Jenkins

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Java Maven Basics

- Check for Java Maven Basics Steps.

Jenkins with Maven Build

Setup maven

- Go to ***Jenkins Dashboard -> Manage Jenkins -> Under System Configuration select Tools > Maven > Maven installations > Add Maven > Give a Name Maven_Local > Check Install Automatically > Install from Apache (specify a version) > Save***
- You can give a logical name to identify the correct version while configuring a build job.

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Maven build phases

- Maven itself requires Java installed on your machine.
- You can verify if Maven is installed on your machine by running **mvn -v** in your command line/terminal.
- Maven is based on the `Project Object Model (POM)` configuration, which is stored in the XML file called the same – `pom.xml`. It is a structured format that describes the project, it's dependencies, plugins, and goals.
- `pom.xml` file should be present in your project directory
- Below are the Maven Build Phases
    - **Validate** : Validate Project is correct & all necessary information is available.
    - **Compile** : Compile the Source Code
    - **test** : Test the Compiled Source Code using suitable unit Testing Framework (like JUnit)
    - **package** : Take the compiled code and package it.
    - **install** : Install package in Local Repo, for use as a dependency in other project locally.
    - **Deploy** : Copy the final package to the remote repository for sharing with other developers.
- The above are always are sequential, if you specify `install`, all the phases before `install` are executed.

```
mvn install -f pom.xml
```

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pom.xml definitions

- `<modelVersion>` : POM model version (always 4.0.0).
- `<groupId>` : Group or organization that the project belongs to. Often expressed as an inverted domain name.
- `<artifactId>` : Name to be given to the project's library artifact (for example, the name of its JAR or WAR file).
- `<version>` : Version of the project that is being built.
- `<packaging>` : How the project should be packaged. Defaults to **jar** for JAR file packaging. Use **war** for WAR file packaging.
- `<dependencies>` : External JAR File dependencies

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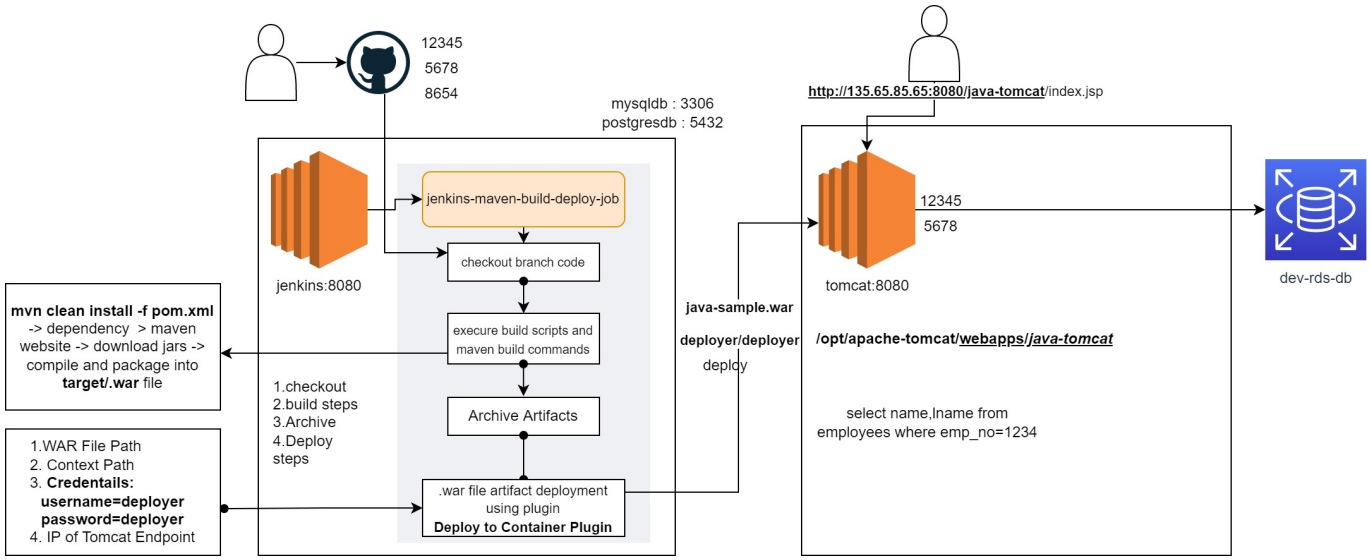
Jenkins Build using Jenkins Job



