sbt Reference Manual

Contents

Preface .................................................. 16
Install .................................................... 16
Getting Started ................................. 16
Features of sbt ................................. 16
Also ................................................... 17

Getting Started with sbt 17
Installing sbt ........................................... 17
   Tips and Notes .................................. 18
Installing sbt on macOS .......................... 18
   Install JDK ...................................... 18
   Installing from a universal package ........ 18
   Installing from a third-party package .... 18
Installing sbt on Windows ....................... 18
   Install JDK ...................................... 18
   Installing from a universal package ........ 18
   Windows installer .............................. 19
   Installing from a third-party package .... 19
Installing sbt on Linux ......................... 19
   Installing from SDKMAN ...................... 19
   Install JDK ...................................... 19
   Installing from a universal package ........ 19
Ubuntu and other Debian-based distributions . 20
   Red Hat Enterprise Linux and other RPM-based distributions . 20
   Gentoo .......................................... 21
sbt by example ......................................... 21
   Create a minimum sbt build ............... 21
   Start sbt shell .................................. 21
   Exit sbt shell ................................... 22
   Compile a project ............................. 22
   Recompile on code change .................. 22
   Create a source file ......................... 22
   Run a previous command ..................... 23
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>How build.sbt defines settings</td>
<td>41</td>
</tr>
<tr>
<td>Keys</td>
<td>42</td>
</tr>
<tr>
<td>Defining tasks and settings</td>
<td>43</td>
</tr>
<tr>
<td>Keys in sbt shell</td>
<td>44</td>
</tr>
<tr>
<td>Imports in build.sbt</td>
<td>45</td>
</tr>
<tr>
<td>Bare .sbt build definition</td>
<td>45</td>
</tr>
<tr>
<td>Adding library dependencies</td>
<td>45</td>
</tr>
<tr>
<td>Multi-project builds</td>
<td>46</td>
</tr>
<tr>
<td>Multiple subprojects</td>
<td>46</td>
</tr>
<tr>
<td>Dependencies</td>
<td>47</td>
</tr>
<tr>
<td>Inter-project dependencies</td>
<td>49</td>
</tr>
<tr>
<td>Default root project</td>
<td>50</td>
</tr>
<tr>
<td>Navigating projects interactively</td>
<td>50</td>
</tr>
<tr>
<td>Common code</td>
<td>50</td>
</tr>
<tr>
<td>Appendix: Subproject build definition files</td>
<td>50</td>
</tr>
<tr>
<td>Task graph</td>
<td>51</td>
</tr>
<tr>
<td>Terminology</td>
<td>51</td>
</tr>
<tr>
<td>Declaring dependency to other tasks</td>
<td>52</td>
</tr>
<tr>
<td>Inlining .value calls</td>
<td>54</td>
</tr>
<tr>
<td>What’s the point of the build.sbt DSL?</td>
<td>57</td>
</tr>
<tr>
<td>Summary</td>
<td>59</td>
</tr>
<tr>
<td>Scopes</td>
<td>59</td>
</tr>
<tr>
<td>The whole story about keys</td>
<td>59</td>
</tr>
<tr>
<td>Scope axes</td>
<td>60</td>
</tr>
<tr>
<td>Referring to scopes in a build definition</td>
<td>62</td>
</tr>
<tr>
<td>Referring to scoped keys from the sbt shell</td>
<td>63</td>
</tr>
<tr>
<td>Examples of scoped key notation in the sbt shell</td>
<td>63</td>
</tr>
<tr>
<td>Inspecting scopes</td>
<td>64</td>
</tr>
<tr>
<td>When to specify a scope</td>
<td>65</td>
</tr>
<tr>
<td>Build-level settings</td>
<td>65</td>
</tr>
<tr>
<td>Scope delegation</td>
<td>66</td>
</tr>
<tr>
<td>Appending values</td>
<td>66</td>
</tr>
<tr>
<td>Appending to previous values: ** and +++</td>
<td>66</td>
</tr>
<tr>
<td>Appending with dependencies: ** and +++</td>
<td>67</td>
</tr>
<tr>
<td>Scope delegation (.value lookup)</td>
<td>68</td>
</tr>
<tr>
<td>Scope delegation rules</td>
<td>69</td>
</tr>
<tr>
<td>Rule 1: Scope axis precedence</td>
<td>69</td>
</tr>
<tr>
<td>Rule 2: The task axis delegation</td>
<td>69</td>
</tr>
<tr>
<td>Rule 3: The configuration axis search path</td>
<td>70</td>
</tr>
<tr>
<td>Rule 4: The subproject axis search path</td>
<td>71</td>
</tr>
<tr>
<td>Inspect command lists the delegates</td>
<td>72</td>
</tr>
<tr>
<td>.value lookup vs dynamic dispatch</td>
<td>73</td>
</tr>
<tr>
<td>Library dependencies</td>
<td>76</td>
</tr>
<tr>
<td>Unmanaged dependencies</td>
<td>76</td>
</tr>
<tr>
<td>Managed Dependencies</td>
<td>77</td>
</tr>
<tr>
<td>Using plugins</td>
<td>80</td>
</tr>
</tbody>
</table>
Contributing to sbt ........................................... 123
Documentation .............................................. 124
Changes ...................................................... 125
Migrating from sbt 0.13.x ................................. 125
  Migrating case class .copy(...) ......................... 125
  SbtPlugin ............................................... 125
  sbt version specific source directory ................. 125
  Migrating from sbt 0.12 style ......................... 127
  Migrating from the Build trait ......................... 129
  Migrating from Resolver.withDefaultResolvers ....... 131
sbt 1.4.x releases ......................................... 131
  sbt 1.4.1 ............................................. 131
  sbt 1.4.0 ............................................. 133
  Build server protocol (BSP) support ................... 133
  Native thin client .................................... 133
  ThisBuild / versionScheme ............................. 134
  VirtualFile + RemoteCache .............................. 134
  Build linting ......................................... 134
  Conditional task ..................................... 135
  Incremental build pipelining ......................... 135
  sbt-dependency-graph is in-sourced .................. 135
  Fixes with compatibility implications ................ 136
  Other updates ......................................... 136
  Participation ......................................... 137
sbt 1.3.x releases ......................................... 138
  sbt 1.3.0 ............................................. 138
sbt 1.2.x releases ......................................... 146
  sbt 1.2.1 ............................................. 146
  sbt 1.2.0 ............................................. 147
sbt 1.1.x releases ......................................... 155
  sbt 1.1.6 ............................................. 155
  sbt 1.1.5 ............................................. 156
  sbt 1.1.4 ............................................. 158
  Contributors .......................................... 159
  sbt 1.1.2 ............................................. 160
  sbt 1.1.1 ............................................. 162
  sbt 1.1.0 ............................................. 163
sbt 1.0.x releases ......................................... 168
  sbt 1.0.4 ............................................. 168
  sbt 1.0.3 ............................................. 169
  sbt 1.0.2 ............................................. 171
  sbt 1.0.1 ............................................. 172
  sbt 1.0.0 ............................................. 173
Detailed Topics ............................................ 181
Using sbt ............................................... 182
Command Line Reference ................................. 182
Notes on the command line ........................................... 182
Project-level tasks ..................................................... 182
Configuration-level tasks .............................................. 183
General commands ...................................................... 184
Commands for managing the build definition ....................... 185
Command Line Options .................................................. 185

Console Project .......................................................... 190
Description .............................................................. 190
Accessing settings ...................................................... 191
Evaluating tasks ......................................................... 191
State ..................................................................... 192

Cross-building .......................................................... 192
Introduction ............................................................. 192
Publishing conventions ................................................ 192
Using cross-built libraries .......................................... 192
Cross building a project using sbt-projectmatrix .................. 193
Cross building a project statefully ................................. 193
Change settings depending on the Scala version ................. 194

Interacting with the Configuration System .......................... 200
Selecting commands, tasks, and settings ......................... 200
Discovering Settings and Tasks ...................................... 201

Triggered Execution ................................................... 205
Compile ................................................................. 205
Testing ................................................................. 205
Running Multiple Commands ......................................... 206
Build sources .......................................................... 206
Clearing the screen .................................................... 207
Configuration .......................................................... 207

Script mode ............................................................. 209
sbt Script runner ....................................................... 209
sbt Server ............................................................... 210
Metals integration ...................................................... 210
Language Server Protocol 3.0 ......................................... 211
Server modes .......................................................... 212
Server discovery and authentication ................................. 213
Initialize request ....................................................... 214
textDocument/publishDiagnostics event ........................... 214
textDocument/didSave event ......................................... 215
sbt/exec request ....................................................... 215
sbt/setting request .................................................... 216
sbt/completion request ............................................... 216
sbt/cancelRequest ..................................................... 217

Understanding Incremental Recompilation .......................... 217
sbt heuristics .......................................................... 218
How to take advantage of sbt heuristics ......................... 219
Implementation of incremental recompilation ...................... 219
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>219</td>
</tr>
<tr>
<td>Interaction with the Scala compiler</td>
<td>221</td>
</tr>
<tr>
<td>Name hashing algorithm</td>
<td>223</td>
</tr>
<tr>
<td>What is included in the interface of a Scala class</td>
<td>229</td>
</tr>
<tr>
<td>Bytecode Enhancers</td>
<td>233</td>
</tr>
<tr>
<td>Further references</td>
<td>233</td>
</tr>
<tr>
<td>Configuration</td>
<td>233</td>
</tr>
<tr>
<td>Classpaths, sources, and resources</td>
<td>234</td>
</tr>
<tr>
<td>Basics</td>
<td>234</td>
</tr>
<tr>
<td>Compiler Plugin Support</td>
<td>236</td>
</tr>
<tr>
<td>Continuations Plugin Example</td>
<td>237</td>
</tr>
<tr>
<td>Version-specific Compiler Plugin Example</td>
<td>237</td>
</tr>
<tr>
<td>Configuring Scala</td>
<td>237</td>
</tr>
<tr>
<td>Automatically managed Scala</td>
<td>237</td>
</tr>
<tr>
<td>Using Scala from a local directory</td>
<td>239</td>
</tr>
<tr>
<td>sbt’s Scala version</td>
<td>240</td>
</tr>
<tr>
<td>Forking</td>
<td>240</td>
</tr>
<tr>
<td>Enable forking</td>
<td>241</td>
</tr>
<tr>
<td>Change working directory</td>
<td>241</td>
</tr>
<tr>
<td>Forked JVM options</td>
<td>242</td>
</tr>
<tr>
<td>Java Home</td>
<td>242</td>
</tr>
<tr>
<td>Configuring output</td>
<td>242</td>
</tr>
<tr>
<td>Configuring Input</td>
<td>243</td>
</tr>
<tr>
<td>Direct Usage</td>
<td>243</td>
</tr>
<tr>
<td>Global Settings</td>
<td>243</td>
</tr>
<tr>
<td>Basic global configuration file</td>
<td>243</td>
</tr>
<tr>
<td>Global Settings using a Global Plugin</td>
<td>244</td>
</tr>
<tr>
<td>Java Sources</td>
<td>244</td>
</tr>
<tr>
<td>Usage</td>
<td>245</td>
</tr>
<tr>
<td>Known issues in mixed mode compilation</td>
<td>245</td>
</tr>
<tr>
<td>Ignoring the Scala source directories</td>
<td>246</td>
</tr>
<tr>
<td>Mapping Files</td>
<td>246</td>
</tr>
<tr>
<td>Relative to a directory</td>
<td>246</td>
</tr>
<tr>
<td>Rebase</td>
<td>247</td>
</tr>
<tr>
<td>Flatten</td>
<td>247</td>
</tr>
<tr>
<td>Alternatives</td>
<td>248</td>
</tr>
<tr>
<td>Local Scala</td>
<td>248</td>
</tr>
<tr>
<td>Macro Projects</td>
<td>249</td>
</tr>
<tr>
<td>Introduction</td>
<td>249</td>
</tr>
<tr>
<td>Defining the Project Relationships</td>
<td>249</td>
</tr>
<tr>
<td>Common Interface</td>
<td>251</td>
</tr>
<tr>
<td>Distribution</td>
<td>252</td>
</tr>
<tr>
<td>Paths</td>
<td>252</td>
</tr>
<tr>
<td>Constructing a File</td>
<td>252</td>
</tr>
<tr>
<td>File Filters</td>
<td>256</td>
</tr>
<tr>
<td>Parallel Execution</td>
<td>256</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Task ordering</td>
<td>256</td>
</tr>
<tr>
<td>Practical constraints</td>
<td>257</td>
</tr>
<tr>
<td>Configuration</td>
<td>257</td>
</tr>
<tr>
<td>Future work</td>
<td>261</td>
</tr>
<tr>
<td>External Processes</td>
<td>262</td>
</tr>
<tr>
<td>Usage</td>
<td>262</td>
</tr>
<tr>
<td>Running Project Code</td>
<td>264</td>
</tr>
<tr>
<td>Problems</td>
<td>264</td>
</tr>
<tr>
<td>sbt's Solutions</td>
<td>265</td>
</tr>
<tr>
<td>Testing</td>
<td>266</td>
</tr>
<tr>
<td>Basics</td>
<td>266</td>
</tr>
<tr>
<td>Output</td>
<td>268</td>
</tr>
<tr>
<td>Options</td>
<td>268</td>
</tr>
<tr>
<td>Additional test configurations</td>
<td>270</td>
</tr>
<tr>
<td>JUnit</td>
<td>273</td>
</tr>
<tr>
<td>Extensions</td>
<td>273</td>
</tr>
<tr>
<td>In process class loading</td>
<td>274</td>
</tr>
<tr>
<td>Troubleshooting</td>
<td>275</td>
</tr>
<tr>
<td>Globs</td>
<td>276</td>
</tr>
<tr>
<td>Constructing Globs</td>
<td>277</td>
</tr>
<tr>
<td>Path names</td>
<td>278</td>
</tr>
<tr>
<td>Filters</td>
<td>278</td>
</tr>
<tr>
<td>Depth</td>
<td>278</td>
</tr>
<tr>
<td>Regular expressions</td>
<td>278</td>
</tr>
<tr>
<td>Remote Caching</td>
<td>283</td>
</tr>
<tr>
<td>Dependency Management</td>
<td>284</td>
</tr>
<tr>
<td>Artifacts</td>
<td>285</td>
</tr>
<tr>
<td>Selecting default artifacts</td>
<td>285</td>
</tr>
<tr>
<td>Modifying default artifacts</td>
<td>285</td>
</tr>
<tr>
<td>Defining custom artifacts</td>
<td>286</td>
</tr>
<tr>
<td>Publishing .war files</td>
<td>287</td>
</tr>
<tr>
<td>Using dependencies with artifacts</td>
<td>288</td>
</tr>
<tr>
<td>Dependency Management Flow</td>
<td>288</td>
</tr>
<tr>
<td>Library Management</td>
<td>289</td>
</tr>
<tr>
<td>Introduction</td>
<td>290</td>
</tr>
<tr>
<td>Manual Dependency Management</td>
<td>290</td>
</tr>
<tr>
<td>Automatic Dependency Management</td>
<td>290</td>
</tr>
<tr>
<td>Proxy Repositories</td>
<td>300</td>
</tr>
<tr>
<td>Overview</td>
<td>300</td>
</tr>
<tr>
<td>sbt Configuration</td>
<td>300</td>
</tr>
<tr>
<td>*/.sbt/repositories</td>
<td>300</td>
</tr>
<tr>
<td>Using credentials for the proxy repository</td>
<td>301</td>
</tr>
<tr>
<td>Proxying Ivy Repositories</td>
<td>302</td>
</tr>
<tr>
<td>Publishing</td>
<td>303</td>
</tr>
<tr>
<td>Skip publishing</td>
<td>303</td>
</tr>
<tr>
<td>Define the repository</td>
<td>303</td>
</tr>
</tbody>
</table>

8
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publishing locally</td>
<td>304</td>
</tr>
<tr>
<td>Credentials</td>
<td>304</td>
</tr>
<tr>
<td>Cross-publishing</td>
<td>305</td>
</tr>
<tr>
<td>Published artifacts</td>
<td>305</td>
</tr>
<tr>
<td>Modifying the generated POM</td>
<td>305</td>
</tr>
<tr>
<td>Version scheme</td>
<td>306</td>
</tr>
<tr>
<td>Resolvers</td>
<td>306</td>
</tr>
<tr>
<td>MAVen resolvers</td>
<td>306</td>
</tr>
<tr>
<td>Local Maven resolvers</td>
<td>306</td>
</tr>
<tr>
<td>Predefined resolvers</td>
<td>307</td>
</tr>
<tr>
<td>Custom resolvers</td>
<td>307</td>
</tr>
<tr>
<td>Update Report</td>
<td>310</td>
</tr>
<tr>
<td>Filtering a Report and Getting Artifacts</td>
<td>310</td>
</tr>
<tr>
<td>Cached Resolution</td>
<td>314</td>
</tr>
<tr>
<td>Setup</td>
<td>314</td>
</tr>
<tr>
<td>Dependency as a graph</td>
<td>314</td>
</tr>
<tr>
<td>Cached Resolution</td>
<td>314</td>
</tr>
<tr>
<td>Caveats and known issues</td>
<td>315</td>
</tr>
<tr>
<td>Motivation</td>
<td>316</td>
</tr>
<tr>
<td>Tasks and Commands</td>
<td>316</td>
</tr>
<tr>
<td>Tasks</td>
<td>317</td>
</tr>
<tr>
<td>Introduction</td>
<td>317</td>
</tr>
<tr>
<td>Features</td>
<td>317</td>
</tr>
<tr>
<td>Defining a Task</td>
<td>317</td>
</tr>
<tr>
<td>Getting values from multiple scopes</td>
<td>321</td>
</tr>
<tr>
<td>Advanced Task Operations</td>
<td>324</td>
</tr>
<tr>
<td>Conditional task</td>
<td>325</td>
</tr>
<tr>
<td>Dynamic Computations with Def.taskDyn</td>
<td>326</td>
</tr>
<tr>
<td>Using Def.sequential</td>
<td>326</td>
</tr>
<tr>
<td>Handling Failure</td>
<td>327</td>
</tr>
<tr>
<td>Caching</td>
<td>331</td>
</tr>
<tr>
<td>Cache.cached</td>
<td>331</td>
</tr>
<tr>
<td>Previous value</td>
<td>333</td>
</tr>
<tr>
<td>Tracked.lastOutput</td>
<td>333</td>
</tr>
<tr>
<td>Tracked.inputChanged</td>
<td>334</td>
</tr>
<tr>
<td>FileInfo</td>
<td>338</td>
</tr>
<tr>
<td>Tracked.inputChanged</td>
<td>338</td>
</tr>
<tr>
<td>Tracked.outputChanged</td>
<td>339</td>
</tr>
<tr>
<td>Tracked.diffInputs</td>
<td>341</td>
</tr>
<tr>
<td>Tracked.diffOutputs</td>
<td>344</td>
</tr>
<tr>
<td>Case study: sbt-scalafmt</td>
<td>344</td>
</tr>
<tr>
<td>Summary</td>
<td>346</td>
</tr>
<tr>
<td>Input Tasks</td>
<td>346</td>
</tr>
<tr>
<td>Input Keys</td>
<td>346</td>
</tr>
<tr>
<td>Basic Input Task Definition</td>
<td>347</td>
</tr>
<tr>
<td>Input Task using Parsers</td>
<td>347</td>
</tr>
</tbody>
</table>
Classpaths

Include a new type of managed artifact on the classpath, such as

- Get the classpath used for compilation
- Get the runtime classpath, including the project’s compiled classes
- Get the test classpath, including the project’s compiled test classes
- Use packaged jars on classpaths instead of class directories
- Get all managed jars for a configuration
- Get the files included in a classpath
- Get the module and artifact that produced a classpath entry

Customizing paths

- Change the default Scala source directory
- Change the default Java source directory
- Change the default resource directory
- Change the default (unmanaged) library directory
- Disable using the project’s base directory as a source directory
- Add an additional source directory
- Add an additional resource directory
- Include/exclude files in the source directory
- Include/exclude files in the resource directory
- Include only certain (unmanaged) libraries

Generating files

- Generate sources
- Generate resources

Inspect the build

- Show or search help for a command, task, or setting
- List available tasks
- List available settings
- Display the description and type of a setting or task
- Display the delegation chain of a setting or task
- Show the list of projects and builds
- Show the current session (temporary) settings
- Show basic information about sbt and the current build
- Show the value of a setting
- Show the result of executing a task
- Show the classpath used for compilation or testing
- Show the main classes detected in a project
- Show the test classes detected in a project

Interactive mode

- Use tab completion
- Show more tab completion suggestions
- Modify the default JLine keybindings
- Configure the prompt string
- Use history
- Change the location of the interactive history file
- Use the same history for all projects
Disable interactive history ........................................424
Run commands before entering interactive mode ..........424
Configure and use logging .......................................425
View the logging output of the previously executed command ..........................................................425
View the previous logging output of a specific task ....426
Show warnings from the previous compilation .............426
Change the logging level globally ..............................427
Change the logging level for a specific task, configuration, or project ........................................427
Configure printing of stack traces ............................428
Print the output of tests immediately instead of buffering .................................................................428
Add a custom logger .................................................429
Log messages in a task .............................................430
Log messages in a setting .........................................431
Project metadata .....................................................431
Set the project name ...............................................431
Set the project version ............................................431
Set the project organization ....................................431
Set the project’s homepage and other metadata ........432
Configure packaging ..............................................432
Use the packaged jar on classpaths instead of class directory .........................................................432
Add manifest attributes ..........................................432
Change the file name of a package ............................433
Modify the contents of the package ..........................433
Running commands .................................................433
Pass arguments to a command or task in batch mode ....433
Provide multiple commands to run consecutively ........433
Read commands from a file ......................................434
Define an alias for a command or task .....................434
Quickly evaluate a Scala expression ........................434
Configure and use Scala .........................................435
Set the Scala version used for building the project ....435
Disable the automatic dependency on the Scala library .................................................................435
Temporarily switch to a different Scala version ........435
Use a local Scala installation for building a project ....435
Build a project against multiple Scala versions .........435
Enter the Scala REPL with a project’s dependencies on the classpath, but not the compiled project classes .................................................................436
Enter the Scala REPL with a project’s dependencies and compiled code on the classpath ................436
Enter the Scala REPL with plugins and the build definition on the classpath ........................................436
Define the initial commands evaluated when entering the Scala REPL .....................................................436
Define the commands evaluated when exiting the Scala REPL ..........................................................436
Use the Scala REPL from project code ......................437
Generate API documentation ....................................437
Select javadoc or scaladoc ........................................... 437
Set the options used for generating scaladoc independently of compilation ........................................... 438
Add options for scaladoc to the compilation options ........ 438
Set the options used for generating javadoc independently of compilation ........................................... 438
Add options for javadoc to the compilation options ........ 438
Enable automatic linking to the external Scaladoc of managed dependencies ........................................... 438
Enable manual linking to the external Scaladoc of managed dependencies ........................................... 439
Define the location of API documentation for a library ....... 439
Define Custom Tasks ..................................................... 439
Define a Task that runs tests in specific sub-projects ........ 439
How to take an action on startup ..................................... 440
Track file inputs and outputs ........................................ 440
File inputs ................................................................ 441
File outputs ................................................................ 443
Filters ...................................................................... 444
File change tracking .................................................... 445
Troubleshoot memory issues ........................................ 446
Sequencing .................................................................. 447
Defining a sequential task with Def. sequential ............... 448
Defining a dynamic task with Def. taskDyn .................... 449
Doing something after an input task ............................... 450
Defining a dynamic input task with Def. inputTaskDyn .... 451
How to sequence using commands ................................. 452
How to define a custom dependency configuration ........... 453
Cautions on custom dependency configurations ............... 453
Example basic custom configuration ............................. 453
Example sandbox configuration ................................... 454
How do I add a test configuration? ............................... 455
Examples .................................................................... 455
.sbt build examples ...................................................... 456
.sbt build with .scala files example ............................... 460
  project/Resolvers.scala ............................................ 460
  project/Dependencies.scala ...................................... 460
  project/ShellPromptPlugin.scala ................................ 461
  build.sbt ................................................................. 462
Advanced configurations example ............................... 463
Advanced command example ....................................... 465
Index ........................................................................ 466
Values and Types ......................................................... 466
Methods .................................................................... 467
Developer’s Guide (Work in progress) ......................... 469
Towards sbt 1.0 ............................................................ 469
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 on the left of every page.

See also Frequently asked question.

See How can I get help? for where you can get help about sbt. For discussing sbt development, use Discussions. To stay up to date about the news related to sbt, follow us [@scala\_sbt](https://twitter.com/scala_sbt).

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
- Library management support using Coursier
- Continuous compilation and testing with triggered execution
- 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 class-path
- Modularization supported with sub-projects
- External project support (list a git repository as a dependency!)
- Parallel task execution, including parallel test execution
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 1.6.2.

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 AdoptOpenJDK JDK 8 or AdoptOpenJDK JDK 11).
- 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 macOS, 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 macOS

Install JDK

Follow the link to install JDK 8 or 11.

Or use SDKMAN!:

$ sdk install java $(sdk list java | grep -o "8\.[0-9]*\.[0-9]*\hs-adpt" | head -1)

SDKMAN!

$ sdk install sbt

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

Installing sbt on Windows

Install JDK

Follow the link to install JDK 8 or 11.

Installing from a universal package

Download ZIP or TGZ package and expand it.
Windows installer

Download msi installer and install 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.

Scoop

$ scoop install sbt

Chocolatey

$ choco install sbt

Installing sbt on Linux

Installing from SDKMAN

To install both JDK and sbt, consider using SDKMAN.

$ sdk install java $(sdk list java | grep -o "8\.[0-9]*\.*\hs-adpt" | head -1)
$ sdk install sbt

This has two advantages. 1. It will install the official packaging by AdoptOpenJDK, as opposed to the “mystery meat OpenJDK builds”. 2. It will install tgz packaging of sbt that contains all JAR files. (DEB and RPM packages do not to save bandwidth)

Install JDK

You must first install a JDK. We recommend AdoptOpenJDK JDK 8 or JDK 11.

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.

Installing from a universal package

Download ZIP or TGZ package and expand it.
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).

```
sudo apt-get update
sudo apt-get install apt-transport-https curl gnupg -yqq
echo "deb https://repo.scala-sbt.org/scalasbt/debian all main" | sudo tee /etc/apt/sources.list.d/sbt.list
echo "deb https://repo.scala-sbt.org/scalasbt/debian /" | sudo tee /etc/apt/sources.list.d/sbt_old.list
curl -sL https://keyserver.ubuntu.com/pks/lookup?op=get&search=0x2EE0EA64E40A89B84B2DF73499
sudo chmod 644 /etc/apt/trusted.gpg.d/scalasbt-release.gpg
sudo apt-get update
sudo apt-get install sbt
```

Package managers will check a number of configured repositories for packages to offer for installation. 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:

Ubuntu Software & Updates Screenshot

**Note:** There have 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-1.1.0.pom which apparently stems from OpenJDK 9 using PKCS12 format for /etc/ssl/certs/java/cacerts cert-bug. According to https://stackoverflow.com/a/50105333/3827 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 workaround.

**Note:** sudo apt-key adv --keyserver hkeys://keyserver.ubuntu.com:443 --recv 2EE0EA64E40A89B84B2DF73499E82A75642AC823 may not work on Ubuntu Bionic LTS (18.04) since it’s using a buggy GnuPG, so we are advising to use web API to download the public key in the above.

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).

```
# remove old Binray repo file
sudo rm -f /etc/yum.repos.d/bintray-rpm.repo

curl -L https://www.scala-sbt.org/sbt-rpm.repo > sbt-rpm.repo

sudo mv sbt-rpm.repo /etc/yum.repos.d/

sudo yum install sbt
```

On Fedora (31 and above), use sbt-rpm.repo:

```
# remove old Binray repo file
sudo rm -f /etc/yum.repos.d/bintray-rpm.repo

curl -L https://www.scala-sbt.org/sbt-rpm.repo > sbt-rpm.repo

sudo mv sbt-rpm.repo /etc/yum.repos.d/

sudo dnf install sbt
```

**Note:** Please report any issues with these to the sbt 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/)
```
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 foo-build directory the following nested directories: `src/main/scala/example`. Then, create `Hello.scala` in the `example` directory using your favorite editor as follows:

```
package example

object Hello {
    def main(args: Array[String]): Unit = {
        println("Hello")
    }
}
```

This new file should be picked up by the running command:
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
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
```
Set `ThisBuild / scalaVersion` from `sbt` shell

```
sbt:foo-build> set ThisBuild / scalaVersion := "2.13.6"
[info] Defining ThisBuild / scalaVersion
```

Check the `scalaVersion` setting:
```
sbt:foo-build> scalaVersion
[info] 2.13.6
```

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 := "2.13.6"
```

Name your project

Using an editor, change `build.sbt` as follows:
```
ThisBuild / scalaVersion := "2.13.6"
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>`.  

24
Add ScalaTest to libraryDependencies

Using an editor, change build.sbt as follows:

ThisBuild / scalaVersion := "2.13.6"
ThisBuild / organization := "com.example"

```scala
lazy val hello = (project in file("."))
  .settings(
    name := "Hello",
    libraryDependencies ++= "org.scalatest" %% "scalatest" % "3.2.7" % Test,
  )
```

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

```bash
sbt:Hello> reload
```

Run tests

```bash
sbt:Hello> test
```

Run incremental tests continuously

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

Write a test

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

```scala
import org.scalatest.funsuite._

class HelloSpec extends AnyFunSuite {
  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.funsuite._

class HelloSpec extends AnyFunSuite {
  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:

```
ThisBuild / scalaVersion := "2.13.6"
ThisBuild / organization := "com.example"

lazy val hello = (project in file("."))
  .settings(
    name := "Hello",
    libraryDependencies += "com.typesafe.play" %% "play-json" % "2.9.2",
    libraryDependencies += "com.eed3si9n" %% "gigahorse-okhttp" % "0.5.0",
    libraryDependencies += "org.scalatest" %% "scalatest" % "3.2.7" % Test,
  )
```

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

Use Scala REPL

We can find out the current weather in New York.
sbt:Hello> console
[info] Starting scala interpreter...
Welcome to Scala 2.12.7 (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 scala.concurrent._, duration._
import gigahorse._, support.okhttp.Gigahorse
import play.api.libs.json._

Gigahorse.withHttp(Gigahorse.config) { http =>
  val baseUrl = "https://www.metaweather.com/api/location"
  val rLoc = Gigahorse.url(baseUrl + "search/").get.
    addQueryString("query" -> "New York")
  val fLoc = http.run(rLoc, Gigahorse.asString)
  val loc = Await.result(fLoc, 10.seconds)
  val woeid = (Json.parse(loc) \
    0 \
    "woeid").get
  val rWeather = Gigahorse.url(baseUrl + s"/$woeid/").get
  val fWeather = http.run(rWeather, Gigahorse.asString)
  val weather = Await.result(fWeather, 10.seconds)
  {{Json.parse(_: String)} andThen Json.prettyPrint)(weather)
}

// press Ctrl+D

// Exiting paste mode, now interpreting.

import scala.concurrent._
import duration._
import gigahorse._
import support.okhttp.Gigahorse
import play.api.libs.json._
res0: String =
{
  "consolidated_weather" : [ {
    "id" : 6446939314847744,
    "weather_state_name" : "Light Rain",
    "weather_state_abbr" : "lr",
    "wind_direction_compass" : "WNW",
    "created" : "2019-02-21T04:39:47.747805Z",
    "applicable_date" : "2019-02-21",
    "min_temp" : 0.4800000000000004,
    "max_temp" : 7.84,
    "the_temp" : 2.1700000000000004,
  }
}
"wind_speed" : 5.996333145703094,
"wind_direction" : 293.12257757287307,
"air_pressure" : 1033.115,
"humidity" : 77,
"visibility" : 14.890539250775472,
"predictability" : 75
}, {
  "id" : 5806299509948416,
  "weather_state_name" : "Heavy Cloud",
...
Add ScalaTest to the subproject

Change build.sbt as follows:

```scala
ThisBuild / scalaVersion := "2.13.6"
ThisBuild / organization := "com.example"

val scalaTest = "org.scalatest" %% "scalatest" % "3.2.7"

lazy val hello = (project in file("."))
  .settings(
    name := "Hello",
    libraryDependencies += "com.eed3si9n" %% "gigahorse-okhttp" % "0.5.0",
    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:

```scala
ThisBuild / scalaVersion := "2.13.6"
ThisBuild / organization := "com.example"

val scalaTest = "org.scalatest" %% "scalatest" % "3.2.7"

lazy val hello = (project in file("."))
  .aggregate(helloCore)
  .settings(
    name := "Hello",
    libraryDependencies += "com.eed3si9n" %% "gigahorse-okhttp" % "0.5.0",
    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 add a dependency on other subprojects. Also let's move the Gigahorse dependency to `helloCore`.

```scala
type ThisBuild / scalaVersion := "2.13.6"
ThisBuild / organization := "com.example"

val scalaTest = "org.scalatest" %% "scalatest" % "3.2.7"

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" % "0.5.0",
    libraryDependencies += scalaTest % Test,
  )
```

**Parse JSON using Play JSON**

Let's add Play JSON to `helloCore`.

```scala
type ThisBuild / scalaVersion := "2.13.6"
ThisBuild / organization := "com.example"

val scalaTest = "org.scalatest" %% "scalatest" % "3.2.7"
val gigahorse = "com.eed3si9n" %% "gigahorse-okhttp" % "0.5.0"
val playJson = "com.typesafe.play" %% "play-json" % "2.9.2"

lazy val hello = (project in file("."))
  .aggregate(helloCore)
  .dependsOn(helloCore)
  .settings(
```
name := "Hello",
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._, duration._
import play.api.libs.json._

object Weather {
  lazy val http = Gigahorse.http(Gigahorse.config)

  def weather: Future[String] = {
    val baseUrl = "https://www.metaweather.com/api/location"  
    val locUrl = baseUrl + "/search/
    val weatherUrl = baseUrl + "/%s/"
    val rLoc = Gigahorse.url(locUrl).get.
      addQueryString("query" -> "New York")
    import ExecutionContext.Implicits.global
    for {
      loc <- http.run(rLoc, parse)
      woeid = (loc \ 0 \ "woeid").get
      rWeather = Gigahorse.url(weatherUrl format woeid).get
      weather <- http.run(rWeather, parse)
    } yield (weather \\ "weather_state_name")(0).as[String].toLowerCase
  }

  private def parse = Gigahorse.asString andThen Json.parse
}

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

package example

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

object Hello {
def main(args: Array[String]): Unit = {
  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] Done packaging.
[info] Done compiling.
[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:

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

Next change build.sbt as follows to add JavaAppPackaging:

```scala
ThisBuild / scalaVersion := "2.13.6"
ThisBuild / organization := "com.example"

val scalaTest = "org.scalatest" %% "scalatest" % "3.2.7"
val gigahorse = "com.eed3si9n" %% "gigahorse-okhttp" % "0.5.0"
val playJson = "com.typesafe.play" %% "play-json" % "2.9.2"

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"))
```

```
name := "Hello Core",
libraryDependencies ++= Seq(gigahorse, playJson),
libraryDependencies += scalaTest % Test,
)

Reload and create a .zip distribution

sbt:Hello> reload
...

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 := "2.13.6"
ThisBuild / organization := "com.example"

val scalaTest = "org.scalatest" %% "scalatest" % "3.2.7"
val gigahorse = "com.eed3si9n" %% "gigahorse-okhttp" % "0.5.0"
val playJson = "com.typesafe.play" %% "play-json" % "2.9.2"
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> ++2.12.14!
[info] Forcing Scala version to 2.12.14 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] 2.12.14
[info] scalaVersion
[info] 2.12.14

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]
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 scala/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 sbt by example.

