DEMEDIA – DECENTRALIZED SOCIAL MEDIA PROTOCOL

2023 - 234

Project Proposal Report

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B.Sc. (Hons) in Information Technology Specializing in Information Technology

Department of Information Technology

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MECHANISM FOR DATA CACHING PRESERVATION

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Declaration

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Signature:

IT20157432	Abeykoon A.W.Y.I.K.	

The above candidates are conducting research for the undergraduate Dissertation under my supervision.

Signature of the Supervisor: ………………………………….

Date: ………………………………….

Acknowledgments

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Abstract

A decentralized social media protocol is a collection of rules and standards for creating social media networks without the need for a central authority or intermediary. These protocols enable users to engage with one another without depending on a centralized service provider by using decentralized technologies such as blockchain, peer-to-peer networking, and distributed storage.

“DeMedia” is a decentralized social media protocol that aims at giving users complete control over their data and utilizes peer-to-peer (P2P) networking rather than a blockchain to cut expenses. The protocol allows users to control their data by using a client application that keeps the data locally on their device rather than on a central server. Users have full control over the length of caching, which is utilized to guarantee optimal speed. Moreover, the protocol uses cryptographic mechanisms to ensure data integrity. “DeMedia” provides a complete decentralized social media solution that prioritizes user data ownership and control above a costly blockchain infrastructure.

This paper describes a decentralized social media platform protocol aimed at addressing centralized social media platform problems such as data privacy, censorship, and data ownership. The protocol is built on peer-to-peer communication, which allows users to connect without the use of intermediaries. The platform contains a user data decentralization protocol, which allows individuals to maintain ownership over their data while assuring that no centralized authority owns or controls it.

This platform also has a data integrity preservation mechanism to ensure the integrity of user data. Additionally, the platform has data cache preservation technology, which aids platform speed by keeping frequently visited information locally on users' devices.

Finally, the suggested platform protocol provides a decentralized and secure social media network in which users control their data and connect without the necessity of centralized intermediaries.

Keywords: protocol, data cache, decentralization, peer-to-peer

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IPFS	Interplanetary File System
AWS S3	Amazon Web Services
CDN	content delivery network
MFS	Mutable File System
CID	Content Identifier

1.0 INTRODUCTION

1.1 Background

Social media has impacted the way we communicate and engage with one another by facilitating global collaboration and knowledge exchange. Along with the remarkable advantages that social networking provides, there is growing worried about the difficulties that centralized platforms encounter, particularly concerning data privacy, censorship, and user data management. In centralized social media platforms, the user data is stored in one single server and owned and managed by a single platform. As a result, there may be some issues regarding because of this. Some issues are happening because of centralized data breaches, privacy violations, censorship, and server outages.

The Decentralized Social Networking Protocol (DSNP) enables everyone to cooperate to build a single decentralized social network. It is an open technology that enables private communications in the way that modern social network users have come to expect. Mastodon, Steemit, and Minds are examples of decentralized social media networks. These platforms make use of blockchain technology to build a distributed network of servers that handle and store data. Users have more influence over a decentralized social network.

DeMedia is a decentralized social media protocol that allows social media platforms to control a decentralized network, removing the need for a centralized server controlled by a single platform. One of the most important aspects of a decentralized social media network is its caching mechanism Data caching is the process of keeping several copies of data or files in a temporary storage space—also known as a cache—so they can be viewed more quickly. In order to guarantee users do not need to download information each time they visit a website or application to speed up site loading, it saves data for software applications, servers, and web browsers. Because there is no central server to store the data, it is crucial to implement a caching method in a decentralized social media platform. Data that is commonly accessed is cached and kept close to the user.

