KLE Technological University
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CLOUD COMPUTING LAB (22ECAC202)

Activity Report

BATCH: **F1**
ROLL NO: 131
INSTRUCTOR: Ms. : **Sadaf Anjum Savanur**

COURSE DETAILS:

Course Name	Cloud Computing
Course Code	24ECAE317
Semester	VI
Division	F

Team Members:

Name	USN	ROLL NO
Bhoomika Marigoudar	**01FE22BCI035**	**131**

Introduction and About Cloud Computing:

Cloud computing is a revolutionary technology that enables on-demand access to a shared pool of configurable computing resources, such as servers, storage, databases, networking, software, and more, over the internet. It allows organizations and developers to scale applications efficiently, reduce infrastructure costs, and accelerate deployment cycles. Through various models like Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS), cloud computing provides flexibility and agility in managing IT services. This course introduces core concepts of cloud computing, emphasizing hands-on experience with virtualization, containerization, Kubernetes orchestration, serverless computing, microservices, and DevOps tools, making students industry-ready for modern cloud-based development and operations.

Course Outcomes Overview:

The projects in this course comprehensively address the key aspects of cloud computing. We begin by understanding and applying various cloud services and deployment models to build cloud-based applications. We then explore virtualization and containerization, managing resources efficiently in cloud environments. With Kubernetes, we implement automation and orchestration, streamlining deployment processes. Projects further involve developing scalable applications using serverless architecture and microservices, ensuring efficient event processing and communication. Finally, through tools like Ansible, Puppet, and Chef, we implement DevOps practices to automate configuration management and optimize infrastructure provisioning. Together, these projects align with the course outcomes, providing a holistic learning experience in cloud technologies and practices.

Lab Evaluation 1: Introduction to Cloud Services and Deployment Models

Objective:

- Understand cloud computing concepts, service models (IaaS, PaaS, SaaS).
- Deploy a simple cloud-based application using one of the service models.

Tasks Performed:

- Explored cloud platforms (AWS, Vercel, GCP) and their service offerings.
- Deployed a basic web application on AWS (PaaS).
- Configured environment variables and deployment parameters.

Tools/Technologies Used:

- GCP: Google Cloud ; Cloud Computing Services
- AWS Management Console
- Simple Web App (Node.js,HTML,CSS, React)

Outcome:

- Demonstrated ability to select appropriate cloud service models.
- Successfully deployed a web app on a cloud platform.
- Gained familiarity with cloud deployment processes.

Different Cloud Services Available:

1. IaaS (Infrastructure as a Service)

Definition:
IaaS provides virtualized computing resources over the internet. This includes servers, storage, networking, and operating systems. Users can install their own applications and manage the entire software stack.

Example Providers:
AWS EC2, Google Compute Engine, Microsoft Azure VM

Use Case:
If a developer wants full control over their virtual machines and network, IaaS is the best choice.

User Responsibility:
You handle the OS, applications, runtime, data, etc. The cloud provider only manages the infrastructure.

---

2. PaaS (Platform as a Service)

Definition:
PaaS provides a ready-to-use platform with an environment for developing, testing, deploying, and maintaining applications. You don't have to manage infrastructure.

Example Providers:
AWS Elastic Beanstalk, Google App Engine, **Vercel**, Heroku

Use Case:
If you're a developer focusing only on app development and not server setup or OS management, PaaS is ideal.

User Responsibility:
You write and deploy your code. The provider manages everything else (OS, middleware, servers).

---

3. SaaS (Software as a Service)

Definition:
SaaS delivers software applications over the internet on a subscription or free basis. Everything is managed by the service provider.

Example **Providers:**
Gmail, Google Docs, Microsoft 365, Dropbox

Use **Case:**
End-users who want ready-to-use software without worrying about installation or updates.

User **Responsibility:**
Only to use the application.

Vercel Deployment – Step-by-Step Implementation

In our project, we used **Vercel**, which is a **PaaS** platform specialized in deploying **frontend frameworks and static sites**.

Pre-requisites:

- A GitHub account (to store code)
- A Vercel account (linked with GitHub)
- A web app built using **HTML, CSS, Node.js, and React**

Step 1: Push Project to GitHub

1. Create a GitHub repository.
2. Add your local project files (React + Node.js code) to the repo.
3. Commit and push the code:

git init

git add .

git commit -m "initial commit"

git remote add origin <repo-link>

git push -u origin main

Step 2: Login to Vercel and Import Project

1. Go to https://vercel.com and log in with your GitHub account.
2. Click on **"Add New Project"**.
3. Select the GitHub repository that contains your project.

Step 3: Configure Project Settings

1. Vercel will auto-detect the framework (e.g., React).
2. Set the **build command** (e.g., npm run build) and **output directory** (usually build or dist).
3. Set **Environment Variables** (if any) like API URLs, tokens, etc.

