Indian Institute of Technology Jodhpur

ASSIGNMENT-1

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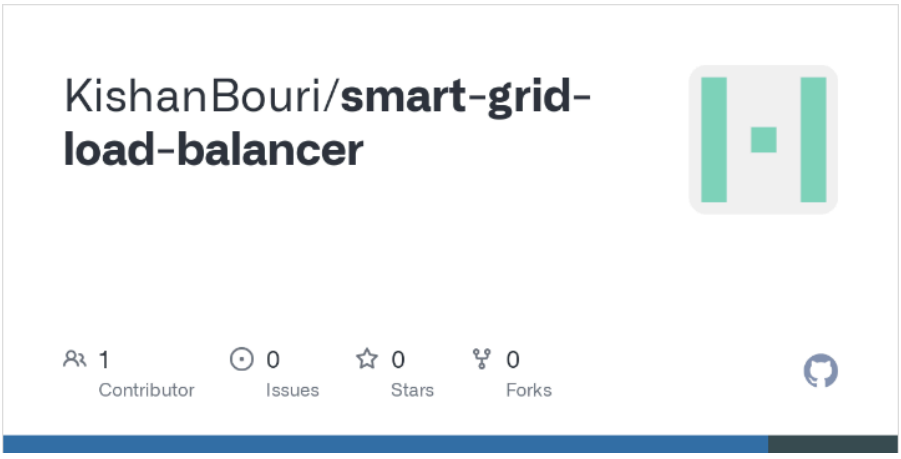
-G24AI2074

Project Report: Dynamic Load Balancing for a Smart Grid



1. Objective

To design and implement a scalable system for dynamically balancing Electric Vehicle (EV) charging requests across substations in a smart grid, using real-time monitoring and intelligent load balancing logic.

2. Architecture Overview

The system follows a **microservices architecture**. It includes:

- **Charge Request Service**: Entry point for EV charging requests.
- **Load Balancer Service**: Core logic that polls real-time substation loads and routes incoming requests.
- **Substation Services**: Simulated EV chargers that expose their current load as Prometheus metrics.
- **Monitoring Stack**: Prometheus for metrics collection, Grafana for real-time dashboard visualization.

3. Load Balancing Logic

The load balancer periodically polls /metrics endpoints from all substations, parses their current load, and selects the one with the **least load** to route incoming charging requests.

4. Observability

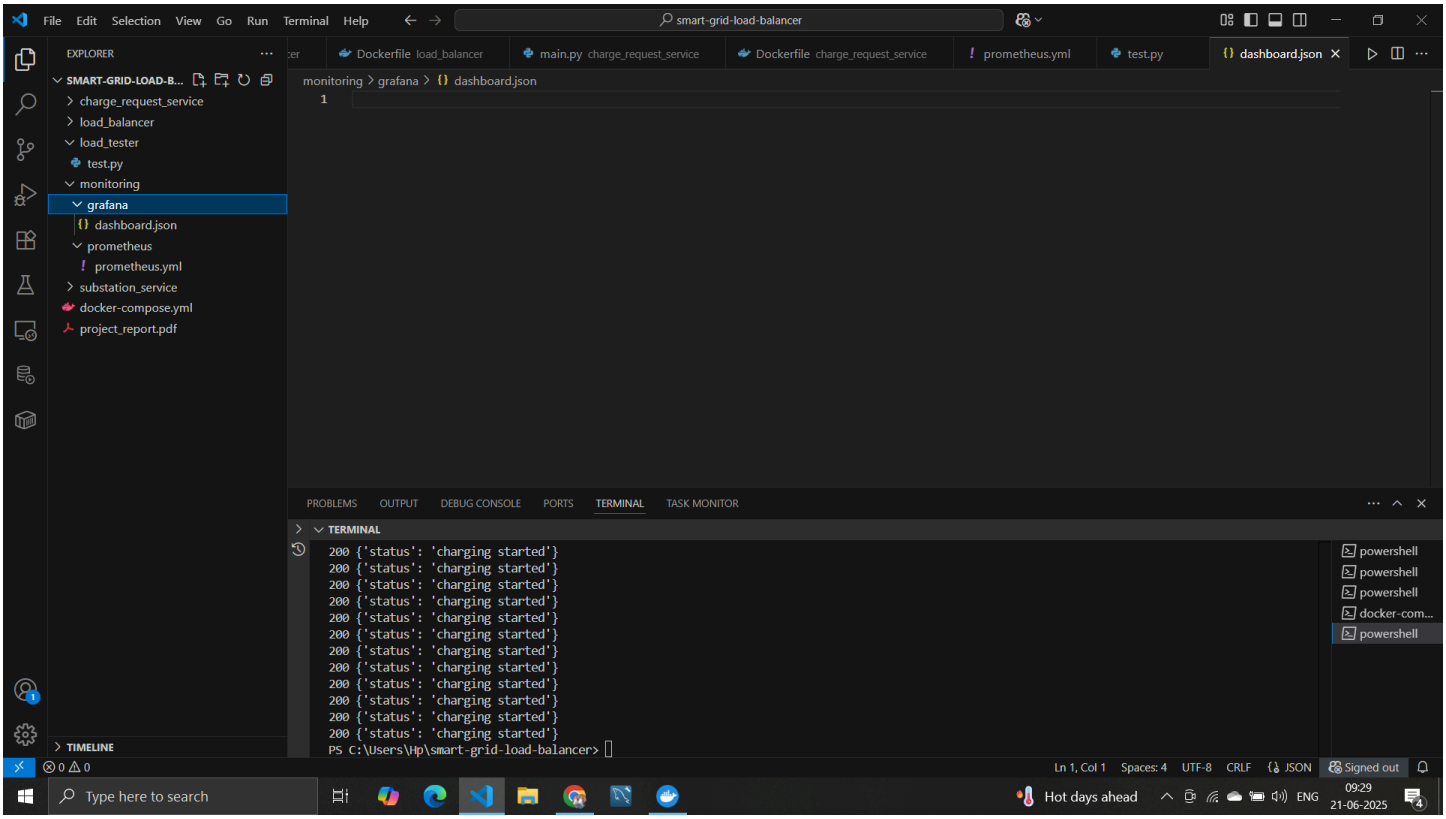
- **Prometheus** scrapes metrics from all substations every few seconds.
- **Grafana** visualizes each substation's load on a real-time dashboard.
- dashboard.json was **exported and saved** from Grafana.

