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Continuous Integration Servers and Tools

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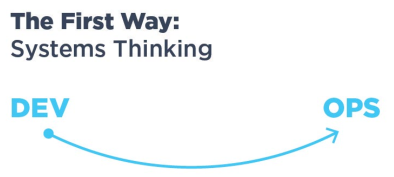
ABOUT CONTINUOUS INTEGRATION & DEVOPS

Continuous Integration is one of several core concepts that must be considered when implementing a DevOps culture within an organization. The core principles of a DevOps implementation are summarized by what Gene Kim describes as "The Three Ways". The First way is to move towards systems thinking—that is, evaluating the performance of the system as a whole. This usually involves organizational changes at a cultural level.

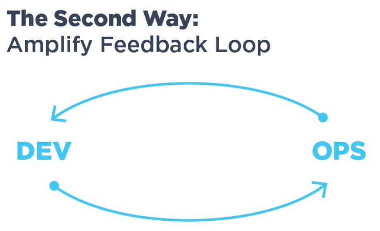


The second way, and what we will be focusing on here, involves amplifying feedback loops.

The Second Way is about creating the right to left feedback loops. The goal of almost any process improvement initiative is to shorten and amplify feedback loops so necessary corrections can be continually made.

The outcomes of the Second Way include understanding and responding to all customers, internal and external, shortening and amplifying all feedback loops, and embedding knowledge where we need it.

— *Gene Kim*
The Three Ways: The Principles Underpinning DevOps



Continuous integration helps to fulfill this second principle. The continuous review, build, and inspection of software allows us to address potential issues as soon as possible. It also promotes transparency as all team members have access to the analytical artifacts produced by the system.

CI TOOLING

There are many tools that can be used to implement a continuous integration system. For the purposes of this reference card we will be focusing on the following:

TOOL	DESCRIPTION
Apache Maven 3.3.3	Apache Maven is A software project management and comprehension tool. Based on the concept of a project object model (POM), Maven can manage a project's build, reporting and documentation from a central piece of information.
Git 2.5.5	A version control system that is widely used for software development and other version control tasks. It is a distributed revision control system with an emphasis on speed, data integrity, and support for distributed, non-linear workflows.
Jenkins 2.0	Jenkins is an open source automation server with an unparalleled plugin ecosystem to support practically every tool as part of your delivery pipelines. Whether your goal is continuous integration, continuous delivery or something else entirely, Jenkins can help automate it. Jenkins 2.0 provides built-in support for delivery pipelines, improved usability and full backwards compatibility.
SonarQube 5.5	An open platform for managing code quality, including static code analysis.
Gerrit 2.12.x	Provides web based code review and repository management for the Git version control system.
SonaType Nexus 3.0.x	A repository for Java artifacts (e.g., JAR and WAR files). Version 3 provides additional support for docker-formatted container images, NPM (node package manager), Bower (HTML, CSS, Javascript repository), and NuGet (Microsoft .NET package manager)

THE DEMO CI PIPELINE

A graphical representation of the CI pipeline is available at raw.githubusercontent.com/kharyam/dzone-ci-demo-app/master/images/ci-pipeline-overview.png The pipeline consists of the following steps:

1. Developer clones code from the authoritative Git repository managed by Gerrit.
2. Developer pushes a code change into the pending changes repository managed by Gerrit.

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3. The team lead reviews the code change in pending changes repository.
4. The team lead approves the code changes in the pending changes repository.
5. The team lead submits the code changes into the authoritative Git repository.
6. Gerrit triggers the Jenkins CI pipeline via a `change-merged` Git hook.
7. The `Checkout` stage of the pipeline is run.
8. The `Checkout` stage clones the source code from the authoritative git repository.
9. The `Build` stage performs a maven build of the code.
10. The `Analyze` stage calls SonarQube to perform static code analysis.
11. The `Archive` stage uploads the WAR file into the Nexus repository. It also archives unit test results within Jenkins.
12. The `Deploy to Development` stage deploys the WAR from Nexus into the development servers. *
13. Upon authorized approval the `Deploy to Test` stage deploys the WAR into the test servers. *
14. Upon authorized approval the `Deploy to Production` stage deploys the WAR into the production servers. *

**Note that the last three steps are considered part of the Continuous Deployment (CD) process, however this can also be handled by the Jenkins pipeline. These steps are simply placeholders that can be implemented if CD is desired.*

*There are two options for continuing with this reference card. The tools can be installed manually following the section **Manually Installing the CI Server Tools** or you can use an example docker-formatted container image, described in the section **Using the CI Server docker-formatted Container Image.***

USING THE CI SERVER DOCKER-FORMATTED CONTAINER IMAGE

A docker-formatted container image was created for the configuration described in this reference card. See https://hub.docker.com/r/kharyam/ciserver/.

For more background information on Docker refer to the Getting Started with Docker Refcard.

Use the following steps to run the container image.

1. Pull the container image

```
docker pull kharyam/ciserver
```

2. Start the container image

```
$ docker run -d -p 8081-8084:8081-8084 -p
29418:29418 -p  40396:40396 --name=ciserver
kharyam/ciserver:latest

a75ac65d97ad5c.... (1)
```

(1) This is the ID of the container started by the docker engine

3. The initial login to Jenkins will require a password printed when Jenkins initially comes up. You can issue the following command to obtain this password.

```
$ docker logs ciserver 2>&1 | grep -A1 "Please
use"

Please use the following password to proceed to
installation:
4a9bb0ea09cb4f21aa8d9fc506661a80 (2)
```

(2) Use this password for the initial Jenkins login described in the section Install and Configure Jenkins

Continue with the section **Manually Installing the CI Server Tools**, skipping the steps noted as unnecessary for container images.

MANUALLY INSTALLING THE CI SERVER TOOLS

Here we describe how to install and configure the above tools on a linux server. Once completed you will be able to test out a continuous integration flow. These steps were tested on Fedora 23 but may be easily tweaked for other linux distributions.

***Note:** The configuration described herein is for demonstration / learning purposes and not meant for production use. For example, we will be using embedded databases for Gerrit and SonarQube while in production you would use a dedicated database such as PostgreSql or MySQL.*

Choose a location to install the software and configuration information for the CI server, for example `/opt/ciserver`. We will refer to this location as `$CI_HOME`.

