DevOps Project CA2

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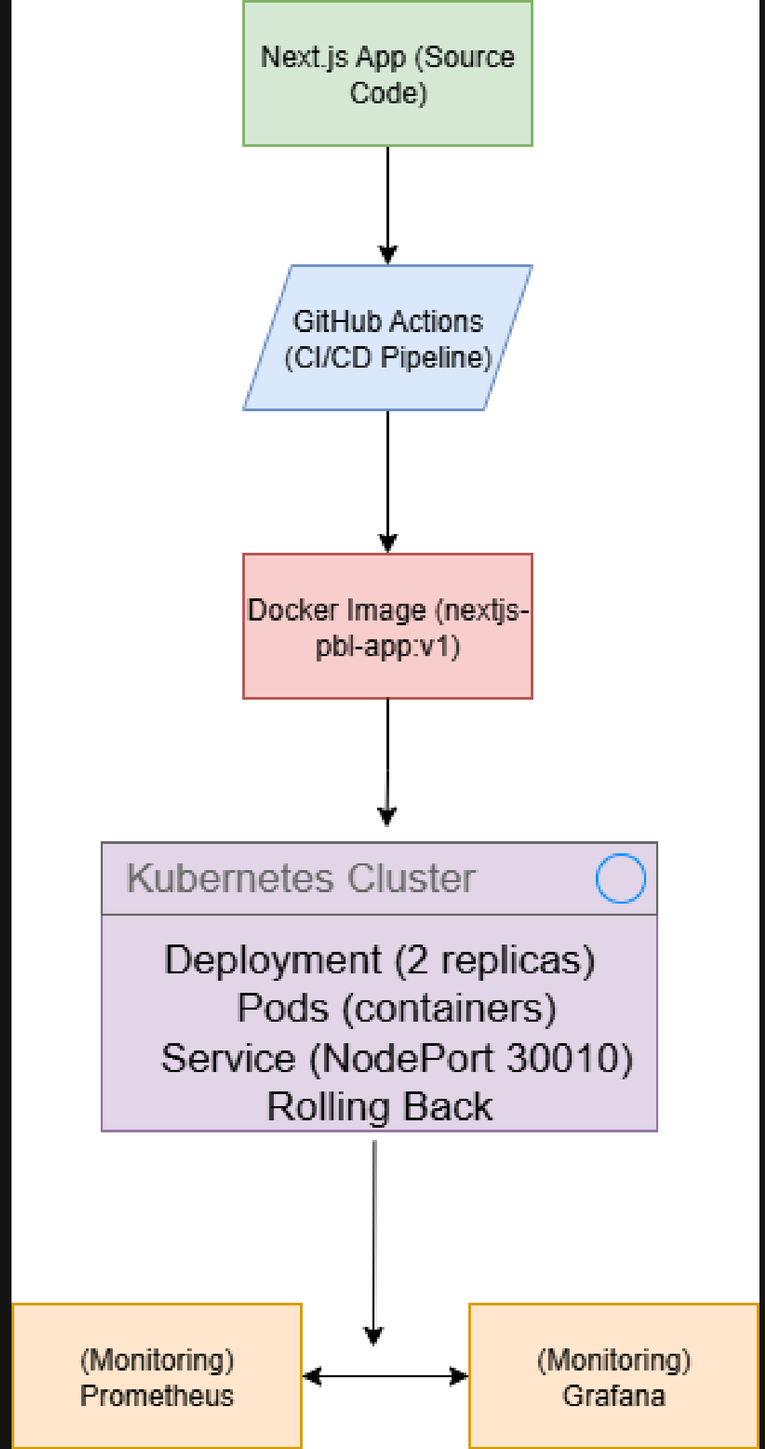
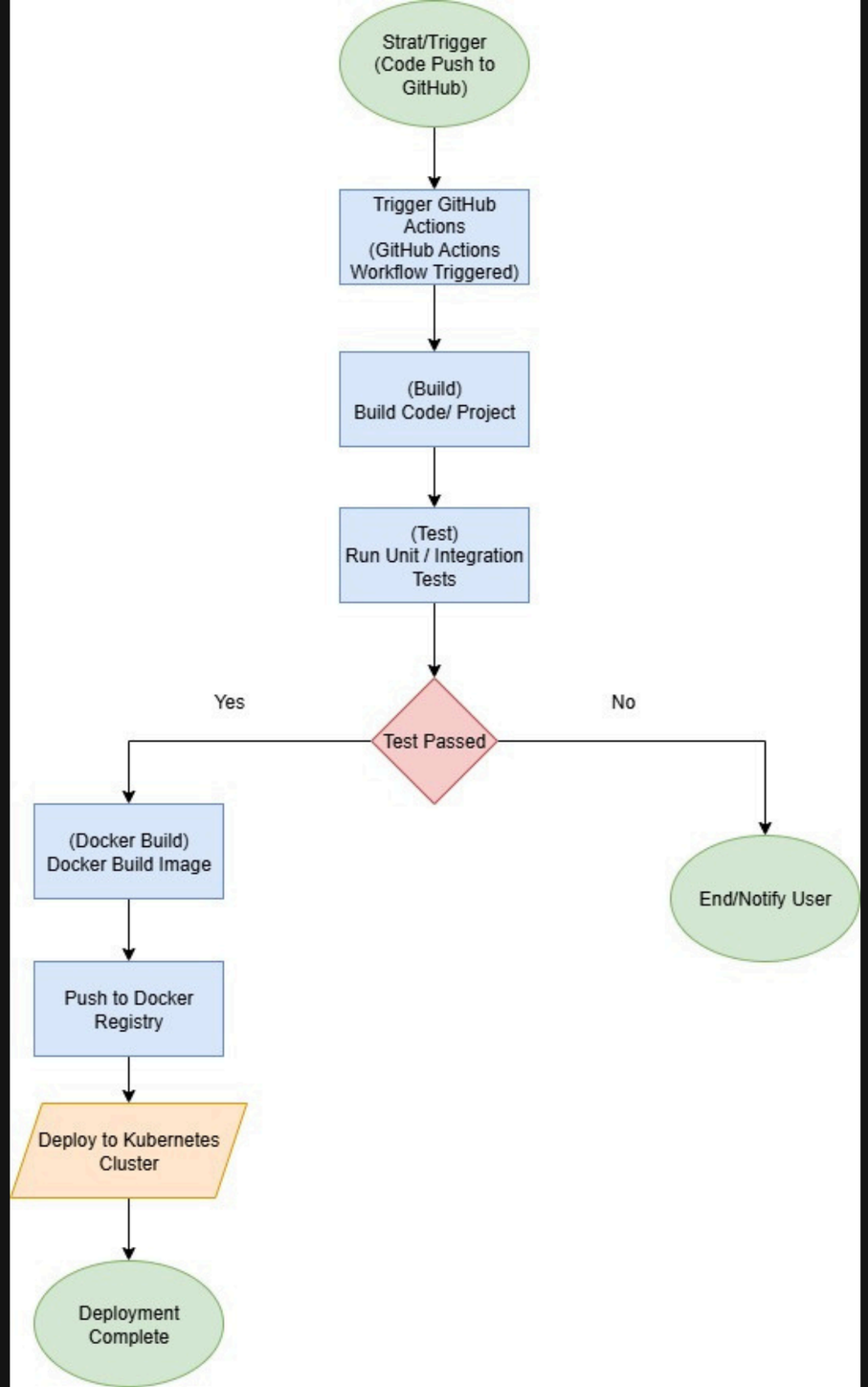
Project Architecture – Next.js App Deployment with GitHub Actions & Kubernetes

The architecture shows a CI/CD flow from code to container, deployed on Kubernetes and monitored via Prometheus & Grafana.