Base directory

In sbt’s terminology, the “base directory” is the directory containing the project. So if you created a project hello containing /tmp/foo-build/build.sbt as in the sbt by example, /tmp/foo-build 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>
    scala-2.12/
      <main Scala 2.12 specific sources>
    java/
      <main Java sources>
  test/
    resources
      <files to include in test jar here>
    scala/
      <test Scala sources>
    scala-2.12/
      <test Scala 2.12 specific 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 OK 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.

```
built.sbt
```

Build support files

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

`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 went through sbt by example.

**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,

```bash
$ 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,

```bash
$ 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 suppressed with `suppressSbtShellNotification := true`.

**Continuous build and test**

To speed up your edit-compile-test cycle, you can ask sbt to automatically re-compile 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:

```sh
> ~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.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
</table>

38
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.

sbt shell history
sbt shell remembers history even if you exit sbt and restart it. The easiest way to access history is to press the up arrow key to cycle through previously entered commands.

Note: Ctrl-R incrementally searches the history backwards.
Through JLine’s integration with the terminal environment, you can customize sbt shell by changing \$HOME/.inputrc file. For example, the following settings in \$HOME/.inputrc will allow up- and down-arrow to perform prefix-based search of the history.

"\e[A": history-search-backward
"\e[B": history-search-forward
"\e[C": forward-char
"\e[D": backward-char

sbt shell also supports the following commands:

Command
Description
!
Show history command help.
!!
Execute the previous command again.
!:n
Show the last n commands.
!n
Show the last n commands.

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 1.6.2, 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:

```property
sbt.version=1.6.2
```

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:

```scala
lazy val root = (project in file("."))
  .settings(
    name := "Hello",
    scalaVersion := "2.12.7"
  )
```

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:

```scala
lazy val root = (project in file("."))
  .settings(
    name := "Hello",
    scalaVersion := "2.12.7"
  )
```

**How build.sbt defines settings**

build.sbt defines subprojects, which holds a sequence of key-value pairs called setting expressions using build.sbt domain-specific language(DSL).
lazy val root = (project in file("."))
  .settings(
    name := "hello"
  )

Let’s take a closer look at the build.sbt DSL: setting expression 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:

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

build.sbt may also be interspersed with vals, lazy vals, and def s. Top-level objects and classes 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,

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

Here we have used the fact that an .sbt file can contain vals and def 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 void for Scala), 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:

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

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

Bare .sbt build definition

The settings can be written directly into the build.sbt file instead of putting them inside a .settings(...) call. We call this the “bare style.”

```scala
ThisBuild / version := "1.0"
ThisBuild / scalaVersion := "2.12.15"
```

This syntax is recommended for ThisBuild scoped settings and adding plugins. See later section about the scoping and 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:

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

```scala
ThisBuild / organization := "com.example"
ThisBuild / scalaVersion := "2.12.15"
ThisBuild / version := "0.1.0-SNAPSHOT"
```

```scala
lazy val root = (project in file("."))
  .settings(
      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,
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, :

```scala
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.

```scala
lazy val util = project

lazy val core = project
```

### Build-wide settings

To factor out common settings across multiple subprojects, define the settings scoped to ThisBuild. ThisBuild acts as a special subproject name that you can use to define default value for the build. When you define one or more subprojects, and when the subproject does not define scalaVersion key, it will look for ThisBuild / scalaVersion.

The limitation is that the right-hand side needs to be a pure value or settings scoped to Global or ThisBuild, and there are no default settings scoped to subprojects. (See Scopes)
ThisBuild / organization := "com.example"
ThisBuild / version := "0.1.0-SNAPSHOT"
ThisBuild / scalaVersion := "2.12.15"

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

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

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

Common settings
Another way to factor out common settings across multiple projects is to create a sequence named commonSettings and call settings method on each project.

lazy val commonSettings = Seq(
  target := { baseDirectory.value / "target2" }
)

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

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

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,

```scala
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:

```scala
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:

```scala
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

48
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 continuously watching files that have changed and use 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.

ThisBuild / trackInternalDependencies := TrackLevel.TrackIfMissing
ThisBuild / exportJars := true

lazy val root = (project in file("."))
  .aggregate(....)
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:

```scala
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.

**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.

**Appendix: Subproject 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.

Style choices:

- Each subproject’s settings can go into *.sbt files in the base directory of that project, while the root build.sbt declares only minimum project declarations in the form of lazy val foo = (project in file("foo")) without the settings.
- We recommend putting all project declarations and settings in the root build.sbt file in order to keep all build definition under a single file. However, it’s up to you.

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

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 `scalaOptions` 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:

```scala
val scalacOptions = taskKey[Seq[String]]("Options for the Scala compiler.")
val update = taskKey[UpdateReport]("Resolves and optionally retrieves dependencies, producing a report.")
val clean = taskKey[Unit]("Deletes files produced by the build, such as generated sources, compiled classes, and task caches.")
```

Here’s how we can rewire `scalacOptions`:

```scala
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:

```scala
ThisBuild / organization := "com.example"
ThisBuild / scalaVersion := "2.12.15"
ThisBuild / version := "0.1.0-SNAPSHOT"

lazy val root = (project in file(".")).settings{
  name := "Hello",
  scalacOptions := {
    val out = streams.value // streams task happens-before scalacOptions
  }
}
```

52
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:

ThisBuild / organization := "com.example"
ThisBuild / scalaVersion := "2.12.15"
ThisBuild / version := "0.1.0-SNAPSHOT"

lazy val root = (project in file("."))
  .settings{
    name := "Hello",
    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/classes...
[info] Running example.Hello
hello
[success] Total time: 0 s, completed Jan 2, 2017 10:45:19 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:

```scala
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] 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.

```scala
> inspect tree compile
```

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.

```scala
lazy val root = (project in file("."))
  .settings{
```
name := "Hello",
organization := "com.example",
scalaVersion := "2.12.15",
version := "0.1.0-SNAPSHOT",
scalacOptions := List("-encoding", "utf8", "-Xfatal-warnings", "-deprecation", "-unchecked"
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 for dependencies.

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 Compile / scalaSource key to a different directory only when scalaBinaryVersion is ”2.11”.

Compile / scalaSource := {
  val old = (Compile / scalaSource).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?

We use the build.sbt domain-specific language(DSL) to 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 / 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:

**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
```

This 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
used to use for managed dependencies Library Dependencies, and from Maven-Scales.

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.

dependency configurations

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

**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):

```scala
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):

```scala
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:

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

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

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

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

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

or you could use Global:

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

```scala
(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 in the sbt shell

- **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 configuration 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] Description:
[info] The exported classpath, consisting of build products and unmanaged and managed, internal and external dependencies.
[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[sbtAttributed[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 ThisBuild / 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 slashes, 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`.

```
ThisBuild / organization := "com.example",
ThisBuild / scalaVersion := "2.12.15",
ThisBuild / version := "0.1.0-SNAPSHOT"
```
```scala
lazy val root = (project in file("."))
  .settings(
    name := "Hello",
    publish / skip := true
  )

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

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

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 prepending `ThisBuild /` where possible.

Due to the nature of scope delegation that we will cover later, build-level settings should be set only to a pure value or settings from either `Global` or `ThisBuild` scoping.

**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:

```scala
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 be 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:

```scala
lazy val projA = (project in file("a"))
  .settings{
    name := {
```

69
"foo-" + (packageBin / scalaVersion).value
},
scalaVersion := "2.11.11"
)
What is the value of projA / name?
1. "foo-2.11.11"
2. "foo-2.12.15"
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:

```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
  }
```

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:

```scala
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:

```scala
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"`

```scala
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] 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
```
Delegates:
projD / Compile / console / scalacOptions
projD / Compile / scalacOptions
projD / console / scalacOptions
projD / scalacOptions
ThisBuild / Compile / console / scalacOptions
ThisBuild / Compile / scalacOptions
ThisBuild / console / scalacOptions
ThisBuild / scalacOptions
Zero / Compile / console / scalacOptions
Zero / Compile / scalacOptions
Zero / console / scalacOptions
Zero / scalacOptions
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:

```scala
lazy val root = (project in file(".")
  .settings{
    inThisBuild(List(
    organization := "com.example",
    scalaVersion := "2.12.2",
```

73
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". projE / 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:

```scala
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:

```scala
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 `Compile / dependencyClasspath` or `Runtime / dependencyClasspath` 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`:

```scala
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 Coursier to implement managed dependencies, so if you’re familiar with Coursier, Apache 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 a `Configuration` value (such as `Test`):

```
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 Coursier) 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 the Coursier cache. (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,
```

77
In rare cases you might find reasons to use := with `libraryDependencies` as well.

### Getting the right Scala version with `%%`

If you use `organization %% moduleName % version` rather than `organization % moduleName % version` (the difference is the double `%%` after the `organization`), sbt will add your project’s binary Scala version to the artifact name. This is just a shortcut. You could write this without the `%%`:

```scala
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"`):

```scala
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 `version` in `organization % moduleName % version` 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, Coursier 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

78
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/snapshots"

The resolvers key is defined in Keys like this:

val resolvers = settingKey[Seq[Resolver]]("The user-defined additional resolvers for automatically managed dependencies.

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/repository"

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.

**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`:

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

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

```scala
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:

```scala
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:

```scala
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:

```scala
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:

```bash
> 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.pluginsJUnitXmlReportPlugin: 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:

```scala
site.settings
```

to enable it for that project.

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

```scala
// 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 `$HOME/.sbt/1.0/plugins/`. `$HOME/.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 `$HOME/.sbt/1.0/plugins/` behave as if they were in the `project/` directory for all projects.

You can create `$HOME/.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:

```scala
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, compiled classes, and task caches.")
```

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 vals 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:

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

```scala
ThisBuild / organization := "com.example"
ThisBuild / version := "0.1.0-SNAPSHOT"
ThisBuild / scalaVersion := "2.12.15"
```
lazy val library = (project in file("library"))
  .settings(
    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.")
```
ThisBuild / organization := "com.example"
ThisBuild / version := "0.1.0-SNAPSHOT"
ThisBuild / scalaVersion := "2.12.15"

```scala
lazy val library = (project in file("library"))
  .settings{
    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:

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:

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 `Test / compile` appears many times as a task dependency of `Test / 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`.

```scala
lazy val library = (project in file("library"))
  .settings{
    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

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 make it easier to use the vals defined in it, import Dependencies._ in your build.sbt file.

```scala
import Dependencies._
```
ThisBuild / organization := "com.example"
ThisBuild / version := "0.1.0-SNAPSHOT"
ThisBuild / scalaVersion := "2.12.15"

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

This technique is useful when you have a multi-project build that’s getting large, and you want to ensure that subprojects 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!

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][sbt 0.3.2 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](https://ja.wikipedia.org/wiki/%E9%85%A2%E8%B1%9A) (subuta) as a nickname.


How do I get help?

- See How can I get help?

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 1.6.2 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 does `ThisBuild / scalaVersion` mean?
`ThisBuild` acts as a special subproject name that you can use to define default value for the build. When you define one or more subprojects, and when the subproject does not define `scalaVersion` key, it will look for `ThisBuild / scalaVersion`.

See build-wide settings.

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, and the API Documentation.
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:

```scala
Compile / packageSrc / mappings += {
  import Path.{flat, relativeTo}
  val base = (Compile / sourceManaged).value
  val srcs = (Compile / managedSources).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?

See Caching.

Extending sbt

How can I add a new dependency configuration?

See How to define a custom dependency configuration.

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 pro-
guard?

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:

lazy 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.
ProguardConfig / managedClasspath := {
  // these are the types of artifacts to include
  val artifactTypes: Set[String] = (ProguardConfig / classpathTypes).value
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.
```scala
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:

```scala
{
  // 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)
  }

  Global / onLoad := {
    val previous = (Global / onLoad).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.

```scala
libraryDependencies += "commons-io" % "commons-io" % "1.4" % "test"
```

```scala
disablePlugins(plugins.IvyPlugin)
```

To correct this, include the IvyPlugin plugin settings, which includes `libraryDependencies := Seq()`. So, we just drop the explicit disabling.

```scala
libraryDependencies += "commons-io" % "commons-io" % "1.4" % "test"
```

A more subtle variation of this error occurs when using scoped settings.

```scala
// 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.

```scala
Compile / fullClasspath := (Compile / fullClasspath).value.filterNot(_.data.name.contains("commons-io"))
```

### 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-fileupload-1.2.2.pom:
invalid sha1: expected=ad3fda4adc95eb0d061341228cc94845ddb9a6fe computed=0ce5d4a03b07c8b00ab
```

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:

```scala
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 2.11.0, sbt will try to find a version of the plugin that’s compiled for 2.11.0—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 1.6.2?**

See Community Plugins for a list of currently available plugins.

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](https://twitter.com/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](https://twitter.com/jsuereth)) at Typesafe became the next maintainer of sbt.

In 2014, Eugene Yokota ([@eed3si9n](https://twitter.com/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][sbt-0.13-Tech-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 Warsaw 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 codebase 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 participated in 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.

From spring 2018, Ethan Atkins joined the sbt project as a community member, and quickly became the leading contributor to the project. Initially his contribution was implementing Close Watch that uses native code to provide watch service on macOS. He’s worked on various performance related improvements since then including layered ClassLoader, logging rewrite, and native thin client that uses GraalVM native image.

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
- 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 Tissue 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
- Ben McCann 3
- Enno Runne 3
- Eric Bowman 3
- Henrik Engstrom 3
- Ian Forsey 3
- James Ward 3
- Jesse Kinkead 3
- Justin Pihony 3
- Kazuhiro Sera 3
- Krzysztof Borowski 3
- Lars Hupel 3
- Leif Wickland 3
- Lukas Rytz 3
- Max Worgan 3
- Oliver Wickham 3
- Olli Helenius 3
- Roman Timushev 3
• Simon Schäfer 3
• ZhiFeng Hu 3
• daniel-shuy 3
• Roland Schatz 3
• soc 3
• wpitula 3
• Alex Dupre 2
• Alexey Alekhin 2
• Allan Erskine 2
• Alois Cochar 2
• Andreas Flierl 2
• Anthony 2
• Antoine Gourlay 2
• Arnout Engelen 2
• Ben Hutchison 2
• Benjamin Darfler 2
• Brendan W. McAdams 2
• Brenman 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
• David Hotham 2
• Derek Wickern 2
• Eric D. Reichert 2
• Eric J. Christeson 2
• Evgeny Goldin 2
• Evgeny Vereshchagin 2
• Francois Armand (fan42) 2
• Fred Dubois 2
• Heejong Lee 2
• Henri Kerola 2
• Hideki Ikio 2
• Ikenna Nwaiwu 2
• 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
• Łukasz Piepiora 2
• Marcus Lönberg 2
• Marko Elezovic 2
• Michael Parrott 2
• Mikael Vallerie 2
• Myyk Seok 2
• Ngoc Dao 2
• Nicolas Rémont 2
• Oscar Vargas Torres 2
• Paul Draper 2
• Paulo “JCranky” Siqueira 2
• Petro Verkhogliad 2
• Piotr Kukielska 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
• beohnix 2
• ddworak 2
• drdamour 2
• Eric K Richardson (ekrich) 2
• Jakob Grunig 1
• James Koch 1
• Jan Polák 1
• Jan Zimiewicz 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
• Lucas Mogari 1
• Lutz Huehnken 1
• Mal Graty 1
• Marcos Savoury 1
• Marek Żebrowski 1
• Markus Siemens 1
• Martynas Mickevičius 1
• Martynas Mickevičius 1
• Michael Bayne 1
• Michael Ledin 1
• Nathan Hamblen 1
• Nyavro 1
• OlegYch 1
• Olivier ROLAND 1
• Pavel Penkov 1
• Pedro Larroy 1
• Peter Pan 1
• Piotr Kukielka 1
• Rikard Pavelic 1
• Robert Jacob 1
• Rogach 1
• Sergey Andreev 1
• Shanbin Wang 1
• Shane Hender 1
• Simon Olofsson 1
• Stefan Zeiger 1
• Stephen Duncan Jr 1
• Steve Gury 1
• Sören Brunk 1
• Thomas Grainger 1
• Tim Sheppard 1
• Todor Todorov 1
• Toshiyuki Takahashi 1
• Travis Brown 1
• Tsubasa Irisawa 1
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• mmcbride 1
• pishen tsai 1
• sanjiv sahayam 1
• saturday06 1
• seroperson 1
• slideon 1
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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
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 (pf
- 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 Olshhevskiy
- sbt-coverage by Stephen Samuel and Mikko Koponen
- sbt-web by Lightbend (Christopher Hunt, Peter Vlugter, et al)
- sbt-builder by Eugene Yokota (eed3si9n)
- sbt-pack by Taro L. Saito (xerial)
- sbt-onejar by Jason Zaugg (retronym)
- sbt-git by Josh Suereth
- sbt-scalajrform by Heiko Seeberger, Daniel Trinh, et al
- ensime-sbt by Sam Halliday (fomnil)
- 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 Coichael
• 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 (pfm)
• sbt-avro by Juan Manuel Caicedo Carvajal (cavorite), Ben McCann, et al
• sbt-aspectj by Lightbend (Peter Vlugter et al)
• sbt-crossproject by 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 Arktkek (Erlend Hannaberg 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 by Doug Tangren (softprops)
• sbt-dependency-check by Alexander v. Buchholtz
• sbt-structure by JetBrains (Justin Krasser 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)

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Thank you all.

[@harrah]: https://github.com/harrah [@jsuereth]: https://github.com/jsuereth
[@eed3si9n]: https://github.com/eed3si9n [@dwijnand]: https://github.com/dwijnand
[@jvican]: https://github.com/jvican [sbt-0.13-Tech-Previews]: sbt-0.13-Tech-Previews.html

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.

The sbt autopplugin giter8 template is a good place to start. This sets up a new sbt plugin project appropriately. The generated README includes a summary of the steps for publishing a new community plugin.

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-scalafmt: code formatting using Scalafmt.
- sbt-scalariform: code formatting using Scalariform.
- neo-sbt-scalafmt: code formatting using Scalafmt.
- sbt-java-formatter: code formatting for Java sources.
- sbt-source-format: code formatting for Java and clang (c/c++/objc) sources.
- safety-plugin: Enforce the use of style rules across your company

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.
- sbt-delombok: delombok Java source files that contain Lombok annotations to make Javadoc contain Lombok-generated classes and methods.
- sbt-alldocs: collect all the docs for a project and dependencies into a single folder.
- sbt-apidoc: A port of apiocjs to sbt, to document REST Api.
- sbt-github-pages (docs): publish a website to GitHub Pages with minimal effort - works well with GitHub Actions.
- sbt-docusaur (docs): build a website using Docusaurus and publish to GitHub Pages with minimal effort - works well with GitHub Actions.
- sbt-hl-compiler: compile the code snippets from documentation (to keep it consistent).
- sbt-scaladoc-compiler: compile the code snippets included in Scaladoc comments.

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-rig: opinionated common release steps.
- sbt-s3: manage objects on Amazon S3.
- sbt-osgi: create OSGi bundles.
- 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 message since last release.
- sbt-gcs: manage objects on Google Cloud Storage.
- sbt-sourcebundler: merge all source code into one scala file.
- sbt-kubeyml: Create a typesafe kubernetes Deployment based on your project settings

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.
- sbt-riotctl: deploy applications as systemd services directly to a Raspberry Pi, ensuring dependencies (e.g. wiringpi) are met.

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-jui: 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-mima-version-check: Automate which Mima Versions to Check.
- sbt-tmpfs: utilize tmpfs to speed up builds.
- sbt-sh: run shell commands from sbt.
- sbt-ammonite-classpath: export classpath for Ammonite and Almond.
- sbt-version-scheme-enforcer-plugin: Derive Mima settings for your library from your declared `versionScheme`. This supports Early SemVer, Strict SemVer, and Package Versioning Policy (PVP).

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-testing: TestNG framework integration.
- sbt-jcstress: Java Concurrency Stress Test (jcstress) integration.
- sbt-stryker4s: Test your tests with mutation testing.
- sbt-cached-ci: Incremental sbt builds for CI environments.

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.
• safety-plugin: Enforce the use of specified versions of dependencies across your company
• sbt-dependency-lock: generate dependency lockfiles and check for changes at build time.
• sbt-unzip: Extract zip dependencies where you want in your project.

Web and frontend development plugins
• Play Framework: reactive web framework for Scala and Java.
• Scala.js: Scala to JavaScript compiler.
• xsbt-web-plugin: Servlet support.
• 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-terser: JavaScript (ES6+) minifier using terser.
• 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.
• sbt-scala-ts: generates TypeScript declaration files from ScalaJS sources and outputs Node modules.

Database plugins
• scalikejdbc-mapper-generator: Scala code generator from database schema.
• sbt-dynamodb: run a local Amazon DynamoDB test instance from sbt.
• sbt-migrations: database migrations manager.
Framework-specific plugins

- 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-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-i18n: transform your i18n bundles into Scala code.
- sbt-lit: build literate code with sbt.
- sbt-embedded-files: generate Scala objects containing the contents of glob-specified files as strings or byte-arrays.
- sbt-scala-ts: generate TypeScript code according compiled Scala types (case class, trait, object, ...).

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-scalafix: refactoring and linting tool for Scala using Scalafix.
- sbt-explicit-dependencies: check that you have declared all your library dependencies correctly
- sbt-taglist: find tags within source files (such as TODO and FIXME).
- sbt-rewarn: always display compilation warnings, despite the incremental compilation.
- sbt-jcheckstyle: Java code style checking using Checkstyle.
- sbt-sonar: integration with SonarQube.
- sbt-scala2plantuml: generates PlantUML diagrams from Scala code.
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.

Language support plugins
- sbt-frege: build Frege code with sbt.
- sbt-cc: compile C and C++ source files with sbt.

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

We no longer use Bintray to host plugins.

First and foremost, we would like to thank JFrog for their continued support of sbt project and the Scala ecosystem. Between 2014 and April, 2021 sbt hosted its community plugin repository on bintray.com/sbt.
When JFrog sunned their Bintray product, they have proactively contacted us and granted Scala Center open source sponsorship that allows us to use an online Artifactory instance.

As of 2021-04-18, we have migrated all sbt plugins and sbt 0.13 artifacts to the Artifactory instance, and redirected https://repo.scala-sbt.org/scala-sbt/ to point to it as well, so existing builds should continue to work without making any changes today and after May 1st. For plugin hosting, we will operate this as a read-only repository. Any new plugin releases should migrate to using Sonatype OSS.

**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
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
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/`:

```bash
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,

```bash
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:

```bash
java -Dhttp.proxyHost=myproxy -Dhttp.proxyPort=8080 -Dhttp.proxyUser=username -Dhttp.proxyPassword=mypassword
```

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

**Path encoding**

If you have files on your system that have non-ascii characters in them on a posix system, e.g. Linux or macOS, it may be necessary to set the `LC_CTYPE` environment variable. If this environment variable is not set to a UTF-8 compatible locale, e.g. `LC_TYPE=en_US.UTF-8`, then sbt may crash with a `java.nio.file.InvalidPathException`. To see a list of available locales, run `locale -a`. For more information about locales, see International Language Environments Guide.

**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. (Optionally sbt-sonatype can publish to a Sonatype repository nicer.)

step 1: PGP Signatures

Follow Working with PGP Signatures.

First, you should install GnuPG, and verify the version:

$ gpg --version
gpg (GnuPG/MacGPG2) 2.2.8
Next generate a key:

$ gpg --gen-key

List the keys:

$ gpg --list-keys

/home/foo/.gnupg/pubring.gpg

-----------------------------

    pub rsa4096 2018-08-22 [SC]
    1234517530FB96F147C6A146A326F592D39AAAAA
uid [ultimate] your name <you@example.com>
sub rsa4096 2018-08-22 [E]

Distribute the key:

$ gpg --keyserver keyserver.ubuntu.com --send-keys 1234517530FB96F147C6A146A326F592D39AAAAA

step 2: sbt-pgp

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.github.sbt" % "sbt-pgp" % "2.1.2")

Note: The plugin is a solution to sign artifacts. It works with the GPG command line tool.

Make sure that the gpg command is in PATH available to the sbt.

step 3: Credentials

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

credentials += Credentials(Path.userHome / ".sbt" / "sonatype_credentials")

Next create a file ~/.sbt/sonatype_credentials:
realm=Sonatype Nexus Repository Manager
host=oss.sonatype.org
user=<your username>
password=<your password>

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

step 4: Configure build.sbt

To publish to a maven repository, you’ll need to configure a few settings so that the correct metadata is generated.

Add these settings at the end of build.sbt or a separate publish.sbt:

ThisBuild / organization := "com.example.project2"
ThisBuild / organizationName := "example"
ThisBuild / organizationHomepage := Some(url("http://example.com/"))

ThisBuild / scmInfo := Some(
  ScmInfo(
    url("https://github.com/your-account/your-project"),
    "scm:git@github.com:your-account/your-project.git"
  )
)
ThisBuild / developers := List(
  Developer(
    id = "Your identifier",
    name = "Your Name",
    email = "your@email",
    url = url("http://your.url")
  )
)

ThisBuild / description := "Some description about your project."
ThisBuild / licenses := List("Apache 2" -> new URL("http://www.apache.org/licenses/LICENSE-2.0.txt"))
ThisBuild / homepage := Some(url("https://github.com/example/project"))

// Remove all additional repository other than Maven Central from POM
ThisBuild / pomIncludeRepository := { _ => false }
ThisBuild / 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")
}
ThisBuild / publishMavenStyle := true
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.

**step 5: Publishing**

From sbt shell run:

> publishSigned

Check the published artifacts in the Nexus Repository Manager (same login as Sonatype’s Jira account).

Close the staging repository and promote the release to central, by hitting “Close” button, then “Release” button.

**Optional steps**

sbt-sonatype

*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" % "3.9.5")
```

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**

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.

Note: If you are using a new OSSRH account created after February 2021, use "s01.oss.sonatype.org" instead of "oss.sonatype.org"

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] sbt-release, you should simply add the publishing commands as steps in the releaseProcess task:

```scala
... 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:

```scala
set logLevel := Level.Warn

or set Test / logLevel := Level.Warn
```

You could make commands that wrap this, like:

```scala
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 repository) 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")

SbtPlugin

sbt 0.13, sbt 1.0, and sbt 1.1 required sbtPlugin setting and scripted plugin to develop an sbt plugin. sbt 1.2.1 combined both into SbtPlugin plugin.

Remove scripted-plugin from project/plugins.sbt, and just use:

```scala
lazy val root = (project in file(".")).enablePlugins(SbtPlugin)
```

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:

```scala
package sbtfoo

import sbt._
import Keys._

object PluginCompat {
  type UpdateConfiguration = sbt.librarymanagement.UpdateConfiguration

  def subMissingOk(c: UpdateConfiguration, ok: Boolean): UpdateConfiguration =
```
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:

```scala
version in ThisBuild := "1.0.0-SNAPSHOT"

lazy val root = (project in file("."))
  .settings(
    name := "hello",
    scalacOptions in Compile += "-Xlint",
    scalacOptions in (Compile, console) --= Seq("-Ywarn-unused", "-Ywarn-unused-import"),
    fork in Test := true
  )
```

They are now written as:

```scala
ThisBuild / version := "1.0.0-SNAPSHOT"
```

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

126
There's a syntactic Scalafix rule for unified slash syntax to semi-automatically rewrite existing sbt 0.13 syntax to the slash syntax. Currently it requires the use of scalafix CLI and it's not very precise (because it's a syntactic rule that only looks at the shape of the code) but it gets most of the job done.

$ scalafix --rules=https://gist.github.com/eed3si9n/57e83f5330592d968ce49f0d5030d4d5/raw/7f576f16a90e432baa49911c9a66204c354947bb/Sbt0_13BuildSyntax.scala *.sbt project/*.scala

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:

```scala
a <<= aTaskDef
b <+= bTaskDef
c <++= cTaskDefs
```

it is sufficient to replace them with the equivalent:

```scala
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:

```scala
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")
```

Migrating when using .dependsOn, .triggeredBy or .runBefore

With the .value DSL you don’t have to know or remember if your key is a SettingKey or a TaskKey:

```scala
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)

Migrating when using .dependsOn, .triggeredBy or .runBefore

When instead calling .dependsOn, instead of:

```scala
a <<= a dependsOn b
```

define it as:

```scala
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:

```scala
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:

```scala
sourceGenerators in Compile <<= buildInfo
```

for sbt 1, you define them as:

```scala
Compile / sourceGenerators += buildInfo
```

or in general,

```scala
Compile / sourceGenerators += Def.task { List(file1, file2) }
```

Migrating with InputKey

When using `InputKey` instead of:

```scala
run <<= docsRunSetting
```

when migrating you mustn’t use `.value` but `.evaluated`:

```scala
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:

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:

```scala
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.

  ```scala
  externalResolvers := Resolver.combineDefaultResolvers(resolvers.value.toVector, mavenCentral = false)
  ```
- You can use Vector directly too.

**sbt 1.4.x releases**

**sbt 1.4.1**

- Fixes sbt new not echoing back the characters #5954 by [@eatkins][@eatkins]
- Fixes compiler error reporting in Zinc zinc#931 by [@adpi2][@adpi2]
- Fixes dependencyBrowseTree etc #5967 by [@naderghanbari][@naderghanbari]
• Fixes Scala 2.13-3.0 sandwich support for Scala.JS #5984 by [@xuwei-k]

• Work around classes directory causing “classes does not exist” error zinc#934 by [@eed3si9n]

• Adds logging to ClassfileManager output #5990 by [@smarter]

• Fixes Ctrl-C and Ctrl-D handling #5947/#5975 by [@eatkins]

• Fixes -Dsbt.color=true not working in some situation #5960 by [@eatkins]

• Fixes FileAlreadyExistsException when project/target is a symbolic link #5972 by [@eatkins]

• Fixes ANSI control character appearing in piped output #5966 by [@eatkins]

• Fixes line reading issue with jEdit #5946 by [@eatkins]

• Fixes sbt hanging on invalid build.sbt and --batch #5945 by [@eatkins]

• Fixes .inputrc file support #5973 by [@xuwei-k]

• Fixes BSP warning diagnostics disappearing on recompilation #5950 by [@adpi2]

• Fixes BSP support for custom configurations #5930 by [@adpi2]

• Fixes custom reporter causing MatchError #5948 by [@adpi2]

• Fixes shellPrompt and release* keys warning on build linting #5983/#5991 by [@xirc] and [@eed3si9n] and #5972 by [@eatkins]

• Fixes <task>.value macro causing spurious “a pure expression does nothing” warning #5981 by [@eed3si9n]

• Preserves SemanticDB files in remote cache #5961 by [@xuwei-k]

• Adds AdoptOpenJDK support for JDK cross building #5964 by [@rdesgroppes]

• Improves plugins command output by grouping by subproject #5932 by [@aaabramov]
sbt 1.4.0

The headline features of sbt 1.4.0 are:

- build server protocol (BSP) support
- sbtn: a native thin client for sbt
- build caching
- ThisBuild / versionScheme to take the guessing out of eviction warning

Build server protocol (BSP) support

sbt 1.4.0 adds build server protocol (BSP) support, contributed by Scala Center. Main implementation was done by Adrien Piquerez ([@adpi2](https://twitter.com/adrienpi2)) based on [eed3si9n](https://twitter.com/eed3si9n)'s prototype.

When sbt 1.4.0 starts, it will create a file named `.bsp/sbt.json` containing a machine-readable instruction on how to run `sbt -bsp`, which is a command line program that uses standard input and output to communicate to sbt server using build server protocol.

How to import to IntelliJ using BSP

1. Start sbt in a terminal
2. Open IntelliJ IDEA 2020.1.2 or later
3. Select “Open or import”, and select “BSP Project”

How to import to VS Code + Metals

1. Delete existing `.bsp`, `.metals`, `.bloop` directories if any
2. Open VS Code in the working directory
3. Ignore the prompt to import the project
4. Start `sbt -Dsbt.semanticdb=true` in the Terminal tab. Wait till it displays “sbt server started”
5. Navigate to Metals view, and select “Restart build server”
6. Type `compile` into the sbt session to generate SemanticDB files

#5538/#5443 by [@adpi2](https://twitter.com/adrienpi2)

Native thin client

sbt 1.4.0 adds an official native thin client called `sbtn` that supports all tasks. If you’re using the official sbt launcher 1.4.0 and not the knockoff kind you can use `--client` option to run the native thin client:
The native thin client will run sbt (server) as a daemon, which avoids the JVM spinup and loading time for the second call onwards. This could be an option if you would like to use sbt from the system shell such as Zsh and Fish.

Remember to call `sbt --client shutdown` when you're done! If you want to enable this via an environment variable you can set `SBT_NATIVE_CLIENT` to `true`. sbtn binary files are also available from https://github.com/sbt/sbtn-dist/releases/tag/v1.4.0

#5620 by [@eatkins](@eatkins)

**ThisBuild / versionScheme**

sbt 1.4.0 adds a new setting called `ThisBuild / versionScheme` to track version scheme of the build:

```
ThisBuild / versionScheme := Some("early-semver")
```

The supported values are "early-semver", "pvp", and "semver-spec". sbt will include this information into pom.xml and ivy.xml as a property. In addition, sbt 1.4.0 will use the information to take the guessing out of eviction warning when this information is available. #5724 by [@eed3si9n](@eed3si9n)

**VirtualFile + RemoteCache**

sbt 1.4.0 / Zinc 1.4.0 virtualizes the file paths tracked during incremental compilation. The benefit for this is that the state of incremental compilation can shared across different machines, as long as `ThisBuild / rootPaths` are enumerated beforehand.

To demonstrate this, we’ve also added `experimental` cached compilation feature to sbt. All you need is the following setting:

```
ThisBuild / pushRemoteCacheTo := Some(MavenCache("local-cache", file("/tmp/remote-cache")))
```

Then from machine 1, call `pushRemoteCache`. This will publish the *.class and Zinc Analysis artifacts to the location. Next, from machine 2, call `pullRemoteCache`.

zinc#712/#5417 by [@eed3si9n](@eed3si9n)

**Build linting**

On start up, sbt 1.4.0 checks for unused settings/tasks. Because most settings are on the intermediary to other settings/tasks, they are included into the linting
by default. The notable exceptions are settings used exclusively by a command. To opt-out, you can either append it to Global / excludeLintKeys or set the rank to invisible.