INSTALL AND CONFIGURE JAVA, MAVEN AND GIT

Note: *You can skip this section if using the container image.*

Note: *If you are using Red Hat Enterprise Linux or CentOS, replace the* `dnf` *command with* `yum`.

1. Install Java, maven, and git:

```
$ sudo dnf install java-1.8.0-openjdk-devel maven
git gitweb
```

INSTALL AND CONFIGURE NEXUS

Note: *You can skip to Step 4 if using the container image. Nexus may take several minutes to start the first time.*

1. Download Nexus 3.0.x at sonatype.com/download-oss-sonatype.
2. Extract the archive:

```
$ tar -xf nexus-3.0.0-03-unix.tar.gz -C $CI_HOME
```

Note: *By default Nexus will run on port 8081. This can be changed by updating* `$CI_HOME/nexus-3.0.0-03/etc/org.sonatype.nexus.cfg`.

3. Start Nexus using the default configuration:

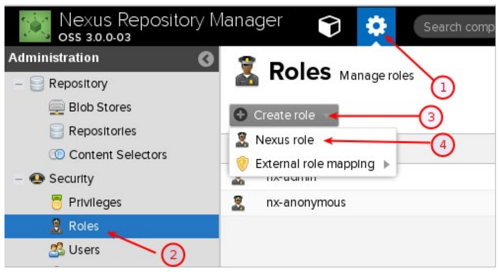
```
$ cd $CI_HOME/nexus-3.0.0-03/bin
$ ./nexus start
Starting Nexus
```

4. Open your browser to `http://localhost:8081` and you should see the Nexus welcome screen. Sign in as `admin` with the password `admin123`.

5. You can change the admin user password by clicking the `Admin` user name in the header menu then selecting `Change password`.

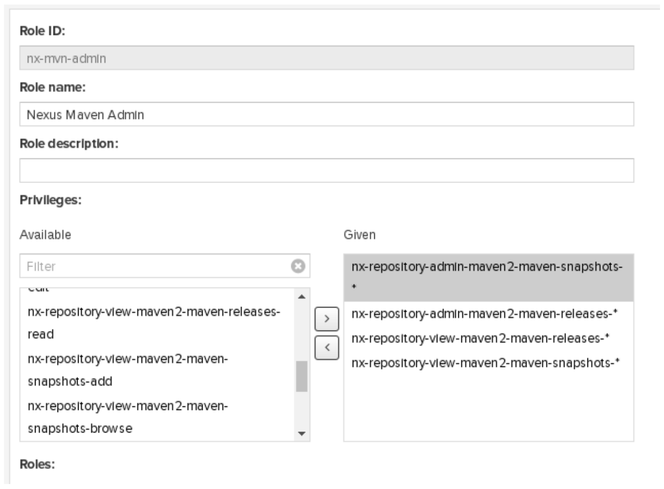
Now we will create a new role in Nexus that has the ability to administer the release and snapshot repositories.

6. Click the gear icon then select `Roles` under the `Security` section on the left of the screen and click the `Create Role > Nexus Role` button.



7. Enter the following values:

FIELD	VALUE
Role ID	nx-mvn-admin
Role Name	Nexus Maven Admin
Privileges	nx-repository-admin-maven2-maven-releases-* , nx-repository-admin-maven2-maven-snapshots-*, nx-repository-view-maven2-maven-releases-*, nx-repository-view-maven2-maven-snapshots-*



Role ID:
nx-mvn-admin
Role name:
Nexus Maven Admin
Role description:

Privileges:

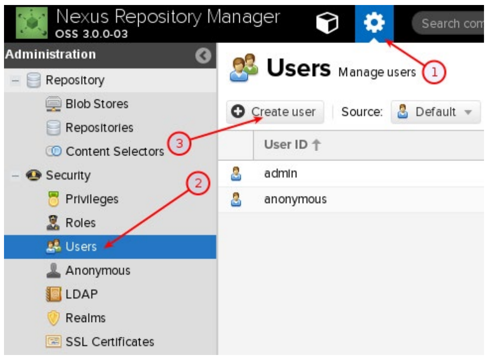
Available	Given
nx-repository-view-maven2-maven-releases-read	nx-repository-admin-maven2-maven-snapshots-*
nx-repository-view-maven2-maven-snapshots-add	nx-repository-admin-maven2-maven-releases-*
nx-repository-view-maven2-maven-snapshots-browse	nx-repository-view-maven2-maven-releases-*
	nx-repository-view-maven2-maven-snapshots-*

Roles:

8. Click the `Create Role` button.

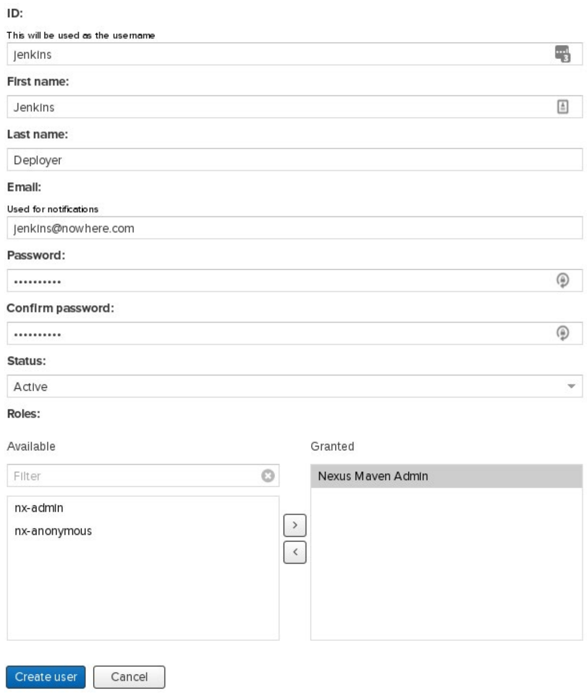
Next we will create a Jenkins user account that will allow our CI pipeline to upload artifacts into the Nexus Repository

1. Click the gear icon then select `Users` under the `Security` section on the left of the screen and click the `Create User` button.



