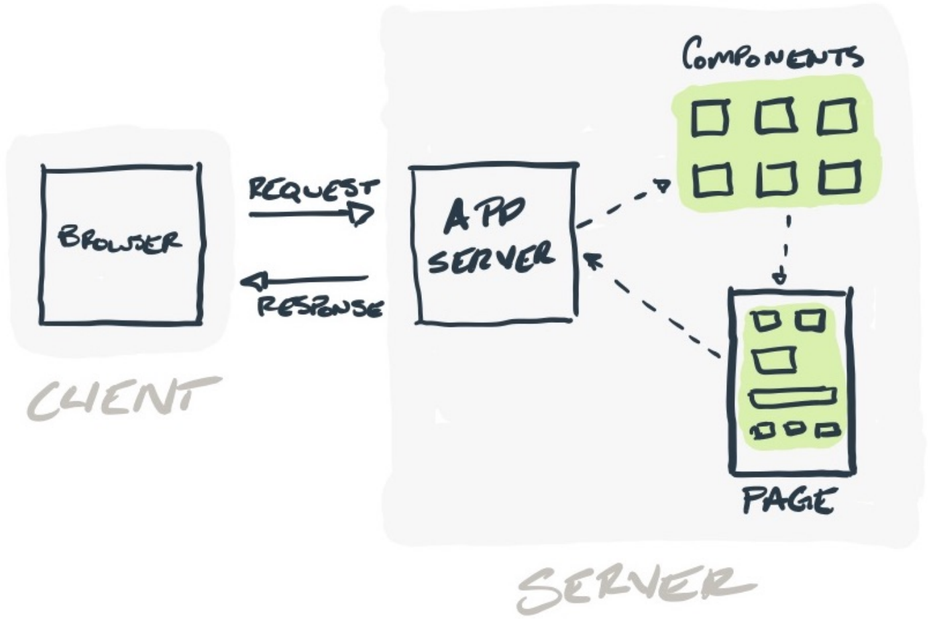
SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ANALYSIS OF DATA FETCHING, CACHING AND MANIPULATION TECHNIQUES WITH SERVER SIDE RENDERING

EXPLORING SERVER ACTIONS, SERVER COMPONENTS, AND PROGRESSIVE ENHANCEMENT



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ABSTRACT

- This research paper examines the optimization of **data fetching**, **caching**, and **manipulation** in **Next.js** by comparing traditional methods with the use of **server actions**, **server components**, and **progressive enhancement**.
- By analyzing the performance and scalability of both approaches, this study aims to highlight the **advantages** and **improvements** offered by the newer techniques in **Next.js** applications.
- The research will provide insights into the effectiveness of server actions, server components, and progressive enhancement in optimizing **data operations**, **enabling developers** to make **informed decisions** about their implementation.

INTRODUCTION

- Web applications play a pivotal role in the digital landscape, and their performance is of paramount importance.
- This research delves into the realm of **Server-Side Rendering** (SSR) and explores various techniques for **data fetching, caching, and manipulation**. It particularly focuses on **server actions, server components,** and **progressive enhancement.**
- In this paper, we aim to analyze these techniques, uncover their merits and demerits, and shed light on their potential impact on web application optimization and user experiences.

OBJECTIVES OF THE RESEARCH

- Compare performance between **traditional** and **modern data caching** and **revalidation techniques** in **Next.js**.
- Evaluate the benefits and limitations of **server actions** and **components** in **data fetching** and **manipulation** compared to **traditional methods**.
- Assess the impact of **progressive enhancement** on user experience in Next.js compared to traditional approaches.
- Optimize **data fetching**, **caching,** and **manipulation in Next.js** by analyzing modern and traditional techniques.
- Provide **practical recommendations** for developers working with data in Next.js, considering both modern and traditional approaches.

INFERENCES (LITERATURE SURVEY)

Title	Author	Year	Methodology	Inference	Merits	Demerits
React Apps with Server-Side Rendering: Next.js	Harish A Jartarghar et al.	2022	Server-Side Rendering (Next.js)	Compares React.js client-side rendering with Next.js server-side rendering.	Next.js improves web page loading speed by using server-side rendering.	Doesn't provide a clear outline of specific performance metrics or case studies.
Modern Front End Web Architectures with React.Js and Next.Js	Mochammad Fariz Syah Lazuardy	2022	Description and Comparison (Next.js)	Describes web architectures using React.js and Next.js.	Highlights advantages and disadvantages of React.js and Next.js.	White screen during initial load. Requires additional libraries for routing and state management.

INFERENCES (LITERATURE SURVEY)

Title	Author	Year	Methodology	Inference	Merits	Demerits
Data Fetching with SSR	John K Renault	2022	Server-Side Rendering (SSR)	Data fetching in SSR involves retrieving data from the server during page load.	Improved initial load times for web pages. Better SEO as HTML is pre-rendered. Caching benefits for frequently visited pages.	Increased server load due to frequent data requests. May not be suitable for real-time applications.
Caching Techniques and Progressive Server Components	Sarah Brown	2022	Caching	Caching techniques enhance performance by storing and reusing previously fetched data.	Reduced data transfer and latency for returning users. Faster page load times for cached content.	Cache management complexity. Content may become stale if not updated properly. Limited use for dynamic data.

INFERENCES (LITERATURE SURVEY)

Title	Author	Year	Methodology	Inference	Merits	Demerits
Data Manipulation	David Wilson	2022	Client-Side and Server-Side Rendering	Data manipulation can occur on both the client and server sides, depending on the application needs.	Flexibility to choose the right data manipulation approach based on specific requirements.	Potential for data synchronization issues between client and server. (Hydration Errors)
Analyzing SSR's Impact on Mobile Performance	Sarah L. Evans	2023	Mobile Benchmarking	Investigates how SSR affects mobile devices' performance and user engagement.	Improved mobile loading times, decreased bounce rates.	Mobile-specific optimization required, potential for over-optimization.

