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A MINOR PROJECT REPORT ON A DECENTRALIZED SOCIAL MEDIA FOR SCIENTIFIC COMMUNICATION

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DHARAN, NEPAL

FEBRUARY,2025

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to our supervisor Mr. Pukar Karki, Head of the Department, for his invaluable guidance and unwavering support throughout the preparation of this report. Their insightful suggestions and constructive feedback have been instrumental in shaping our work, and we are truly appreciative of the time and effort they dedicated to our development. Their leadership has not only provided us with direction but has also inspired us to pursue excellence in our academic endeavors.

We are also deeply thankful to our esteemed teachers and faculty members for their encouragement and thoughtful insights, which have significantly enriched this proposal. Their commitment to academic excellence and their willingness to share knowledge have served as a constant source of inspiration for us. The collective guidance and support we received from them have greatly contributed to the refinement and improvement of our work, and we are sincerely grateful for their contributions.

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ABSTRACT

Abstract goes here.

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LIST OF ABBREVIATIONS

API : Application Programming Interface

UI : User Interface

W3C : World Wide Web Consortium

CHAPTER 1

INTRODUCTION

1.1 Background

Scientific communication plays a vital role in advancing research and knowledge sharing across academic communities. Traditional social media platforms while effective for general communication often lacks specialized features necessary for scientific discource. The emergence of decentralized technologies particularly the ActivityPub [1] Protocol and the Fediverse presents an oppurtunity to create a more switable platform for academic communication.

1.2 Gap Identification

Current platforms for scientific communication face several limitations:

- Limited accessibility of scientific communication to the broader population beyond niche communities.
- Insufficient support for mathematical expressions and scientific notations.
- Lack of integration with academic citation systems.
- Reliance on a third party for the protection and moderation of user data.

1.3 Motivation

To create a social media platform that empowers researchers and academics to communicate their scientific work effectively. By bridging the gap between specialized communities and the general public, the platform aims to promote the understanding and appreciation of cutting-edge research across a wider audience. Along with the ability to run individual servers by individual people/institutions without losing the ability to communicate between each other.

1.4 Objectives

- Develop a federated social media platform using the ActivityPub protocol with support for mathematical and scientific typesetting.
- Streamline the server setup process to enable technically literate individuals to host their own servers with minimal effort.

CHAPTER 2

RELATED THEORY

2.1 Decentralization

Decentralization refers to the distribution of authority, control, and decision-making away from a central authority. In the context of digital platforms, decentralization allows users to maintain control over their data and interactions, fostering a more democratic and resilient online environment. This approach contrasts with traditional centralized systems, where a single entity governs all operations and data management.

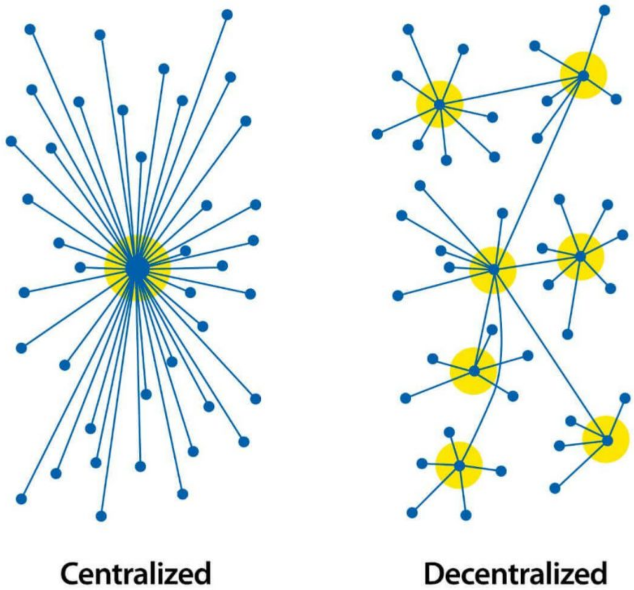

Figure 2.1: The structure of a centralized network compared to a decentralized network.