2. Enter the following values:

FIELD	VALUE
ID	jenkins
First Name	Jenkins
Last Name	Deployer
Email	jenkins@nowhere.com
Password	jenkins123
Confirm password	jenkins123
Status	Active
Roles	Nexus Maven Admin



ID:
This will be used as the username
jenkins
First name:
Jenkins
Last name:
Deployer
Email:
Used for notifications
jenkins@nowhere.com
Password:
••••••••••
Confirm password:
••••••••••
Status:
Active
Roles:

Available	Granted
nx-admin	Nexus Maven Admin
nx-anonymous	

Create user Cancel

3. Click the `Create User` button.

INSTALL AND CONFIGURE GERRIT

Note: *You can skip this section if using the container image*

1. Download Gerrit 2.12.x - https://Gerrit-releases.storage.googleapis.com/index.html.
2. Place the WAR file in `$CI_HOME`.

3. Initialize Gerrit:
```
$ java -jar Gerrit.war init --batch -d $CI_HOME/
Gerrit
```

4. Add the following to the end of `$CI_HOME/Gerrit/etc/Gerrit.config`:
```
[gitweb]
cgi = /var/www/git/gitweb.cgi
```

5. Change the port Gerrit runs on from 8080 to 8082. Edit `$CI_HOME/Gerrit/etc/Gerrit.config` and replace all occurrences of 8080 with 8082.

6. Change the authentication type from `OPENID` to `DEVELOPMENT_BECOME_ANY_ACCOUNT`. Edit `$CI_HOME/Gerrit/etc/Gerrit.config` and replace all occurrences of `OPENID` with `DEVELOPMENT_BECOME_ANY_ACCOUNT`.

Note: Gerrit supports many authentication schemes including OPENID and LDAP. For our demonstration purposes we will enable a simple developmental authentication scheme, not meant for use in production. Refer to https://Gerrit-review.googlesource.com/Documentation/config-Gerrit.html#auth for more information on Gerrit's authentication support.

7. Download the latest bouncy castle security JAR from here www.bouncycastle.org/latest_releases.html.
8. Copy the JAR file to `$CI_HOME/Gerrit/lib`.
9. Restart Gerrit:
```
$ $CI_HOME/Gerrit/bin/Gerrit.sh restart
```

10. You should now be able to access the Gerrit home page via `http://localhost:8082`.

INSTALL AND CONFIGURE SONARQUBE

Note: You can skip this section if using the container image. Just note the default username is admin, with password admin.

1. Download SonarQube - sonarqube.org/downloads.
```
$ unzip sonarqube-5.5.zip -d $CI_HOMEsonar.web.
port=8084
$ echo "sonar.web.port=8084" >> $CI_HOME/
sonarqube-5.5/conf/sonar.properties
$ cd $CI_HOME/sonarqube-5.5/bin/linux-x86-64
$ ./sonar.sh start
```

2. You should now be able to log in to the web console by pointing your browser to `http://localhost:8084` Sign in as admin with the password `admin`.

INSTALL AND CONFIGURE JENKINS

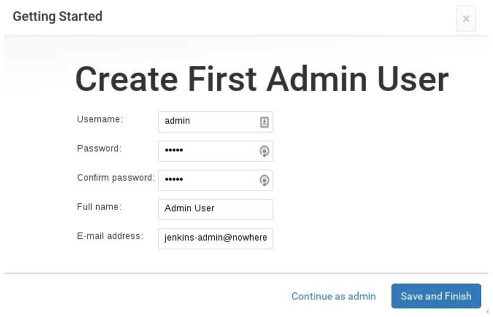
Note: *You can skip to Step 3 if using the container image.*

1. Download Jenkins - https://Jenkins.io/2.0/
```
$ mv Jenkins.war $CI_HOME
```

2. Startup Jenkins on port 8083 and make a note of the admin password:
```
$ java -jar Jenkins.war --httpPort=8083

...
Jenkins initial setup is required. An admin user
has been created and a password generated.
Please use the following password to proceed to
installation:

112233445566778899aabbccddeeff11 (1)

...
```

(1) The initial Jenkins password

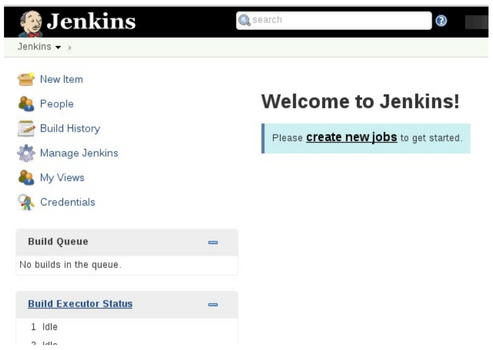
3. Log in to Jenkins via `http://localhost:8083` using the password noted above. If you are using the container image, use the password that was provided via the `docker logs` command.
4. Select the `Install suggested plugins` option.
5. Complete the requested information to create the `admin` account. Use the username `admin` and password `admin`. Click `Save and finish` then click `Start using Jenkins`.


Getting Started

Create First Admin User

Username:	admin
Password:	•••••
Confirm password:	•••••
Full name:	Admin User
E-mail address:	jenkins-admin@nowhere

6. You should now be presented with the main Jenkins page.



No builds in the queue.
1 Idle

Welcome to Jenkins!

Please **create new jobs** to get started.

You can now proceed to **Configuring a CI pipeline**.

CONFIGURING A CI PIPELINE

CONFIGURE GERRIT

We are going to create two user accounts in Gerrit. One representing a development team lead and another representing a developer.

1. Connect to Gerrit via `http://localhost:8082/login`.
2. Select the `New Account` button under the `Register` heading.
3. Enter `Team Lead` for the full name and click the `Save Changes` button.
4. Enter `teamlead` for the username and click the `Select Username` button (Click ok to confirm).

