Exploring Jenkins Pipelines: Shared Libraries

29 Dec 2017 | 16 mins | 8 Comments | Jenkins, Continuous Delivery

Continuing the mini-series about Jenkins Pipelines, it is time to take a closer look at how our pipelines can follow the DRY (Don't Repeat Yourself) principle when our scripts are getting bigger and bigger, and we need to share parts of them across multiple projects. In this post, we will explore the concept of Jenkins Shared Libraries - a mechanism that allows keeping bits of our pipeline scripts within reusable units.

Examples from this post will be based on the code from the other articles in this mini-series. If you haven't had the chance, it might be a good idea to check them out first:

- Running Selenium tests with Jenkins Pipelines and Zalenium
- Exploring Jenkins Pipelines: a simple delivery flow

General information

First, let's take a closer look at the whole idea behind Jenkins Shared Libraries. The official documentation can be found here. It thoroughly describes the general concept, but some details may not be so apparent when trying to pull pieces of your script code into a library.

Library structure and contents

Taking a look at the directory structure, it maps to the three types of elements of a library:

- `/vars` - over here global variables and functions are kept - this will be your bread and butter for creating your own custom DSLs inside your scripts.

  After a successful run of a pipeline using a library containing such elements, they will be listed under `<jenkins-url>/pipeline-syntax/globals` page and, when a corresponding `.txt` file is inside the library, present additional documentation from it - this way you can provide extra help to other team members using your API.

- `/src` - a regular Java source directory; everything kept here will be added to the classpath during script compilation; the available classes can be loaded with an import statement;
- `/resources` - additional non-Groovy/Java files that can be loaded via `libraryResource` step

The order I've put the above folders is not random - I've based it on the frequency I have been using them when working with Pipelines. That's me - maybe your use case will be different :). I have noticed though that in general, managing steps via global methods in `vars` folder is more straightforward - you can use freely other steps, while the code from `src` requires passing the `steps` object from the pipeline itself.

What's noteworthy is that all scripts are put through CPS (continuation-passing style) transformation - the magic that enables pipelines to survive a restart and occasionally make you pull your hair off due to the related errors :).

Ways of loading libraries into your scripts

We configure the Shared Libraries on Jenkins' main configuration page - we need to provide a name and SCM details to have a way to refer to our library from the script.

The most important part here is also mentioned in the official doc: such libraries are considered **'trusted'**. There might be a chance that if you developed pipelines you'd run into problems when calling internal Jenkins or Java/Groovy APIs, where Jenkins failed the pipeline saying something about the sandbox, rejection, lack of permissions, etc. This is because pipelines scripts kept, e.g., directly in the job (which is one of the ways to debug parts of your pipelines) are run in a Groovy sandbox that is the cause of all these 'pleasures'. Using Global Libraries solves that problem but bear in mind (if you missed this info in the docs) **people with push permissions to the repository containing the Global Library have basically unlimited access to Jenkins**. You have been warned, and hopefully, this is not a reason for your InfoSec team to ban Pipelines or libraries from being used.

One additional thing when it comes to a Library configuration - you can select the checkbox which loads it implicitly, meaning you do not have to worry about remembering about loading it manually. If you have some libraries that are must-haves in your pipelines that may be an excellent improvement to your workflow.

Since libraries are yet another bunch of code, you might want to version them by tagging the repository or keeping different branches active - you can specify the default revision in the configuration (which probably is a good idea when combined with implicit loading).

If like me, you prefer to control the whole pipeline from the code, you can load the library using `@Library` annotation. It can be put above one of your import statements or (in case you are using only global variables/functions) with an underscore: `@Library('your-lib') _` .

There is an additional step that loads a library dynamically during the runtime: `library 'your-lib'` . Keep in mind though, that with this approach all your library classes have to be accessed via a different method: `library('your-lib').com.company.SomeUtil.method()` . I haven't found a use case for such approach yet, so let me know when you needed to load a library like that!

Refactoring time!

