentation Relevant API documentation for custom transformers:

- TransformInfo
- BuildLoader
- BuildUnit

Manipulating Project Dependencies in Settings The `buildDependencies` setting, in the Global scope, defines the aggregation and classpath dependencies between projects. By default, this information comes from the dependencies defined by `Project` instances by the `aggregate` and `dependsOn` methods. Because `buildDependencies` is a setting and is used everywhere dependencies need to be known (once all projects are loaded), plugins and build definitions can transform it to manipulate inter-project dependencies at setting evaluation time. The only requirement is that no new projects are introduced because all projects are loaded before settings get evaluated. That is, all Projects must have been declared directly in a Build or referenced as the argument to `Project.aggregate` or `Project.dependsOn`.

The BuildDependencies type

The type of the `buildDependencies` setting is BuildDependencies. `BuildDependencies` provides mappings from a project to its aggregate or classpath dependencies. For classpath dependencies, a dependency has type `ClasspathDep[ProjectRef]`, which combines a `ProjectRef` with a configuration (see ClasspathDep and ProjectRef). For aggregate dependencies, the type of a dependency is just `ProjectRef`.

The API for `BuildDependencies` is not extensive, covering only a little more than the minimum required, and related APIs have more of an internal, unpolished feel. Most manipulations consist of modifying the relevant map (classpath or aggregate) manually and creating a new `BuildDependencies` instance.

Example As an example, the following replaces a reference to a specific build URI with a new URI. This could be used to translate all references to a certain git repository to a different one or to a different mechanism, like a local directory.

```
buildDependencies in Global := {
  val deps = (buildDependencies in Global).value
  val oldURI = uri("...") // the URI to replace
  val newURI = uri("...") // the URI replacing oldURI
  def substitute(dep: ClasspathDep[ProjectRef]): ClasspathDep[ProjectRef] =
    if(dep.project.build == oldURI)
      ResolvedClasspathDependency(ProjectRef(newURI, dep.project.project), dep.configuratio
    else
      dep
  val newcp =
    for( (proj, deps) <- deps.cp) yield
      (proj, deps map substitute)
  BuildDependencies(newcp, deps.aggregate)
}
```

It is not limited to such basic translations, however. The configuration a dependency is defined in may be modified and dependencies may be added or removed. Modifying `buildDependencies` can be combined with modifying `libraryDependencies` to convert binary dependencies to and from source dependencies, for example.

Creating Command Line Applications Using sbt

There are several components of sbt that may be used to create a command line application. The launcher and the command system are the two main ones illustrated here.

As described on the launcher page, a launched application implements the xsbti.AppMain interface and defines a brief configuration file that users pass to the launcher to run the application. To use the command system, an application sets up a State instance that provides command implementations and the initial commands to run. A minimal hello world example is given below.

Hello World Example

There are three files in this example:

1. build.sbt
2. Main.scala
3. hello.build.properties

To try out this example:

1. Put the first two files in a new directory
2. In sbt's shell run `publishLocal` in that directory
3. Run `sbt @path/to/hello.build.properties` to run the application.

Like for sbt itself, you can specify commands from the command line (batch mode) or run them at an prompt (interactive mode).

Build Definition: build.sbt The build.sbt file should define the standard settings: name, version, and organization. To use the sbt command system, a dependency on the `command` module is needed. To use the task system, add a dependency on the `task-system` module as well.

```
organization := "org.example"

name := "hello"

version := "0.1-SNAPSHOT"

libraryDependencies += "org.scala-sbt" % "command" % "0.12.0"
```

Application: Main.scala The application itself is defined by implementing xsbti.AppMain. The basic steps are