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- Create a Github Repo with **java-tomcat-sample** source code.
- Click on **New Item** then enter an item name, select **Freestyle project**.
- Under **Source Code Management** tab, select Git and then set the Repository URL to point to your GitHub Repository. `https://github.com/YourUserName/repo-name.git`
- Under **Build Environment > Build Step > Select Invoke top-level Maven targets** from dropdown > select the Maven Version that we just created, specify **clean install**.
- Under Advanced tab, specifiy the **pom.xml** file relative path location from git repository.
- Click on `Save`

> it will run command `mvn clean install -f pom.xml`

```
[test-jenkins-maven-build-freestyle-project] $
/var/lib/jenkins/tools/hudson.tasks.Maven_MavenInstallation/Maven_Local/bin/mvn -f
java-tomcat-sample/pom.xml clean install
```

- Click OK and Build a Job and you will see that a `war file` is created.
- Check the content of the **jar tf java-tomcat-maven-demo.war**

> `clean` -> Deletes `/var/lib/jenkins/workspace/jenkins-maven-build/java-tomcat-sample/target`

- To view the content of `.war` file use : `jar tf java-tomcat-sample-deploy.war`

--

pom.xml parameters

- In the `mvn` command, a parameter can be passed using `mvn clean install "-Dparameter1=value1" "-Dparameter2=value2"`
  - The above values passed in the command can be referenced in `pom.xml` definition with `${parameter1}` and `${parameter2}`.

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Artifacts Archive

- Go to `Jenkins dashboard` -> `Jenkins project or build job` -> `Post-build Actions` -> `Add post-build action` -> `Archive the artifacts`:
- Enter details for options in `Archive the artifacts` section:
    - For `Files to archive` enter the Path of the `.war` file like : `java-tomcat-sample/target/*.war`
- `Save` the changes and `Build Now`.
- Check the directories as below to validate above information:

--

```
ls /var/lib/jenkins/jobs
ls /var/lib/jenkins/jobs/<JOB_NAME>
ls /var/lib/jenkins/jobs/<JOB_NAME>/builds/<BUILD_NUMBER>
ls /var/lib/jenkins/workspace/<JOB_NAME>

[ec2-user@ip-172-31-4-240 java-tomcat-sample]$ tree /var/lib/jenkins/jobs/test-jenkins-maven-build-freestyle-project/
/var/lib/jenkins/jobs/test-jenkins-maven-build-freestyle-project/
├── builds
│   ├── 1
│   │   ├── build.xml
│   │   ├── changelog.xml
│   │   └── log
│   ├── 2
│   │   ├── build.xml
│   │   ├── changelog.xml
│   │   └── log
│   ├── 3
│   │   ├── archive
│   │   │   └── java-tomcat-sample
│   │   │       └── target
│   │   │           └── java-tomcat-maven-example.war
│   │   ├── build.xml
│   │   ├── changelog.xml
│   │   └── log
```