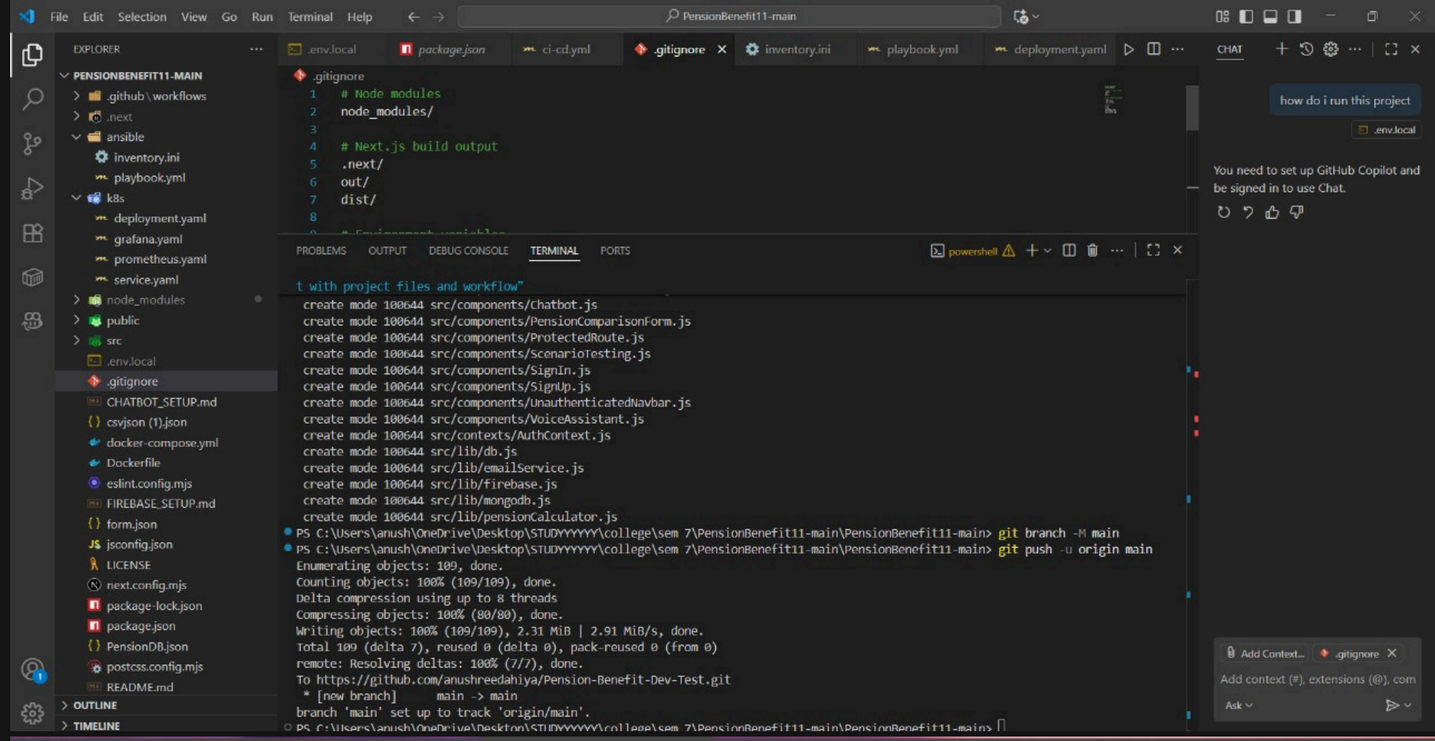
CI/CD Pipeline Flow – GitHub Actions

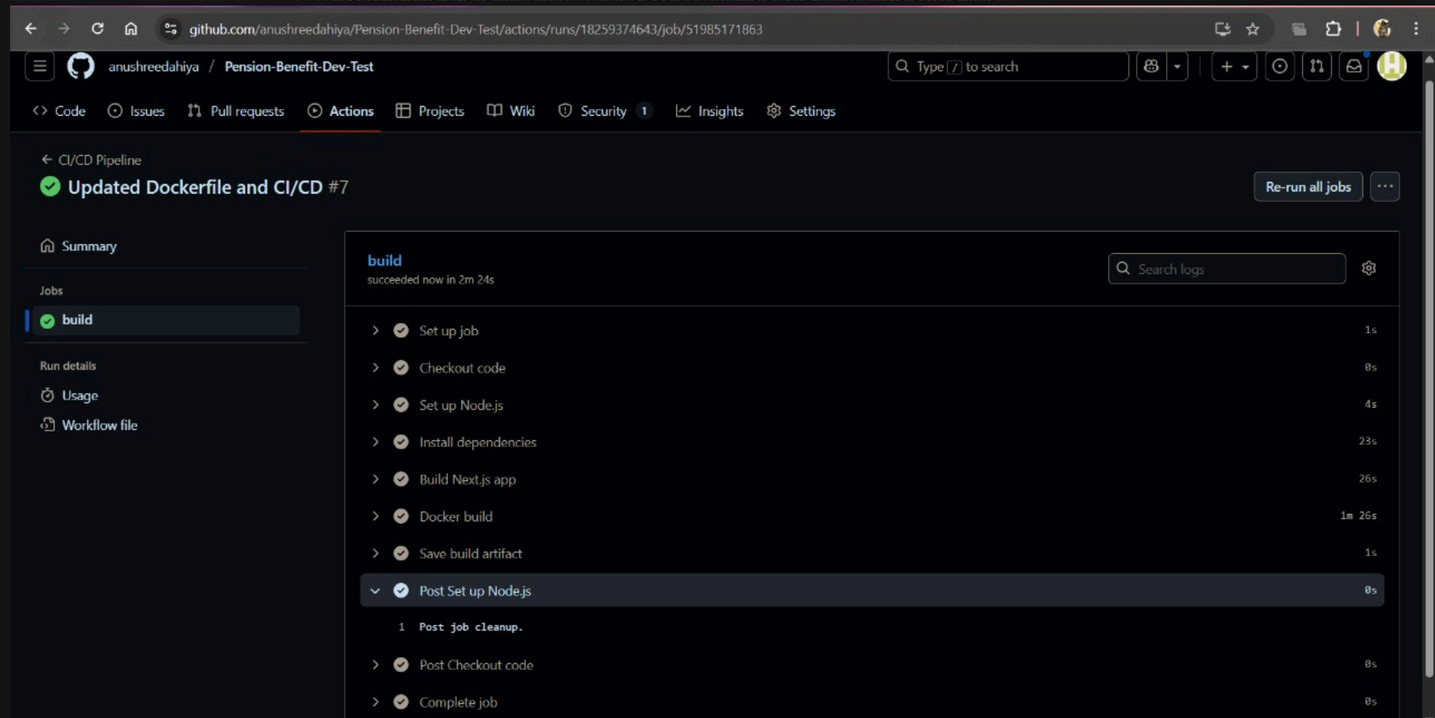
- When code is pushed to GitHub, a workflow triggers automatically.
- The app is built, tested, and containerized with Docker.
- The Docker image is pushed to the registry.
- Finally, it’s deployed on Kubernetes using kubectl apply.