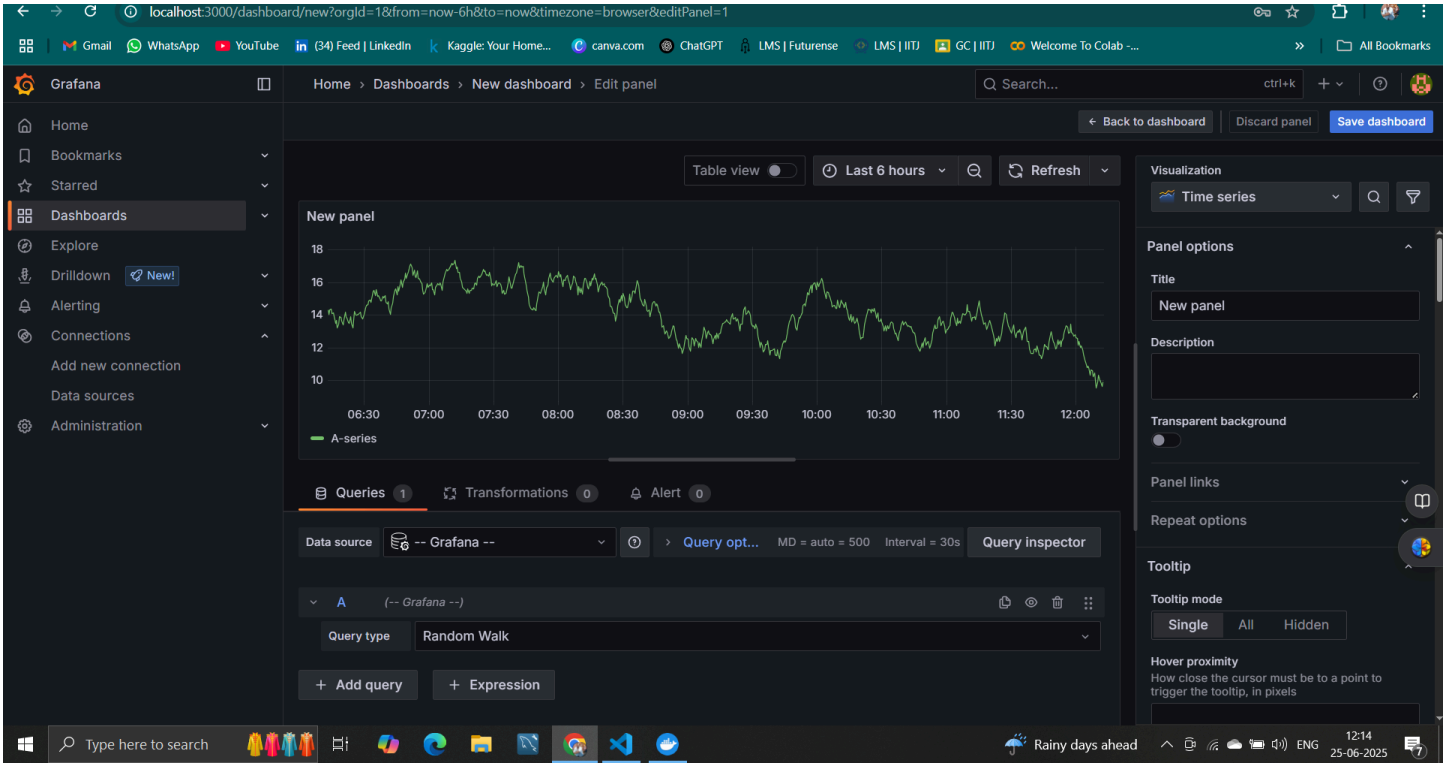
5. Load Testing

- A Python script (test.py) was written to simulate a **rush hour** of 100+ EV charge requests.
- The requests were **handled successfully and distributed evenly**, as seen in the Grafana dashboard.