5. Paste the ssh public key that you use for Git (e.g., ~/.ssh/id_rsa.pub) into the `Add SSH Public Key` text box and click the `Add` button.

   a. If you are using the container image, you can generate an ssh key pair by following these steps:

      i. Log in to your container

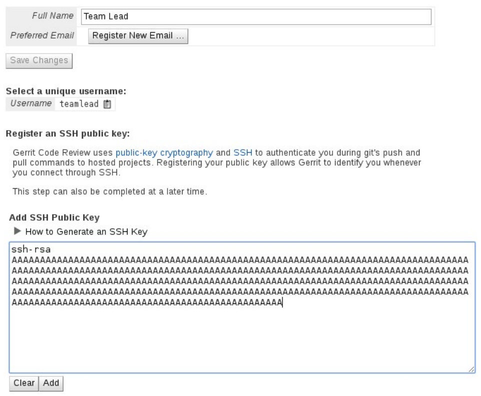
      ```
      $ docker exec -it ciserver /bin/bash
      ```

      ii. Generate a key pair

      ```
      $ ssh-keygen
      Generating public/private rsa key pair.
      Enter file in which to save the key (/opt/ci-
      server/.ssh/id_rsa): (1)
      Created directory '/opt/ci-server/.ssh'.
      Enter passphrase (empty for no passphrase):
      (1)
      Enter same passphrase again: (1)
      Your identification has been saved in /opt/ci-
      server/.ssh/id_rsa.
      Your public key has been saved in /opt/ci-
      server/.ssh/id_rsa.pub.
      The key fingerprint is:
      SHA256:ApTkVs+jY/N85pLY4WTKOJ1n2SOojs7B8Fi6F4/
      wsOg ci-server@2cdd3e3d74de
      The keys randomart image is:
      +---[RSA 2048]----+
      | .o.. |
      | o.. |
      | + + |
      | . . . . |
      |. . * S |
      | |
      |+=++ + Xo=o |
      | |
      |oE+.oo o o.. |
      +----[SHA256]-----+
      ```

      Note: *Press enter when prompted.*

      iii. Copy the public key that was created in `/opt/ci-server/.ssh/id_rsa.pub`



Full Name: Team Lead
Preferred Email: Register New Email ...
Save Changes

Select a unique username:
Username: teamlead

Register an SSH public key:

Gerrit Code Review uses public-key cryptography and SSH to authenticate you during git's push and pull commands to hosted projects. Registering your public key allows Gerrit to identify you whenever you connect through SSH.

This step can also be completed at a later time.

Add SSH Public Key

▶ How to Generate an SSH Key

```
ssh-rsa
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
```

6. Click the `Continue` link on the bottom of the page. Since this is the first user we have created in Gerrit, the user is automatically granted administrator privileges.

7. Go back to `http://localhost:8082/login` and Select the `New Account` button under the `Register` heading again.

8. Enter `Team Developer` for the full name and click the Save Changes button.

9. Enter `teamdeveloper` for the username and click the `Select Username` button (Click ok to confirm).

10. Click the `Register New Email..` button, enter the email address that you have (or will have) in your .gitconfig. Click `Register`.

11. Paste the ssh public key that you use for Git (e.g., ~/.ssh/id_rsa.pub) into the `Add SSH Public Key` text box and click the `Add` button. Use the same public key as was used for the team lead user.

12. Click the `Continue` link on the bottom of the page.

CONFIGURE MAVEN FOR SONARQUBE

Note: *You can skip this section if using the container image.*

Make a backup copy of `/usr/share/maven/conf/settings.xml` and use the following instead. If you are using the container image this file is already in place.

```
<?xml version="1.0" encoding="UTF-8"?>
<settings>

  <servers>
      <server> (1)
      <id>internal.repo</id>
      <username>jenkins</username>
      <password>jenkins123</password>
    </server>
  </servers>

  <pluginGroups> (2)
    <pluginGroup>org.sonarsource.scanner.maven</pluginGroup>
  </pluginGroups>
  <profiles>
    <profile>
      <id>sonar</id>
      <activation>
        <activeByDefault>true</activeByDefault>
      </activation>
      <properties>
        <sonar.host.url>
          http://localhost:8084 (3)
        </sonar.host.url>
      </properties>
    </profile>
  </profiles>
</settings>
```

(1) Credentials for pushing artifacts into Nexus. Note Maven also supports password encryption - http://maven.apache.org/guides/mini/guide-encryption.html

(2) Sonar plugin for static code analysis

(3) URL of the sonar server

CONFIGURE JENKINS

Note: *You will need to run through these steps even if you are using the container image.*

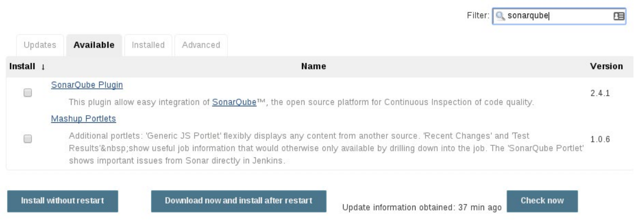
CONFIGURE MAVEN

1. Return to the Jenkins console (`http://localhost:8083`) and login as `admin`.
2. Click the `Manage Jenkins` link on the left.

3. Click `Global Tool Configuration`.
4. At the very bottom, click `Add Maven`. For the name specify `M3`. Deselect `Install automatically` and set the value of `MAVEN_HOME` to `/usr/share/maven`.
5. Click the `Save` button at the bottom of the page.

INSTALL ADDITIONAL PLUGINS

1. On the `Manage Jenkins` page, select `Manage Plugins`.
2. Click the `Available` tab and type `sonarqube` in the search filter.



Filter: sonarqube

Updates | Available | Installed | Advanced

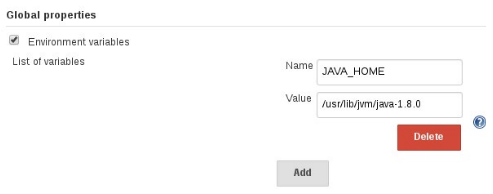
Install ↓	Name	Version
☐	SonarQube Plugin This plugin allow easy integration of SonarQube™, the open source platform for Continuous Inspection of code quality.	2.4.1
☐	Mashup Portlets Additional portlets: 'Generic JS Portlet' flexibly displays any content from another source. 'Recent Changes' and 'Test Results' show useful job information that would otherwise only available by drilling down into the job. The 'SonarQube Portlet' shows important issues from Sonar directly in Jenkins.	1.0.6

Update information obtained: 37 min ago

3. Select the check box next to `SonarQube Plugin` and click the `Install without restart` button.
4. Repeat the previous steps to install the `Sidebar Link` plugin by specifying `sidebar link` in the search filter.

SET JAVA_HOME

1. Navigate to `Manage Jenkins > Configure System`.
2. Under `Global Properties` select `Environment Variables`.
3. Enter `JAVA_HOME` for the name and `/usr/lib/jvm/java-1.8.0` as the value.



