Je passe à Gradle Maturité, performance et plaisir!

Cédric Champeau (@CedricChampeau), Gradle Inc.

Louis Jacomet (@ljacomet), Gradle Inc.

Who are we?

```
speaker {
    name 'Cédric Champeau'
    company 'Gradle Inc'
    oss 'Apache Groovy committer',
    successes 'Static type checker',
              'Static compilation',
              'Traits',
              'Markup template engine',
              'DSLs'
        failures Stream.of(bugs),
        twitter '@CedricChampeau',
        github 'melix',
        extraDescription '''Groovy in Action 2 co-author
Misc OSS contribs'''
}
```

```
speaker {
    name 'Louis Jacomet'
    company 'Gradle Inc'
    past 'Terracotta / Ehcache',
              'Freelance consultant',
         failures Stream.of(bugs),
         twitter '@ljacomet',
         github 'ljacomet',
         extraDescription '''Not fully figured out
how to stay out of management?!?'''
}
```

What is Gradle?

Gradle's purpose

Gradle is a build and automation tool.

Gradle can automate the building, testing, publishing, deployment and more of software packages or other types of projects such as generated static websites, generated documentation or indeed anything else.

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- JVM based
- Implemented in Java
- 100% Free Open Source - Apache Standard

Agnostic Build System

- Java ecosystem
  - Groovy, Kotlin, Scala, …
- Native ecosystem
  - C, C++, Swift, …
- Android
- Misc
  - Go, Asciidoctor, …

Gradle in figures

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- 5.0M downloads / month

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- 35 Gradle Engineers
- 300K builds/week @LinkedIn

Gradle Inc.

The company behind Gradle.

- Build Happiness
- Employs full time engineers
- Providing Gradle Build Scans and Gradle Enterprise
- Gradle consulting, support, development services etc.
- Training: online, public and in-house

Objectives

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Get you started with Gradle

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- As a user needing to interact with a Gradle project

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Get you started with Gradle

- As a user needing to interact with a Gradle project
- As a build author starting to use Gradle for your projects

Agenda

- Anatomy of a Gradle project
- Use Gradle
- Concepts and plugins
- Incremental build and tasks
- Advanced configuration
- Dependency Management
- IDE integration
- Caching

Gradle survival guide

Anatomy of a Gradle project

Gradle is based on a set of conventions.

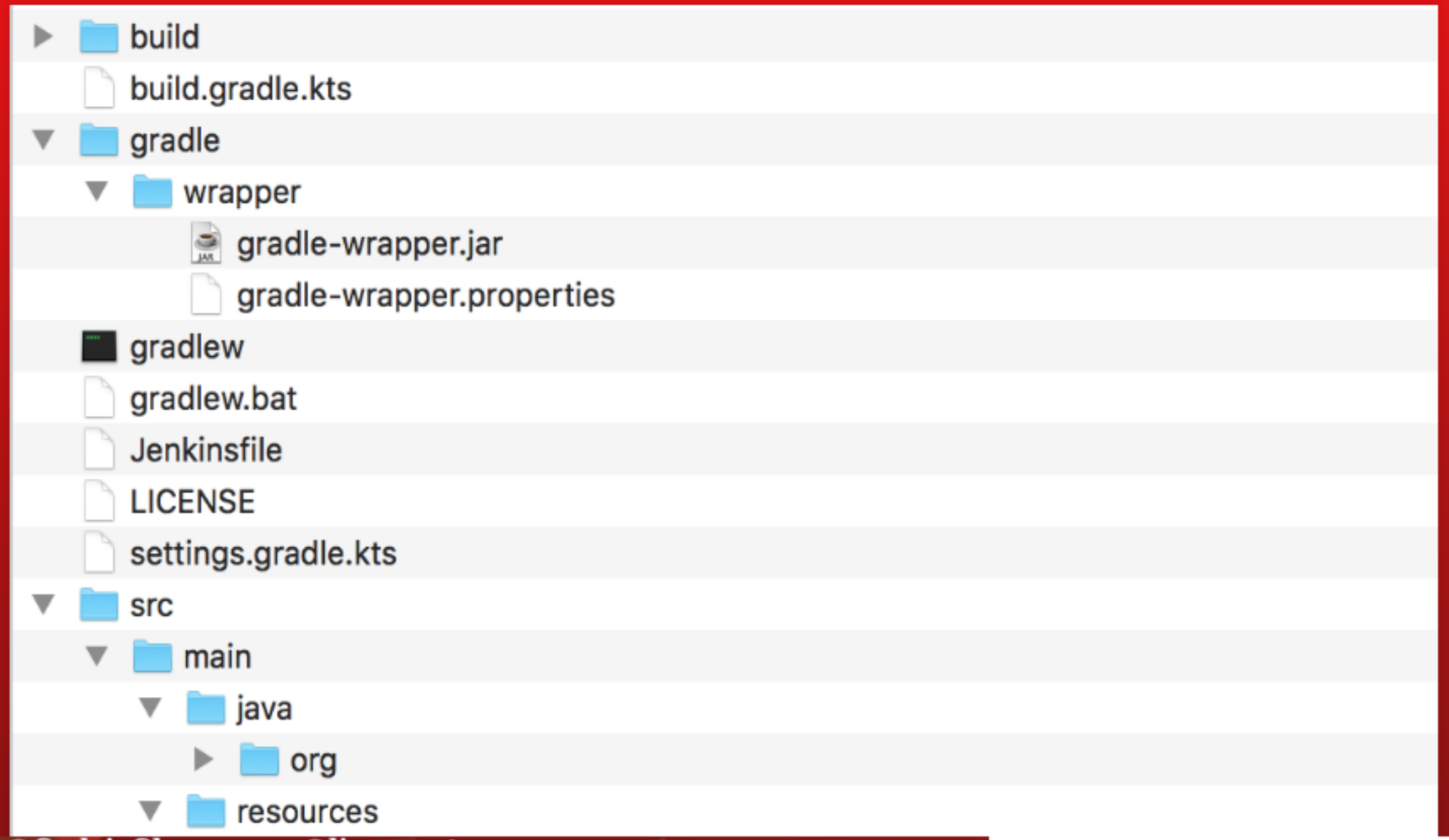
Some inherited from the history of Java build systems:

- `src/main/java`
- `src/test/resources`

Others brought by Gradle:

- The name of the project is the name of the containing folder

A simple project



A multi project build

Demo

The build file

- By default, named `build.gradle` which can be configured.
- Describes what the build is about through configuration.

Companion files

- `settings.gradle`: Configure the project(s) that compose the build
- `gradle.properties`: Defines properties specific to the build, which can be overridden

Additional build artifacts

Directories:

- `buildSrc`
- `.gradle`
- `build`

The Gradle Wrapper

The Gradle Wrapper

- Bootstraps Gradle for project contributors

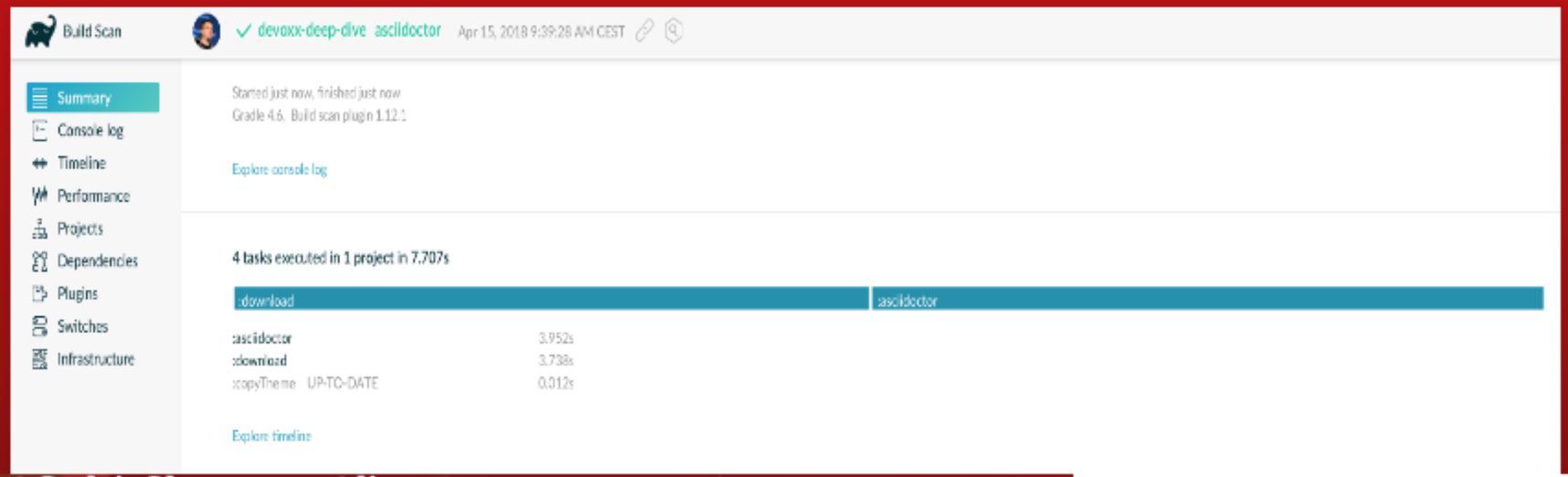
The Gradle Wrapper

- Bootstraps Gradle for project contributors
- Project controls Gradle version

Build scans

What is a build scan?