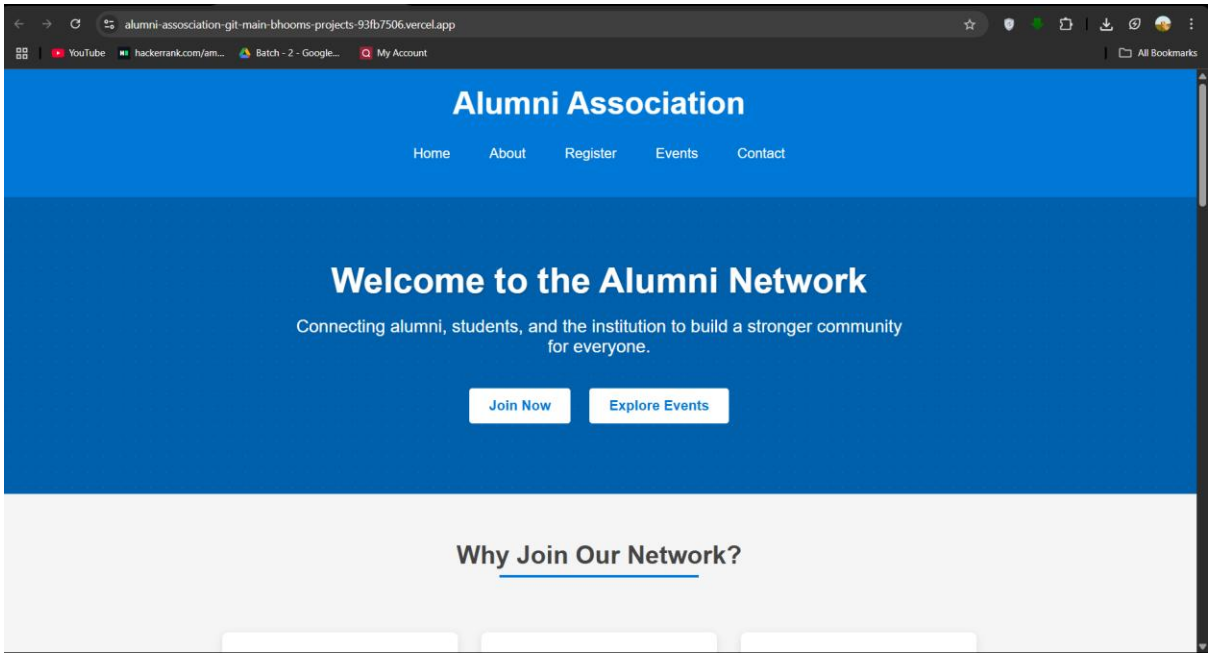
Step 4: Deploy the Application

1. Click on **"Deploy"**.
2. Vercel will install dependencies, build the app, and host it.
3. After a successful deployment, Vercel will provide a live URL (e.g., https://myapp.vercel.app).

Step 5: Post-Deployment Configuration

- Monitor logs in the Vercel dashboard.
- Set up custom domains (if needed).
- Configure automatic redeploys on GitHub pushes.

Link for Website: https://alumni-assosciation-git-main-bhooms-projects-93fb7506.vercel.app/


alumni-assosciation-git-main-bhooms-projects-93fb7506.vercel.app
YouTube
hackerrank.com/am...
Batch - 2 - Google...
My Account
All Bookmarks
Alumni Association
Home
About
Register
Events
Contact
Welcome to the Alumni Network
Connecting alumni, students, and the institution to build a stronger community for everyone.
Join Now
Explore Events
Why Join Our Network?

Lab Evaluation 2: Virtualization and Containerization Techniques

Objective:

- Learn virtualization basics and containerization using Docker.
- Create and manage containers for resource management.

Tasks Performed:

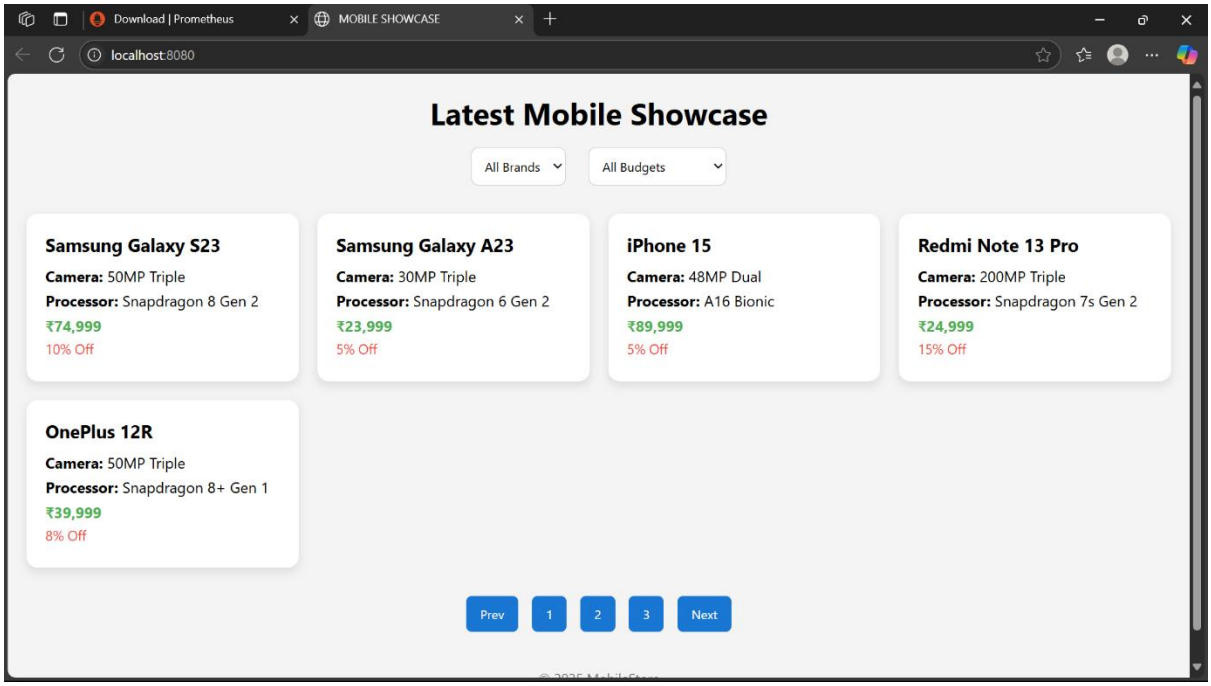
- Installed Docker on local machine.
- Created Docker images and containers using Dockerfiles.
- Managed containers lifecycle (start, stop, restart).
- Explored isolation and resource sharing in containers.

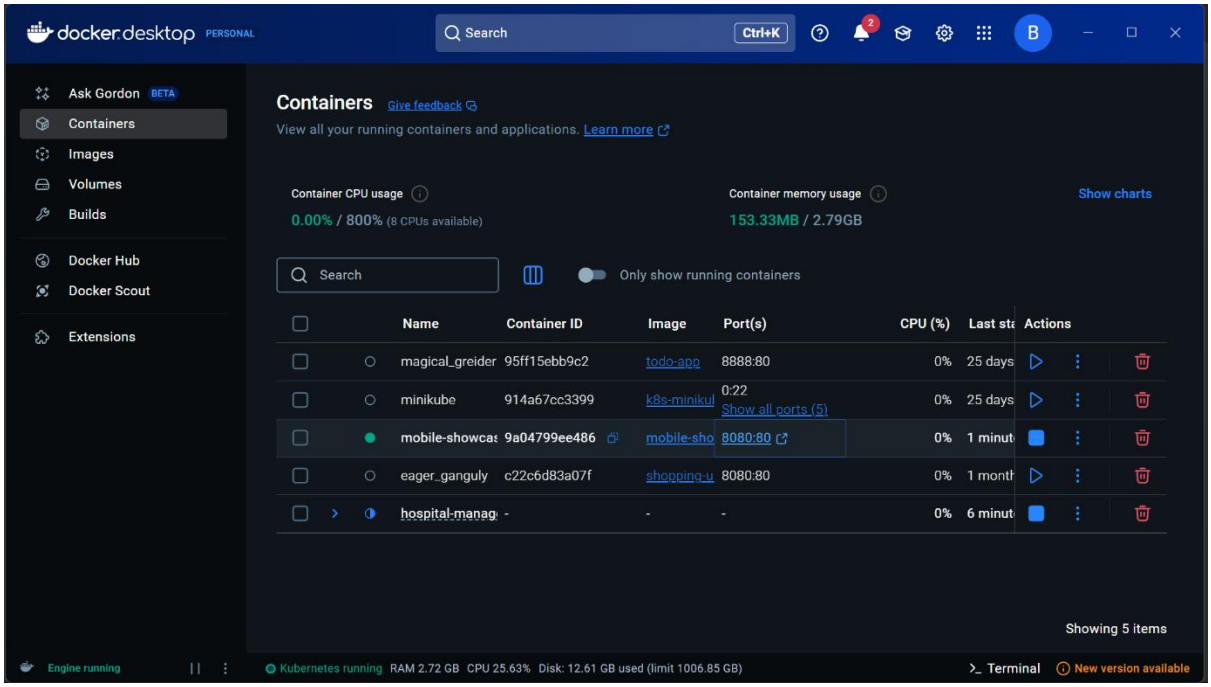
Tools/Technologies Used:

- Docker Engine and CLI
- Docker Hub for images

Outcome:

- Understood virtualization vs containerization differences.
- Created and deployed containers effectively.
- Recognized benefits of containers for cloud environments.


Download | Prometheus
MOBILE SHOWCASE
localhost:8080
Latest Mobile Showcase
All Brands
All Budgets
Samsung Galaxy S23
Camera: 50MP Triple
Processor: Snapdragon 8 Gen 2
₹74,999
10% Off
Samsung Galaxy A23
Camera: 30MP Triple
Processor: Snapdragon 6 Gen 2
₹23,999
5% Off
iPhone 15
Camera: 48MP Dual
Processor: A16 Bionic
₹89,999
5% Off
Redmi Note 13 Pro
Camera: 200MP Triple
Processor: Snapdragon 7s Gen 2
₹24,999
15% Off
OnePlus 12R
Camera: 50MP Triple
Processor: Snapdragon 8+ Gen 1
₹39,999
8% Off
Prev
1
2
3
Next


docker desktop
PERSONAL
Search
Ctrl+K
Ask Gordon
BETA
Containers
Images
Volumes
Builds
Docker Hub
Docker Scout
Extensions
Containers
Give feedback
View all your running containers and applications. Learn more
Container CPU usage
0.00% / 800% (8 CPUs available)
Container memory usage
153.33MB / 2.79GB
Show charts
Search
Only show running containers
Name
Container ID
Image
Port(s)
CPU (%)
Actions
magical_greider
95ff15ebb9c2
todo-app
8888:80
0%
25 days
minikube
914a67cc3399
k8s-minikul
0:22
Show all ports (5)
0%
25 days
mobile-showcas
9a04799ee486
mobile-sho
8080:80
0%
1 minut
eager_ganguly
c22c6d83a07f
shopping-u
8080:80
0%
1 month
hospital-manag
0%
6 minut
Showing 5 items
Engine running
Kubernetes running
RAM 2.72 GB
CPU 25.63%
Disk: 12.61 GB used (limit 1006.85 GB)
Terminal
New version available

Lab Evaluation 3: Kubernetes Orchestration and Automation

Objective:

- Understand container orchestration and automation using Kubernetes.
- Deploy multi-container applications and **manage scaling**.

Tasks Performed:

- Set up a Kubernetes cluster using Minikube.
- Deployed sample multi-container apps with Kubernetes manifests (YAML).
- Explored pods, services, deployments, and scaling.
- Implemented basic automation for rolling updates.

Tools/Technologies Used:

- Minikube (local Kubernetes)
- kubectl CLI
- Sample microservices app (multi-container)

Outcome:

- Learned Kubernetes architecture and components.
- Successfully deployed and managed containerized apps with orchestration.
- Gained skills in automating deployment and scaling processes.

Lab Evaluation 4: Development of Microservices-Based Applications

Hospital Management System – Monitoring with Prometheus and Grafana

Overview

In the Hospital Management System, we employed microservice architecture to break down functionality into separate services:

- **patient-service**
- **doctor-service**
- **billing-service**
- **frontend**

To monitor the health and performance of these services, we used:

- **Prometheus (for collecting metrics)**
- **Grafana (for visualizing those metrics)**

Microservices Used

Each of the microservices was containerized using Docker and run using Docker Compose. They included:

Service Name	Port	Technology
patient-service	5004	Spring Boot
doctor-service	5002	Node.js
billing-service	5003	Spring Boot
frontend	80/3000	React + Nginx

Prometheus Integration

- **What is Prometheus?**

Prometheus is an open-source monitoring tool that collects metrics from configured targets at given intervals, evaluates rule expressions, displays results, and can trigger alerts.

- **Prometheus Configuration (prometheus.yml)**

yaml

```
scrape_configs:
  - job_name: 'patient-service'
    metrics_path: /actuator/prometheus
    static_configs:
      - targets: ['patient-service:5004']

  - job_name: 'doctor-service'
    metrics_path: /metrics
    static_configs:
      - targets: ['doctor-service:5002']

  - job_name: 'billing-service'
    metrics_path: /actuator/prometheus
    static_configs:
      - targets: ['billing-service:5003']
```

This configuration:

- **Scrapes metrics from each service every 15 seconds (default).**

- **Uses the appropriate metrics endpoint:**
  - **/actuator/prometheus for Spring Boot (via Micrometer)**
  - **/metrics for Node.js (via prom-client)**

With this, the services expose a Prometheus-compatible endpoint at:

bash

CopyEdit

http://localhost:5004/actuator/prometheus

Configuring Node.js Services

For doctor-service (Node.js), we used the prom-client library.

Installation:

npm install prom-client express

```
const express = require('express');
const client = require('prom-client');
const app = express();

client.collectDefaultMetrics(); // Enables basic system metrics

app.get('/metrics', async (req, res) => {
  res.set('Content-Type', client.register.contentType);
  res.end(await client.register.metrics());
});
```

app.listen(5002, () => console.log("Doctor Service running on port 5002"));

This exposes:

bash

CopyEdit

http://localhost:5002/metrics

🔲 Common Prometheus Queries Used

Query	Description
up	**Displays the status of all targets (1 = UP, 0 = DOWN)**
http_server_requests_seconds_count	**Shows number of HTTP requests handled by Spring Boot services**
http_server_requests_seconds_count{status=~"5.."}	**Tracks how many 5xx server errors occurred**
rate(http_server_requests_seconds_count[1m])	**Rate of HTTP requests per second in the last minute**

📊 Grafana Integration

◇ What is Grafana?

