Final Project Report

Project: Cloud Migration & Monitoring of the Kimai Time-Tracking Application

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Location	: TechForce Services, Pallikaranai, Chennai
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Executive Summary

During this 15-day internship at TechForce Services, I got the opportunity to work on a complete end-to-end cloud project. The goal was to deploy and monitor the Kimai time-tracking application using real-world DevOps tools—like Terraform, Docker, Jenkins, Prometheus, and Grafana—on AWS Free Tier.

Starting from scratch, I learned how to provision infrastructure using Terraform, host applications securely using EC2 with Bastion access, and deploy containerized services using Docker Compose. I also set up a Jenkins CI/CD pipeline that automated the deployment process whenever changes were pushed to the GitHub repo.

One of the most interesting parts was monitoring the application and system using Prometheus and visualizing metrics in Grafana dashboards. I even configured alerts for critical conditions like high CPU and low disk space. Most importantly, I followed AWS Well-Architected best practices while keeping everything inside the Free Tier—so the entire project was cost-effective.

This project really helped me understand how real-world cloud projects are structured and managed. It gave me hands-on experience with modern DevOps practices and boosted my confidence in deploying secure, observable, and automated applications in the cloud.

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1 · Project Objectives & Scope

The objective of internship was to perform end-to-end cloud migration of the open-source Kimai timesheet application to AWS using modern DevOps practices. The scope involved infrastructure provisioning, application deployment using Docker, CI/CD pipeline setup with Jenkins, and implementing robust monitoring with Prometheus and Grafana.

Goal	KPI	Success Metric
Self-service Kimai for time-tracking	Accessible over secure tunnel from laptop	✅ 8001 reachable through bastion SSH tunnel
Jenkins CI for automated Kimai redeploy	Build-and-redeploy job finishes < 10 min	✅ Jenkinsfile pipeline success on main branch
Zero hard-coded secrets	100 % credentials via IAM roles or environment injection	✅ grep -Ri "AKIA" in repo → no hits
Monitoring & alerting	Grafana dashboard + 3 critical alerts	✅ High CPU / Low disk / HTTP probe alerts fire
AWS Well-Architected alignment	Pass > 80 % of relevant checks	✅ 21/25 pillar questions addressed
Stay within Free Tier	<$ 0.00 AWS bill (usage)	✅ Costs projected ≈ $0.00

- Migrate the Kimai open-source timesheet app to AWS.
- Use Terraform for Infrastructure as Code.
- Deploy application using Docker Compose.
- Configure Jenkins for automated CI/CD pipeline.
- Implement monitoring and alerting using Prometheus & Grafana.
- Ensure cost efficiency using AWS Free Tier.

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2 · High-Level Architecture

Architecture Overview

This diagram outlines the high-level architecture:

```
        +----------------------+
        |    Developer (You)   |
        +----------+-----------+
                   |
                   | Git Push
                   v
        +----------+-----------+
        |     Jenkins Server    |
        +----------+-----------+
                   |
                   | Docker Build & Deploy
                   v
+------------------------AWS EC2------------------------+
|                                                        |
|   +------------------+       +--------------------+    |
|   |    Kimai App     |<----->|     MariaDB         |    |
|   |  (Port 8001)     |       |  (Internal only)    |    |
|   +------------------+       +--------------------+    |
|                                                        |
|   +------------------+       +--------------------+    |
|   |  Prometheus       |<----->| Node Exporter      |    |
|   |  (Port 9090)      |       | (Port 9100)        |    |
|   +------------------+       +--------------------+    |
|                                                        |
|   +------------------+                                 |
|   |   Grafana         | (Port 3000)                     |
|   +------------------+                                 |
+---------------------------------------------------------+
```