1. Provide command definitions. These are the commands that are available for users to run.
2. Define initial commands. These are the commands that are initially scheduled to run. For example, an application will typically add anything specified on the command line (what sbt calls batch mode) and if no commands are defined, enter interactive mode by running the 'shell' command.
3. Set up logging. The default setup in the example rotates the log file after each user interaction and sends brief logging to the console and verbose logging to the log file.

```
package org.example

   import sbt._
   import java.io.{File, PrintWriter}

final class Main extends xsbti.AppMain
{
   /** Defines the entry point for the application.
   * The call to `initialState` sets up the application.
   * The call to runLogged starts command processing. */
   def run(configuration: xsbti.AppConfiguration): xsbti.MainResult =
      MainLoop.runLogged( initialState(configuration) )

   /** Sets up the application by constructing an initial State instance with the supported
   * and initial commands to run.  See the State API documentation for details. */
   def initialState(configuration: xsbti.AppConfiguration): State =
   {
      val commandDefinitions = hello +: BasicCommands.allBasicCommands
      val commandsToRun = Hello +: "iflast shell" +: configuration.arguments.map(_.trim)
      State( configuration, commandDefinitions, Set.empty, None, commandsToRun, State.newHis
         AttributeMap.empty, initialGlobalLogging, State.Continue )
   }

   // defines an example command.  see the Commands page for details.
   val Hello = "hello"
   val hello = Command.command(Hello) { s =>
      s.log.info("Hello!")
      s
   }

   /** Configures logging to log to a temporary backing file as well as to the console.
   * An application would need to do more here to customize the logging level and
```

```
    * provide access to the backing file (like sbt's last command and logLevel setting).*/
   def initialGlobalLogging: GlobalLogging =
      GlobalLogging.initial(MainLogging.globalDefault _, File.createTempFile("hello", "log")
}
```

Launcher configuration file: hello.build.properties The launcher needs a configuration file in order to retrieve and run an application. `hello.build.properties`:

```
[scala]
  version: 2.9.1

[app]
  org: org.example
  name: hello
  version: 0.1-SNAPSHOT
  class: org.example.Main
  components: xsbti
  cross-versioned: true

[repositories]
  local
  maven-central
 typesafe-ivy-releases: http://repo.typesafe.com/typesafe/ivy-releases/, [organization]/[mod
```

Nightly Builds

The latest development versions of 1.2.1 are available as nightly builds on Typesafe Snapshots.

To use a nightly build, the instructions are the same for normal manual setup except:

1. Download the launcher jar from one of the subdirectories of nightly-launcher|. They should be listed in chronological order, so the most recent one will be last.
2. The version number is the name of the subdirectory and is of the form `1.2.1.x-yyyyMMdd-HHmmss`. Use this in a build.properties file.
3. Call your script something like `sbt-nightly` to retain access to a stable sbt launcher. The documentation will refer to the script as sbt, however.

Related to the third point, remember that an `sbt.version` setting in `<build-base>/project/build.properties` determines the version of sbt to use in a project. If it is not present, the default version associated with the launcher is used. This means that you must set `sbt.version=yyyyMMdd-HHmmss` in an existing `<build-base>/project/build.properties`. You can verify the right version of sbt is being used to build a project by running `about`.

To reduce problems, it is recommended to not use a launcher jar for one nightly version to launch a different nightly version of sbt.

out: Archive.html

Archived pages

Hello, World

This page assumes you've installed sbt 0.13.13 or later.

sbt new command

If you're using sbt 0.13.13 or later, you can use sbt `new` command to quickly setup a simple Hello world build. Type the following command to the terminal.

```
$ sbt new sbt/scala-seed.g8
....
Minimum Scala build.

name [My Something Project]: hello

Template applied in ./hello
```

When prompted for the project name, type `hello`.

This will create a new project under a directory named `hello`.

Running your app

Now from inside the `hello` directory, start `sbt` and type `run` at the sbt shell. On Linux or OS X the commands might look like this:

```
$ cd hello
$ sbt
...
> run
...
```

```
[info] Compiling 1 Scala source to /xxx/hello/target/scala-2.12/classes...
[info] Running example.Hello
hello
```

We will see more tasks later.

Exiting sbt shell

To leave sbt shell, type `exit` or use Ctrl+D (Unix) or Ctrl+Z (Windows).

```
> exit
```

Build definition

The build definition goes in a file called `build.sbt`, located in the project's base directory. You can take a look at the file, but don't worry if the details of this build file aren't clear yet. In .sbt build definition you'll learn more about how to write a `build.sbt` file.