#5153 by [@eed3si9n][@eed3si9n]

**Conditional task**

sbt 1.4.0 adds support for conditional task (or Selective task), which is a new kind of task automatically created when Def.task { ... } consists of an if-expression:

```
bar := {
  if (number.value < 0) negAction.value
  else if (number.value == 0) zeroAction.value
  else posAction.value
}
```

Unlike the regular (Applicative) task composition, conditional tasks delays the evaluation of then-clause and else-clause as naturally expected of an if-expression. This is already possible with Def.taskDyn { ... }, but unlike dynamic tasks, conditional task works with inspect command. See Selective functor for sbt for more details. #5558 by [@eed3si9n][@eed3si9n]

**Incremental build pipelining**

sbt 1.4.0 adds experimental incremental build pipelining. To enable build pipelining for the build:

```
ThisBuild / usePipelining := true
```

To opt-out of creating an early output for some of the subprojects:

```
exportPipelining := false
```

#5703 by [@eed3si9n][@eed3si9n]

**sbt-dependency-graph is in-sourced**

sbt 1.4.0 brings in Johannes Rudolph’s sbt-dependency-graph plugin into the code base. Since it injects many tasks per subprojects, the plugin is split into two parts: - MiniDependencyTreePlugin that is enabled by default, bringing in dependencyTree task to Compile and Test configurations - Full strength DependencyTreePlugin that is enabled by putting the following to project/plugins.sbt:

```
addDependencyTreePlugin
```
Fixes with compatibility implications

- Replaces Apache Log4j with our own logger by default to avoid Appender leakage. Use `ThisBuild / useLog4J := true` to use Log4j.  #5731 by [@eatkins] [@eatkins]
- Makes JAR file creation repeatable by sorting entry by name and dropping timestamps #5344/io#279 by [@raboof] [@raboof]
- Loads bare settings in the alphabetic order of the build files #2697/#5447 by [@eed3si9n] [@eed3si9n]
- Loads vals from top-to-bottom within a build file #2232/#5448 by [@eed3si9n] [@eed3si9n]
- HTTP resolvers require explicit opt-in using `.withAllowInsecureProtocol(true)` #5593 by [@eed3si9n] [@eed3si9n]
- Ctrl-C during triggered execution returns to the shell instead of shutting down sbt #5804 by [@eatkins] [@eatkins]

Other updates

- Updates shell to use JLine 3 for better tab completion #5671 by [@eatkins] [@eatkins]
- Adds support for Scala 2.13-3.0 sandwich #5767 by [@eed3si9n] [@eed3si9n]
- Throws an error if you run sbt from without `-Dsbt.rootdir=true` #5112 by [@eed3si9n] [@eed3si9n]
- Updates `StateTransform` to accept `State => State` #5260 by [@eatkins] [@eatkins]
- Fixes various issues around background run #5259 by [@eatkins] [@eatkins]
- Turns off supershell when `TERM` is set to “dumb” #5278 by [@hvesalai] [@hvesalai]
- Avoids using system temporary directories for logging #5289 by [@eatkins] [@eatkins]
- Adds library endpoint for `sbt.ForkMain` #5315 by [@olafurpg] [@olafurpg]
- Avoids using last modified time of directories to invalidate `doc` #5362 by [@eatkins] [@eatkins]
- Fixes the default artifact of packageSrc for custom configuration #5403 by [@eed3si9n] [@eed3si9n]
- Fixes task cancellation handling #5446/zinc#742 by [@azolotko] [@azolotko]
- Adds `toTaskable` method injection to `Initialize[A]` for tuple syntax #5439 by [@dwijnand] [@dwijnand]
- Fixes the error message for an undefined setting #5469 by [@nigredo-tori] [@nigredo-tori]
- Updates `semanticdbVersion` to 4.3.7 #5481 by [@anilkumarmyla] [@anilkumarmyla]
- Fixes various supershell interferences #5319 by [@eatkins] [@eatkins]
- Adds extension methods to State to facilitate sbt server communication #5207 by [@eed3si9n]
- Adds support for testGrouping #5527 by [@frosforever]
- Updates to sjson-new, which shades Jawn 1.0.0 #5595 by [@eed3si9n]
- Fixes NullPointerException when credential realm is null #5526 by [@3rwww1]
- Adds Def.promise for long-running tasks to communicate to another task #5552 by [@eed3si9n]
- Uses Java’s timestamp on JDK 10+ as opposed to using native call io#274 by [@slandelle]
- Adds retry with backoff during publish (-Dsbt.repository.publish.attempts set to 3) lm#340 by [@izharahmd]
- Improves failure message for PUT lm#309 by [@swaldman]
- Adds provenance to AnalyzedClass zinc#786 by [@dwijnand]
- Makes hashing childrenOfSealedClass stable zinc#788 by [@dwijnand]
- Fixes performance regressions around build source monitoring #5530 by [@eatkins]
- Fixes performance regressions around super shell #5531 by [@eatkins]
- Various performance improvements in Zinc zinc#756/zinc#763 by [@retronym]
- Adds a monitor to warn about excessive GC #5812 by [@eatkins]
- Fixes forked tests running tests twice when they match multiple fingerprints #5800 by [@Duhemm]

**Participation**

sbt 1.4.0 was brought to you by 34 contributors. Ethan Atkins, Eugene Yokota (eed3si9n), Johannes Rudolph, Dale Wijnand, Adrien Piquerez, Jason Zuugg, Arnout Engelen, Josh Soref, Guillaume Martres, Maksim Ochenaskho, Anil Kumar Myla, Brice Jaglin, Claudio Bley, João Ferreira, Steve Waldman, frosforever, Alex Zolotko, Heikki Vesalainen, Ismael Juma, Stephane Landelle, Jannik Theiß, izharahmd, lloydmeta, Alexandre Archambault, Eric Peters, Erwan Queffelec, Kenji Yoshida (xuwe-k), Martin Duhem, Olafur Pall Geirsson, Renato Cavalcanti, Vincent PERICART, nigredo-tori. Thanks!

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[@raboof]: https://github.com/raboof
[@azolotko]: https://github.com/azolotko
[@nigredo-tori]: https://github.com/nigredo-tori
[@anilkumarmyla]: https://github.com/anilkumarmyla
[@bjaglin]: https://github.com/bjaglin
[@frosforever]: https://github.com/frosforever
[@adpi2]: https://github.com/adpi2
[@3rwww1]: https://github.com/3rwww1
sbt 1.3.x releases

sbt 1.3.0

This is the third feature release of sbt 1.x, a binary compatible release focusing on new features. sbt 1.x is released under Semantic Versioning, and the plugins are expected to work throughout the 1.x series.

The headline features of sbt 1.3 are out-of-box Coursier library management, ClassLoader layering, IO improvements, and super shell. Combined together we hope these features will improve the user experience of running your builds.

Changes with compatibility implication

- Library management with Coursier. See below for details.
- Super shell. See below for details.
- Multi command no longer requires leading semicolon. clean;Test/compile; would work. #4456 by @eatkins
- Deprecates HTTP resolvers, but allow localhost or resolvers marked .withAllowInsecureProtocol(true) #4997
- ClassLoader management: To prevent resource leaks, sbt 1.3.0 closes the ephemeral ClassLoaders used by the run and test tasks after those tasks complete. This may cause downstream crashes if the task uses Shutdown-Hooks or if any threads created by the tasks continue running after the task completes. To disable this behavior, either set Compile / run / fork := true or run sbt with -Dsbt.classloader.close=false.

Library management with Coursier

sbt 1.3.0 adopts Coursier for the library management. Coursier is a dependency resolver like Ivy, rewritten in Scala by Alexandre Archambault ([@alexarchambault](https://github.com/alexarchambault)), aiming to be a faster alternative.

**Note:** Under some situations, Coursier may not resolve the same way as Ivy (for example remote -SNAPSHOTs are cached for 24 hours). If you wish to go back to Apache Ivy for library management, put the following in your build.sbt:

```scala
ThisBuild / useCoursier := false
```
Many people were involved in the effort of bringing Coursier to sbt. Early in 2018 Leonard Ehrenfried ([@leonardehrenfried](https://github.com/leonardehrenfried)) started the Coursier-backed LM API implementation as lm#190. During the fall, it was further improved by Andrea Peruffo ([@andreaTP](https://github.com/andreaTP)), and lm-coursier eventually became part of coursier/sbt-coursier repository maintained by Alex. This spring, Eugene ([@eed3si9n](https://github.com/eed3si9n)) revisited this again to make a few more changes so we can swap out the LM engine in #4614 with the help from Alex.

**Turbo mode with ClassLoader layering**

sbt 1.3.0 adds “turbo” mode that enables experimental or advanced features that might require some debugging by the build user when it doesn’t work.

```scala
ThisBuild / turbo := true
```

Initially we are putting the layered ClassLoader (ClassLoaderLayeringStrategy.AllLibraryJars) behind this flag.

sbt has always created two-layer ClassLoaders when evaluating the run and test tasks. The top layer of the ClassLoader contains the scala library jars so that the classes in the scala package may be reused across multiple task evaluations. The second layer loads the rest of the project classpath including the library dependencies and project class files. sbt 1.3.0 introduces experimental classLoaderLayeringStrategy feature that furthers this concept.

```
Compile / classLoaderLayeringStrategy := ClassLoaderLayeringStrategy.Flat // default
Compile / classLoaderLayeringStrategy := ClassLoaderLayeringStrategy.ScalaLibrary // enabled with turbo
Compile / classLoaderLayeringStrategy := ClassLoaderLayeringStrategy.AllLibraryJars
```

```
Test / classLoaderLayeringStrategy := ClassLoaderLayeringStrategy.Flat // default
Test / classLoaderLayeringStrategy := ClassLoaderLayeringStrategy.ScalaLibrary // enabled with turbo
Test / classLoaderLayeringStrategy := ClassLoaderLayeringStrategy.AllLibraryJars
```

- **ClassLoaderLayeringStrategy.Flat** includes all classes and JARs except for the Java runtime. The behavior of tasks using this strategy should be similar to forking without the overhead of starting a new jvm.
- **ClassLoaderLayeringStrategy.ScalaLibrary** creates a two-layer ClassLoader where Scala standard library is kept warm, similar to sbt 1.2.x
- **ClassLoaderLayeringStrategy.AllLibraryJars** creates a three-layer ClassLoader where library dependencies, in addition to Scala standard libraries are kept warm

**ClassLoaderLayeringStrategy.AllLibraryJars** should benefit the response
time of run and test tasks. By caching the library jar classloader, the startup latency of the run and test tasks can be reduced significantly when they are run multiple times within the same session. GC pressure is also reduced because libraries jars will not be reloaded every time the task is evaluated.

**Note:** ClassLoaderLayeringStrategy.AllLibraryJars reuses the singleton object between the tests, which requires libraries to clean after itself.

ClassLoaderLayeringStrategy.Flat on the other hand will benefit certain applications that do not work well with layered ClassLoaders. One such example is Java serialization + serialization proxy pattern used by Scala collections.

ClassLoader layering was contributed by Ethan Atkins (@eatkins) as #4476

**IO improvements**

In addition to classloader layering, sbt 1.3.0 incorporates numerous performance enhancements including:

- faster recursive directory listing – sbt internally uses a native library, swoval, that provides a jni interface to native os apis that allow for faster recursive directory listing than the implementations in the java standard library.
- reduced latency of file change detection in continuous builds. In most cases file events will trigger task evaluation within 10ms.

As of this writing sbt 1.3.0’s edit-compile-test loop for 5000 source files is faster than that edit-compile-test with three source files using sbt 0.13, Gradle, and other build tools we tested (see build performance for details). These changes were contributed by Ethan Atkins (@eatkins).

**Glob**

sbt 1.3.0 introduces a new type, Glob, that describes a path search query. For example, all of the scala sources in the project directory can be described by Glob(baseDirectory.value, RecursiveGlob / "*.scala") or baseDirectory.value.toGlob / ** / "*.scala", where ** is an alias for RecursiveGlob. Glob expands on PathFinders but they can be composed with no io overhead. Globs can be retrieved using a FileTreeView. For example, one can write:

```scala
val scalaSources = baseDirectory.value.toGlob / ** / "*.scala"
val javaSources = baseDirectory.value.toGlob / ** / "*.java"
val allSources = fileTreeView.value.list(Seq(scalaSources, javaSources))
```

and the FileTreeView will only traverse the base directory once. Globs and FileTreeView were added by Ethan Atkins (@eatkins)[@eatkins]) in io#178.io#216.io#226
Watch improvements

sbt 1.3.0 introduces a new file monitoring implementation. It uses enhanced apis for tracking file change events using os events. It adds a new parser that extracts the specific task(s) for which it will monitor source files and rerun when it detects changes. Only source dependencies of the running tasks are monitored. For example, when running `~compile`, changes to test source files will not trigger a new build. Between file events, there are also now options to return to the shell, rerun the previous command(s) or exit sbt. These changes were implemented by Ethan Atkins ([@eatkins][@eatkins]) in io#178,#216,#226,#4512,#4627.

Build definition source watch

sbt 1.3.0 automatically watches the build definition sources and displays a warning if you execute a task without reloading. This can be configured to reload automatically as follows:

```
Global / onChangedBuildSource := ReloadOnSourceChanges
```

This feature was contributed by Ethan Atkins ([@eatkins][@eatkins]) in #4664

Custom incremental tasks

sbt 1.3.0 provides support to implement custom incremental tasks based on files. Given a custom task that returns `java.nio.file.Path`, `Seq[Path]`, `File`, or `Seq[File]`, you can define a few helper tasks to make it more incremental.

```
import java.nio.file._
import scala.sys.process._

val gccCompile = taskKey[Seq[Path]]("compile C code using gcc")
val gccHeaders = taskKey[Seq[Path]]("header files")
val gccInclude = settingKey[Path]("include directory")
val gccLink = taskKey[Path]("link C code using gcc")

gccCompile / sourceDirectory := sourceDirectory.value
gccCompile / fileInputs += (gccCompile / sourceDirectory).value.toGlob / ** / "*.c"
gccInclude := (gccCompile / sourceDirectory).value.toPath / "include"
gccHeaders / fileInputs += gccInclude.value.toGlob / "*.h"
gccCompile / target := baseDirectory.value / "out"

gccCompile := {
  val objectDir = Files.createDirectories((gccCompile / target).value.toPath / "objects")
  def objectFile(path: Path): Path =
    target.value.toPath / path.getName.toString.replaceAll(".c$", ".o")
  Files.createDirectories(target.value.toPath)
  val headerChanges = gccHeaders.inputFileChanges.hasChanges
```
val changes = gccCompile.inputFileChanges
changes.deleted.foreach(sf => Files.deleteIfExists(objectFile(sf)))
val sourceFileChanges = changes.created ++ changes.modified
val needRecompile = (sourceFileChanges ++ (if (headerChanges) changes.unmodified else Nil)).toSet
val logger = streams.value.log
gccCompile.inputFiles.map { sf =>
  val of = objectFile(sf)
  if (!Files.exists(of) || needRecompile(sf)) {
    logger.info(s"Compiling $sf")
    s"gcc -I${gccInclude.value} -c $sf -o $of".!!
  }
  of
}

Given this setup, gccCompile.inputFiles will return a sequence of all of the input C source files, gccCompile.inputFileChanges returns a data structure containing the created, deleted, modified and unmodified files since the last run of gccCompile while gccHeaders.changedInputFiles returns the headers that have changed since the last run of gccCompile. Taken together, these tasks can be used to incrementally only rebuild the source files that need to be rebuilt given the file system changes since the last time gccCompile completed.

In another task such as gccLink, the result of gccCompile can be tracked as well using gccCompile.outputFileChanges.

gccLink := {
  val library = (gccCompile / target).value.toPath / "libmylib.dylib"
  val objectFiles = gccCompile.outputFiles
  val logger = streams.value.log
  if (!Files.exists(library) || gccCompile.outputFileChanges.hasChanges) {
    logger.info(s"Rebuilding $library")
    s"gcc -dynamiclib -o $library ${objectFiles mkString " "}".!!
  }
  library
}

The inputs of a task will automatically be monitored by the ~ command which has a new parser that is context aware. A custom clean task is also implemented for any task that generates file outputs. The clean tasks are aggregated across the project and config scopes. For example, Test / clean will clean all of the files generated by tasks in the Test config declared in the Test config but not the files generated in the Compile config.

This feature was contributed by Ethan Atkins (@eatkins) in #4627.
Super shell

When running in an ANSI-compatible terminal, sbt 1.3.0 will display the currently running tasks. This gives the developer the idea of what tasks are being processed in parallel, and where the build is spending its time. In homage to Gradle’s “Rich Console” and Buck’s “Super Console”, we call ours “Super shell.”

To opt-out put the following in the build:

```
ThisBuild / useSuperShell := false
```
or run sbt with `--supershell=false` (or `-Dsbt.supershell=false`). This feature was added by Eugene Yokota ([@eed3si9n]) as #4396/util#196.

Tracing

To view the task breakdown visually, run sbt with `--traces` (or `-Dsbt.traces=true`). This will generate `build.traces` file, which is viewable using Chrome Tracing `chrome://tracing/`. This feature was contributed by Jason Zaugg ([@retronym]).

To output the task timings on screen, run sbt with `--timings` (or `-Dsbt.task.timings=true -Dsbt.task.timings.on.shutdown=true`).

SemanticDB support

sbt 1.3.0 makes it easier to generate [SemanticDB][SemanticDB]. To enable the generation of SemanticDB build-wide:

```
ThisBuild / semanticdbEnabled := true
ThisBuild / semanticdbVersion := "4.1.9"
ThisBuild / semanticdbIncludeInJar := false
```
This was added by [@eed3si9n] as #4410.

print command

sbt 1.3.0 adds a new `print` command, similar to `show` but prints directly to standard out.

```
# sbt -no-colors --error "print akka-cluster/scalaVersion"
2.12.8
```
This was contributed by David Knapp ([@Falmarri]) as #4341

Appending Function1

Function1 can be appended using `+=`. 
Global / onLoad += { s =>
  doSomething()
  s
}

This was contributed by Dale Wijnand ([@dwijnand](@dwijnand)) as #4521.

**JDK 11 support**

sbt 1.3.0 is first release of sbt that’s been testing on JDK11 extensively. All integration tests on Travis CI are on AdoptOpenJDK’s JDK 11, which were updated by [@eed3si9n](@eed3si9n) as #4389/zinc#639/zinc640.

- Fixes warnings on JDK 9+ by upgrading to protobuf 3.7.0 zinc#644 by [@smarter](@smarter)
- Fixes spurious rebuilds caused by invalidation of rt.jar on JDK 11 #4679 by [@eatkins](@eatkins)

**Other bug fixes and improvements**

- Fixes cross building with a single-letter alias #4355 / #1074 by [@eed3si9n](@eed3si9n)
- Removes old warning about global directory #4356 / #1054 by [@raboof](@raboof)
- Improves JDK discovery for cross-JDK forking #4313 / #4462 by [@raboof](@raboof)
- Expands ~ in `-Dsbt.global.base` property to user home. #4367 by [@kai-chi](@kai-chi)
- Adds `def sequential[A](tasks: Seq[Initialize[Task[A]]]): Initialize[Task[A]].` #4369 by [@3tty0n](@3tty0n)
- Fixes sbt server to send error event on command failure. #4378 by [@andreaTP](@andreaTP)
- Implements cancellation of request by LSP client. #4384 by [@andreaTP](@andreaTP)
- Implements "sbt/completion" command in sbt to server to complete sbt commands. #4397 by [@andreaTP](@andreaTP)
- Fixes errors order reported by sbt server. #4497 by [@tdroxler](@tdroxler)
- Fixes cached resolution. #4424 by [@eed3si9n](@eed3si9n)
- The sbt task definition linter warns rather than errors by default. The linter can be disabled entirely by putting `import sbt.del.LinterLevel.Ignore` in scope. #4485 by [@eatkins](@eatkins)
- Full GC is only automatically triggered when sbt has been idle for at least a minute and is only run at most once between shell commands. This improves shell responsiveness. #4544 by [@eatkins](@eatkins)
- Avoids NPE in JDK12. #4549 by [@retronym](@retronym)
- Fixes the eviction warning summary lm#288 by [@bigwheel](@bigwheel)
• Fixes Zinc’s flag to skip the persistence of API info. zinc#399 by [@romanowski][@romanowski]
• Fixes Zinc not detecting synthetic top level member changes. #4316/zinc#572 by [@jvican][@jvican]
• Zinc to notify callback of generated non-local classes before the compiler’s middle and backend phases. zinc#582 by [@jvican][@jvican]
• Removes a use of regex in Zinc for performance. zinc#583 by [@retronym][@retronym]
• Fixes incremental compilation involving default arguments. zinc#591 by [@jvican][@jvican]
• Adds Analysis callback of Zinc thread-safe. zinc#626 by [@dotta][@dotta]
• Fixes a non-zero exit Javadoc not failing the task. zinc#625 by [@raboof][@raboof]

Participation

First, I’d like to introduce Ethan Atkins, a core community member of sbt project, and author of Close Watch that uses native code to provide watch service on macOS. Normally I don’t publicize the number of commits, but here’s the top 10 for sbt 1.3.0:

541 Ethan Atkins
369 Eugene Yokota (eed3si9n)
42 Jorge Vicente Cantero (jvican)
35 Łukasz Wawrzyk
34 Dale Wijnand
24 Andrea Peruffo
16 Kenji Yoshida (xuwei-k)
13 Guillaume Martres
7 Arnout Engelen
7 Jason Zaugg

As a community member, Ethan has contributed various IO related improvements to make sbt more responsive in his own time. sbt 1.3.0 reflects many of his ideas.

The last feature release of sbt 1 was sbt 1.2.0 in July, 2018. Since then, we’ve released eight patch releases under sbt 1.2.x for bug fixes, but most of the feature enhancements were merged to develop branch. Over the course of these months, 45 contributors participated in sbt 1.3.0 and Zinc: Ethan Atkins, Eugene Yokota (eed3si9n), Jorge Vicente Cantero (jvican), Łukasz Wawrzyk, Dale Wijnand, Andrea Peruffo, Kenji Yoshida (xuwei-k), Guillaume Martres, Arnout Engelen, Jason Zaugg, Krzysztof Romanowski, Antonio Cunei, Mirco Dotta, OlegYch, Alex Dupre, Nepomuk Seiler, 0lejk4, Alexandre Archambault, Eric Peters, Kazuhiro Sera, Philippus, Som Snytt, Syed Akber Jafri, Thomas Droxler, Veera Venky, bigwheel, Akhtyam Sakaev, Alexey Vakhrenev, Eugene Platonov, Helena Edelson, Ignasi Marimon-Clos, Julien Sirocchi, Justin Kaeser,
Kajetan Maliszewski, Leonard Ehrenfried, Mikołaj Jakubowski, Nafer Sanabria, Stefan Wachter, Yasuhiro Tatsumo, Yusuke Izawa, falmarri, ilya, kai-chi, tanishiking, Ólafur Páll Geirsson. Thank you!

[@eed3si9n]: https://github.com/eed3si9n[@eatkins]: https://github.com/eatkins
[@dwijnand]: https://github.com/dwijnand [@cunei]: https://github.com/cunei
[@Falmarri]: https://github.com/Falmarri [@raboof]: https://github.com/raboof
[@3tty0n]: https://github.com/3tty0n [@[andreaTP]:https://github.com/andreaTP
[@tdroxler]: https://github.com/tdroxler [@[leonardehrenfried]: https://github.com/leonardehrenfried
[@jvican]: https://github.com/jvican [@[dotta]: https://github.com/dotta

sbt 1.2.x releases

sbt 1.2.1

Forward bincompat breakage

If you are writing a plugin, please use 1.2.1+, and avoid 1.2.0.

We unintentionally broke forward binary compatibility in 1.2.0. If someone publishes an sbt plugin using sbt 1.2.0, it cannot be used from sbt 1.0.x or 1.1.x. sbt 1.2.1 reverts the change, so the forward compatibility is restored. Unfortunately, this means we won’t be able to use varargs in inThisBuild(...) etc again.

Note that we might eventually break forward compatibility, like we did in 0.13.5 for AutoPlugin, but only when the tradeoff is worth it.

The project Foo references an unknown configuration “bar”

Second regression fix is for the wall of warnings you might have seen in 1.2.0 that looks as follows:

[warn] The project ProjectRef(uri("file:/Users/xxx/work/akka/"), "akka-actor-typed") references an unknown configuration “multi-jvm” and was guessed to be “Multi-jvm”.
[warn] This configuration should be explicitly added to the project.
[warn] The project ProjectRef(uri("file:/Users/xxx/work/akka/"), "akka-actor-typed-tests") references an unknown configuration “multi-jvm” and was guessed to be “Multi-jvm”.
[warn] This configuration should be explicitly added to the project.

The original issue was that unified slash syntax doesn’t pick the configuration names when the configuration is not part of the subproject. Since this warning is immaterial, we are removing them in this patch release.

One thing the plugin authors can start doing is declaring the custom configuration as hidden, and adding them into the subprojects as follows:

146
import sbt._
import sbt.Keys._

object ParadoxPlugin extends AutoPlugin {
  val ParadoxTheme = config("paradox-theme").hide
  override def projectConfigurations: Seq[Configuration] = Seq(ParadoxTheme)
}

We are also looking into improving unified slash syntax parser to make it more robust.

Other bug fixes

- Updates `IO.relativize` for JDK 9. io#175 by [@eatkins][@eatkins]
- Fixes logic for adding external class file manager. zinc#562 by [@allanrenucci][@allanrenucci]

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.

sbt 1.2.1 was brought to you by 4 contributors, according to `git shortlog -snn --no-merges v1.2.1...v1.2.0` on sbt, zinc, librarymanagement, util, io, launcher-package, and website: Eugene Yokota, Aaron S. Hawley, Ethan Atkins, and Allan Renucci. Thanks! Also special thanks to Ches Martin and Yoshidasan for reporting these issues.

[@eed3si9n]: https://github.com/eed3si9n
[@dwijnand]: https://github.com/dwijnand
[@cunei]: https://github.com/cunei
[@eatkins]: https://github.com/eatkins
[@allanrenucci]: https://github.com/allanrenucci

sbt 1.2.0

**Warning**: We found forward compatibility breakage in 1.2.0, so we recommend everyone to upgrade to sbt 1.2.1 or later.

The headline features of sbt 1.2 are cross JDK forking, composite project, and experimental thin clients. But, there are lots of other bug fixes and enhancements that we’ve been accumulating for six months since sbt 1.1.
SbtPlugin for plugin development

SbtPlugin is a plugin to declare a project for sbt plugins. This automatically brings in scripted tests, and sets `sbtPlugin := true`.

```scala
lazy val root = (project in file("."))
  .enablePlugins(SbtPlugin)
```

**Compatibility note:** ScriptedPlugin is no longer a triggered plugin.

#3875 by [@eed3si9n][@eed3si9n]

Cross JDK forking

For forked `run` and `test`, java++ can now switch Java Home.

```
sbt:helloworld> run
[info] Running (fork) Hello
[info] 1.8.0_171
sbt:helloworld> java++ 10!
[info] Reapplying settings...
sbt:helloworld> run
[info] Running (fork) Hello
[info] 10.0.1
```

sbt will try to detect Java homes into `discoveredJavaHomes` setting, supporting shyiko/jabba. This can be augmented by `Global / javaHomes`:

```
Global / javaHomes += "6" -> file("/something/java-6")
```

This feature is intended for testing your library in an older JVM to check compatibility.

#4139 by [@2m][@2m], [@cunei][@cunei], and [@eed3si9n][@eed3si9n]

**scalaVersion-filtered aggregation**

In 2015 James Roper contributed scalaVersion-filtered aggregation to sbt-doge. This feature is brought back into sbt 1.2 by Rui Gonçalves ([@ruippeixotog][@ruippeixotog]) in #3698/#3995!

This extends switch command `++` to take an optional `<command>`:

```
> ++2.12.7 compile
```

This will aggregate only the subproject where `++2.12.7` is valid, which is useful when you have a build where some subprojects are 2.11 only etc.
**Composite project**

sbt 1.2.0 introduces “composite project” trait, which allows plugin authors to generate subprojects, for example for cross building.

```scala
trait CompositeProject {
  def componentProjects: Seq[Project]
}
```

This was contributed by [@BennyHill](https://twitter.com/BennyHill) as #4056.

**Project matrix**

Experimental. As a reference implementation of the `CompositeProject` I implemented a new DSL called `projectMatrix` introduced by sbt-projectmatrix plugin.

```scala
lazy val core = (projectMatrix in file("core"))
  .scalaVersions("2.12.7", "2.11.12")
  .settings{
    name := "core"
  }
  .jvmPlatform()

lazy val app = (projectMatrix in file("app"))
  .dependsOn(core)
  .scalaVersions("2.12.7")
  .settings{
    name := "app"
  }
  .jvmPlatform()
```

The aim of the plugin is to support a generic notion of cross building (Scala version, platform, etc) expressed using subprojects. In the above `projectMatrix` will produce three subprojects: `coreJVM2_12`, `coreJVM2_11`, and `appJVM2_12`.

**Semantic Version selector API**

sbt 1.2.0 introduces Semantic Version selector on `VersionNumber()` datatype supporting basic match, comparison (`<=`, `<`, `>=`, `>`,), combination (`>1.0.0 <2.0.0`, `||`), ranges (`A.B.C - D.E.F`), and wildcard (`2.12.x`).

```scala
import sbt.librarymanagement.{ VersionNumber, SemanticSelector }
import sbt.librarymanagement.{VersionNumber, SemanticSelector}

scala> VersionNumber("2.12.5").matchesSemVer(SemanticSelector(">=2.12"))
res1: Boolean = true
```
scala> VersionNumber("2.12.5").matchesSemVer(SemanticSelector("<2.12"))
res2: Boolean = false

scala> VersionNumber("2.13.0-M4").matchesSemVer(SemanticSelector("2.13"))
res3: Boolean = false

scala> VersionNumber("2.12.5").matchesSemVer(SemanticSelector("2.12.1 ~ 2.12.7"))
res4: Boolean = true

scala> VersionNumber("2.12.5").matchesSemVer(SemanticSelector("2.12.x"))
res5: Boolean = true

scala> VersionNumber("2.12.5").matchesSemVer(SemanticSelector("2.11.x || 2.12.x"))
res6: Boolean = true

Note: This has no effect on library management at the moment.

This was contributed by Rikito Taniguchi ([@tanishiking][@tanishiking]) as lm#239.

**addPluginSbtFile command**

There’s been a request from IntelliJ to safely inject a plugin to a build. sbt 1.2.0 adds `-addPluginSbtFile` command to do so.

$ cat /tmp/extra.sbt
addSbtPlugin("com.eed3si9n" % "sbt-assembly" % "0.14.7")

$ sbt -addPluginSbtFile=/tmp/extra.sbt
...
...sbt:helloworld> plugins
In file:/xxxx/hellotest/
...sbtassembly.AssemblyPlugin: enabled in root

Implmented by [@eed3si9n][@eed3si9n] as #4211.

**Extensible sbt server**

Experimental. sbt server can now be extended via the plugin.

```scala
Global / serverHandlers += ServerHandler{
  callback =>
    import callback._
    import sjsonnew.BasicJsonProtocol._
    import sbt.internal.protocol.JsonRpcRequestMessage
    ServerIntent{
      case r: JsonRpcRequestMessage if r.method == "lunar/helo" =>
```
This feature is still experimental and the API may change in the future.

#3975 by [@eed3si9n]@eed3si9n

### Thin client(s)

**Experimental.** sbt 1.2.0 adds a new mode called `-client`. When sbt is started with `-client` command, it no longer loads the build, and instead tries to connect to an instance of sbt server over JSON-RPC. When the server is not running (portfile is not found), it will fork a new instance of sbt entirely in a new JVM.

This lets you invoke `sbt` from the terminal shell or from an editor.

```
$ time sbt -client clean
[info] entering *experimental* thin client - BEEP WHIRR
[info] server was not detected. starting an instance
[info] waiting for the server...
[info] waiting for the server...
[info] waiting for the server...
[info] waiting for the server...
[info] server found
> clean
[success] completed
sbt -client clean  9.23s user 2.33s system 22% cpu 50.558 total
```

# server stays

```
$ ps | rg java
21860 ttys015 1:22.43 java -Xms2048M -Xmx2048M -Xss2M -jar /usr/local/Cellar/sbt/1.1.6/libexec/bin/sbt-launch.jar
22014 ttys015 0:00.00 rg java
```

```
$ time sbt -client clean
[info] entering *experimental* thin client - BEEP WHIRR
> clean
[info] Updating ...
[info] Done updating.
[success] completed
sbt -client clean  3.39s user 1.75s system 104% cpu 4.898 total
```

To end the server, call `sbt -client shutdown`. #4227 by [@eed3si9n]@eed3si9n

In addition, there are also an alternative thin clients cb372/sbt-client and dwijnand/sblt implemented using Rust.
Changes with compatibility implication

- Removes deprecated commands -, --, and ---. Use onFailure, sbtClearOnFailure, and resumeFromFailure instead. #4124
- Makes ++ fail when it doesn’t affect any subprojects #4269 by [@eed3si9n]

Other bug fixes and improvements

- Fixes output caching bug. util#169 by [@bpholt]
- Fixes “destination file exists” error message. lm#255 by [@eed3si9n]
- Reintroduces Command.process(String, State): State. #4023 by [@dwijnand]
- Fixes active.json not getting removed on JVM shutdown. #4194 by [@veera83372]
- Fixes file permission error (“CreateFile() failed”) while reading the timestamp on Windows. io#134 by [@cunei]
- Fixes the linter that detects missing .value. #4090 by [@eed3si9n]
- Fixes StringIndexOutOfBoundsException in removeEscapeSequences. util#139 by [@dwijnand]
- Fixes OkHttp’s JavaNetAuthenticator with a null check. lm#177 by [@eed3si9n]
- Fixes Sonatype timeout issue by extending the default timeout to 1h. lm#246 by [@peterneyens]
- Fixes thread thrashing error during the parallel download. lm249 by [@OlegYch]
- Fixes JavaDoc warnings logged as errors. zinc#506 by [@kaygorodov]
- Fixes class dependency not picking up classOf[A]. zinc#510 by [@natanasil]
- Fixes class dependency including non-existing objects. zinc422 by [@romanowski]
- Fixes link to the documentation of deprecated 0.10/0.12 DSL syntax. #3901 by [@colindean]
- Fixes the documentation of skip key. #3926 by [@dkim]
- Fixes race condition in non-forked parallel tests. #3985 by [@retronym]
- Fixes Ctrl-C handing in forked tests when Global / cancelable is set to true. #4226 by [@driquelme]
- Fixes the stacktrace of `run`. #4232 by [@eed3si9n]
- Bumps the version of Giter8 used by `sbt new` to 0.11.0, fixing various issues #4263 by [@eed3si9n]
- Improves Javac error parsing. zinc #557 by [@eed3si9n]
- Displays only the eviction warning summary by default, and make it configurable using `ThisBuild / evictionWarningOptions`. lm211 and #3947 by [@exoego]
- Allow `varargs` in `inThisBuild(...)`, `inConfig(C)(...)`, `inTask(t)(...)`, `inScope(scope)(...)`. #4106 by [@dwijnand]
- Adds `fgRun` and `fgRunMain` tasks that behaves like `sbt 0.13`’s `run`. #4216 by [@agaro1121]
- Supports `test.script` and `pending.script` as the scripted file name. #4220 by [@regadas]
- Supports aliases in `inspect` command. #4221 by [@gpoirier]
- Adds the current project’s id to `~`’s watching message. #2038 / #3813 by [@dwijnand]
- Changes `PathFinder#get` to `get()`. io #104 by [@dwijnand]
- Improves the error message when access is denied. lm #203 by [@stephennancekivell]
- Improve the warning message “Choosing local” to something more actionable. lm #248 by [@khvatov]
- Adds an option to ignore scalac options change. zinc #548 by [@lukaszwawrzyk]
- Enable parallel execution of scripted in the plugin. #3891 by [@jvican]
- Adds factory methods for Configuration axis scope filters `inConfigurationsByKeys` and `inConfigurationsByRefs`. #3994
- Adds `lastGrep`, `loadFailed`, etc commands to replace the kebab-cased commands. #4080 by [@naferx], #4159 by [@Asamsig], and #4169 by [@tiqwab]
- Adds timestamp field to `JUnitXML` report. 4154 by [@timcharper]
- “Loading settings” log messages now show subproject name. #4164 by [@alodavi]
- `about` command sorts and indents plugins list. #4187 by [@mcanlas]
- `-Dsbt.offline` sets `offline` setting. #4198 by [@eed3si9n]
• Selects most recent JDK during cross JDK forking (see below for details)
  #4245 by [@raboof]@[raboof]

Internal

• Removes some compiler warnings. #3087 by [@dwijnand]@[dwijnand]
• Lots of other refactorings by [@dwijnand]@[dwijnand]
• Removes some compiler warnings in Zinc. zinc#493 by [@exoego]@[exoego]
• Perf: Prevents creation of useless URI copies in IO.directoryURI. io#132
  by [@jrudolph]@[jrudolph]
• Perf: Avoids reflect universe initialization in initStringCodecs. util#153
  by [@jrudolph]@[jrudolph]
• Perf: Speeds up Parsers.validID. #3952 by [@jrudolph]@[jrudolph]
• Perf: Optimizes scope delegation by hand rolling for comprehension.
  #4003 by [@jrudolph]@[jrudolph] and [@eed3si9n]@[eed3si9n]
• Use val instead of var in an internal code. #4253 by [@xuwei-k]@[xuwei-k]

Contributors

Thanks again to everyone who’s helped improve sbt and Zinc 1.

sbt 1.2.0 was brought to you by 60 contributors. Dale Wijnand, Eugene Yokota,
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[@khvatov]: https://github.com/khvatov
sbt 1.1.x releases

sbt 1.1.6

Bug fixes

- Fixes file watching for Unix/Linux. io#150 by [@eatkins](@eatkins)
- Fixes packageBin not creating file when deleted. sbt/sbt#4161 by [@dadarakt](@dadarakt)
- Fixes help -v rendering of multi-line descriptions. #4160 by [@ninjalama](@ninjalama)
- Fixes -error etc to set log level. #4162 by [@holdenk](@holdenk)
- Handles managedSources writing into unmanaged source directories. #4099 by [@eatkins](@eatkins)
- Fixes handling of overflows in EventMonitor. io#155 by [@eatkins](@eatkins)
- Recovers “Resolving…” log under UpdateLogging.Full. lm#240 by [@hodga](@hodga)
- Fixes -Dconfig.resource=/path/to/configFile conflicting with Gigahorse. lm#241 by [@tanishiking](@tanishiking)
- Removes use of deprecated ModifiedTime methods. io#154 by [@dwestheide](@dwestheide)
- Fixes tests on Windows. io#153 by [@OlegYch](@OlegYch)

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.

sbt 1.1.6 was brought to you by 15 contributors, according to git shortlog -sn --no-merges v1.1.5...v1.1.6 on sbt, zinc, librarymanagement, util, io, launcher-package, and website: Ethan Atkins, Eugene Yokota, Dale Wijnand,
sbt 1.1.5

Bug fixes

- Fixes the latency between file modification events and triggered execution. [io#142][4096] by [eatkins][eatkins]
- Fixes NPE that could arise from WatchEvent [io#140] by [oneill][oneill]
- Fixes deleted files not triggering `~`. [sbt#4098][4098] by [eatkins][eatkins]
- Fixes MacOSWatchService to meet the WatchService API. [io#142][4096] by [eatkins][eatkins]
- Avoids printing `RejectedExecutionException` stack trace after cancellation. [sbt#4058][4058] by [retronym][retronym]
- Fixes Java version checking on Windows. [lp#227][lp227] / [lp#228][lp228] by [jessicah][jessicah] and [spangaer][spangaer]
- Fixes unexpected responses from sbt server. [sbt#4093][4093] by [laughedelic][laughedelic]
- Re-fix console and JLine bug. [sbt#4123][4123] by [eed3si9n][eed3si9n]
- Fixes grammar for contributors guide. [sbt#4133][4133] by [som-snytt][som-snytt]

Improvements

- Performance optimization for Zinc. [zinc#492][zinc492] by [retronym][retronym]
- Adds support for detecting Dotty compiler plugins. [zinc#529][zinc529] by [liufengyun][liufengyun]
- Bumps Scala to 2.12.6. [sbt#4129][4129] by [SethTisue][SethTisue]
- Updates to JLine 2.14.6. [sbt#4087][4087] by [hvesalai][hvesalai]
- Start sbt in VS Code terminal window. See below.
Watcher improvements

Continuing from sbt 1.1.4, Ethan Atkins contributed fixes and improvements for triggered execution - watcher. sbt 1.1.5 should fix the latency between file modification events and the command execution.