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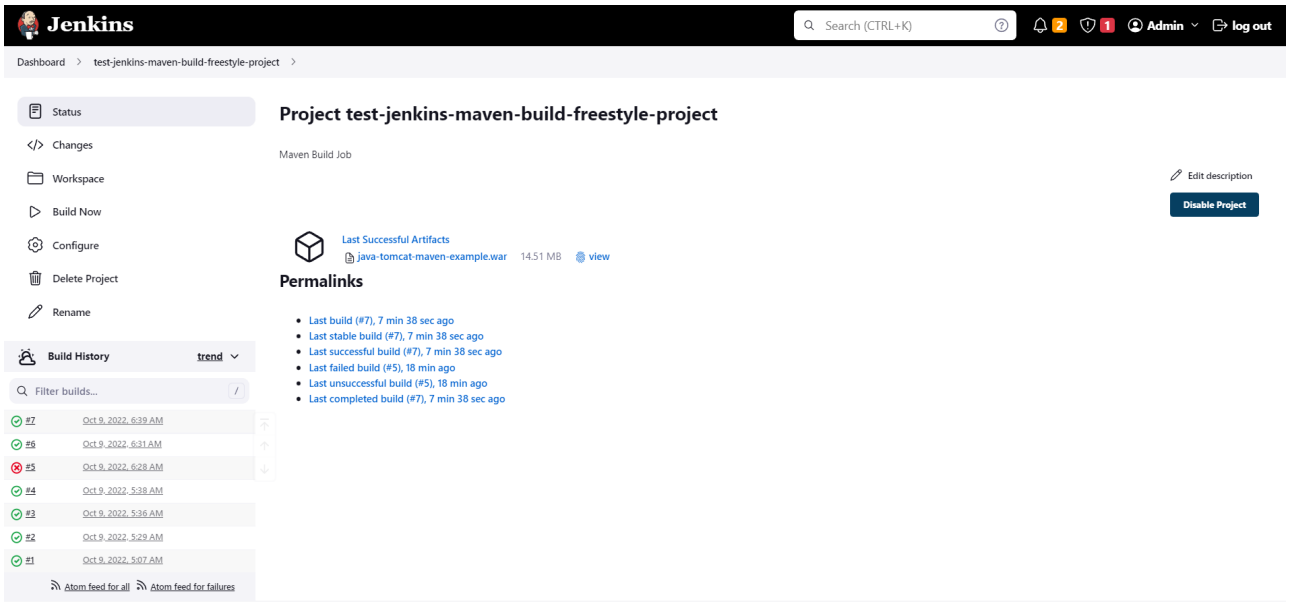
- The Build Project Summary, shows the last successful Build Artifact Name.



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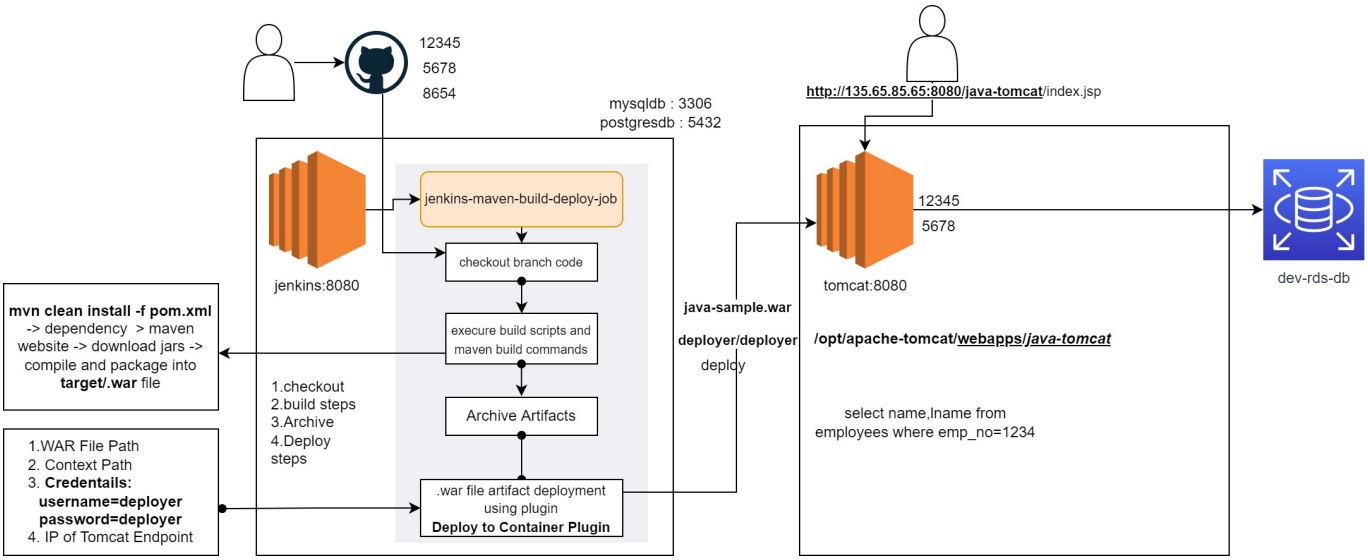
- If you check the directory structure, there will be `archive` directory present under the subsequent build number for which the job is executed with Post build action as `Archive the artifacts`

Jenkins Build and Deploy



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- Below steps assume that, you have a Jenkins Server Up and Running on one of the EC2 instance.