Now that we know the basics, it is time to apply them to an actual script! Let's analyze the pipelines that we created in previous posts - they should give us at least couple points that we could refactor. Here are the pipelines:

```
#!groovy

node('master') {
    stage('Checkout') {
        checkout scm
    }

    stage('Run tests') {
        try {
            withMaven(maven: 'Maven 3') {
                dir('bobcat') {
                    sh 'mvn clean test -Dwebdriver.type=remote -Dwebdriver.url=http://localhost:4444/wd/hub -Dwebdriver.cap.browserName=chrome -Dmaven.test.failure.ignore=true'
                }
            }
        } finally {
            junit testResults: 'bobcat/target/*.xml', allowEmptyResults: true
            archiveArtifacts 'bobcat/target/**'
        }
    }
}
```

Jenkinsfile hosted with ♡ by GitHub **view raw**

```
#!groovy

def releasedVersion

node('master') {
  def dockerTool = tool name: 'docker', type: 'org.jenkinsci.plugins.docker.commons.tools.DockerTool'
  withEnv(["DOCKER=${dockerTool}/bin"]) {
    stage('Prepare') {
        deleteDir()
        parallel Checkout: {
            checkout scm
        }, 'Run Zalenium': {
            dockerCmd '''run -d --name zalenium -p 4444:4444 \
            -v /var/run/docker.sock:/var/run/docker.sock \
            --network="host" \
            --privileged dosel/zalenium:3.4.0a start --videoRecordingEnabled false --chromeContainers 1 --firefoxContainers 0'''
        }
    }

    stage('Build') {
        withMaven(maven: 'Maven 3') {
            dir('app') {
                sh 'mvn clean package'
                dockerCmd 'build --tag automatingguy/sparktodo:SNAPSHOT .'
            }
        }
    }

    stage('Deploy') {
        stage('Deploy') {
            dir('app') {
                dockerCmd 'run -d -p 9999:9999 --name "snapshot" --network="host" automatingguy/sparktodo:SNAPSHOT'
            }
        }
    }

    stage('Tests') {
        try {
            dir('tests/rest-assured') {
                sh './gradlew clean test'
            }
        } finally {
            junit testResults: 'tests/rest-assured/build/*.xml', allowEmptyResults: true
            archiveArtifacts 'tests/rest-assured/build/**'
        }

        dockerCmd 'rm -f snapshot'
        dockerCmd 'run -d -p 9999:9999 --name "snapshot" --network="host" automatingguy/sparktodo:SNAPSHOT'

        try {
            withMaven(maven: 'Maven 3') {
                dir('tests/bobcat') {
                    sh 'mvn clean test -Dmaven.test.failure.ignore=true'
                }
            }
        } finally {
            junit testResults: 'tests/bobcat/target/*.xml', allowEmptyResults: true
            archiveArtifacts 'tests/bobcat/target/**'
        }

        dockerCmd 'rm -f snapshot'
        dockerCmd 'stop zalenium'
        dockerCmd 'rm zalenium'
    }

    stage('Release') {
        withMaven(maven: 'Maven 3') {
            dir('app') {
                releasedVersion = getReleasedVersion()
                withCredentials([usernamePassword(credentialsId: 'github', passwordVariable: 'password', usernameVariable: 'username')]) {
                    sh "git config user.email test@automatingguy.com && git config user.name Jenkins"
                    sh "mvn release:prepare release:perform -Dusername=${username} -Dpassword=${password}"
                }
                dockerCmd "build --tag automatingguy/sparktodo:${releasedVersion} ."
            }
        }
    }

    stage('Deploy @ Prod') {
            dockerCmd "run -d -p 9999:9999 --name 'production' automatingguy/sparktodo:${releasedVersion}"
        }
    }
}

def dockerCmd(args) {
    sh "sudo ${DOCKER}/docker ${args}"
}

def getReleasedVersion() {
    return (readFile('pom.xml') =~ '<version>(.+)-SNAPSHOT</version>')[0][1]
}
```

Jenkinsfile hosted with ♡ by GitHub view raw

Creating a library

As I mentioned before, a library is merely a code repository with a specific folder structure so first let’s create a simple Git repository. Now, what shall we put inside?