- It is a permanent, centralized and shareable record of a build
- It offers *tons* of insights into how your software is building



How to enable build scans?

- Simply add `--scan` to your build command
  - Will prompt you to accept terms of service
- Or configure your build for it:

```
plugins {
    id 'com.gradle.build-scan' version '1.13.1'
}

buildScan {
    licenseAgreementUrl = 'https://gradle.com/terms-of-service'
    licenseAgree = 'yes'
}
```

Using Gradle

Invoking Gradle using the wrapper

```
./gradlew hello
```

Note the implicit invocation from the project root. With Gradle, no need to navigate inside project directories. Instead, you can pass a specific task name and path to execute.

Invoking tasks

```
./gradlew [taskName...] [--option-name...]
```

Where `taskName` is one or more tasks names, space separated.

Each task can also reference a specific task in a subproject:

```
./gradlew :server:test
```

Discovering tasks

```
./gradlew tasks
```

Will list all the tasks defined by the project, with a description

Getting help on a task

```
./gradlew help --task <taskName>
```

Will list all projects having the task and give some usage context.

Exclude a task

- `--exclude-task` or `-x`
  - To exclude one task from the execution graph

```
./gradlew build -x test
```

This will exclude the specific task *and* all tasks it depended upon

Continue a build

- `--continue`
  - To continue with the build even when a task fails

```
./gradlew test --continue
```

The dependents task(s) of the failed one will still not be executed.

Continuous build

- `--continuous` or `-t`
  - Runs the tasks every time the input changes

```
./gradlew -t test
```

Use <CTRL>-D to stop the build

Logging

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- Gradle defines 6 log levels: `error`, `quiet`, `warning`, `lifecycle`, `info`, `debug`

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- Default log level (`lifecycle`) is minimalistic

Configuring logging

- Command line flags allow to set a different level:

```
> gradle hello -i
> gradle -q hello
```

When troubleshooting, `info` is usually enough, `debug` has a *lot* of output.

Convention tasks

Gradle built-in plugins define a set of convention tasks.

These are used as as entry points to request execution of canonical project operations.

`assemble` task

This convention task indicates that all output producing tasks have to be executed.

check task

This convention task indicates that all verification tasks are to be executed.

`build` task

This convention task triggers `assemble` and `check`.

No task argument?

```
./gradlew
```

The above will invoke the `help` task by default.

However a project can define a set of default tasks to be run when it is invoked without a task argument.

```
defaultTasks 'assemble', 'test'
```

Gradle daemon

By default, Gradle will start a background process to execute your builds.

This allows to have a warmed up JVM running your build instead of having a fresh one each time.

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Gradle daemon

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This allows to have a warmed up JVM running your build instead of having a fresh one each time.

- `org.gradle.daemon` can be used to disable the daemon
- `org.gradle.daemon.idletimeout` can be used to tweak the idle time

Parallel builds

Gradle can run tasks of decoupled projects in parallel

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- `org.gradle.parallel` can be used to disable parallel mode
- `org.gradle.workers.max` can be used to limit the number of workers used by parallel builds
  - Defaults to number of CPUs

Demo

Gradle construction guide

Concepts

Gradle lifecycle

Configuration phase

Gradle lifecycle

Configuration phase

- Discovering projects

Gradle lifecycle

Configuration phase

- Discovering projects
- Build scripts evaluation

Gradle lifecycle

Configuration phase

- Discovering projects
- Build scripts evaluation
- Model construction

Gradle lifecycle

Configuration phase

- Discovering projects
- Build scripts evaluation
- Model construction
- Task graph construction

Gradle lifecycle (2)

Execution phase

Gradle lifecycle (2)

Execution phase

- Run tasks that are required by the build invocation

Demo

Lifecycle best practices

- Do the minimum during configuration
  - At this stage, Gradle walks all configuration items to determine which need to be part of the execution

Concepts by example

What are the building blocks of a *compile* task for a Java project?

Tasks

It is the target of a build execution and does the work.