1. Pushing the code to GitHub

2. In GitHub Actions, the app is getting built, tested and containerized with Docker.





Configuration Management & IaC Through Ansible

1. Infrastructure setup automated using Ansible

Wrote playbook.yml to:

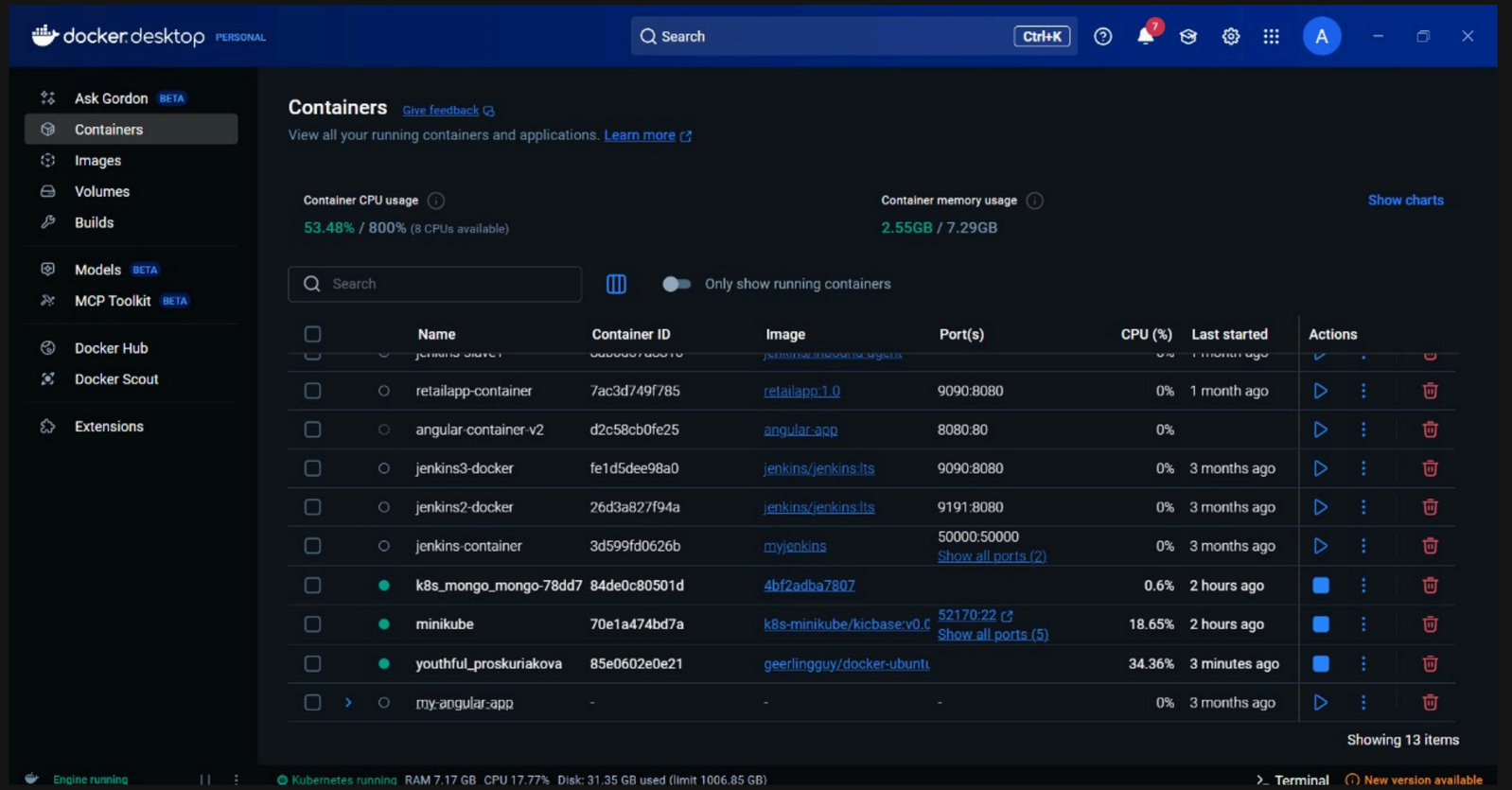
- Update apt package index.
- Install Node.js 18.x, npm, and Docker.
- Ensure Docker service is running.
- Create /opt/nextjs-app directory.
- Copy app files into it.

2. Verified: Node.js, npm, and Docker installed successfully inside the runtime environment.

```
Command Prompt - call SET D   root@85e0602e0e21: /ansible

PS C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main\ansible> docker pull geerlingguy/docker-ubuntu2004-ansible
Using default tag: latest
latest: Pulling from geerlingguy/docker-ubuntu2004-ansible
233c62bd96b5: Pull complete
4326705da5ac: Pull complete
13b7e930469f: Pull complete
64ecc960fd70: Pull complete
25ca35afe4ae: Pull complete
097bc46b0ae7: Pull complete
d4bf89240257: Pull complete
5df9c8bce3a9: Pull complete
c8a40668118b: Pull complete
bf55635d1e9f: Pull complete
Digest: sha256:fd9137f13362d1888d3e22e579ca18280054ff4dbf3de06e3f0dc9efe9a77a46
Status: Downloaded newer image for geerlingguy/docker-ubuntu2004-ansible:latest
docker.io/geerlingguy/docker-ubuntu2004-ansible:latest
PS C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main\ansible> docker run -it --rm -v "C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main:/ansible" -w /ansible geerlingguy/docker-ubuntu2004-ansible bash
root@85e0602e0e21:/ansible# ansible --version
ansible [core 2.13.13]
  config file = None
  configured module search path = ['/root/.ansible/plugins/modules', '/usr/share/ansible/plugins/modules']
  ansible python module location = /usr/local/lib/python3.8/dist-packages/ansible
  ansible collection location = /root/.ansible/collections:/usr/share/ansible/collections
  executable location = /usr/local/bin/ansible
  python version = 3.8.10 (default, Mar 18 2025, 20:04:55) [GCC 9.4.0]
  jinja version = 3.1.6
  libyaml = True
```