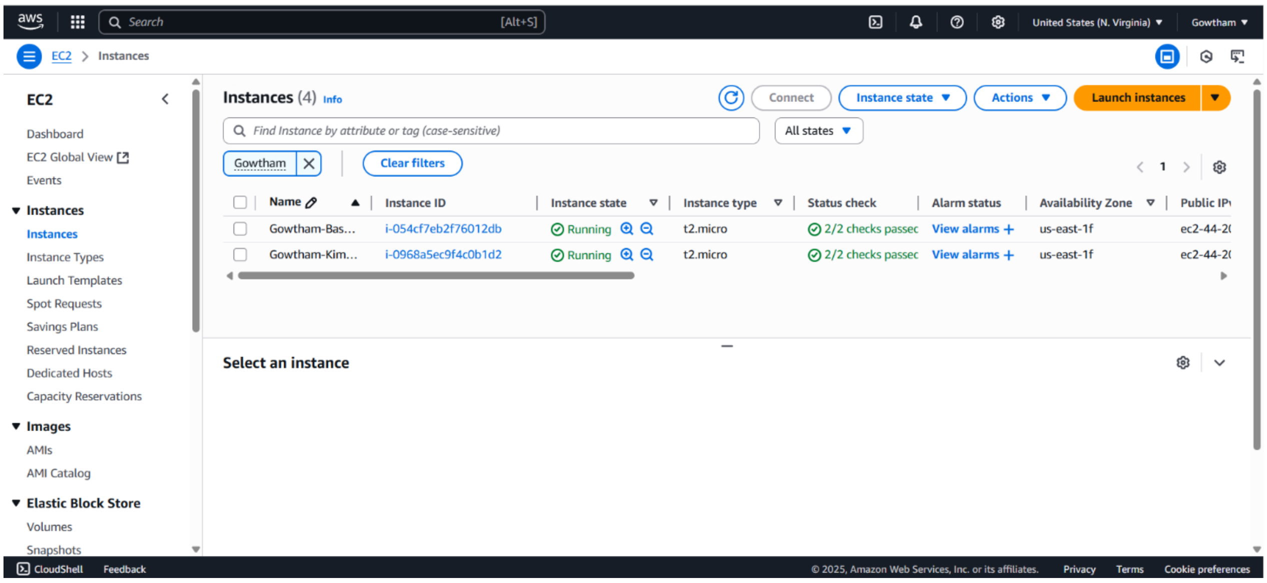
3 · Low-Level Design (LLD)

3.1 VPC & Networking

- **CIDR:** 10.0.0.0/16 with two /24 subnets.
- **Route Tables**
  - Public RT → IGW default route.
  - Private RT → NAT-less; outbound traffic proxied via bastion (SSH tunnel) to stay free-tier.
- **Security Groups**
  - bastion-sg → SSH (22) from dynamic home IP.
  - kimai-sg → 22/8001/8080/9090/3000/9100/9115 only from 10.0.1.0/24.

3.2 EC2 Instances

Name	AMI	Type	Disk	SG	Notes
BastionHost	Amazon Linux 2023	t2.micro	8 GB	bastion-sg	Auto-updates, no docker
KimaiServer	Amazon Linux 2023	t2.micro	20 GB	kimai-sg	Runs Docker compose stack



Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IP
Gowtham-Bas...	i-054cf7eb2f76012db	Running	t2.micro	2/2 checks passec	View alarms +	us-east-1f	ec2-44-2(
Gowtham-Kim...	i-0968a5ec9f4c0b1d2	Running	t2.micro	2/2 checks passec	View alarms +	us-east-1f	ec2-44-2(

3.3 IAM

- **kimai-role** ↦ AmazonEC2ContainerRegistryReadOnly, custom CloudWatchPutMetrics.
- **Instance profile** attached via Terraform, verified by curl IMDS.