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Setup Apache Tomcat on Amazon Linux

- Launch a new EC2 Instance for Webserver Configuration

```
sudo hostnamectl set-hostname tomcat.example.com
sudo yum install java-1.8.0 java-devel -y
```

```
cd /opt/
sudo wget https://archive.apache.org/dist/tomcat/tomcat-9/v9.0.35/bin/apache-tomcat-9.0.35.tar.gz
sudo tar -zvxf apache-tomcat-9.0.35.tar.gz
----------------------------
z - The file is a "gzipped" file
v - Verbose, print the file names as they are extracted one by one
x -  Extract files
f - Use the following tar archive for the operation
----------------------------
sudo ls -ltr /opt/apache-tomcat-9.0.35/bin
```

- To Start Apache Tomcat : Run the `./startup.sh` file in `/opt/apache-tomcat-9.0.35/bin`
- We can make the scripts executable and then create a symbolic link for this scripts.

```
sudo chmod +x /opt/apache-tomcat-9.0.35/bin/startup.sh
sudo chmod +x /opt/apache-tomcat-9.0.35/bin/shutdown.sh
```

--

- Create symbolic link to these file so that tomcat server start and stop can be executed from any directory.

```
echo $PATH
sudo ln -s /opt/apache-tomcat-9.0.35/bin/startup.sh /usr/bin/tomcatup
sudo ln -s /opt/apache-tomcat-9.0.35/bin/shutdown.sh /usr/bin/tomcatdown
sudo tomcatup
netstat -nltp | grep 8080
```

> If you want to run Apache Tomcat on same Machine where Jenkins is Installed, then change the port of Apache Tomcat in : **/opt/apache-tomcat-9.0.35/conf/server.xml** file to `8090` as below,

```
<Connector port="8090" protocol="HTTP/1.1"
               connectionTimeout="20000"
               redirectPort="8443" />
```

- If above changes are made, execute the command **tomcatdown** and **tomcatup**.
- Create an empty repo and clone it, add project files into the local git folder and commit -> push the local repo to remote github repo using Git Bash.
- Verify the files are available in your github repository.

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Tomcat War file deployment Configs

Tomcat Users Configuration

- To have access to the dashboard the admin user needs the manager-gui role. Later, we will need to deploy a WAR file using Maven, for this, we need the `manager-script` role too.
- In order for Tomcat to accept remote deployments, we have to add a user with the role `manager-script`. To do so, edit the file `../conf/tomcat-users.xml` and add the following lines:
- In this case : add below configurations in the file ***/opt/apache-tomcat-9.0.35/conf/tomcat-users.xml*** under **tomcat-users**.

```
<role rolename="manager-gui"/>
<role rolename="manager-script"/>
<user username="admin" password="admin" roles="manager-gui, manager-script"/>
<user username="deployer" password="deployer" roles="manager-script" />
```

--

Tomcat Network Configuration

- Edit the **RemoteAddrValve** under this file to allow all.
  - **/opt/apache-tomcat-9.0.35/webapps/manager/META-INF/context.xml**
- `Before`

```
        <Valve className="org.apache.catalina.valves.RemoteAddrValve"
         allow="127\.\d+\.\d+\.\d+|::1|0:0:0:0:0:0:0:1" />
```

- `After`

```
        <Valve className="org.apache.catalina.valves.RemoteAddrValve"
         allow=".*" />
```

- Restart the tomcat server using **tomcatdown** and **tomcatup**

--

Apache Tomcat Terminology

- **Document root** : This is the top-level directory of a web application where all the application resources are located, like JSP files, HTML pages, Java classes, and images, artifact libraries.
- **Context path** : This refers to the location that's relative to the server's address and represents the name of the web application. For e.g, If the WAR File is kept under the `$CATALINA_HOME\webapps\myapp` directory, it'll be accessed by the URL `http://TOMCAT_IP:PORT/myapp` , and its context path will be `/myapp`.
- **WAR** – Web Archive. It's the extension of a file that packages a web application directory hierarchy in ZIP format.