VS Code extension update

We released a new sbt VS Code extension that starts sbt session in the embedded terminal window. This was contributed by Robert Walker (@WalkingOlof) in sbt#4130.

sbt by example

We added [sbt by example][by-example] to the sbt documentation. This is a single-page guide that takes you from zero to building an app on Docker, inspired by, and largely based on William Narmonatas (@ScalaWilliam)'s Essential sbt.

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.

sbt 1.1.5 was brought to you by 21 contributors, according to git shortlog -sn --no-merges v1.1.4...v1.1.5 on sbt, zinc, librarymanagement, util, io, launcher-package, and website: Eugene Yokota, Ethan Atkins, Jason Zaugg, Liu Fengyun, Antonio Cunei, Dale Wijnand, Roberto Bouvallet, Alexey Alekhin, Daniel Parks, Heikki Vesalainen, Jean-Luc Deprez, Jessica Hamilton, Kenji Yoshida (xuwei-k), Nikita Gazarov, OlegYch, Richard Summerhayes, Robert Walker, Seth Tisue, Som Snytt, oneill, and (Yang Bo)

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[4087]: https://github.com/sbt/sbt/pull/4087 [4093]: https://github.com/sbt/pull/4093

157
sbt 1.1.4

Bug fixes

- Fixes triggered execution on macOS. See below for details.
- Fixes running `console` twice messing up JLine. [#3482]/[#4054] by [@eed3si9n]
- Fixes `updateSbtClassifiers`. [#4070]/[#3432] by [@steinybot]
- Fixes Java error message handling. [zinc#524]/[zinc#525]/[zinc525] by [@retronym]/[@retronym] and [@dwijnand]/[@dwijnand]
- Fixes the error message linking to the migration guide. [#4063] by [@dwijnand]/[@dwijnand]
- Fixes batch script so sbt runs on JDK 10 on Windows. [lp#225]/[lp225] by [@eed3si9n]/[@eed3si9n]
- Fixes bash script so `sbt -debug` changes log level to debug. [lp#226]/[lp226] by [@eed3si9n]/[@eed3si9n]

Improvements

- Exposes `sbt.io.JavaMilli`. [io#139]/[io139] by [@dwijnand]/[@dwijnand]
- Adds `-sbt.launcher.cp.prepend` JVM flag that is used for monkey patching sbt. [launcher#50]/[launcher50] by [@fommil]/[@fommil]

Triggered execution on macOS

sbt has long had issues with triggered execution on macOS. Ethan Atkins has contributed a fix for this problem by merging MacOSXWatchService from his [CloseWatch]/[closewatch]. Thanks, Ethan!

Credit also goes to Greg Methvin and Takari's directory-watcher. [#3860]/[3860]/[#4071]/[4071]/[io#138]/[io138] by [@eatkins]/[@eatkins]

Running sbt with standby

One of the tricky things you come across while profiling is figuring out the process ID, while wanting to profile the beginning of the application.
For this purpose, we’ve added `sbt.launcher.standby` JVM flag. Starting sbt 1.1.4, you can run:

```
$ sbt -J-Dsbt.launcher.standby=20s exit
```

This will count down for 20s before doing anything else. [launcher51]

**Loading performance improvement**

Using Flame graph (if you haven’t yet, check out Profiling JVM applications post), Jason Zaugg identified hashing code of the build file to be one of the hot paths during sbt startup. Flame graph supports Ctrl+F to filter on method names; and when I ran it, it showed 4.5% of the time was spent in `Eval#evalCommon` method.

Instead of creating an intermediate `Array[Byte]` and passing it to `MessageDigest` at the end, Jason suggested that we pass the arrays to `MessageDigest#update` in a more procedural style. After confirming that it worked, we’ve next identified file timestamp code to be the next bottle neck using Flame graph, so that was switched to using NIO. After both changes, `Eval#evalCommon`’s footprint reduced to 2.3%.

This means that your build loads slightly faster on sbt 1.1.4 (about 0.54s faster on akka/akka, for example). [#4067] by [@eed3si9n]

**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.

sbt 1.1.4 was brought to you by 11 contributors, according to `git shortlog -sn --no-merges v1.1.2...v1.1.4` on sbt, zinc, librarymanagement, util, io, launcher-package, and website: Eugene Yokota, Dale Wijnand, (Yang Bo), Ethan Atkins, Sam Halliday, Aaron S. Hawley, Gabriele Petronella, Jason Steenstra-Pickens, Jason Zaugg, Julien Jean Paul Sirocchi, and aumann.

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[io138]: https://github.com/sbt/io/pull/138
[io139]: https://github.com/sbt/io/pull/139
[3860]: https://github.com/sbt/sbt/issues/3860
[4071]: https://github.com/sbt/sbt/pull/4071
[zinc524]: https://github.com/sbt/zinc/pull/524
[zinc525]: https://github.com/sbt/zinc/pull/525
[4054]: https://github.com/sbt/sbt/pull/4054
[3482]: https://github.com/sbt/sbt/issues/3482
sbt 1.1.2

Bug fixes

- Fixes triggered execution’s resource leak by caching the watch service. [3999] by @eatkins
- Fixes class loader inheriting the dependencies of Scala compiler during run [zinc505] by @eed3si9n
- Fixes forked test concurrency issue. [4030] by @eatkins
- Fixes new command leaving behind target directory [4033] by @eed3si9n
- Fixes handling on null Content-Type. [lm214] by @staale
- Fixes null handling of managedChecksums in ivySettings file. [lm218] by @IanGaber
- Adds sbt.boot.lock as a JVM property to opt-out of locking. [3927] by @dwijnand
- Provides SBT_GLOBAL_SERVER_DIR env var as a workaround to long socket file path on UNIX. [3932] by @dwijnand
- Fixes forked runs reporting noisy “Stream closed” exception. [3970] by @retronym
- Fixes test compilation not getting included in VS Code save trigger. [4022] by @tiqwab
- Fixes sbt server responding with string id when number id passed. [4025] by @tiqwab
- Fixes getDecoder in Analysis format [zinc502] by @jilen
- Fixes equal / hashCode inconsistencies around Array. [zinc513] by @eed3si9n
- Whitelists java9-rt-ext-output in rt export process [lp211] by @eatkins
- Fixes JDK version detection for Java 10 friendliness. [lp219] by @eed3si9n and @2m
- Fixes quoting in Windows bat file. [lp220] by @ForNeVeR
- Fixes -error not suppressing startup logs. [4036] by @eed3si9n

Improvements
• Performance optimization around logging. [util#152][util152] by [@retronym][@retronym]
• Performance fix by caching the hashCode of Configuration. [lm#213][lm213] by [@retronym][@retronym]
• Returns error code -33000L on sbt server when a command fails. [#3991][3991] by [@dwijnand][@dwijnand]
• Allows wildcards in organization and artifact. [#215][lm215] by [@dhs3000][@dhs3000]
• Updates to latest Jsch to support stronger key exchange algorithms. [lm#217][lm217] by [@ryandbair][@ryandbair]
• Fixes preloading of compiler bridge. [lp#222][lp222] by [@analytically][@analytically]

Internal

• Updates [contribution guide][CONTRIBUTING]. [#3960][3960]/[#4019][4019] by [@eed3si9n][eed3si9n] and [@itohiro73][itohiro73]
• Deletes buildinfo.BuildInfo from sbt main that was intended for testing. [3967][3967] by [@dwijnand][@dwijnand] and [@xuwei-k][@xuwei-k]
• Various improvements around Zinc benchmark by [@retronym][@retronym]

Contributors

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[3932]: https://github.com/sbt/sbt/pull/3932
[3933]: https://github.com/sbt/sbt/pull/3933
[3960]: https://github.com/sbt/sbt/pull/3960
[3967]: https://github.com/sbt/sbt/pull/3967
[3999]: https://github.com/sbt/sbt/pull/3999
[4019]: https://github.com/sbt/sbt/pull/4019
[4022]: https://github.com/sbt/sbt/pull/4022

161
sbt 1.1.1

Bug fixes

- Fixes “Modified names for (class) is empty” error. *[#zinc292][zinc292] / [zinc484][zinc484] by [@jvican][jvican] (Scala Center)*
- Fixes tab completion in `console` while running in batch mode as `sbt console`. * [#3841][3841]/[#3876][3876] by [@eed3si9n][eed3si9n]*
- Fixes file timestamp retrieval of missing files on Windows. * [#3871][3871] / [io120][io120] by [@cunei][cunei]*
- Aligns the errors thrown by file timestamp implementations. Fixes * [#3894][3894] / [io121][io121] by [@j-keck][j-keck]*
- Adds file timestamps native support for FreeBSD. * [#3894][3894] / [io124][io124] by [@cunei][cunei]*
- Fixes JDK 10 version string parsing. * [sbt-launcher-package#209][launch209] by [@2m][2m]*

Improvements

- Deprecates `Extracted#append` in favour of `appendWithSession` or `appendWithoutSession`. * [#3865][3865] by [@dwijnand][dwijnand]*
- Adds a new global Boolean setting called `autoStartServer`. See below.
- Upgrades Scala versions used for sbt cross building `^`. * [#3923][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, Anthony 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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[3871]: https://github.com/sbt/sbt/issues/3871
[io120]: https://github.com/sbt/io/pull/120
[3894]: https://github.com/sbt/sbt/issues/3894
[io121]: https://github.com/sbt/io/pull/121
[io124]: https://github.com/sbt/io/pull/124
[zinc292]: https://github.com/sbt/zinc/issues/292
[zinc484]: https://github.com/sbt/zinc/pull/484
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[3876]: https://github.com/sbt/sbt/pull/3876
[3923]: https://github.com/sbt/sbt/pull/3923
[3922]: https://github.com/sbt/sbt/pull/3922
[launcher209]: https://github.com/sbt-launcher-package/pull/209

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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]
- Fixes Java compilation causing NullPointerException by making PositionImpl thread-safe. zinc#465 by [@eed3si9n]
- Fixes PollingWatchService by preventing concurrent modification of keysWithEvents map. io#90 by [@mechkg]
- Provides workaround for File#lastModified() losing millisecond-precision by using native code when possible. io#92/io#106 by [@cunei]
- Fixes I0.relativize not working with relative path. io#108 by [@dwijnand]
- Fixes warning message when multiple instances are detected. #3828 by [@eed3si9n]
- Fixes over-compilation bug with Java 9. zinc#450/zinc450 by [@retronym]
- Fixes handling of deeply nested Java classes. zinc#423/zinc423 by [@romanowski]
- Fixes JavaDoc not printing all errors. zinc#415/zinc415 by [@raboof]
- Preserves JAR order in ScalaInstance.otherJars. zinc#411/zinc411 by [@dwijnand]
- Fixes used name when it contains NL. zinc#449/zinc449 by [@jilen]
- Fixes handling of ThisProject. #3609/3609 by [@dwijnand]
- Escapes imports from sbt files, so if user creates a backquoted definition then task evaluation will not fail. #3635/3635 by [@panaeon]
- Removes reference to version 0.14.0 from a warning message. #3693/3693 by [@saniyatech]
- Fixes scripl throwing “Not a valid key: console-quick”. #3762/3762 by [@xuwei-k]
- Restores Scala 2.13.0-M1 support. #461 by [@dwijnand]
- Fixes the encoding of Unix-like file path to use file://. #3805 by [@eed3si9n]
- Fixes Log4J2 initialization error during startup. #3814 by [@dwijnand]

Improvements

- Filters scripted tests based on optional project/build.properties. See below.
- Adds Project#withId to change a project’s id. [#3601]3601 by [@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][3659] by [@eed3si9n][eed3si9n]

• Adds a check for a change in sbt version before `reload`. [#1055][1055]/[#3673][3673] by [@RomanIakovlev][RomanIakovlev]

• Adds a new setting `insideCI`, which indicates that sbt is likely running in a Continuous Integration environment. [#3672][3672] by [@RomanIakovlev][RomanIakovlev]

• Adds `nameOption` to `Command` trait. [#3671][3671] by [@miklos-martin][miklos-martin]

• Adds POSIX permission operations in IO, such as `IO.chmod(..)`. [#76][76] by [@eed3si9n][eed3si9n]

• Treat sbt 1 modules using Semantic Versioning in the eviction warning. [#188][188] by [@eed3si9n][eed3si9n]

• Uses `kind-projector` in the code. [#3650][3650] by [@dwijnand][dwijnand]

• Make `displayOnly` etc methods strict in `Completions`. [#3763][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:

```
```

```
[#1812][1812]/[#3434][3434]/[#3617][3617]/[#3620][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:

```json
{"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` (Ctrl-V then Return):

```bash
$ nc -U /Users/foo/.sbt/1.0/server/0845deda85cb41abcdef/sock
```

Content-Length: 99

```json
{ "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 accepts input from the network. Here's how we can call `compile`:

```bash
$ nc -U /Users/foo/.sbt/1.0/server/0845deda85cb41abcdef/sock
```

Content-Length: 93

```json
{ "jsonrpc": "2.0", "id": 2, "method": "sbt/exec", "params": { "commandLine": "compile" } }
```

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

```json
{"jsonrpc":"2.0","method":"textDocument/publishDiagnostics","params":{"uri":"file:/Users/foo/work/hellotest/Hello.scala","... X is not a member of package foo"}]
```

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.
- Display compiler errors.
- Display log messages.
- Jump to class definitions.

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][3564]/[#3566][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, Wieslaw Popielski, Age Mooij, Allan Timothy Leong, Ivan Poliakov, Jason Zaug, Jilen Zhang, Long Jinwei, Martin Duhem, Michael Stringer, Michael Wizner, Nud Teeraworamongkol, OlegYch, PanAeon, Philippus Baalman, Pierre Dal-Pra, Rafal Wojdyła, Saniya Tech, Tom Walford, and many others who contributed ideas. Thank you!

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167
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][zinc444] by [@smarter][@smarter]
- Fixes ArrayIndexOutOfBoundsException on Ivy when running on Java 9. [ivy#27][ivy27] by [@xuwei-k][@xuwei-k]
- Fixes Java 9 warning by upgrading to launcher 1.0.2. [ivy#26][ivy26]/[launcher#45][launcher45] by [@dwijnand][@dwijnand]
- Fixes -jvm-debug on Java 9. [launcher-package197][sbt-launcher-package197] by [@mkurz][@mkurz]
- Fixes run outputting debug level logs. [#3655][3655]/[#3717][3717] by [@cunei][@cunei]
- Fixes performance regression caused by classpath hashing. [zinc#452][zinc452] by [@jvican][@jvican], [@fommil][@fommil] provided reproduction, and [@ecd3si9n][ecd3si9n] fixed https://github.com/sbt/zinc/issues/457
- Fixes performance regression of testQuick. [#3680][3680]/[#3720][3720] by [@OlegYch][@OlegYch]
- Disables Ivy log4j caller location calculation for performance regression reported in [#3711][3711]. [util#132][util132] by [@leonardehrenfried][@leonardehrenfried]
- Works around Scala compiler’s templateStats() not being thread-safe. [#3743][3743] by [@cunei][@cunei]
- Fixes “Attempting to overwrite” error message. [lm#174][lm174] by [@dwijnand][@dwijnand]
- Fixes incorrect eviction warning message. [lm#179][lm179] by [@xuwei-k][@xuwei-k]
- Registers Ivy protocol only for http: and https: to be more plugin friendly. [lm183][lm183] by [@tpunder][@tpunder]
- Fixes script issues related to bc by using expr. [launcher-package#199][sbt-launcher-package199] by [@thatfulvioguy][@thatfulvioguy]

Enhancement

- Adds Scala 2.13.0-M2 support. [zinc#453][zinc453] by [@eed3si9n][eed3si9n] and [@jan0sch][@jan0sch]

Internal

- Improves Zinc scripted testing. [zinc#440][zinc440] 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!

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[@fommil]: https://github.com/fommil
[3655]: https://github.com/sbt/sbt/issues/3655
[3717]: https://github.com/sbt/sbt/pull/3717
[ivy26]: https://github.com/sbt/ivy/pull/26
[ivy27]: https://github.com/sbt/ivy/pull/27
[launcher45]: https://github.com/sbt/sbt/issues/3655
[3680]: https://github.com/sbt/sbt/pull/3720
[3743]: https://github.com/sbt/sbt/pull/3711
[util132]: https://github.com/sbt/util/pull/132
[lm174]: https://github.com/sbt/librarymanagement/pull/174
[lm179]: https://github.com/sbt/librarymanagement/pull/179
[lm183]: https://github.com/sbt/librarymanagement/pull/183
[zinc452]: https://github.com/sbt/zinc/pull/452
[zinc444]: https://github.com/sbt/zinc/pull/444
[zinc453]: https://github.com/sbt/zinc/pull/453
[zinc440]: https://github.com/sbt/zinc/pull/440
[sbt-launcher-package197]: https://github.com/sbt/sbt-launcher-package/pull/197
[sbt-launcher-package199]: https://github.com/sbt/sbt-launcher-package/pull/199

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][3501]/[#3634][3634] by [@dwijnand][@dwijnand]
• Fixes undercompilation on inheritance on same source. [zinc#424] by [@eed3si9n]
• Fixes the compilation of package-protected objects. [zinc#431] by [@jvican]
• Workaround for Java returning null for `getGenericParameterTypes`. [zinc#446] by [@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]
• 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]
• Fixes extra / in Ivy style patterns. [lm#170] by [@laughedelic]
• Fixes “destination file exist” error message by including the file name. [lm171] by [@leonardehrenfried]
• Fixes JDK 9 warning “Illegal reflective access” in library management module and Ivy. [lm173] by [@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]

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!

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[lm170]: https://github.com/sbt/librarymanagement/pull/170  [lm171]:
[zinc446]: https://github.com/sbt/zinc/pull/446

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**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][3487] by [@cunei][@cunei]
- Replaces the deprecated use of OkUrlFactory, and fixes connection leaks.  [lm#164][ln164] by [@dpratt][@dpratt]
- Refixes false positive in DSL checker for setting keys. [#3513][3513] by [@dwijnand][@dwijnand]
- Fixes run and bgRun not picking up changes to directories in the classpath.  [#3517][3517] by [@dwijnand][@dwijnand]
- Fixes ++ so it won’t change the value of crossScalaVersion.  [#3495][3495]/[#3526][3526] by [@dwijnand][@dwijnand]
- Fixes sbt server missing some messages.  [#3523][3523] by [@guillaume- bort][@guillaumebort]
- Refixes consoleProject.  [zinc#386][zinc386] 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][lm167] 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][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 Popiełarski. Thank you!

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[3507]: https://github.com/sbt/sbt/pull/3507  [3533]: https://github.com/sbt/sbt/pull/3533
[lm167]: https://github.com/sbt/librarymanagement/pull/167

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 traverse over the subprojects, respecting `crossScalaVersions`;
however, it no longer accepted commands as arguments. This brings back the support for it. #3446 by [@jroper]

- Fixes addSbtPlugin to use the correct version of sbt during cross building. #3442 by [@dwijnand]
- Fixes run in Compile task not including Runtime configuration, by reimplementing run in terms of bgRun. #3477 by [@eed3si9n]
- Shows actual as a potential option of inspect #3335 by [@Duhemm]
- Includes base directory to watched sources. #3439 by [@Duhemm]
- Adds an attempt to workaround intermittent NullPointerException around logging. util#121 by [@eed3si9n]
- Reverts a bad forward porting. #3481 by [@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 compatibility, 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]; #3478 and io#74 by [@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/#2059]/[#2662/#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.


• `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 deprecated:**

• 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`. 

174
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][3198]/[util#80][util80] by [@eed3si9n][eed3si9n]
- Fixes confusing log about “Unable to parse”. [lm#98][lm98] by [@jvican][jvican]
- Fixes `console` task. [zinc#295][zinc295] by [@dwijnand][dwijnand]
- Fixes spurious recompiations when unrelated constructor changes. [zinc#288][zinc288] by [@smarter][smarter]
- Fixes restligieist macro for old operators. [#3218][3218] by [@eed3si9n][eed3si9n]
- Fixes task caching of `update` task. [#3233][3233] by [@eed3si9n][eed3si9n]
- Fixes ncurses-JLine issue by updating to JLine 2.14.4. [util#81][util81] 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][zinc304] 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][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][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][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][1518]/[lm#88][lm88] by [@jvican][@jvican]

Adds new offline mode to the Ivy-based library management. [lm#92][lm92] 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][zinc287] by [@smarter][@smarter]

For faster startup, sbt will use Java reflection to discover autoImport . [#3115][3115] by [@jvican][@jvican]

For faster startup, reuse the same global instance for parsing. [#3115][3115] by [@jvican][@jvican]

Adds InteractionService from sbt-core-next to keep compatibility with sbt 0.13. [#3182][3182] by [@eed3si9n][eed3si9n]

Adds new WatchService that abstracts PollingWatchService and Java NIO. [io#47][io47] by [@Duhemm][@Duhemm] on behalf of The Scala Cen-
• 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` by @muuki88

• ApiDiff feature used to debug Zinc uses Scala implementation borrowed from Dotty. [zinc#346][zinc346] by @Krever

• In Zinc internal, make `ExtractAPI use perRunCaches`. [zinc#347][zinc347] by @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][3151] by @jvican

• sbt 1.0.0-M6 is built using sbt 1.0.0-M5. [#3184][3184] by @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 dependencies 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 `xsbti.F1` are changed to corresponding Java 8 classes `java.util.Optional`, `java.util.Supplier` and `java.util.Function`.
• Removes unused “resident” option. [zinc#345][zinc345] 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:

```json
{"type":"xsbti.Problem","message":{"category":"","severity":"Warn","message":"a pure expression does nothing in statement ... ","sourcePath":"/tmp/hello/Hello.scala","sourceFile":"file:/tmp/hello/Hello.scala"}}
```

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][3216] and [#3225][3225] by [@jvican][@jvican]

**Eviction warning presentation**

`sbt` 1.0 improves the eviction warning presentation.

Before:
There may be incompatibilities among your library dependencies. Here are some of the libraries that were evicted:

* com.google.code.findbugs:jsr305:2.0.1 -> 3.0.0

Run ‘evicted’ to see detailed eviction warnings

After:

Found version conflict(s) in library dependencies; some are suspected to be binary incompatible:

* com.typesafe.akka:akka-actor_2.12:2.5.0 is selected over 2.4.17
  +- de.heikoseeberger:akka-log4j_2.12:1.4.0 (depends on 2.5.0)
  +- com.typesafe.akka:akka-parsing_2.12:10.0.6 (depends on 2.4.17)
  +- com.typesafe.akka:akka-stream_2.12:2.4.17 () (depends on 2.4.17)

Run ‘evicted’ to see detailed eviction warnings

#3202 by @eed3si9n

sbt-cross-building

[@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 (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][io53] by [@dwijnand][@dwijnand]

Library management API and parallel artifact download

sbt 1.0 adds Library management API co-authored by Eugene Yokota (@eed3si9n) from Lightbend and Martin Duhem (@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) from Scala Center. It also introduces Gigahorse OkHttp as the Network API, and it uses Square OkHttp for artifact download as well.

[lm#124][lm124] by [@eed3si9n][@eed3si9n]/[@Duhemm][@Duhemm], [lm#90][lm90] by [@jvican][@jvican]/[@jsuereth][@jsuereth] and [lm#104][lm104] by [@eed3si9n][@eed3si9n].

Binary format for Zinc’s internal storage

Jorge (@jvican) from Scala Center contributed a binary format for Zinc’s internal storage using Google Protocol 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][zinc351] by [@jvican][@jvican]

Dependency locking

Dependency locking feature is still in progress, but Jorge (@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][lm100]
- Adds support to specify a resolver for dependencies. [lm#97][lm97]
• Adds “managed checksums”, which tells Ivy to skip the checksum process.

Contributors

Too many people to thank here. See Credits

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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.
- `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`.
- `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 multi-threading (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 multi-threading (including GUIs) in code run by this action. `test:runMain` runs the specified main class in the test code.
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 cross ScalaVersions 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:

  ```scala
  > 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.

<table>
<thead>
<tr>
<th>Property</th>
<th>Values</th>
<th>Default</th>
<th>Meaning</th>
</tr>
</thead>
</table>

185
sbt.banner
Boolean
true (in 1.3+)
Show a welcome banner advertising new features.
sbt.boot.directory
Directory
~/.sbt/boot
Path to shared boot directory. You should define sbt.boot.directory explicitly if you are using sbt in a CI environment and want to cache sbt boot classes between runs.
sbt.boot.properties
File
Roughly sbt.boot.properties internal to the sbt launcher and specific to the sbt version.
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.ci
Boolean
false (unless then env var BUILD_NUMBER is set)
For continuous integration environments. Suppress supershell and color.
sbt.client
Boolean
false
sbt.color
String
auto
Supercedes sbt.log.format. To turn on color, use always or true. To turn off color, use never or false>. To use color if the output is a terminal (not a pipe) that supports color, use auto.
sbt.coursier
Boolean
true (in 1.3+)
Use coursier to retrieve packages. (See also sbt.ivy.)

sbt.coursier.home
Directory
CoursierDependencyResolution.defaultCacheLocation (in 1.3+)
Location of coursier artifact cache, where the default is defined by Coursier cache resolution logic. You can verify the value with the command csrCacheDirectory. You should define sbt.coursier.home explicitly if you are using coursier in a CI environment and want to cache artifacts between runs.

sbt.extraClasspath
Classpath Entries
(jar files or directories) that are added to sbt’s classpath. Note that the entries are delimited by comma, e.g.: entry1, entry2,... See also resource in the sbt launcher documentation.

sbt.genbuildprops
Boolean
true
Generate build.properties if missing. If unset, this defers to sbt.skip.version.write.

sbt.global.base
Directory
$HOME/.sbt/1.0
The directory containing global settings and plugins.

xsbt.inc.debug
Boolean
false
Extra debugging for the incremental debugger.

sbt.ivy
Boolean
true (in <1.3)
Use ivy to retrieve packages.

sbt.ivy.home
Directory
~/.ivy2
The directory containing the local Ivy repository and artifact cache. You should define sbt.ivy.home explicitly if you are using sbt in a CI environment and want to cache ivy artifacts between runs.

sbt.log.noformat

Boolean
false

If true, disable ANSI color codes. Useful on build servers or terminals that do not support color.

sbt.main.class

String
sbt.xMain

The sbt class to use (alternatives include sbt.ConsoleMain and sbt.ScriptMain).

sbt.offline

Boolean
false

Avoid retrieving classes from repositories.

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.progress

String
?

Use always to show progress ("supershell").

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 sbt.override.build.repos and the sbt launcher documentation).
sbt.resident.limit
Number
0
The number of scala compilers to keep around. This experimental feature was intended to improve compilation time. It does not appear to have succeeded and this flag will probably be removed.

sbt.skip.version.write
Boolean
false
Generate build.properties if missing. See sbt.genbuildprops.

sbt.supershell
Boolean
true if color is enabled
Use supershell (show progress at bottom of shell).

sbt.supershell.sleep
Number
100
Time to wait between updating the supershell progress area.

sbt.task.timings
Boolean
false
Measure the time elapsed for running tasks.

sbt.task.timings.omit.paths
Boolean
false
Omit paths when reporting timings.

sbt.task.timings.on.shutdown
Boolean
false
Report timings at JVM shutdown (instead of at task completion).
String
0
Omit items from timing report if they are below this threshold.
sbt.traces
Boolean
false
Generate Chrome Trace Event Format log for tasks.
sbt.turbo
Boolean
false
Use additional layered class loaders.
sbt.version
Version
1.6.2
sbt version to use, usually taken from project/build.properties.
sbt.watch.mode
String
auto
If polling, check file system periodically for updates.

**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:

```scala
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):
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:

```scala
> val value = (<scope> / <key>).eval
```

### Examples

```scala
> IO.delete( (Compile / classesDirectory).eval )
```

Show current compile options:

```scala
> (Compile / scalacOptions).eval foreach println
```

Show additionally configured repositories:

```scala
> resolvers.eval foreach println
```

### Evaluating tasks

To evaluate a task (and its dependencies), use the same form:

```scala
> val value = (<scope> / <key>).eval
```

### Examples

Show all repositories, including defaults:

```scala
> fullResolvers.eval foreach println
```

Show the classpaths used for compilation and testing:

```scala
> (Compile / fullClasspath).eval.files foreach println
> (Test / fullClasspath).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.

For cross building sbt plugins see also Cross building plugins.

Publishing conventions

The underlying mechanism used to indicate which version of Scala a library was compiled against is to append `<scala-binary-version>` to the library’s name. For example, the artifact name `dispatch-core_2.12` is used when compiled against Scala 2.12.0, 2.12.1 or any 2.12.x version. This fairly simple approach allows interoperability with users of Maven, Ant and other build tools.

For pre-prelease versions of Scala such as 2.13.0-RC1 and for versions prior to 2.10.x, full version is used as the suffix.

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:

```scala
libraryDependencies += "net.databinder.dispatch" %% "dispatch-core" % "0.13.3"
```

A nearly equivalent, manual alternative for a fixed version of Scala is:

```scala
libraryDependencies += "net.databinder.dispatch" % "dispatch-core_2.12" % "0.13.3"
```

**Cross building a project using sbt-projectmatrix**

Consider using `sbt-projectmatrix` that is capable of cross building across Scala versions and different platforms in parallel.

**Cross building a project statefully**

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:

```scala
lazy val scala212 = "2.12.15"
lazy val scala211 = "2.11.12"
lazy val supportedScalaVersions = List(scala212, scala211)

ThisBuild / organization := "com.example"
ThisBuild / version := "0.1.0-SNAPSHOT"
ThisBuild / scalaVersion := scala212

lazy val root = (project in file("."))
  .aggregate(util, core)
  .settings(
    // crossScalaVersions must be set to Nil on the aggregating project
    crossScalaVersions := Nil,
    publish / skip := true
  )

lazy val core = (project in file("core"))
  .settings(
    crossScalaVersions := supportedScalaVersions,
    // other settings
  )

lazy val util = (project in file("util"))
  .settings(
    crossScalaVersions := supportedScalaVersions,
  )
```

193
Note: `crossScalaVersions` must be set to `Nil` on the root project to avoid double publishing.

To build against all versions listed in `crossScalaVersions`, prefix the action to run with `+`. For example:

```
> + test
```

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.

Change settings depending on the Scala version

Here’s how we can change some settings depending on the Scala version. `CrossVersion.partialVersion(scalaVersion.value)` returns `Option[(Int, Int)]` containing the first two segments of the Scala version.

This can be useful for instance if you include a dependency that requires the macro paradise compiler plugin for Scala 2.12 and the `-Ymacro-annotations` compiler option for Scala 2.13.

```scala
lazy val core = (project in file("core"))
  .settings(
    crossScalaVersions := supportedScalaVersions,
    libraryDependencies ++= {
      CrossVersion.partialVersion(scalaVersion.value) match {
        case Some((2, n)) if n <= 12 =>
          List(compilerPlugin("org.scalamacros" % "paradise" % "2.1.1" cross CrossVersion.full))
        case _ => Nil
      },
    },
    Compile / scalacOptions ++= {
      CrossVersion.partialVersion(scalaVersion.value) match {
        case Some((2, n)) if n <= 12 => Nil
        case _ => List("-Ymacro-annotations")
      },
    },
  )
```

#### Scala-version specific source directory

In addition to `src/main/scala/` directory, `src/main/scala-<scala binary version>/` directory is included as a source directory. For example if the current subproject’s `scalaVersion` is 2.12.10, then `src/main/scala-2.12` is included as a Scala-version specific source.
By `crossPaths` setting to `false` you can opt out of both Scala-version source directory and the `_<scala-binary-version>` publishing convention. This might be useful for non-Scala projects.

Similarly, the build products such as `*.class` files are written into `crossTarget` directory, which by default is `target/scala-<scala binary version>`.

**Cross building with a Java project**

A special care must be taken when cross building involves pure Java project. Let’s say in the following example, `network` is a Java project, and `core` is a Scala project that depends on `network`.

```scala
lazy val scala212 = "2.12.15"
lazy val scala211 = "2.11.12"
lazy val supportedScalaVersions = List(scala212, scala211)

ThisBuild / organization := "com.example"
ThisBuild / version := "0.1.0-SNAPSHOT"
ThisBuild / scalaVersion := scala212

lazy val root = (project in file("."))
  .aggregate(network, core)
  .settings(
    // crossScalaVersions must be set to Nil on the aggregating project
    crossScalaVersions := Nil,
    publish / skip := false
  )

// example Java project
lazy val network = (project in file("network"))
  .settings(
    // set to exactly one Scala version
    crossScalaVersions := List(scala212),
    crossPaths := false,
    autoScalaLibrary := false,
    // other settings
  )

lazy val core = (project in file("core"))
  .dependsOn(network)
  .settings(
    crossScalaVersions := supportedScalaVersions,
    // other settings
  )

1. crossScalaVersions must be set to `Nil` on the aggregating projects such
as the root.

2. Java subprojects should set `crossPaths` to false, which turns off the \_<scala-binary-version> publishing convention and the Scala-version specific source directory.

3. Java subprojects should have exactly one Scala version in `crossScalaVersions` to avoid double publishing, typically scala212.

4. Scala subprojects can have multiple Scala versions in `crossScalaVersions`, but must avoid aggregating Java subprojects.

### Switching Scala version

You can use `++ <version>` `[command]` to temporarily switch the Scala version currently being used to build the subprojects given that `<version>` is listed in their `crossScalaVersions`.

For example:

```bash
> ++ 2.12.15
[info] Setting version to 2.12.15
> ++ 2.11.12
[info] Setting version to 2.11.12
> 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.