Finding candidates for a library

When thinking about moving parts of your pipeline to a library, imagine creating a similar script in the next project or creating an additional pipeline that reuses bits of the one you already have. What can/should be extracted to make that possible or painless? Keep in mind that when scaling your delivery pipelines you probably want to introduce a change in a few places as possible.

Now, let’s take a look at following elements in the above scripts, our potential candidates that we can delegate:

1. Methods defined inside the script: `dockerCmd` and `getReleasedVersion`
2. The way we run tests
3. The release procedure

Methods defined in the script

The first on our list are the methods that we defined in our pipeline. They are usually the most obvious candidates to be moved to a library - it is a piece of logic that has been already extracted out of the main script body. Naturally, sometimes such methods will make sense only in the context of the given pipeline, where they will stay.

Let’s focus on the `getReleasedVersion` method, as this one will be easier to handle:

```
def getReleasedVersion() {
    return (readFile('pom.xml') =~ '<version>(.+)-SNAPSHOT</version>')[0][1]
}
```

It does not depend on any additional environmental variables, it just reads and processes a POM file. Assuming we leave navigating to it to the pipeline, we can basically almost copy-paste it into the library.

To do so, we need to create a small Groovy script in our still empty repository. Since we would like to re-use the above as a regular step in the pipeline, we will put it inside `vars` folder and name the file just as our step will be invoked: `getReleasedVersion.groovy` . The contents will be a simple `call` function, without any parameters (for simplicity/laziness reasons :)):

```
def call() {
    (readFile('pom.xml') =~ '<version>(.+)-SNAPSHOT</version>')[0][1]
}
```

And that’s it, we have the first step in our shared library! On to the next one then.

The `dockerCmd` is a more tricky case. The definition might not be, but let’s see how it is being invoked:

```
//...
  def dockerTool = tool name: 'docker', type: 'org.jenkinsci.plugins.docker.commons.tools.DockerTool'
  withEnv(["DOCKER=${dockerTool}/bin"]) {
    //...
  }
//...
def dockerCmd(args) {
    sh "sudo ${DOCKER}/docker ${args}"
}
```

The `dockerCmd` depends on the environment variable `DOCKER` , which on the other hand requires a Jenkins tool properly configured. We could simply move the function as is, perhaps with an additional safeguard throwing an exception when such variable is missing but imagine using such step in another pipeline. You probably would copy-paste these two lines (who would remember in what package lies the type of the tool?). This is not the most user-friendly approach, right? But perhaps we could wrap them in a single handy call, like… `withDocker` ?

> Note here: be careful how you name your steps to avoid conflicts with in-built or plugin-provided steps. It is always a good idea to peek at the list available at JENKINS_URL/pipeline-syntax, just to be sure.

Let’s create two additional global steps in our library:

- `withDocker.groovy` :

  ```
  def call(Closure body) {
      def dockerTool = tool name: 'docker', type: 'org.jenkinsci.plugins.docker.commons.tools.DockerTool'
      withEnv(["DOCKER=${dockerTool}/bin"]) {
          body()
      }
  }
  ```

- `dockerCmd.groovy` :

```
def call(args) {
    assert DOCKER != null
    assert args != null
    return sh(script: "sudo ${DOCKER}/docker ${args}", returnStdout: true)
}
```

The additional return here might come in handy when we would like to use the returned information (e.g., container ID) somewhere further in the pipeline.

Save, commit and we’re done. Having the above, we can now directly call, e.g.:

```
withDocker {
    //...
    dockerCmd 'run -d -p 9999:9999 --name "snapshot" --network="host" automatingguy/sparktodo:SNAPSHOT'
    //...
}
```

The way we run tests

The next element on our list is how we run specific tests in our pipelines. Usually, in your team or organization, you will have to execute the tests the same way multiple times - there are various environments, different groups reuse the same test automation frameworks, etc. Such executions are perfect bits that can end up in a library.