Grafana is a powerful visualization tool that allows users to create interactive dashboards from various data sources, including Prometheus.

◇ Grafana Setup in Docker Compose

yaml

```
grafana:
  image: grafana/grafana:latest
  container_name: grafana
  ports:
    - "3005:3000"
  environment:
    - GF_SECURITY_ADMIN_USER=admin
    - GF_SECURITY_ADMIN_PASSWORD=admin
  depends_on:
    - prometheus
  networks:
    - monitoring-net
```

◇ Steps to Visualize Metrics

1. **Visit Grafana at http://localhost:3005**
2. **Log in with:**
    - **Username: admin**
    - **Password: admin**

3. **Add Prometheus as a data source (URL: http://prometheus:9090)**
4. **Create a dashboard with panels for:**
    - **CPU usage**
    - **Memory usage**
    - **HTTP error rates**
    - **Service uptime**

🔍 Debugging: Prometheus Not Seeing Services

If up = 0 for any service:

- **Check Docker container logs (docker logs <container-name>)**
- **Ensure metrics endpoint is reachable from Prometheus container**
- **Confirm ports and paths match in prometheus.yml**
- **Visit Prometheus /targets UI: http://localhost:9090/targets**

📦 Final Docker Compose Overview

yaml

```
services:
  patient-service: ...
  doctor-service: ...
  billing-service: ...
  frontend: ...
  prometheus:
    image: prom/prometheus
```

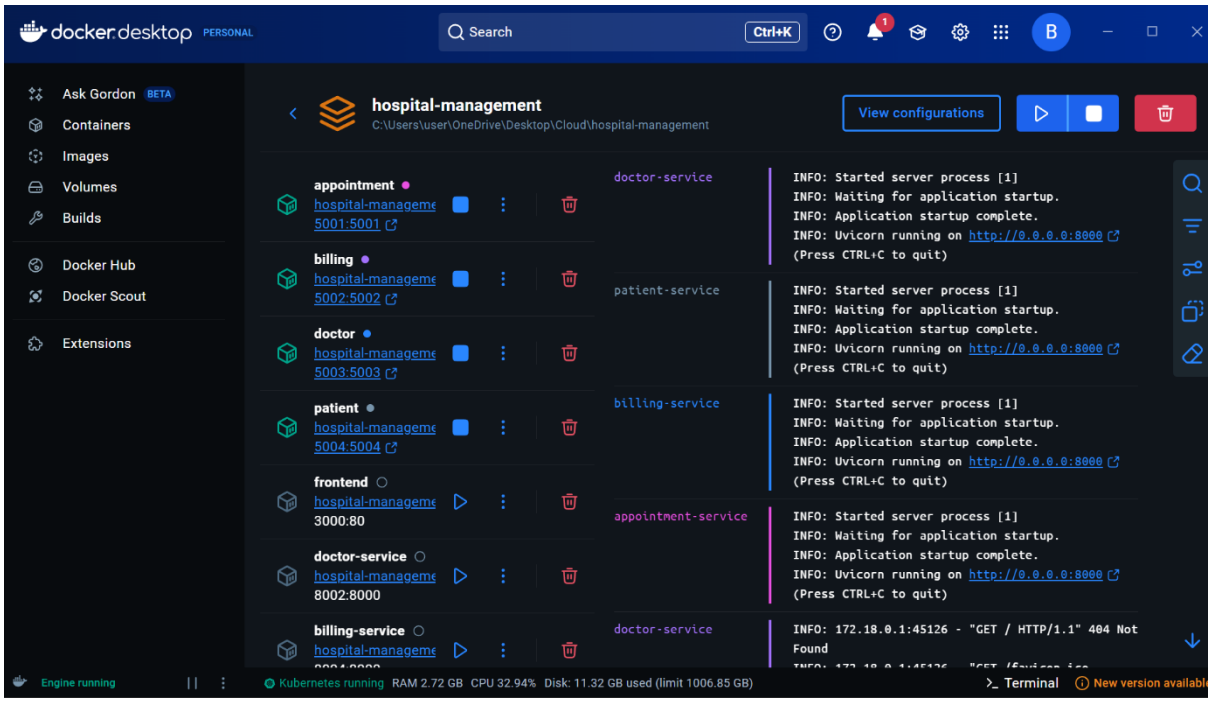
...

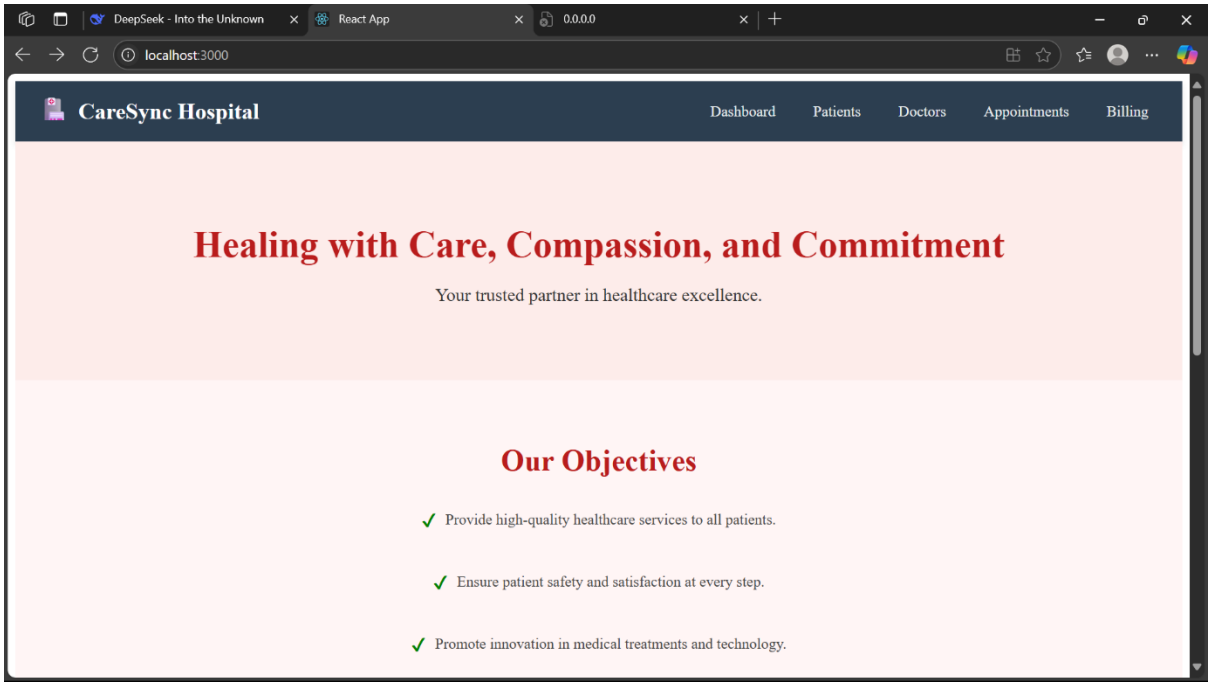
grafana:

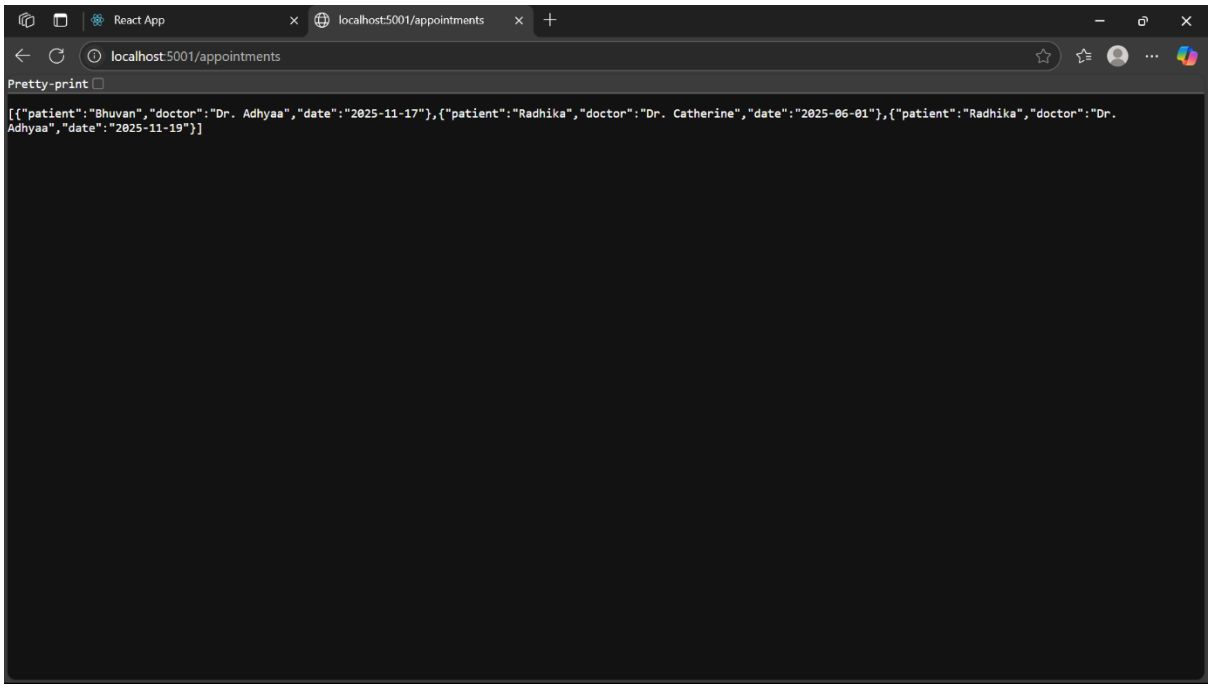
image: grafana/grafana

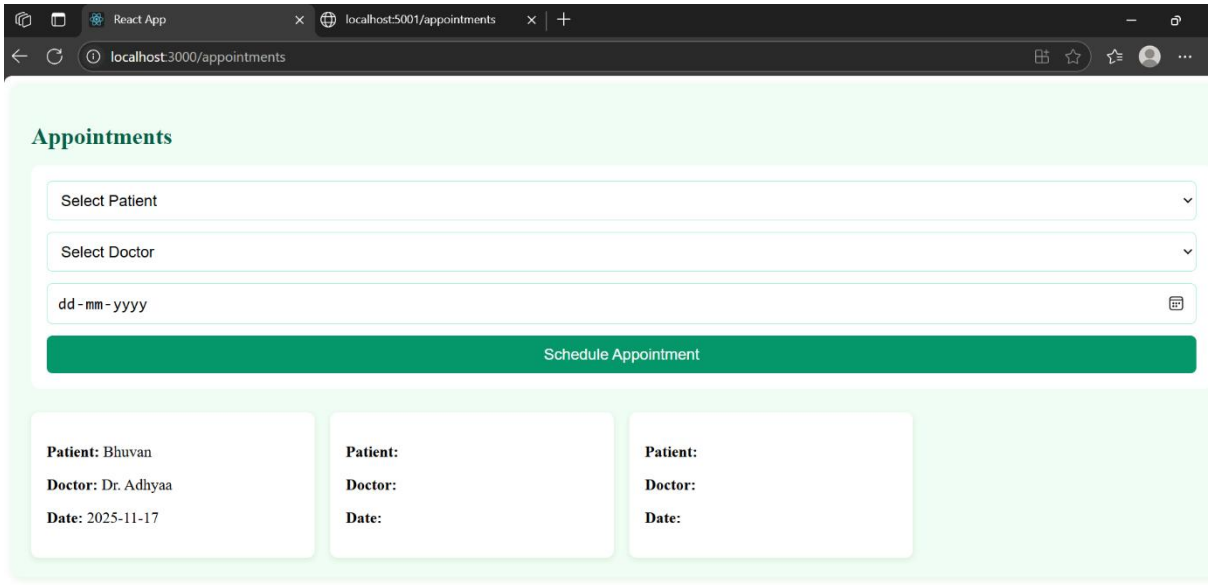
...

All services run inside a shared Docker network (monitoring-net) to ensure proper communication.