When a `[command]` is passed in to `++`, it will execute the command on the subprojects that supports the given `<version>`.

For example:

```bash
> ++ 2.11.12 -v test
[info] Setting Scala version to 2.11.12 on 1 projects.
[info] Switching Scala version on:
[info]   core (2.12.15, 2.11.12)
[info] Excluding projects:
[info]   * root ()
[info] Reapplying settings...
[info] Set current project to core (in build file:/Users/xxx/hello/)
```

Sometimes you might want to force the Scala version switch regardless of the `crossScalaVersions` values. You can use `++ <version>!` with exclamation mark for that.

For example:

```bash
> ++ 2.13.0-M5! -v
[info] Forcing Scala version to 2.13.0-M5 on all projects.
```
Cross publishing

The ultimate purpose of + is to cross-publish your project. That is, by doing:

> + publishSigned

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 2.12.7,

- \./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.

Overriding the publishing convention

crossVersion setting can override the publishing convention:

- CrossVersion.disabled (no suffix)
- CrossVersion.binary (_<scala-binary-version>)
- CrossVersion.full (_<scala-version>)

The default is either CrossVersion.binary or CrossVersion.disabled depending on the value of crossPaths.

Because (unlike Scala library) Scala compiler is not forward compatible among the patch releases, compiler plugins should use CrossVersion.full.

Scala 3 specific cross-versions

In a Scala 3 project you can use Scala 2.13 libraries:

("a" % "b" % "1.0") cross CrossVersion.for3Use2_13
This is equivalent to using `%%` except it resolves the `_2.13` variant of the library when `scalaVersion` is `3.x.y`.

Conversely we have `CrossVersion.for2_13Use3` to use the `_3` variant of the library when `scalaVersion` is `2.13.x`:

```scala
("a" % "b" % "1.0") cross CrossVersion.for2_13Use3
```

**Warning for library authors:** It is generally not safe to publish a Scala 3 library that depends on a Scala 2.13 library or vice-versa. The reason is to prevent your end users from having two versions x_2.13 and x_3 of the same x library in their classpath.

**More about using cross-built libraries**

You can have fine-grained control over the behavior for different Scala versions by using the `cross` method on `ModuleID` These are equivalent:

```scala
"a" % "b" % "1.0"
("a" % "b" % "1.0").cross(CrossVersion.disabled)
```

These are equivalent:

```scala
"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 variant but binary compatible Scala toolchain builds.

```scala
("a" % "b" % "1.0").cross(CrossVersion.patch)
```

`CrossVersion.constant` fixes a constant value:

```scala
("a" % "b" % "1.0") cross CrossVersion.constant("2.9.1")
```

It is equivalent to:

```
"a" % "b_2.9.1" % "1.0"
```

A constant cross version 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.

```scala
("a" % "b" % "1.0") cross CrossVersion.constant {
  scalaVersion.value match {
    case "2.9.1" => "2.9.0"
    case x => x
  }

198
Note about sbt-release

sbt-release implemented cross building support by copy-pasting sbt 0.13’s + implementation, so at least as of sbt-release 1.0.10, it does not work correctly with sbt 1.x’s cross building, which was prototyped originally as sbt-doge.

To cross publish using sbt-release with sbt 1.x, use the following workaround:

```scala
ThisBuild / organization := "com.example"
ThisBuild / version := "0.1.0-SNAPSHOT"
ThisBuild / scalaVersion := scala212

import ReleaseTransformations._
lazy val root = (project in file("."))
  .aggregate(util, core)
  .settings(
    // crossScalaVersions must be set to Nil on the aggregating project
crossScalaVersions := Nil,
publish / skip := true,

    // don't use sbt-release's cross facility
releaseCrossBuild := false,
releaseProcess := Seq[ReleaseStep](
  checkSnapshotDependencies,
inquireVersions,
runClean,
releaseStepCommandAndRemaining("+test"),
setReleaseVersion,
commitReleaseVersion,
tagRelease,
releaseStepCommandAndRemaining("+publishSigned"),
setNextVersion,
commitNextVersion,
pushChanges
)
  )

This will then use the real cross (+) implementation for testing and publishing.
Credit for this technique goes to James Roper at playframework#4520 and later inventing releaseStepCommandAndRemaining.
```
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
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.

```scala
> 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,

```scala
> inspect libraryDependencies
[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] 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 / initialCommands
[info]  Compile / console / streams
[info]  Compile / console / compilers
[info]  Compile / console / cleanupCommands
[info]  Compile / console / taskTemporaryDirectory
[info]  Compile / console / scalaInstance
[info]  Compile / console / scalacOptions
```
This shows the inputs to the console task. We can see that it gets its classpath and options from Compile / console / fullClasspath and Compile / console / scalacOptions. 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 Compile / console / initialCommands := "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 / console / streams
[info] Global / taskTemporaryDirectory
[info] scalaInstance
[info] Compile / scalacOptions
[info] Global / initialCommands
[info] Global / cleanupCommands
[info] Compile / fullClasspath
[info] console / compilers
```
For `initialCommands`, we see that it comes from the global scope (`Global`). 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] Compile / console
[info] Test / console
[info] consoleProject
[info] Test / consoleQuick
[info] Compile / consoleQuick
```

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 console / initialCommands := "import mypackage._"
> set consoleQuick / initialCommands := "import mypackage._"
```

or configuration axis:

```
> set Compile/ initialCommands := "import mypackage._"
> set Test / initialCommands := "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:

```bash
> inspect console/initialCommands
...
[info] Delegates:
[info] console / initialCommands
[info] initialCommands
[info] ThisBuild / console / initialCommands
[info] ThisBuild / initialCommands
[info] Zero / console / initialCommands
[info] Global / 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**

sbt provides the ability to monitor the input files for a particular task and repeat the task when changes to those files occur.

Some example usages are described below:

**Compile**

A common use-case is continuous compilation. The following commands will make sbt watch for source changes in the Test and Compile (default) configurations respectively and re-run the compile command.

```bash
> ~ Test / compile
> ~ compile
```

Note that because Test / compile depends on Compile / compile, source changes in the main source directory will trigger recompilation of the test sources.

**Testing**

Triggered execution is often used when developing in a test driven development (TDD) style. The following command will monitor changes to both the main
and test source sources for the build and re-run only the tests that reference classes that have been re-compiled since the last test run.

> ~ testQuick

It is also possible to re-run only a particular test if its dependencies have changed.

> ~ testQuick foo.BarTest

It is possible to always re-run a test when source changes are detected regardless of whether the test depends on any of the updated source files.

> ~ testOnly foo.BarTest

To run all of the tests in the project when any sources change, use

> ~test

Running Multiple Commands

sbt supports watching multiple, semicolon separated, commands. For example, the following command will monitor for source file changes and run clean and test:

> ~ clean; test

Build sources

If the build is configured to automatically reload when build source changes are made by setting Global / onChangedBuildSource := ReloadOnSourceChanges, then sbt will monitor the build sources (i.e. *.sbt and *.java,scala files in the project directory). When build source changes are detected, the build will be reloaded and sbt will re-enter triggered execution mode when the reload completes.

The following snippet can be added as a global setting to ~/.sbt/1.0/config.sbt to enable ReloadOnSourceChanges for all sbt 1.3+ builds without breaking earlier versions:

Def.settings {
  try {
    val value = Class.forName("sbt.nio.Keys$ReloadOnSourceChanges$").getDeclaredField("MODULE$").get(null)
    val clazz = Class.forName("sbt.nio.Keys$WatchBuildSourceOption")
    val manifest = new scala.reflect.Manifest[AnyRef]{ def runtimeClass = clazz }
    Seq( 
      Global / SettingKey[AnyRef]("onChangedBuildSource") (manifest, sbt.util.NoJsonWriter()) 
    )
  } catch {
  }
}
Clearing the screen

sbt can clear the console screen before it evaluates the task or after it triggers an event. To configure sbt to clear the screen after an event is triggered add

```
ThisBuild / watchTriggeredMessage := Watch.clearScreenOnTrigger
```
to the build settings. To clear the screen before running the task, add

```
ThisBuild / watchBeforeCommand := Watch.clearScreen
```
to the build settings.

Configuration

The behavior of triggered execution can be configured via a number of settings.

- **watchTriggers**: `Seq[Guid]` adds search queries for files that should task trigger evaluation but that the task does not directly depend on. For example, if the project build.sbt file contains `foo / watchTriggers += baseDirectory.value.toGlob / "*.txt"`, then any modifications to files ending with the `txt` extension will cause the `foo` command to trigger when in triggered execution mode.

- **watchTriggeredMessage**: `(Int, Path, Seq[String]) => Option[String]` sets the message that is displayed when a file modification triggers a new build. Its input parameters are the current watch iteration count, the file that triggered the build and the command(s) that are going to be run. By default, it prints a message indicating what file triggered the build and what commands its going to run. No message is printed when the function returns `None`. To clear the screen before printing the message, just add `Watch.clearScreen()` inside of the task definition. This will ensure that the screen is cleared and that the message, if any is defined, will be printed after the screen clearing.

- **watchInputOptions**: `Seq[Watch.InputOption]` allows the build to over-ride the default watch options. For example, to add the ability to reload the build by typing the ‘l’ key, add `ThisBuild / watchInputOptions += Watch.InputOption('l', "reload", Watch.Reload)` to the build.sbt file. When using the default `watchStartMessage`, this will also add the option to the list displayed by the ‘?’ option.
• **watchBeforeCommand**: () => Unit provides a callback to run before evaluating the task. It can be used to clear the console screen by adding `ThisBuild / watchBeforeCommand := Watch.clearScreen` to the project build.sbt file. By default it is no-op.

• **watchLogLevel** sets the logging level of the file monitoring system. This can be useful if the triggered execution is not being evaluated when source files or modified or if is unexpectedly triggering due to modifications to files that should not be monitored.

• **watchInputParser**: Parser[Watch.Action] changes how the monitor handles input events. For example, setting `watchInputParser := 'l' ^^^ Watch.Reload | '\r' ^^^ new Watch.Run("")` will make it so that typing the 'l' key will reload the build and typing a newline will return to the shell. By default this is automatically derived from the `watchInputOptions`.

• **watchStartMessage**: (Int, ProjectRef, Seq[String]) => Option[String] sets the banner that is printed while the watch process is waiting for file or input events. The inputs are the iteration count, the current project and the commands to run. The default message includes instructions for terminating the watch or displaying all available options. This banner is only displayed if `watchOnIteration` logs the result of `watchStartMessage`.

• **watchOnIteration**: (Int, ProjectRef, Seq[String]) => Watch.Action a function that is evaluated before waiting for source or input events. It can be used to terminate the watch early if, for example, a certain number of iterations have been reached. By default, it just logs the result of `watchStartMessage`.

• **watchForceTriggerOnAnyChange**: Boolean configures whether or not the contents of a source file must change in order to trigger a build. The default value is false.

• **watchPersistFileStamps**: Boolean toggles whether or not sbt will persist the file hashes computed for source files across multiple task evaluation runs. This can improve performance for projects with many source files. Because the file hashes are cached, it is possible for the evaluated task to read an invalid hash if many source files are being concurrently modified. The default value is false.

• **watchAntiEntropy**: FiniteDuration controls the time that must elapse before a build is re-triggered by the same file that previously triggered the build. This is intended to prevent spurious builds that can occur when a file is modified in short bursts. The default value is 500ms.
Script mode

sbt has an alternative entry points that may be used to:

- Compile and execute a Scala script containing dependency declarations or other sbt settings

This entry point should be considered experimental. A notable disadvantage of these approaches is the startup time involved.

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 script.scala, you would do on Unix:

```bash
chmod u+x script.scala
./script.scala
```

```scala
#!/usr/bin/env sbt -Dsbt.version=1.6.1 -Dsbt.main.class=sbt.ScriptMain -error
/***/
ThisBuild / scalaVersion := "2.13.8"
libraryDependencies += "org.scala-sbt" % "io" % "1.6.0"
*/
println("hello")
```

This prints out hello. If you’re used to using IO from sbt, we can use that do basic file operations, like reading a text file.

```bash
#!/usr/bin/env sbt -Dsbt.version=1.6.1 -Dsbt.main.class=sbt.ScriptMain -error
/***/
ThisBuild / scalaVersion := "2.13.8"
libraryDependencies += "org.scala-sbt" % "io" % "1.6.0"
*/
import sbt.io.IO
import sbt.io.Path._
```
```scala
import sbt.io.syntax._
import java.io.File
import java.net.URI
import sys.process._

def file(s: String): File = new File(s)
def uri(s: String): URI = new URI(s)

def processFile(f: File): Unit = {
  val lines = IO.readLine(f)
  lines foreach { line =>
    println(line.toUpperCase)
  }
}

args.toList match {
  case Nil => sys.error("usage: ./script.scala <file>...")
  case xs => xs foreach { x => processFile(file(x)) }
}

This script will take file names as argument and print them out in all upper case.

$ ./script.scala script.scala
#!/USR/BIN/ENV SBT -DSBT.MAIN.CLASS=SBT.SCRIPTMAIN -ERROR

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.

Metals integration

As of sbt 1.4.x, sbt server implements Build Server Protocol used by Metals. Here is how to use sbt server as Metals backend.

1. Delete existing .bsp, .metals, .bloop directories if any
2. Open VS Code in the working directory

210
3. Ignore the prompt to import the project
4. Add `Global / semanticdbEnabled := true` in `build.sbt`
5. Start `sbt` in the View > Terminal tab. Wait till it displays “sbt server started”
6. From command palette (Cmd-Shift-P in VS Code) issue “Metals: Switch Build Server”, and select “sbt”
7. Reload the sbt session to make sure `project/metals.sbt` gets loaded
8. Navigate to Metals view, and select “Connect to build server”
9. It should start compiling all your subprojects automatically
10. Once Metals finishes indexing, it should be able to perform code completion etc

Use the following setting to opt-out some of the subprojects from BSP.

```scala
bspEnabled := false
```

**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:

```text
Content-Type: application/vscode-jsonrpc; charset=utf-8\r\nContent-Length: ...
```

```
{
  "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:
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 governed 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.

213


**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` datatye 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:

```java
type InitializationOptionsParams {
  token: String!
}
```

On telnet it would look as follows:

```bash
$ 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": { "token": "84046191245433876643612047032303751629" } } }
```

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:

```bash
$ nc -U /Users/foo/.sbt/1.0/server/0845deda85cb41abcdef/sock
Content-Length: 99

{ "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):

```json
{
  "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:

```scala
type SbtExecParams {
  commandLine: String!
}
```

On telnet it would look as follows:

```json
{ "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.

215
sbt/setting request

A `sbt/setting` request can be used to query settings.

- method: `sbt/setting`
- params:

```typescript
type SettingQuery {
  setting: String!
}
```

On telnet it would look as follows:

```json
Content-Length: 102

{
  "jsonrpc": "2.0",
  "id": 3,
  "method": "sbt/setting",
  "params": {
    "setting": "root/scalaVersion"
  }
}
```

Unlike the command execution, this will respond immediately.

sbt/completion request

(sbt 1.3.0+)

A `sbt/completion` request is used to emulate tab completions for sbt shell.

- method: `sbt/completion`
- params:

```typescript
type CompletionParams {
  query: String!
}
```

On telnet it would look as follows:

```json
Content-Length: 100

{
  "jsonrpc": "2.0",
  "id": 15,
  "method": "sbt/completion",
  "params": {
    "query": "testOnly org."
  }
}
```

This will respond immediately based on the last available state of sbt.
sbt/cancelRequest

(sbt 1.3.0+)

A `sbt/cancelRequest` request can be used to terminate the execution of an on-going task.

- method: `sbt/cancelRequest`
- params:

```typescript
type CancelRequestParams {
  id: String!
}
```

On telnet it would look as follows (assuming a task with Id “foo” is currently running):

```json
Content-Length: 93

{ "jsonrpc": "2.0", "id": "bar", "method": "sbt/cancelRequest", "params": { "id": "foo" } }

Content-Length: 126
Content-Type: application/vscode-jsonrpc; charset=utf-8

{"jsonrpc":"2.0","id":"bar","result":{"status":"Task cancelled","channelName":"network-1","execId":"foo","commandQueue":[]}}
```

This will respond back with the result of the action.

### 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:

```scala
// 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 \texttt{A.scala} affect other files. We see that the return type of the \texttt{foo} public method has changed so this might affect compilation results of other files. Indeed, \texttt{B.scala} contains call to the \texttt{foo} method so has to be compiled in the second step. Compilation of \texttt{B.scala} will fail because of type mismatch in \texttt{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.

\textbf{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

\textbf{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.foo
}

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:

// 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:

```bash
curl -O https://java-diff-utils.googlecode.com/files/diffutils-1.2.1.jar
sbt -Dsbt.extraClasspath=diffutils-1.2.1.jar
```

```text
---
```

Let’s suppose you have the following source code in `Test.scala`:

```scala
230
```
class A {
    def b: Int = 123
}

compile it and then change the Test.scala file so it looks like:

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] @@ -23,7 +23,7 @@
[debug] ^inherited^ final def ##(): scala.this#Int
[debug] ^inherited^ final def $isInstanceOf[ java.lang.Object.T0 : scala.this#Nothing <: scala.this#Any](): scala.this#Boolean
[debug] ^inherited^ final def $asInstanceOf[ java.lang.Object.T0 : scala.this#Nothing <: scala.this#Any](): <java.lang.Object.T0>
[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 representations. 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:

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 \( \text{openFiles} \) is not specified explicitly, but computed by type inference to be \( \text{List[FileWriter]} \). Suppose that after writing this source code, we introduce some client code and then modify \( A \text{.scala} \) 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 \( \text{Vector[BufferedWriter]} \); 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:

```scala
val res: List[FileWriter] = A.openFiles(List(new File("foo.input")))
```

Also the following code will break:

```scala
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 \( \text{Seq[Writer]} \). 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 \( \text{Seq[Writer]} \), 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

```scala
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 clasfile 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:

```scala
Compile / manipulateBytecode := {
  val previous = (Compile / manipulateBytecode).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`:

```scala
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`:

```scala
val raw: Seq[File] = ...
val cp: Classpath = raw.classpath

val rawFile: File = ..
```

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:

```scala
Compile / sourceGenerators +=
    generate( (Compile / sourceManaged).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 (`Compile / sourceGenerators`).

To insert a named task, which is the better approach for plugins:
val mySourceGenerator = taskKey[Seq[File]](...)  

Compile / mySourceGenerator :=  
  generate((Compile / sourceManaged).value / "some_directory")  

Compile / sourceGenerators += (Compile / mySourceGenerator)  

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: 

unmanagedSources / excludeFilter := "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 unmanaged-SourceDirectories, 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.

Runtime / unmanagedClasspath += 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.

```scala
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:

```scala
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:

```scala
// declare the main Scala source directory as the base directory
scalacOptions :=
    scalacOptions.value :+: ("-Psxr:base-directory:" + (Compile / scalaSource).value.getAbsolutePath)
```

You can still specify compiler plugins manually. For example:

```scala
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.

```scala
val continuationsVersion = "1.0.3"
autoCompilerPlugins := true
addCompilerPlugin("org.scala-lang.plugins" % "scala-continuations-plugin_2.12.2" % continuationsVersion)
libraryDependencies += "org.scala-lang.plugins" %% "scala-continuations-library" % continuationsVersion
scalacOptions += "-P:continuations:enable"
```

Version-specific Compiler Plugin Example

Adding a version-specific compiler plugin can be done as follows:

```scala
val continuationsVersion = "1.0.3"
autoCompilerPlugins := true
libraryDependencies += compilerPlugin("org.scala-lang.plugins" % ("scala-continuations-plugin_" + scalaVersion.value) % continuationsVersion)
libraryDependencies += "org.scala-lang.plugins" %% "scala-continuations-library" % continuationsVersion
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:

```scala
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:

```scala
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,

```scala
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:

```scala
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,

```scala
managedScalaInstance := false
```

```scala
// 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
```

```scala
// 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,

```scala
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,

```scala
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:

```scala
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,

```scala
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 1.6.2, this version is Scala 2.12.14. 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 Compile / run / baseDirectory or Test / baseDirectory:

```
// 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/")
```

241
// 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:

```scala
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 `$HOME/.sbt/1.0/global.sbt` (or any file in `$HOME/.sbt/1.0` with a `.sbt` extension). Plugins that are defined globally in `$HOME/.sbt/1.0/plugins/` are available to these settings. For example, to change the default `shellPrompt` for your projects:

```
$HOME/.sbt/1.0/global.sbt
```
You can also configure plugins globally added in $HOME/.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 $HOME/.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 $HOME/.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 $HOME/.sbt/1.0/plugins/ShellPrompt.scala:

```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 $HOME/.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 $HOME/.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`:

```scala
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:

```scala
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:

```scala
compileOrder := CompileOrder.JavaThenScala
```

To specify different orders for main and test sources, scope the setting by configuration:

```scala
// 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
Compile / unmanagedSourceDirectories := (Compile / javaSource).value :: Nil

// Include only src/test/java in the test configuration
Test / unmanagedSourceDirectories := (Test / javaSource).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:

```scala
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)

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:
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`:

```scala
lazy val commonSettings = Seq(
  scalaVersion := "2.12.15",
  organization := "com.example"
)

lazy val scalaReflect = Def.
  setting {
    "org.scala-lang" % "scala-reflect" % scalaVersion.value
  }

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 depen-
dency on the compiler for the macro implementation. As an example macro, we’ll use desugar from macrocosm. macro/src/main/scala/demo/Demo.scala:

```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:

```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:

```scala
package demo

object Usage {
```

250
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 := "2.12.15",
  organization := "com.example"
)
lazy val scalaReflect = Def.setting{
  "org.scala-lang" % "scala-reflect" % scalaVersion.value
}
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 val 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:

```scala
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
    Compile / packageBin / mappings += (macroSub / Compile / packageBin / mappings).value,
    // include the macro sources in the main source jar
    Compile / packageSrc / mappings += (macroSub / Compile / packageSrc / mappings).value
  )
```

You may wish to disable publishing the macro implementation. This is done by overriding publish and publishLocal to do nothing:

```scala
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
}

253
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 `*`:

```scala
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:

```scala
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`:

```scala
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,

```scala
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 FileFilters.

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:

```scala
def testSrcs(base: File): PathFinder = (base / "src") \* "*Test*.scala"
```

There are some useful combinators added to FileFilter. The || method declares alternative FileFilters. The following example selects all Java or Scala source files under “src”:

```scala
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:

```scala
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:

```scala
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:

```scala
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).

```scala
def myCompileTask = Def.task { ... } tag(Tags.CPU, Tags.Compile)
```

Different weights may be specified by passing tag/weight pairs to `tagw`:

```scala
def downloadImpl = Def.task { ... } tagw(Tags.Network -> 3)
```

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,

```scala
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:
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:

```scala
... 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:

```scala
... 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, `Test / parallelExecution` 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.

```scala
def myCompileTask = Def.task { ... } tag(Tags.CPU, Tags.Compile)
compiled := myCompileTask.value
compiled := {
  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 enhanced, 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

You can get a `Logger` with:

```scala
val log = streams.value.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.

```scala
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 Files and input from Files and URLs. 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.

```scala
val listed: String = "ls" !!
val lines2: Stream[String] = "ls" lines_
```

Finally, there is a cat method to send the contents of Files and URLs to standard output.

**Examples**

Download a URL to a File:

```scala
download("http://databinder.net/dispatch/About") #> file("About.html") !
// or
file("About.html") #< url("http://databinder.net/dispatch/About") !
```

Copy a File:

```scala
download("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:

```scala
download("http://databinder.net/dispatch/About") #>> file("About_final.html") !
```

263
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 http
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:

```scala
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:

```text
> test
```
**testOnly**

The `testOnly` task accepts a whitespace separated list of test names to run. For example:

```bash
> testOnly org.example.MyTest1 org.example.MyTest2
```

It supports wildcards as well:

```bash
> 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

    Test / testGrouping := groupByFirst( (Test / definedTests).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.

```scala
lazy val scalatest = "org.scalatest" %% "scalatest" % "3.0.5"

ThisBuild / organization := "com.example"
ThisBuild / scalaVersion := "2.12.15"
ThisBuild / version := "0.1.0-SNAPSHOT"

lazy val root = (project in file("."))
  .configs(IntegrationTest)
  .settings(
    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.
```
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 `IntegrationTest/`. For example to run all integration tests:

```scala
> IntegrationTest/test
```

Or to run a specific test:

```scala
> 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:

```scala
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:

```scala
IntegrationTest / testOptions += ...
```

Or, use `:=` to overwrite any existing options, declaring these to be the definitive integration test options:

```scala
IntegrationTest / testOptions := Seq(...)
```

### Custom test configuration

The previous example may be generalized to a custom test configuration.

```scala
lazy val scalatest = "org.scalatest" %% "scalatest" % "3.0.5"
lazy val FunTest = config("fun") extend(Test)

ThisBuild / organization := "com.example"
ThisBuild / scalaVersion := "2.12.15"
ThisBuild / version := "0.1.0-SNAPSHOT"

lazy val root = (project in file("."))) .configs(FunTest) .settings(
  inConfig(FunTest)(Defaults.testSettings),
  libraryDependencies += scalatest % FunTest
)
Instead of using the built-in configuration, we defined a new one:

```scala
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:

```scala
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:

```scala
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`:

```scala
FunTest / testOptions += ...
```

Test tasks are run by prefixing them with `fun`:

```scala
> 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.

```scala
lazy val scalatest = "org.scalatest" %% "scalatest" % "3.0.5"
lazy val FunTest = config("fun") extend(Test)
```

```scala
ThisBuild / organization := "com.example"
ThisBuild / scalaVersion := "2.12.15"
ThisBuild / version := "0.1.0-SNAPSHOT"
```

```scala
def itFilter(name: String): Boolean = name endsWith "ITest"
def unitFilter(name: String): Boolean = (name endsWith "Test") && !itFilter(name)
```

```scala
lazy val root = (project in file("."))
  .configs(FunTest)
  .settings(
    inConfig(FunTest)(Defaults.testTasks),
    libraryDependencies += scalatest % FunTest,
```

272
Test / testOptions := Seq(Tests.Filter(unitFilter)),
    FunTest / testOptions := 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`.

**In process class loading**

By default, sbt executes the `run` and `test` tasks within its own JVM instance. It emulates running an external java command by invoking the task in an isolated `ClassLoader`. Compared to forking, this approach reduces the start start up latency and total runtime. The performance benefit from simply reusing the JVM is modest. Class loading and linking of the application dependencies dominate the start up time of many applications. sbt reduces this start up latency by re-using some of the loaded classes between runs. It does this by creating a layered `ClassLoader` following the standard delegation model of a java `ClassLoader`. The outermost layer, which always contains the class files and jars specific to the project, is discarded between runs. The inner layers, however, can be reused.

Starting with sbt 1.3.0, it is possible to configure the particular approach that sbt takes to generate layered `ClassLoader` instances. It is specified via the `classLoaderLayeringStrategy`. There are three possible values:
1. **ScalaLibrary** - The parent of the outermost layer is able to load the scala standard library as well as the scala reflect library provided it is on the application classpath. This is the default strategy. It is most similar to the layered **ClassLoader** provided by sbt versions < 1.3.0.

2. **AllLibraryJars** - Adds an additional layer for all of the dependency jars between the scala library layer and the outermost layer. It is the default strategy when turbo mode is enabled. This strategy can significantly improve the startup and total runtime performance compared to ScalaLibrary. Results may be inconsistent if any of the libraries have mutable global state because, unlike ScalaLibrary, the global state persists between runs. When any libraries use java serialization, AllLibraryJars should be avoided.

3. Flat - No layering is used. The full classpath, as specified by the fullClasspath key of the task is loaded in the outermost layer. Consider using as an alternative to fork if any issues are experienced with ScalaLibrary or if the application requires all classes to be loaded in the same ClassLoader, which may be the case for some uses of java serialization.

The classLoaderLayeringStrategy can be set in different configurations. For example, to use the AllLibraryJars strategy in the Test configuration, add

```
Test / classLoaderLayeringStrategy := ClassLoaderLayeringStrategy.AllLibraryJars
```

to the build.sbt file. Assuming no other changes to the build.sbt file, The run task will still use ScalaLibrary strategy.

**Troubleshooting**

Java reflection may cause issues when used with layered classloaders because it is possible that the class method that loads another class via reflection may not have access to that class to be loaded. This is particularly likely if the class is loaded using Class.forName or Thread.currentThread.getContextClassLoader.loadClass. Consider the following example:

```scala
package example

import scala.concurrent.{ Await, Future }
import scala.concurrent ExecutionContext.Implicits.global
import scala.concurrent.duration.Duration

object ReflectionExample {
  def main(args: Array[String]): Unit = Await.result(Future {
    val cl = Thread.currentThread.getContextClassLoader
    println(cl.loadClass("example.Foo"))
  })
}
```
If one runs ReflectionExample with sbt run using the sbt default ScalaLibrary strategy, it will fail with a ClassNotFoundException because the context classloader of the thread that backs the future is the scala library classloader which is not able to load project classes. To work around this limitation without changing the layering strategy to Flat, one can do the following:

1. Use Class.forName instead of ClassLoader.loadClass. The jvm implicitly uses the loader of the calling class for loading classes using Class.forName. In this case, ReflectionExample is the calling class and it will be in the same classloader as Foo since they are both part of the project classpath.

2. Provide a classloader for loading. In the example above, this can be done by replacing val cl = Thread.currentThread.getContextClassLoader with val cl = getClass.getClassLoader.

For case (2), if the name lookup is performed by a library, then a ClassLoader parameter could be added to the library method that does the lookup. For example,

```scala
object Library {
  def lookup(name: String): Class[_] = 
    Thread.currentThread.getContextClassLoader.loadClass(name)
}
```
could be rewritten to

```scala
object Library {
  def lookup(name: String): Class[_] = 
    lookup(name, Thread.currentThread.getContextClassLoader)
  def lookup(name: String, loader: ClassLoader): Class[_] = 
    loader.loadClass(name)
}
```

Globs

sbt 1.3.0 introduces the Glob type which can be used to specify a file system query. The design is inspired by shell globs. Glob has only one public method, matches(java.nio.file.Path), that can be used to check if a path matches the glob pattern.
Constructing Globs

Globs can be constructed explicitly or using a dsl that uses the `/` operator to extend queries. In all of the examples provided, we use `java.nio.file.Path`, but `java.io.File` may also be used.

The simplest Glob represents a single path. Explicitly create a single path glob with:

```scala
val glob = Glob(Paths.get("foo/bar"))
println(glob.matches(Paths.get("foo"))) // prints false
println(glob.matches(Paths.get("foo/bar"))) // prints true
println(glob.matches(Paths.get("foo/bar/baz"))) // prints false
```

It can also be created using the glob dsl with:

```scala
val glob = Paths.get("foo/bar").toGlob
```

There are two special glob objects: 1) `AnyPath` (aliased by `*`) matches any path with just one name component 2) `RecursiveGlob` (aliased by `**`) matches all paths

Using `AnyPath`, we can explicitly construct a glob that matches all children of a directory:

```scala
val path = Paths.get("/foo/bar")
val children = Glob(path, AnyPath)
println(children.matches(path)) // prints false
println(children.matches(path.resolve("baz"))) // prints true
println(children.matches(path.resolve("baz").resolve("buzz"))) // prints false
```

Using the dsl, the above becomes:

```scala
val children = Paths.get("/foo/bar").toGlob / AnyPath
```

// these two definitions have identical results

Recursive globs are similar:

```scala
val path = Paths.get("/foo/bar")
val allDescendants = Glob(path, RecursiveGlob)
println(allDescendants.matches(path)) // prints false
println(allDescendants.matches(path.resolve("baz"))) // prints true
println(allDescendants.matches(path.resolve("baz").resolve("buzz"))) // prints true
```

or

```scala
val allDescendants = Paths.get("/foo/bar").toGlob / **
```
Path names

Globs may also be constructed using path names. The following three globs are equivalent:

```scala
val pathGlob = Paths.get("foo").resolve("bar")
val glob = Glob("foo/bar")
val altGlob = Glob("foo") / "bar"
```

When parsing glob paths, any `/` characters are automatically converted to `\` on windows.

Filters

Globs can apply name filters at each path level. For example,

```scala
val scalaSources = Paths.get("/foo/bar").toGlob / ** / "src" / "*.scala"
```

specifies all of the descendants of `/foo/bar` that have the `scala` file extension whose parent directory is named `src`.

More advanced queries are also possible:

```scala
val scalaAndJavaSources = Paths.get("/foo/bar").toGlob / ** / "src" / "*.{scala,java}"
```

Depth

The `AnyPath` special glob can be used to control the depth of the query. For example, the glob

```scala
val twoDeep = Glob("/foo/bar") / * / * / *
```

matches any path that is a descendant of `/foo/bar` that has exactly two parents, e.g. `/foo/bar/a/b/c.txt` would be accepted but not `/foo/bar/a/b` or `/foo/bar/a/b/c/d.txt`.

Regular expressions

The `Glob` apis use glob syntax (see `PathMatcher` for details). Regular expressions can be used instead:

```scala
val digitGlob = Glob("/foo/bar") / ".*-\d\{2,3\}.*.txt".r
digitGlob.matches(Paths.get("/foo/bar").resolve("foo-1.txt")) // false
digitGlob.matches(Paths.get("/foo/bar").resolve("foo-23.txt")) // true
digitGlob.matches(Paths.get("/foo/bar").resolve("foo-123.txt")) // true
```

It is possible to specify multiple path components in the regex:
Recursive globs cannot be expressed using regex syntax because `**` is not valid in a regex and paths are matched component wise (so "foo/**/foo.txt" is actually split into three regular expressions {"foo", ".*", "foo.txt"} for matching purposes. To make the `multiRegex` from above recursive, one could write:

```scala
val multiRegex = Glob("/foo/bar") / "baz-\d/".r / "foo.txt".r
multiRegex.matches(Paths.get("/foo/bar/baz-1/buzz/foo.txt")) // true
multiRegex.matches(Paths.get("/foo/bar/baz-12/buzz/foo.txt")) // true
```

In regex syntax, `\` is an escape character and cannot be used as a path separator. If the regex covers multiple path components, `/` must be used as the path separator, even on Windows:

```scala
val multiRegex = Glob("/foo/bar") / "baz-\d/\".r
val validRegex = Glob("/foo/bar") / "baz/Foo[.].txt".r
// throws java.util.regex.PatternSyntaxException because \F is not a valid regex construct
val invalidRegex = Glob("/foo/bar") / "baz\Foo[.].txt".r
```

### Querying the file system with FileTreeView

Querying the file system for the files that match one or more `Glob` patterns is done via the `sbt.nio.file.FileTreeView` trait. It provides two methods:

1. `def list(glob: Glob): Seq[(Path, FileAttributes)]`
2. `def list(globs: Seq[Glob]): Seq[(Path, FileAttributes)]`

that can be used to retrieve all of the paths matching the provided patterns.

```scala
val scalaSources: Glob = "** / "*.scala"
val regularSources: Glob = "/foo/src/main/scala" / scalaSources
val scala212Sources: Glob = "/foo/src/main/scala-2.12"
val allSources: Seq[Path] = FileTreeView.default.list(regularSources).map(_._1)
```

In the variant that takes `Seq[Glob]` as input, sbt will aggregate all of the globs in such a way that it will only ever list any directory on the file system once. It should return all of the files whose path name matches *any* of the provided `Glob` patterns in the input `Seq[Glob]`.