Global properties

☑ Environment variables

List of variables

Name: JAVA_HOME

Value: /usr/lib/jvm/java-1.8.0

4. Click the `Save` button at the bottom of the page.

ADD LINKS TO SONARQUBE, NEXUS AND GERRIT (OPTIONAL)

These steps will create links on the main Jenkins page to the Nexus, Gerrit, and SonarQube pages.

1. Navigate to `Manage Jenkins > Configure System`
2. Under `Additional Sidebar Links` enter the following information:

FIELD	VALUE
Link URL	http://localhost:8084
Link Text	SonarQube
Link Icon	gear.png

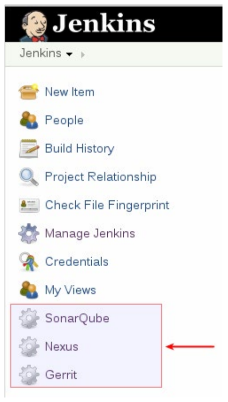
3. Click the `Add Link` button and enter the following values for Nexus:

FIELD	VALUE
Link URL	http://localhost:8081
Link Text	Nexus
Link Icon	gear.png

4. Click the `Add Link` button and enter the following values for Gerrit:

FIELD	VALUE
Link URL	http://localhost:8082
Link Text	Gerrit
Link Icon	gear.png

5. Click the `Save` button at the bottom of the screen.



PUSH CODE TO GERRIT

These directions will refer to `$GIT_HOME` as the directory where you store your git projects, for example `~/git`. With these steps we will create a new project in Gerrit, seeding it with source code from an existing GitHub repository.

Note: If you are using the container image, you can perform these steps within the container. Log in to the container and create a git directory within the home directory: `mkdir ~/git && cd ~/git`.

1. Clone the demo application (https://github.com/kharyam/dzone-ci-demo-app) from GitHub and remove the `.git` directory:
```
$ cd $GIT_HOME
$ git clone https://github.com/kharyam/dzone-ci-
demo-app.git
$ rm -fr $GIT_HOME/dzone-ci-demo-app/.git
```
2. Create a new project named `Demo` in Gerrit as the `teamlead` user:
```
$ ssh -p 29418 teamlead@localhost gerrit create-
project Demo --empty-commit
```
3. Clone the new project as the `teamdeveloper` user:
```
$ cd $GIT_HOME
$ git clone ssh://teamdeveloper@localhost:29418/
Demo.git
```
4. Move the files from the GitHub project into the Gerrit project:
```
$ mv $GIT_HOME/dzone-ci-demo-app/* $GIT_HOME/
Demo
$ mv $GIT_HOME/dzone-ci-demo-app/.gitignore $GIT_
HOME/Demo
```
5. Install the Gerrit Git commit hook. This hook will append a change-id to the commit message, which is required

by Gerrit. For more information see Gerrit-review.googlesource.com/Documentation/user-changeid.html.

```
$ cd $GIT_HOME/Demo
$ gitdir=$(git rev-parse --git-dir); scp -p -P
29418
teamdeveloper@localhost:hooks/commit-msg
${gitdir}/hooks/
```

6. Commit and push the code to Gerrit.
   Note: If you are running this within the container, run the following commands first:

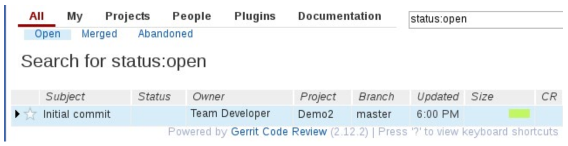
```
$ git config --global user.name "teamdeveloper"

$ git config --global user.email "email@somewhere.
com" (1)

$ cd $GIT_HOME/Demo
$ git add . (1)
$ git commit -am "Initial commit" (2)
$ git push origin HEAD:refs/for/master (3)

Counting objects: 20, done.
Delta compression using up to 8 threads.
Compressing objects: 100% (11/11), done.
Writing objects: 100% (20/20), 3.32 KiB | 0
bytes/s, done.
Total 20 (delta 0), reused 0 (delta 0)
remote: Processing changes: new: 1, refs: 1, done
remote:
remote: New Changes:
remote: http://localhost:8082/6 Initial commit
remote:
To ssh://teamdeveloper@localhost:29418/Demo.git
```

(1) Recursively stage all files into the local Git repository

(2) Commit all newly added / modified files into the local Git repository

(3) Push the commit into the remote Gerrit repository. `HEAD:refs/for/master` is a special Git reference used by Gerrit to stage changes for review prior to making them available on the authoritative Git repository.

7. Now if you navigate to the Open Reviews in Gerrit (`http://localhost:8082/#/q/status:open`) you will see the pending review for this initial commit.



Search for status:open

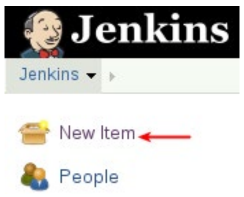
	Subject	Status	Owner	Project	Branch	Updated	Size	CR
▸ ☆	Initial commit		Team Developer	Demo2	master	6:00 PM	🟩	

Powered by Gerrit Code Review (2.12.2) | Press '?' to view keyboard shortcuts

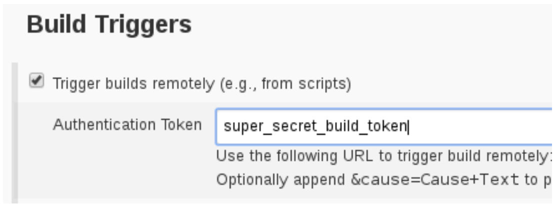
CREATE THE JENKINS PROJECT

Here we will create a new Jenkins project that will deploy our Continuous Integration Pipeline. The Pipeline itself is defined in the `Jenkinsfile` of our sample project.

1. Login to the Jenkins console (`http://localhost:8083/`) as the `admin` user.
2. Click the `New Item` link.



3. Enter a project name of `CI Demo`, Select the `Pipeline` option then click the `OK` button.
4. Under `Build Triggers` select `Trigger builds remotely (e.g., from scripts)`. For the `Authentication Token` enter `super_secret_build_token`.