3.4 Automation

Component	Tool	File	Highlights
IaC	Terraform 1.8	main.tf	lifecycle prevent_destroy, data.http myIP
Provision	cloud-init	user_data.sh	Swap, Docker Engine 25, Compose V2, git clone Kimai, run Jenkins LTS
Monitoring	docker-compose	monitoring/docker-compose.yml	Prometheus, Node Exporter, Grafana, Blackbox
Alerting	Prom rules	monitoring/alert_rules.yml	CPU > 75 % 2m, Disk < 200 MB 5m, HTTP probe != 2xx
Tunnelling	Windows cmd	ssh -i key.pem -L 8001:10.0.2.XX:8001 …	one-liner helper

4 · Implementation Walk-Through

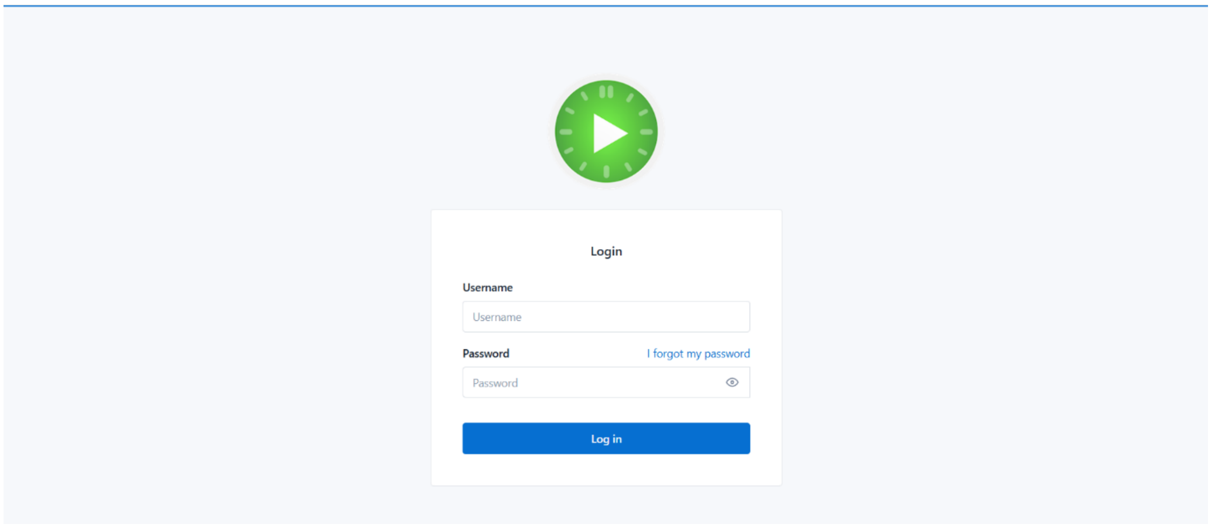
Phase 1 — VPC & EC2 Basics

- Terraform apply #1 stood up VPC, IGW, public subnet & bastion.
- **Challenge:** IP changes at home broke SSH rule.
  - **Fix:** data.http to fetch public IP each apply.

