Low-Level Design (LLD)

Kimai Cloud Automation Project

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1. Objective

The objective of this project is to migrate the open-source **Kimai timesheet application** to the **AWS cloud**. It includes automated infrastructure provisioning with **Terraform**, containerized deployment using **Docker**, secure access via a **Bastion Host**, monitoring with **Prometheus & Grafana**, and logging with **Amazon CloudWatch**.

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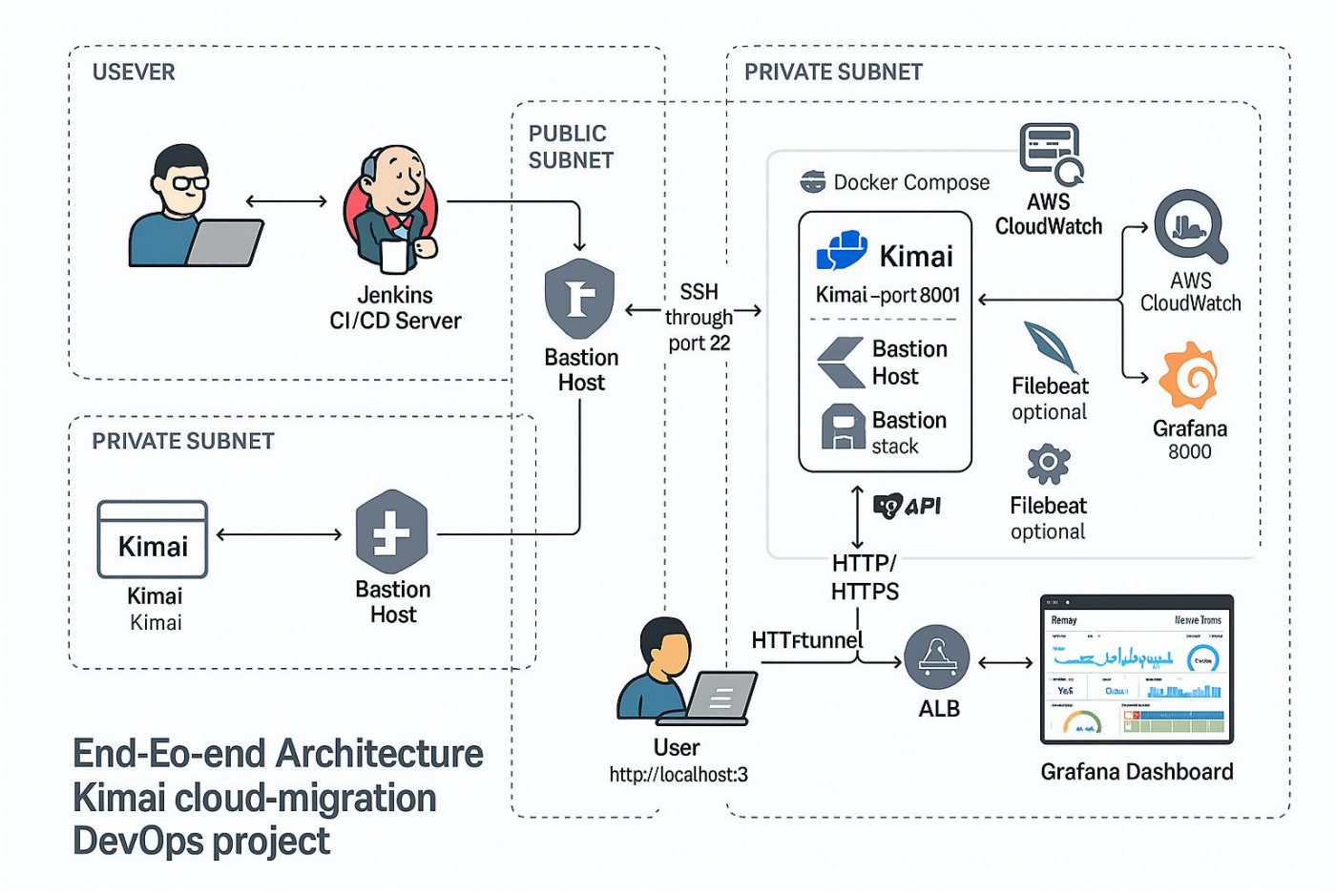
2. Overview of Architecture

Components:

- **VPC** with Public and Private Subnets
- **EC2 Bastion Host** (Public Subnet)
- **EC2 App Server** for Kimai, Jenkins, Prometheus, Grafana (Private Subnet)
- **IAM Role** for CloudWatch Logs
- **Security Groups** for controlled access
- **Docker Compose** deployment of Kimai and supporting tools
- **Prometheus & Grafana** for monitoring
- CloudWatch Agent for system log collection