### File attributes

The `FileTreeView` trait is parameterized by a type, `T`, that is always `(java.nio.file.Path, sbt.nio.file.FileAttributes)` in sbt. The
**FileAttributes** trait provides access to the following properties:

1. **isDirectory** – returns true if the **Path** represents a directory.
2. **isRegularFile** – returns true if the **Path** represents a regular file. This should usually be the inverse of **isDirectory**.
3. **isSymbolicLink** – returns true if the **Path** is a symbolic link. The default **FileTreeView** implementation always follows symbolic links. If the symbolic link targets a regular file, both **isSymbolicLink** and **isRegularFile** will be true. Similarly, if the link targets a directory, both **isSymbolicLink** and **isDirectory** will be true. If the link is broken, **isSymbolicLink** will be true but both **isDirectory** and **isRegularFile** will be false.

The reason that the **FileTreeView** always provides the attributes is because checking the type of a file requires a system call, which can be slow. All of the major desktop operating systems provide APIs for listing a directory where both the file names and file node types are returned. This allows sbt to provide this information without making an extra system call. We can use this to efficiently filter paths:

```scala
// No additional io is performed in the call to attributes.isRegularFile
val scalaSourcePaths = FileTreeView.default.list(Glob("/foo/src/main/scala/**/*.scala")).collect {
  case (path, attributes) if attributes.isRegularFile => path
}
```

### Filtering

In addition to the **list** methods described above, there are two additional overloads that take an **sbt.nio.file.PathFilter** argument:

1. **def list(glob: Glob, filter: PathFilter): Seq[(Path, FileAttributes)]**
2. **def list(globs: Seq[Glob], filter: PathFilter): Seq[(Path, FileAttributes)]**

The **PathFilter** has a single abstract method:

```scala
def accept(path: Path, attributes: FileAttributes): Boolean
```

It can be used to further filter the query specified by the glob patterns:

```scala
val regularFileFilter: PathFilter = (a, a) => a.isRegularFile
val scalaSourceFiles = FileTreeView.list(Glob("/foo/bar/src/main/scala/**/*.scala"), regularFileFilter)
```

A **Glob** may be used as a **PathFilter**:

```scala
val filter: PathFilter = ** / "*include*"
val scalaSourceFiles = FileTreeView.default.list(Glob("/foo/bar/src/main/scala/**/*.scala"), filter)
```

Instances of **PathFilter** can be negated with the `!` unary operator:
val hiddenFileFilter: PathFilter = (p, _) => Try(Files.isHidden(p)).getOrElse(false)
val notHiddenFileFilter: PathFilter = !hiddenFileFilter

They can be combined with the && operator:

val regularFileFilter: PathFilter = (_, a) => a.isRegularFile
val notHiddenFileFilter: PathFilter = (p, _) => Try(Files.isHidden(p)).getOrElse(false)
val andFilter = regularFileFilter && notHiddenFileFilter
val scalaSources = FileTreeView.default.list(Glob("/foo/bar/src/main/scala/**/*.scala"), andFilter)

They can be combined with the || operator:

val scalaSources: PathFilter = ** / "*.scala"
val javaSources: PathFilter = ** / "*.java"
val jvmSourceFilter = scalaSources || javaSources
val jvmSourceFiles = FileTreeView.default.list(Glob("/foo/bar/src/**"), jvmSourceFilter)

There is also an implicit conversion from String to PathFilter that converts the String to a Glob and converts the Glob to a PathFilter:

val regularFileFilter: PathFilter = (p, a) => a.isRegularFile
val regularScalaFiles: PathFilter = regularFileFilter && "**/*.scala"

In addition to the ad-hoc filters, there are some commonly used filters that are available in the default sbt scope:

1. sbt.io.HiddenFileFilter – accepts any file that is hidden according to Files.isHidden. On posix systems, this will just check if the name starts with . while on Windows, it will need to perform io to extract the dos:hidden attribute.
2. sbt.io.RegularFileFilter – equivalent to (_, a: FileAttributes) => a.isRegularFile

There is also a converter from sbt.io.FileFilter to sbt.nio.file.PathFilter that can be invoked by calling toNio on the sbt.io.FileFilter instance:

val excludePathFilter: sbt.nio.file.PathFilter = excludeFilter.toNio

The HiddenFileFilter, RegularFileFilter and DirectoryFilter inherit both sbt.io.FileFilter and sbt.nio.file.PathFilter. They typically can be treated like a PathFilter:

val regularScalaFiles: PathFilter = RegularFileFilter && "**/*.scala"

This will not work when the implicit conversion from String to PathFinder is required.
val regularScalaFiles = RegularFileFilter && "**/*.scala"
// won't compile because it gets interpreted as
// (RegularFileFilter: sbt.io.FileFilter).&&("**/*.scala": sbt.io.NameFilter)

In these situations, use toNio:

val regularScalaFiles = RegularFileFilter.toNio && "**/*.scala"

It is important to note that semantics of Glob are different from NameFilter. When using the sbt.io.FileFilter, in order to filter files ending with the .scala extension, one would write:

val scalaFilter: NameFilter = "*.scala"

An equivalent PathFilter is written

val scalaFilter: PathFilter = "**/*.scala"

The glob represented "*.scala" matches a path with a single component ending in scala. In general, when converting sbt.io.NameFilter to sbt.nio.file.PathFilter, it will be necessary to add a "**/" prefix.

Streaming

In addition to FileTreeView.list, there is also FileTreeView.iterator. The latter may be used to reduce memory pressure:

// Prints all of the files on the root file system
FileTreeView.iterator(Glob("/**")).foreach { case (p, _) => println(p) }

In the context of sbt, the type parameter, T, is always (java.nio.file.Path, sbt.nio.file.FileAttributes). An implementation of FileTreeView is provided in sbt with the fileTreeView key:

fileTreeView.value.list(baseDirectory.value / ** / ".txt")

Implementation

The FileTreeView[+T] trait has a single abstract method:

def list(path: Path): Seq[T]

sbt only provides implementations of FileTreeView[(Path, FileAttributes)]. In this context, the list method should return the (Path, FileAttributes) pairs for all of the direct children of the input path.

There are two implementations of FileTreeView[(Path, FileAttribute)] provided by sbt: 1. FileTreeView.native – this uses a native jni library to efficiently extract the file names and attributes from the file system without performing additional io. Native implementations are available for 64 bit FreeBSD, Linux, Mac OS and Windows. If no native implementation is available, it falls
back to a java.nio.file based implementation. 2. FileTreeV
1\text{iew.nio} – uses
apis in java.nio.file to implement FileTreeV
1\text{iew}

The FileTreeV.default method returns FileTreeV.na\.tive.

The list and iterator methods that take Glob or Seq[Glob] as arguments are
provided as extension methods to FileTreeV[(Path, FileAttributes)].
Since any implementation of FileTreeV[(Path, FileAttributes)] automa\text{tically}
receives these extensions, it is easy to write an alternative implemen-
tation that will still correctly work with Glob and Seq[Glob]:

\begin{verbatim}
val listedDirectories = mutable.Set.empty[Path]
val trackingView: FileTreeV[(Path, FileAttributes)] = path => {
  val results = FileTreeV.default.list(path)
  listedDirectories += path
  results
}
val scalaSources =
  trackingView.list(Glob("/foo/bar/src/main/scala/**/*.scala")).map(_._1)
println(listedDirectories) // prints all of the directories traversed by list
\end{verbatim}

### Globs vs. PathFinder

sbt has long had the PathFinder api which provides a dsl for collecting files.
While there is overlap, Glob is a less powerful abstraction than PathFinder.
This makes them more suitable for optimization. Glob describe the what, but
not the how, of a query. PathFinders combine the what and the how, which
makes them more difficult to optimize. For example, the following sbt snippet:

\begin{verbatim}
val paths = fileTreeView.value.list(
  baseDirectory.value / ** / "*.scala",
  baseDirectory.value / ** / "*.java").map(_._1)
\end{verbatim}

will only traverse the file system once to collect all of the scala and java sources
in the project. By contrast,

\begin{verbatim}
val paths =
  (baseDirectory.value ** "*.scala" +++
  baseDirectory.value ** "*.java").allPaths
\end{verbatim}

will make two passes and will thus take about twice as long to run when com-
pared to the Glob version.

**Remote Caching**

sbt 1.4.0 / Zinc 1.4.0 virtualizes the file paths tracked during incremental com-
pilation, and uses content hash for change detection. With these combination,
we can realize repeatable build, also known as build as function.
This enables experimental remote caching (cached compilation) feature. The idea is for a team of developers and/or a continuous integration (CI) system to share build outputs. If the build is repeatable, the output from one machine can be reused by another machine, which can make the build significantly faster.

Usage

```scala
to := Some(MavenCache("local-cache", file("/tmp/remote-cache")))
```

Then from machine 1, call `pushRemoteCache`. This will publish the `*.class` and Zinc Analysis artifacts to the location. Next, from machine 2, call `pullRemoteCache`.

Remote caching via Maven repository

As of sbt 1.4.0, we're reusing the Maven publishing and resolution mechanism to exchange the cached build outputs. This is likely to easy to get started using existing infrastructure such as Bintray.

In the future, we might consider simpler cache server like plain HTTP server that uses `PUT` and `GET`. This would require someone to host an HTTP server somewhere, but provisioning them might become simpler.

ThisBuild / rootPaths

To abstract machine-specific paths such as your working directory and Coursier cache directory, sbt keeps a map of root paths in `ThisBuild / rootPaths`. If your build adds special paths for your source or output directory, add them to `ThisBuild / rootPaths`.

If you need to guarantee that `ThisBuild / rootPaths` contains all necessary paths you can set `ThisBuild / allowMachinePath` to `false`.

remoteCacheId

As of sbt 1.4.2, `remoteCacheId` uses hash of content hashes for input sources.

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:

```scala
lazy val app = (project in file("app"))
  .settings(
    Test / publishArtifact := true,
  )
```

To add them individually:

```scala
lazy val app = (project in file("app"))
  .settings(
    // enable publishing the jar produced by `Test/package`
    Test / packageBin / publishArtifact := true,
    
    // enable publishing the test API jar
    Test / packageDoc / publishArtifact := true,
    
    // enable publishing the test sources jar
    Test / packageSrc / publishArtifact := true,
  )
```

To disable main artifacts individually:

```scala
lazy val app = (project in file("app"))
  .settings(
    // disable publishing the main jar produced by `package`
    Compile / packageBin / publishArtifact := false,
    
    // disable publishing the main API jar
    Compile / packageDoc / publishArtifact := false,
    
    // disable publishing the main sources jar
    Compile / packageSrc / publishArtifact := 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:

```
Compile / packageBin / artifact := {
    val prev: Artifact = (Compile / packageBin / artifact).value
    prev.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) = (Compile / packageBin / packagedArtifact).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:

```scala
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:

```scala
lazy val app = (project in file("app"))
  .settings(
    addArtifact(...)
  )
```

### Publishing .war files

A common use case for web applications is to publish the `.war` file instead of the `.jar` file.

```scala
lazy val app = (project in file("app"))
  .settings(
    // disable .jar publishing
    Compile / packageBin / publishArtifact := false,
  )
```
// create an Artifact for publishing the .war file
Compile / packageWar / artifact := {
  val prev: Artifact = (Compile / packageWar / artifact).value
  prev.withType("war").withExtension("war")
},

// add the .war file to what gets published
addArtifact(Compile / packageWar / artifact, 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 classifier 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

There's a getting started page about library management, which you may want
to read first.

This page explains the relationship between the compile task and library de-
pendency management.

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.
In addition, sbt 1.x introduced the notion of Library Management API (LM API), which abstracted the notion of library management. As of sbt 1.3.0, there are two implementations for the LM API: one based on Coursier, and the other based on Apache Ivy.

Caching and Configuration

1. If no library dependency settings have changed since the last successful resolution and the retrieved files are still present, sbt does not ask dependency resolver (like Coursier) to perform resolution.
2. Changing the settings, such as adding or removing dependencies or changing the version or other attributes of a dependency, will automatically cause resolution to be performed.
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.
4. Clearing the task cache by running `clean` will also cause resolution to be performed.
5. Overriding all of the above, `update / skip := true` will tell sbt to never perform resolution. Note that this can cause dependent tasks to fail.

Notes on SNAPSHOTs

Repeatability of the build is paramount, especially when you share the build with someone else. SNAPSHOT versions are convenient way of locally testing something, but its use should be limited only to the local machine because it introduces mutability to the build, which makes it brittle, and the dependency resolution slower as the publish date must be checked over the network even when the artifacts are locally cached.

By default, SNAPSHOT artifacts in Coursier are given 24h time-to-live (TTL) to avoid network IO. If you need to force re-resolution of SNAPSHOTs, run sbt with `COURSIER_TTL` environment variable set to 0s.

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 directly in a .sbt 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/`:

```scala
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:

```scala
Compile / unmanagedJars := (baseDirectory.value ** "*.jar").classpath
```

If you want to add jars from multiple directories in addition to the default directory, you can do:

```scala
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 1.3.0+ uses Coursier to implement dependency management. Until sbt 1.3.0, sbt has used Apache Ivy for ten years. Coursier does a good job of keeping the
compatibility, but some of the feature might be specific to Apache Ivy. In those cases, you can use the following setting to switch back to Ivy:

```
ThisBuild / useCoursier := false
```

## 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/snapshots"

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

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

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/snapshots"

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]/[artifact]

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:

```scala
libraryDependencies += "slinky" % "slinky" % "2.1" from "https://slinky2.googlecode.com/svn/artifacts/2.1/slinky.jar"
```

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:

```scala
libraryDependencies += "org.apache.felix" % "org.apache.felix.framework" % "1.8.0" intransitive
```

**Classifiers**

You can specify the classifier for a dependency using the `classifier` method. For example, to get the jdk15 version of TestNG:

```scala
libraryDependencies += "org.testng" % "testng" % "5.7" classifier "jdk15"
```

For multiple classifiers, use multiple `classifier` calls:

```scala
libraryDependencies +=
  "org.lwjgl.lwjgl" % "lwjgl-platform" % lwjglVersion classifier "natives-windows" classifier "natives-linux" classifier "natives-osx"
```

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:

```scala
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,

```scala
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,

```scala
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`.

```scala
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:

```scala
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:

```scala
libraryDependencies += "org" % "name" % "rev" extra("color" -> "blue")
```
To define extra attributes on the current project:

```scala
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:

```xml
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:

```bash
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:

```scala
update / checksums := Nil
```

To disable checksum creation during artifact publishing:

```scala
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
```
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:

```scala
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:

```scala
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```
::: ::::::::::::::::::::::::::::::::::::::::::::::::::::::::
:: UNRESOLVED DEPENDENCIES ::
::::::::::::::::::::::::::::::::::::::::::::::::::::::::
:: foundrylogic.vpp#vpp;2.2.1: not found
::::::::::::::::::::::::::::::::::::::::::::::::::::::::
```

Note: Unresolved dependencies path:
```
foundrylogic.vpp:vpp:2.2.1
+- org.apache.cayenne:cayenne-tools:3.0.2
+- org.apache.cayenne.plugins:maven-cayenne-plugin:3.0.2 (/foo/some-test/build.sbt#L28)
+- 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:

```scala```
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

---

298
to automatically download jQuery and then include it in your jar by modifying resources. For example:

```scala
val JS = config("js") hide

ivyConfigurations += JS

libraryDependencies += "jquery" % "jquery" % "3.2.1" % "js->default" from "https://code.jquery.com/jquery-3.2.1.min.js"

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:

```scala
libraryDependencies += "org.scalatest" %% "scalatest" % "2.1.3" % "test"
```

**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()`:

```scala
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 Coursier or 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:

- JFrog Artifactory Open Source
- JFrog Artifactory Pro
- Sonatype Nexus Repository Manager
- Apache Archiva
- CloudRepo

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.

~/.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
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:

```bash
export SBT_CREDENTIALS="$HOME/.ivy2/.credentials"
```

with file contents

```ini
realm=My Nexus Repository Manager
host=my.artifact.repo.net
user=admin
password=admin123
```

If the above does not work for your system, then another approach is to explicitly provide the boot credentials via:

```bash
-Dsbt.boot.credentials="$HOME/.ivy2/.credentials"
```

As well as add the credentials to your build file directly:

```scala
credentials += Credentials(Path.userHome / ".ivy2" / ".credentials")
```

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:

define image

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/scala/sbt-plugin-releases. If you do not, Nexus will stop short of proxing the original request to this url and issue a HTTP 404 in its place and the dependency will not resolve.
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 $HOME/.ivy2/local/. You can then use this project from other projects on the same machine.

Skip publishing

To avoid publishing a project, add the following setting to the subprojects that you want to skip:

```
publish / skip := true
```

Common use case is to prevent publishing of the root project.

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/repositories/snapshots")
```

To publish to a local maven repository:

```
publishTo := Some(MavenCache("local-maven", file("path/to/maven-repo/releases")))
```

To publish to a local Ivy repository:

```
publishTo := Some(Resolver.file("local-ivy", file("path/to/ivy-repo/releases")))
```

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")
}

Publishing locally

The publishLocal task will publish to the “local” Ivy repository. By default, this is at $HOME/.ivy2/local/. Other builds on the same machine can then list the project as a dependency. For example, if the project you are publishing has configuration parameters like:

ThisBuild / organization := "org.me"
ThisBuild / version := "0.1-SNAPSHOT"
name := "My Project"

Then another build on the same machine 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 to indicate that it’s a changing artifact.

*Note*: SNAPSHOT dependencies should be avoided beyond local testing since it makes dependency resolution slower and the build non-repeatable.

Similar to publishLocal, publishM2 task will publish the user’s Maven local repository. This is at the location specified by $HOME/.m2/settings.xml or at $HOME/.m2/repository/ by default. Another build would require Resolver.mavenLocal to resolve out of it:

resolvers += Resolver.mavenLocal

See Resolvers for more details.

Credentials

There are two ways to specify credentials for such a repository.

The first and better way is to load them from a file, for example:

credentials += Credentials(Path.userHome / ".sbt" / ".credentials")

The credentials file is a properties file with keys realm, host, user, and password. For example:

realm=Sonatype Nexus Repository Manager
host=my.artifact.repo.net
user=admin
password=admin123

The second way is to specify them inline:
credentials += Credentials("Sonatype Nexus Repository Manager", "my.artifact.repo.net", "admin", "admin123")

**NOTE:** Credentials matching is done using both: realm and host keys. The realm key is the HTTP WWW-Authenticate header’s realm directive, which is part of the response of HTTP servers for HTTP Basic Authentication. For a given repository, this can be found by reading all the headers received. For example:

curl -D - my.artifact.repo.net

**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:

```scala
pomExtra := <something></something>
```

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`.

```scala
pomPostProcess := { (node: Node) =>
  ...
}
```

`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:

```scala
pomIncludeRepository := { (repo: MavenRepository) =>
  repo.root.startsWith("file:")
}
```
Version scheme

sbt 1.4.0 adds a new setting called `ThisBuild / versionScheme` to track version scheme of the build:

`ThisBuild / versionScheme := Some("early-semver")`

The supported values are "early-semver", "pvp", "semver-spec", and "strict". sbt will include this information into `pom.xml` and `ivy.xml` as a property.

versionScheme
description
Some("early-semver")

Early Semantic Versioning that would keep binary compatibility across patch updates within 0.Y.z (for instance 0.13.0 and 0.13.2). Once it goes 1.0.0, it follows the regular Semantic Versioning where 1.1.0 is bincompat with 1.0.0.

Some("semver-spec")

Semantic Versioning where all 0.y.z are treated as initial development (no bincompat guarantees)

Some("pvp")

Haskell Package Versioning Policy where X.Y are treated as major version

Some("strict")

Requires exact match of version

Resolvers

Maven resolvers

Resolvers for Maven repositories are added as follows:

```scala
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.

Local Maven resolvers

Following adds a resolver to the Maven local repository:

```scala
resolvers += Resolver.mavenLocal
```
To add a resolver for a custom location:

```scala
resolvers += MavenCache("local-maven", file("path/to/maven-repo/releases"))
```

### Predefined resolvers

A few predefined repositories are available and are listed below:

- **Resolver.mavenLocal** This is the local Maven repository.
- **DefaultMavenRepository** This is the main Maven repository at https://repo1.maven.org/maven2/ and is included by default
- **JavaNet2Repository** This is the java.net Maven2 Repository at https://maven.java.net/content/repositories/public/
- **Resolver.sonatypeRepo("public")** (or “snapshots”, “staging”, “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/%5Bowner%5D/%5Brepo%5D/
- **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:

```scala
resolvers += JavaNet2Repository
```

Predefined repositories will go under Resolver going forward so they are in one place:

```scala
Resolver.sonatypeRepo("releases") // Or "snapshots"
```

### Custom resolvers

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.

```scala
resolvers += Resolver.file("my-test-repo", file("test")) transactional()
```

**URL**

Define a URL repository at "https://example.org/repo-releases/".

```scala
resolvers += Resolver.url("my-test-repo", url("https://example.org/repo-releases"))
```

To specify an Ivy repository, use:

```scala
resolvers += Resolver.url("my-test-repo", 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":

```scala
resolvers += Resolver.sftp("my-sftp-repo", "example.org")
```

To explicitly specify the port:

```scala
resolvers += Resolver.sftp("my-sftp-repo", "example.org", 22)
```

To specify a base path:

```scala
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:

```scala
resolvers += Resolver.ssh("my-ssh-repo", "example.org") as("user", "password")
```

or to be prompted for the password:

```scala
resolvers += Resolver.ssh("my-ssh-repo", "example.org") as("user")
```

To use key authentication:

```scala
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:

```scala
resolvers += Resolver.ssh("my-ssh-repo", "example.org") as("user", keyFile)
```
To specify the permissions used when publishing to the server:

```scala
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:

```scala
resolvers += Resolver.url("my-test-repo", url)( Patterns("[organisation]/[module]/[revision]/[artifact].[ext]") )
```

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`:

```scala
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 `Artifact` list is always empty for `update`, which will fail if it is non-empty. However, it may be non-empty for `updateClassifiers` and `updateSbtClassifiers`.

**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:

```scala
def matching(f: DependencyFilter): Seq[File]
```

```scala
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.

```scala
import sbt._
// each argument is of type NameFilter
val mf: ModuleFilter = moduleFilter(organization = "*sbt*", name = "main" | "actions", revision = "1.\*" - "1.0")

// 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 NameFilter
val nf: NameFilter = (s: String) => s.startsWith("dispatch-")

// a Set[String] is a function String => Boolean
val acceptConfigs: Set[String] = Set("compile", "test")
```

311
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 `ConfigurationFilters`.

```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 `NameFilters`: 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:

```scala
def moduleFilter(organization: NameFilter = ..., name: NameFilter = ..., revision: NameFilter = ...): ModuleFilter
```

An omitted argument does not contribute to the match. If all arguments are omitted, the filter matches all `ModuleIDs`. 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 `ModuleFilters`:

```scala
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:

```scala
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:

```scala
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:

```scala
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:

```scala
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

The 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, the Cached Resolution feature creates minigraphs – one for each direct dependency appearing in all related sub-projects. These minigraphs are resolved using Ivy’s resolution engine, and the result is stored locally under `$HOME/.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 `$HOME/.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 projects A, B, and C, all hitting the same set of json files.

fig1

The actual speedup will vary case by case, but you should see significant speedup if you have many subprojects. An initial report from a user showed a change from 260s to 25s. Your mileage 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 the 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 seems 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->compile(*),master(*);runtime->runtime(*)"/>
```

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 experience 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 latestSnapshots, 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 servers. So here’s how to disable it:

```scala
updateOptions := updateOptions.value.withLatestSnapshots(false)
```

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 greater the chance of version conflicts. 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 exclusion 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
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
}

318
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`.

```
Test / sampleTask := (Compile / intTask).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:

```
(Test / sampleTask).:=((Compile / intTask).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 implementation
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

NOTE! Make sure to assign the ScopeFilter as a val! This is an implementation detail requirement of the .all macro.

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

val filter = ScopeFilter(inProjects(core, util), inConfigurations(Compile))

lazy val root = project.settings{
    sources := {
        // 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 ),
```
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:

```scala
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:

<table>
<thead>
<tr>
<th>Target</th>
</tr>
</thead>
</table>
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.

```scala
val filter: ScopeFilter = ScopeFilter( inAggregates(ThisProject, includeRoot=false) )

maxErrors := {
  // 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.

323
• **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):

```scala
// 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:

```scala
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:

```scala
logLevel in myTask := Level.Debug
```

```scala
traceLevel in myTask := 5
```

To obtain the last logging output from a task, use the last command:

```bash
$ 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.

**Conditional task**

(Requires sbt 1.4.0+)

When `Def.task { ... }` consists of an if-expression at the top-level, a conditional task (or Selective task) is automatically created:

```scala
bar := {
  if (number.value < 0) negAction.value
  else if (number.value == 0) zeroAction.value
  else posAction.value
}
```

Unlike the regular (Applicative) task composition, conditional tasks delays the evaluation of then-clause and else-clause as naturally expected of an if-expression. This is already possible with `Def.taskDyn { ... }`, but unlike dynamic tasks, conditional task works with inspect command.
Dynamic Computations with \texttt{Def.taskDyn}

It can be useful to use the result of a task to determine the next tasks to evaluate. This is done using \texttt{Def.taskDyn}. The result of \texttt{taskDyn} is called a dynamic task because it introduces dependencies at runtime. The \texttt{taskDyn} method supports the same syntax as \texttt{Def.task} and \texttt{:=} except that you return a task instead of a plain value.

For example,

```scala
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 \texttt{myTask} is \texttt{stringTask}. The dependency on \texttt{intTask} is only introduced in non-dev mode.

\textbf{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 \texttt{taskDyn} referenced \texttt{myTask}.

Using \texttt{Def.sequential}

sbt 0.13.8 added \texttt{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 \texttt{compilecheck} that runs \texttt{Compile / compile} and then \texttt{Compile / scalastyle} task added by \texttt{scalastyle-sbt-plugin}.
lazy val compilecheck = taskKey[Unit]("compile and then scalastyle")

lazy val root = (project in file("."))
  .settings(
    Compile / compilecheck := Def.sequential(
      Compile / compile,
      (Compile / scalastyle).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] 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:

<table>
<thead>
<tr>
<th>invoked task</th>
<th>intTask result</th>
<th>aTask result</th>
<th>bTask result</th>
<th>cTask result</th>
<th>overall result</th>
</tr>
</thead>
<tbody>
<tr>
<td>intTask</td>
<td>failure</td>
<td>not run</td>
<td>not run</td>
<td>not run</td>
<td>failure</td>
</tr>
<tr>
<td>aTask</td>
<td>failure</td>
<td>success</td>
<td>not run</td>
<td>not run</td>
<td>success</td>
</tr>
<tr>
<td>bTask</td>
<td>failure</td>
<td>not run</td>
<td>failure</td>
<td>not run</td>
<td>failure</td>
</tr>
<tr>
<td>cTask</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
failure
cTask
failure
success
failure
failure
failure
intTask
success
not run
not run
not run
success
aTask
success
failure
not run
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:

```scala
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:

```scala
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:

```scala
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:

```scala
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.

### Caching

Tasks and settings are introduced in the getting started guide, and explained in more detail in Tasks. You may wish to read them first.

When you define a custom task, you might want to cache the value to avoid unnecessary work.

#### Cache.cached

`sbt.util.Cache` provides a basic caching facility:

```scala
package sbt.util

/**
 * A simple cache with keys of type `I` and values of type `O`
 */
trait Cache[I, O] {
```
/**
 * Queries the cache backed with store `store` for key `key`.
 */
def apply(store: CacheStore)(key: I): CacheResult[O]
}

We can derive the instances of `Cache[I, O]` from `sjsonnew.JsonFormat` instances for both `I` and `O` by importing `sbt.util.CacheImplicits._` (This also brings in `BasicJsonProtocol`).

To use the cache, we can create a `cached` function by calling `Cache.cached` with a `CacheStore` (or a file) and a function that does the actual work. Normally, the cache store would be created as `streams.value.cacheStoreFactory"something"`. In the following REPL example, I will create a cache store from a temp file.

```scala
import sbt._, sbt.util.CacheImplicits._
import sbt._
import sbt.util.CacheImplicits._

def doWork(i: Int): List[String] = {
  println("working...")
  Thread.sleep(1000)
  List.fill(i)("foo")
}
doWork: (i: Int)List[String]

// use streams.value.cacheStoreFactory.make("something") for real tasks
val store = sbt.util.CacheStore(file("/tmp/something"))
store: sbt.util.CacheStore = sbt.util.FileBasedStore@5a4a6716

cachedWork: Int => List[String] = sbt.util.Cache$$Lambda$5577/1548870528@3bb59fba

cachedWork(1)
working...
res0: List[String] = List(foo)

cachedWork(1)
res1: List[String] = List(foo)

cachedWork(3)
working...
res2: List[String] = List(foo, foo, foo)

cachedWork(1)
```
As you can see, `cachedWork(1)` is cached when it is called consecutively.

### Previous value

`TaskKey` has a method called `previous` that returns `Option[A]`, which can be used a lightweight tracker. Suppose we would want to create a task where it initially returns "hi", and append "!" for subsequent calls, you can define a `TaskKey[String]` called `hi`, and retrieve its previous value, which would be typed `Option[String]`. The previous value would be `None` the first time, and `Some(x)` for the subsequent calls.

```scala
lazy val hi = taskKey[String]("say hi again")
hi := {
  import sbt.util.CacheImplicits._
  val prev = hi.previous
  prev match {
    case None => "hi"
    case Some(x) => x + "!
  }
}
```

We can test this by running `show hi` from the sbt shell:

```
sbt:hello> show hi
[info] hi
[success] Total time: 0 s, completed Aug 16, 2019 12:24:32 AM
sbt:hello> show hi
[info] hi!
[success] Total time: 0 s, completed Aug 16, 2019 12:24:33 AM
sbt:hello> show hi
[info] hi!!
[success] Total time: 0 s, completed Aug 16, 2019 12:24:34 AM
sbt:hello> show hi
[info] hi!!!
[success] Total time: 0 s, completed Aug 16, 2019 12:24:35 AM
```

For each call `hi.previous` contains the previous result from evaluating `hi`.

### Tracked.lastOutput

`sbt.util.Tracked` provides a facility for partial caching that can be mixed and matched with other trackers.
Similar to the previous value associated with task keys, `sbt.util.Tracked.lastOutput` creates a tracker for the last calculated value. `Tracked.lastOutput` offers more flexibility in terms of where to store the value. (This allows the value to be shared across multiple tasks).

Suppose we would initially take an `Int` as the input, and turn it into a `String`, but for subsequent invocation we’d append "!":

```scala
import sbt._, sbt.util.CacheImplicits._
import sbt._
import sbt.util.CacheImplicits._

// use streams.value.cacheStoreFactory.make("last") for real tasks
val store = sbt.util.CacheStore(file("/tmp/last"))
store: sbt.util.CacheStore = sbt.util.FileBasedStore@5a4a6716

val badCachedWork = Tracked.lastOutput[Int, String](store) {
  case (in, None) => in.toString
  case (in, Some(read)) => read + "!"
}
badcachedWork: Int => String = sbt.util.Tracked$$Lambda$6326/638923124@68c6ff60

badCachedWork(1)
res1: String = 1

badCachedWork(1)
res2: String = 1!

badCachedWork(2)
res3: String = 1!!

badCachedWork(2)
res4: String = 1!!!

Note: `Tracked.lastOutput` does not invalidate the cache when the input changes.

See the `Tracked.inputChanged` section below to make this work.

**Tracked.inputChanged**

To track the changes of input parameters, use `Tracked.inputChanged`.

```scala
import sbt._, sbt.util.CacheImplicits._
import sbt._
import sbt.util.CacheImplicits._
```
// use streams.value.cacheStoreFactory.make("input") for real tasks
scala> val store = sbt.util.CacheStore(file("/tmp/input"))
store: sbt.util.CacheStore = sbt.util.FileBasedStore@5a4a6716

scala> val tracker = Tracked.inputChanged[Int, String](store) { case (changed, in) => 
    if (changed) {
      println("input changed")
    }
    in.toString
  }
tracker: Int => String = sbt.util.Tracked$\$$Lambda$8357/1296627950e6837@6e6837e4

scala> tracker(1)
input changed
res6: String = 1

scala> tracker(1)
res7: String = 1

scala> tracker(2)
input changed
res8: String = 2

scala> tracker(2)
res9: String = 2

scala> tracker(1)
input changed
res10: String = 1

Now, we can nest Tracked.inputChanged and Tracked.lastOutput to regain the cache invalidation.

// use streams.value.cacheStoreFactory
scala> val cacheFactory = sbt.util.CacheStoreFactory(file("/tmp/cache"))
cacheFactory: sbt.util.CacheStoreFactory = sbt.util.DirectoryStoreFactory@3a3d3778

scala> def doWork(i: Int): String = {
    println("working...")
    Thread.sleep(1000)
    i.toString
  }
doWork: (i: Int)String

scala> val cachedWork2 = Tracked.inputChanged[Int, String](cacheFactory.make("input")) { case (in, None) => doWork(in)

335
case (in, Some(read)) =>
  if (changed) doWork(in)
  else read
}
tracker(in)
}
cachedWork2: Int => String = sbt.util.Tracked$$Lambda$$6548/97230846701c9788cc

scala> cachedWork2(1)
working...
res0: String = 1

scala> cachedWork2(1)
res1: String = 1

One benefit of combining trackers and/or previous value is that we can control the invalidation timing. For example, we can create a cache that works only twice.

lazy val hi = taskKey[String]("say hi")
lazy val hiCount = taskKey[(String, Int)]("track number of the times hi was called")

hi := hiCount.value._1
hiCount := {
  import sbt.util.CacheImplicits._
  val prev = hiCount.previous
  val s = streams.value
  def doWork(x: String): String = {
    s.log.info("working...")
    Thread.sleep(1000)
    x + "!"
  }
  val cachedWork = Tracked.inputChanged[String, (String, Int)](s.cacheStoreFactory.make("input")) prev match {
    case None => (doWork(in), 0)
    case Some((last, n)) =>
      if (changed || n > 1) (doWork(in), 0)
      else (last, n + 1)
  }
  cachedWork("hi")
}

This uses hiCount task’s previous value to track the number of times it got called, and invalidates the cache when n > 1.
### Tracking file attributes

Files often come up as caching targets, but `java.io.File` just carries the file name, so it’s not very useful on its own for the purpose of caching.

For file caching, sbt provides a facility called `sbt.util.FileFunction.cached(…)` to cache file inputs and outputs. The following example implements a cached task that counts the number of lines in `*.md` and outputs `*.md` under cross target directory with the number of lines as their contents.