Task actions

```
task hello {
    doLast { print "Let's have a great week!" }
}
```

- `doLast` adding actions to a task

Task type

```
task compileMe(type: JavaCompile) {
    destinationDir "$buildDir/myDir"

    //enable compilation in a separate daemon process
    options.fork = true

    //enable incremental compilation
    options.incremental = true
}
```

- Provides declarative configuration
- Task action is defined by the task type
- Models what the build is about in terms of execution

What does compile do then?

Transform Java source files into class files.

Task inputs

Task inputs

- Java source files

Task inputs

- Java source files
- Source encoding

Task inputs

- Java source files
- Source encoding
- Compile options

Task inputs

- Java source files
- Source encoding
- Compile options
- Classpath

Task outputs

Task outputs

- Class files

Importance of inputs / outputs

You can think of a Gradle task as a function.

Based on a set of inputs, you produce outputs.

And ideally, the same set of inputs results in the same outputs.

Inputs origin

Inputs origin

- Java source files
  - `SourceSet` concept

Inputs origin

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  - `SourceSet` concept
- Source encoding & compile options
  - Task configuration

Inputs origin

- Java source files
  - `SourceSet` concept
- Source encoding & compile options
  - Task configuration
- Classpath
  - From associated configuration

Configurations

A configuration is a container of dependencies and produced artifacts.

A configuration can extend another one, inheriting its dependencies.

Dependencies

A dependency is a pointer to another piece of software required to build, test or run your project.

When declaring a dependency, you tie it to a `Configuration`.

In practice

```
configurations {
    implementation
}

dependencies {
    implementation 'org.slf4j:slf4j-api:1.7.25'
    implementation project(':common')
}
```

Constructing the classpath

Constructing the classpath

- Resolve the configuration
  - Resolve the graph of dependencies
  - Retrieve or build the dependencies

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- Resolve the configuration
  - Resolve the graph of dependencies
  - Retrieve or build the dependencies
- Build the classpath

Invocation chain

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- User requests `compileJava`

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- → Build needs the compileClasspath

Invocation chain

- User requests `compileJava`
- → Build needs the compileClasspath
- → Build needs to resolve the `implementation` configuration

Building the task graph

Gradle will arrange tasks in an execution graph during the configuration phase:

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Gradle will arrange tasks in an execution graph during the configuration phase:

- Each task to be executed is a node
- Implicit and explicit relationships define the edges between nodes
- No cycles are allowed

Base plugins

Plugin base

- Adds tasks
- Adds conventions
- Provides some build structure

Base configurations

- `archives`
  - A configuration that contains the production artifacts of a project
  - Has a matching `uploadArchives` task for uploading the artifacts of `archives`

Base conventions

Properties and defaults at project level:

Base conventions

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- `archivesBaseName` that defaults to `project.name`

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- `archivesBaseName` that defaults to `project.name`
- `distsDirName` that defaults to `distributions`
- `libsDirName` that defaults to `libs`

Base conventions (2)

Default values for archive tasks:

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- `version` that default to `project.version`

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- `destinationDir` with defaults depending on the type of archive produced
- `version` that default to `project.version`
- `baseName` that defaults to `archiveBaseName`

Java Plugins: `java-base`

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- Adds model elements

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- Defines additional tasks

Java Plugins: `java-base`

- Adds model elements
- Defines additional tasks
- Extends the DSL with declarative elements, such as `SourceSet`

SourceSet

Models a source code logical unit:

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- Input source files (Java, Groovy, Scala, …)

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Models a source code logical unit:

- Input source files (Java, Groovy, Scala, …)
- Input resource files (`*.properties`, `*.xml`, …)
- Output class files
- Compilation and runtime classpaths
- Tasks for processing inputs to outputs

Java Plugins: java

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- Adds task instances

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- Defines a set of *conventions*
  - Defines default values for added tasks
  - Defines `main` and `test` source sets

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SourceSet conventions

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- Source: `src/<name>/<lang>`

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- Compilation tasks: `compile<Name><Lang>`

SourceSet conventions

- Source: `src/<name>/<lang>`
- Resources: `src/<name>/resources`
- Compilation tasks: `compile<Name><Lang>`
- Dependency configurations:
  - Compilation: `<name>Implementation`
  - Runtime: `<name>Runtime`

Naming conventions for `main`

The `main` part is ignored, having the resulting name respect camel case.

```
configurations {
    implementation
    runtime
}

compileJava
```