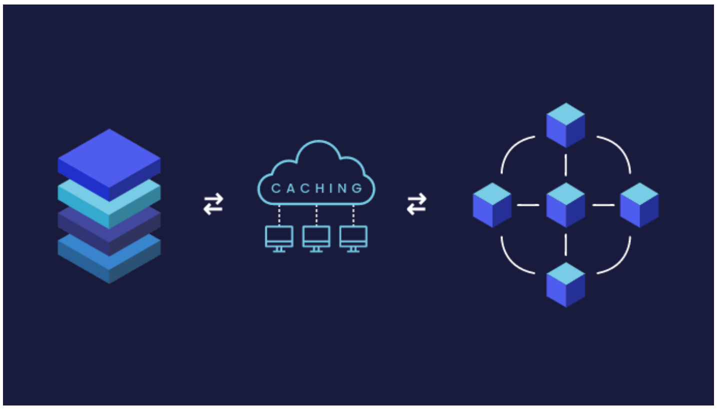

Figure 1.1.1: Caching in web3 prodcuts

1.2 Literature Survey

A lot of people frequently use social media in their daily lives. Because most tasks in the modern world are time-based and take place on these social networks, they couldn't survive without it. These networks are typically concentrated. It enables socially conscious businesses to monitor and analyze their data. It might be a reason to question the users' data's protection. Additionally, these businesses frequently transfer them to third parties while making sizable profits without the consumer's permission. Numerous people have brought up this problem because data is the most important resource in both the present and the future. As a result, attention has turned to decentralized social media sites where users can store their data locally. [1] The network resources and services are distributed through the network called "distributed" and it might be geographically distributed over the network. The network and resources are managed by a central authority, and they have the power to do everything in the system. Decentralized refers to a situation in which there is no central location or supervisor with authority over the system. Users of the system are controlled by the system.

There are various decentralized social media networks available. The majority of the time, they are based on Blockchain technology. Peepath, Mastodon, Mirror, Hive, and Minds are some examples. Decentralized social networks are networks in which user data and content are held on a blockchain and independent servers rather than centralized servers controlled by a single corporation. [2]

1.2.1 Examples for decentralized social media platforms

Social Media Platform	Brief Description	Storage Network	How cache works
Peepath [3] *Figure 1.2.1.1: Peepath logo*	It consists of two components: an open-source smart contract that runs on the Ethereum **blockchain** (data storage) and Peepeth.com. (a front-end).	IPFS	Metadata and optional file caching
Mastodon [4] *Figure 1.2.1.2: Mastodon logo*	Software for running self-hosted social networking services called Mastodon is open-source and free. Similar to Twitter, it has features for micro blogging.	Federated network of Mastodon instances	No built-in caching mechanism

Hive [5] *Figure 1.2.1.3: Hive logo*	Hive is a forward-thinking decentralized blockchain and ecosystem that is built to expand with universal adoption of the currency and platforms in mind.	Hive Blockchain	Using LevelDB [6] and RocksDB [7]
Steemit [8] *Figure 1.2.1.4: Steemit Logo*	Steemit is a decentralized application (DApp) built on the Steem blockchain that rewards user for their content with the eponymous cryptocurrency STEEM. Users can decide the payout of posts and comments by voting on them.	Steemit Blockchain	Using LevelDB [6] and RocksDB [7]

Table 1.2.1.1: Features of decentralized social media

1.2.2 Decentralized data storage network

Decentralized storage networks need to be discussed when discussing decentralized social media platforms. With decentralized storage, information is encrypted and distributed across several locations, or nodes, that are managed by people or businesses that sell off any extra disk space they have. It is now acting as a challenger to established online storage models. The Decentralized storage networks can have a significant impact on the caching system used by decentralized social media platforms. Many companies presently offer decentralized storage options, and some of them use blockchain technology to speed up storage operations and validate transactions across a distributed network. Cost savings are one advantage of decentralized storage networks. Since a decentralized network serves as a middleman between those who need storage and those who have extra capacity accessible for leasing, organizations may experience lower costs by primarily using it for storage. Decentralized storage is consequently less costly than conventional cloud storage. Decentralized storage network goods come in a variety. (Arweave, BitTorrent, Filecoin, MaidSafe and Safe Network, Sia, Storj, Utopia) [9]

1.2.1.1 Arweave

Figure 1.2.1.1.1: Arweave Logo

The Arweave protocol makes use of a blockchain-like structure known as block weave to provide a mechanism for permanent on-chain data storage as well as storage payment. A block in the block weave points to the preceding block and a recall block that is deterministically chosen based on the previous block's information. [10]While the weave is immutable and its data is censorship-resistant, each node has the option to refuse accepting content. Refusing content by a large enough number of nodes prevents unwanted content from being included. [11]