Jenkins Job to deploy war file

Jenkins Plugin installation

- To install the Plugin `Deploy to container` navigate to `Manage Jenkins` > `Manage Plugins`, search **Deploy to container** under `Available` tab, Install.
- Create a New Job/Clone an existing Job.Click on **New Item** then enter an item name, select **Freestyle project**.
- Select the GitHub project checkbox and set the Project URL to point to your GitHub Repository. **https://github.com/YourUserName/** keep the branch as **main**.
- Go to Jenkins Project -> Configure -> Under Build Environment Build Step > Select `Invoke top-level Maven targets` from dropdown > select the `Maven Version` that is configured > Enter **clean install**

--

- After the `Archive the Artifacts` Post Build Action.
- Under **Post-build Actions**, from the `Add post-build action` dropdown button select the option **Deploy war/ear to a container**
- Enter details of the War file that will be created as:
    - For **WAR/EAR files** you can use wild cards, e.g. `**/*.war`.
    - The `context path` is the part of the URL under which your application will be published in Tomcat. Enter **java-sample-webapp**
    - Select the appropriate Tomcat version from the Container dropdown box (note that you can also deploy to Glassfish or JBoss using this Jenkins plugin).
    - Under the **Credentials**, Add username and password value that is entered in the **tomcat-users.xml** file.
    - Specify the ID of the credentials as **tomcat_creds**. This will be used later in Pipeline Script.
    - The Tomcat URL is the base URL through which your Tomcat instance can be reached (e.g `http://172.31.67.85:8080`)

> Make Sure network is open on specific port by checking the Security Group attached to EC2 Instance.

    - `Save` the changes and `Build Now`.

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- Once Jenkins Job is build, if there is a Success for deploy, verify the deployment files on Tomcat Server under **/opt/apache-tomcat-9.0.35/webapps/** path.
- Access the Application in Browser with specific Home Page present in `src/webapp` i.e `<TOMCAT_SERVER_IP>:<TOMCAT_PORT>/<CONTEXT_PATH>/index.jsp`
- Make some changes in the code on the github configured branch in the Jenkins Job and build the Job again to verify the Artifact Deployment on Tomcat Path.

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Jenkinsfile Deployment for Build and Deployment

- Create a new Jenkins Pipeline Job and execute the **Jenkinsfile_Maven_Build_Deploy** to run the same Build Steps from Freestyle Project using Jenkinsfile Pipeline Code.
- Modify the necessary Pipeline Code inside the Jenkinsfile.
    - Modify the IP address of the Jenkinsfile Code.

Assignment

Execution of Java Build and Deployment using AWS CICD.

- Configure CodeCodePipeline, CodeBuild, CodeDeploy to use the existing Java Code Files and create a .war file using maven and deploy the .war file on Tomcat Servers.

```
Jenkins:
- Integration with Github.
- Build Step for Maven Command Execution:
    - mvn clean install -f pom.xml
- Archiving the artifacts ( .war file )
- Deploy to Container Plugin:
    - .war file path, tomcat url, context path.

AWS CICD:
Environment Pre-requisite : EC2 instance ( codedeploy agent, tomcat installed )
CodePipeline Integration with Github.
- CodeBuild buildspec.yml command execution:
  - install maven inside buildspec.yml
    - mvn clean install -f pom.xml
    - artifacts: section , .war file to be copied on S3.
- CodeDeploy for .war deployment:
    - appspec.yml
        src: path/to/java-tomcat.war
        dest: /opt/apache-tomcat/webapps/
```

Java Database Connection

- The Java Project Object Model file i.e `pom.xml` file contains `dependency` specified as below:

```
  <dependency>
      <groupId>mysql</groupId>
      <artifactId>mysql-connector-java</artifactId>
      <version>8.0.24</version>
  </dependency>
```

- During the Java Build, the above mentioned dependency packages i.e jar files are downloaded from Maven Website Portal and added inside the **lib** path inside the Artifact **.war** file.
- The **mysql-connector-java-8.0.24.jar** file can be found under **/opt/apache-tomcat-9.0.35/webapps/java-tomcat-sample-deploy/WEB-INF/lib/mysql-connector-java-8.0.24.jar**

- Jar files contain **.class** files already compiled and can be used as **import packages in .java programs**.
- To view the content of the Jar files use command as : **jar tf FILENAME.jar**
    - **jar tf /opt/apache-tomcat-9.0.35/webapps/java-tomcat-sample-deploy/WEB-INF/lib/mysql-connector-java-8.0.24.jar**
- This will display all the **.class** files present.
- The **mysql-connector-java-8.0.24.jar** file is used in the **java-tomcat-sample/src/main/java/dao/GetDao.java** file to import **methods/functions** and use objects to make connection to mysql database.

