Continuous Integration

Continuous Integration (CI) is a software development practice where developers frequently merge their code changes into a central repository, preferably multiple times a day. Each merge triggers an automated build and testing process, which helps in identifying and addressing integration errors as quickly as possible. The primary purpose of CI is to improve software quality and accelerate the development process.

Key aspects of Continuous Integration include:

1. **Automated Building and Testing**: Automated tools are used to compile the code and run tests every time changes are integrated. This ensures that the software is always in a state where it can be deployed.
2. **Version Control Integration**: CI relies heavily on version control systems to manage changes to the codebase. Developers are encouraged to commit changes frequently, which supports the detection of conflicts and integration issues early in the development cycle.
3. **Immediate Feedback**: Developers receive immediate feedback on their commits. If a build or test fails, the system alerts the responsible developers so they can fix the issue promptly. This reduces the debugging time later in the development cycle.
4. **Consistency**: The use of automated tools ensures that builds and tests are executed in a consistent environment. This minimizes the "it works on my machine" syndrome, where code behaves differently on different developers' environments.
5. **Efficiency**: Automated tests and builds reduce the manual work required from developers, allowing them to focus on writing code. This efficiency can lead to faster development cycles and quicker time to market.

The purpose of Continuous Integration is to:

- **Detect and address integration issues early**: By integrating frequently, issues can be identified and resolved early in the development process, reducing the complexity of fixing bugs.
- **Improve software quality**: Regular testing ensures that defects are caught and corrected early, improving the overall quality of the software.
- **Reduce time to market**: Efficient processes and early detection of issues lead to shorter development cycles, enabling faster release of products.
- **Enhance project visibility and feedback**: Continuous Integration provides a clear insight into the project's health through the status of builds and tests, making it easier to assess progress.

> Overall, Continuous Integration is a critical component of modern software development practices, particularly in agile environments. It supports the development of high-quality software while

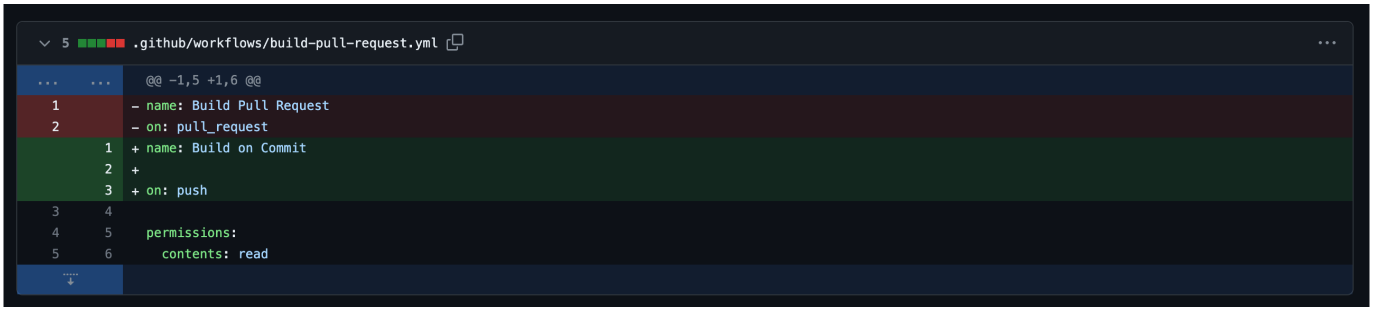
> enabling teams to be more productive and responsive to changes.

