Pala, A Cloud-Native Election Management System

Operating Systems (23AID213)

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Introduction

Cloud Native Applications:

Cloud native is the software approach of building, deploying, and managing modern applications in cloud computing environments.

We propose a solution that is a containerized instance of a backend that allows for flexible scalability.

Elections are unique situations where large swathes of people are performing an action at the same time concurrently.

Motivation

Why Should Elections Be Cloud-Native?

- Elections are situations that demand security, reliability and the ability to be flexible in situations.
- Modern on-premise solutions are difficult and prohibitively expensive to scale.
- Cloud native applications are fault tolerant and self-healing.

Problem Statement

Building a performant and reliable election voting system that is easily scalable and deployable.

Literature Survey

Item No.	Paper Title	Author	Year	Key Takeaway
1.	Web Based Online Election Management Systems: Technical Review	Ms. Shweta A. Solanke, Prof. Dr. A. P. Jadhao, Prof. Akash V. Katode	2023	Identified potential problems with: - Security - Maintenance - Latency Issues No outlined solution leveraged modern cloud technologies to maximise efficiency
2.	Effiiciency Unveiled: Comparative Analysis of Load Balancing Algorithms in Cloud Environments	Avanthi Nagelli, Dr. Naveen Kumar Yadav	2023	Identified Round Robin as an excellent and versatile form of load balancing.

Challenges Faced

- A simple backend was initially deployed with Flask
- The following issues emerged:
    - The server couldn't process as many requests as we deemed ideal.
    - Dependency management was troublesome with pip
    - Cold start time for the container was high.
- Similar problems arose with node.js.

Why Golang?

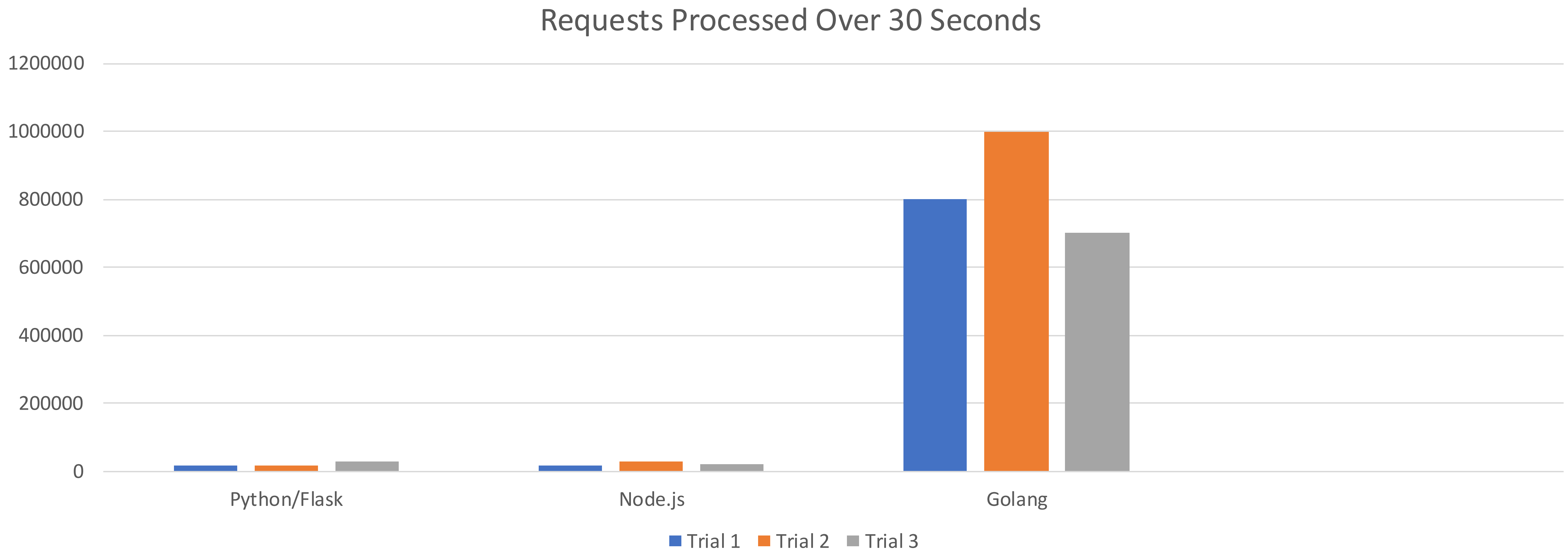


Figure 2. Web Server Benchmark

Why Golang

- Golang has a lightweight runtime and the ability to bundle the runtime into binaries with relative ease.
- Golang was written for the web with excellent libraries to process HTTP requests with multithreading.
- Golang's simple syntax allows for easy iteration of new features and bug fixes.
- Efficient garbage collection with low latency

Mapping Course Outcomes

- CO1 – Illustrate the use of system calls

  The HTTP requests to the reverse proxy act as system calls.