2.2 Federation

Federation is a model that enables different systems or organizations to interoperate while maintaining their independence. In social media, a federated approach allows users from different platforms to communicate and share content seamlessly, creating a more interconnected online community. This is achieved through protocols that facilitate data exchange and interaction across diverse platforms.

2.3 Scientific Typesetting

Scientific typesetting involves the formatting of mathematical and scientific content for clarity and precision. It is essential for effectively communicating complex ideas in academic and research contexts. Proper typesetting ensures that equations, symbols, and notations are presented in a way that is easily understandable and visually appealing. The prime example of a Scientific Typesetting is LaTeX but there are alternatives like AsciiMath and Typst.

2.4 ActivityPub Protocol

ActivityPub is a decentralized social networking protocol standardized by the World Wide Web Consortium (W3C) [1]. It provides a client-to-server API for creating, updating, and deleting content, as well as a server-to-server API for delivering notifications and content between different servers.

The federation model offers several key advantages over centralized systems, such as resilience (no single point of failure as the network operates across multiple independent servers), data sovereignty (each instance maintains control over its users' data and policies), interoperability (users can communicate across instances using standardized protocols), and scalability (the network can grow organically as new instances join the federation).

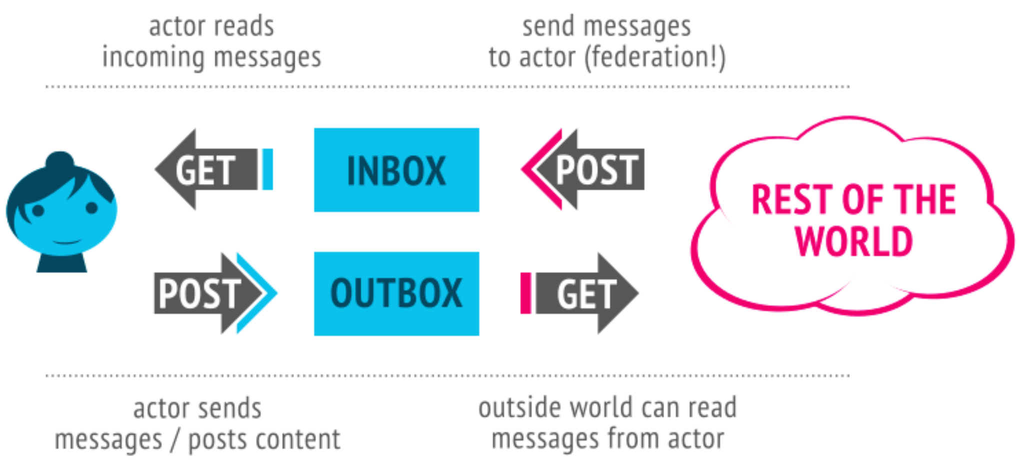

Figure 2.2: Communication using ActivityPub Protocol.

The protocol is built on several key concepts:

- **Actors** which represent users, groups, or applications that can send and receive activities.
- **Activities** which describe actions that actors take.
- **Objects** which represent the content being acted upon.

CHAPTER 3

LITERATURE REVIEW

3.1 Related Works

The Fediverse connects various decentralized social networks, allowing users to interact across different platforms. This section reviews some of the prominent projects within the Fediverse.

- **Mastodon**[2]
  Mastodon is a decentralized social network that operates on open-source software. It allows users to create their own servers (instances) and interact with users on other instances. Mastodon emphasizes user privacy and control over content, providing features like content warnings and robust moderation tools.
- **Pixelfed**[3]
  Pixelfed is a federated image-sharing platform similar to Instagram. It focuses on user privacy and data ownership, allowing users to share photos and interact with others without centralized control. Pixelfed supports ActivityPub, enabling interaction with other Fediverse platforms.
- **PeerTube**[4]
  PeerTube is a decentralized video hosting platform that uses peer-to-peer technology to distribute video content. It aims to provide an alternative to centralized video platforms like YouTube, giving users control over their content and reducing reliance on centralized servers. PeerTube instances can federate with each other, allowing for a distributed network of video content.
- **Lemmy**[5]
  Lemmy is a federated link aggregation and discussion platform similar to Reddit. It allows users to create and join communities, share links, and engage in discussions. Lemmy instances can federate with each other like it is the case with other social media in this list, enabling a decentralized network of communities that can still connect with one another.