1.2.1.2 BitTorrent

Figure 1.2.1.2.1: BitTorrent Logo

We can define BitTorrent as a peer-to-peer file-sharing protocol. It has an incentive system that manages download behaviors to ensure appropriate resource usage. BitTorrent was designed to provide a more efficient way to distribute rather than a centralized server. This is accomplished by taking advantage of the fact that data are replicated with each download, allowing for self-scalability in file distribution. [11] BitTorrent Fie System designed to reduce costs, improve fault tolerance and avoid government censorship. [9]

1.2.1.3 Storj

Figure 1.2.1.3.1: Storj Logo

Storj aims to be a decentralized cloud storage service. Storj Labs Incorporated intends to compete with centralized storage providers. Storj offers compatibility with the Amazon S3 Application Programming Interface to increase general adoption and ease migration for new users. [12]Because Storj offers Cloud Storage, users can store and retrieve data as well as delete, move, and copy data. Storj is based on Blockchain technology [13]

1.2.1.4 IPFS

Figure 1.2.1.4.1: IPFS Logo

IPFS is a modular set of protocols for organizing and sharing data that was built from the ground up with content addressing and peer-to-peer networking in mind. Because IPFS is open source, there are numerous IPFS implementations. While IPFS has other use cases, its primary use case is for decentralized data publication (files, directories, webpages, etc.). IPFS network nodes can automatically cache resources they download and make them available to other nodes. This system is dependent on nodes being willing and capable of caching and sharing network resources. Because storage is limited, nodes must purge part of their previously cached resources to create a place for new resources. This is known as garbage collection. [14]

1.2 Research Gap

This research aims to address the current limitations and problems of decentralized social media systems. It will examine the consequences of storing a decentralized social media protocol using a caching mechanism specifically. Existing decentralized social media protocols can use caching mechanisms to improve performance and reduce network load, but there are some issues with existing protocols such as data consistency, privacy concerns, issues of caching strategies, network congestion, and scalability issues. We proposed IPFS to solve these issues, providing a distributed and decentralized infrastructure for content delivery, potentially reducing reliance on social networks. Users may find it more attractive to participate in content caching and delivery if they do not have to rely on a certain social network.

Steemit and Peepath are two examples of decentralized social media platforms that use blockchain, but it raises challenges such as crime, volatility, and storage issues. Even though they use caching mechanisms, there are still problems such as crime, volatility, and storage issues. [15]. DeMedia suggests using IPFS as a storage network, as it has an aggressive caching mechanism that keeps items local for a short period of time. However, these objects may be garbage-collected on a frequent basis, so it is important to pin or add the CID to MFS to prevent garbage collection. [16]

IPFS is a peer-to-peer distributed file system designed to provide a more durable and decentralized system for saving and distributing files on the internet. Caching mechanisms are important for content management, and IPFS caching and peer-to-peer networking techniques can be used to manage the cache. This can help store frequently requested information closer to users, improving speed and decreasing delay. [14]

	Mastodon	Steemit	Peepath	DeMedia
Caching	No	Yes	Yes	Yes
Decentralized Data Storage Network	No	IPFS	Swarm	IPFS
Blockchain based	No	Yes	Yes	No
Scalability	No	Yes	Yes	Yes
Resource Consumption	low	high	Medium	low

Table 1.2.1: Comparison of existing decentralized social media platforms

2.0 RESEARCH PROBLEMS

Decentralized social media networks need a caching system to improve their usefulness and scalability. In order to speed up response times and lessen network load, the platform may swiftly fetch and display frequently accessed content for users by caching user data. In addition, caching methods can improve the user experience by reducing network load and scalability issues. Decentralized social media networks must use a reliable caching technique to retain optimum performance, scalability, and user experience.

There are so many issues on decentralized social media platforms when we don't use caching mechanisms correctly. The major problems are inconsistent data, cache invalidation, storage capacity, security vulnerabilities, and scalability issues. So, it is very important to identify the most suitable way to implement the caching mechanism on decentralized social media platforms.