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Using Mysql Database Server

Configure Mysql DB AWS RDS

- Go to RDS service and click on create database, Chose standard create, Select Mysql.
- On templates select **Free tier**.
- Keep the username and password as desired.
- For DB instance size, let us keep the default value of db.t3.micro.
- For allocated storage we can keep the default 20 GB as storage.
- The RDS similar to EC2 is launched in the VPC.Under connectivity select the VPC and click on "additional connectivity configuration ".
- Select the subnet group by default.
- Always make sure the "Public Access" setting is always set to No. As we'd never want our database to be accessed by internet.
- Select the security group. Make sure EC2 instance IP is whitelisted on port 3306 on this security group.
- Keep other default configuration same.

--

Connecting to an RDS

- Since we have selected public access as no , this RDS can be only accessed from within a VPC.
- On one of the EC2 machine, install mysql client to connect to RDS.

```
#Install the mysql client on EC2
sudo yum install mysql mysql-connector-java.noarch -y
```

- These commands will install the mysql client which helps us connect to any mysql database
- Now to connect to the RDS that we have created, navigate to the RDS console. Click on the RDS and copy the endpoint.

```
# command to connect to mysql
mysql -h rds-endpoint-name -P 3306 -u username -p
mysql -h java-tomcat-db.cgsel8pj8zsp.ap-south-1.rds.amazonaws.com -P 3306 -u admin
-p
```

- Use below mysql commands to create database and tables.

```
mysql> show databases;
mysql> create database db;
mysql> use db;

# Create employees table
CREATE TABLE employees (
    emp_no      INT             NOT NULL,
    birth_date  DATE            NOT NULL,
    first_name  VARCHAR(14)     NOT NULL,
    last_name   VARCHAR(16)     NOT NULL,
    gender      ENUM ('M','F')  NOT NULL,
    hire_date   DATE            NOT NULL,
    PRIMARY KEY (emp_no)
);

show tables;
desc employees;

select * from employees;

INSERT INTO `employees` VALUES (10001,'1953-09-02','Georgi','Facello','M','1986-
06-26'),
(10002,'1964-06-02','Bezalel','Simmel','F','1985-11-21'),
(10003,'1959-12-03','Parto','Bamford','M','1986-08-28'),
(10004,'1954-05-01','Chirstian','Koblick','M','1986-12-01'),
(10005,'1955-01-21','Kyoichi','Maliniak','M','1989-09-12'),
(10006,'1953-04-20','Anneke','Preusig','F','1989-06-02'),
(10007,'1957-05-23','Tzvetan','Zielinski','F','1989-02-10'),
(10008,'1958-02-19','Saniya','Kalloufi','M','1994-09-15'),
(10009,'1952-04-19','Sumant','Peac','F','1985-02-18'),
(10010,'1963-06-01','Duangkaew','Piveteau','F','1989-08-24');

# Create Title Table
CREATE TABLE titles (
    emp_no      INT             NOT NULL,
    title       VARCHAR(50)     NOT NULL,
    from_date   DATE            NOT NULL,
    to_date     DATE,
    # FOREIGN KEY (emp_no) REFERENCES employees (emp_no) ON DELETE CASCADE,
    PRIMARY KEY (emp_no,title, from_date)
);

INSERT INTO `titles` VALUES (10001,'Senior Engineer','1986-06-26','9999-01-01'),
(10002,'Staff','1996-08-03','9999-01-01'),
(10003,'Senior Engineer','1995-12-03','9999-01-01'),
(10004,'Engineer','1986-12-01','1995-12-01'),
(10004,'Senior Engineer','1995-12-01','9999-01-01'),
(10005,'Senior Staff','1996-09-12','9999-01-01'),
(10005,'Staff','1989-09-12','1996-09-12'),
```

```
(10006,'Senior Engineer','1990-08-05','9999-01-01'),
(10007,'Senior Staff','1996-02-11','9999-01-01'),
(10007,'Staff','1989-02-10','1996-02-11'),
(10008,'Assistant Engineer','1998-03-11','2000-07-31'),
(10009,'Assistant Engineer','1985-02-18','1990-02-18'),
(10009,'Engineer','1990-02-18','1995-02-18'),
(10009,'Senior Engineer','1995-02-18','9999-01-01'),
(10010,'Engineer','1996-11-24','9999-01-01');

select * from titles;

SELECT employees.emp_no,employees.first_name, employees.last_name,
employees.hire_date, titles.title, titles.from_date, titles.to_date FROM employees
left JOIN titles ON employees.emp_no=titles.emp_no;
```