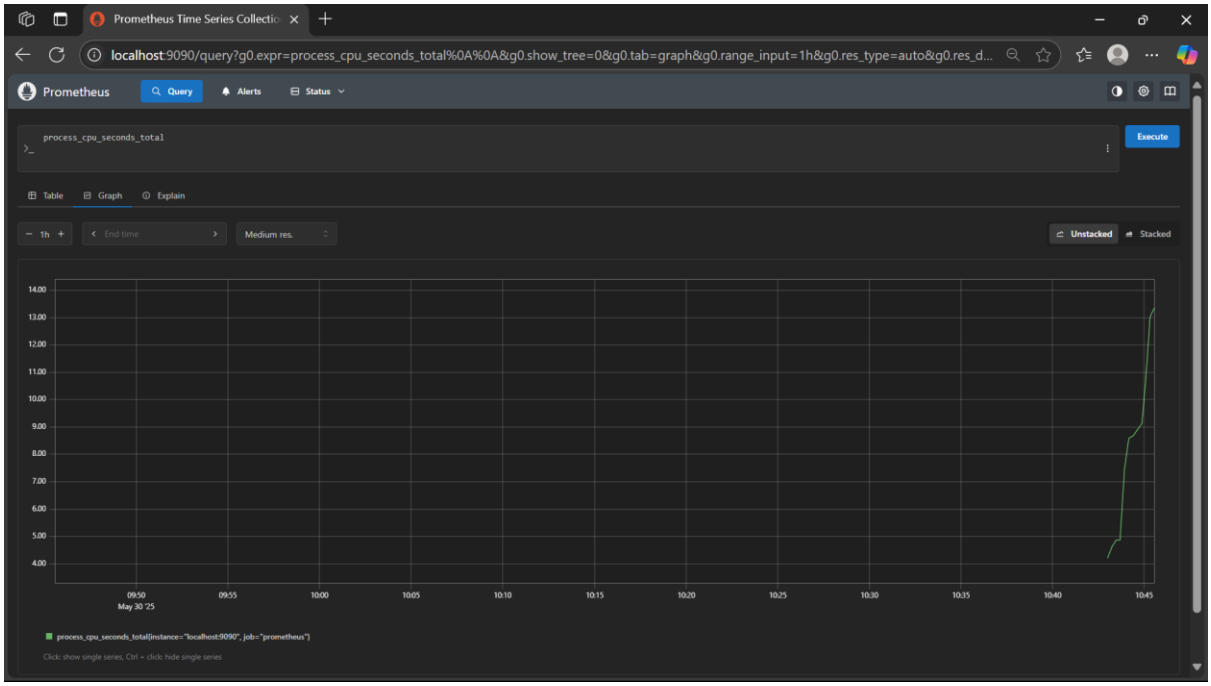


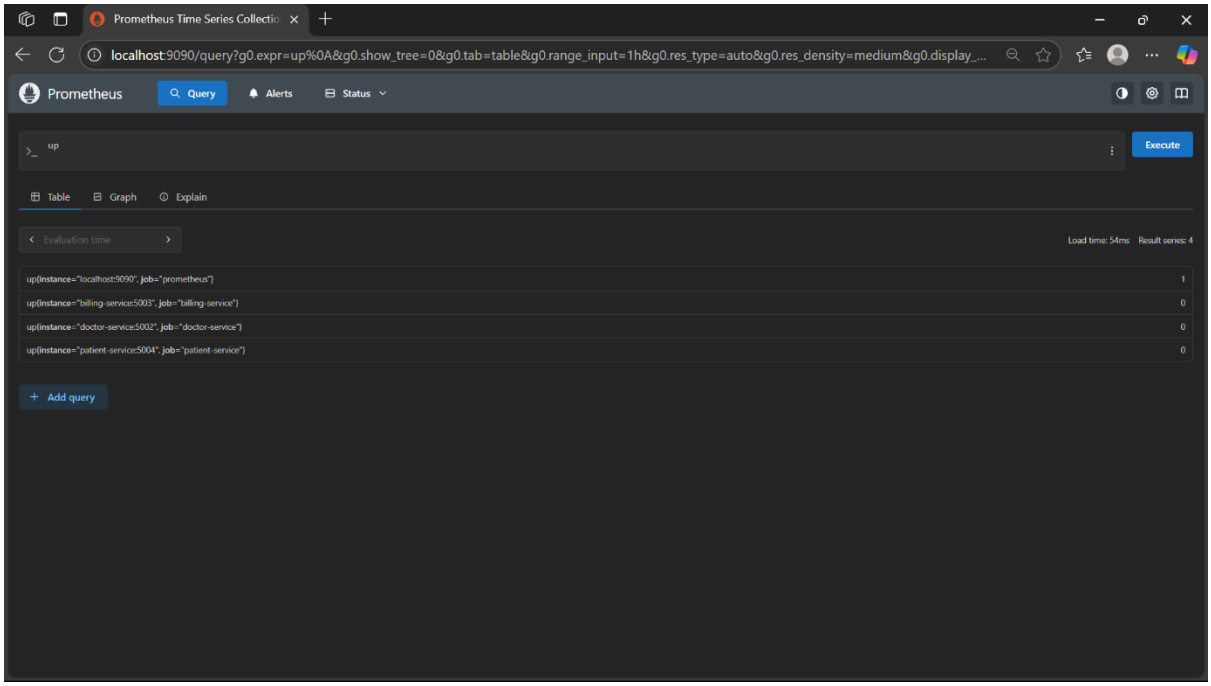

DeepSeek - Into the Unknown
React App
0.0.0.0
localhost:3000
CareSync Hospital
Dashboard
Patients
Doctors
Appointments
Billing
Healing with Care, Compassion, and Commitment
Your trusted partner in healthcare excellence.
Our Objectives
✓ Provide high-quality healthcare services to all patients.
✓ Ensure patient safety and satisfaction at every step.
✓ Promote innovation in medical treatments and technology.