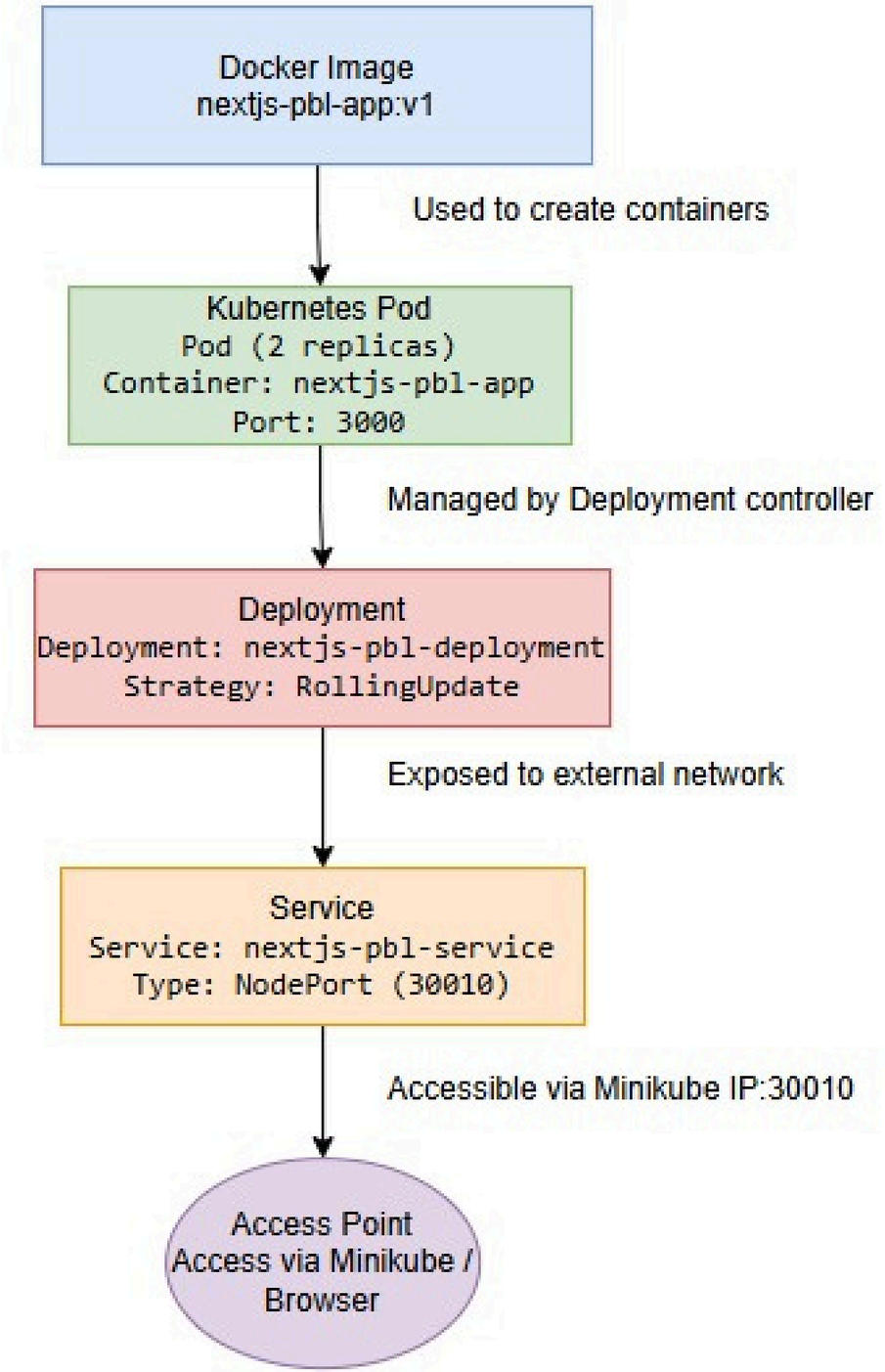
```
root@85e0602e0e21:/ansible# ansible-playbook -i ansible/inventory.ini ansible/playbook.yml --ask-become-pass
BECOME password:

PLAY [Setup runtime environment] ***********************************************************************************

TASK [Gathering Facts] *********************************************************************************************
ok: [localhost]

TASK [Update apt] **************************************************************************************************
ok: [localhost]

TASK [Install Node.js 18.x] ****************************************************************************************
ok: [localhost]

TASK [Install npm] *************************************************************************************************
ok: [localhost]

TASK [Install Docker] **********************************************************************************************
ok: [localhost]

TASK [Create app user] *********************************************************************************************
changed: [localhost]

TASK [Create app directory] ****************************************************************************************
changed: [localhost]

TASK [Copy app files] **********************************************************************************************
changed: [localhost]

PLAY RECAP *********************************************************************************************************
localhost                  : ok=8    changed=3    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0

root@85e0602e0e21:/ansible# node -v
v10.19.0
root@85e0602e0e21:/ansible# npm -v
6.14.4
root@85e0602e0e21:/ansible# ls -l /opt/nextjs-app
total 8
-rwxr-xr-x 1 nextjs nextjs   45 Oct  5 14:15 inventory.ini
-rwxr-xr-x 1 nextjs nextjs 1078 Oct  5 14:15 playbook.yml
root@85e0602e0e21:/ansible# docker --version
Docker version 26.1.3, build 26.1.3-0ubuntu1~20.04.1
root@85e0602e0e21:/ansible#
```

2. Formation of docker image for Ansible



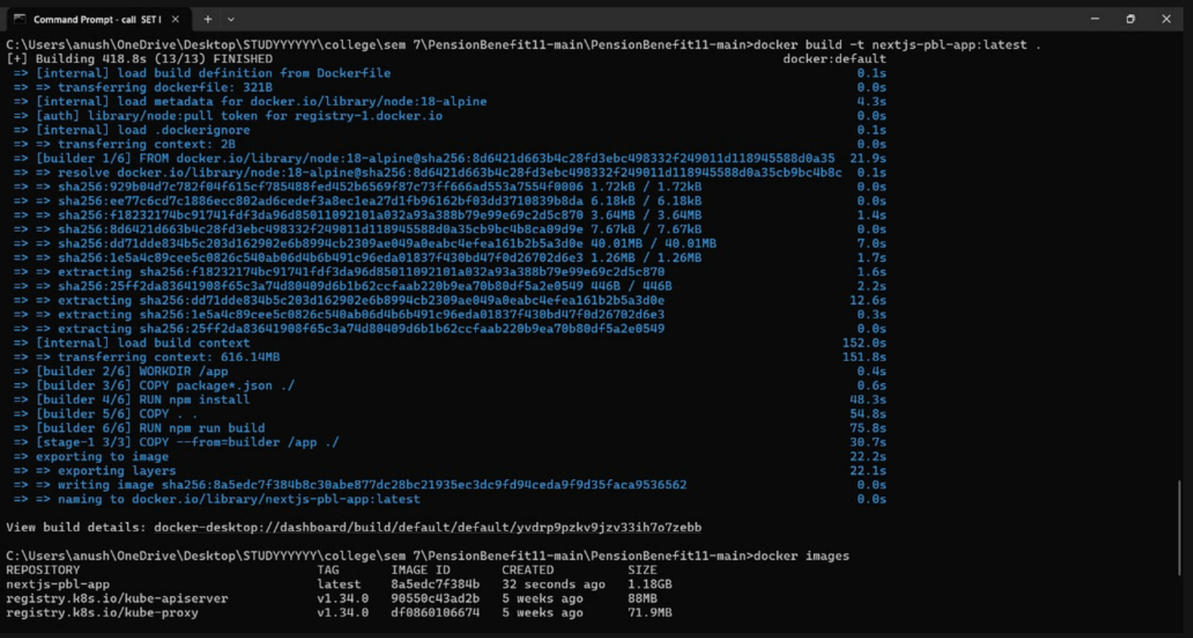
Containerization & Orchestration

1. Created Dockerfile
2. Built and tagged the image: docker build -t nextjs-pbl-app:v1 .
3. Verified image via docker images.
4. Created deployment.yaml and service.yaml for Kubernetes.
5. Applied manifests:
    a. kubectl apply -f deployment.yaml
    b. kubectl apply -f service.yaml
6. Verified pods: kubectl get pods
7. Tested rolling updates and rollback:
    a. kubectl set image deployment/nextjs-pbl-deployment nextjs-pbl-container=nextjs-pbl-app:v2
    b. kubectl rollout undo deployment/nextjs-pbl-deployment

