

# 11

# Microservice CI/CD Pipeline

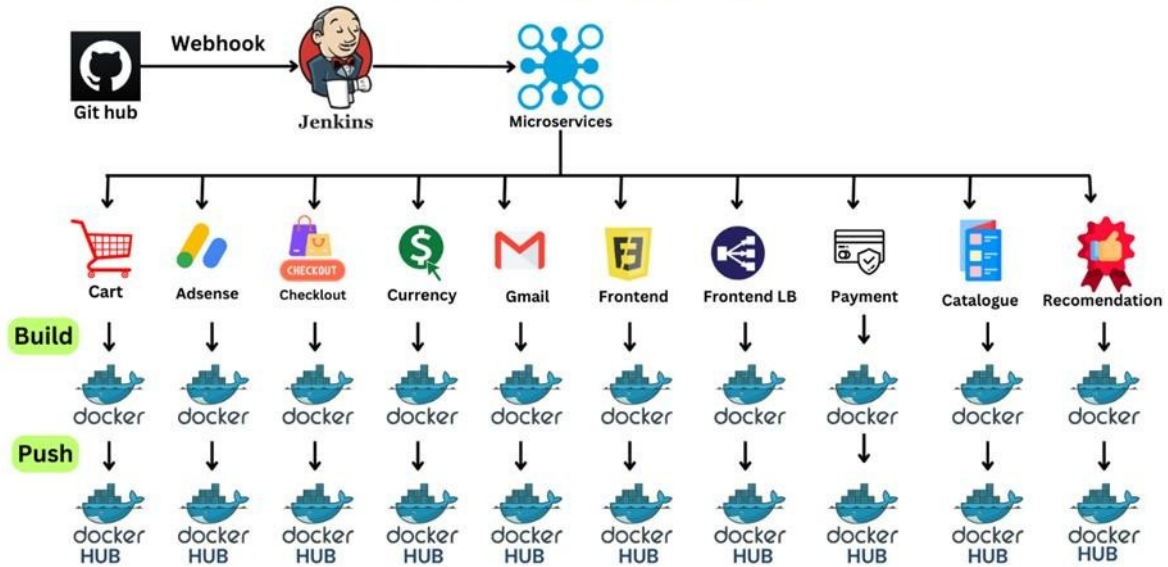
BY DEVOPS SHACK

[Click here for DevSecOps & Cloud DevOps Course](#)

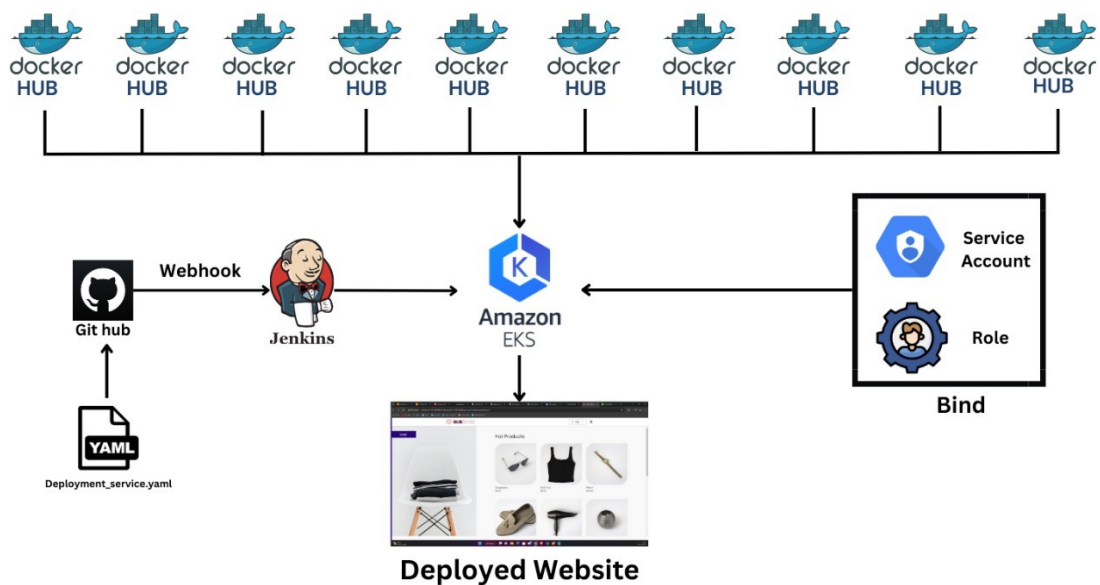
## DevOps Shack

### E-Commerce Website

#### Continuous Integration



#### Continuous Deployment



---

## **Why Microservices?**

Microservices is an architectural style that structures an application as a collection of small, autonomous services modeled around a business domain. Each microservice is self-contained and implements a single business capability. They communicate with each other over well-defined APIs.