Java Plugins: `java-library`

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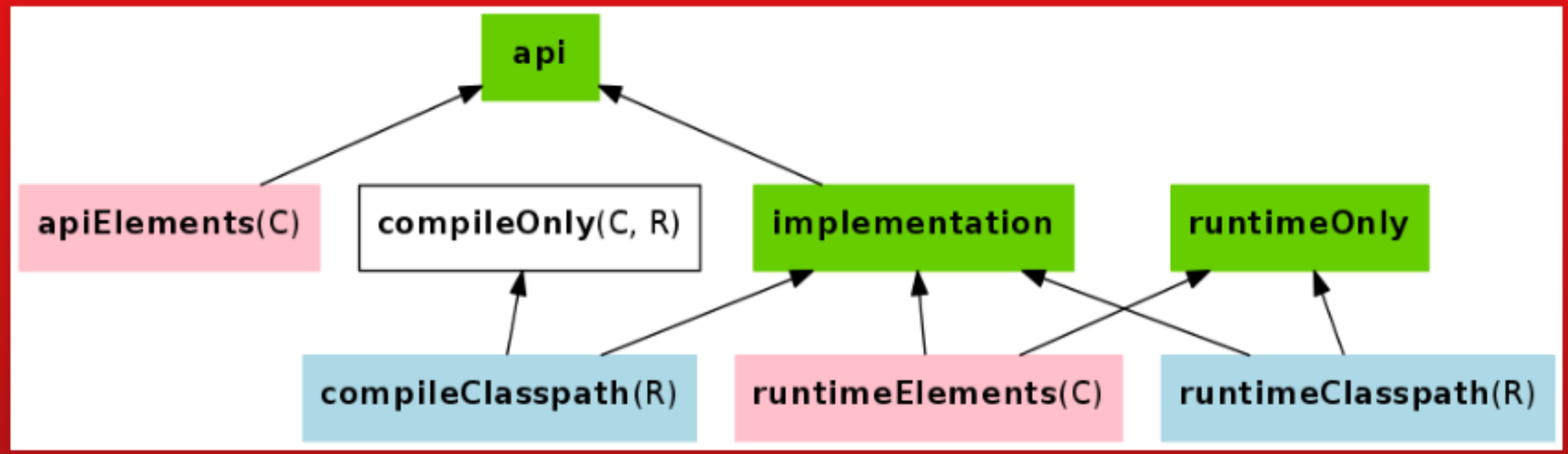
- Adds extra *configurations*

Java Plugins: `java-library`

- Adds extra *configurations*
- Express the difference in your dependencies:
  - The ones part of your API
  - The ones required at runtime by your implementation

java-library configurations



Demo

Plugin portal

Up to date and incremental tasks

Why does it matter?

- Gradle is meant for incremental builds
- `clean` is a waste of time
- Time is $$$

The incrementality test

The incrementality test

- Run a build

The incrementality test

- Run a build
- Run again with no change

The incrementality test

- Run a build
- Run again with no change
- If a task was re-executed, you got it wrong

Incremental build

A task is UP-TO-DATE iff:

- Inputs have not changed
- Outputs are still present and un-tampered

Change detection

- Hash of input / output files
- Hash of contents of input / output folders
- Serialize input properties

Control change detection

- `--rerun-tasks` bypasses up-to-date checks
- Running at *info* level will give you insights in up-to-date calculations

Example: building a shaded jar

```
task shadedJar(type: ShadedJar) {
   jarFile = file("$buildDir/libs/shaded.jar")
   classpath = configurations.runtime
   mapping = ['org.apache': 'shaded.org.apache']
}
```

- What are the task inputs?
- What are the task outputs?
- What if one of them changes?

Declaring inputs

```
public class ShadedJar extends DefaultTask {
    ...
    @InputFiles
    FileCollection getClasspath() { ... }

    @Input
    Map<String, String> getMapping() { ... }
}
```

Declaring outputs

```
public class ShadedJar extends DefaultTask {
    ...

    @OutputFile
    File getJarFile() { ... }
}
```

Annotation sensitivity

- `@InputFiles`: File path or contents
- `@Classpath`: File contents only, order sensitive
- `@CompileClasspath`: **Class** file contents, limited to ABI
- `@Input`: Value change

Know why your task is out-of-date

Demo

Incremental task inputs

- Know precisely *which* files have changed
- Task action can perform the minimal amount of work

Incremental task inputs

```
@TaskAction
public void execute(IncrementalTaskInputs inputs) {
   if (!inputs.isIncremental()) {
      // clean build, for example
      // ...
   } else {
      inputs.outOfDate(change ->
         if (change.isAdded()) {
           ...
         } else if (change.isRemoved()) {
           ...
         } else {
           ...
         }
      });
   }
}
```

Incrementality gotchas

Adding a timestamp to a jar manifest will make the jar task always out of date.

What if you do want / need that? Maybe you could only do it for a release build.