As I have identified, the majority of current platforms depend on blockchain technology while considering the caching system and storage network of decentralized social media platforms. [17] However, there may be several problems with existing decentralized systems implemented on the blockchain. [18] Some disadvantages of implementing blockchain in decentralized systems include high resource consumption, limited storage capacity, slow transaction speed, difficulty in cache invalidation, high cost, lack of adoption, low scalability, and low workforce availability. It impacts user behavior through the caching mechanisms of decentralized social media platforms.

There are several problems with the caching mechanism on previously decentralized social media platforms. We have to implement a better caching mechanism to solve the issues on the existing platforms.

3.0 OBJECTIVES

3.1 Main Objective

This research aims to provide a reliable solution for storage management concerns in existing decentralized social media platforms by implementing caching mechanisms. This component is important because there are various issues with the caching mechanism in decentralized social media protocols. As a solution to the above problem, we can use IPFS (Interplanetary File System) without using blockchain based technology.

3.2 Sub Objective

- Get familiar with storage management using caching mechanism.

  This subtask aims to understand the fundamentals of storage management using caching mechanisms, including how it works, different types of caching mechanisms, and their pros and cons. It also focuses on different use cases and best practices for implementing and managing caching in a storage system.

- Study what is the impact of caching mechanism for decentralized social media protocol.

  This subtask investigates how caching strategies can increase performance, reduce latency, and minimize bandwidth requirements for decentralized social media systems. It is critical to assess the potential drawbacks of implementing caching in a decentralized setting.

- Analyzing the areas of storage management using caching mechanisms in decentralized social media protocol.

  This subtask investigates how caching strategies can be used to enhance performance and reduce resource usage in decentralized social media protocols. It includes assessing how caching can be used to manage user-generated content, optimize storage of media assets, and minimize data movement between nodes.

- Integrating the caching mechanism with the IPFS.

  This subtask investigates how caching systems can be combined with IPFS to improve efficiency and reduce resource usage in decentralized social media protocols. It involves understanding how to combine caching with IPFS content addressing and retrieval and assessing various caching techniques to maximize IPFS storage.

- Reduce resource consumption in data storage.

This subtask involves developing methods to reduce data storage resources for decentralized social media protocols. It involves assessing the use of caching technologies to decrease resource consumption, optimize data retrieval, and reduce storage needs. It is important to consider how caching can be used with other methods.

- Documenting caching mechanism and integration with IPFS to facilitate adoption and optimization.

The final objective is to document the caching mechanisms and integration with IPFS to facilitate adoption and optimization of decentralized social media protocols. This includes creating documentation that outlines best practices for using caching in a decentralized environment, providing guidance on how to integrate caching with IPFS, and providing examples of successful caching implementations in decentralized social media platforms.

4.0 METHODOLOGY

4.1 Requirement Gathering

The requirements of the protocol and client apps used to connect to peer-to-peer networks are gathered in the initial step of building a decentralized social media protocol with a caching mechanism. One of the most difficult challenges is ensuring that cached content is up to current and consistent across all network nodes. To address these issues, protocols and client applications must prioritize scalability, performance, security, and usability. Finally, the client application should have an easy-to-use interface.

4.2 Feasibility Study

4.2.1 Technical Feasibility

The development of a client application that can communicate with network nodes and peers will come first. A secure user data storage option on the user's native device storage should also be available to the client. It is technically possible to construct a client that includes the aforementioned functionalities using the technology stack that is currently being proposed.

4.2.2 Schedule Feasibility

This research component is expected to take about ten months to complete, and the work has been arranged accordingly. A Gantt chart has been created to show the work that must be performed within particular time constraints. After considering the factors mentioned above, this component can be considered timetable feasible.