Spring boot

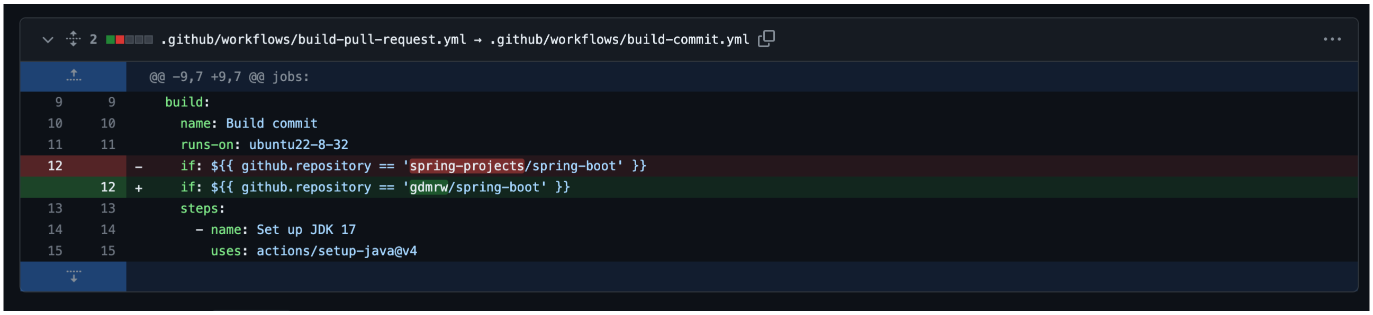
Spring boot itself has its own continuous integration located in GitHub Actions. The specific configuration is written like this:

```yaml
name: Build Pull Request
on: pull_request

permissions:
  contents: read

jobs:
  build:
    name: Build pull request
    runs-on: ubuntu22-8-32
    if: ${{ github.repository == 'spring-projects/spring-boot' }}
    steps:
      - name: Set up JDK 17
        uses: actions/setup-java@v4
        with:
          java-version: '17'
          distribution: 'liberica'

      - name: Check out code
        uses: actions/checkout@v4

      - name: Validate Gradle wrapper
        uses: gradle/wrapper-validation-action@699bb18358f12c5b78b37bb0111d3a0e2276e0e2

      - name: Set up Gradle
        uses: gradle/gradle-build-action@3b1b3b9a2104c2b47fbae53f3938079c00c9bb87

      - name: Build
        env:
          CI: 'true'
          GRADLE_ENTERPRISE_URL: 'https://ge.spring.io'
        run: ./gradlew -Dorg.gradle.internal.launcher.welcomeMessageEnabled=false --no-

      - name: Print JVM thread dumps when cancelled
        uses: ./.github/actions/print-jvm-thread-dumps
        if: cancelled()

      - name: Upload build reports
        uses: actions/upload-artifact@v4
        if: failure()
        with:
          name: build-reports
          path: '**/build/reports/'
```

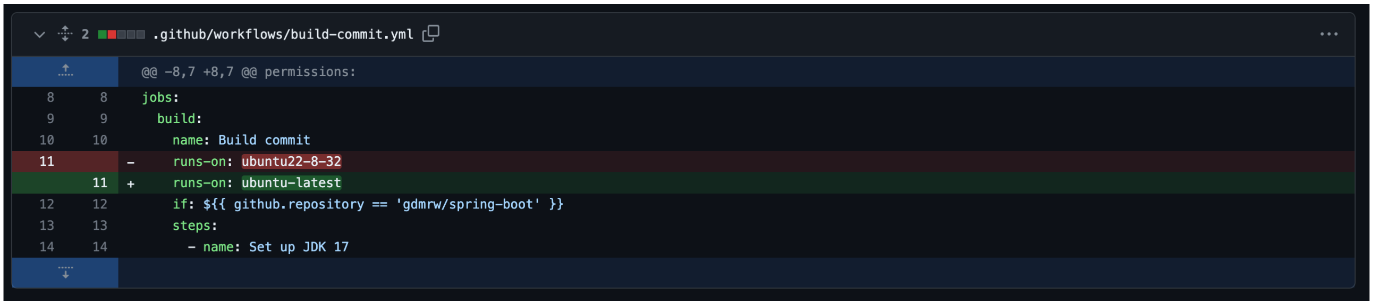
However, if not make any changes, it will be automatically skip rather than triggered.



```
5 .github/workflows/build-pull-request.yml
@@ -1,5 +1,6 @@
- name: Build Pull Request
- on: pull_request
+ name: Build on Commit
+
+ on: push

  permissions:
    contents: read
```