Advanced configuration

Declarative vs. Imperative

The ability to have code inside Gradle build scripts is a powerful feature.

While it adds flexibility, abusing the feature leads to builds that are hard to understand.

Gradle extensibility

- Define properties
- Add *extensions* to existing objects

Allows built in domain objects to be extended, including `Project`.

Makes the *build language* extensible.

Gradle properties

Gradle properties

- Different levels

Gradle properties

- Different levels
- Matching different use cases

`gradle.properties` and command line

- Define items that have a sensible default

```
org.gradle.parallel = true
deployUrl = https://example.com/default
```

Can be overridden on the command line:

```
./gradlew -Dorg.gradle.parallel=false -PdeployUrl='https://example.c
```

Project properties

- Added to the `ext` container

```
def getRevision = {
    def cmd = 'git rev-parse HEAD'
    try {
        def proc = cmd.execute()
        return proc.text.trim()
    } catch (IOException) {
        return 'Unknown'
    }
}

ext.revision = getRevision()
```

Extensions

```
class MyExtension {
    String someProperty
}

extensions.create("myDSL", MyExtension)

myDSL {
    someProperty = "someValue"
}
```

Configuration rules

```
configurations.all {
    println "Configuration $it.name"
}
tasks.withType(Jar) {
    destinationDir = "somePath"
    doLast { /* do something */ }
}

plugins.withType(IdeaPlugin) {
    // Perform actions if plugin gets applied
}
```

Implicit task relationships

Tasks can have implicit dependencies:

- `taskA.inputs = taskB.outputs`
  - `jar` task consumes `compileJava` output

This is known by Gradle through task implementations.

The heart of the Gradle execution model.

Explicit task relationships

```
task generateCode
task compileJava

compileJava.dependsOn generateCode
```

Aim for having implicit dependencies, based on proper modelling, instead of having to resort to explicit wiring.

Demo

SourceSet output

Source sets have an `output` property. It references:

- Class files
- Processed resources

```
task jar {
  from sourceSets.main.output
}
```

Script plugins

plugin.gradle

```
task taskFromPlugin() {
    doLast { println "added by a script plugin!" }
}
```

master.gradle

```
apply from: "plugin.gradle"
```

Note: the script reference can be a URL

Binary plugins

- Implementation of the `Plugin` interface
- Can be bundled in `buildSrc`
- Can extend the Gradle model
  - New task types, extensions, …

Build code management

- Use script plugins to decompose build scripts
  - Enhances comprehension and allows for reuse
  - Modularize according to domain (integ tests) or role (user/build admin)
- Encapsulate the imperative into plugins and custom tasks

Dependency management

Dependency management engine

- Gradle has its own engine
- Supports Ivy, Maven and more
- Aims at consistency
- Doesn't use `.m2` by default
- Local cache knows where a dependency comes from

Declaring repositories

Basics

```
repositories {
   mavenCentral()
   jcenter()
   google()
}
```

Declaring repositories

Uncommon

```
repositories {
   maven {
      url "https://my-repo/
   }

   ivy {
      url "https://my-repo/
   }

   flatDir name: 'libs', dirs: "$projectDir/libs"
}
```

Maven local

- Should almost never use it
- Mainly for Gradle/Maven interoperability

Dependency notations

```
dependencies {
   api project(':core')
   implementation "com.google.code.gson:gson:2.8.2"
   implementation("org.ow2.asm:asm") {
      version { prefer "6.1.1" }
      because "Only version compatible with JDK 11"
   }

   testImplementation group:"junit", name:"junit", version:"4.12"
}
```

Dependency versions

- `1.0`: fixed, cached forever
- `[1.0, )`: dynamic, cached for 24h
- `1.0-SNAPSHOT`: changing, cached for 24h
- Use `--refresh-dependencies` to force update

Danger zone

```
dependencies {
   api('dont.do.this.at:home:1.0') {
      changing = true
   }
}
```

Resolution strategy

```
configurations.all {
    resolutionStrategy {
        failOnVersionConflict()
        cacheDynamicVersionsFor(5, HOURS)
    }
}
```

Fixing dependency management issues

```
configurations {
   compileClasspath.resolutionStrategy {
      eachDependency { DependencyResolveDetails details ->
         // specifying a fixed version for all
         // libraries with 'org.gradle' group
         if (details.requested.group == 'org.gradle') {
            details.useVersion '1.4'
         }
      }
   }
}
```