In our pipelines, we have executions of two frameworks, Rest Assured and Bobcat:

```
try {
    dir('tests/rest-assured') {
        sh './gradlew clean test'
    }
} finally {
    junit testResults: 'tests/rest-assured/build/*.xml', allowEmptyResults: true
    archiveArtifacts 'tests/rest-assured/build/**'
}
```

```
try {
    withMaven(maven: 'Maven 3') {
        dir('tests/bobcat') {
            sh 'mvn clean test -Dmaven.test.failure.ignore=true'
        }
    }
} finally {
    junit testResults: 'tests/bobcat/target/*.xml', allowEmptyResults: true
    archiveArtifacts 'tests/bobcat/target/**'
}
```

Let’s assume that we will execute them using Gradle and Maven respectively.

Taking a look at the above code snippets in the context of extracting them to an external function, parametrizing the paths used in them is probably a good idea. We will leave the `dir` steps out of the library though - in my opinion, it is the responsibility of given pipeline to know the context of a given stage and navigate correctly through its workspace.

Just like with any other library that we would implement when creating steps for Jenkins, it is always a good idea to stop for a second and think about possible and relatively cheap extension points. What could be a bit different use case of the step we are trying to introduce? What modifications our user might need in the future? How would we like to adjust triggering the above code?

In general, the most common case when it comes to executing Maven/Gradle or other build system are the parameters we provide. Let's try to include a capability that allows that in our steps.

Keeping in mind all the above, we can create two new scripts (same as before, in `vars` folder):

- `restAssured.groovy`

  ```
  def call(Map config) {
      try {
          sh "./gradlew test ${config?.params ?: ''}"
      } finally {
          def path = config?.artifactsPath?.concat('/') ?: ''
          junit testResults: "${path}build/*.xml", allowEmptyResults: true
          archiveArtifacts "${path}build/**"
      }
  }
  ```

  We are using here a bit different construction for passing parameters. Thanks to the above syntax, we can invoke the new step in a following, more understandable way: `restAssured params: '-Psuite=MyTests' artifactsPath: '/some/directory'` .

  Additionally, note one more significant thing: I have removed the `clean` task. I did it so this step can be safely used in `parallel` blocks - otherwise, such executions would wipe results from the other runs.

  Oh, and remember about swapping single quotes for double ones to make string interpolation possible.

- `bobcat.groovy`

  ```
  def call(Map config) {
      try {
          sh "mvn clean test -Dmaven.test.failure.ignore=true ${config?.params ?: ''}"
      } finally {
          def path = config?.artifactsPath?.concat('/') ?: ''
          junit testResults: "${path}target/*.xml", allowEmptyResults: true
          archiveArtifacts "${path}target/**"
      }
  }
  ```

  We applied the same rules here, with the exact two parameters, which adds a nice consistency in our library.

Looking at the above code snippets we can clearly see that they are very similar - the `try-finally` , `junit` and `archiveArtifacts` steps. We could refactor both scripts even further and extract an additional wrapping step, named, e.g. `testWithJunit` , to make life easier for another framework - I'll leave that exercise to you though :).

The release procedure

Time for the last part - the release procedure. Let's analyze it (and imagine that this is a regular way of making releases in our team/organization, so putting this in the library is justified):