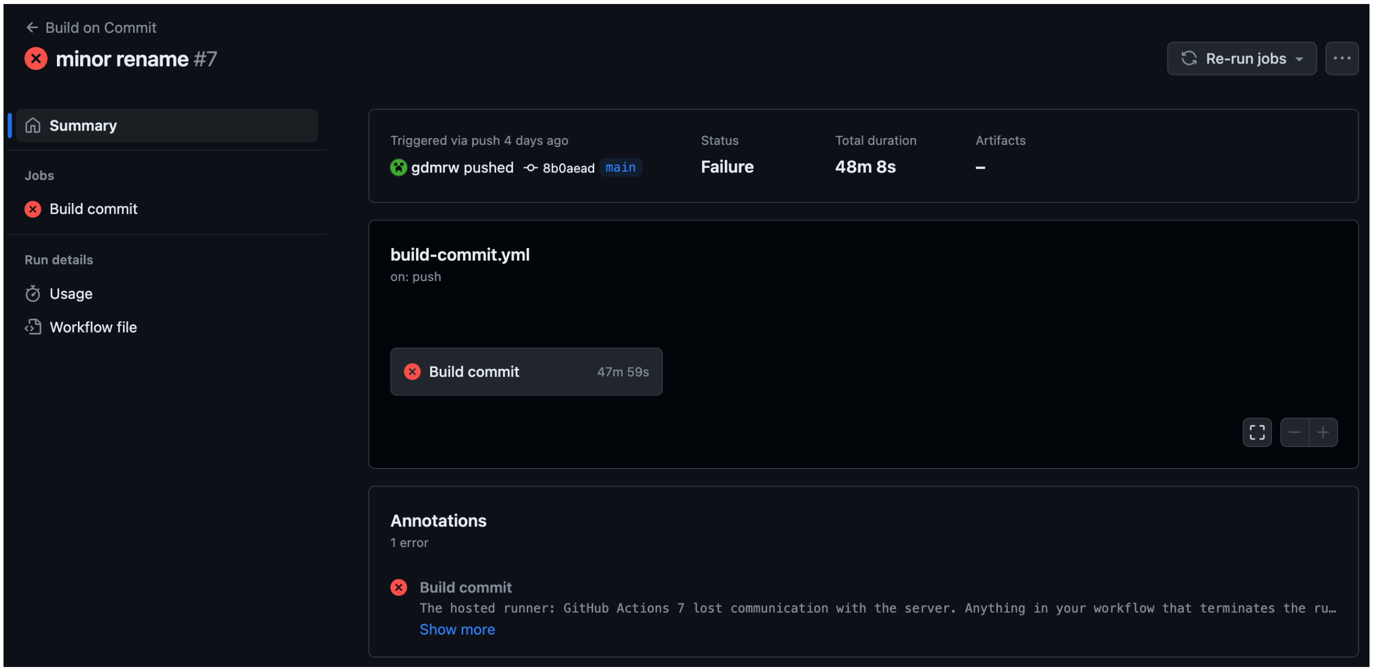
```
2 .github/workflows/build-pull-request.yml → .github/workflows/build-commit.yml
@@ -9,7 +9,7 @@ jobs:
    build:
      name: Build commit
      runs-on: ubuntu22-8-32
-     if: ${{ github.repository == 'spring-projects/spring-boot' }}
+     if: ${{ github.repository == 'gdmrw/spring-boot' }}
      steps:
        - name: Set up JDK 17
          uses: actions/setup-java@v4
```



```
2 .github/workflows/build-commit.yml
@@ -8,7 +8,7 @@ permissions:
  jobs:
    build:
      name: Build commit
-     runs-on: ubuntu22-8-32
+     runs-on: ubuntu-latest
      if: ${{ github.repository == 'gdmrw/spring-boot' }}
      steps:
        - name: Set up JDK 17
```

Three places modified to make sure the action builds trigger. The first one changes the trigger type, from pull request to commit. The second one changes the repo location. And the last one makes an adjustment on system type to make it match GitHub Action's environment identifier.

Let's make a push to see if github actions working properly.