Making sense of the mess

Talk Jeudi 19, 14:55 - 15:40, Maillot

En finir avec les problèmes de gestion de dépendances

IDE integration

Plugins

Plugins

- Dedicated IDE plugins
  - For IntelliJ: `idea`
  - For Eclipse: `eclipse`

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Plugins

- Dedicated IDE plugins
  - For IntelliJ: `idea`
  - For Eclipse: `eclipse`
- Generation of IDE configuration files for project integration
- Native IDE integration available as well

IntelliJ Idea

IntelliJ Idea

- Recommended: use Idea native integration

IntelliJ Idea

- Recommended: use Idea native integration
- Imports Gradle projects

IntelliJ Idea

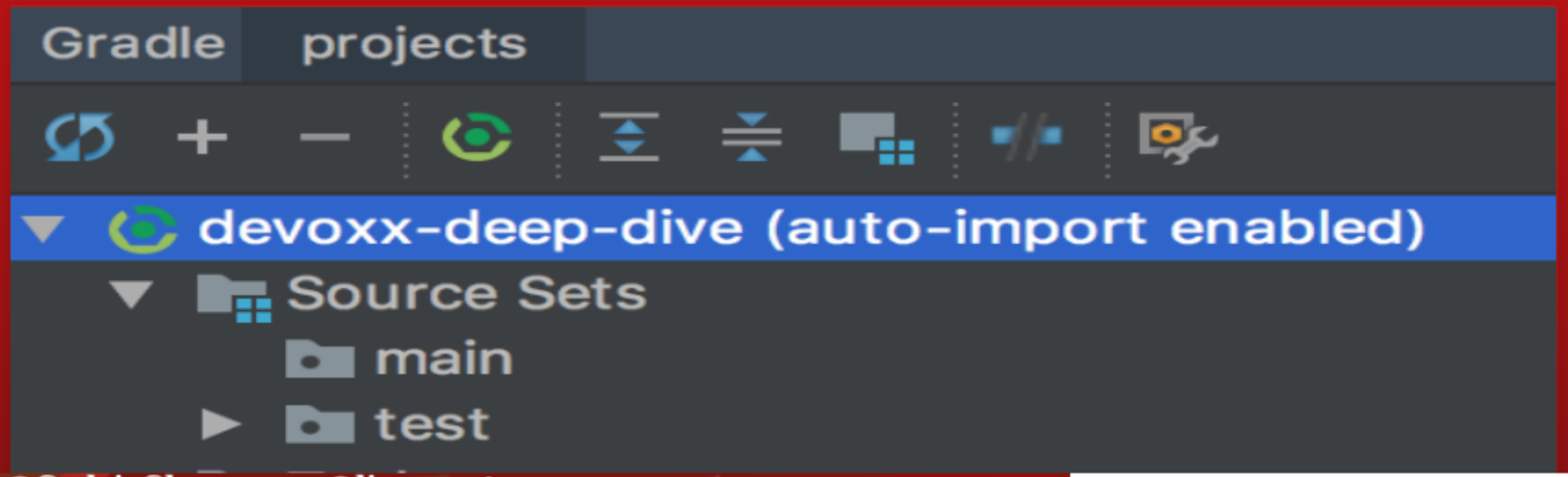
- Recommended: use Idea native integration
- Imports Gradle projects
- Enables compilation and tests execution

IntelliJ Idea

- Recommended: use Idea native integration
- Imports Gradle projects
- Enables compilation and tests execution
- Changes to the Gradle build need to be imported again
  - Unless auto-import is enabled

Advanced Idea integration

- The Gradle view enables invocation of project tasks.
- The IDE can even delegate all compilation and executions to Gradle



Customizing Idea integration

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- `idea` plugin enables modifying the generated IDE configuration
- Needed for project with very specific setups
- Example: configure default run / debug configurations with extra properties