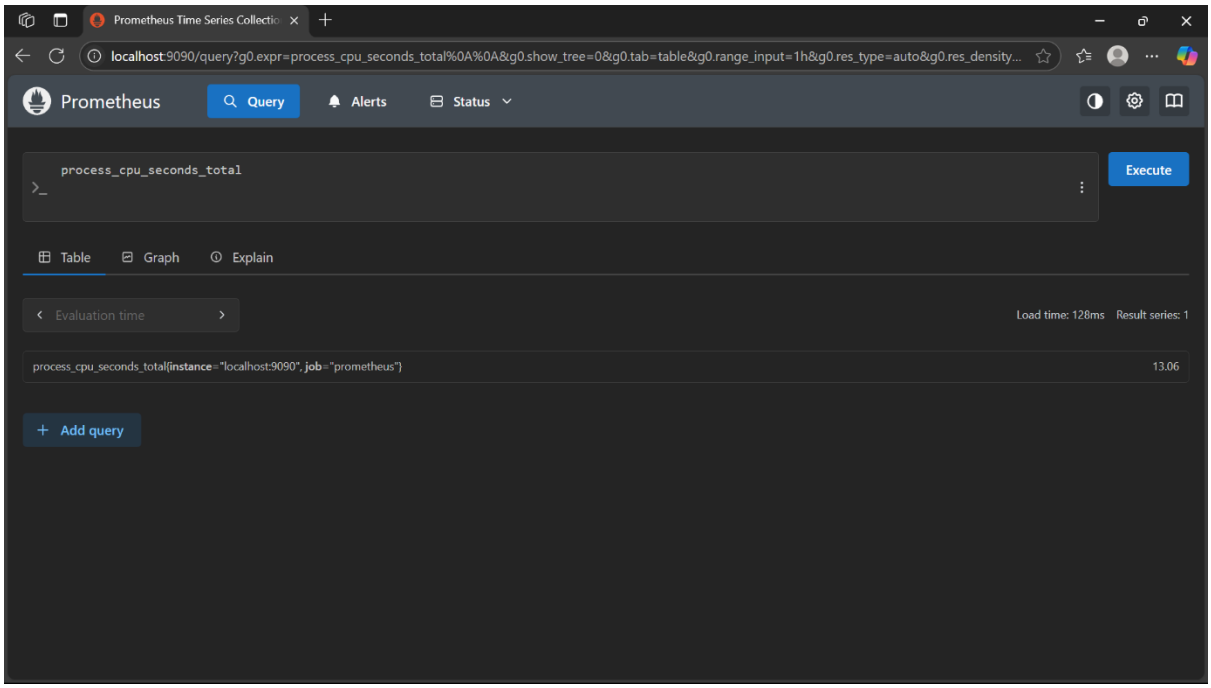

React App
localhost:5001/appointments
localhost:5001/appointments
Pretty-print
[{"patient":"Bhuvan","doctor":"Dr. Adhyaa","date":"2025-11-17"},{"patient":"Radhika","doctor":"Dr. Catherine","date":"2025-06-01"},{"patient":"Radhika","doctor":"Dr. Adhyaa","date":"2025-11-19"}]



PROMETHUS VISUALIZATION ALONG WITH LOAD BALANCER:




Prometheus Time Series Collectio
localhost:9090/query?g0.expr=up%0A&g0.show_tree=0&g0.tab=table&g0.range_input=1h&g0.res_type=auto&g0.res_density=medium&g0.display_...
Prometheus
Query
Alerts
Status
up
Execute
Table
Graph
Explain
Evaluation time
Load time: 54ms
Result series: 4
up{instance="localhost:9090", job="prometheus"} 1
up{instance="billing-service:5003", job="billing-service"} 0
up{instance="doctor-service:5002", job="doctor-service"} 0
up{instance="patient-service:5004", job="patient-service"} 0
Add query


Prometheus Time Series Collectio
localhost:9090/query?g0.expr=process_cpu_seconds_total%0A%0A&g0.show_tree=0&g0.tab=table&g0.range_input=1h&g0.res_type=auto&g0.res_density...
Prometheus
Query
Alerts
Status
process_cpu_seconds_total
Execute
Table
Graph
Explain
Evaluation time
Load time: 128ms
Result series: 1
process_cpu_seconds_total{instance="localhost:9090", job="prometheus"} 13.06
Add query

Lab Evaluation 5: Configuration Management Using Ansible

What is Ansible?

Ansible is an **open-source automation tool** used for:

- **Provisioning** servers (setting them up)
- **Configuring** software/services
- **Deploying applications**
- **Managing multiple machines** at once

It follows the **Infrastructure as Code (IaC)** approach and is **agentless**, meaning it does not require any software to be installed on the target machines.

Ansible Architecture Overview

- **Control Node**: The machine where Ansible is installed (usually your local system or admin server).
- **Managed Nodes**: The servers you want to configure using Ansible (e.g., Ubuntu servers).
- **Inventory File**: A file listing the IP addresses or hostnames of all managed nodes.
- **Playbook**: A YAML file that defines the automation tasks to be run on the nodes.

Steps to Configure and Use Ansible

Step 1: Install Ansible (on Control Node)

For Ubuntu/Debian:

bash

sudo apt update

sudo apt install ansible -y

To verify:

bash

ansible --version

Step 2: Set Up SSH Access to Managed Nodes

- Ensure the control node can connect to managed nodes via **SSH**.

bash

ssh-copy-id user@<managed-node-ip>

This command adds your control node's SSH key to the authorized keys of the managed node so that it can connect without a password.

Step 3: Create an Inventory File

The **inventory file** tells Ansible which servers to manage.

Example (hosts file):

ini

[webservers]

192.168.1.101

192.168.1.102

[dbservers]

192.168.1.201

Save this file as hosts or inventory.txt.

Step 4: Ping Test to Check Connectivity

Use Ansible's built-in ping module to test the connection:

bash

```
ansible all -i hosts -m ping
```

Expected output:

ruby

```
192.168.1.101 | SUCCESS => {
    "changed": false,
    "ping": "pong"
}
```

Step 5: Write Your First Ansible Playbook

A **playbook** is a YAML file that defines what tasks to perform.

Example (install_apache.yaml):

yaml

```
---
- name: Install Apache on webservers
  hosts: webservers
  become: true  # Runs tasks as root (sudo)

  tasks:
    - name: Install Apache package
```

```
    apt:
      name: apache2
      state: present
      update_cache: yes

  - name: Start Apache service
    service:
      name: apache2
      state: started
      enabled: yes
```

Step 6: Run the Playbook

Use the following command:

bash

```
ansible-playbook -i hosts install_apache.yaml
```

This will:

- Install Apache on all servers under [webservers]
- Ensure the service is started and enabled at boot

Step 7: Use Roles for Structured Playbooks (Optional but Recommended)

Roles allow us to organize our playbooks in a reusable way.

Folder structure:

css

```
roles/
  apache/
    tasks/
      main.yaml
    handlers/
      main.yaml
    templates/
    files/
```

Then your main playbook includes:

```
yaml
- hosts: webservers
  roles:
    - apache
```

Step 8: Verify and Debug

- Use ansible-playbook with -v or -vvv for verbose output.
- Check logs and execution results directly from terminal.

Objective:

- Automate infrastructure provisioning and system configuration using Ansible.
- Apply Infrastructure as Code (IaC) concepts for cloud environments.