--

- Once above DB and Tables are created, validate the details of the **DB Hostname, Database, DB UserName, DB Password values** in file **java-tomcat-sample/src/main/java/dao/GetDao.java**
- Modify the above DB Password that is set in the above file and build and deploy artifact WAR File again.
- Execute the Jenkins Job to build above artifact and deploy the same on the Webserver Context Path.
- A directory with name of the `.war` file is present on the `webapps` path.

--

```
[root@tomcat java-tomcat-sample-deploy]# pwd
/opt/apache-tomcat-9.0.35/webapps/java-tomcat-sample-deploy
[root@tomcat java-tomcat-sample-deploy]# tree .
.
├── index.jsp
├── META-INF
│   ├── MANIFEST.MF
│   ├── maven
│   │   └── com.example
│   │       └── java-tomcat-sample
│   │           ├── pom.properties
│   │           └── pom.xml
│   └── war-tracker
├── register_2.jsp
├── register_3.jsp
├── register_4.jsp
├── register.jsp
├── showUser.jsp
└── WEB-INF
    ├── classes
    │   ├── app_login.class
    │   ├── app_register.class
    │   ├── dao
    │   │   └── GetDao.class
    │   ├── GetController.class
    │   └── model
    │       └── Users.class
    ├── lib
    │   ├── mysql-connector-java-8.0.24.jar
    │   └── protobuf-java-3.11.4.jar
    └── web.xml

9 directories, 18 files
[root@tomcat java-tomcat-sample-deploy]#
```

--

- To view the content of `.war` file use : `jar tf java-tomcat-sample-deploy.war`

```
[root@tomcat webapps]# pwd
/opt/apache-tomcat-9.0.35/webapps
[root@tomcat webapps]# jar tf java-tomcat-sample-deploy.war
META-INF/
META-INF/MANIFEST.MF
WEB-INF/
WEB-INF/classes/
WEB-INF/classes/dao/
WEB-INF/classes/model/
WEB-INF/lib/
WEB-INF/web.xml
WEB-INF/classes/app_register.class
WEB-INF/classes/app_login.class
WEB-INF/classes/dao/GetDao.class
WEB-INF/classes/model/Users.class
WEB-INF/classes/GetController.class
WEB-INF/lib/mysql-connector-java-8.0.24.jar
WEB-INF/lib/protobuf-java-3.11.4.jar
register.jsp
register_2.jsp
register_3.jsp
register_4.jsp
index.jsp
showUser.jsp
META-INF/maven/
META-INF/maven/com.example/
META-INF/maven/com.example/java-tomcat-sample/
META-INF/maven/com.example/java-tomcat-sample/pom.xml
META-INF/maven/com.example/java-tomcat-sample/pom.properties
[root@tomcat webapps]#
```

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- Also, validate the details retured in the WebPage from Database.
    - Enter the Employee ID details in the UI and check if you are getting response from the values in the Database Tables.

> Once Environment setup and deployment is working, delete all AWS Resources created to avoid cost in AWS Account.

Multiple Environment Configuration

- In Application Code, the details that will change as per Environments (**dev/qa/prod**), those config changes, should not be hardcoded in the program code.
- No cross environment resources should be connecting or accessing each other.

SSM Parameter Store.