ALGORITHMS INVOLVED IN SSR

- Combination of **LRU, FIFO and LFU.**
- **KMP and Boyer-Moore's algorithm** are used for string matching.
- **Deflate** and **Botli's algorithms** for compression.
- **Summation Algorithm, Binary Search** for processing and transforming data before rendering or storing.
- **Dijkstra's** Algorithm and **BFS** for route optimization.
- **Memoisation** and **State While Revalidate** for validating state.

BASE PAPERS

Modern Front End Web Architectures with React.Js and Next.Js

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Email Address: [1] mochammadfariz11(at)gmail.com, [2] d_anggraini(at)staff.gunadarma.ac.id

React Apps with Server-Side Rendering: Next.js

Harish A Jartarghar[1], Girish Rao Salanke[1], Ashok Kumar A.R[1], Sharvani G.S[1] and Shivakumar Dalali[2]
[1]Department of Computer Science and Engineering, R.V College of Engineering, Bengaluru, India.
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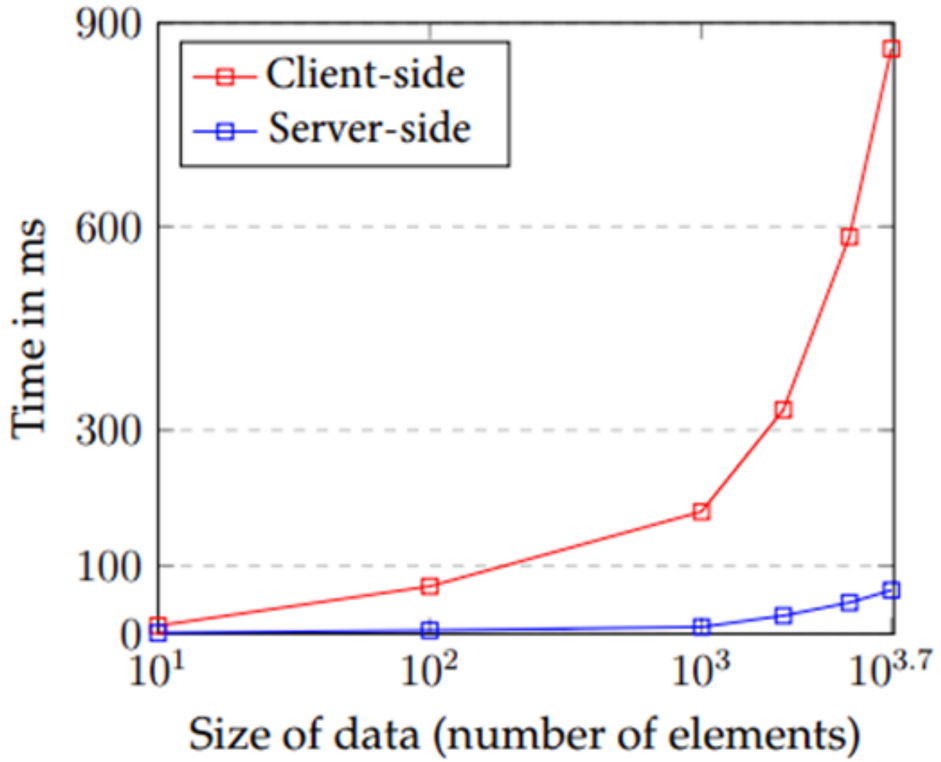
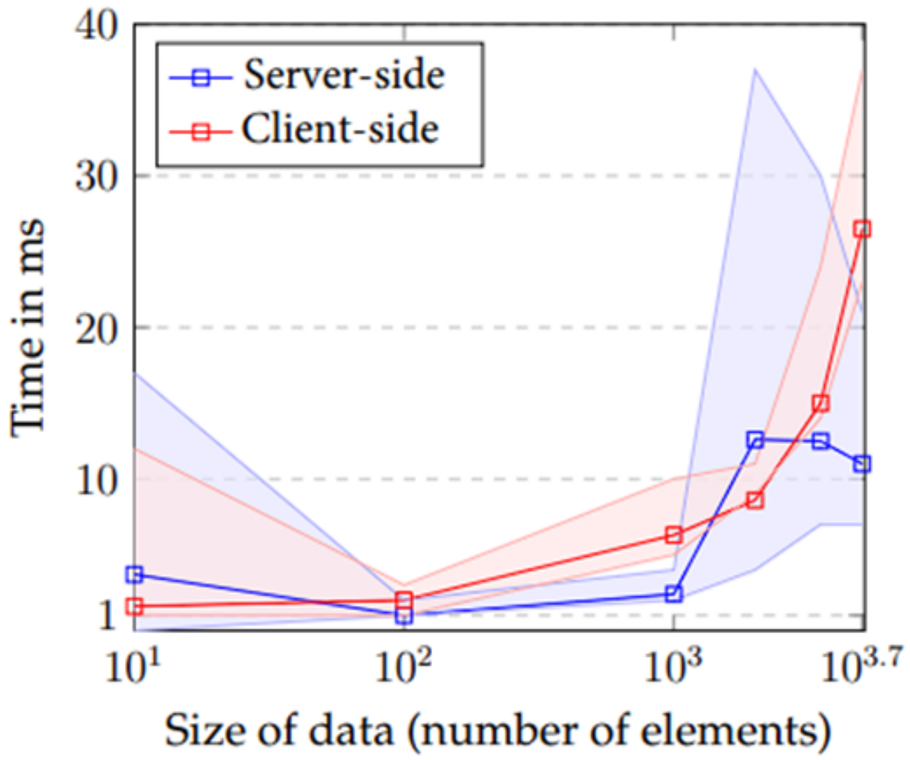
PROCESSING TIMES