## **Project Overview:**

**Project Name:** 11 Microservice CI/CD Pipeline

**Deployment Platform:** AWS EKS (Elastic Kubernetes Service)

**Application Type:** E-Commerce Website

## **Microservices Overview**

Microservices Implemented:

1. Ad Sense Service
2. Cart Service
3. Checkout Service
4. Currency Service
5. Email Service
6. Frontend Service
7. External Frontend (for load balancing)
8. Payment Service
9. Product Catalogue Service
10. Recommendation Service

## **Reasons for Choosing Microservices:**

### **1. Scalability:**

Microservices allow individual services to scale independently based on their specific demand. For instance, the Cart Service can be scaled during high traffic periods without affecting other services.

### **2. Resilience:**



In a microservices architecture, the failure of one service does not necessarily impact the entire system. Each service can be designed to handle failures gracefully, thereby improving the overall resilience of the application.

### **3. Development Speed:**

Development teams can work on different services simultaneously without waiting for other teams. This parallel development accelerates the overall development process and allows for quicker releases.

### **4. Technology Diversity:**

Each microservice can be developed using the most suitable technology stack for its specific needs. For example, the Product Catalogue Service can use a NoSQL database for better performance, while the Checkout Service might use a relational database for transaction consistency.

### **5. Isolation and Maintenance:**

Microservices encapsulate their own logic, making it easier to understand, develop, test, and maintain. Changes in one service do not directly affect others, reducing the risk and complexity of updates.

## **Project Components and Pipeline**

### **CI/CD Pipeline Using Jenkins:**

**Jenkinsfiles:** Each microservice has its own Jenkinsfile defining the steps for building, testing, and deploying the service.

**Docker:** Microservices are containerized using Docker, allowing for consistent environments from development to production.

**AWS EKS:** The microservices are deployed on AWS EKS, a managed Kubernetes service, which orchestrates and manages the lifecycle of the containers.

## Phase 1 : Infrastructure Setup

### Create a user in AWS IAM with any name

Attach Policies to the newly created user.








below policies:

- *AmazonEC2FullAccess*
- *AmazonEKS\_CNI\_Policy*
- *AmazonEKSClusterPolicy*
- *AmazonEKSWorkerNodePolicy*
- *AWSCloudFormationFullAccess*
- *IAMFullAccess*

One more **inline policy** we need to create with content as below:

```
{  
  "Version": "2012-10-17",  
  "Statement": [  
    {  
      "Sid": "VisualEditor0",  
      "Effect": "Allow",  
      "Action": "eks:*",  
      "Resource": "*"   
    }  
  ]  
}
```

Attach this policy to your user as well.

<input type="checkbox"/>	Policy name <a href="#">↗</a>	Type	Attached via <a href="#">↗</a>
<input type="checkbox"/>	 <a href="#">AmazonEC2FullAccess</a>	AWS managed	Directly
<input type="checkbox"/>	 <a href="#">AmazonEKS_CNI_Policy</a>	AWS managed	Directly
<input type="checkbox"/>	 <a href="#">AmazonEKSClusterPolicy</a>	AWS managed	Directly
<input type="checkbox"/>	 <a href="#">AmazonEKSWorkerNodePolicy</a>	AWS managed	Directly
<input type="checkbox"/>	 <a href="#">AWSCloudFormationFullAccess</a>	AWS managed	Directly
<input type="checkbox"/>	 <a href="#">eksfullaccess</a>	Customer inline	Inline
<div>eksfullaccess <span>Copy JSON</span> <span>Edit <a href="#">↗</a></span></div> <pre> 1 { 2   "Version": "2012-10-17", 3   "Statement": [ 4     { 5       "Sid": "VisualEditor0", 6       "Effect": "Allow", 7       "Action": "eks:*", 8       "Resource": "*" 9     } 10  ] 11 }</pre>			
<input type="checkbox"/>	 <a href="#">IAMFullAccess</a>	AWS managed	Directly

Once IAM User is created, Create its Secret Access Key and download the **credentials.csv** file .

## Launch Virtual Machine using AWS EC2

Here is a detailed list of the basic requirements and setup for the EC2 instance i have used for running Jenkins, including the specifics of the instance type, AMI, and security groups.

### EC2 Instance Requirements and Setup:

#### 1. Instance Type

- Instance Type: `t2.large`
- vCPUs: 2
- Memory: 8 GB
- Network Performance: Moderate

#### 2. Amazon Machine Image (AMI)

- AMI: Ubuntu Server 20.04 LTS (Focal Fossa)

#### 3. Security Groups

Security groups act as a virtual firewall for your instance to control inbound and outbound traffic.