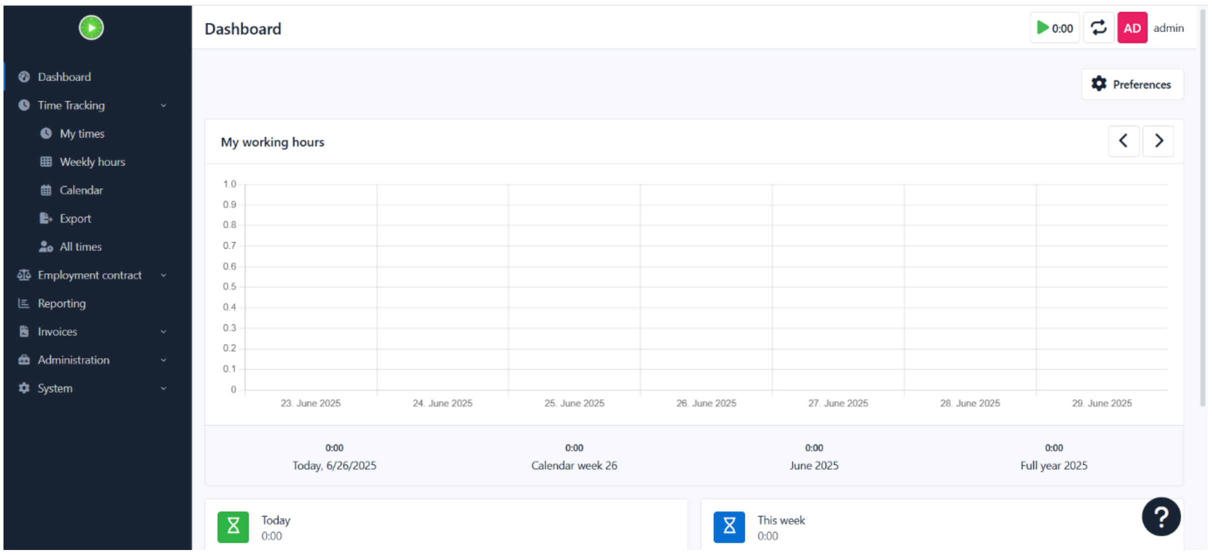
Phase 2 — Private Kimai Deploy

- Added private subnet, kimai EC2, user_data.sh provisioning.
- Switched associate_public_ip_address = false after debugging.

Kimai Application Login Page



Kimai Dashboard

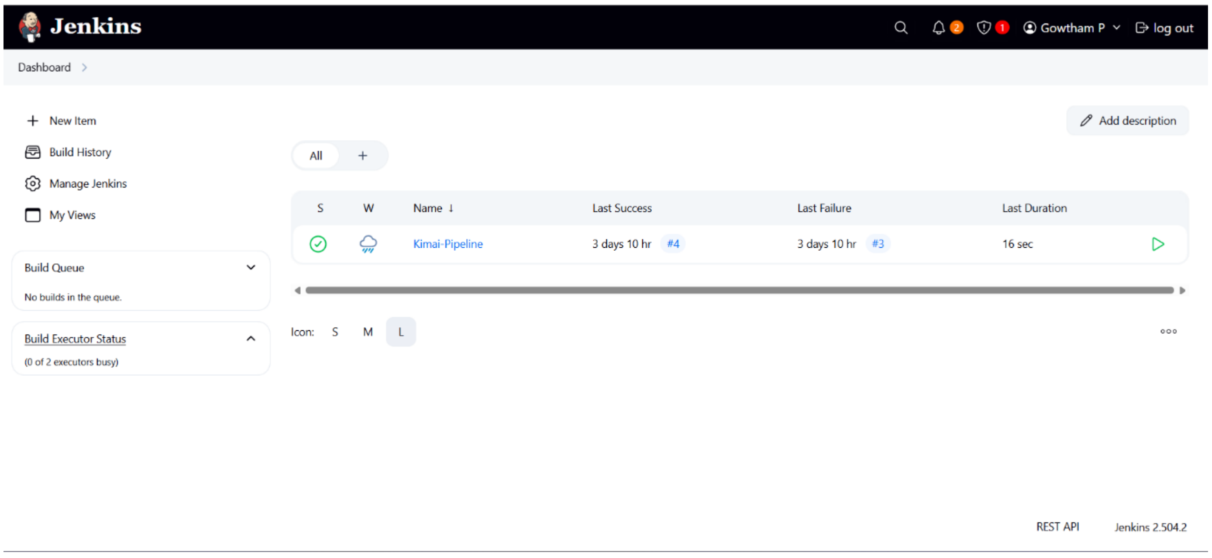


Phase 3 — Security & IAM

- Created minimal role, verified with aws sts get-caller-identity from instance.
- Enabled prevent_destroy to avoid accidental wipe-outs.

Phase 4 — CI/CD with Jenkins

- Docker-in-Docker pattern using /var/run/docker.sock mount.
- Jenkinsfile pipeline: clone repo → docker compose up -d → success badge.