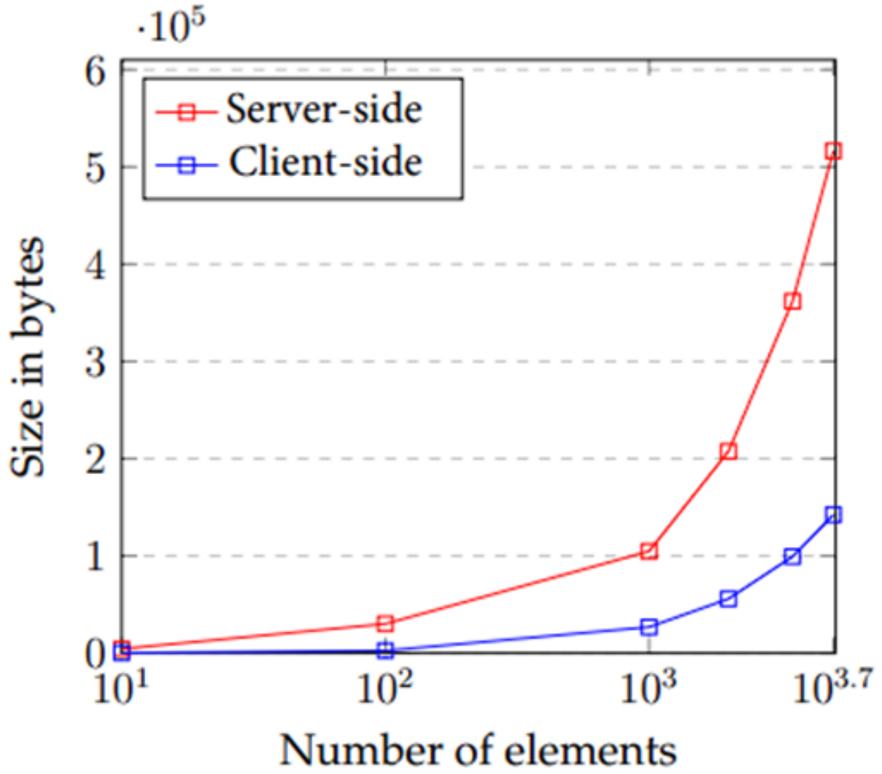


- The graph shows the **processing times** for Next.js **server-side rendering (SSR)** and React.js **client-side rendering (CSR)** as the amount of data processed increases. As you can see, the SSR times are much lower than the CSR times, especially for larger amounts of data.
- This is **because SSR renders the page on the server** before it is sent to the client, while **CSR renders the page on the client** after it is loaded. This means that **SSR has access to all of the data** that is needed to render the page, while **CSR has to wait for the data** to load from the server.



TRANSFER

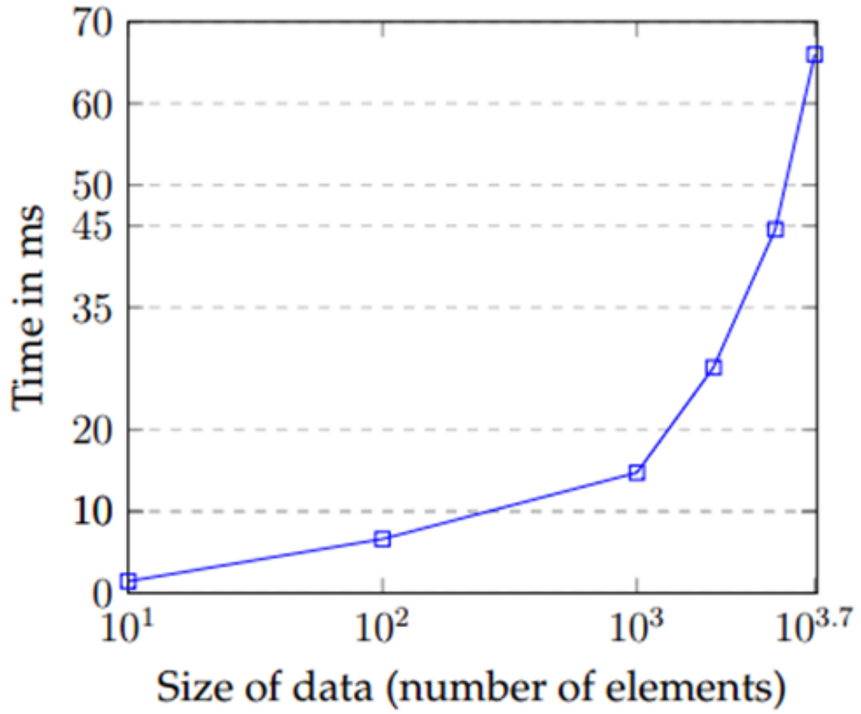
- The graph shows that the **number of elements** is a major factor in **determining the rendering time**.
- If you are trying to reduce the rendering time, you can try to reduce the number of elements that need to be rendered.
- You can also try to use a **more efficient rendering engine**.