4.3 Proposed System Diagram

4.3.1 System Overview Diagram (Overall)

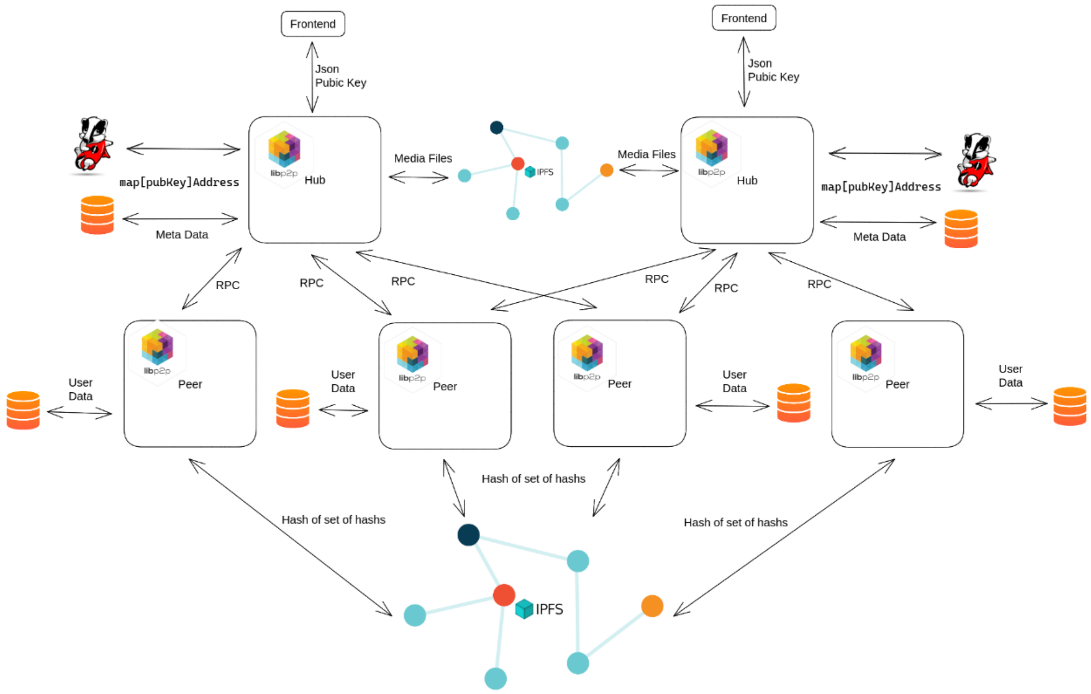

Figure 4.3.1.1: High Level architecture diagram (Overall)

This diagram shows the under-consideration DeMedia architecture. DeMedia is made up of four essential parts: the data decentralization protocol, peer-to-peer communication, decentralized data storage, and data integrity in a decentralized network. To demonstrate these features, an IPFS-based social network platform will be constructed. Hubs, peers, and a decentralized data storage network will comprise this infrastructure. This graphic depicts a high-level architectural view of the presented social networking platform.

4.3.2 System Overview Diagram (Individual)

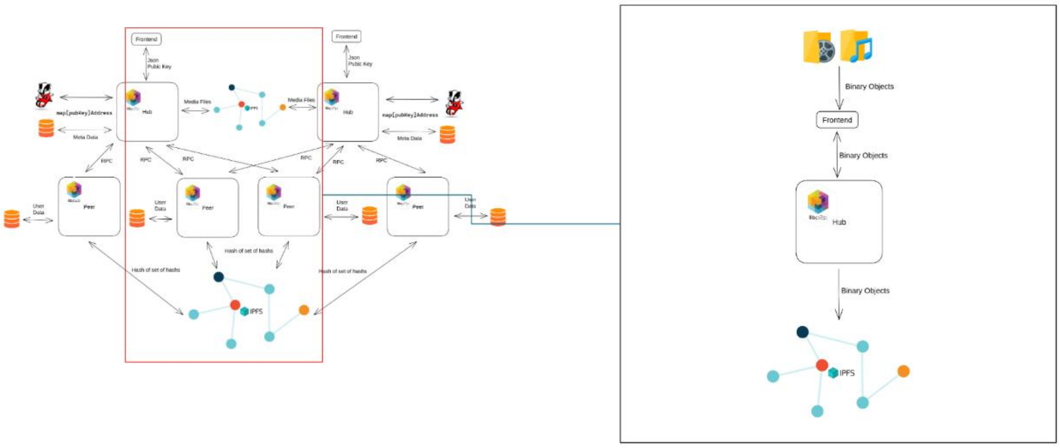

Figure 4.3.2.1: High Level architecture diagram (Component)

This component will produce a client application and a decentralized social media protocol with a caching system to show off its functionality. Performance, scalability, security, and usability of both the protocol and client application will be enhanced. They'll enable simple content sharing and distribution over the decentralized social media network, support a range of content categories, and support a number of different content models. There will be a user-friendly interface in the client application.