Inbound rules (11)								
<input type="text" value="Search"/> <span>Manage tags</span> <span>Edit inbound rules</span>								
<input type="checkbox"/>	Name	Security group rule...	IP version	Type	Protocol	Port range		
<input type="checkbox"/>	-	sgr-0d37abdd416f485a7	IPv4	Custom TCP	TCP	8080		
<input type="checkbox"/>	-	sgr-05039c761a83a472f	IPv4	Custom TCP	TCP	3000		
<input type="checkbox"/>	-	sgr-0c8a37b32250d40...	IPv4	Custom TCP	TCP	9090		
<input type="checkbox"/>	-	sgr-01c22c57e1cae5357	IPv4	Custom TCP	TCP	9000		
<input type="checkbox"/>	-	sgr-05147c8d7f990658b	IPv4	Custom TCP	TCP	32630		
<input type="checkbox"/>	-	sgr-08e5d857074de8...	IPv4	SSH	TCP	22		
<input type="checkbox"/>	-	sgr-03ba7f02232c511d5	IPv4	Custom TCP	TCP	8081		
<input type="checkbox"/>	-	sgr-03f10a0d8f689f506	IPv4	Custom TCP	TCP	6443		
<input type="checkbox"/>	-	sgr-053a7766d864dd...	IPv4	SMTPS	TCP	465		
<input type="checkbox"/>	-	sgr-0c96dd75b35d3f40c	IPv4	HTTP	TCP	80		
<input type="checkbox"/>	-	sgr-0aae64d181f9a5a99	IPv4	Custom TCP	TCP	9115		

After Launching your Virtual machine ,**SSH** into the Server.

## Install AWS CLI , EKSTL & KUBECTL on VM Server

### AWSCLI

```
curl "https://awscli.amazonaws.com/awscli-exe-linux-x86_64.zip" -o  
"awscliv2.zip"
```

```
sudo apt install unzip
```

```
unzip awscliv2.zip
```

```
sudo ./aws/install
```

```
aws configure
```

### KUBECTL

```
curl -o kubectl https://amazon-eks.s3.us-west-2.amazonaws.com/1.19.6/2021-  
01-05/bin/linux/amd64/kubectl
```

```
chmod +x ./kubectl
```

```
sudo mv ./kubectl /usr/local/bin
```

```
kubectl version --short --client
```

### EKSTL

```
curl --silent --location  
"https://github.com/weaveworks/eksctl/releases/latest/download/eksctl_$(un  
ame -s)_amd64.tar.gz" | tar xz -C /tmp
```

```
sudo mv /tmp/eksctl /usr/local/bin
```

```
eksctl version
```

Save all the script in a file, for example, ctl.sh, and make it executable  
using:

```
chmod +x ctl.sh
```

Then, you can run the script using:

```
./ctl.sh
```



## Installing Jenkins on Ubuntu

Execute these commands on Jenkins Server

```
#!/bin/bash

# Install OpenJDK 17 JRE Headless
sudo apt install openjdk-17-jre-headless -y

# Download Jenkins GPG key
sudo wget -O /usr/share/keyrings/jenkins-keyring.asc \
https://pkg.jenkins.io/debian-stable/jenkins.io-2023.key
# Add Jenkins repository to package manager sources
echo deb [signed-by=/usr/share/keyrings/jenkins-keyring.asc] \
https://pkg.jenkins.io/debian-stable binary/ | sudo tee \
/etc/apt/sources.list.d/jenkins.list > /dev/null

# Update package manager repositories
sudo apt-get
update # Install
Jenkins
sudo apt-get install jenkins -y
```

Save this script in a file, for example, install\_jenkins.sh, and make it executable using:

```
chmod +x install_jenkins.sh
```

Then, you can run the script using:

```
./install_jenkins.sh
```

This script will automate the installation process of OpenJDK 17 JRE Headless and Jenkins.

## Create EKS Cluster

```
eksctl create cluster --name=EKS-1 \  
--region=ap-south-1 \  
--zones=ap-south-1a,ap-south-1b \  
--without-nodegroup
```

## Open ID Connect

```
eksctl utils associate-iam-oidc-provider \  
--region ap-south-1 \  
--cluster EKS-1 \  
--approve
```

## Create node Group

```
eksctl create nodegroup --cluster=EKS-1 \  
--region=ap-south-1 \  
--name=node2 \  
--node-type=t3.medium \  
--nodes=3 \  
--nodes-min=2 \  
--nodes-max=4 \  
--node-volume-size=20 \  
--ssh-access \  
--ssh-public-key=DevOps \  
--managed \  
--asg-access \  
--external-dns-access \  
--full-ecr-access \  
--appmesh-access \  
--alb-ingress-access
```

Make sure to change the name of **ssh-public-Key** with your SSH key.

---

## **Phase 2 : Multi-branch Pipeline Setup**

### **Step 1: Install Jenkins Plugins**

To get started, you need to install the required Jenkins plugins. Follow these steps to install the plugins:

#### **Access Jenkins Dashboard:**

Open a web browser and navigate to your Jenkins instance (e.g., `http://your-instance-public-dns:8080`).

Log in with your Jenkins credentials. (cat address provided on Jenkins)

#### **Install Plugins:**

-Go to Manage Jenkins > Manage Plugins.

-Click on the Available tab.

Search for and install the following plugins:

- **Docker:** Enables Jenkins to use Docker containers.
- **Docker Pipeline:** Allows Jenkins to use Docker containers in pipeline jobs.
- **Kubernetes:** Provides support for Kubernetes in Jenkins.
- **Kubernetes CLI:** Allows Jenkins to interact with Kubernetes clusters.
- **Multibranch Scan Webhook Trigger:** Adds webhook trigger functionality for multibranch projects.