3. Infrastructure Components

Component	Type	Configuration/Tool	Notes
VPC	AWS VPC	CIDR: 10.0.0.0/16	Isolated virtual network
Subnets	Public & Private	/24 each	Public: Bastion, Private: Kimai
EC2 (Bastion)	t2.micro	Amazon Linux 2023	SSH Access point
EC2 (Kimai)	t2.micro	Amazon Linux 2023	Kimai App + Jenkins + Monitoring
Security Groups	AWS SG	Port-based access rules	SSH, 8001, 3000, 9090, 9100
IAM Role	EC2 IAM Role	CloudWatchAgent access	Logs pushed securely

Infrastructure Breakdown

VPC

- CIDR: 10.0.0.0/16
- Enables isolation of private and public layers

Subnets

- Public Subnet: `10.0.1.0/24` (for Bastion)
- Private Subnet: `10.0.10.0/24` (for App EC2)

EC2 Instances

Instance	AMI	Type	Subnet	Role
Bastion	Amazon Linux 2023	t2.micro	Public	SSH Access Point
App Server	Amazon Linux 2023	t2.micro	Private	App Hosting

Security Groups

SG Name	Allowed Ports	Source
bastion-sg	22 (SSH)	My IP
app-sg	8001, 3000, 9090	10.0.1.0/24

IAM Role

- Attached to App Server
- Grants permission to publish logs to CloudWatch
- Uses Instance Profile

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4. Provisioning (Terraform)

Files:

- `main.tf:` defines EC2s, VPC, SGs, Subnets
- `variables.tf:` defines all inputs (region, AMI ID, etc.)
- `outputs.tf:` prints IP addresses

The `user_data.sh` is a type of script , it calls shellscript file

user_data.sh installs:

- Docker, Docker Compose
- Git and Kimai repo
- Jenkins container

File	Description
main.tf	AWS EC2, VPC, Subnet, SG, Role setup
variables.tf	Parameterization of key configs
outputs.tf	Displays IPs of EC2s
user_data.sh	Installs Docker, Jenkins, Kimai, CloudWatch

Terraform Flow:

terraform init

terraform apply

🐳 4. Application Deployment (Docker Compose)

Service	Image	Ports	Notes
Kimai	kimai/kimai2:apache	8001	Web UI
MySQL	mariadb	3306	DB backend for Kimai
Jenkins	jenkins/jenkins:lts	8080, 50000	CI/CD pipeline execution

Kimai docker-compose.yml sample:

```
version: '3.7'
services:
 kimai:
  image: kimai/kimai2:apache
  ports:
   - "8001:8001"
  depends_on:
   - mysql
 mysql:
  image: mariadb
  environment:
   MYSQL_DATABASE: kimai
```

🔄 5. CI/CD Pipeline (Jenkins)

Stage	Tool/Script	Purpose
Clone Repo	GitHub	Clones kimai-app repo
Deploy App	docker-compose	Spins up Kimai + MySQL
Verify	docker ps	Confirms container status
Output App URL	curl + echo	Displays access link in console

Pipeline file: Jenkinsfile

📈 6. Monitoring (Prometheus + Grafana)

Component	Docker Image	Port	Purpose
Prometheus	prom/prometheus	9090	Pulls metrics from exporters
Grafana	grafana/grafana	3000	Visual dashboards
Node Exporter	prom/node-exporter	9100	System-level metrics

Prometheus

- Installed via Docker
- Scrapes metrics from:
    - Node Exporter (host metrics)
    - Docker (app health)

Grafana

- Connected to Prometheus
- Dashboard created for:
    - CPU Utilization
    - Memory Usage
    - Disk IO
    - Container Health

Prometheus scrape config (prometheus.yml):

```
scrape_configs:
 - job_name: 'node-exporter'
   static_configs:
    - targets: ['localhost:9100']
```

🚨 7. Alerting Rules (Grafana)

Alert Name	Expression (PromQL)	Trigger Threshold
CPU High	100 - avg(irate(...)) * 100	CPU > 70% for 1 min
Disk Low	node_filesystem_avail_bytes	Disk < 20% remaining
App Down	Optional (Blackbox or port ping)	If health check fails

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📦 8. Logging (CloudWatch Agent)

- Installed on EC2 via user_data.sh
- Collects:
  - /var/log/messages
  - /var/log/secure
  - /var/log/cloud-init.log
- Logs are forwarded to **CloudWatch Logs**
- Configured in /opt/aws/amazon-cloudwatch-agent/etc/amazon-cloudwatch-agent.json

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🔐 9. Security & Access

Layer	Config
SSH Access	Allowed only from my IP via Bastion
Kimai EC2	Private subnet, no public SSH
Ports	Only 8001, 3000, 9090, 9100 exposed via Bastion
IAM Role	Fine-grained CloudWatch access only

Security & IAM Roles

SSH Bastion Access

- SSH is allowed only to Bastion from user IP
- Kimai EC2 has no public IP
- Private EC2 is accessible only via Bastion

🧪 10. SSH Tunneling

Used to access Grafana & Prometheus from local browser:

```
ssh -i My-Aws-Key.pem \
-L 3000:localhost:3000 \
-L 9090:localhost:9090 \
-L 8001:localhost:8001 \
ec2-user@<Bastion-IP>
```

- This avoids exposing these tools to the internet
- Works well under Free Tier with private EC2