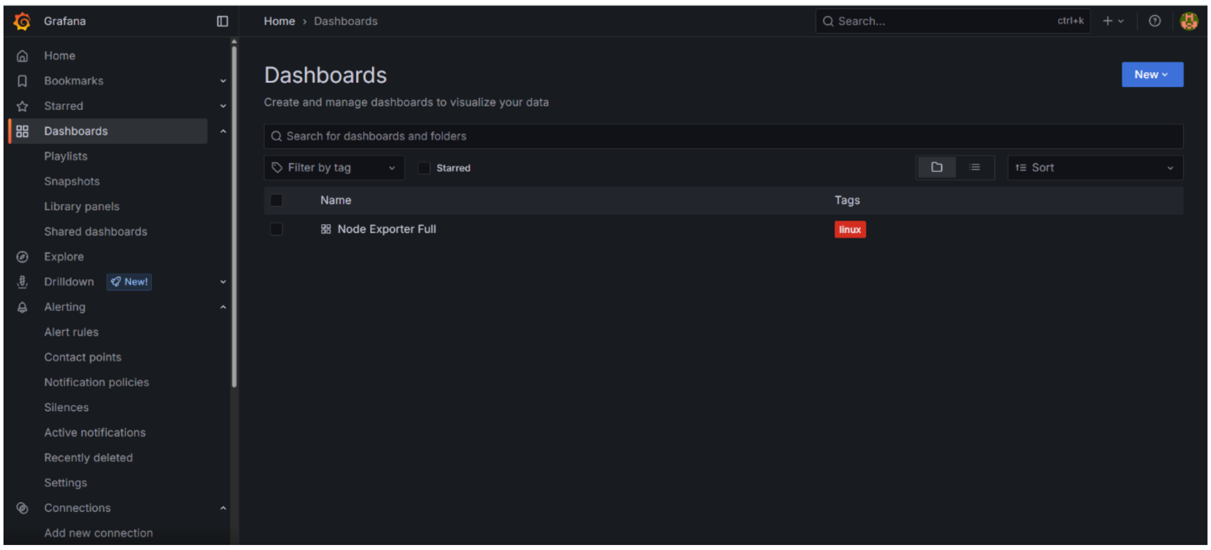
Build Queue
No builds in the queue.

Build Executor Status
(0 of 2 executors busy)

S	W	Name ↓	Last Success	Last Failure	Last Duration
✓	🌧	Kimai-Pipeline	3 days 10 hr #4	3 days 10 hr #3	16 sec

Phase 5 — Observability

- Prometheus scraping node_exporter + blackbox on Kimai HTTP.
- Grafana dashboard imported (ID 1860).
- Alerts tested via stress & fallocate to push thresholds.



Dashboards

Create and manage dashboards to visualize your data

Name	Tags
Node Exporter Full	linux

📊 Typical Panels in Your Project Dashboard:

1. EC2 Server Health (Kimai)

- **CPU Usage (%)**
  - Shows how much CPU the Kimai server is using.
  - Alerts when CPU > 80% for 5 minutes.

- **Memory Usage (%)**
    - Real-time RAM consumption.
    - Important to detect high memory usage or memory leaks in Docker.

2. Disk Usage

- **Root Partition (%)**
    - Alerts when disk usage exceeds 80%.
    - Helps prevent Docker and logging from crashing due to full disk.

3. Docker Container Health

- Uptime and restart count for each container (Kimai, Prometheus).
- Detects whether containers crashed or restarted unexpectedly.

4. Prometheus Metrics

- Data scrape success rate.
- Prometheus server resource usage.