Eclipse

Eclipse

- Use the `Buildship` IDE plugin

Eclipse

- Use the `Buildship` IDE plugin
- Imports Gradle projects

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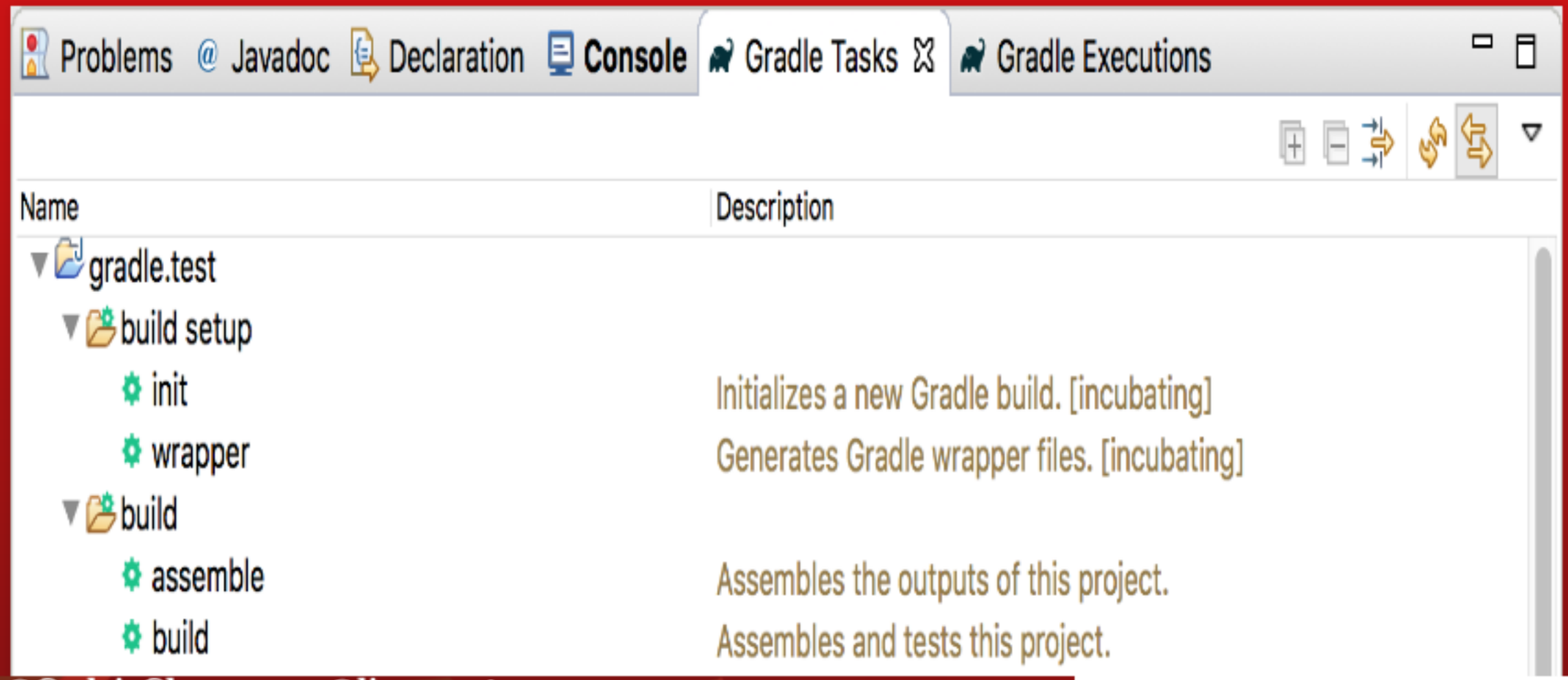
Advanced Eclipse integration

- Custom Gradle views enable invoking build tasks



Gradle build cache

Cached tasks

It is the cross build level expression of Gradle efficiency.

Based on tasks inputs, Gradle can fetch the outputs from cache instead of having to run the task.

Usage scenarios

- Local cache for faster `git bisect`
- CI populated cache for faster *morning builds* of developers
- Faster CI feedback by reusing common elements
  - Pull request jobs usually vary from master only in a few modules

Pre-requisites

- Gradle up-to-date checks are working
  - Two subsequent invocations of the same build result in all tasks up-to-date
- Tasks are declared *cacheable*
  - This is an opt-in support

Cacheable tasks

The benefit of getting the result from the cache only matters if the operation is expensive.

By default in Gradle compilation tasks can be cached, but not copy tasks for example.

Inputs / Outputs specifics

While the system is similar to up-to-date checks, a few things need to be considered in addition:

- Relative vs. absolute paths
  - Since the goal of caching is across builds, absolute paths will differ

Enabling caching

- Add `--build-cache` to your command line
- Configure `org.gradle.caching=true` in `gradle.properties`

Configuring local caching

By default, a directory cache in the Gradle user home dir is used.

settings.gradle

```
buildCache {
    local(DirectoryBuildCache) {
        directory = new File(rootDir, 'build-cache')
        removeUnusedEntriesAfterDays = 30
    }
}
```

Configuring remote caching

settings.gradle

```
buildCache {
    remote(HttpBuildCache) {
        url = 'https://example.com:8123/cache/'
    }
}
```

Demo

Conclusion

Gradle Enterprise

- On premise build cache and build scan solution
- Out of the box solution for distributed build cache
- Improved build scan feature set
  - Searchable build history
  - Build comparison