4.4 Software Development Cycle (SDLC)

SCRUM, an agile software development framework, will be the main framework for managing software projects throughout the research. The agile methodology known as Agile is preferred above other software project management methodologies like Lean, Waterfall, and Six Sigma because it is better suited for efficient and quick software development. The article claims that SCRUM, an agile framework, is well-liked because it characterizes the systems development process as a loose collection of activities integrating the best tools and methodologies a development team can come up with to produce a system. [19]

According to additional information in the same article, [19]SCRUM implies that the system's development process is unpredictable, complex and can only be described as an overall progression.

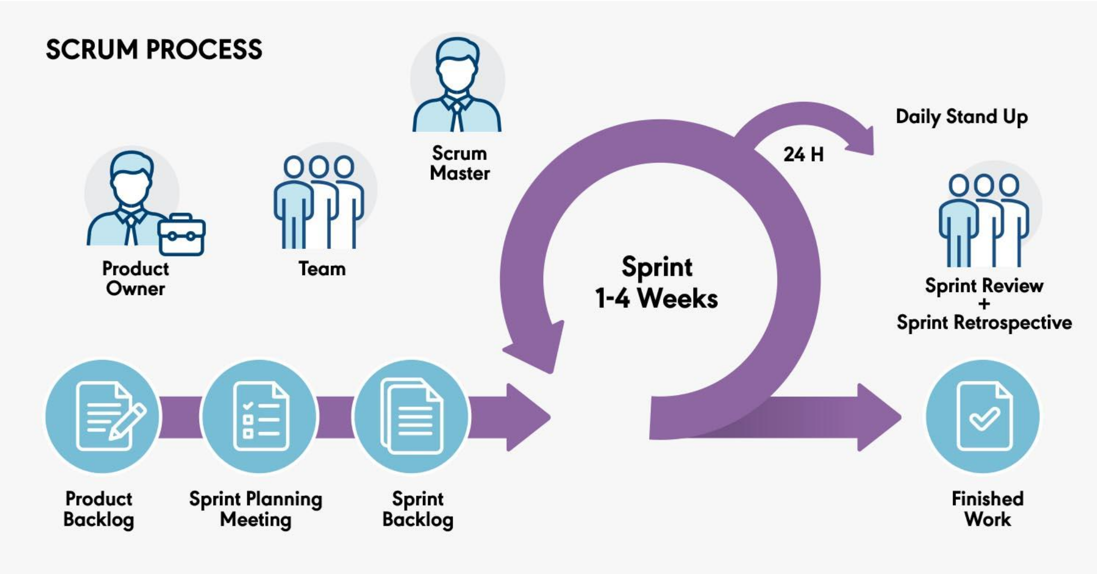

Figure 4.4.1: SCRUM process

The research's defined objectives and intended outcomes have been met by a methodical allocation and organization of the activity. To ensure that each component of the research has enough time to be completed on time, a thorough timetable complete with a Gantt chart has been created. Additionally, the choice of the right technology to successfully implement the suggested solution and show the expected outcomes of this research has been well thought out. Each step has been taken to ensure a well-structured and systematic approach to reaching the research objectives, as seen by the thorough planning and strategic choices made throughout this research.