- CO2 – Apply the algorithms for resource management

  The Traefik load balancer applies weighted round robin and least connections algorithms

- CO3 – To introduce the memory management techniques used by the Operating System

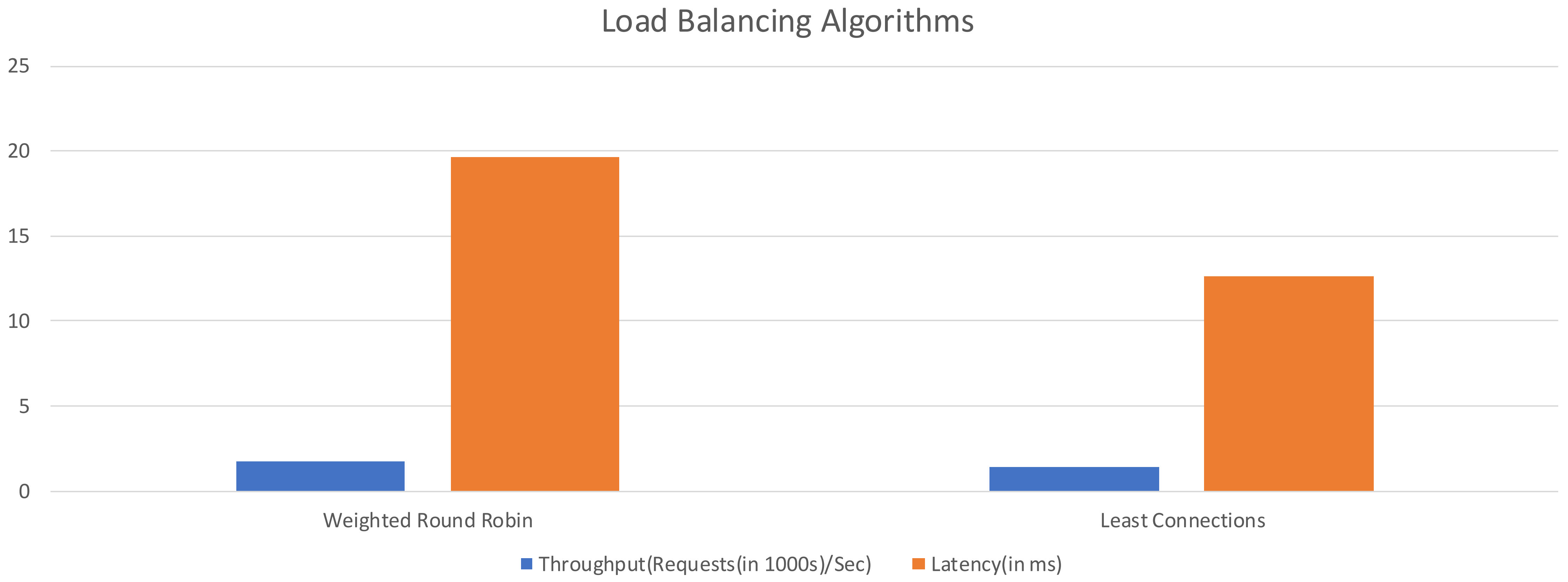
  The usage of Docker creates virtual memory segments. We then use Traefik to switch between memory segments.

- CO4 – To understand the adaptation of the concepts by modern OS.

  The extensive logging framework we have established which includes grafana, gin's logs as well as wrk.