☑ Trigger builds remotely (e.g., from scripts)

Authentication Token: super_secret_build_token

Use the following URL to trigger build remotely:
Optionally append &cause=Cause+Text to p

Note: This will allow us to trigger a build by performing an HTTP get on the URL `http://localhost:8083/job/CI%20Demo/build?token=super_secret_build_token`. *We will use this to create a Git hook in Gerrit that will trigger a Jenkins build when code has been successfully peer reviewed.*

5. In the `Pipeline` section, set the `Definition` to `Pipeline script from SCM`.
6. Set the `SCM` to `Git` and enter the URL of the Gerrit repository - `http://localhost:8082/p/Demo.git`.
7. Click the `Save` button.

THE PIPELINE DEFINITION

To learn more about the Jenkins Pipeline plugin (formerly known as the Jenkins Workflow plugin), refer to dzone.com/refcardz/continuous-delivery-with-Jenkins-workflow.

```
node { (1)
  // Mark the code checkout 'stage'....
  stage 'Checkout' (2)

  // Get the latest code from Gerrit
  git url: 'http://localhost:8082/p/Demo.git' (3)

  // Get the maven tool.
  def mvnHome = tool 'M3' (4)

  stage 'Build'

  // Update the version in the pom to
  // match the Jenkins build number. (5)
  sh "${mvnHome}/bin/mvn versions:set -DnewVersion=
    ${env.BUILD_NUMBER} -DallowSnapshots=true"

  // Run the maven build
  sh "${mvnHome}/bin/mvn clean package"

  stage 'Analyze'
  sh "${mvnHome}/bin/mvn sonar:sonar" (6)

 stage 'Archive'

  // Archive the artifacts in Jenkins (7)
  step([$class: 'ArtifactArchiver', artifacts:
    '**/target/*.jar,**/target/*.war', fingerprint: true])

  // Archive the test results. (8)
  step([$class: 'JUnitResultArchiver',
    testResults: '**/target/surefire-reports/TEST-*.xml'])

  // Deploy the artifacts to Nexus (9)
  sh "${mvnHome}/bin/mvn deploy"
```

Code continued on next page

```
  stage concurrency:1, name: 'Deploy to Development' (10)
  echo 'Simulating deployment to Development Environment'
  echo "Downloading WAR file from http://localhost:8081/
    repository/maven-releases/org/example/cisampleapp/${env.
    BUILD_NUMBER}/cisampleapp-${env.BUILD_NUMBER}.war"
  echo 'Deploying WAR file to development server(s)'
  sleep 2


  stage concurrency:1, name: 'Deploy to Test'
  timeout(time: 7, unit: 'DAYS') { (11)
    input message: 'Do you want to deploy to Test?',
      submitter:   'admin' (12)
  }
  echo 'Simulating deployment to Test Environment'
  echo "Downloading WAR file from http://localhost:8081/
    repository/maven-releases/org/example/cisampleapp/${env.
    BUILD_NUMBER}/cisampleapp-${env.BUILD_NUMBER}.war"
  echo 'Deploying WAR file to Test server(s)'
  sleep 5

  stage concurrency:1, name: 'Deploy to Production'
  timeout(time: 7, unit: 'DAYS') {
    input message: 'Do you want to deploy to Production?',
    submitter: 'admin'
  }
  echo 'Simulating deployment to Production Environment'
  echo "Downloading WAR file from http://localhost:8081/
    repository/maven-releases/org/example/cisampleapp/${env.
    BUILD_NUMBER}/cisampleapp-${env.BUILD_NUMBER}.war"
  echo 'Deploying WAR file to production server(s)'
  sleep 5
}
```

(1) The node specifies that the contained steps will run on a Jenkins node. Optionally a node label can be specified to restrict the steps to run a specific node.

(2) Defining the first stage in the pipeline, named `Checkout`.

(3) Checkout the source code from our Git repository.

(4) Define the location of the Maven command line, from our previously configured M3 definition in the Jenkins configuration.

(5) Prior to running the build, use the maven `set:versions` command to update the version in our POM file with the Jenkins build number. This gives will give us code traceability back to the Jenkins build.

(6) Run the sonar plugin to perform static code analysis.

(7) Archive the built JARs and WARs within Jenkins. Record fingerprints for traceability.

(8) Archive the unit test results to enable the generation of trends.

(9) Issue the Maven deploy command to upload our artifacts (POM and WAR file) into Nexus. It will be versioned by the Jenkins build number as set by the Maven set:versions command.

(10) Simulate an automatic deployment to the development servers. `concurrency:1` indicates that if there are multiple instances of this pipeline running only one may run this stage at a time. The WAR file would be downloaded from Nexus and deployed to application servers in the development environment.

(11) Simulate a deployment to the test environment.

(12) The input message will prompt before deploying into the specified environment. The `submitter` option specifies a user or group allowed to execute the step. In this case only the admin user can deploy to test or production.

CREATE THE GIT HOOK IN GERRIT

Note: You can skip this section if you are using the container image

We will create a hook in Gerrit that will automatically start our Jenkins pipeline when code has been successfully peer reviewed and submitted into the authoritative Git repository managed by Gerrit. Note that it assumes the Jenkins login is `admin/admin` and the project name is `CI Demo`.

Note: We are using Gerrit to manage code review and promotion however other techniques and tools can be incorporated as well. An example would be the use of the Git flow workflow nvie.com/posts/a-successful-git-branching-model.

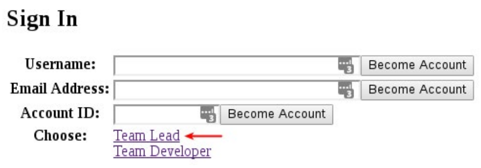
For more information on the change-merged Gerrit hook refer to review.typo3.org/Documentation/config-hooks.html#_change_merged.

```
$ mkdir ${CI_HOME}/gerrit/hooks
$ printf '#!/bin/sh
if [ $8 == \"Demo\" ]; then
  curl -u admin:admin
http://localhost:8083/job/CI%%20Demo/build\?token=super_secret_
build_token > /tmp/results.txt
fi ' > ${CI_HOME}/gerrit/hooks/change-merged

$ chmod 555 ${CI_HOME}/gerrit/hooks/change-merged
```

TESTING THE CI PIPELINE

APPROVE THE INITIAL CODE CHECKIN WITHIN GERRIT

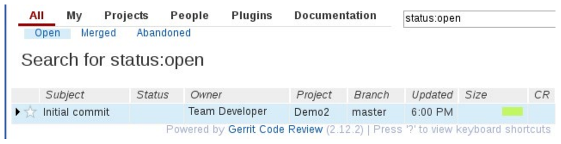
1. Log in to gerrit (`http://localhost:8082/login`) as the `Team Lead` user.