Triggered via push 4 days ago
gdmrw pushed 8b0aead main

Status
Failure

Total duration
48m 8s

Artifacts
–

build-commit.yml
on: push

Build commit 47m 59s

Annotations
1 error

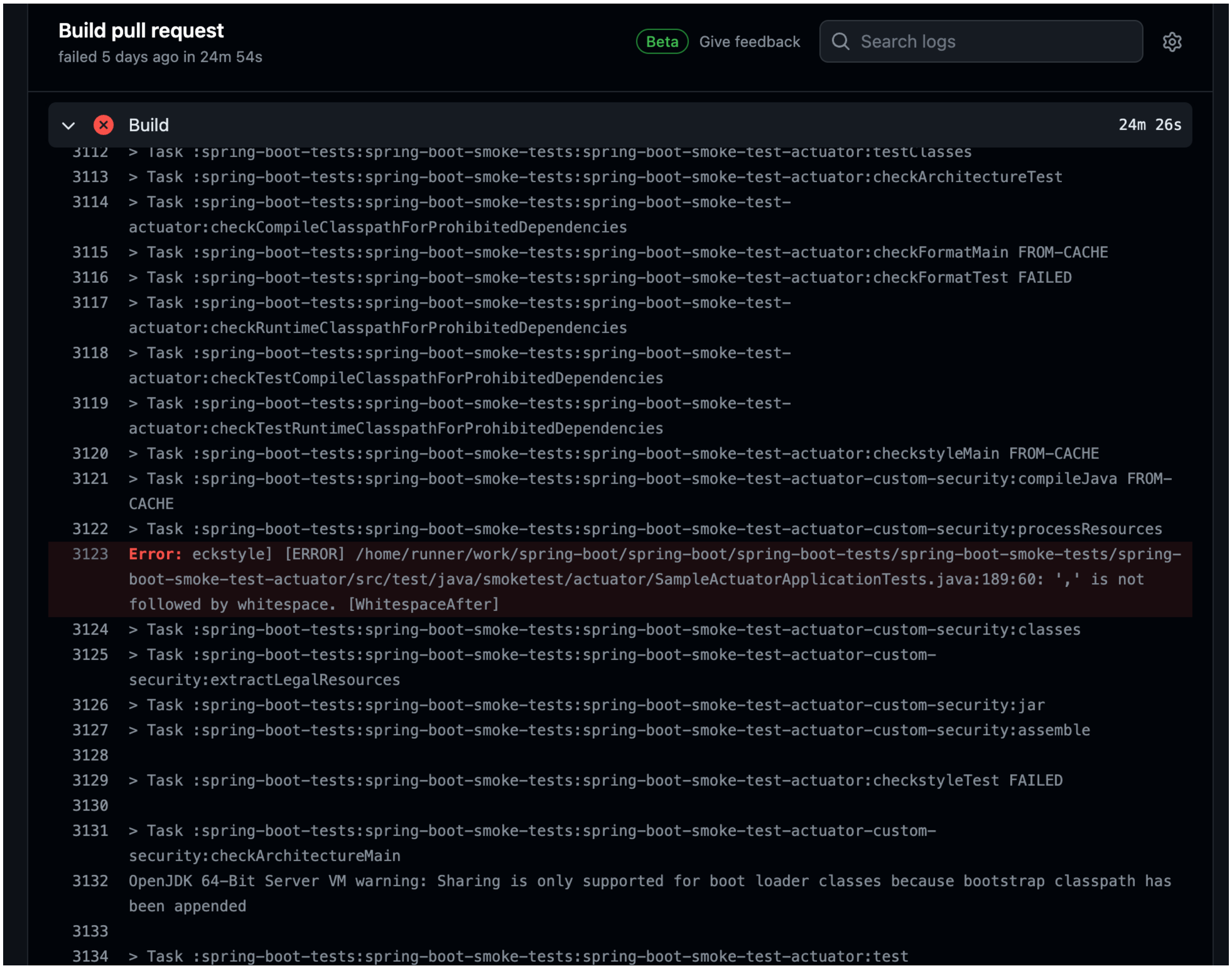
Build commit
The hosted runner: GitHub Actions 7 lost communication with the server. Anything in your workflow that terminates the ru…
Show more

After 50 minutes wait, the build action gets successfully triggered, but the build failed. We get not log file except one annotation:

> Build commit The hosted runner: GitHub Actions 7 lost communication with the server. Anything in your workflow that terminates the runner process, starves it for CPU/Memory, or blocks its network access can cause this error.