Exploration Of Load Balancing Options With Traefik

With 5 containers:



Final Methodology

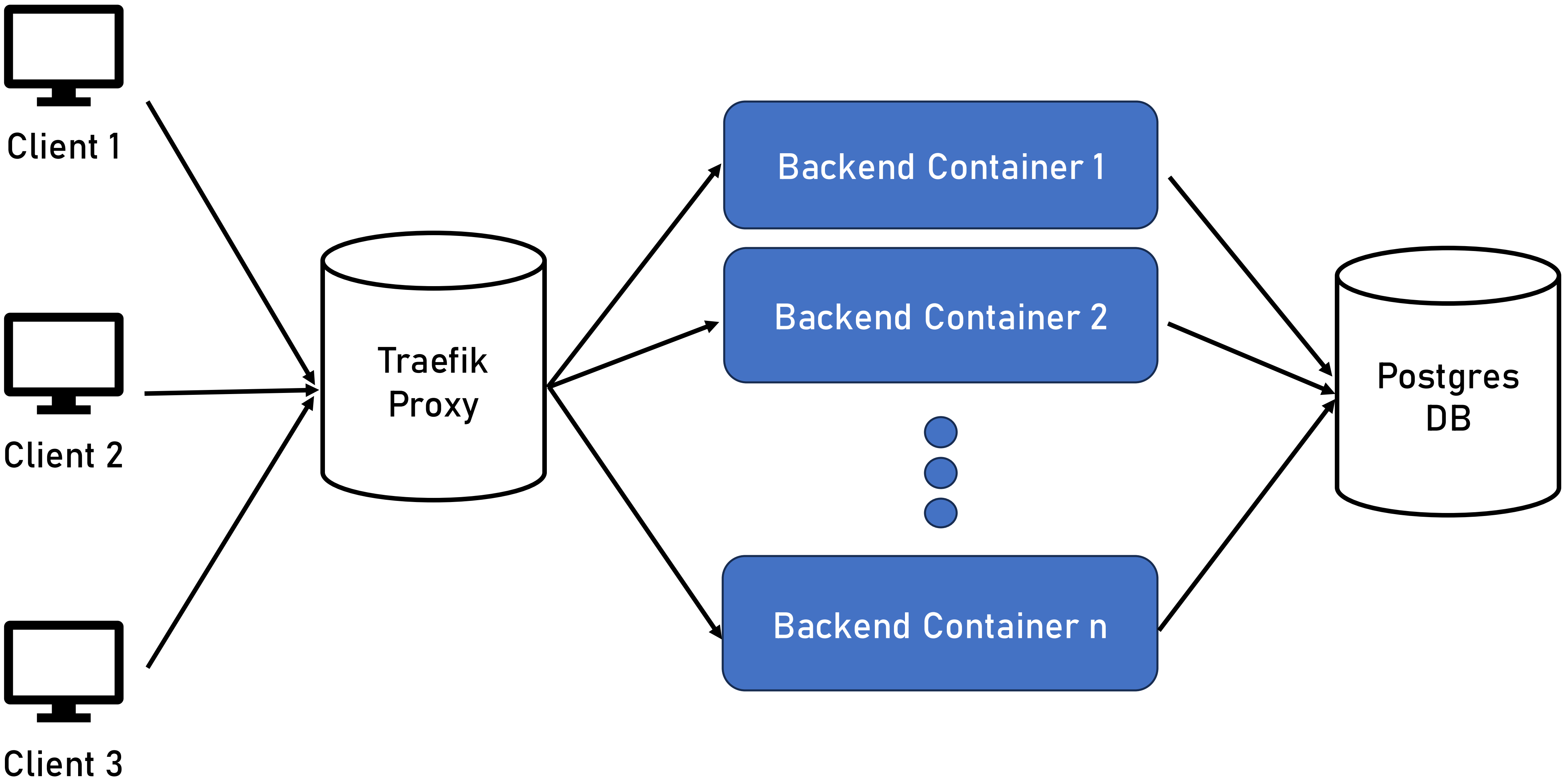


Figure 1. Overview Of Entire Systems Architecture

Demo Outline

- Voter Registration Flow
- Casting A Vote
- wrk benchmarking
- Grafana dashboard
- Docker logs
- Demonstrating Scalability
- Codebase

Conclusion And Future Work

A performant and reliable election system was implemented, with complete reverse proxying and load balancing.

The system is deployable via Docker on any major cloud platform.

An accessible, clean and modern UI has been built to allow for a smooth voter experience.

Future Work:

- Better security and authentication measures can be implemented leveraging technologies such as JWT and zero knowledge proofs.
- Better logging can be implemented to allow software admins to quickly diagnose problems.
- Redundancy can be established by usinng sub-database nodes to reduce latency.

Thank You