Sign In

Username:		Become Account
Email Address:		Become Account
Account ID:		Become Account
Choose:	Team Lead Team Developer	

2. `Select All > Open`. There will be a pending peer review labeled `Initial commit`.



Search for status:open

Subject	Status	Owner	Project	Branch	Updated	Size	CR
Initial commit		Team Developer	Demo2	master	6:00 PM	🟩	

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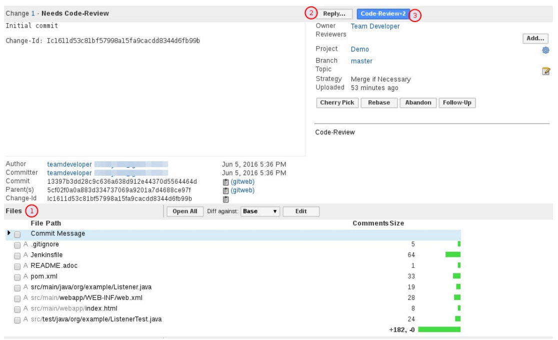
3. Click the `Initial commit` link.



Change 1 - Needs Code-Review

```
Initial commit

Change-Id: Ic1611d53c81bf57998a15fa9cacdd8344d6fb99b
```

Owner	Team Developer
Reviewers	
Project	Demo
Branch	master
Topic	
Strategy	Merge if Necessary
Uploaded	53 minutes ago

Code-Review

Author	teamdeveloper [redacted]	Jun 5, 2016 5:36 PM	
Committer	teamdeveloper [redacted]	Jun 5, 2016 5:36 PM	
Commit	13397b3dd28c9c636a638d912e44370d5564464d	(gitweb)	
Parent(s)	5cf02f0a0a883d334737069a9201a7d4688ce97f	(gitweb)	
Change-Id	Ic1611d53c81bf57998a15fa9cacdd8344d6fb99b		

Files — Diff against: Base

File Path	Comments	Size
Commit Message		
A .gitignore		5
A Jenkinsfile		64
A README.adoc		1
A pom.xml		33
A src/main/java/org/example/Listener.java		19
A src/main/webapp/WEB-INF/web.xml		28
A src/main/webapp/index.html		8
A src/test/java/org/example/ListenerTest.java		24
		+182, -0

(1) This section lists all files that are modified and need to be removed as part of the review. Clicking a file in the list will reveal a diff from the previous version of the file. The diff screen also allows comments to be placed on lines of a file.

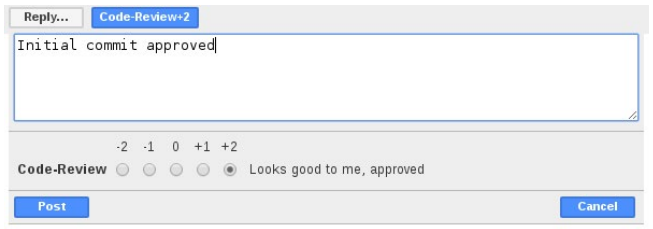
(2) `Reply...` allows a reviewer to submit overall feedback on a set of changes.

(3) The default behavior of Gerrit requires that at least one person of sufficient

redhat.

privilege give a vote of +2 in order for a change to be eligible for submission into the authoritative Git repository. This button provides a quick means of doing so.

4. Select the Reply… button



```
Initial commit approved
```

	-2	-1	0	+1	+2	
Code-Review	○	○	○	○	●	Looks good to me, approved

5. Enter a textual description and choose the +2 option so that the code can be submitted into the authoritative repository. Click the `Post` button.

6. Note that a `Submit` button is now available. This will place the change into the authoritative repository. Open a browser tab to the Jenkins `CI Demo` project (`http://localhost:8083/job/CI%20Demo/`).

7. Now click the `Submit` button in Gerrit and switch back to the Jenkins tab. A new build should start shortly, since our change-merged hook will be called by Gerrit.

8. If you hover the mouse over the `Deploy to Test` stage, you will be prompted to deploy to the test environment. Since the pipeline only allows the admin user to deploy, we can click the `Proceed` button. Repeat for Production.

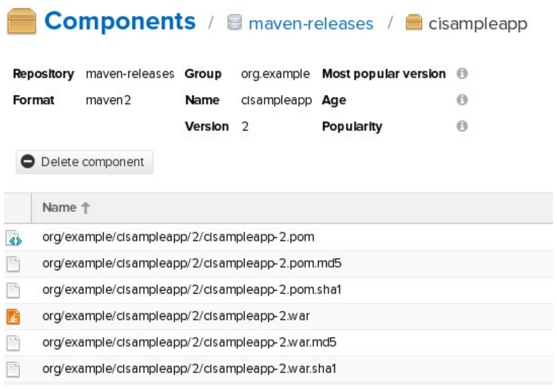
VIEW THE NEXUS AND SONARQUBE RESULTS

Verify the WAR file was uploaded into Nexus:

1. Log in to Nexus via `http://localhost:8081/` using admin/admin123.

2. Select `Browse > Components > maven-releases`.

3. cisampleapp should be visible with its corresponding version number. Click it and you should see the WAR, pom and their corresponding checksums in the repository.



Repository	maven-releases	Group	org.example	Most popular version	
Format	maven2	Name	cisampleapp	Age	
		Version	2	Popularity	

Name ↑
org/example/cisampleapp/2/cisampleapp-2.pom
org/example/cisampleapp/2/cisampleapp-2.pom.md5
org/example/cisampleapp/2/cisampleapp-2.pom.sha1
org/example/cisampleapp/2/cisampleapp-2.war
org/example/cisampleapp/2/cisampleapp-2.war.md5
org/example/cisampleapp/2/cisampleapp-2.war.sha1

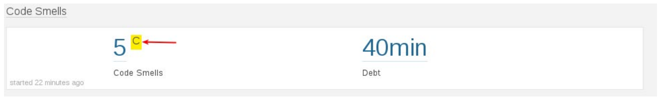
VIEW THE SONARQUBE ANALYSIS RESULTS

1. Login to SonarQube via `http://localhost:8084/` using admin/admin.

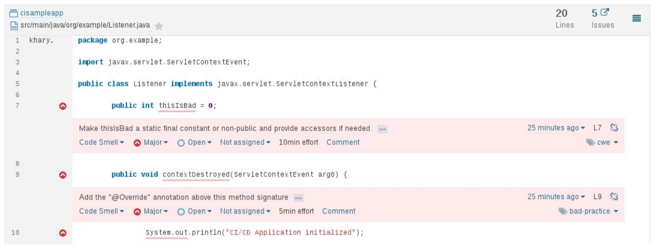
2. The `cisample` application should be visible, click it.