GitHub action unexpectedly lost the connection to the server.Based on its prompt, I speculate the system crashes due to **out of memory** . Spring boot is so huge that an average performance server is unable to handle this task. I checked peers build time. On average, it only takes 5 to 10 minutes to complete the build on one platform, maximum no over 15min.

Fortunately, We made a pull request in the previous coverage test, which gave us a chance to call the build system of the main repository, we can see what's going on inside.



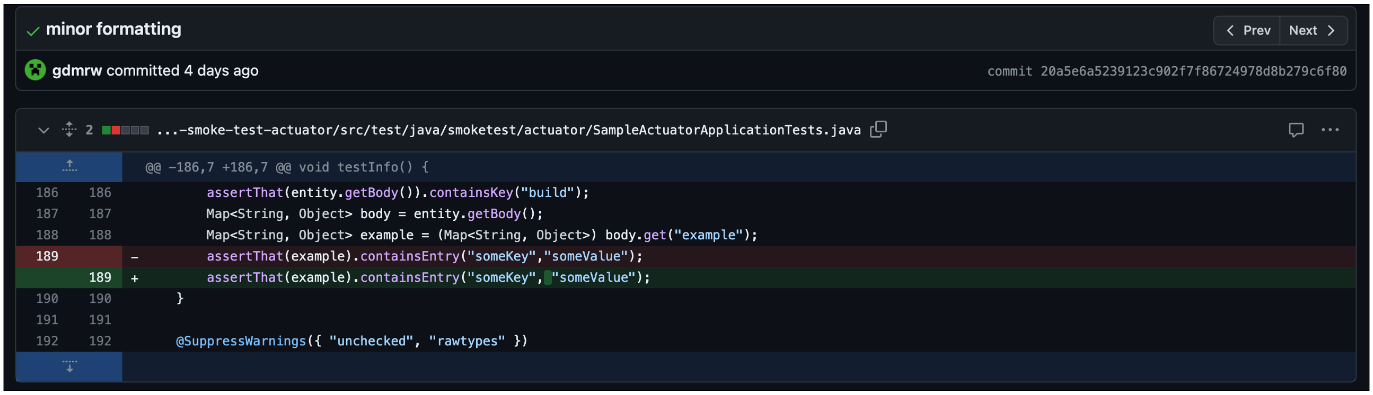
Build pull request

failed 5 days ago in 24m 54s

Build 24m 26s

```
3112  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:testClasses
3113  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkArchitectureTest
3114  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkCompileClasspathForProhibitedDependencies
3115  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkFormatMain FROM-CACHE
3116  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkFormatTest FAILED
3117  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkRuntimeClasspathForProhibitedDependencies
3118  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkTestCompileClasspathForProhibitedDependencies
3119  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkTestRuntimeClasspathForProhibitedDependencies
3120  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkstyleMain FROM-CACHE
3121  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:compileJava FROM-CACHE
3122  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:processResources
3123  Error: eckstyle] [ERROR] /home/runner/work/spring-boot/spring-boot/spring-boot-tests/spring-boot-smoke-tests/spring-boot-smoke-test-actuator/src/test/java/smoketest/actuator/SampleActuatorApplicationTests.java:189:60: ',' is not followed by whitespace. [WhitespaceAfter]
3124  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:classes
3125  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:extractLegalResources
3126  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:jar
3127  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:assemble
3128
3129  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkstyleTest FAILED
3130
3131  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:checkArchitectureMain
3132  OpenJDK 64-Bit Server VM warning: Sharing is only supported for boot loader classes because bootstrap classpath has been appended
3133
3134  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:test
```

In the right conor of the panel, we can clearly see that even with a well-tuned server, it still took 24 minutes to complete the build.Furthermore, a total of five thousand lines were recorded in the log. In line `3123` , we can notice that as a widely used framework, spring boot has strict content review standards. The red block is the cause of the build failure, which is caused by my introduced code. Springboot's build configuration introduces format detection, which they call `check-style` , and uses this to normalize all code blocks. You will see that I just miss one space after a comma, a whole build failure. I adjusted this and committed to the remote repo again.