## Step 2: Create Credentials

You need to create credentials for Docker and GitHub access.

### Create Docker Credentials:

- Go to Manage Jenkins > Manage Credentials > (global) > Add Credentials.
- Choose Username with password as the kind.
- ID: docker-cred
- Username: Your Docker Hub username.
- Password: Your Docker Hub password.
- Click OK.

### Create GitHub Credentials:

- Go to Manage Jenkins > Manage Credentials > (global) > Add Credentials.
- Choose Secret text as the kind.
- ID: git-cred
- Secret: Your GitHub Personal Access Token.
- Click OK.

---

### Step 3: Configure Multibranch Pipeline

Create a New Multibranch Pipeline:

- Go to New Item.
- Enter a name for your project (e.g., microservice-pipeline).
- Select Multibranch Pipeline and click OK.
- Configure Branch Sources:

- Under Branch Sources, click Add source.
- Choose Git.

**Credentials:** Select the git-cred credentials.

#### Configure Build Configuration:

Under Build Configuration, ensure by **Jenkinsfile** is selected.

**Script Path:** Leave it as the default (**Jenkinsfile**).

#### Configure Webhook Trigger:

- Under Scan Repository Triggers, click Add.
- Select Multibranch Scan Webhook Trigger.

**Trigger Token:** Enter a token name (e.g., shubham).

#### Webhook URL:

Note the webhook URL:

http://your-jenkins-instance:8080/multibranch-webhook-trigger/invoke?token=shubham

Replace your-jenkins-instance with the public DNS or IP address of your Jenkins instance.

Replace shubham with the token name you provided.

### Step 4: Set Up GitHub Webhook

Go to GitHub Repository Settings:



-Navigate to your repository on GitHub.

-Go to Settings > Webhooks.

## Add Webhook:

-Click Add webhook.

-Payload URL: Enter the webhook URL you noted earlier (http://your-jenkins-instance:8080/multibranch-webhook-trigger/invoke?token=shubham).

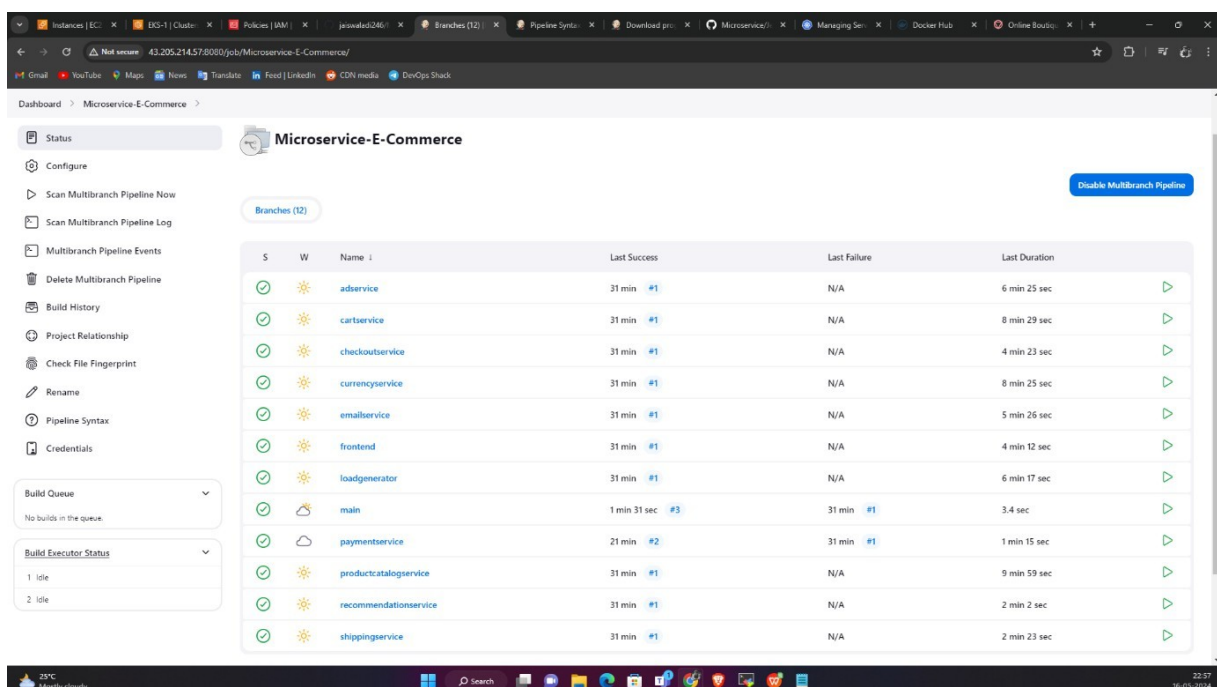
-Content type: Select application/json.

-Secret: Leave it blank.

-Select Let me select individual events and choose Push events.

-Click Add webhook.

After completing this you will see your Jenkins multi-branch Pipeline starts build automatically.