3. Under `Code Smells` notice the rating of `C`.

4. Click the `C` then click the `Listener.java` source file.



5. Expand each item in the source code to reveal the code smells.



```
package org.example;

import javax.servlet.ServletContextEvent;

public class Listener implements javax.servlet.ServletContextListener {

        public int thisIsBad = 0;
```

Make thisIsBad a static final constant or non-public and provide accessors if needed. … 25 minutes ago L7
Code Smell Major Open Not assigned 10min effort Comment cwe

```
        public void contextDestroyed(ServletContextEvent arg0) {
```

Add the "@Override" annotation above this method signature … 25 minutes ago L9
Code Smell Major Open Not assigned 5min effort Comment bad-practice

```
                System.out.println("CI/CD Application initialized");
```

6. Explore other areas of the SonarQube interface.

UPDATE THE CODE

Here we resolve some of the code smells and exercise the pipeline once again.

1. Update the `Listener.java` source file located in `${GIT_HOME}/Demo/src/main/java/org/example/Listener.java`
   a. Remove the line `public int thisIsBad = 0;`.
   b. Add the `@Override` annotation above each method:

```
package org.example;

import javax.servlet.ServletContextEvent;

public class Listener implements javax.servlet.
ServletContextListener {

  @Override
  public void
  contextDestroyed(ServletContextEvent arg0) {
    System.out.println("CI/CD Application
    initialized");
  }

  @Override
  public void
  contextInitialized(ServletContextEvent arg0) {
    System.out.println("CI/CD Application
    exiting");
  } ...
```

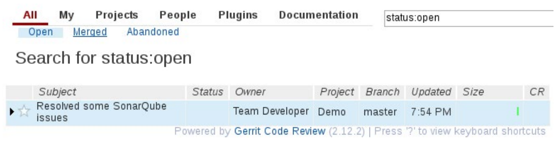
2. Commit and push the changes to Gerrit:

```
$ git commit -am "Resolved some SonarQube
issues"
$ git push origin HEAD:refs/for/master
```

APPROVE THE CODE IN GERRIT

1. Log back in to Gerrit as the teamlead user.

2. A new open peer review is now listed.



Search for status:open

Subject	Status	Owner	Project	Branch	Updated	Size	CR
Resolved some SonarQube issues		Team Developer	Demo	master	7:54 PM		

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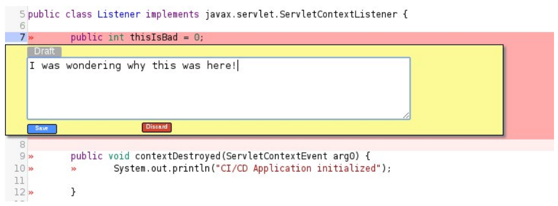
3. Click the issue then click the file listing to view the diff.
4. Comments can be added to the diff by clicking the line number in one of the margins.



```
public class Listener implements javax.servlet.ServletContextListener {

»       public int thisIsBad = 0;
```

Draft

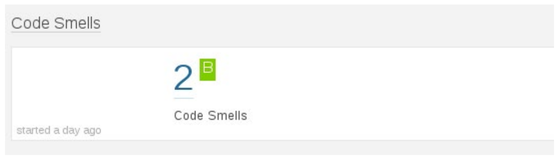
```
I was wondering why this was here!
```

```

»       public void contextDestroyed(ServletContextEvent arg0) {
»       »       System.out.println("CI/CD Application initialized");

»       }
```

5. Click the browser back button to return to the previous screen.
6. Click the `Code-Review+2` button to approve the change.
7. Click the `Submit` button to submit the change into the authoritative Git repository. Verify another build has started in Jenkins.

Verify SonarQube has fewer issues

8. Log in to SonarQube and note the number of Code Smells has decreased from five to two.

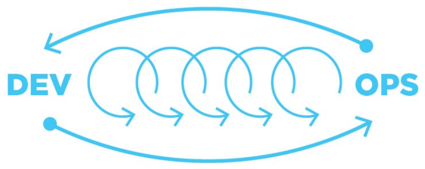


THE THIRD WAY

The Third Way is about creating a culture that fosters two things: continual experimentation, taking risks and learning from failure; and understanding that repetition and practice is the prerequisite to mastery.

— *Gene Kim*
The Three Ways: The Principles Underpinning DevOps

The Third Way:
Culture of Continual Experimentation and Learning



Developers need to be able to rapidly create production-like environments to deploy and experiment with code and application changes. This capability, which enables the third way, is facilitated through Platform As a Service (PaaS) using tools such as Red Hat® OpenShift Container Platform (OCP) openshift.com/container-platform.

TOOLS

The following is a sampling of tools available to support your continuous integration effort.

TOOL TYPE	NAME
CI/CD Server	Jenkins/Hudson, Bamboo, TravisCI, GitLab CI
Code Quality Static Analysis	Findbugs, PMD, CheckStyle
Automated Testing	JUnit, Selenium, Cucumber
Build Tools	Maven, Gradle, Ant, Buildr, Rake
Artifact Repository	Nexus, Artifactory
Code Quality Reporting and Aggregation	SonarQube
Version Control	Git, Subversion, Mercurial
Code Review	Gerrit, Crucible, Git Lab, Phabricator

The Three Ways: The Principles Underpinning DevOps, Gene Kim - itrevolution.com/the-three-ways-principles-underpinning-devops/

ABOUT THE AUTHOR

After having worked over ten years as a software engineer, **KHARY MENDEZ** joined Red Hat North America Public Sector Consulting in 2011. He has enabled clients in the areas of software development, CI/CD, DevOps, and business automation.

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