TRANSFER SIZES

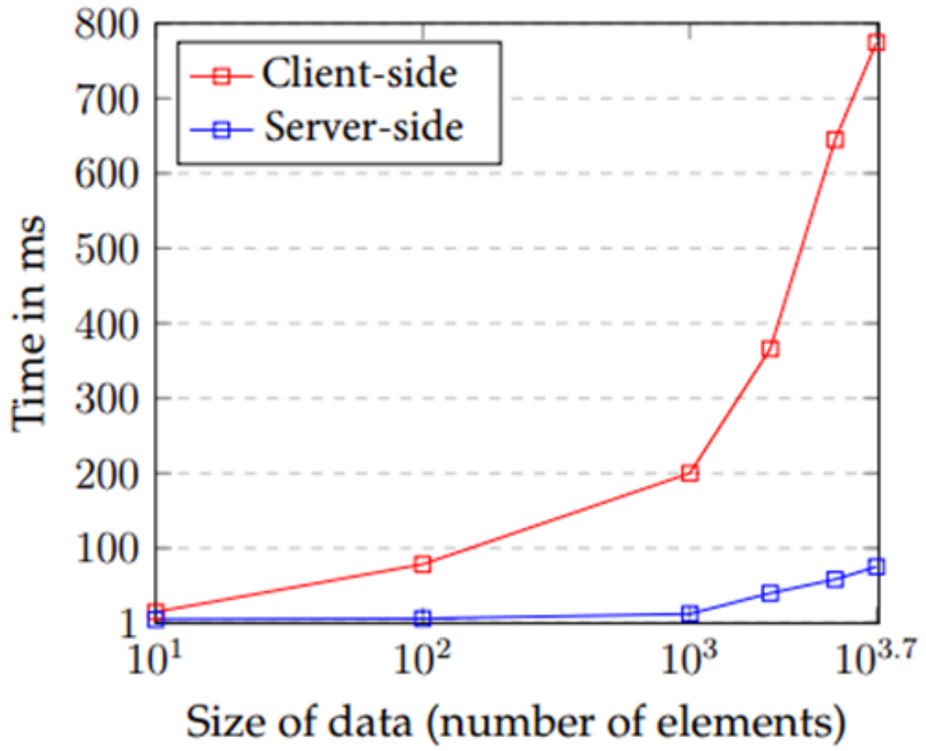
- The graph shows that **the size of the data** transferred increases as the number of elements in the **DOM increases**.
- This is because each element in the DOM requires a **certain amount of data to be transferred**, so the more elements there are, the **more data needs** to be transferred.

SSR DOM MANIPULATION TIMES



- The graph shows the time it takes to manipulate the DOM (**Document Object Model**) on the server side (SSR) as the size of the data (number of elements) increases.
- The time increases linearly, meaning that it takes twice as long to manipulate the DOM for twice as much data.
- This is because **the server has to do more work** to process the larger amount of data.

TOTAL TIME (PROCESSING + TRANSFER + DOM MANIPULATION)

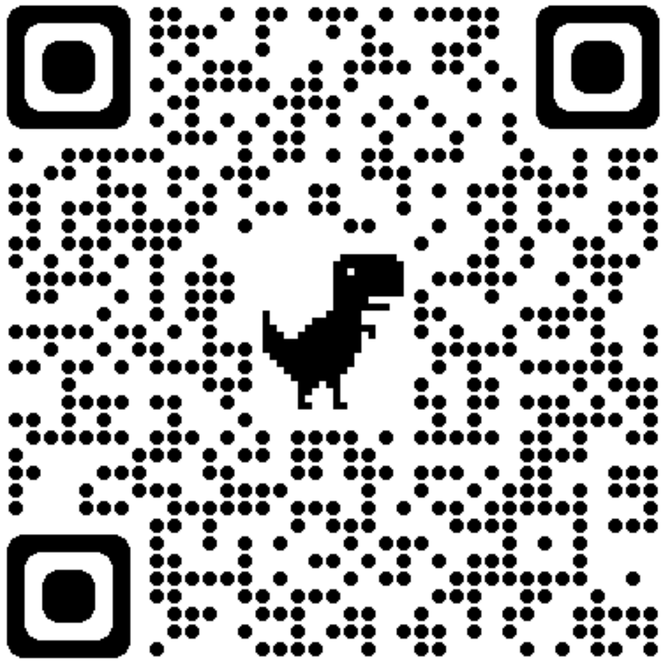


- The graph shows the total time it takes to process, transfer, and manipulate DOM data on the client side and server side. The **x-axis** shows the **size of the data** in terms of the number of elements, and **the y-axis** shows **the total time in milliseconds.**
- The graph shows that the total time increases as the size of the data increases. However, **the rate of increase is much steeper on the client side than on the server side**. This is because the client side has to do more processing and manipulation of the DOM data.

FEATURES OF THE PROJECT

- **Server-Side Rendering** for Improved Performance
- Database **Password Encryption** using JSON Web Tokens (JWT)
- **Advanced Search** Functionality
- **Rapid Application Submission**
- **Rapid Certificate Distribution**
- User-Centric Dashboard and User Interface (UI)
- **Intelligent Authentication**
- **Session Management** for Login State
- **Hierarchical Administration** Structure
- **Multi-state Loading** and **Dynamic** Views
- **Admin Panel for** College Administrators