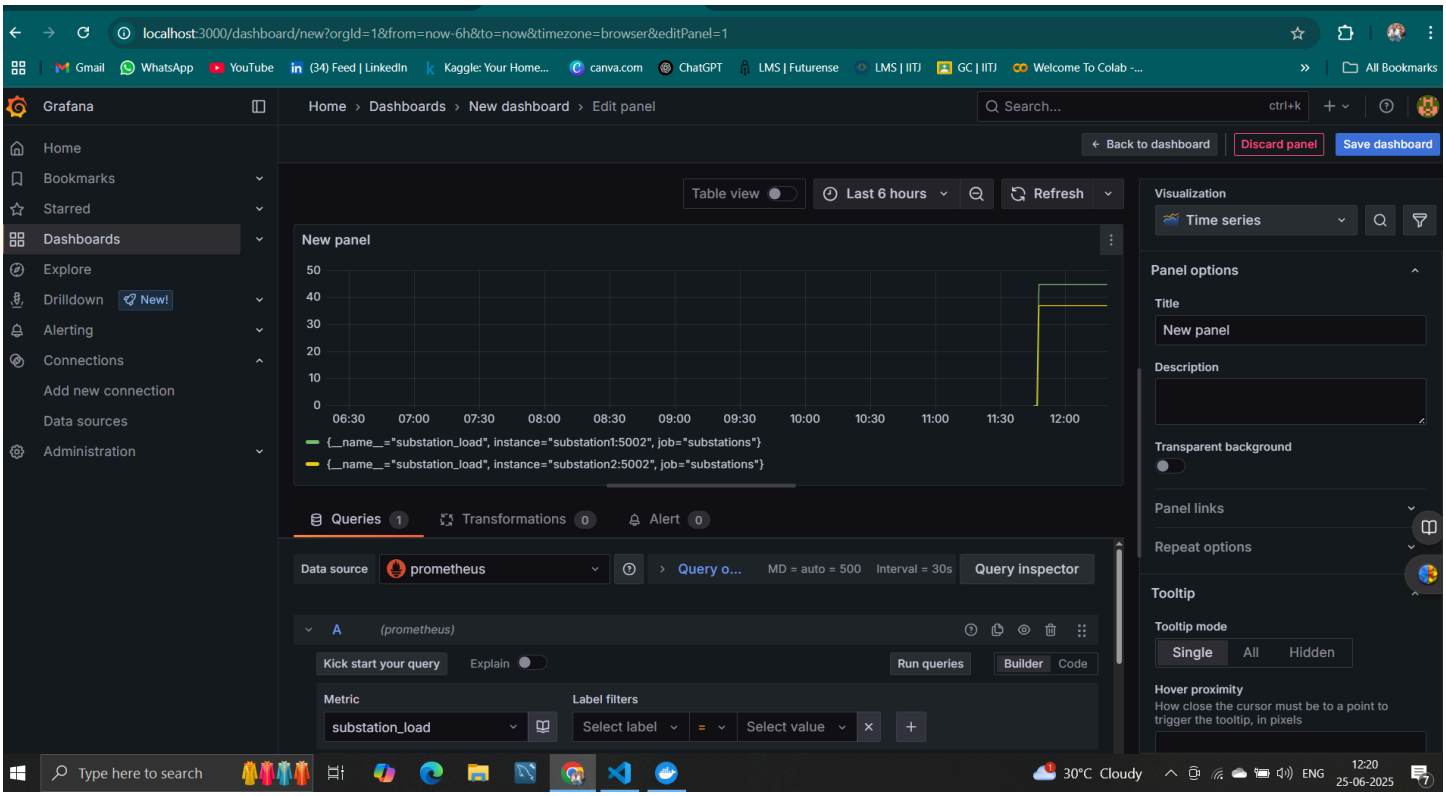
6. Screenshots

Testing charging status





Grafana Dashboard



7. Folder Structure

smart-grid-load-balancer/

├── charge_request_service/

│ ├── main.py

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│   └── Dockerfile
├── load_balancer/
│   ├── main.py
│   └── Dockerfile
├── substation_service/
│   ├── main.py
│   └── Dockerfile
├── load_tester/
│   └── test.py
├── monitoring/
│   ├── prometheus/
│   │   └── prometheus.yml
│   └── grafana/
│       └── dashboard.json
├── docker-compose.yml
└── project_report.pdf
```

8. Demo Video Link:

https://drive.google.com/file/d/1hgpbot3HlnzGVB5trtlQC9_5qA6-5rZf/view?usp=sharing

https://drive.google.com/file/d/17DGEh-LXDeeYU7aw-S_QNygeTjkKvjT6/view?usp=sharing

9. GIT REPO:

https://github.com/KishanBouri/smart-grid-load-balancer.git