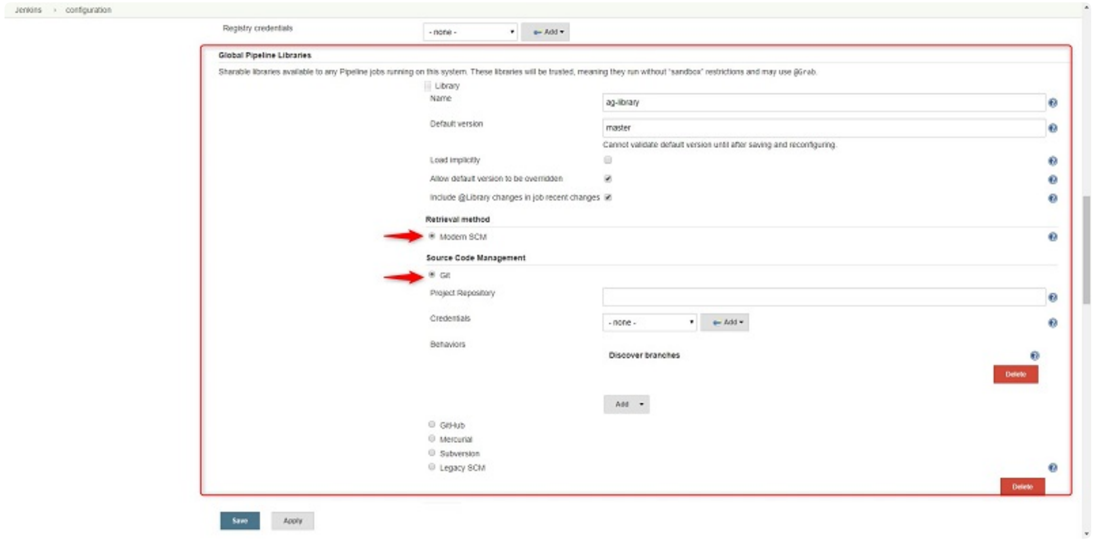
```
    withMaven(maven: 'Maven 3') {
        dir('app') {
            releasedVersion = getReleasedVersion()
            withCredentials([usernamePassword(credentialsId: 'github', passwordVariable: 'password', usernameVariable: 'username')]) {
                sh "git config user.email test@automatingguy.com && git config user.name Jenkins"
                sh "mvn release:prepare release:perform -Dusername=${username} -Dpassword=${password}"
            }
            dockerCmd "build --tag automatingguy/sparktodo:${releasedVersion} ."
        }
    }
```

At this point, you probably already noticed what and how we are going to extract :). Time to create `release.groovy` in `vars` folder!

```
def call(Map config) {
    withCredentials([usernamePassword(credentialsId: config.credentials, passwordVariable: 'password', usernameVariable: 'username')]) {
        sh "git config user.email ${config?.email ?: 'jenkins@example.com'} && git config user.name ${config?.username ?: 'Jenkins'}"
        sh "mvn release:prepare release:perform -Dusername=${username} -Dpassword=${password}"
    }
}
```

Setting up the library in Jenkins

To actually use the library, we need to configure it first. Navigate to the Jenkins configuration page (`/configure`) and in the 'Global Pipeline Libraries' hit the 'Add' button. Now, provide a name that can be used to import it later on and, after selecting the 'Modern SCM' option, information about your library repository:


Jenkins › configuration

Registry credentials: - none - | Add

Global Pipeline Libraries

Sharable libraries available to any Pipeline jobs running on this system. These libraries will be trusted, meaning they run without "sandbox" restrictions and may use @Grab.

Library

Name	ag-library
Default version	master
	Cannot validate default version until after saving and reconfiguring.
Load implicitly	☐
Allow default version to be overridden	✓
Include @Library changes in job recent changes	✓

Retrieval method

[✓ Modern SCM]

Source Code Management

[✓ Git]

Project Repository	
Credentials	- none -
Behaviors	Discover branches

GitHub
Mercurial
Subversion
Legacy SCM

After this, we are all set!

Using a library in your script

Now that the hard part is finished, it is time to clean up our pipelines. We are going to replace parts of the script with corresponding library methods and add the necessary imports.

After the refactoring our pipelines look as follows:

```
#!groovy

@Library('ag-library@master') _

node('master') {
    stage('Checkout') {
        checkout scm
    }

    stage('Run tests') {
        bobcat params: '-Dwebdriver.type=remote -Dwebdriver.url=http://localhost:4444/wd/hub -Dwebdriver.cap.browserName=chrome', artifactsPath: 'bobcat'
    }
}
```

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```
#!groovy

@Library('ag-library@master') _
```