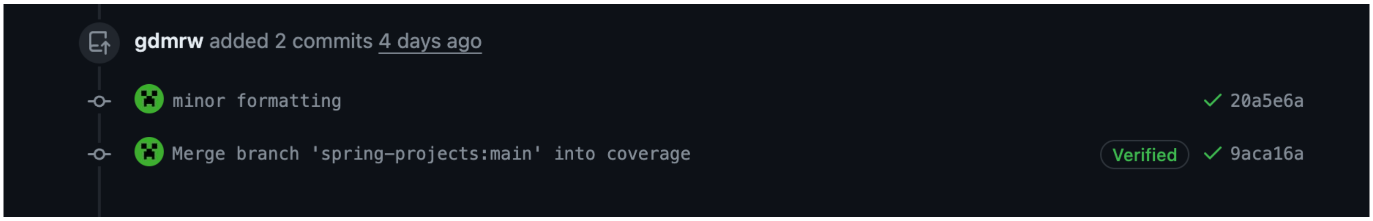
✓ **minor formatting**

gdmrw committed 4 days ago

commit 20a5e6a5239123c902f7f86724978d8b279c6f80

2 ...-smoke-test-actuator/src/test/java/smoketest/actuator/SampleActuatorApplicationTests.java

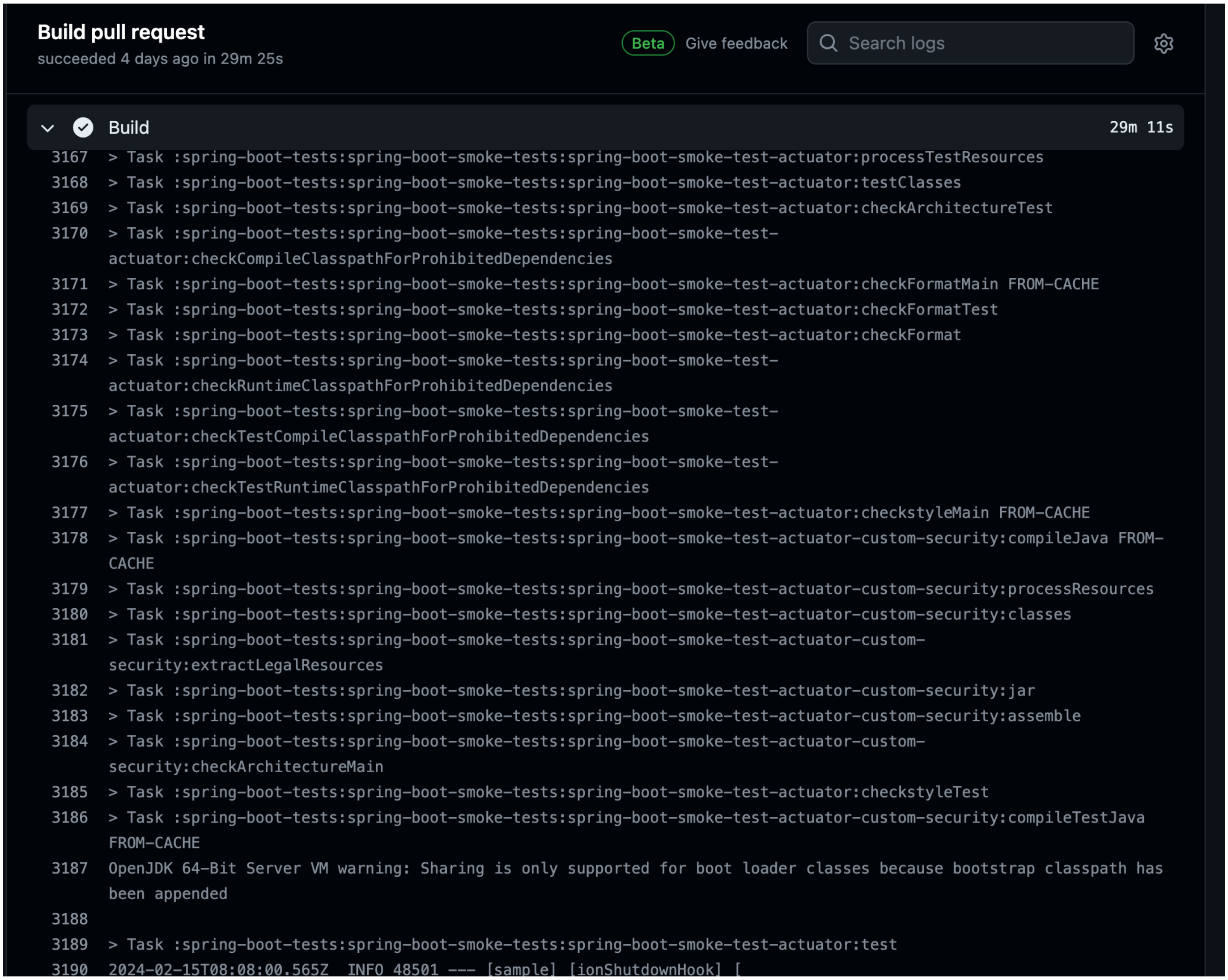
```
          @@ -186,7 +186,7 @@ void testInfo() {
186  186              assertThat(entity.getBody()).containsKey("build");
187  187              Map<String, Object> body = entity.getBody();
188  188              Map<String, Object> example = (Map<String, Object>) body.get("example");
189       -           assertThat(example).containsEntry("someKey","someValue");
     189  +           assertThat(example).containsEntry("someKey", "someValue");
190  190          }
191  191
192  192          @SuppressWarnings({ "unchecked", "rawtypes" })
```