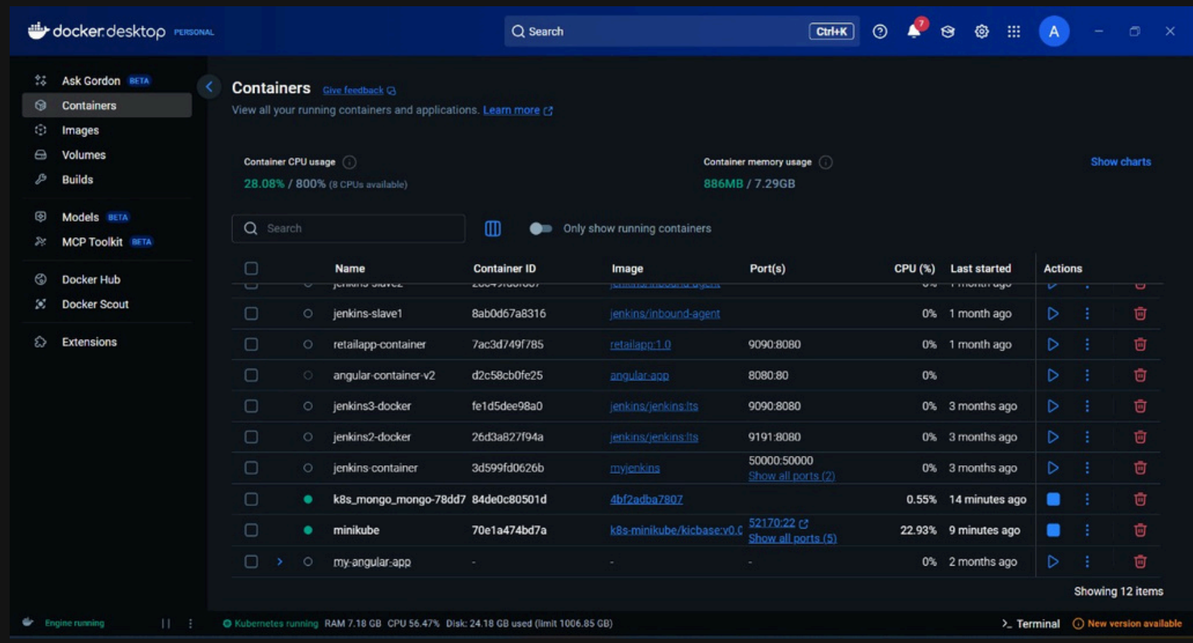


Containerization & Orchestration

1. Docker Build



2. Image generation



3. Formation of Docker Image

```
View build details: docker-desktop://dashboard/build/desktop-linux/desktop-linux/1ib0z7s0k15ropgba8c6g82fa

C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main>docker images
REPOSITORY                                TAG                                                                 IMAGE ID       CREATED
      SIZE
nextjs-pbl-app                            latest                                                              7b83e89d9ca6   About a minute
ago   1.63GB
```

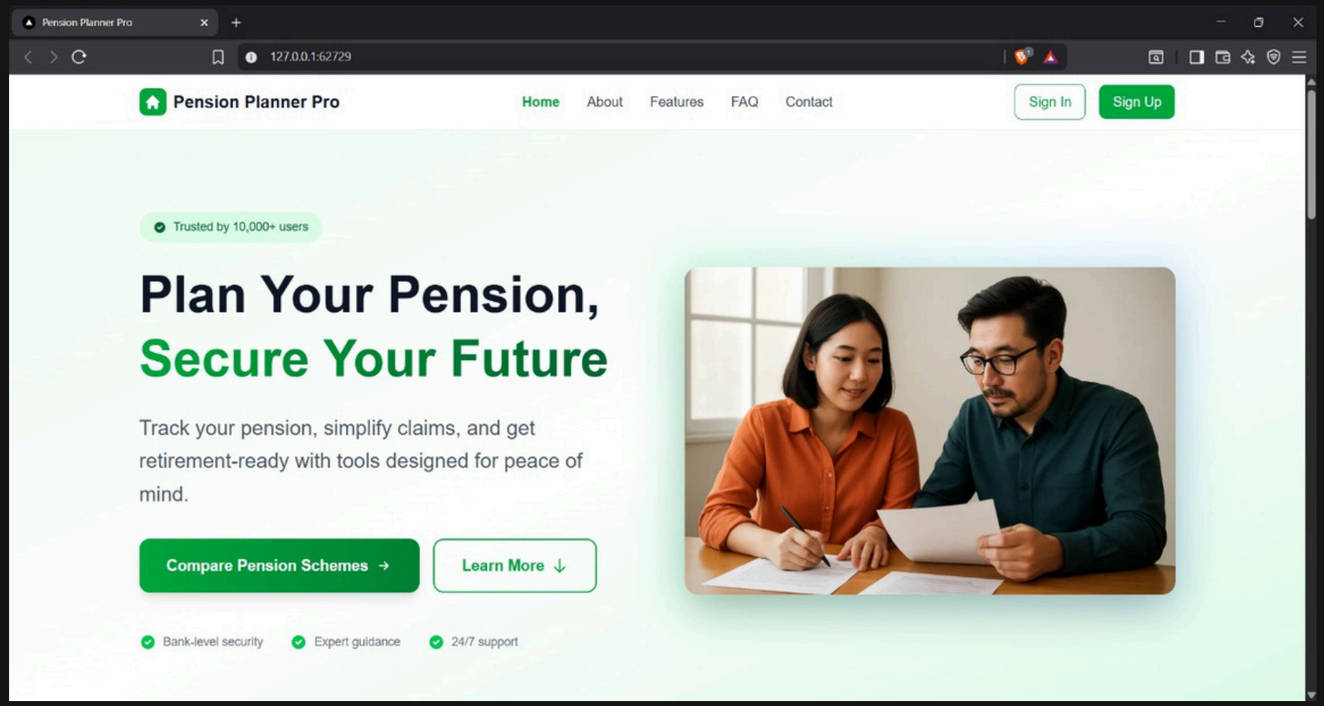
4. Applying kubernetes deployment.yaml file

```
C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main>kubectl apply -f k8
s/deployment.yaml
deployment.apps/nextjs-pbl-deployment created

C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main>kubectl get pods
NAME                                    READY   STATUS    RESTARTS   AGE
nextjs-pbl-deployment-7996476b8d-996kj   1/1     Running   0          4s
nextjs-pbl-deployment-7996476b8d-kd4dp   1/1     Running   0          4s
```

5. checking Status of Pods and through minikube calling the application

```
NAME                                    READY   STATUS    RESTARTS   AGE
nextjs-pbl-deployment-85b9fb455c-9d4zs   1/1     Running   0          20s
nextjs-pbl-deployment-85b9fb455c-mvqjq   1/1     Running   0          20s

C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main>kubectl logs -l app=nextjs-pbl

   ▲ Next.js 15.4.6
   - Local:        http://localhost:3001
   - Network:      http://10.244.0.10:3001

 ✓ Starting...
 ✓ Ready in 1482ms
(node:18) Warning: Setting the NODE_TLS_REJECT_UNAUTHORIZED environment variable to '0' makes TLS connections and HTTPS requests insecure by disabling certificate verification.
(Use `node --trace-warnings ...` to show where the warning was created)
Transporter is ready to send emails

   ▲ Next.js 15.4.6
   - Local:        http://localhost:3001
   - Network:      http://10.244.0.11:3001

 ✓ Starting...
 ✓ Ready in 1485ms
(node:18) Warning: Setting the NODE_TLS_REJECT_UNAUTHORIZED environment variable to '0' makes TLS connections and HTTPS requests insecure by disabling certificate verification.
(Use `node --trace-warnings ...` to show where the warning was created)
Transporter is ready to send emails

C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main>minikube service nextjs-pbl-service
|-----------|--------------------|-------------|---------------------------|
| NAMESPACE |        NAME        | TARGET PORT |            URL            |
|-----------|--------------------|-------------|---------------------------|
| default   | nextjs-pbl-service | 3001        | http://192.168.49.2:30010 |
|-----------|--------------------|-------------|---------------------------|
* Starting tunnel for service nextjs-pbl-service./-----------|--------------------|-------------|------------------------|
| NAMESPACE |        NAME        | TARGET PORT |          URL           |
|-----------|--------------------|-------------|------------------------|
| default   | nextjs-pbl-service |             | http://127.0.0.1:62729 |
|-----------|--------------------|-------------|------------------------|
* Starting tunnel for service nextjs-pbl-service.
* Opening service default/nextjs-pbl-service in default browser...
! Because you are using a Docker driver on windows, the terminal needs to be open to run it.
```