The screenshot shows the Jenkins dashboard for a project named "Microservice-E-Commerce". The left sidebar contains various navigation options like Status, Configure, Scan Multibranch Pipeline Now, etc. The main area displays a table of 12 branches. Each branch has a status icon (green checkmark for success, yellow lightning bolt for in progress, or red X for failure), a name, and columns for Last Success, Last Failure, and Last Duration.

S	W	Name	Last Success	Last Failure	Last Duration
✓	⚡	adservice	31 min #1	N/A	6 min 25 sec
✓	⚡	cartservice	31 min #1	N/A	8 min 29 sec
✓	⚡	checkoutservice	31 min #1	N/A	4 min 23 sec
✓	⚡	currencyservice	31 min #1	N/A	8 min 25 sec
✓	⚡	emailservice	31 min #1	N/A	5 min 26 sec
✓	⚡	frontend	31 min #1	N/A	4 min 12 sec
✓	⚡	loadgenerator	31 min #1	N/A	6 min 17 sec
✓	☁	main	1 min 31 sec #3	31 min #1	3.4 sec
✓	☁	paymentservice	21 min #2	31 min #1	1 min 15 sec
✓	⚡	productcatalogservice	31 min #1	N/A	9 min 59 sec
✓	⚡	recommendationservice	31 min #1	N/A	2 min 2 sec
✓	⚡	shippingservice	31 min #1	N/A	2 min 23 sec

## Phase 3 : Continuous Deployment

## Run these commands on Server

Create Service Account, Role & Assign that role, And create a secret for Service Account and generate a Token. We will Deploy our Application on the main branch .

Create a file : `Vim`

`svc.yml` **Creating Service**

**Account** `apiVersion: v1`

`kind:`

`ServiceAccount`

`metadata:`

`name: jenkins`

`namespace: webapps`

To run the `svc.yml` : `kubectl apply -f svc.yml`

Similarly create a **role.yml** file

**Create Role**

`apiVersion: rbac.authorization.k8s.io/v1`

`kind: Role`

`metadata:`

`name: app-role`

`namespace: webapps`

`rules:`

`- apiGroups:`

`- ""`

`- apps`

`- autoscaling`

---

- batch

---

- extensions

- policy

- rbac.authorization.k8s.io

resources:

- pods

- componentstatuses

- configmaps

- daemonsets

- deployments

- events

- endpoints

- horizontalpodautoscalers

- ingress

- jobs

- limitranges

- namespaces

- nodes

- pods

- persistentvolumes

- persistentvolumeclaims

- resourcequotas

- replicaset

- replicationcontrollers

- serviceaccounts

- services

verbs: ["get", "list", "watch", "create", "update", "patch", "delete"]

---

To run the role.yaml file: `kubectl apply -f`

Similarly create a **bind.yaml** file

### Bind the role to service account

```
apiVersion: rbac.authorization.k8s.io/v1
```

```
kind: RoleBinding
```

```
metadata:
```

```
  name: app-rolebinding
```

```
  namespace: webapps
```

```
roleRef:
```

```
  apiGroup: rbac.authorization.k8s.io
```

```
  kind: Role
```

```
  name: app-role
```

```
subjects:
```

```
- namespace: webapps
```

```
  kind: ServiceAccount
```

```
  name: jenkins
```

To run the bind.yaml file: `kubectl apply -f bind.yaml`

### Create Token



Similarly create a secret.yml file

```
apiVersion: v1
kind: Secret
type: kubernetes.io/service-account-token
metadata:
  name: mysecretname
  annotations:
    kubernetes.io/service-account.name: Jenkins
```

To run the secret.yml file: `kubectl apply -f secret.yml -n webapps`

Save the token .

-Create a dummy job in your Jenkins with Pipeline job and go to the **pipeline syntax** and select **With Kubernetes:Configure Kubernetes**

1. **Credentials** – Provide the Token that you have saved .
2. **Kubernates Endpoint API**- You can find it in your AWS EKS cluster.
3. **Cluster name**- Provide any name.
4. **Namespace** –

webapps Click on Generate

Syntax.

You will get pipeline syntax :-

```
withKubeCredentials(kubectxCredentials: [[caCertificate: "", clusterName: 'EKS-1', contextName: '', credentialsId: 'k8-token', namespace: 'webapps', serverUrl: 'https://B7C7C20487B2624AAB0AD54DF1469566.yl4.ap-south-1.eks.amazonaws.com']]]) {
  //block of code
}
```