```scala
lazy val countInput = taskKey[Seq[File]]("")
lazy val countFiles = taskKey[Seq[File]]("")

  in map { source =>
    val out = outDir / source.getName
    val c = IO.readLines(source).size
    IO.write(out, c + 
               

  out
  }
}

lazy val root = (project in file("."))
  .settings{
    countInput :=
      sbt.nio.file.FileTreeView.default
        .list(Glob(baseDirectory.value + "/*.md"))
        .map(_.toFile),
    countFiles := {
      val s = streams.value
      val in = countInput.value
      val t = crossTarget.value

      // wraps a function doCount in an up-to-date check
      val cachedFun = FileFunction.cached(s.cacheDirectory / "count") { (in: Set[File]) =>
        doCount(in, t): Set[File]
      }
      // Applies the cached function to the inputs files
      cachedFun(in.toSet).toSeq.sorted
    },
```
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.

**FileInfo**

- `FileInfo.exists` tracks if the file exists
- `FileInfo.lastModified` track the last modified timestamp
- `FileInfo.hash` tracks the SHA-1 content hash
- `FileInfo.full` tracks both the last modified and the content hash

```
scala> FileInfo.exists(file("/tmp/cache/last"))
res23: sbt.util.PlainFileInfo = PlainFile(/tmp/cache/last,true)
```

```
scala> FileInfo.lastModified(file("/tmp/cache/last"))
res24: sbt.util.ModifiedFileInfo = FileModified(/tmp/cache/last,1565855326328)
```

```
scala> FileInfo.hash(file("/tmp/cache/last"))
res25: sbt.util.HashFileInfo = FileHash(/tmp/cache/last,List(-89,-11,75,97,65,-109,-74,-126,-124,43,37,-16,9,-92,-70,-100,-82,95,93,-112))
```

```
scala> FileInfo.full(file("/tmp/cache/last"))
res26: sbt.util.HashModifiedFileInfo = FileHashModified(/tmp/cache/last,List(-89,-11,75,97,65,-109,-74,-126,-124,43,37,-16,9,-92,-70,-100,-82,95,93,-112)),1565855326328)
```

There is also `sbt.util.FilesInfo` that accepts a `Set` of `File`s (though this doesn’t always work due to complicated abstract type that it uses).

```
scala> FilesInfo.exists(Set(file("/tmp/cache/last"), file("/tmp/cache/nonexistent")))
res31: sbt.util.FilesInfo[_1.F] forSome { val _1: sbt.util.FileInfo.Style } = FilesInfo(Set(PlainFile(/tmp/cache/last,true), PlainFile(/tmp/cache/nonexistent,false)))
```

**Tracked.inputChanged**

The following example implements a cached task that counts the number of lines in README.md.

```
lazy val count = taskKey[Int]("
```

```
count := {
  import sbt.util.CacheImplicit._
  val prev = count.previous
  val s = streams.value
  val toCount = baseDirectory.value / "README.md"
  def doCount(source: File): Int = {
    s.log.info("working...")
    IO.readLines(source).size
  }
```

338
```scala
val cachedCount = Tracked.inputChanged[ModifiedFileInfo, Int](s.cacheStoreFactory.make("input")
  (changed: Boolean, in: ModifiedFileInfo) =>
  prev match {
    case None => doCount(in.file)
    case Some(last) =>
      if (changed) doCount(in.file)
      else last
  }
}
cachedCount(FileInfo.lastModified(toCount))
```

We can try this by running `show count` from the sbt shell:

```text
sbt:hello> show count
[info] working...
[info] 2
[success] Total time: 0 s, completed Aug 16, 2019 9:58:38 PM
sbt:hello> show count
[info] 2
[success] Total time: 0 s, completed Aug 16, 2019 9:58:39 PM
```

```text
// change something in README.md
sbt:hello> show count
[info] working...
[info] 3
[success] Total time: 0 s, completed Aug 16, 2019 9:58:44 PM
```

This works out-of-box thanks to `sbt.util.FileInfo` implementing `JsonFormat` to persist itself.

**Tracked.outputChanged**

The tracking works by stamping the files (collecting file attributes), storing the stamps in a cache, and comparing them later. Sometimes, it's important to pay attention to the timing of when stamping happens. Suppose that we want to format TypeScript files, and use SHA-1 hash to detect changes. Stamping the files before running the formatter would cause the cache to be invalidated in subsequent calls to the task. This is because the formatter itself may modify the TypeScript files.

Use `Tracked.outputChanged` stamps after your work is done to prevent this.

```scala
lazy val compileTypeScript = taskKey[Unit]("compiles *.ts files")
lazy val formatTypeScript = taskKey[Seq[File]]("format *.ts files")
```
compileTypeScript / sources := (baseDirectory.value / "src").globRecursive("*.ts").get

formatTypeScript := {
  import sbt.util.CacheImplicits._
  val s = streams.value
  val files = (compileTypeScript / sources).value

  def doFormat(source: File): File = {
    s.log.info(s"formatting $source")
    val lines = IO.readLineList(source)
    IO.writeLines(source, lines ++ List("// something"))
    source
  }
  val tracker = Tracked.outputChanged(s.cacheStoreFactory.make("output")) {
    (outChanged: Boolean, outputs: Seq[HashFileInfo]) =>
    if (outChanged) outputs map { info => doFormat(info.file) }
    else outputs map { _.file }
  }
  tracker(() => files.map(FileInfo.hash(_)))
}

Type formatTypeScript from the sbt shell to see how it works:

sbt:hello> formatTypeScript
[info] formatting /Users/eed3si9n/work/hellotest/src/util.ts
[success] Total time: 0 s, completed Aug 17, 2019 10:07:30 AM
sbt:hello> formatTypeScript
[success] Total time: 0 s, completed Aug 17, 2019 10:07:32 AM

One potential drawback of this implementation is that we only have true/false information about the fact that any of the files have changed. This could result in a reformattting of all of the files anytime one file gets changed.

// make change to one file
sbt:hello> formatTypeScript
[info] formatting /Users/eed3si9n/work/hellotest/src/util.ts
[info] formatting /Users/eed3si9n/work/hellotest/src/hello.ts
[success] Total time: 0 s, completed Aug 17, 2019 10:13:47 AM

See the Tracked.diffOuputs in the below to prevent this all-or-nothing behavior.

Another potential use for Tracked.outputChanged is using it with FileInfo.exists(_)) to track if the output file still exists. This is usually not necessary if you output something under target directory where caches are also stored.

340
Tracked.diffInputs

The Tracked.inputChanged tracker only gives Boolean value, so when the cache is invalidated we need to redo all the work. Use Tracked.diffInputs to track the differences.

Tracked.diffInputs reports a datatype called sbt.util.ChangeReport:

```scala
/** The result of comparing some current set of objects against a previous set of objects. */
trait ChangeReport[T] {

  /** The set of all of the objects in the current set. */
  def checked: Set[T]

  /** All of the objects that are in the same state in the current and reference sets. */
  def unmodified: Set[T]

  /**
   * All checked objects that are not in the same state as the reference. This includes objects in both sets but have changed and files that are only in one set.
   */
  def modified: Set[T] // all changes, including added

  /** All objects that are only in the current set. */
  def added: Set[T]

  /** All objects only in the previous set */
  def removed: Set[T]

}
```

Let's see how the report works by printing it out.

```scala
lazy val compileTypeScript = taskKey[Unit]("compiles *.ts files")

compileTypeScript / sources := (baseDirectory.value / "src").globRecursive("*.ts").get
compileTypeScript := {
  val s = streams.value
  val files = (compileTypeScript / sources).value
  Tracked.diffInputs(s.cacheStoreFactory.make("input_diff"), FileInfo.lastModified)(files.toSet) { inDiff: ChangeReport[File] =>
    s.log.info(inDiff.toString)
  }
}
```

Here's how it looks when you rename a file for example:
If we had a mapping between *.ts files and *.js files, then we should be able to make the compilation more incremental. For incremental compilation of Scala, Zinc tracks both the relationship between the *.scala and *.class files as well as the relationship among *.scala. We could make something like that for TypeScript. Save the following as project/TypeScript.scala:

```scala
import sbt._
import sjsonnew.{ :*:, LList, LNil}
import sbt.util.CacheImplicits._

/**
 * products - products keep the mapping between source *.ts files and *.js files that are generated.
 * references - references keep the mapping between *.ts files referencing other *.ts files.
 */

case class TypeScriptAnalysis(products: List[(File, File)], references: List[(File, File)]) {
  def ++(that: TypeScriptAnalysis): TypeScriptAnalysis =
    TypeScriptAnalysis(products ++ that.products, references ++ that.references)
}

object TypeScriptAnalysis {
  implicit val analysisIso = LList.iso(
    { a: TypeScriptAnalysis => ("products", a.products) :*: ("references", a.references) :*: 
      { in: List[(File, File)] :*: List[(File, File)] :*: LNil => TypeScriptAnalysis(in._1, in._2)}
  }
}
```

In the build.sbt:

```scala
lazy val compileTypeScript = taskKey[TypeScriptAnalysis]("compiles *.ts files")

compileTypeScript / sources := (baseDirectory.value / "src").globRecursive("*.ts").get
compileTypeScript / target := target.value / "js"
compileTypeScript := {
```
import sbt.util.CacheImplicits_
val prev0 = compileTypeScript.previous
val prev = prev0.getOrElse(TypeScriptAnalysis(Nil, Nil))
val s = streams.value
val files = (compileTypeScript / sources).value

def doCompile(source: File): TypeScriptAnalysis = {
  println("working...")
  val out = (compileTypeScript / target).value / source.getName.replaceAll(""\ts$"", "")
  IO.touch(out)
  // add a fake reference from any file to util.ts
  val references: List[(File, File)] =
  if (source.getName != "util.ts") List(source -> (baseDirectory.value / "src" / "util.ts"))
  else Nil
  TypeScriptAnalysis(List(source -> out), references)
}

Tracked.diffInputs(s.cacheStoreFactory.make("input_diff"), FileInfo.lastModified)(files.toSet)
(inDiff: ChangeReport[File]) =>
val products = scala.collection.mutable.ListBuffer(prev.products: _*)
val references = scala.collection.mutable.ListBuffer(prev.references: _*)
val initial = inDiff.modified & inDiff.checked
val reverseRefs = initial.flatMap(x => Set(x) ++ references.collect({ case (k, `x`) => k })
products --= products.filter({ case (k, v) => reverseRefs(k) || inDiff.removed(k) })
references --= references.filter({ case (k, v) => reverseRefs(k) || inDiff.removed(k) })
reverseRefs foreach { x =>
  val temp = doCompile(x)
  products ++= temp.products
  references ++= temp.references
}
TypeScriptAnalysis(products.toList, references.toList)
}

The above is a fake compilation that just creates .js files under target/js.

sbt:hello> compileTypeScript
working...
working...
[success] Total time: 0 s, completed Aug 16, 2019 10:22:58 PM
sbt:hello> compileTypeScript
[success] Total time: 0 s, completed Aug 16, 2019 10:23:03 PM

Since we added a reference from hello.ts to util.ts, if we modified src/util.ts, it should trigger the compilation of src/util.ts as well as src/hello.ts.

sbt:hello> show compileTypeScript
working...
It works.

Tracked.diffOutputs

Tracked.diffOutputs is a finer version of Tracked.outputChanged that stamps after the work is done, and also able to report the set of modified files.

This can be used to format only the changed TypeScript files.

```scala
lazy val formatTypeScript = taskKey[Seq[File]]("format *.ts files")

compileTypeScript / sources := (baseDirectory.value / "src").globRecursive("*.ts").get
formatTypeScript := {
  val s = streams.value
  val files = (compileTypeScript / sources).value
  def doFormat(source: File): File = {
    s.log.info(s"formatting $source")
    val lines = IO.readLineers(source)
    IO.writeLines(source, lines ++ List("// something"))
    source
  }
  Tracked.diffOutputs(s.cacheStoreFactory.make("output_diff"), FileInfo.hash)(files.toSet) {
    (outDiff: ChangeReport[File]) =>
    val initial = outDiff.modified & outDiff.checked
    initial.toList map doFormat
  }
}
```

Here's how formatTypeScript looks like in the shell:

```bash
sbt:hello> formatTypeScript
[info] formatting /Users/eed3si9n/work/hellotest/src/util.ts
[info] formatting /Users/eed3si9n/work/hellotest/src/hello.ts
[success] Total time: 0 s, completed Aug 17, 2019 9:28:56 AM
```

Case study: sbt-scalafmt

sbt-scalafmt implements scalafmt and scalafmtCheck tasks that cooperate with each other. For example, if scalafmt ran successfully, and no changes have been made to the sources, it will skip scalafmtCheck's checking.

Here's a snippet of how that may be implemented:
private def cachedCheckSources(
  cacheStoreFactory: CacheStoreFactory,
  sources: Seq[File],
  config: Path,
  log: Logger,
  writer: PrintWriter
): ScalafmtAnalysis = {
  trackSourcesAndConfig(cacheStoreFactory, sources, config) { (outDiff, configChanged, prev) =>
    log.debug(outDiff.toString)
    val updatedOrAdded = outDiff.modified & outDiff.checked
    val filesToCheck = if (configChanged) sources
      else updatedOrAdded.toList
    val failed = prev.failed filter { _.exists }
    val files = (filesToCheck ++ failed.toSet).toSeq
    val result = checkSources(files, config, log, writer)
    // cachedCheckSources moved the outDiff cursor forward,
    // save filesToCheck so scalafmt can later run formatting
    prev.copy(
      failed = result.failed,
      pending = (prev.pending ++ filesToCheck).distinct
    )
  }
}

private def trackSourcesAndConfig(
  cacheStoreFactory: CacheStoreFactory,
  sources: Seq[File],
  config: Path
)(
  f: (ChangeReport[File], Boolean, ScalafmtAnalysis) => ScalafmtAnalysis
): ScalafmtAnalysis = {
  val prevTracker = Tracked.lastOutput[Unit, ScalafmtAnalysis](cacheStoreFactory.make("last"),
    (_, prev0) =>
      val prev = prev0.getOrElse(ScalafmtAnalysis(Nil, Nil))
      val tracker = Tracked.inputChanged[HashFileInfo, ScalafmtAnalysis](cacheStoreFactory.make("config"),
        case (configChanged, configHash) =>
          Tracked.diffOutputs(cacheStoreFactory.make("output-diff"), FileInfo.lastModified)(source =>
            (outDiff: ChangeReport[File]) =>
              f(outDiff, configChanged, prev)
          )
      )
      tracker(FileInfo.hash(config.toFile))
  )
  prevTracker()
In the above, `trackSourcesAndConfig` is a triple-nested tracker that tracks configuration file, source last modified stamps, and the previous value shared between two tasks. To share the previous value across two different tasks, we are using `Tracked.lastOutput` instead of the `.previous` method associated with the keys.

Summary

Depending on the level of control you need, sbt offers a flexible set of utilities to cache and track values and files.

- `.previous`, `FileFunction.cached`, and `Cache.cached` are the basic cache to get started.
- To invalidate some result based on a change to its input parameters, use `Tracked.inputChanged`.
- File attributes can be tracked as values by using `FileInfo.exists`, `FileInfo.lastModified`, and `FileInfo.hash`.
- `Tracked` offers trackers that are often nested to track input invalidation, output invalidation, and diffing.

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:

```scala
// 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`.

346
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.

```scala
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)
  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 2.12.14, the current sbt version is 1.6.2, and there are 3 commands left to run):

- (scala,2.12.14)
- (sbt,1.6.2)
- (commands,3)

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.

```scala
val run2 = inputKey[Unit](
  "Runs the main class twice with different argument lists separated by --")

val separator: Parser[String] = "--"

run2 := {
  val one = (Compile / run).evaluated
  val sep = separator.parsed
  val two = (Compile / run).evaluated
}
```

For a main class `Demo` that echoes its arguments, this looks like:

```
$ sbt
```

349
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

```scala
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 = (Compile / run).fullInput(firstInput.value).evaluated
```
val two = (Compile / run).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 _ = (Compile / run).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 = (Compile / run).toTask("blue green").value
    val y = (Compile / run).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 \((\text{State}, T) \mapsto \text{State}\), 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 \texttt{help} command to display command help.

**Defining a Command**

A command combines a function \(\text{State} \mapsto \text{Parser}[T]\) with an action \((\text{State}, T) \mapsto \text{State}\). The reason for \(\text{State} \mapsto \text{Parser}[T]\) and not simply \(\text{Parser}[T]\) 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:

```scala
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.

```scala
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.

```scala
// 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.

```scala
val action: (State, Seq[String]) => State = ...
```

// <arg> is the suggestion printed for tab completion on an argument
```scala
val command: Command = Command.command("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`:

```scala
import CommandExample._

ThisBuild / organization := "com.example"
ThisBuild / scalaVersion := "2.12.15"
ThisBuild / version := "0.1.0-SNAPSHOT"

lazy val root = (project in file("."))
  .settings(
    commands ++= Seq(hello, helloAll, failIfTrue, changeColor, printState)
  )
```

Here's `project/CommandExample.scala`:

```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._

  355
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 values.
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 not a digit
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.

```scala
def select1(items: Iterable[String]) =
  token(Space ~> StringBasic.examples(FixedSetExamples(items)))
```

```scala
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:

```scala
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:

```scala
val addPower2 = (state: State) => state ++ powerCommands
```

Some examples of functions that modify the remaining commands to execute:

```scala
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`.

```scala
(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:

```scala
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 Settings 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:

```scala
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:

```scala
import Keys._
val extracted: Extracted
import extracted._

// get name of current project
val nameOpt: Option[String] = (currentRef / name).get(structure.data)
```
val pkgOpts: Seq[PackageOption] = (currentRef / Test / packageSrc / packageOptions).get(structure.data.getOrElse(Nil))

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:

- localBase: File

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:

```scala
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 = Compile / Keys.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 Incomplete.show(inc.tpe) to get an error message
    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]]] =
  (projectRef / Test / Keys.fullClasspath)

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 ...

Updating State in a task

It is also possible to update the sbt state in a task. To do this, the task must return type StateTransform. The state will be transformed upon completion of task evaluation. The StateTransform is constructed with a function from State => State that accepts the previous value of the State and generates a new state. For example:

import complete.DefaultParsers._
val counter = AttributeKey[Int]("counter")
val setCounter = inputKey[StateTransform]("Set the value of the counter attribute")
setCounter := {

val count = (Space -> IntBasic).parsed
StateTransform(_.put(counter, count))
}
creates the input task `setCounter` that sets the counter attribute to some 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:

```scala
// 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:

```scala
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`.

```scala
lazy val foo: Foo = ... initialize foo ...
```

with the example usage:

```scala
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:

```scala
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.

```scala
zip := {
  val bin: File = (Compile / packageBin).value
  val src: File = (Compile / packageSrc).value
  val doc: File = (Compile / packageDoc).value
  val out: File = zipPath.value
  val inputs: Seq[(File,String)] = Seq(bin, src, doc) x Path.flat
  IO.zip(inputs, 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:

```scala
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:

```scala
resolvers := {
  val localMaven = "Local Maven Repository" at "file://"+Path.userHome.absolutePath+"/.m2/repository"
  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:

```scala
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:

```scala
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
}
```

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

```scala
file("/home/user/A.scala")
```

or construct the file from an absolute base:

```scala
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.

```scala
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:

```scala
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. 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) and will be available to the build definitions.

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:

```scala
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 `$HOME/.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, 2.12.14) 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 enable SbtPlugin.

```scala
lazy val root = (project in file(".")).enablePlugins(SbtPlugin).

ThisBuild / version := "0.1.0-SNAPSHOT"
ThisBuild / organization := "com.example"
ThisBuild / homepage := Some(url("https://github.com/sbt/sbt-hello"))
```

Some details to note: - sbt plugins must be compiled with Scala 2.12.x that sbt itself is compiled in. By NOT specifying scalaVersion, sbt will default to the Scala version suited for a plugin. - By default sbt plugin is compiled with whichever the sbt version you are using. Because sbt does NOT keep forward compatibility, that would typically require all of your plugin users to upgrade to the latest too. pluginCrossBuild / sbtVersion is an optional setting to compile your plugin against an older version of sbt, which allows the plugin users to choose from a range of sbt versions.

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 task named hello to sbt projects:

```scala
package sbthello
```
import sbt._
import Keys._

object HelloPlugin extends AutoPlugin {
  override def trigger = allRequirements

  object autoImport {
    val helloGreeting = settingKey[String]("greeting")
    val hello = taskKey[Unit]("say hello")
  }

  import autoImport._

  override lazy val globalSettings: Seq[Setting[_]] = Seq(
    helloGreeting := "hi",
  )

  override lazy val projectSettings: Seq[Setting[_]] = Seq(
    hello := {
      val s = streams.value
      val g = helloGreeting.value
      s.log.info(g)
    }
  )
}

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.

package sbtless

import sbt._
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:
As it turns out, PlayScala plugin (in case you didn’t know, the Play framework is an sbt plugin) lists SbtJsTaskPlugin as one of its required plugins. So, if we define a build.sbt with:

```scala
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.

```scala
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**:

```scala
ThisBuild / version := "0.1.0-SNAPSHOT"
ThisBuild / organization := "com.example"
ThisBuild / homepage := Some(url("https://github.com/sbt/sbt-obfuscate"))

lazy val root = (project in file("."))
  .enablePlugins(SbtPlugin)
  .settings(
    name := "sbt-obfuscate",
    pluginCrossBuild / sbtVersion := {
      scalaBinaryVersion.value match {
        case "2.12" => "1.2.8" // set minimum sbt version
      }
    }
  )

ObfuscatePlugin.scala:

```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]("Obfuscates literals.")

    // default values for the tasks and settings
    lazy val baseObfuscateSettings: Seq[Def.Setting[_]] = Seq(
      obfuscate := {
        Obfuscate(sources.value, (obfuscateLiterals in obfuscate).value)
      },
```

376
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
$HOME/.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 $HOME/.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
  $HOME/.sbt/1.0/plugins/project/Build.scala as described at
  .scala build definition.

- A Plugin may be directly defined in Scala source files in $HOME/.sbt/1.0/plugins/,
  such as $HOME/.sbt/1.0/plugins/MyPlugin.scala. $HOME/.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 re-
   compiling again. This approach skips the overhead of `publishLocal`
   and cleaning the plugins directory of the project using the plugin.

These are all consequences of `$HOME/.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/r
   epositories/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`

```scala
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 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:

```scala
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.

For cross building sbt plugins see also Cross building 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 {
  object autoImport {

    val assembly = taskKey[File]("Builds a deployable fat jar.")
    val assembleArtifact = settingKey[Boolean]("Enables (true) or disables (false)"

380
val assemblyOption = taskKey[AssemblyOption]("Configuration for making a deployable fat jar.")
val assembledMappings = taskKey[Seq[MappingSet]]("Keeps track of jar origins for each source.")
val assemblyPackageScala = taskKey[File]("Produces the scala artifact.")
val assemblyJarName = taskKey[String]("name of the fat jar")
val assemblyMergeStrategy = settingKey[String => MergeStrategy]("mapping from archive member path to merge strategy")

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`:

```
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 request 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:

```scala
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 advice

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).

```scala
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:

```
Fuzz / scalaSource := baseDirectory.value / "source" / "fuzz" / "scala"
```

```
Compile / scalaSource := 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:

```scala
def 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:

```scala
import sbtobfuscate.ObfuscatePlugin

lazy val app = (project in file("app"))
  .settings(inConfig(Test)(ObfuscatePlugin.baseObfuscateSettings))
```
Scoping advice

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.

```scala
package sbtobfuscate

import sbt._, Keys._

object ObfuscatePlugin extends sbt.AutosPlugin {
  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 = pluginsJvmPlugin
  override def trigger = allRequirements

  override val globalSettings: Seq[Def.Setting[_]] = Seq(
    Global / onLoad := (Global / onLoad).value andThen { state =>
```
Setting up GitHub Actions with sbt

GitHub Actions is a workflow system by GitHub that supports continuous integration (CI) and continuous deployment (CD). As CI/CD feature was introduced in 2019, it’s a newcomer in the CI/CD field, but it quickly rised to the de-facto standard CI solution for open source Scala projects.

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=1.6.2
```

Your build will now use 1.6.2.

Read the GitHub Actions manual

A treasure trove of Github Actions tricks can be found in the Github Actions official documentation, including the Reference. Use this guide as an inspiration, but consult the official source for more details.

Basic setup

Setting up your build for GitHub Actions is mostly about setting up `.github/workflows/ci.yml`. Here’s what a minimal CI workflow could look like using setup-java:

```
name: CI
on:
  pull_request:
  push:
jobs:
  test:
    runs-on: ubuntu-latest
    steps:
    - name: Checkout
      uses: actions/checkout@v2
```
- name: Setup JDK
  uses: actions/setup-java@v2
  with:
    distribution: temurin
    java-version: 8
- name: Build and Test
  run: sbt -v +test

Custom JVM options

The default JVM options are provided by the official sbt runner adopted by setup-java, and it should work for most cases. If you do decide to customize it, use -v option to let the script output the current options first:

```
# Executing command line:
java
-Dfile.encoding=UTF-8
-Xms1024m
-Xmx1024m
-Xss4M
-XX:ReservedCodeCacheSize=128m
-jar
/usr/share/sbt/bin/sbt-launch.jar
```

We can define JAVA_OPTS and JVM_OPTS environment variables to override this.

name: CI

on:
  pull_request:
  push:

jobs:
  test:
    runs-on: ubuntu-latest
    env:
      # define Java options for both official sbt and sbt-extras
      JAVA_OPTS: -Xms2048M -Xmx2048M -Xss6M -XX:ReservedCodeCacheSize=256M -Dfile.encoding=UTF-8
      JVM_OPTS: -Xms2048M -Xmx2048M -Xss6M -XX:ReservedCodeCacheSize=256M -Dfile.encoding=UTF-8

steps:
- name: Checkout
  uses: actions/checkout@v2
- name: Setup JDK
  uses: actions/setup-java@v2
  with:
    distribution: temurin
    java-version: 8
- name: Build and Test
run: sbt -v +test

Again, let’s check the log to see if the flags are taking effect:

# Executing command line:
[process_args] java_version = '8'
java
-Xms2048M
-Xmx2048M
-Xss6M
-XX:ReservedCodeCacheSize=256M
-Dfile.encoding=UTF-8
-jar
/usr/share/sbt/bin/sbt-launch.jar
+test

Caching

You can speed up your sbt builds on GitHub Actions by caching various artifacts in-between the jobs.

Here are sample caching steps that you can use:

- name: Coursier cache
  uses: coursier/cache-action@v6
- name: Build and test
  run: sbt -v +test
- name: Cleanup before cache
  shell: bash
  run: |
    rm -rf "$HOME/.ivy2/local" || true
    find $HOME/Library/Caches/Coursier/v1 -name "ivydata-*.properties" -delete || true
    find $HOME/.ivy2/cache -name "ivydata-*.properties" -delete || true
    find $HOME/.cache/coursier/v1 -name "ivydata-*.properties" -delete || true
    find $HOME/.sbt -name ".lock" -delete || true

With the above changes combined GitHub Actions will tar up the cached directories and uploads them to a cloud storage provider. Overall, the use of caching should shave off a few minutes of build time per job.

Build matrix

When creating a continuous integration job, it’s fairly common to split up the task into multiple jobs that runs in parallel. For example, we could:

- Run identical tests on JDK 8, JDK 11, Linux, macOS, and Windows
- Run different subset of tests on the same JDK, OS, and other setups
Both use cases are possible using the build matrix. The point here is that we would like to mostly reuse the steps except for a few variance. For tasks that do not overlap in steps (like testing vs deployment), it might be better to just create a different job or a new workflow.

Here’s an example of forming a build matrix using JDK version and operating system.

```yaml
name: CI
on:
pull_request:
push:
jobs:
test:
  strategy:
    fail-fast: false
  matrix:
    include:
    - os: ubuntu-latest
      java: 8
    - os: ubuntu-latest
      java: 17
    - os: windows-latest
      java: 17
  runs-on: ${{ matrix.os }}
steps:
- name: Checkout
  uses: actions/checkout@v2
- name: Setup JDK
  uses: actions/setup-java@v2
  with:
    distribution: temurin
    java-version: ${{ matrix.java }}
- name: Build and test
  shell: bash
  run: sbt -v +test
```

Note that there’s nothing magical about the `os` or `java` keys in the build matrix.

The keys you define become properties in the `matrix` context and you can reference the property in other areas of your workflow file.

You can create an arbitrary key to iterate over! We can use this and create a key named `jobtype` to split the work too.

```yaml
name: CI
on:
pull_request:
push:
```

391
jobs:
  test:
    strategy:
      fail-fast: false
    matrix:
      include:
        - os: ubuntu-latest
          java: 17
          jobtype: 1
        - os: ubuntu-latest
          java: 17
          jobtype: 2
        - os: ubuntu-latest
          java: 17
          jobtype: 3
    runs-on: ${{ matrix.os }}
    steps:
    - name: Checkout
      uses: actions/checkout@v2
    - name: Setup JDK
      uses: actions/setup-java@v2
      with:
        distribution: temurin
        java-version: ${{ matrix.java }}
    - name: Build and test (1)
      if: ${{ matrix.jobtype == 1 }}
      shell: bash
      run: |
        sbt -v "mimaReportBinaryIssues; scalafmtCheckAll; +test;"
    - name: Build and test (2)
      if: ${{ matrix.jobtype == 2 }}
      shell: bash
      run: |
        sbt -v "scripted actions/*"
    - name: Build and test (3)
      if: ${{ matrix.jobtype == 3 }}
      shell: bash
      run: |
        sbt -v "dependency-management/*"

Sample .github/workflows/ci.yml setting

Here’s a sample that puts them all together. Remember, most of the sections are optional.
name: CI
on:
  pull_request:
  push:
jobs:
test:
  strategy:
    fail-fast: false
matrix:
  include:
    - os: ubuntu-latest
      java: 17
      jobtype: 1
    - os: ubuntu-latest
      java: 17
      jobtype: 2
    - os: windows-latest
      java: 17
      jobtype: 2
    - os: ubuntu-latest
      java: 17
      jobtype: 3
  runs-on: "${{ matrix.os }}"
env:
  # define Java options for both official sbt and sbt-extras
  JAVA_OPTS: -Xms2048M -Xmx2048M -Xss6M -XX:ReservedCodeCacheSize=256M -Dfile.encoding=UTF-8
  JVM_OPTS: -Xms2048M -Xmx2048M -Xss6M -XX:ReservedCodeCacheSize=256M -Dfile.encoding=UTF-8
steps:
- name: Checkout
  uses: actions/checkout@v2
- name: Setup JDK
  uses: actions/setup-java@v2
  with:
    distribution: temurin
    java-version: "${{ matrix.java }}"
- name: Coursier cache
  uses: coursier/cache-action@v6
- name: Build and test (1)
  if: "${{ matrix.jobtype == 1 }}"
  shell: bash
  run: |
    sbt -v "mimaReportBinaryIssues; scalafmtCheckAll; +test;"
- name: Build and test (2)
  if: "${{ matrix.jobtype == 2 }}"
  shell: bash
  run: |
sbt -v "scripted actions/*"
- name: Build and test (3)
  if: ${{ matrix.jobtype == 3 }}
  shell: bash
  run: |
    sbt -v "dependency-management/*"
- name: Cleanup before cache
  shell: bash
  run: |
    rm -rf "$HOME/.ivy2/local" || true
    find $HOME/Library/Caches/Coursier/v1 -name "ivydata-*.properties" -delete || true
    find $HOME/.ivy2/cache -name "ivydata-*.properties" -delete || true
    find $HOME/.cache/coursier/v1 -name "ivydata-*.properties" -delete || true
    find $HOME/.sbt -name ".lock" -delete || true

sbt-github-actions

There's also sbt-github-actions, an sbt plugin by Daniel Spiewak that can generate the workflow files, and keep the settings in build.sbt file.

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=1.6.2

Your build will now use 1.6.2.

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:

```yaml
language: scala

jdk: openjdk8

scala:
  - 2.10.4
  - 2.12.15

By default Travis CI executes `sbt ++$TRAVIS_SCALA_VERSION test`. Let’s specify that explicitly:

```yaml
language: scala

jdk: openjdk8

scala:
  - 2.10.4
  - 2.12.15

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:

```yaml
language: scala

jdk: openjdk8

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/1.6.2/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-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/1.6.2/sbt-launch.jar
```

Note: This duplicates the -Xms flag as intended, which might not be the best thing to do.

## Caching

You can speed up your sbt builds on Travis CI by using their caching feature.

Here’s a sample cache configuration that you can use:
```
cache:
directories:
  - $HOME/.cache/coursier
  - $HOME/.ivy2/cache
  - $HOME/.sbt
```

Note: Coursier uses different cache location depending on the OS, so the above needs to be changed accordingly for macOS or Windows images.

You’ll also need the following snippet to avoid unnecessary cache updates:
```
before_cache:
  - rm -fv $HOME/.ivy2/.sbt.ivy.lock
  - 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 a cloud storage provider. Overall, the use of caching should shave off a few minutes of build time per job.

## Build matrix

We’ve already seen the example of Scala cross building.

**language**: scala

**jdk**: openjdk8
scala:
- 2.10.4
- 2.12.15

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.
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: SbtPlugin

Enable `SbtPlugin` in `build.sbt`:

```scala
lazy val root = (project in file("."))
  .enablePlugins(SbtPlugin)
  .settings(
    name := "sbt-something"
  )
```

Then add the following settings to `build.sbt`:

```scala
lazy val root = (project in file("."))
  .enablePlugins(SbtPlugin)
  .settings(
    name := "sbt-something",
    scriptedLaunchOpts := { scriptedLaunchOpts.value ++
      Seq("-Xmx1024M", ":Dplugin.version=" + version.value)
    },
    scriptedBufferLog := false
  )
```

Note: You must use sbt 1.2.1 and above to use `SbtPlugin`.

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`:

```scala
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 carldouglas/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 {
  def main(args: Array[String]): Unit = {
    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 (in milliseconds)
- `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:

```scala
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/AbC1EFghIj4LMNOQPrStUV+++XX/-Tmp-/sbt_cdd1b3c4/}default-0314bd/*:check: unexpected output: hello
[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 failed
[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/AbC1EFghIj4LMNOQPrStUV+++XX/-Tmp-/sbt_8d950687/simple/project/plugins/)
...
```

Add the following line to your test script to suspend the test until you hit the enter key:

```bash
$ 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.

```bash
> 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

404
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/scala3.g8 (A template for Scala 3 projects)
- 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)
• 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-crossproject)
• 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

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License
-------
Written in <YEAR> by <AUTHOR NAME> <AUTHOR E-MAIL ADDRESS>
[other author/contributor lines as appropriate]
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:

```scala
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-resolver", "0.1.0"),
          "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 0.13 plugins while staying on sbt 1.x.

crossSbtVersions := Vector("1.2.8", "0.13.18")

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. To switch between the sbt versions use

```
[^ 0.13.18

[info] Setting `sbtVersion in pluginCrossBuild` to 0.13.18
[info] Set current project to sbt-something (in build file:/xxx/sbt-something/)
```
or `compile` to cross compile.

Mixing libraries and sbt plugins in a build

When you want to mix both libraries and sbt plugins into a multi-project build, it’s more convenient to drive the sbt version based on the Scala version.

You can do that as follows:

```
ThisBuild / crossScalaVersions := Seq("2.10.7", "2.12.10")
```
lazy val core = (project in file("core"))

lazy val plugin = (project in file("sbt-something"))
    .enablePlugins(SbtPlugin)
    .dependsOn(core)
    .settings{
        // change the sbt version based on Scala version
        pluginCrossBuild / sbtVersion := {
            scalaBinaryVersion.value match {
                case "2.10" => "0.13.18"
                case "2.12" => "1.2.8"
            }
        }
    }

This is a technique discovered by [@jroper](https://github.com/jroper) in sbt-pgp#115. It works because sbt 0.13 and 1.x series use different Scala binary versions.

Using the setting, you can now use Scala cross building commands such as +compile and +publish.

**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] = (Compile / dependencyClasspath).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] = (Test / fullClasspath).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:

```scala
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:

```scala
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,

```scala
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,

```scala
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,

Compile / scalaSource := baseDirectory.value / "src"

Test / scalaSource := 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,

Compile / javaSource := baseDirectory.value / "src"

Test / javaSource := 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,

```
Compile / resourceDirectory := baseDirectory.value / "resources"
Test / resourceDirectory := 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:

```
Compile / unmanagedBase := 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,

```
Compile / unmanagedSourceDirectories += 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,

```
Compile / unmanagedResourceDirectories += 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,

```
unmanagedSources / excludeFilter := HiddenFileFilter || "*impl*"
```

To have different filters for main and test libraries, configure `Compile` and `Test` separately:

```
Compile / unmanagedSources / includeFilter := ".scala" || ".java"
Test / unmanagedSources / includeFilter := 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,
unmanagedResources / excludeFilter := HiddenFileFilter || "*impl*

To have different filters for main and test libraries, configure Compile and Test separately:

Compile / unmanagedResources / includeFilter := ".*txt"
Test / unmanagedResources / includeFilter := ".*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,

unmanagedJars / excludeFilter := HiddenFileFilter || "*.zip"

To have different filters for main and test libraries, configure Compile and Test separately:

Compile / unmanagedJars / includeFilter := ".jar"
Test / unmanagedJars / includeFilter := "*.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:

```scala
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:
Compile / sourceGenerators += <task of type Seq[File]>.taskValue

For example, assuming a method def makeSomeSources(base: File): Seq[File],

Compile / sourceGenerators += Def.task {
  makeSomeSources((Compile / sourceManaged).value / "demo")
}.taskValue

As a specific example, the following source generator generates Test.scala application object that once executed, prints "Hi" to the console:

Compile / sourceGenerators += Def.task {
  val file = (Compile / sourceManaged).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. Instead, the outputs should be cached based on the input values either using the File tracking system or by manually tracking the input values using sbt.Tracked.{ inputChanged, outputChanged } etc.

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:

```scala
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:
Compile / resourceGenerators += <task of type Seq[File]> .taskValue

For example, assuming a method def makeSomeResources(base: File): Seq[File],

Compile / resourceGenerators += Def.task {
    makeSomeResources((Compile / resourceManaged).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:

Compile / resourceGenerators += Def.task {
    val file = (Compile / resourceManaged).value / "demo" / "myapp.properties"
    val contents = "name=%s
    version=%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 re-generating 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 set-
tings. 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[_ <: Any]]
[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] 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.

```bash
### 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.