6. output of minikube call

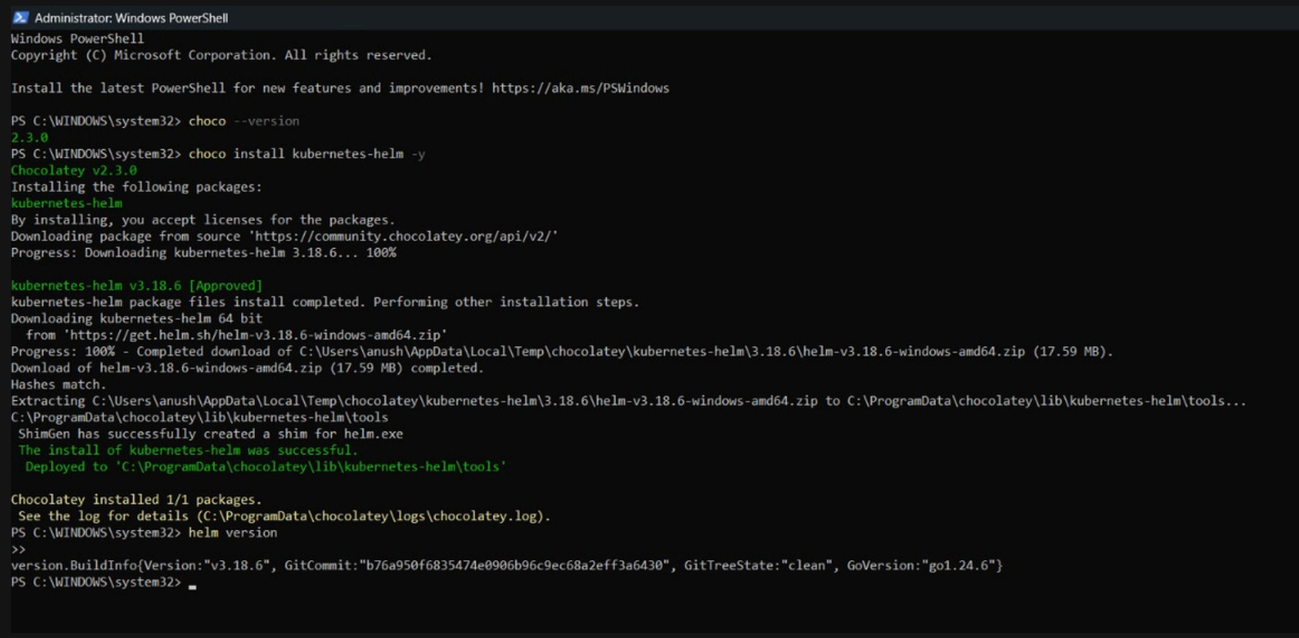


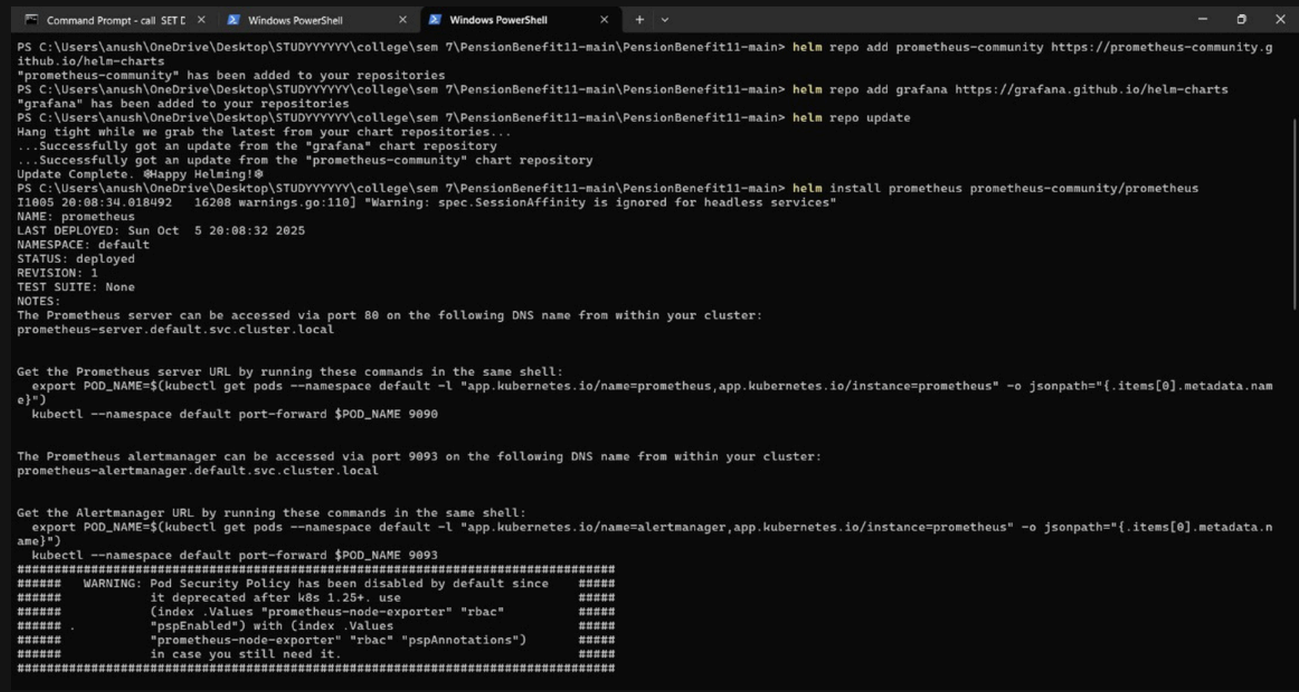
7. Tested rolling updates and rollback

```
C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main>kubectl set image deployment/nextjs-pbl-deployment nextjs-pbl-contain
er=nextjs-pbl-app:v2
deployment.apps/nextjs-pbl-deployment image updated

C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main>kubectl rollout status deployment/nextjs-pbl-deployment
deployment "nextjs-pbl-deployment" successfully rolled out

C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main>kubectl get pods
NAME                                  READY   STATUS    RESTARTS   AGE
nextjs-pbl-deployment-596bb66d5d-59zw2   1/1     Running   0          12s
nextjs-pbl-deployment-596bb66d5d-85gzh   1/1     Running   0          10s

C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main>kubectl rollout undo deployment/nextjs-pbl-deployment
deployment.apps/nextjs-pbl-deployment rolled back

C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main>kubectl get pods
NAME                                  READY   STATUS              RESTARTS   AGE
nextjs-pbl-deployment-596bb66d5d-59zw2   1/1     Running             0          26s
nextjs-pbl-deployment-596bb66d5d-85gzh   1/1     Running             0          24s
nextjs-pbl-deployment-85b9fb455c-pj4jk   0/1     ContainerCreating   0          6s

C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main>
```

