



## **Indian Institute of Technology, Jodhpur**

Fundamentals of Distributed Systems

Assignment 1 – Project Report

Dynamic Load Balancing for a Smart Grid

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## 1. Overview:

The objective of this project is to design and implement a scalable Smart Grid Load Balancer system that dynamically distributes electric vehicle (EV) charging requests across multiple substations based on real-time load. This system aims to optimize charging efficiency, prevent substation overload, and provide full observability into system performance using modern monitoring tools.

## 2. System Architecture:

**Charge Request Service** - Entry point for EVs to send charge requests via REST API.

**Load Balancer** - Core logic that polls real-time substation load using Prometheus metrics and routes each request to the least-loaded substation.

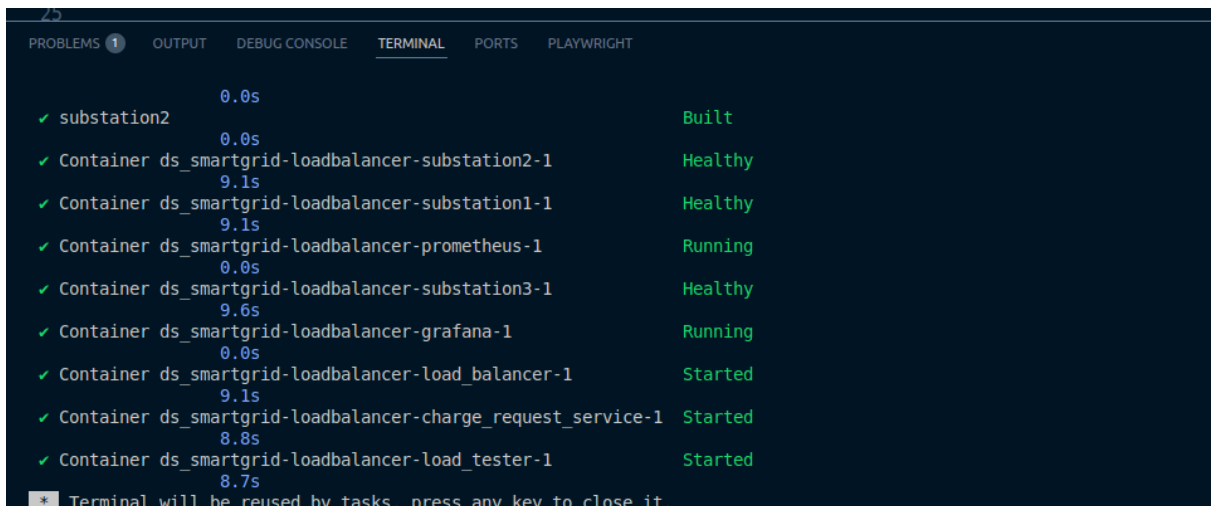
**Substation Services** (2 replicas) - Simulate EV charging and expose a Prometheus gauge metric `substation_load`.

**Observability Stack** - Prometheus: Scrapes metrics from substations & Grafana: Visualizes substation load trends in a live dashboard.