```bash
> 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,

```bash
> 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,

```bash
> 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**

```bash
> 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]  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,

```shell
> show organization
[info] com.github.sbt
```

The `show` command also works for tasks, described next.

Show the result of executing a task

```shell
> 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.

```shell
> show compile:dependencyClasspath
...
```

Show the classpath used for compilation or testing

For the test classpath,

```shell
> show test:dependencyClasspath
...
...
```

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>

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.
ThisBuild / shellPrompt := { 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

See sbt shell history.

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:

```scala
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:

```scala
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:

```scala
> 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,

```bash
$ 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,

```bash
$ 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 up to date is:

```plaintext
> 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:

```plaintext
> 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] Sandbox run complete..
[debug] Exited with code 0
```
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:

```bash
> 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,

```bash
> last compile
[debug]
[debug] Initial source changes:
[debug]   removed: Set()
[debug]   added: Set(/home/mark/tmp/a/b/A.scala)
[debug]   modified: Set()
... and:
```

```bash
> last update
[info] Updating {file:/.../demo/}example...
[debug] post 1.3ivy 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-internal, test-internal, plugin, sources, docs, pom]
[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:

```scala
> 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,

```scala
> printWarnings
[warn] A.scala:2: method error in object Predef is deprecated: Use sys.error(message) instead
[warn] def x = error("Failed.")
```

**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,

```scala
> 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,

```bash
$ sbt --warn
> compile
[warn] there were 2 feature warning(s); re-run with -feature for details
[warn] one warning found
[succeed] 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:

```scala
427
```
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 Test / traceLevel := 5
> set update / traceLevel := 0
> set ThisProject / traceLevel := -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. Internally, sbt makes use of the log4j2 library, so a custom logger should implement `org.apache.logging.log4j.core.Appender`, usually by extending `AbstractAppender`.

`extraLoggers` is a function `ScopedKey[_] => Seq[Appender]`. This means that it can provide different logging based on the task that requests the logger.

```scala
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.

An `Appender` in log4j2 appends a `LogEvent`, whose core internally is a `Message`. There can be many types of `Message`, but sbt generates events containing instances of `ObjectMessage`, containing a payload that can be retrieved by calling `getParameter()`.

The payload emitted by sbt logging is an instance of `StringEvent`, which contains `String` fields including `message` and `level`.

Putting all that together, here’s a (completely useless!) example of an extra logger that logs messages from tasks in reverse to the console:

```scala
extraLoggers := {
  import org.apache.logging.log4j.core.LogEvent;
  import org.apache.logging.log4j.core.appender.AbstractAppender
  import org.apache.logging.log4j.message.{Message, ObjectMessage}
  import sbt.internal.util.StringEvent

  def loggerNameForKey( key : sbt.Def.ScalableKey[_] ) = s"" reverse.$(key.scope.task.toOption.getOrElse("<unknown>"))

  class ReverseConsoleAppender( key : ScalableKey[_] ) extends AbstractAppender {
    loggerNameForKey( key ), // name : String
    null, // filter : org.apache.logging.log4j.core.Filter
    null, // layout : org.apache.logging.log4j.core.Layout[_ <: Serializable]
    false // ignoreExceptions : Boolean
  }

  this.start() // the log4j2 Appender must be started, or it will fail with an Exception
```
override def append( event : LogEvent ) : Unit = {
  val output = {
    def forUnexpected( message : Message ) = s"[$(this.getName())] Unexpected: ${message.getFormattedMessage()}
    event.getMessage() match {
      case om : ObjectMessage => {
        // what we expect
        om.getParameter() match {
          case se : StringEvent => s"[$(this.getName()) - ${se.level}] ${se.message.reverse}
          case other => forUnexpected( om )
        }
        case unexpected : Message => forUnexpected( unexpected )
      }
    }
    System.out.synchronized { // sbt adopts a convention of acquiring System.out's monit
      println( output )
    }
  }
  val currentFunction = extraLoggers.value(key: ScopedKey[_]) => {
    new ReverseConsoleAppender(key) +: currentFunction(key)
  }
}

Now, if we execute a task that logs messages, we should see our logger invoked:

sbt:sbt-logging-example> update
[info] Updating ...
[reverse.update - info] ... gnitadpU
[info] Done updating.
[reverse.update - info] .gnitadpu enoD
[success] Total time: 0 s, completed Oct 16, 2019 5:22:22 AM

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:

import sbt.Keys.streams

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.

```scala
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`.

```scala
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

```scala
version := "1.0"
```

Set the project organization

```scala
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:

```scala
organizationName := "Example, Inc."
```

```scala
organizationHomepage := Some(url("http://example.org"))
```
Set the project’s homepage and other metadata

```scala
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,

```scala
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,

```scala
Compile / packageBin / packageOptions +=
  Package.ManifestAttributes(java.util.jar.Attributes.Name.SEALED -> "true")
```

Other attributes may be added with `Package.JarManifest`.

```scala
Compile / packageBin / packageOptions += {
  import java.util.jar.{Attributes, Manifest}
  val manifest = new Manifest
  manifest.getAttribute("foo/bar/").put(Attributes.Name.SEALED, "false")
  Package.JarManifest( manifest )
}
```
Or, to read the manifest from a file:

```
Compile / packageBin / packageOptions += {
  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”,

```
Compile / packageBin / mappings += {
  (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 `Test / packageSrc / mappings` 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 evals, 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”,

```scala
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.

```scala
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,

```scala
scalaVersion := "2.10.0-local"
```

```scala
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,

```scala
initialCommands in console := "println("Hello from console")"
```

```scala
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,

```scala
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:

```scala
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:

```scala
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,

```
Compile / doc / scalacOptions := 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,

```
Compile / doc / scalacOptions ++= 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,

```
Compile / doc / javacOptions ++= 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,

```scala
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,

```scala
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.

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:

```scala
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 := {
  (core / Test / test).value
  (tools / Test / 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:

```scala
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{
    ThisBuild / scalaVersion := "2.12.6",
    ThisBuild / organization := "com.example",
    name := "helloworld",
    dependencyUpdates := { println("hi") },

    // onLoad is scoped to Global because there's only one.
    Global / onLoad := {
      val old = (Global / onLoad).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.

Track file inputs and outputs

Many sbt tasks depend on a collection of files. For example, the `package` task generates a jar file containing the resources and class files, which are generated by the `compile` task, for a project. Staring with version 1.3.0, sbt provides a file management system that tracks the inputs and outputs of any task. The task can query which of its file dependencies have changed since the task last completed allowing it to incrementally re-build only the modified files. This
system integrates with Triggered execution so that the file dependencies of a task are automatically monitored in a continuous build.

To best illustrate the file tracking system, we construct a build.sbt that illustrates all of the essential features. The example will be a project that is able to build a shared library in c using gcc. This will be done with two tasks: `buildObjects`, which compiles c source files to object files, and `linkLibrary`, which links the object files into a shared library. These can be defined with:

```scala
import java.nio.file.Path
val buildObjects = taskKey[Seq[Path]]("Compiles c files into object files.")
val linkLibrary = taskKey[Path]("Links objects into a shared library.")
```

The `buildObjects` task will depend on *.c source file inputs. The `linkLibrary` task depends on the output *.o object files generated by `buildObjects`. This creates a build pipeline: if none of the input sources to `buildObjects` are modified between calls to `linkLibrary` then neither compilation nor linking should occur. Conversely, when input source changes are detected, sbt should both generate new object files corresponding to the modified source files and link the shared library.

### File inputs

It is natural for a task to specify the inputs on which it depends. These are set with the `fileInputs` key, which has type: `Seq[Glob]` (see Globs). The `fileInputs` are specified as `Seq[Glob]` so that more than one search query may be provided, which may be necessary if sources are located in multiple directories or different file types are needed within the same task.

When the `fileInputs` key is set in a given scope, sbt automatically generates a task named `allInputFiles` for that scope that returns a `Seq[Path]` containing all of the files matching the `fileInputs` queries. For convenience, there is an extension method defined for `Task[_]` that translates `foo.inputFiles` to `(foo / allInputFiles).value`. We can use these to write a simple implementation of `buildObjects`:

```scala
import scala.sys.process._
import java.nio.file.{ Files, Path }
import sbt.nio._
import sbt.nio.Keys._

val buildObjects = taskKey[Seq[Path]]("Compiles c files into object files.")
buildObjects / fileInputs += baseDirectory.value.toGlob / "src" / "*.c"
buildObjects := {
  val outputDir = Files.createDirectories(streams.value.cacheDirectory.toPath)
  def outputPath(path: Path): Path =
    outputDir / path.getFileName.toString.replaceAll(".c$", ".o")
}
```
val logger = streams.value.log
buildObjects.inputFiles.map { path =>
  val output = outputPath(path)
  logger.info(s"Compiling $path to $output")
  Seq("gcc", ":-c", path.toString, ":-o", output.toString).!!
  output
}

This implementation will gather all of the files ending with the ".c" extension and shell out to gcc to compile them to the output directory.

sbt will automatically monitor any file matched by the globs specified by fileInputs. In this case, modifying any file with ".c" extension in the src directory will trigger a build in a continuous build.

**Incremental builds**

Every time that buildObjects is invoked from the sbt shell, it will re-compile all of the source files. This becomes expensive as the number of source files increases. In addition to fileInputs, sbt also provides another api, inputFileChanges, that provides information about what source files have changed since the last time the task successfully completed. Using the inputFileChanges, we can make the build above incremental:

```scala
import scala.sys.process._
import java.nio.file.{ Files, Path }
import sbt.nio._
import sbt.nio.Keys._

val buildObjects = taskKey[Seq[Path]]("Generate object files from c sources")
buildObjects / fileInputs += baseDirectory.value.toGlob / "src" / "*.c"
buildObjects := {
  val outputDir = Files.createDirectories(streams.value.cacheDirectory.toPath)
  val logger = streams.value.log
  def outputPath(path: Path): Path =
    outputDir / path.getFileName.toString.replaceAll(".c$", ":.o")
  def compile(path: Path): Path = {
    val output = outputPath(path)
    logger.info(s"Compiling $path to $output")
    Seq("gcc", ":-fPIC", "-std=gnu99", ":-c", s"$path", ":-o", s"$output").!!
    output
  }
  val sourceMap = buildObjects.inputFiles.view.map(p => outputPath(p) -> p).toMap
  val existingTargets = fileTreeView.value.list(outputDir.toGlob / **).flatMap { case (p, _) =>
    if (!sourceMap.contains(p)) {
      Files.deleteIfExists(p)
    }
  }
```
The FileChangeReport makes it possible to write an incremental task without manually tracking the input files. It is a sealed trait implemented by three case classes:

1. Changes – indicates that one or more source files have been modified.
2. Unmodified – none of the source file have been modified since the last run.
3. Fresh – there is no cache entry for the previous source file hashes.

It is sometimes convenient to pattern match on the result of the inputFileChanges:

```scala
foo.inputFileChanges match {
  case FileChanges(created, deleted, modified, unmodified) if created.nonEmpty || modified.nonEmpty =>
    build(created ++ modified)
    delete(deleted)
  case _ => // no changes
}
```

The input file report says nothing about the outputs. This is why the buildObjects implementation needs to check the target directory to see which outputs exist. In that example, there is a 1:1 mapping between inputs and outputs, but this need not be the case in general. An implementation of buildObjects may include header files in the fileInputs. These are not compiled themselves, but they may trigger re-compilation of one or more *.c source files.

Note that calling buildObjects.inputFileChanges also causes buildObjects / fileInputs to automatically be watched in a continuous build.

**File outputs**

The outputs of a file are often best specified as the result of a task. In the example above, buildObjects is a Task returning a Seq[Path] containing the object files generated by compilation. sbt will automatically track the outputs of any task that returns one of the following result types: Path, Seq[Path],...
File or Seq[File]. We can use this to build on the buildObjects example to write a task that links the object into a shared library:

```scala
val linkLibrary = taskKey[Path]("Links objects into a shared library.")
linkLibrary := {
  val outputDir = Files.createDirectories(streams.value.cacheDirectory.toPath)
  val logger = streams.value.log
  val isMac = scala.util.Properties.isMac
  val library = outputDir / s"mylib.${if (isMac) "dylib" else "so"}"
  val linkOpts = if (isMac) Seq("-dynamiclib") else Seq("-shared", "-fPIC")
  if (buildObjects.outputFileChanges.hasChanges || !Files.exists(library)) {
    logger.info(s"Linking $library")
    (Seq("gcc") ++ linkOpts ++ Seq("-o", s"$library") ++
     buildObjects.outputFiles.map(_.toString)).!!
  } else {
    logger.debug(s"Skipping linking of $library")
  }
  library
}
```

Here the tracking was simpler because linking a shared library is not incremental. Thus we have to rebuild if any of the outputs of buildObjects has changed or if the library doesn’t exist.

Similar to fileInputs, there is a fileOutputs key. This can be used as an alternative to returning the output files in the task when the outputs have a known pattern. For example, buildObjects could have been defined as:

```scala
val buildObjects = taskKey[Unit]("Compiles c files into object files.")
buildObjects / fileOutputs := target.value / "objects" / ** / "*.o"
```

This can be useful when using an opaque external tool where the mapping of inputs to outputs is not known.

Like allInputFiles, there is an allOutputFiles task of return type Seq[Path] that is automatically generated for a task, foo, if the return type of foo is one of Seq[Path], Path, Seq[File] or File. It is also generated if foo / outputFiles is specified. When both fileOutputs is specified and the return type represents a file or collection of files, the result of allOutputFiles is the distinct union of the files returned by the task and the files described by outputFiles. Calling foo.outputFiles is syntactic sugar for (foo / allOutputFiles).value.

Filters

The fileInputs and fileOutputs can be filtered beyond what is specified by their Glob patterns. sbt provides four settings of type sbt.nio.file.PathFilter: 1. inputFileIncludeFilter – only include file inputs that also match this filter
2. **fileInputExcludeFilter** – exclude any file inputs that also match this filter
3. **fileOutputIncludeFilter** – only include file inputs that also match this filter
4. **fileOutputExcludeFilter** – exclude any file output that also match this filter

By default, sbt sets

```scala
fileInputExcludeFilter := HiddenFileFilter.toNio || DirectoryFilter
```

Both **fileInputIncludeFilter** and **fileInputOutputFilter** are set to AllPassFilter.toNio. The **fileOutputExcludeFilter** is set to NothingFilter.toNio.

To exclude files matching with test in the name from buildObjects, write:

```scala
buildObjects / fileInputExcludeFilter := "*test*"
```

To preserve the previous excludes of hidden files and directories, write:

```scala
buildObjects / fileInputExcludeFilter :=
  (buildObjects / fileInputExcludeFilter).value || "*test*"
```

or

```scala
buildObjects / fileInputExcludeFilter -= { ef => ef || "*test*" }
```

In most cases, it shouldn’t be necessary to set the **fileInputIncludeFilter** since the path name filtering it should be handled by **fileInputs** itself. It also shouldn’t commonly be necessary to filter the outputs.

### Cleaning outputs

sbt automatically generates an implementation of **clean** scoped to the task foo whenever it also generates the allOutputFiles task. Calling `foo / clean` will remove all of the files previously generated by foo. It will not re-evaluate foo. For example, calling `buildObjects / clean` will remove all of the object files generated by the previous call to `buildObjects`. The generated clean tasks are not transitive. Calling `linkLibrary / clean` will delete the shared library but will not delete the object files generated by `buildObjects`.

### File change tracking

For each input or output file tracked by sbt, there is an associated **FileStamp**. This can either be the last modified time of the file or a hash. By default, inputs are tracked using the hash and outputs are tracked using the last modified time.

To change this, set the **inputFileStamper** or **outputFileStamper**:

```scala
val generateSources = taskKey[Seq[Path]]("Generates source files from json schema.")
generateSources / fileInputs := baseDirectory.value.toGlob / "schema" / ** / ".json"
generateSources / outputFileStamper := FileStamper.Hash
```
Continuous build file monitoring

In a continuous build, `-bar`, for an arbitrary task, `bar`, given some task, `foo`, any calls to `foo.inputFiles` and `foo.inputFileChanges` within `bar` will cause all of the globs specified by `foo / fileInputs` to be monitored in a continuous build. Transitive file input dependencies are automatically monitored. For example, the `-linkLibrary` continuous build command will monitor the `*.c` source files defined for `buildObjects`.

Input files will only trigger a re-build if their hash has changed. This behavior can be overridden with:

Global / watchForceTriggerOnAnyChange := true

Changes to file outputs, which are gathered with either `foo.outputFiles` or `foo.outputFileChanges`, do not trigger a re-build.

Partial pipeline evaluation / error handling

The stamps for each file are tracked on a per-task basis. They are only updated if the incremental task itself succeeds. In the example above, this means that the current file last modified times for `buildObjects` are stored by the `linkLibrary` task only when it succeeds. This means that `buildObjects` can be run many times between calls to `linkLibrary` and `linkLibrary` will see the cumulative changes to the outputs of `buildObjects`.

If `linkLibrary` fails to complete, sbt will also skip updating the last modified times for the outputs of `buildObjects` corresponding to `linkLibrary` because it is impossible to know in general which files were successfully processed.

Troubleshoot memory issues

sbt may sometimes run out of memory, leading to a crash or badly degraded performance. The amount of memory needed by sbt is dependent on the number of subprojects in the build and the plugins that are enabled. For projects with a large memory footprint, it may be necessary to start sbt with an increased java heap size. The default java heap size is 1GB. To increase it to 2GB, you can run the following command:

sbt -J-Xmx2G

Any command argument with a leading `-J` is interpreted as a java vm argument. To automatically increase the heap to 2GB in a project, create or edit the file `.sbt opts` and add a line with `-J-Xmx2G`.

When sbt is run in interactive mode or as a server (i.e. it was started with `sbt --client` or `sbtm`), it is important that each task in the build clean up all of its resources or the memory footprint of sbt may grow over time. For example, if the run task starts an Akka ActorSystem, it is necessary to shutdown the
ActorSystem before run exits or else the memory utilization of the sbt process will increase each time run is invoked.

In order to fix memory leaks, it is necessary to figure out what classes are persisting in memory longer than expected. The easiest way to do this is with the jmap command, which is provided by the jdk, and a jvm memory analyzer tool like VisualVM. Find the process id of the sbt process that you with to debug using the ps command. Then run `jmap -dump:format=b,file=leak.hprof $SBT_PID`. Open the leak.hprof file in VisualVM. It may be obvious what classes are taking up the most memory, but sometimes it is necessary to click the “Compute Retained Sizes” button. This may take a while if there is a large heap, but it can identify what classes are taking up the most memory. Often this will help you identify where there is a thread that has leaked or a cache that has not been cleared.

**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.

```scala
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:

```scala
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 / 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 / compile and then Compile / scalastyle task added by scalastyle-sbt-plugin.

Here’s how to set it up

project/build.properties
sbt.version=1.6.2

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{
    Compile / compilecheck := Def.sequential(
      Compile / compile,
      (Compile / scalastyle).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] } ignored here
[error] } ignored here
[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 / compile and then Compile / scalastyle task added by scalastyle-sbt-plugin.

project/build.properties

sbt.version=1.6.2

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 / compile).value
    Def.task {
      val x = (Compile / scalastyle).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 / compile, might actually rewire the key to our dynamic task.

lazy val root = (project in file("."))

.settings{
  Compile / compile := (Def.taskDyn {
    val c = (Compile / compile).value
    Def.task {
      
    }})
}
val x = (Compile / scalastyle).toTask("").value
c
}
}).value
)
Now we can actually call Compile / 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 Compile / run 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 Compile / run task and then open the browser
for testing purposes.
src/main/scala/Greeting.scala
object Greeting {
def main(args: Array[String]): Unit = {
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 := {
(Compile / run).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!
450


We can actually remove `runopen` key, by rewriting the new input task to `Compile / run`:

```scala
lazy val root = (project in file("."))
  .settings(
    Compile / run := {
      (Compile / run).evaluated
      println("open browser!")
    }
  )
```

---

### Defining a dynamic input task with `Def.inputTaskDyn`

Let’s suppose that there’s a task already that does the browser opening called `openbrowser` because of a plugin. Here’s how we can sequence a task after an input task.

---

#### build.sbt v1

```scala
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 {
        (Compile / run).toTask(" " + args.mkString(" ")).value
        openbrowser
      }
    }).evaluated,
    openbrowser := {
      println("open browser!")
    }
  )
```

---

#### build.sbt v2

Trying to rewire `Compile / run` is going to be complicated. Since the reference to the inner `Compile / run` is already inside the continuation task, simply rewiring `runopen` to `Compile / run` will create a cyclic reference. To break the cycle, we will introduce a clone of `Compile / run` called `Compile / actualRun`:
lazy val actualRun = inputKey[Unit]("The actual run task")
lazy val openbrowser = taskKey[Unit]("open the browser")

lazy val root = (project in file("."))
.settings{
  Compile / run := (Def.inputTaskDyn {
    import sbt.complete.Parsers.spaceDelimited
    val args = spaceDelimited("<args>").parsed
    Def.taskDyn {
      (Compile / actualRun).toTask(" " + args.mkString(" ")).value
      openbrowser
    }
  }).evaluated,
  Compile / actualRun := Defaults.runTask(
    Runtime / fullClasspath,
    Compile / run / mainClass,
    Compile / run / runner
  ).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 Compile / actualRun'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 Compile / actualRun 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:

```scal
commands += Command.command("releaseNightly") { state =>
  "stampVersion" ::
  "clean" ::
  "compile" ::
```
How to define a custom dependency configuration

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 used to use 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.

Cautions on custom dependency configurations

A custom configuration should be considered only when you are introducing either a new set of source code or its own library dependencies (like Test).

In general, it would be a bad idea to introduce configuration merely as a way to namespace keys.

One drawback of the custom configuration is that the users will be confused about the complexity around scoping. They might be familiar with subprojects and tasks, but it becomes complicated when configuration scoping is involved.

Another drawback is that there is limited support from sbt. For instance, you can express that a configuration is meant to extend another configuration, but there is no inheritance of settings. You have to provide all expected settings and tasks. This means that when a new features are added to sbt, there’s a good chance the custom configurations will not be covered. The same goes for third-party plugins.

Example basic custom configuration

Here’s an example of a minimum custom configuration.

```
"publish" ::
"bintrayRelease" ::
state
}
```

```
package com.example.sbfuzz

import sbt._
```
object FuzzPlugin extends AutoPlugin {
  object autoImport {
    lazy val Fuzz = config("fuzz")
  }
  import autoImport._
  override lazy val projectSettings =
    inConfig(Fuzz)(Defaults.configSettings)
}

build.sbt

ThisBuild / scalaVersion := "2.13.4"
ThisBuild / version := "0.1.0-SNAPSHOT"

lazy val root = (project in file("."))
  .configs(Fuzz)
  .enablePlugins(FuzzPlugin, ScalafmtCliPlugin)
  .settings{
    name := "use",
  }

Example sandbox configuration

One sometimes useful technique with a configuration is adding a side graph to
the user’s project so Coursier would download some JARs, which your task can
invoke. This is called a sandbox configuration. This can be used for instance to
invoke Scala 2.13 CLI version of scalafmt. As of sbt 1.4.x there’s a limitation
so the sandbox configuration must use the same Scala version as the user’s
subproject.

project/ScalafmtPlugin.scala

package com.example

import sbt._
import Keys._

object ScalafmtCliPlugin extends AutoPlugin {
  object autoImport {
    lazy val ScalafmtSandbox = config("scalafmt").hide
    lazy val scalafmt = inputKey[Unit]("")
  }
  import autoImport._
  override lazy val projectSettings = Seq(

ivyConfigurations += ScalafmtSandbox,
libraryDependencies += "org.scalameta" %% "scalafmt-cli" % "2.7.5" % ScalafmtSandbox,
scalafmt := (ScalafmtSandbox / run).evaluated
) ++ inConfig(ScalafmtSandbox)(
  Seq(
    run := Defaults.runTask(managedClasspath, run / mainClass, run / runner)
      .evaluated,
    managedClasspath := Classpaths.managedJars(
      ScalafmtSandbox,
      classpathTypes.value,
      update.value,
    )
  ) ++
  inTask(run)(
    Seq(
      mainClass := Some("org.scalafmt.cli.Cli"),
      fork := true, // to avoid exit
    ) ++ Defaults.runnerSettings
  )
)

Enabling ScalafmtPlugin would add scalafmt task, which runs the CLI.

sbt:custom-configs> scalafmt --version
[info] running (fork) org.scalafmt.cli.Cli --version
[success] Total time: 3 s, completed Feb 8, 2021 12:01:34 AM
sbt:custom-configs> scalafmt
[info] running (fork) org.scalafmt.cli.Cli
[info] Reformattting...
[success] Total time: 6 s, completed Feb 8, 2021 12:01:40 AM

How do I add a test configuration?

See the Additional test configurations section of Testing.

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.

```scala
import scala.concurrent.duration._

// factor out common settings
ThisBuild / organization := "org.myproject"
ThisBuild / scalaVersion := "2.12.15"
// set the Scala version used for the project
ThisBuild / version := "0.1.0-SNAPSHOT"

// set the prompt (for this build) to include the project id.
ThisBuild / shellPrompt := { state => Project.extract(state).currentRef.project + " > " }

// 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/$osmlibVersion/libosm-$osmlibVersion.jar")

lazy val root = (project in file(.))

.settings{
  // set the name of the project
  name := "My Project",

  // set the main Scala source directory to be <base>/src
  Compile / scalaSource := baseDirectory.value / "src",

  // set the Scala test source directory to be <base>/test
  Test / scalaSource := 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,
}
```

456
// 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 'consoleProject'
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 'consoleProject'
console / initialCommands := "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
Compile / packageBin / mainClass := Some("myproject.MyMain"),

// set the main class for the main 'run' task
// change Compile to Test to set it for 'test:run'
Compile / run / mainClass := 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 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.SimpleDateFormat
  SimpleDateFormat.getDateTimeInstance(SimpleDateFormat.SHORT, SimpleDateFormat.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'
Test / fork := 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.
Test / parallelExecution := 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")),

// don't aggregate clean (See FullConfiguration for aggregation details)
clean / aggregate := false,
// only show warnings and errors on the screen for compilations.
// this applies to both test:compile and compile and is Info by default
compile / logLevel := 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
Compile / unmanagedJars += Attributed.blank(file("/usr/share/java/swt.jar")),

// publish test jar, sources, and docs
Test / publishArtifact := true,

// disable publishing of main docs
Compile / packageDoc / publishArtifact := false,

// change the classifier for the docs artifact
packageDoc / artifactClassifier := 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 jdmk, jmx, or jms.

libraryDependencies +=
  "log4j" % "log4j" % "1.2.15" excludeAll(
    ExclusionRule(organization = "com.sun.jdmk"),
    ExclusionRule(organization = "com.sun.jmx"),
    ExclusionRule(organization = "javax.jms")
)
These files can be used to manage 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.

```
build.sbt

Now that we factored out custom settings and dependencies out to project/*.scala, we can make use of them in build.sbt:

```scala
import Resolvers._
import Dependencies._

// factor out common settings into a sequence
lazy val buildSettings = Seq(
  organization := "com.example",
  version := "0.1.0",
  scalaVersion := "2.12.15"
)

// 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,
```

462
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.

// Custom configurations
lazy val Common = config("common").describedAs("Dependencies required in all configurations.
lazy val Scalate = config("scalate").extend(Common).describedAs("Dependencies for using Scalate utilities.
lazy val Saxon = config("saxon").extend(Common).describedAs("Dependencies for using Saxon utilities.

463
// Define a customized compile configuration that includes dependencies defined in our other custom configurations

lazy val CustomCompile = config("compile").extend(Saxon, Common, Scalate)

// Factor out common settings

ThisBuild / organization := "com.example"
ThisBuild / scalaVersion := "2.12.15"
ThisBuild / version := "0.1.0-SNAPSHOT"

// An example project that only uses the Scalate utilities.

lazy val a = (project in file("a"))
  .dependsOn(utils % "compile->scalate")

// 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")

// Defines the utilities project

lazy val utils = (project in file("utils"))
  .settings(
    inConfig(Common)(Defaults.configSettings), // Add the src/common/scala/ compilation configuration.
    addArtifact(Common / packageBin / artifact, Common / packageBin), // Publish the common artifact

    // We want our Common sources to have access to all of the dependencies on the classpath for compile and test, but when depended on, it should only require dependencies in 'common'.
    Common / classpathConfiguration := CustomCompile,

    // Modify the default Ivy configurations.
    // 'overrideConfigs' ensures that Compile is replaced by CustomCompile
    ivyConfigurations := overrideConfigs(Scalate, Saxon, Common, CustomCompile)(ivyConfigurations.value)

    // 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.

```-scala
import sbt._
import Keys._

object Canon extends AutoPlugin {
  // Registers the canonicalize command in every project
  override def trigger = allRequirements
  override def projectSettings = 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[ModuleID] =
  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

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:

Module diagram

We’ll discuss the details in the next page.

Module summary

The following is a conceptual diagram of the modular layers:

Module diagram

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.
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 existence.

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`
- `Yinlined-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
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:
```scala
package sbt.io

object syntax {
}
```
When all the layers are available, the sbt package should also define an object called syntax which forwards implicit conversions from all the layers:
```scala
package sbt

object syntax {
  ....
}
```

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`:

```scala
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:

```scala
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.

```json
{
  "types": [
    {
      "name": "Person",
      "type": "record",
    }...
```
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)
  }
}
```

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;
}
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.

{
  "types": [
    {
      "name": "Greeting",
      "namespace": "com.example",
      "target": "Scala",
      "type": "interface",
      "fields": [
        {
          "name": "message",
          "type": "String"
        }
      ]
    }
  ]
}
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.

```json
{
  "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.

```json
{
   "types": [
      {
         "name": "Weekdays",
         "type": "enum",
         "target": "Java",
         "symbols": [
            "Monday", "Tuesday", "Wednesday", "Thursday", "Friday", "Saturday", "Sunday"
         ]
      }
   ]
}
```

This schema will generate the following Java code:

```java
public enum Weekdays {
   Monday,
   Tuesday,
   Wednesday,
   Thursday,
   Friday,
   Saturday,
   Sunday
}
```

Or the following Scala code (after changing the `target` property to):

```scala
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:

```
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:

```
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.

```scala
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.

```json
{
  "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 Definitions. 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 protocols and records that extend it.

For an enumeration, it defines the values of the enumeration.

**since**
This parameter exists for fields 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 fields 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. Compile / generateDatatypes / datatypeScalaFileNames This setting accepts a function `Definition => File` which will determine the filename for every generated Scala definition.

2. Compile / generateDatatypes / datatypeScalaSealInterfaces
   This setting accepts a boolean value, and will determine whether interfaces should be sealed or not.

Syntax summary

```plaintext
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* ])?
}
```

486
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:

```
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 Scala
        // 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
```
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
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.

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: xsbt1,extra
cross-versioned: ${sbt.cross.versioned-false}

[repositories]
```

495
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
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 `repo1.maven.org`.

Besides built in repositories, other repositories can be configured using the following syntax:

```scala
name: url,(pattern),(bootOnly),(descriptorOptional),(skipConsistencyCheck),(allowInsecureProtocol)
```

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 `bootOnly` string is used to tell Ivy to only use this repository during startup, i.e. To find sbt’s own JARs and the JARs of any plugins. Repositories with the `bootOnly` string will not be used for build-time dependency resolution.

The `skipConsistencyCheck` string is used to tell Ivy not to validate checksums and signatures of files it resolves.

The `allowInsecureProtocol` string tells SBT not to output a warning about this repository being `http://`. Please think carefully before using HTTP repositories as they can present a significant security risk.

### 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 exist 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 repositories: "[ "repositories" ]" nl (repository nl)*
boot: "[ "boot" ]" nl directory nl bootProperties nl search nl promptCreate nl promptFill nl
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"
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 (\texttt{sbt.State}) and produce the next state. In other words, they are essentially functions of \texttt{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 \texttt{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 \texttt{Map<String,Any>}. However, this violates tenant #1: Everything should have a Type. So, sbt defines a new type of map called an \texttt{AttributeMap}. An \texttt{AttributeMap} is a key-value storage mechanism where keys are both strings and expected Types for their value.

Here is what the type-safe \texttt{AttributeKey} key looks like:

```scala
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 \texttt{AttributeMap}, we first need to construct one of these keys. Let’s look at the basic definition of the \texttt{AttributeMap}:

```scala
trait AttributeMap {
  /** Gets the value of type `\texttt{T}` associated with the key `\texttt{k}` or `\texttt{None}` if no value is */
  def get[T](k: AttributeKey[T]): Option[T]

  /** Adds the mapping `\texttt{k -> value}` to this map, replacing any existing mapping for `\texttt{k}` */
  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 \texttt{Setting[_]} sequence.

**Settings Architecture**

A Setting represents the means of constructing the value of one particular \texttt{AttributeKey[_]} in the \texttt{AttributeMap} of build state. A setting consists of two pieces:

1. The \texttt{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)
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:

```scala
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 Scopes 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:

```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 type lambdas
// 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 settings system.
}
```

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 \( a_3 \), we explicitly defined it to be 3.
- \( a_4 \) wasn’t defined, so it delegates to \( a_3 \) according to our **delegates** function.
- \( b_4 \) gets the value for \( a_4 \) (which delegates to \( a_3 \), so it is 3) and multiplies by 3
- \( a_5 \) is defined as the previous value of \( a_5 + 1 \) and since no previous value of \( a_5 \) was defined, it delegates to \( a_4 \), resulting in \( 3+1=4 \).
- \( b_5 \) isn’t defined explicitly, so it delegates to \( b_4 \) 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 \(\text{setting}(a, \text{value}(3))\). For a TaskKey \(a\), it will roughly translate to \(\text{setting}(a, \text{value}(\text{task} \{ 3 \}))\). 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:

```
image
```

The blue circles represent actions happening when sbt loads a project. We can see that sbt performs the following actions in load:

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 build.sbt file:
  ```scala
  ThisBuild / foo := "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 one project, in which case the values are duplicated for each project. You add project specific settings, e.g. in project/build.scala:
  ```scala
  lazy val root = (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 the user directory (~/.sbt/<version>/*.sbt)
3. All local configurations (build.sbt)

### 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.

```scala
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.

```scala
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.newHistory
      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 applica-
input. 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
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.