- **snac**[6]

  SNAC is a decentralized, open-source social network that emphasizes user privacy and content control. It allows users to create their own servers (instances) and interact with others across the Fediverse. SNAC is a lightweight ActivityPub implementation with features like Mastodon API support, a simple web interface, and no database or JavaScript dependencies. Written in portable C, SNAC can be easily compiled and deployed on various platforms, providing a minimalistic alternative to mainstream social media.

3.2 Decentralization and Federation

Decentralization and federation are key concepts in the Fediverse. Decentralization refers to the distribution of data and control across multiple servers, reducing reliance on a single central authority. Federation allows different servers to communicate and interact with each other, creating a network of interconnected platforms.

3.2.1 Benefits of Decentralization

Decentralization offers several benefits, including:

- **Privacy and Control**: Users have greater control over their data and privacy settings, as there is no central authority collecting and monetizing user data.
- **Resilience**: Decentralized networks are more resilient to censorship and outages, as there is no single point of failure.
- **Community Governance**: Users can create and govern their own instances, fostering diverse and self-sustaining communities.

3.2.2 Challenges of Decentralization

Despite its benefits, decentralization also presents challenges:

- **Interoperability**: Ensuring seamless interaction between different platforms and instances can be complex.
- **Moderation**: Decentralized networks require robust moderation tools to manage

content and prevent abuse.

- **Scalability**: Decentralized systems must be designed to handle large numbers of users and high volumes of data.

3.3 Protocols and Technologies

The Fediverse relies on various protocols and technologies to enable decentralization and federation. Some of the key protocols include:

- **ActivityPub**[1]
  ActivityPub is a decentralized social networking protocol used by many Fediverse platforms. It enables users to follow, share, and interact with content across different instances.
- **WebFinger**[7]
  WebFinger is a protocol for discovering information about people and resources on the internet. It is used in the Fediverse to locate user profiles and instances.

3.4 Conclusion

The Fediverse represents a growing movement towards decentralized and federated social networks. By leveraging protocols like ActivityPub, platforms within the Fediverse offer users greater control over their data, enhanced privacy, and resilient communities. However, challenges such as interoperability, moderation, and scalability must be addressed to ensure the continued growth and success of decentralized social networks.

CHAPTER 4

METHODOLOGY

The development of our decentralized microblogging platform for scientific communication followed an Agile methodology, prioritizing iterative progress, flexibility, and team collaboration. This chapter outlines the key phases—Requirement Analysis, System Design, Development, Integration with Decentralized Protocols, and Testing—highlighting the processes and strategies that shaped the platform's realization.

4.1 Requirement Analysis

We began by identifying user needs and system requirements through a review of online academic forums, existing social media platforms, and federated system documentation. This research informed essential features: secure data sharing, privacy controls, scientific typesetting support, and decentralized communication. By analyzing the strengths and weaknesses of comparable platforms, we established core functionalities such as user profiles, microblog posts, and cross-instance federation.

4.2 Development

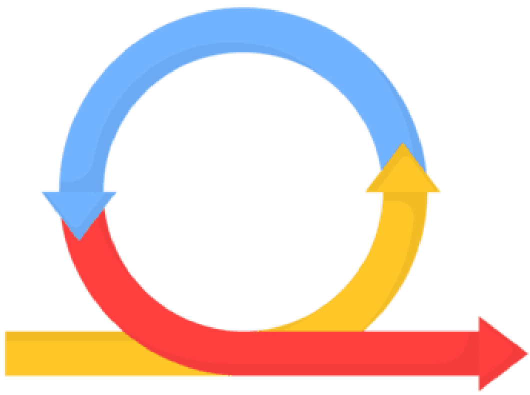

Figure 4.1: Agile Model

Development proceeded in iterative Agile sprints, split into backend and frontend streams.