**Load Tester** - Python script simulating a high-traffic scenario with 50 EV charging requests.

## 3. Screenshots:

Here, the screenshots display the terminal logs and status of the various services up and running. Also displayed the screenshots of the grafana dashboard created



```
25
PROBLEMS 1 OUTPUT DEBUG CONSOLE TERMINAL PORTS PLAYWRIGHT

0.0s
✓ substation2 Built
0.0s
✓ Container ds_smartgrid-loadbalancer-substation2-1 Healthy
9.1s
✓ Container ds_smartgrid-loadbalancer-substation1-1 Healthy
9.1s
✓ Container ds_smartgrid-loadbalancer-prometheus-1 Running
0.0s
✓ Container ds_smartgrid-loadbalancer-substation3-1 Healthy
9.6s
✓ Container ds_smartgrid-loadbalancer-grafana-1 Running
0.0s
✓ Container ds_smartgrid-loadbalancer-load_balancer-1 Started
9.1s
✓ Container ds_smartgrid-loadbalancer-charge_request_service-1 Started
8.8s
✓ Container ds_smartgrid-loadbalancer-load_tester-1 Started
8.7s
* Terminal will be reused by tasks, press any key to close it.
```

```
25
PROBLEMS 1 OUTPUT DEBUG CONSOLE TERMINAL PORTS PLAYWRIGHT

Vehicle EV-0031 charged 6kWh: 200
Vehicle EV-0031 error (200): {"kwh":6,"status":"charged"}

Vehicle EV-0083 charged 22kWh: 200
Vehicle EV-0083 error (200): {"kwh":22,"status":"charged"}

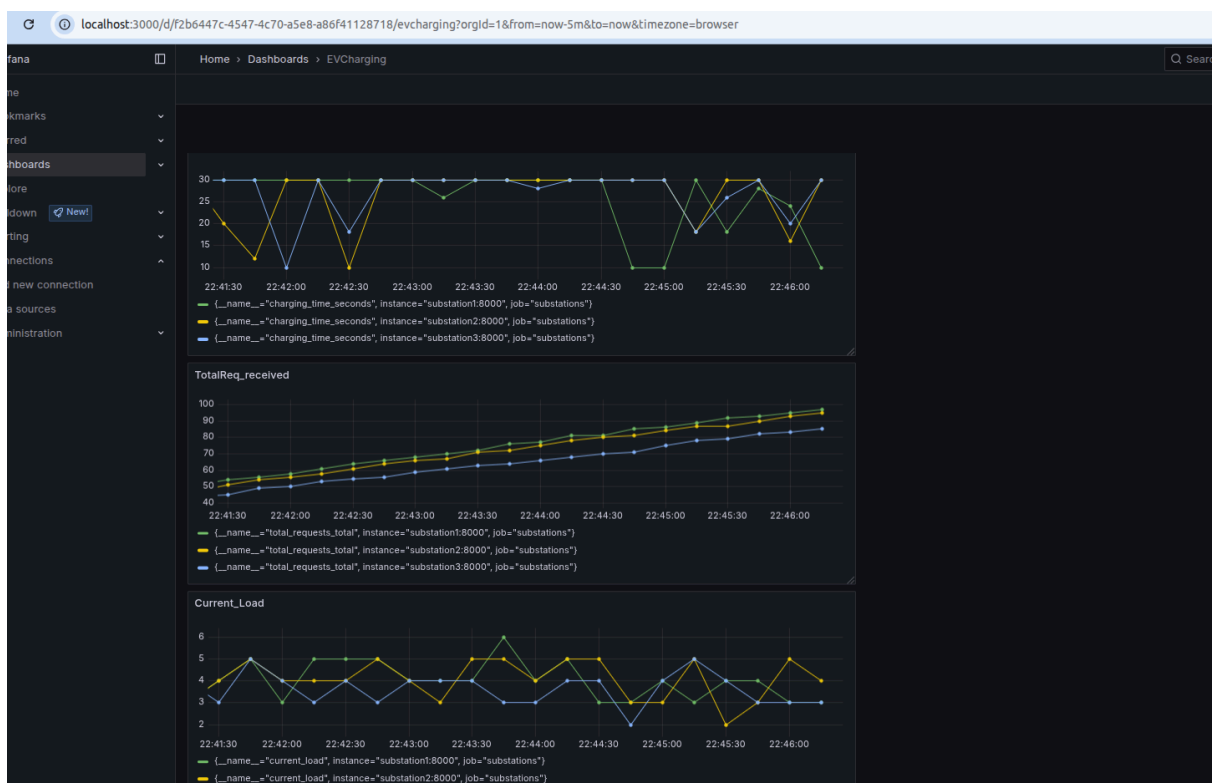
Vehicle EV-0099 charged 15kWh: 200
Vehicle EV-0099 error (200): {"kwh":15,"status":"charged"}

Vehicle EV-0988 charged 25kWh: 200
Vehicle EV-0988 error (200): {"kwh":25,"status":"charged"}

Vehicle EV-0741 charged 18kWh: 200
Vehicle EV-0741 error (200): {"kwh":18,"status":"charged"}

Vehicle EV-0408 charged 22kWh: 200
Vehicle EV-0408 error (200): {"kwh":22,"status":"charged"}

Vehicle EV-0700 charged 12kWh: 200
Vehicle EV-0700 error (200): {"kwh":12,"status":"charged"}
```



## 5. Important Links:

Public Repository: [https://github.com/AKB47-001/ds\\_smartgrid-loadbalancer.git](https://github.com/AKB47-001/ds_smartgrid-loadbalancer.git)

Video Link:

<https://drive.google.com/file/d/1l-jfeZLqYCksITpD-XI4hhcdGxwmH9Fm/view?usp=sharing>