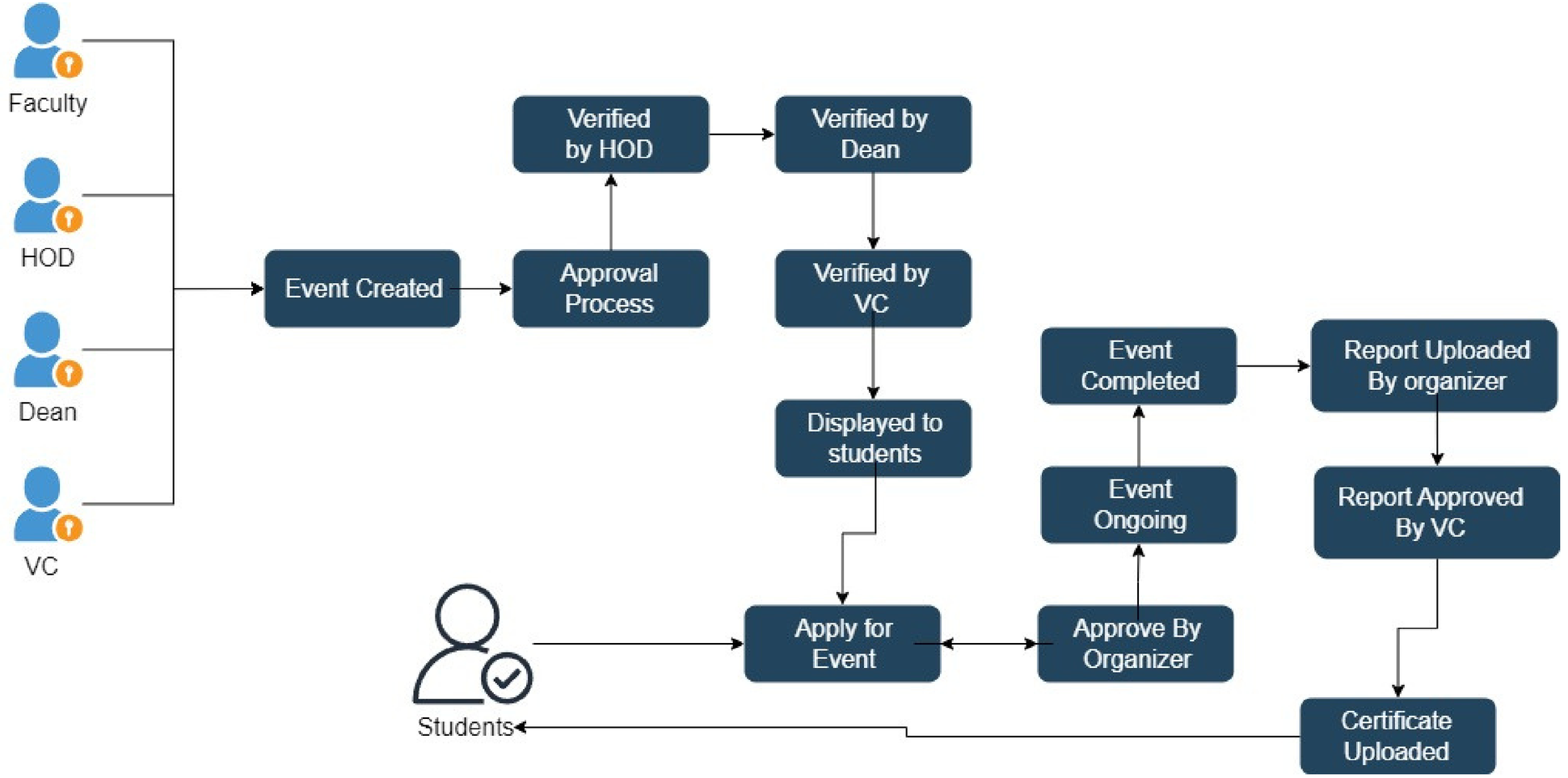
LINKS



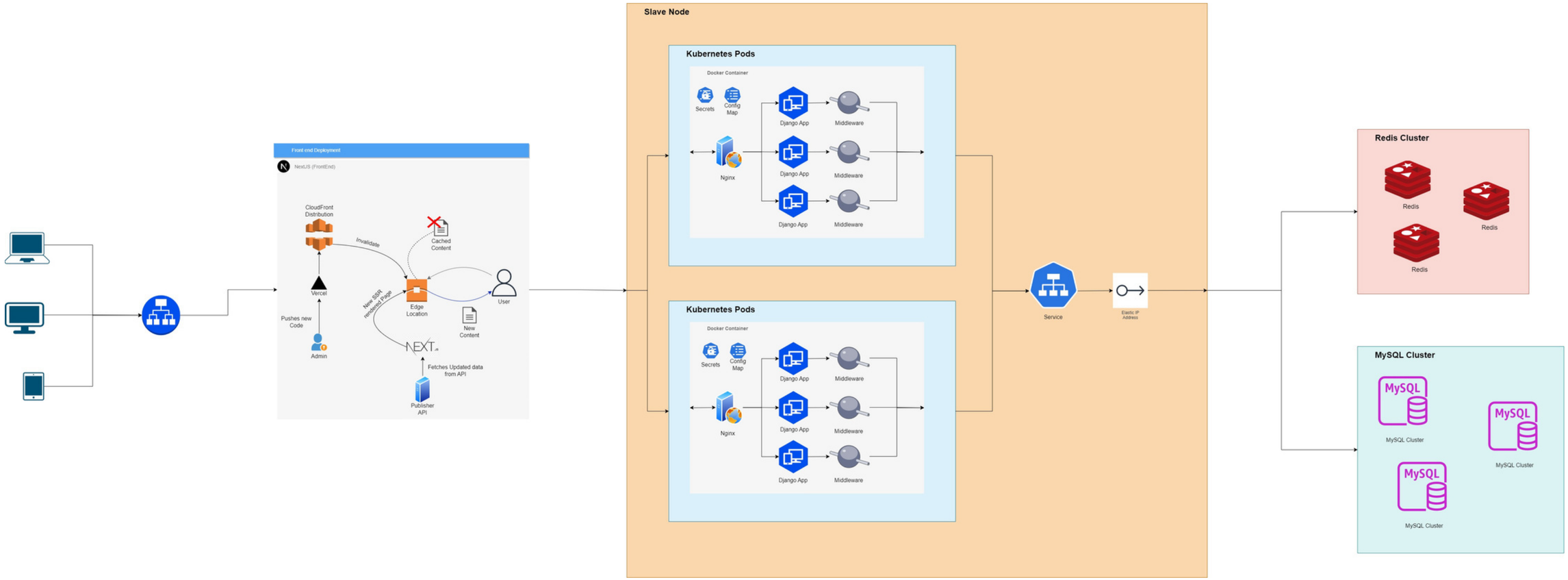
PRODUCTION

DEMO

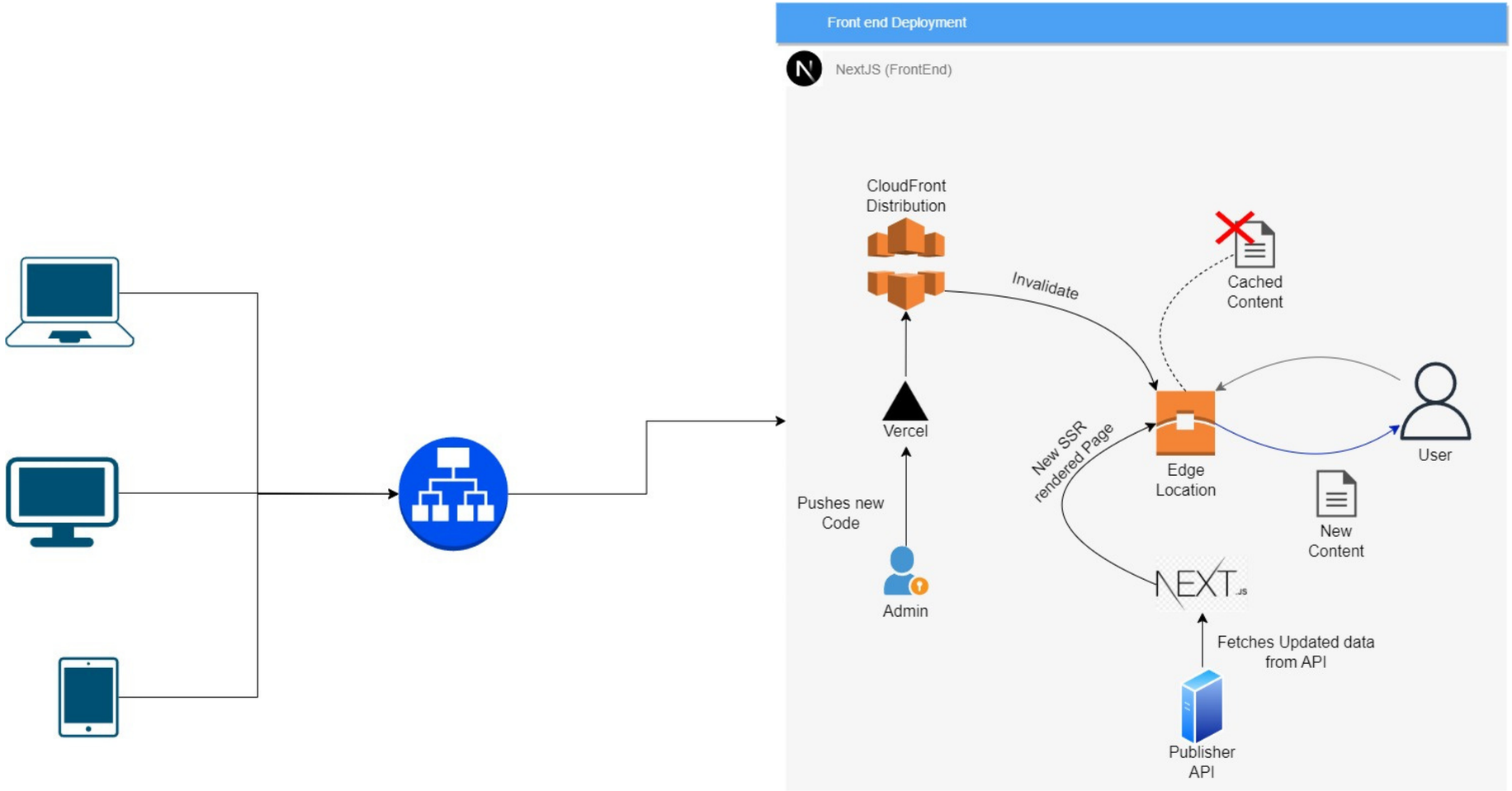
FLOW CHART


Faculty
HOD
Dean
VC
Event Created
Approval Process
Verified by HOD
Verified by Dean
Verified by VC
Displayed to students
Apply for Event
Approve By Organizer
Event Ongoing
Event Completed
Report Uploaded By organizer
Report Approved By VC
Certificate Uploaded
Students