Create a Jenkinsfile on the main branch .

```
pipeline {
  agent any

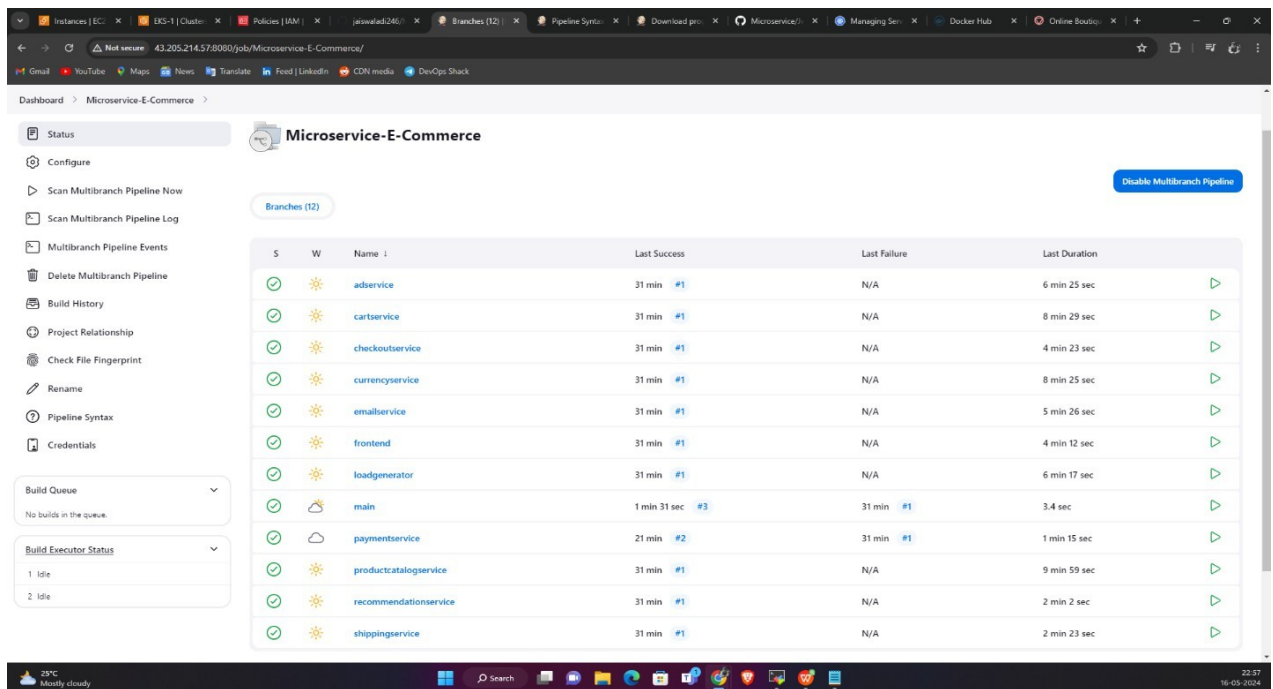
  stages {
    stage('Deploy To Kubernetes') {
      steps {
        withKubeCredentials(kubectxCredentials: [[caCertificate: '', clusterName: 'EKS-1',
contextName: '', credentialsId: 'k8-token', namespace: 'webapps', serverUrl:
'https://B7C7C20487B2624AAB0AD54DF1469566.yl4.ap-south-1.eks.amazonaws.com']]]) {
          sh "kubectl apply -f deployment-service.yml"
        }
      }
    }
  }

  stage('verify Deployment') {
    steps {
      withKubeCredentials(kubectxCredentials: [[caCertificate: '', clusterName: 'EKS-1',
contextName: '', credentialsId: 'k8-token', namespace: 'webapps', serverUrl:
'https://B7C7C20487B2624AAB0AD54DF1469566.yl4.ap-south-1.eks.amazonaws.com']]]) {
        sh "kubectl get svc -n webapps"
      }
    }
  }
}
```

As you Jenkinsfile is created your Pipeline will automatically start the build and Deployment.