This approach allowed continuous refinement based on emerging technical needs and team feedback. The backend handled authentication, content management, and federation, while the frontend focused on delivering an intuitive interface for scientific content creation and consumption.

4.3 System Architecture

The design phase centered on creating a scalable, federated architecture. We chose the ActivityPub protocol to enable decentralization, structuring the system around a backend for core logic and a mobile-first frontend for user interaction. Emphasis was placed on secure data exchange and usability across devices, with RESTful APIs as the backbone of component communication.

A modular architecture is used for scalability and maintainability. The figure below gives a high-level view of the system architecture.

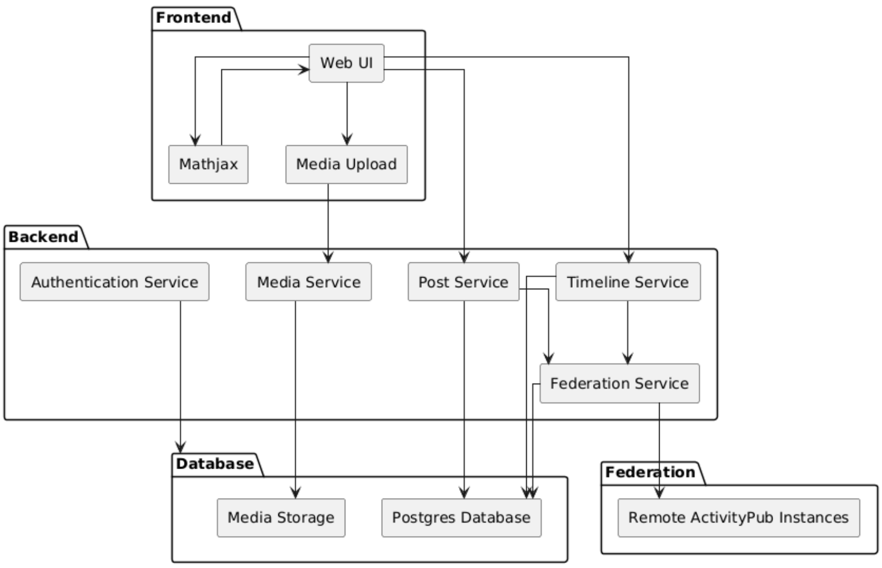

Figure 4.2: Component Diagram

4.4 Integration with Decentralized Protocols

Federation was a cornerstone of the platform, achieved through ActivityPub compliance. We implemented server-to-server communication and user activity management (e.g., posting, following) to ensure interoperability with other federated systems. This phase was validated iteratively to confirm seamless cross-platform interaction.

4.5 Testing

Testing was integrated throughout development to maintain functionality and reliability. We employed a multi-layered strategy, including unit tests for individual components and integration tests for system-wide interactions, ensuring robustness at every stage.

4.6 Technology Stack and Environment Setup

4.6.1 Backend

- **Language:** Node.js and Hono Server
- **Database:** Posgres, S3 Storage, Minio
- **Authentication:** OAuth

4.6.2 Frontend

- **Framework:** ReactNative, Expo, Mathjax

4.6.3 Environment

- **Deployment:** Docker
- **Development:** Docker and Nix

4.7 Detailed Implementation Steps

4.7.1 Backend Implementation

- **User Authentication:** Using OAuth.
- **Content Management:** CRUD operations for posts, comments, and likes.

4.7.2 Frontend Implementation

- **User Interface:** Developed as a Single-Page Application (SPA) using React.