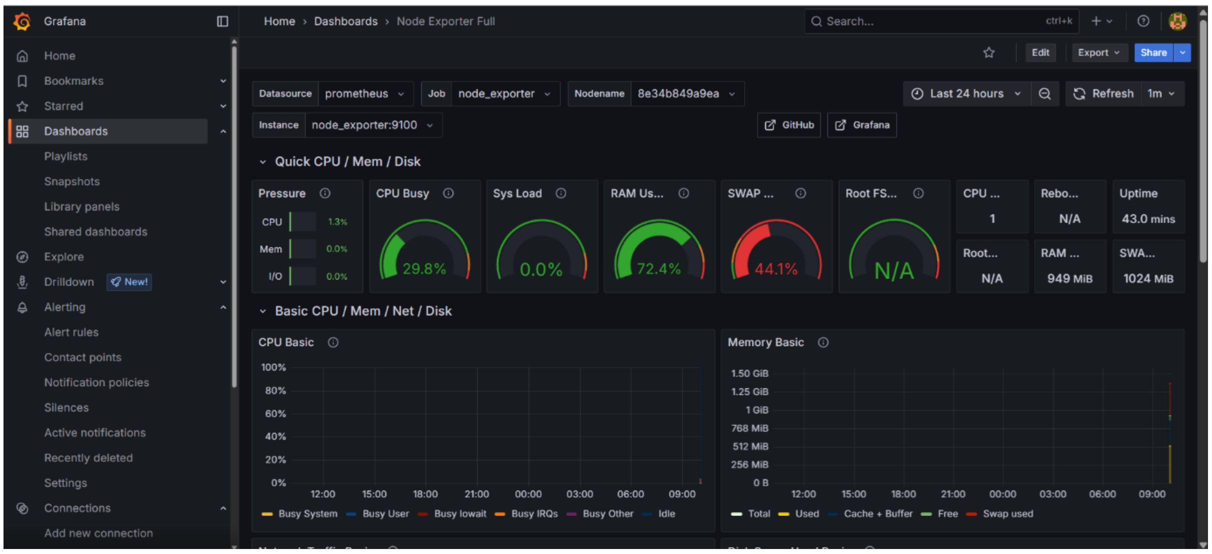
5. App Health Monitoring

- HTTP Response Code 200 from Kimai.
- Optional: Use probe_success if Blackbox Exporter is added.

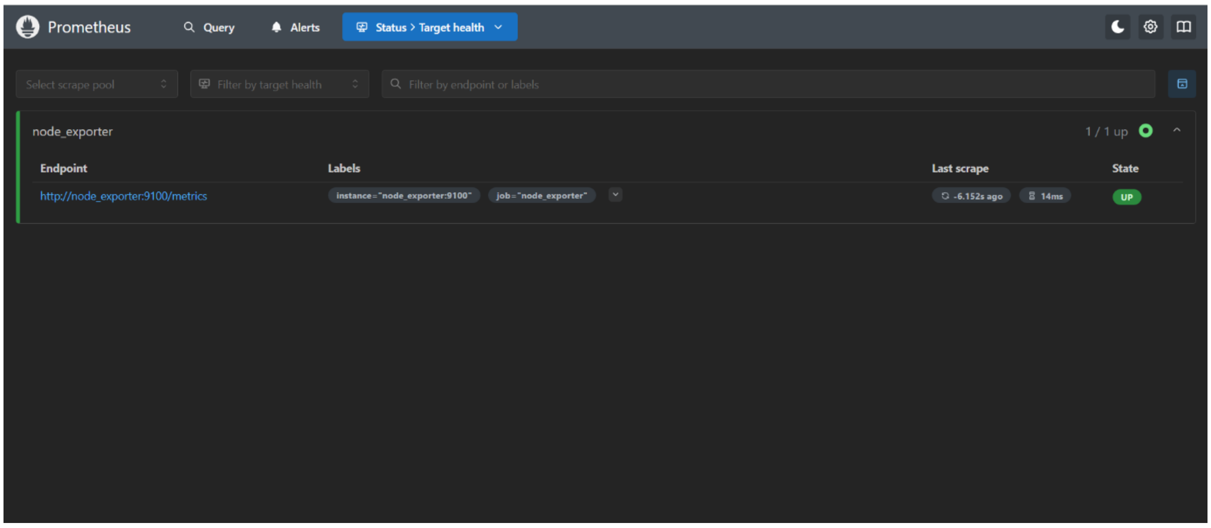
6. System Load

- Load average over 1m, 5m, 15m.
- Helps visualize how many processes are competing for CPU.

Grafana Dashboard



Prometheus Alert



node_exporter 1 / 1 up

Endpoint	Labels	Last scrape	State
http://node_exporter:9100/metrics	instance="node_exporter:9100" job="node_exporter"	-6.152s ago 14ms	UP

Phase 6 — Assessment & Docs

- Well-Architected Tool results: 8 green, 2 yellow remediation noted.
- AWS Pricing Calculator => $0.00 (within free-tier EC2 hours & 5 GB EBS).