Monitoring & Logging

1. Installed Helm using Chocolatey : choco install kubernetes-helm -y
2. Added Helm repositories:
    a. helm repo add prometheus-community https://prometheus-community.github.io/helm-charts
    b. helm repo add grafana https://grafana.github.io/helm-charts
    c. helm repo update
3. Installed Prometheus : helm install prometheus prometheus-community/prometheus
4. Installed Grafana: helm install grafana grafana/grafana



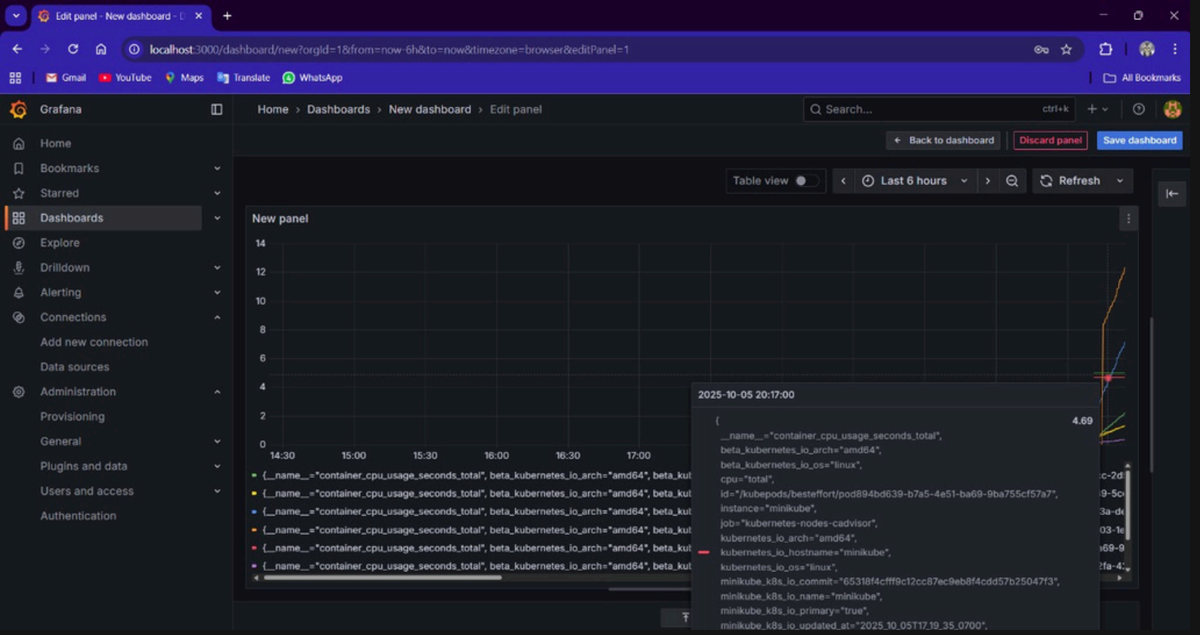


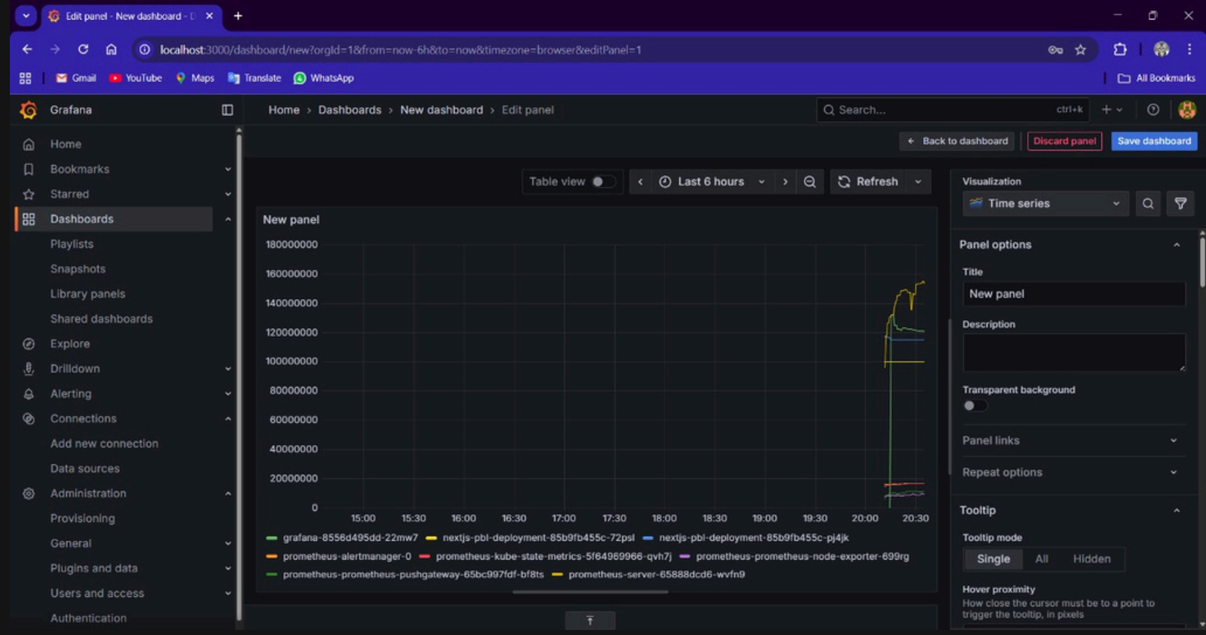
5.Verified pods : kubectl get pods
6. Forwarded Grafana service to a free local port:
    - kubectl port-forward svc/grafana 35000:80
7. Logged into Grafana (http://localhost:35000, admin/admin).
8. Added Prometheus Data Source → URL http://prometheus-server.default.svc.cluster.local:80.
9. Created dashboards with queries such as:
    - Memory usage per pod : sum(container_memory_usage_bytes{namespace="default"}) by (pod)
    - CPU usage per pod : sum(rate(container_cpu_usage_seconds_total{namespace="default"}[1m])) by (pod)
10. Saved dashboards for continuous monitoring.

```
PS C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main> kubectl get pods
NAME                                                READY   STATUS    RESTARTS   AGE
nextjs-pbl-deployment-85b9fb455c-72psl              1/1     Running   0          63m
nextjs-pbl-deployment-85b9fb455c-pj4jk              1/1     Running   0          63m
prometheus-alertmanager-0                           1/1     Running   0          2m13s
prometheus-kube-state-metrics-5f64969966-qvh7j      1/1     Running   0          2m13s
prometheus-prometheus-node-exporter-699rg           1/1     Running   0          2m13s
prometheus-prometheus-pushgateway-65bc997fdf-bf8ts  1/1     Running   0          2m13s
prometheus-server-65888dcd6-wvfn9                   2/2     Running   0          2m13s
```