## Results

## PIPELINE

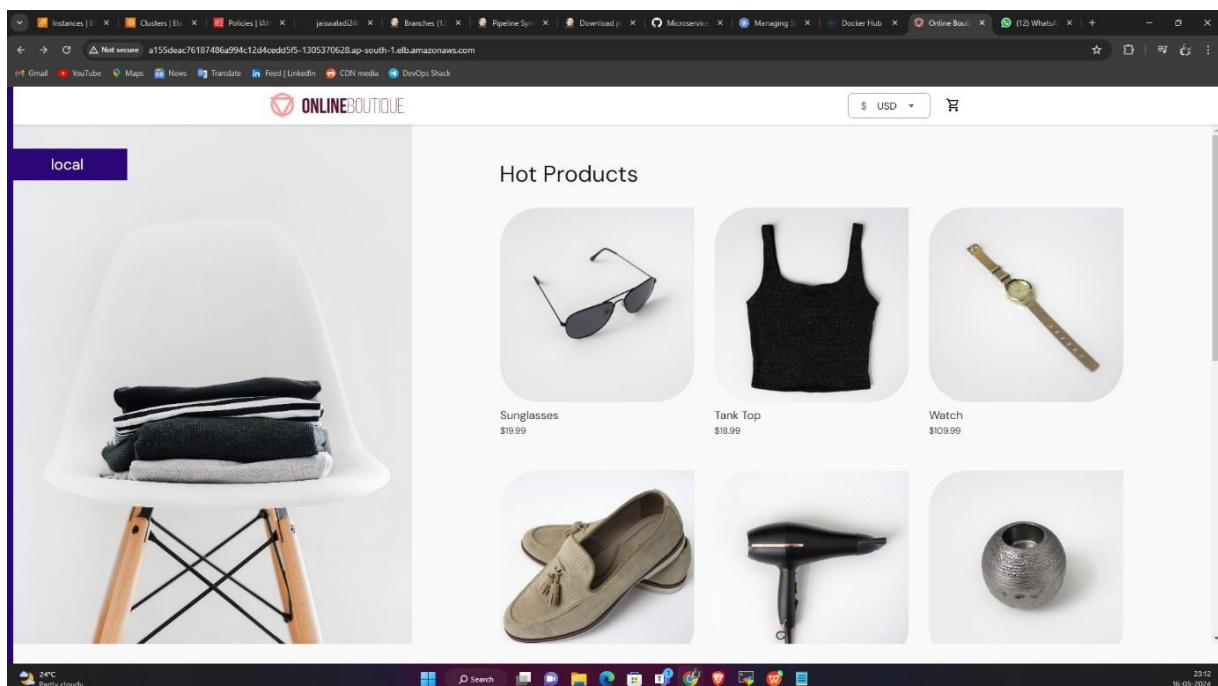


**Microservice-E-Commerce**

Branches (12)

S	W	Name	Last Success	Last Failure	Last Duration
✓	☀	adservice	31 min #1	N/A	6 min 25 sec
✓	☀	cartservice	31 min #1	N/A	8 min 29 sec
✓	☀	checkoutservice	31 min #1	N/A	4 min 23 sec
✓	☀	currencyservice	31 min #1	N/A	8 min 25 sec
✓	☀	emailservice	31 min #1	N/A	5 min 26 sec
✓	☀	frontend	31 min #1	N/A	4 min 12 sec
✓	☀	loadgenerator	31 min #1	N/A	6 min 17 sec
✓	☁	main	1 min 31 sec #3	31 min #1	3.4 sec
✓	☁	paymentervice	21 min #2	31 min #1	1 min 15 sec
✓	☀	productcatalogservice	31 min #1	N/A	9 min 59 sec
✓	☀	recommendationservice	31 min #1	N/A	2 min 2 sec
✓	☀	shippingservice	31 min #1	N/A	2 min 23 sec

## APPLICATION



**ONLINEBOUTIQUE**

local

Hot Products

- Sunglasses \$19.99
- Tank Top \$18.99
- Watch \$109.99
- Loafers
- Hair Dryer
- Metal Container

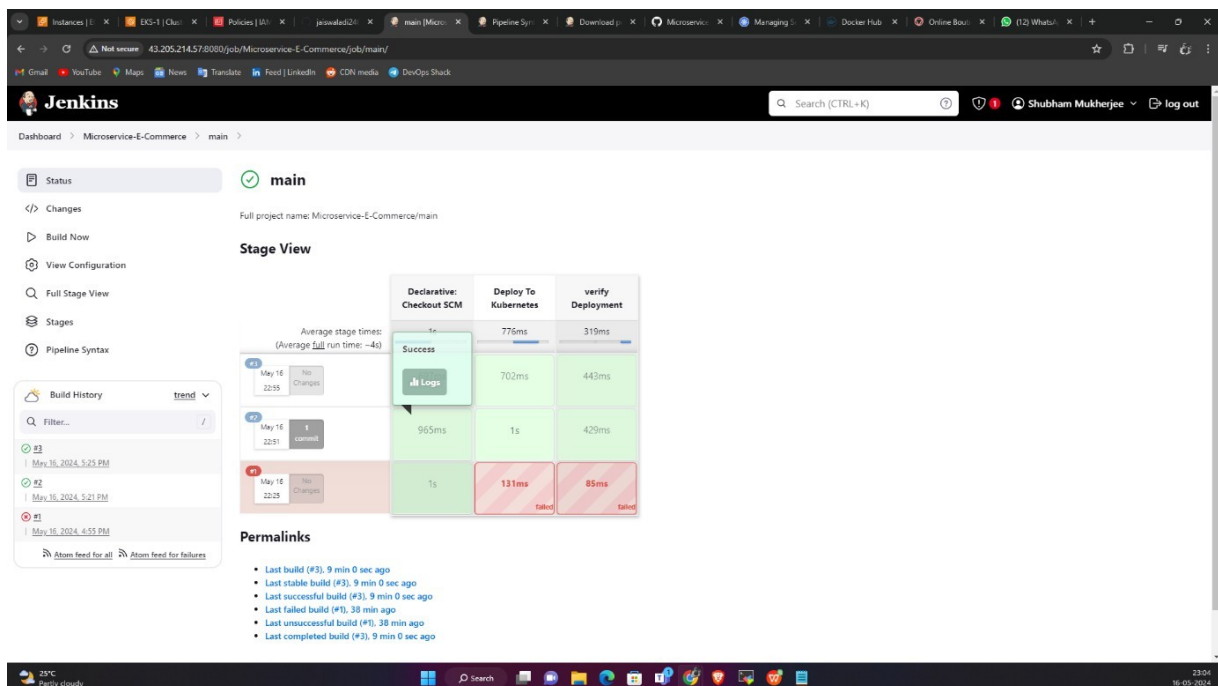
## CONSOLE OUTPUT

```
+ kubectl get svc -n webapps
```

NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
adservice	ClusterIP	10.100.103.174	<none>	9555/TCP	3m52s
cartservice	ClusterIP	10.100.237.236	<none>	7070/TCP	3m53s
checkoutservice	ClusterIP	10.100.102.76	<none>	5050/TCP	3m53s
currencyservice	ClusterIP	10.100.9.201	<none>	7000/TCP	3m53s
emailservice	ClusterIP	10.100.140.105	<none>	5000/TCP	3m53s
frontend	NodePort	10.100.19.87	<none>	80:32183/TCP	3m53s
frontend-external	LoadBalancer	10.100.146.35	a155deac76187486a994c12d4cedd5f5-1305370628.ap-south-1.elb.amazonaws.com	80:32195/TCP	3m53s
paymentservice	ClusterIP	10.100.227.91	<none>	50051/TCP	3m53s
productcatalogservice	ClusterIP	10.100.107.131	<none>	3550/TCP	3m53s
recommendationservice	ClusterIP	10.100.146.47	<none>	8080/TCP	3m53s
redis-cart	ClusterIP	10.100.7.161	<none>	6379/TCP	3m53s
shippingservice	ClusterIP	10.100.23.22	<none>	50051/TCP	3m53s

```
[Pipeline] }
```

## MAIN BRANCH PIPELINE



The screenshot shows the Jenkins Pipeline View for the 'main' branch. The pipeline is named 'main' and is associated with the project 'Microservice-E-Commerce/main'. The pipeline is currently in a 'Success' state.

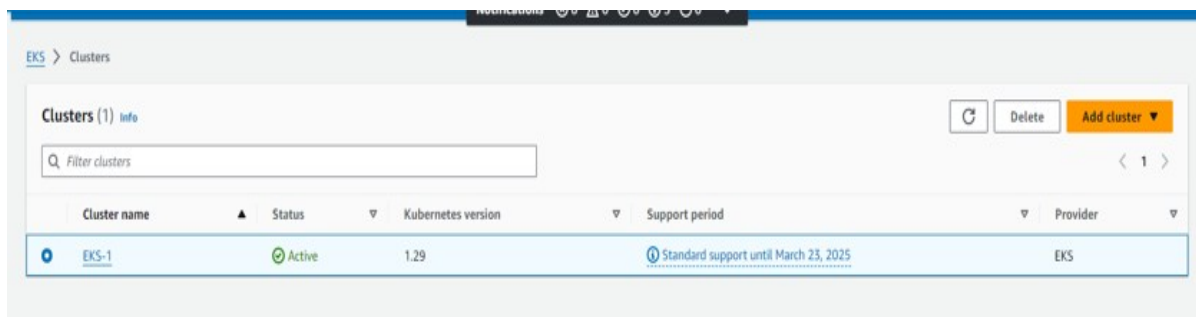
**Stage View:**

Stage	Declarative: Checkout SCM	Deploy To Kubernetes	verify Deployment
Success	776ms	702ms	443ms
Success	965ms	1s	429ms
Failed	1s	131ms	85ms

**Permalinks:**

- Last build (#3), 9 min 0 sec ago
- Last stable build (#3), 9 min 0 sec ago
- Last successful build (#3), 9 min 0 sec ago
- Last failed build (#1), 38 min ago
- Last unsuccessful build (#1), 38 min ago
- Last completed build (#3), 9 min 0 sec ago

## EKS CLUSTER



The screenshot shows the AWS EKS Clusters console. There is one cluster named 'EKS-1' which is in an 'Active' state. The cluster is using Kubernetes version 1.29 and has standard support until March 23, 2025. The provider is EKS.

Cluster name	Status	Kubernetes version	Support period	Provider
EKS-1	Active	1.29	Standard support until March 23, 2025	EKS

---

## **Project Impact**

The implementation of this 11 Microservice CI/CD Pipeline project provides several significant benefits:

**Improved Efficiency:** Automation of the build and deployment process reduces the time and effort required for manual deployments, leading to faster delivery cycles.

**Enhanced Reliability:** Automated testing and deployment help in identifying and resolving issues early, improving the overall reliability and quality of the application.

**Scalability:** The microservices architecture and Kubernetes orchestration enable the application to handle varying loads efficiently, ensuring consistent performance and availability.

**Maintainability:** Independent development and deployment of services simplify the maintenance and updates, reducing the complexity and risk of making changes.

## **Acknowledgment**

Special thanks to Aditya Jaiswal of "DevOps Shack" on YouTube for his invaluable guidance and tutorials, which were instrumental in the successful completion of this project. Thank you, Aditya!

## **Conclusion**

The successful deployment of the e-commerce website using a microservices architecture and an automated CI/CD pipeline on AWS EKS exemplifies the advantages of modern software development practices. This project not only achieves the goals of scalability, reliability, and efficiency but also sets a strong foundation for future enhancements and growth. The methodologies and technologies employed in this project can serve as a blueprint for similar projects aiming to leverage microservices and CI/CD pipelines for continuous innovation and delivery.