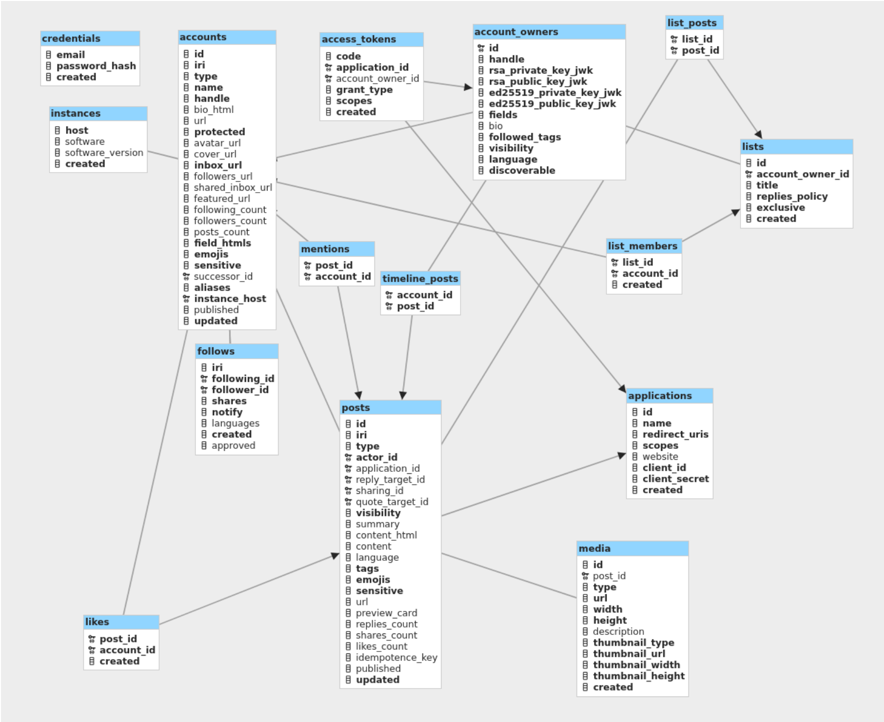

Figure 4.3: ER Diagram

- **State Management:** Handled with Redux integrating with backend APIs.

4.8 Use Case

Integration was performed using API gateways and containerization. Figure **??** shows the integration flow.

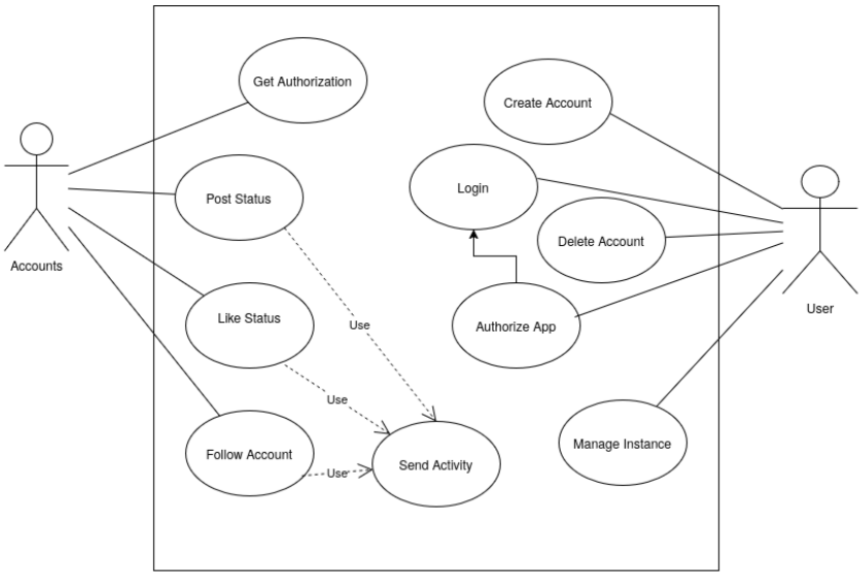

Figure 4.4: Use Case Diagram

CHAPTER 5

RESULTS

Here we write about what metohods we used to make the project possible.

CHAPTER 6

CONCLUSION

Here we write about what metohods we used to make the project possible.

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APPENDIX A

APPENDIX B