gdmrw added 2 commits 4 days ago

```
minor formatting                                                     ✓ 20a5e6a
Merge branch 'spring-projects:main' into coverage          Verified  ✓ 9aca16a
```

You can see that after the new commit new build finishes successfully.Below are excution details.



Build pull request

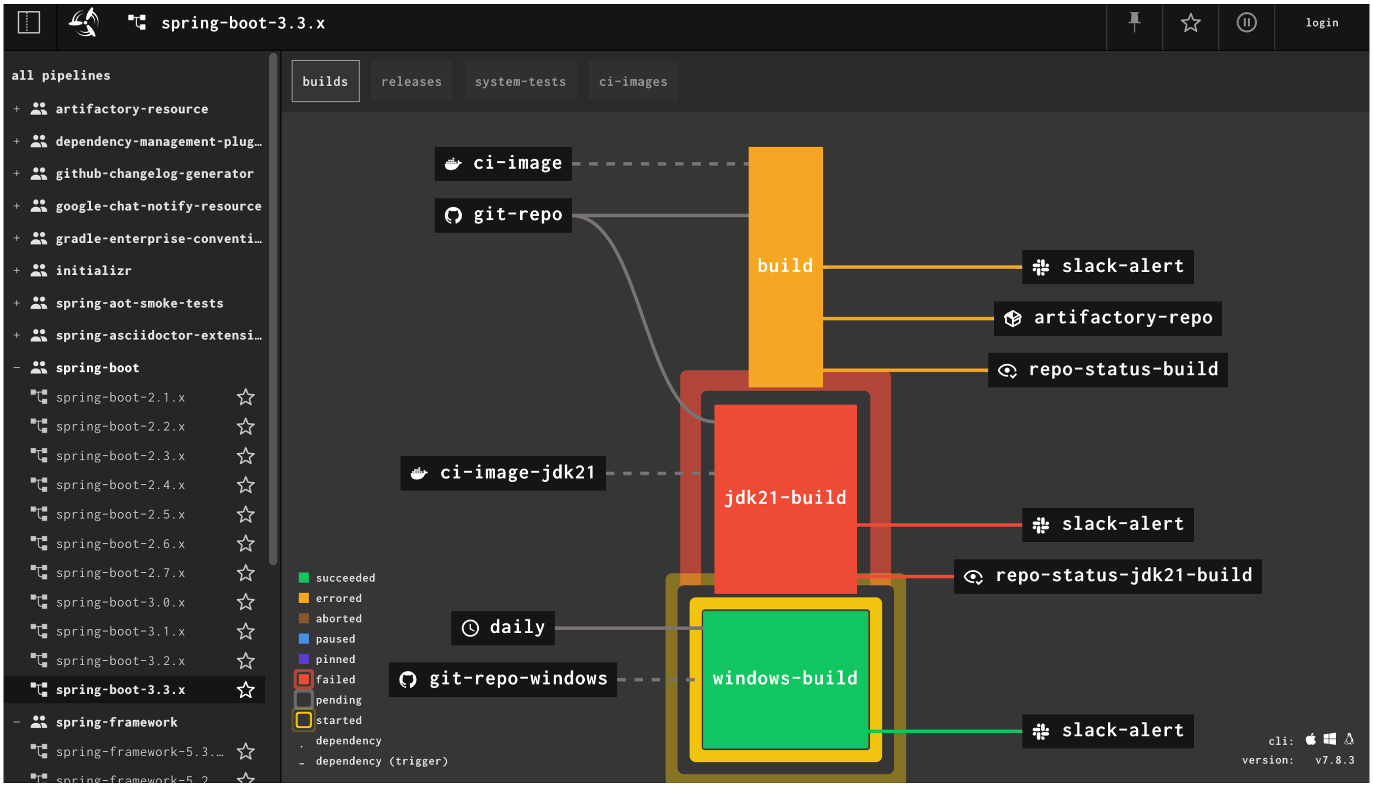
succeeded 4 days ago in 29m 25s

Build 29m 11s

```
3167  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:processTestResources
3168  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:testClasses
3169  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkArchitectureTest
3170  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-
      actuator:checkCompileClasspathForProhibitedDependencies
3171  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkFormatMain FROM-CACHE
3172  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkFormatTest
3173  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkFormat
3174  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-
      actuator:checkRuntimeClasspathForProhibitedDependencies
3175  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-
      actuator:checkTestCompileClasspathForProhibitedDependencies
3176  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-
      actuator:checkTestRuntimeClasspathForProhibitedDependencies
3177  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkstyleMain FROM-CACHE
3178  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:compileJava FROM-
      CACHE
3179  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:processResources
3180  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:classes
3181  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-
      security:extractLegalResources
3182  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:jar
3183  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:assemble
3184  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-
      security:checkArchitectureMain