- Create Parameter for each environment **qa_db_rds_password** as **SecureString** Type, store the DB Password.
- In Java, there is **aws-sdk**, add the dependency in your **pom.xml** file.
- Dynamically as per users input for specific deployment
    - **sh "sed -i /s/SDLC_ENV/${params.SDLC_ENV}/ java-tomcat-sample/src/main/java/dao/GetDao.java"** , during the build and packaging, the code is replaced with correct environment variables, so that, credentials are retrieved specifically for that environment.

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AWS Secrets Manager

- Create a secret in AWS Secret Manager Service and store the DB Endpoint, Username, Password.
- In Java, there is `aws-sdk`, add the dependency in your pom.xml file.
- Dynamically as per users input for specific deployment, **sh "sed -i /s/SDLC_ENV/${params.SDLC_ENV}/ java-tomcat-sample/src/main/java/dao/GetDao.java"** , during the build and packaging, the code is replaced with correct environment variables, so that, credentials are retrieved specifically for that environment.

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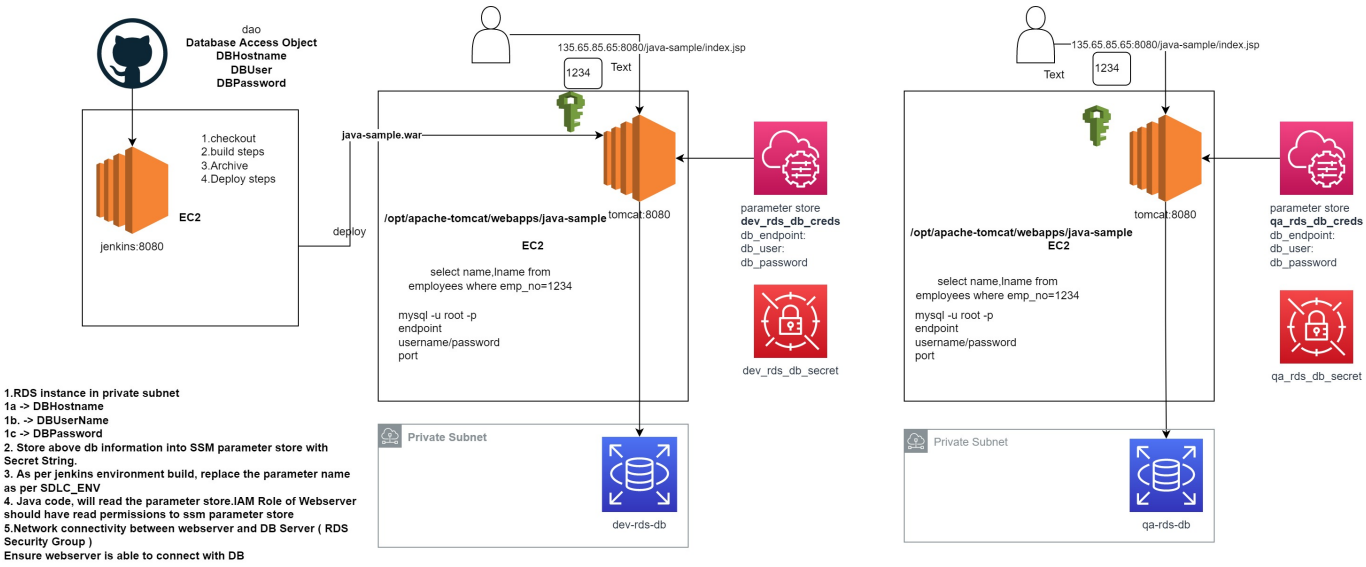

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Infra Creation using IAC

- Tomcat Server EC2 instances, VPC, IAM Roles, Secrets, RDS all the resources required for application code to run, should be created using IAC framework.
    - Terraform
    - CloudFormation

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Working with Jenkins

- Jenkins Installation
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    - Jenkins Audit trail
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    - Maven Java
        - pom.xml definition
- CICD Comparison
    - Infrastructure Creation using Terraform with AWS CICD and Jenkins
    - Docker Image Creation Pipeline In Jenkins.
        - Image Creation shell script can be executed from Jenkins Freestyle Job or Jenkinsfile
    - AWS CICD for Maven Build and Deployment