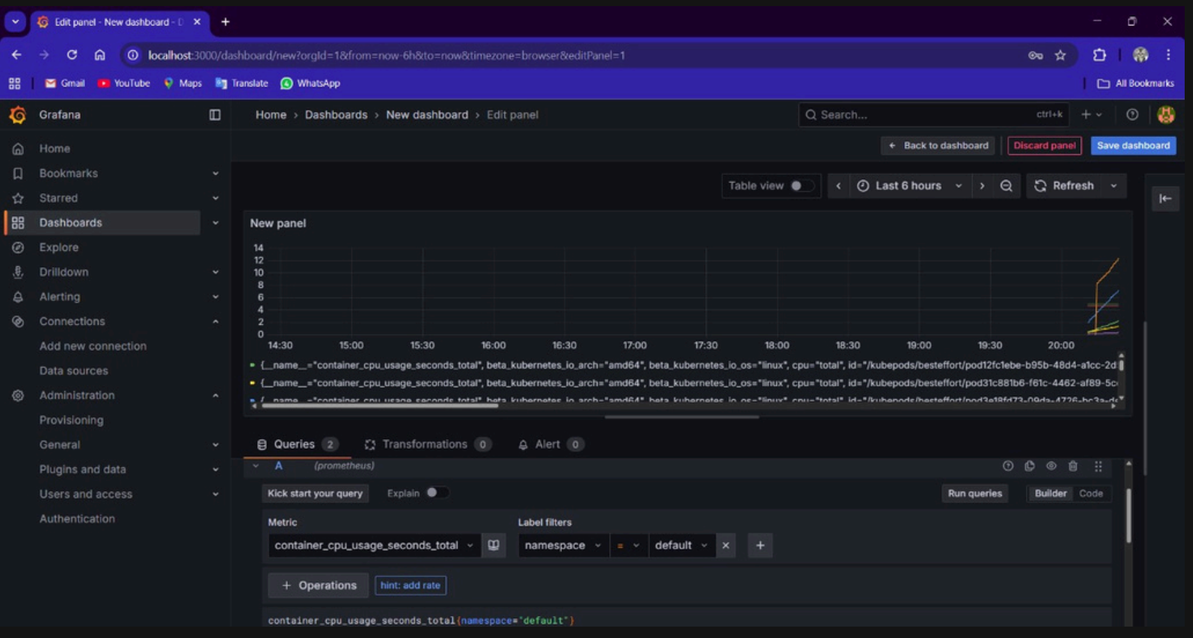
```
PS C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main> helm install grafana grafana/grafana
NAME: grafana
LAST DEPLOYED: Sun Oct  5 20:13:06 2025
NAMESPACE: default
STATUS: deployed
REVISION: 1
NOTES:
1. Get your 'admin' user password by running:

   kubectl get secret --namespace default grafana -o jsonpath="{.data.admin-password}" | base64 --decode ; echo


2. The Grafana server can be accessed via port 80 on the following DNS name from within your cluster:

   grafana.default.svc.cluster.local

   Get the Grafana URL to visit by running these commands in the same shell:
     export POD_NAME=$(kubectl get pods --namespace default -l "app.kubernetes.io/name=grafana,app.kubernetes.io/instance=grafana" -o jsonpath="{.items[0].m
etadata.name}")
     kubectl --namespace default port-forward $POD_NAME 3000

3. Login with the password from step 1 and the username: admin
#################################################################################
######   WARNING: Persistence is disabled!!! You will lose your data when   #####
######            the Grafana pod is terminated.                            #####
#################################################################################
```

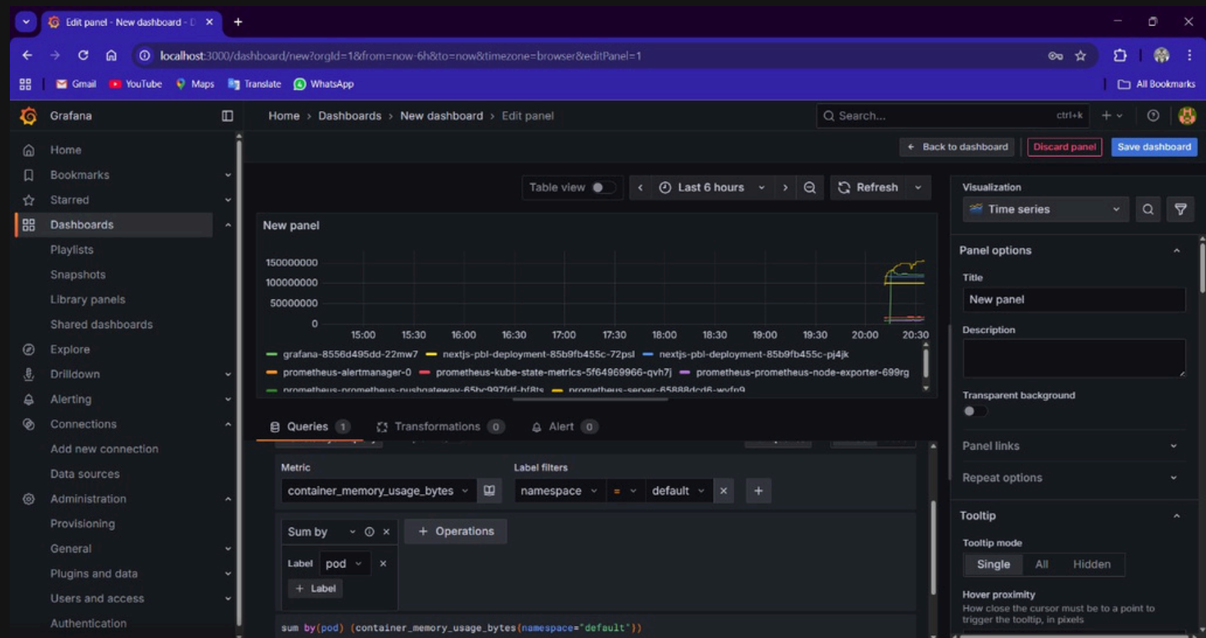
```
PS C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main> kubectl get pod
s
NAME                                                READY   STATUS    RESTARTS   AGE
grafana-8556d495dd-22mw7                            1/1     Running   0          109s
nextjs-pbl-deployment-85b9fb455c-72psl              1/1     Running   0          67m
nextjs-pbl-deployment-85b9fb455c-pj4jk              1/1     Running   0          67m
prometheus-alertmanager-0                           1/1     Running   0          6m21s
prometheus-kube-state-metrics-5f64969966-qvh7j      1/1     Running   0          6m21s
prometheus-prometheus-node-exporter-699rg           1/1     Running   0          6m21s
prometheus-prometheus-pushgateway-65bc997fdf-bf8ts  1/1     Running   0          6m21s
prometheus-server-65888dcd6-wvfn9                   2/2     Running   0          6m21s
PS C:\Users\anush\OneDrive\Desktop\STUDYYYYYY\college\sem 7\PensionBenefit11-main\PensionBenefit11-main>
```





Grafana Dashboard and Testing





Challenges Faced

- Port Conflicts (Grafana & Next.js) : Local ports (3000, 8080) were occupied. Resolved by identifying processes using netstat -ano, terminating them, and port-forwarding Grafana to 35000.
- Running Ansible in Docker : Faced permission and dependency issues. Fixed by adjusting playbook configurations and removing unnecessary privilege escalation.
- Docker Build & Deployment Errors : Build failed due to incorrect Dockerfile path. Reorganized project structure, verified build context, and successfully tested rolling updates and rollbacks.
- Prometheus–Grafana Integration : Faced data source connection issues. Solved by verifying service endpoints, correcting ports, and creating dashboards for CPU & memory usage per Pod.

Lesson learned

- *CI/CD Automation* : GitHub Actions streamlined build and deployment, ensuring faster and consistent releases.
- *Containerization & Scalability* : Docker and Kubernetes enabled easy scaling, replica management, and smooth rollbacks.
- *Monitoring & Observability* : Prometheus and Grafana provided real-time insights into CPU, memory, and app stability.
- *Simplified Deployments with Helm* : Helm charts reduced setup complexity and made upgrades effortless.
- *End-to-End DevOps Exposure* : Gained hands-on experience in automation, orchestration, and monitoring across the full DevOps pipeline.

Thank You