3185  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:checkstyleTest
3186  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator-custom-security:compileTestJava
      FROM-CACHE
3187  OpenJDK 64-Bit Server VM warning: Sharing is only supported for boot loader classes because bootstrap classpath has
      been appended
3188
3189  > Task :spring-boot-tests:spring-boot-smoke-tests:spring-boot-smoke-test-actuator:test
3190  2024-02-15T08:08:00.565Z  INFO 48501 --- [sample] [ionShutdownHook] [
```

You can see it consume 29 minutes to finish the build. All the tasks in the screenshot are related to spring boot actuator smoke test.I speculate all the changes I made are tested by the task on line `3189` , and the other tasks are some system-level tests.

> Spring boot's CI tool is characterized for long building time, and its complex dependencies are the main contributor. Even so, we still see that the spring boot project team is still actively performing frequent build tests. As I write this assignment, the spring boot panel shows that new builds are still in progress. I think this is one of the reasons for the success of spring boot


spring-boot-3.3.x
login
all pipelines
+ artifactory-resource
+ dependency-management-plug…
+ github-changelog-generator
+ google-chat-notify-resource
+ gradle-enterprise-conventi…
+ initializr
+ spring-aot-smoke-tests
+ spring-asciidoctor-extensi…
− spring-boot
spring-boot-2.1.x ☆
spring-boot-2.2.x ☆
spring-boot-2.3.x ☆
spring-boot-2.4.x ☆
spring-boot-2.5.x ☆
spring-boot-2.6.x ☆
spring-boot-2.7.x ☆
spring-boot-3.0.x ☆
spring-boot-3.1.x ☆
spring-boot-3.2.x ☆
spring-boot-3.3.x ☆
− spring-framework
spring-framework-5.3.… ☆
spring-framework-5.2
builds
releases
system-tests
ci-images
ci-image
git-repo
build
slack-alert
artifactory-repo
repo-status-build
ci-image-jdk21
jdk21-build
slack-alert
repo-status-jdk21-build
daily
git-repo-windows
windows-build
slack-alert
🟩 succeeded
🟧 errored
🟫 aborted
🟦 paused
🟪 pinned
🟥 failed
□ pending
□ started
. dependency
- dependency (trigger)
cli:
version: v7.8.3