Tasks Performed:

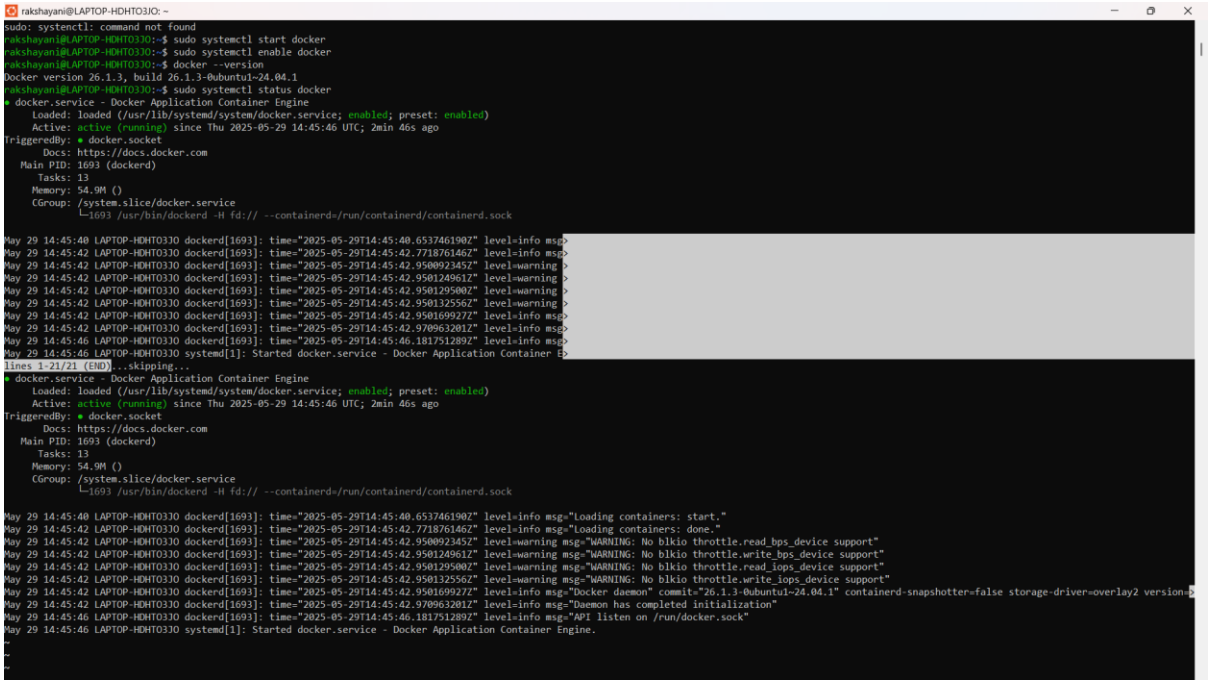
- Installed and configured Ansible on a control node.
- Defined inventory files to manage multiple target hosts.
- Wrote Ansible playbooks to automate tasks like installing packages, starting services, and configuring files.
- Tested idempotency and error handling of playbooks.
- Simulated deployment of a web server stack using Ansible roles.

Tools/Technologies Used:

- Ansible CLI
- YAML (for writing playbooks)
- Ubuntu/Linux servers (as managed nodes)
- SSH (for remote execution)

Outcome:

- Developed automation scripts to streamline infrastructure management.
- Demonstrated knowledge of Ansible architecture, inventory management, and playbooks.
- Enhanced deployment speed, consistency, and reduced human error in system configuration.
- Laid the foundation for implementing full DevOps pipelines in cloud environments.


rakshayani@LAPTOP-HDHTO3JO: ~
sudo: systenctl: command not found
rakshayani@LAPTOP-HDHTO3JO:~$ sudo systemctl start docker
rakshayani@LAPTOP-HDHTO3JO:~$ sudo systemctl enable docker
rakshayani@LAPTOP-HDHTO3JO:~$ docker --version
Docker version 26.1.3, build 26.1.3-0ubuntu1~24.04.1
rakshayani@LAPTOP-HDHTO3JO:~$ sudo systemctl status docker
● docker.service - Docker Application Container Engine
Loaded: loaded (/usr/lib/systemd/system/docker.service; enabled; preset: enabled)
Active: active (running) since Thu 2025-05-29 14:45:46 UTC; 2min 46s ago
TriggeredBy: ● docker.socket
Docs: https://docs.docker.com
Main PID: 1693 (dockerd)
Tasks: 13
Memory: 54.9M ()
CGroup: /system.slice/docker.service
└─1693 /usr/bin/dockerd -H fd:// --containerd=/run/containerd/containerd.sock
May 29 14:45:40 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:40.653746190Z" level=info msg
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.771876146Z" level=info msg
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.950092345Z" level=warning
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.950124961Z" level=warning
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.950129500Z" level=warning
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.950132556Z" level=warning
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.950169927Z" level=info msg
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.970963201Z" level=info msg
May 29 14:45:46 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:46.181751289Z" level=info msg
May 29 14:45:46 LAPTOP-HDHTO3JO systemd[1]: Started docker.service - Docker Application Container E
lines 1-21/21 (END)...skipping...
● docker.service - Docker Application Container Engine
Loaded: loaded (/usr/lib/systemd/system/docker.service; enabled; preset: enabled)
Active: active (running) since Thu 2025-05-29 14:45:46 UTC; 2min 46s ago
TriggeredBy: ● docker.socket
Docs: https://docs.docker.com
Main PID: 1693 (dockerd)
Tasks: 13
Memory: 54.9M ()
CGroup: /system.slice/docker.service
└─1693 /usr/bin/dockerd -H fd:// --containerd=/run/containerd/containerd.sock
May 29 14:45:40 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:40.653746190Z" level=info msg="Loading containers: start."
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.771876146Z" level=info msg="Loading containers: done."
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.950092345Z" level=warning msg="WARNING: No blkio throttle.read_bps_device support"
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.950124961Z" level=warning msg="WARNING: No blkio throttle.write_bps_device support"
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.950129500Z" level=warning msg="WARNING: No blkio throttle.read_iops_device support"
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.950132556Z" level=warning msg="WARNING: No blkio throttle.write_iops_device support"
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.950169927Z" level=info msg="Docker daemon" commit="26.1.3-0ubuntu1~24.04.1" containerd-snapshotter=false storage-driver=overlay2 version=
May 29 14:45:42 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:42.970963201Z" level=info msg="Daemon has completed initialization"
May 29 14:45:46 LAPTOP-HDHTO3JO dockerd[1693]: time="2025-05-29T14:45:46.181751289Z" level=info msg="API listen on /run/docker.sock"
May 29 14:45:46 LAPTOP-HDHTO3JO systemd[1]: Started docker.service - Docker Application Container Engine.