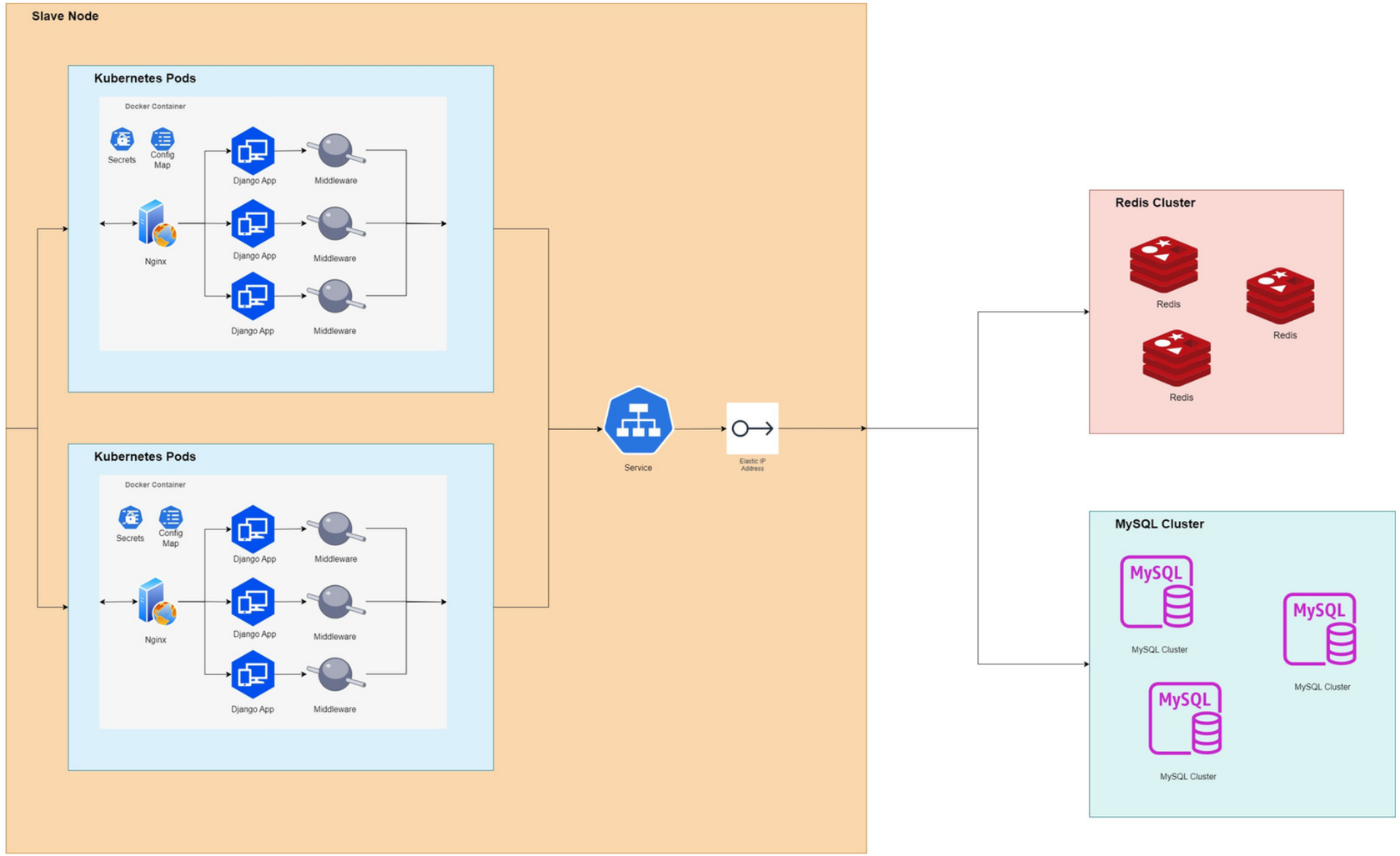
SYSTEM ARCHITECTURE



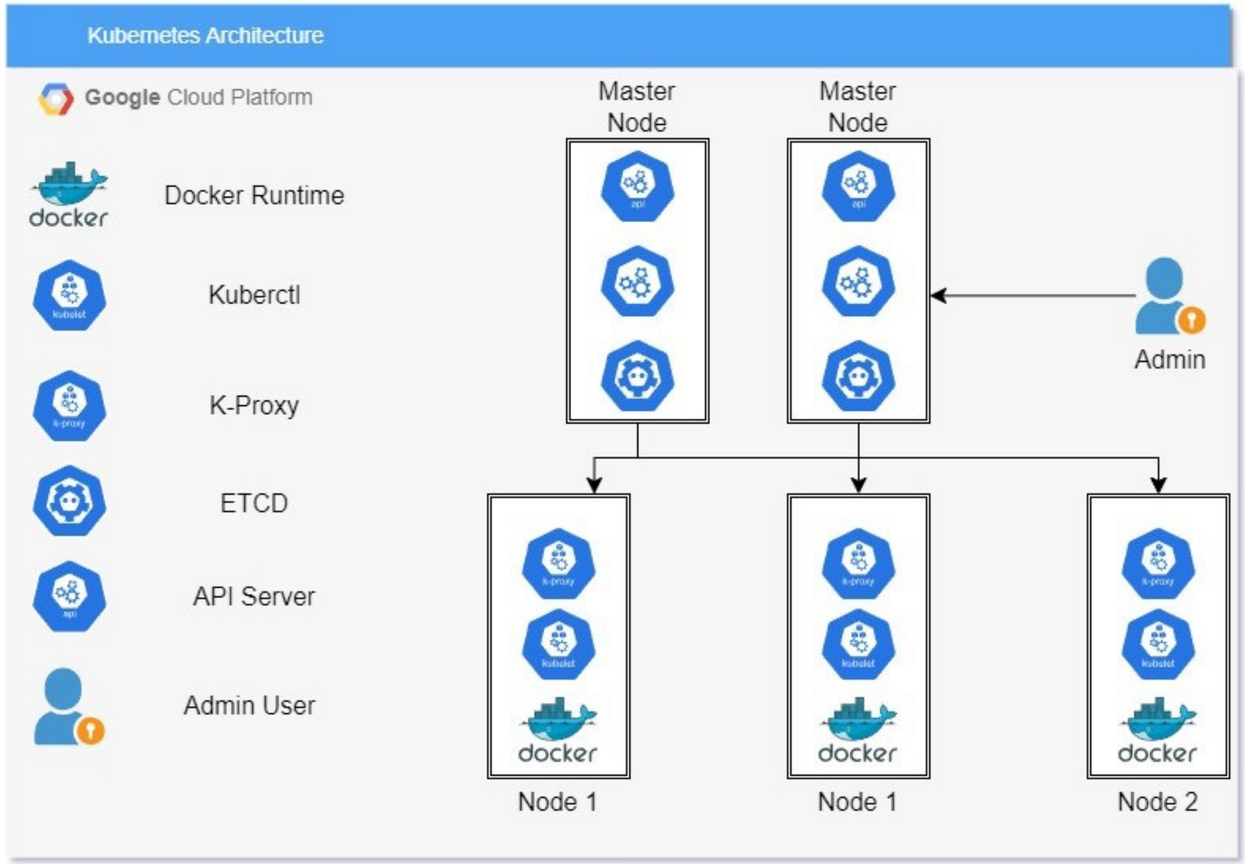
SSR ARCHITECTURE



BACKEND ARCHITECTURE



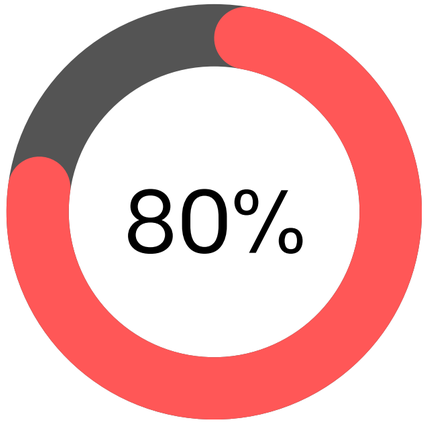
KUBERNETES ARCHITECTURE



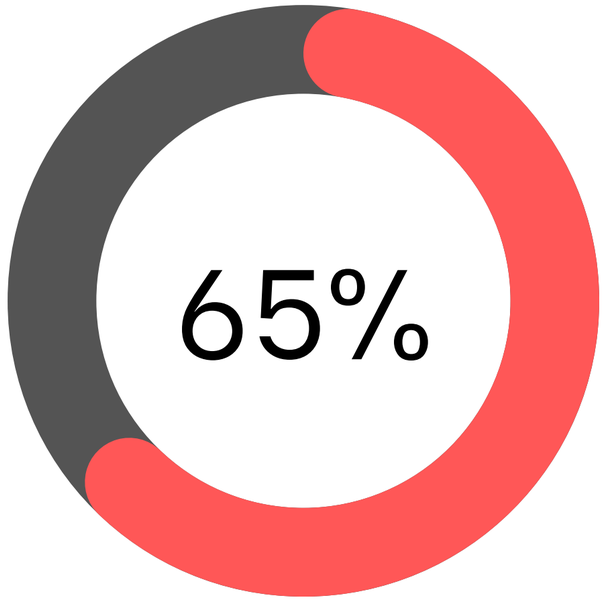
MODULES

- Authentication Service
- E-mail Service
- CDN (Content- Delivery Network)
- CRON Jobs
- Image Compression
- Caching Service
- Load Balancer Service
- CI/CD with Jenkins
- Data Pipeline Service with ERP
- Bulk OTP Polling Queue

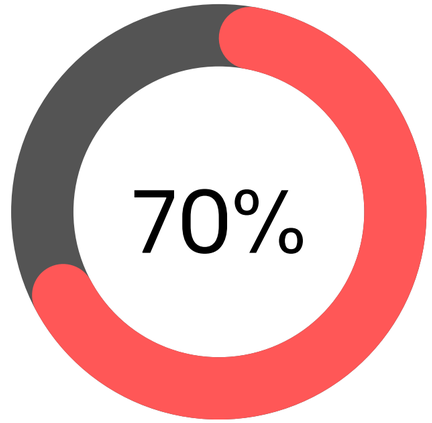
BENCHMARKS



More Efficient Event Approval and Tracking



Faster Initial Load Times



Faster Event Announcements

REFERENCES

- P. Kishore and M. B M, "**Evolution of Client-Side Rendering over Server-Side Rendering**," vol. 3, no. 2, pp. 1–10, 2020.
- Vercel, "**Data Fetching Overview**," 2022. **https://nextjs.org/docs/basicfeatures/data-fetching/index** (accessed Jan. 24, 2022)
- S. G. V and A. Sandeep, "**Comprehensive Analysis of React-Redux Development Framework**," Int. J. Creat. Res. Thoughts www.ijcrt.org, vol. 8, no. 4, p. 4230, 2020.
- B. McNamee, "**Server-Side Rendering with React: A Comprehensive Guide**," Smashing Magazine, Nov. 2020.
- A. Bhattacharya, "**The Pros and Cons of Server-Side Rendering in React Apps**," The Startup, May 2022. **https://medium.com/swlh/the-pros-and-cons-of-server-side-rendering-in-react-apps-3505f4a2fcd5**.
- A. Srinivasan, "**React SSR vs CSR: Benefits and Trade-offs**," LogRocket Blog, May 2021. Available: **https://blog.logrocket.com/react-ssr-vs-csr-benefits-and-trade-offs/**.
- S. Jangra, "**A Comprehensive Guide to Server-Side Rendering with Next.js**," Hashnode Blog, Mar. 2023. **https://hashnode.com/post/a-comprehensive-guide-to-server-side-rendering-with-nextjs-ckxwoagb100x3gvs15kxdhswf**.

THANK YOU