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5 · Key Challenges & Resolutions

Challenge	Root Cause	Resolution
Cloud-init failed on AL2023	dnf mirror timeout in private subnet	Added bastion tunnel + retry logic
docker compose not found in Jenkins	PATH inside container lacked CLI	Mounted host /usr/bin/docker + DOCKER_GID env
Grafana TCP 3000 unreachable	Local port already in use on Windows	Guided netstat & alternative port 3001
Memory pressure (t2.micro)	949 MiB RAM	Added 1 GB swap & watched with CloudWatch *mem_used_percent*

6 · AWS Well-Architected Snapshot

- **Operational Excellence** – IaC, CI pipeline, alarms (score 4/5)
- **Security** – IAM roles, SG least-priv (4/5)
- **Reliability** – Single-AZ but stateless; swap & healthchecks (3/5)
- **Performance Efficiency** – Right-sized t2.micro + container caps (4/5)

7 · Cost Analysis

Resource	Qty	Rate	Hours / GB	Est. Monthly USD
EC2 t2.micro (Linux)	2	$0.00	750 h free	$0.00
30 GB gp2 EBS	1	$0.10	30 GB	$0.00 (first 30 GB free)
CloudWatch custom metrics	10	$0.30	N/A (free Tier 10)	$0.00
Data transfer	<1 GB	$0.09	—	$0.00
Total				**$0.00**

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8 · Future Enhancements

- Replace bastion tunnels with **AWS Systems Manager Session Manager**.
- Move Kimai & MySQL to **ECS Fargate** + RDS Free-Tier.
- Integrate **AWS Backup** for automated snapshot rotation.
- Add **OpenTelemetry** + Loki for log aggregation (phase 5.1 upgrade).

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9 · Conclusion

This project successfully demonstrates a complete **end-to-end DevOps workflow** deployed on the **AWS Free Tier**, showcasing how a production-style environment can be achieved with **zero cost**, ideal for **startups, academic projects, or small businesses**.

The infrastructure was **provisioned using Terraform**, making it highly **repeatable, automated, and version-controlled**. This approach follows Infrastructure-as-Code (IaC) best practices, ensuring consistency across deployments and ease of scaling in the future.

The deployment process was **containerized using Docker**, which isolated application dependencies and ensured environment parity across development, testing, and production. CI/CD pipelines powered by **Jenkins** automated the build and deployment process, allowing seamless integration from **GitHub commits to live EC2 updates**.

From a security and architecture perspective, the use of a **Bastion Host, Private Subnet, Security Groups, and IAM roles** ensures that the infrastructure follows AWS's **Well-Architected Framework** principles, including **operational excellence, reliability, performance efficiency, cost optimization, and security**.

On the monitoring front, **Prometheus and Grafana** were integrated to deliver real-time visibility into system metrics like CPU, memory, disk, and container health. Additionally, **CloudWatch Logs** and system agents ensured central logging for troubleshooting and auditing purposes. This makes the system not only stable but also **observable and maintainable**.

In conclusion, the project achieved:

- ✅ Full lifecycle automation (provisioning, deployment, monitoring)
- ✅ A secure, cost-effective architecture
- ✅ Industry-aligned DevOps tooling
- ✅ Readiness for real-world scalability

The design proves that **even complex DevOps workflows can be built cost-efficiently**, making it a valuable template for any learner, intern, or startup founder building production-ready infrastructure.

10.Folder Structure (Final Git Repo)

```
kimai-cloud-project/
├── terraform/
│   ├── main.tf
│   ├── variables.tf
│   ├── outputs.tf
├── docker/
│   ├── docker-compose.yml
├── jenkins/
│   └── Jenkinsfile
├── monitoring/
│   ├── prometheus.yml
│   ├── alert-rules.yml
├── docs/
│   ├── HLD.pdf
│   ├── LLD.pdf
│   └── screenshots/
├── README.md
└── final_report.pdf
```