4.5 Work Breakdown Structure (WBS)

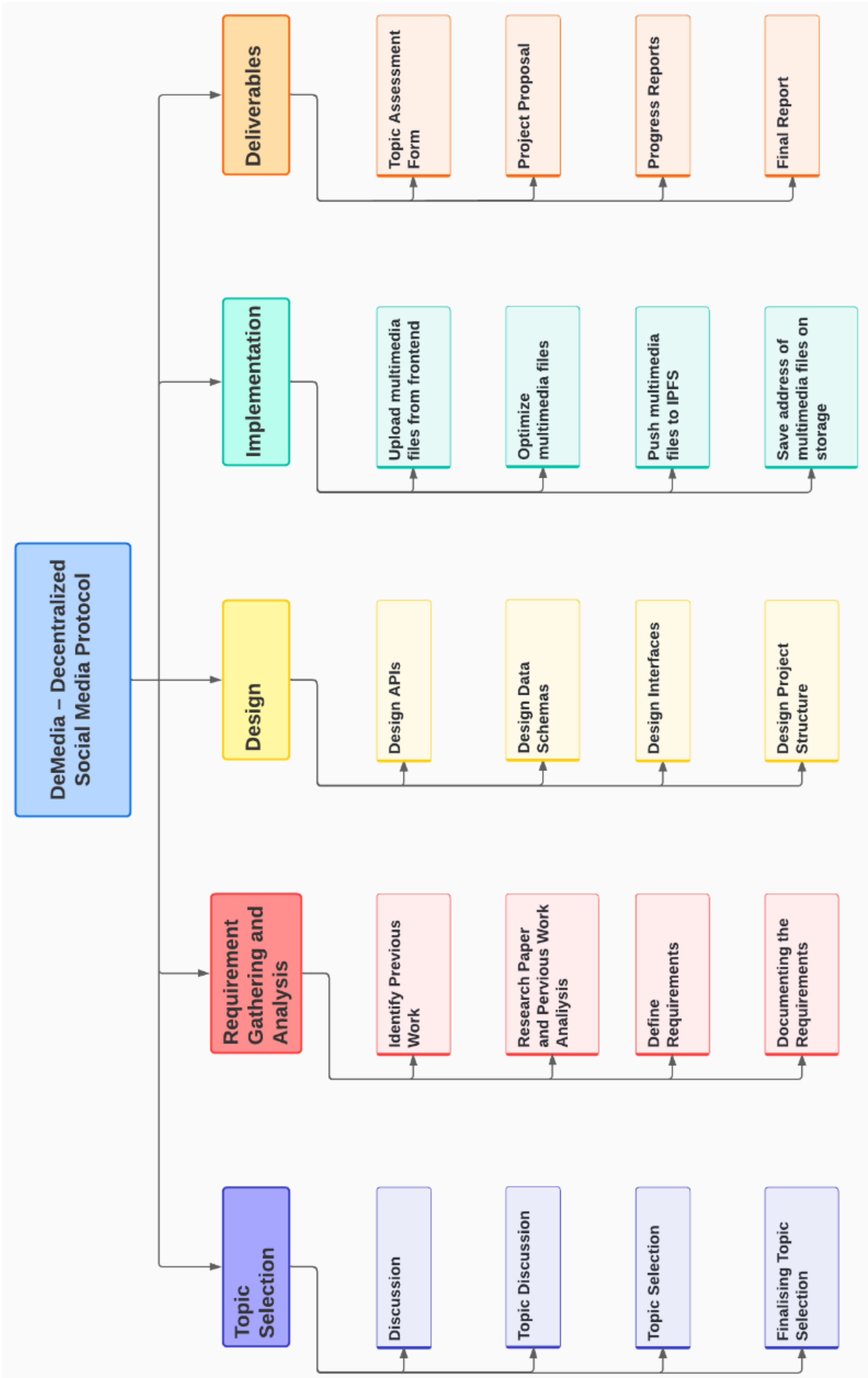

Figure 4.5.1: Work Breakdown Structure

4.6 Gantt Chart

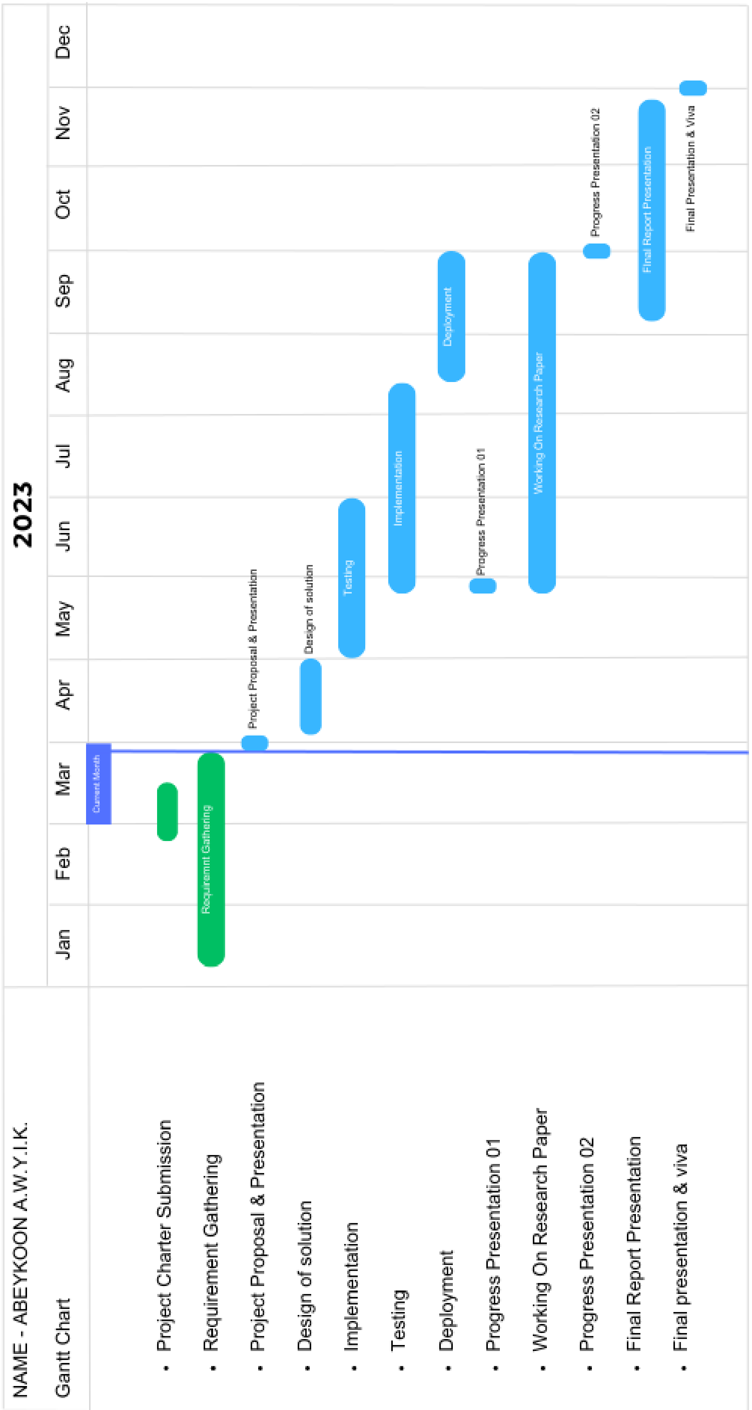

Figure 4.6.1: Gantt Chart

4.7 Proposed Tools and Technologies

Tool/Technology	Purpose
Quasar	Frontend development
Go Lang	Backend Development
Libp2p, Markdown	Libraries
IPFS, PostgresSQL	Data Storage
VScode, GoLand	IDEs
GitHub	Version Control System
GitLab	CI/CD
AWS	Cloud Service
Microsoft planner	Project Management
Microsoft Teams, WhatsApp	Communication

Table 4.7.1: Proposed Tools and Technologies to be used

5.0 SOFTWARE SPECIFICATIONS

5.1 Functional Requirements

- Upload multimedia files from frontend

This is the procedure for uploading multimedia files from the user's device to the front-end interface of the decentralized social media platform. Both web and mobile applications can be used to implement the front end.

- Optimize multimedia files.

Depending on their size, which can be very enormous, multimedia files can upload and download slowly. Therefore, it is crucial to optimize the files in order to reduce their size without sacrificing quality. Performance is improved through compression and other optimization techniques.

- Push multimedia files to IPFS

After the multimedia files are optimized, they can be pushed to the IPFS network. This involves breaking files into small pieces and distributing the across the network of nodes. This ensures that files are always available, even if some nodes are offline.

- Save addresses of multimedia files in storage

After the multimedia files are uploaded to IPFS, their unique addresses (also known as content-based addresses) are generated. These addresses are then saved in storage, such as a decentralized database, to make it easier to retrieve the files later on.

5.2 Non-Functional Requirements

The non-functional requirements identified within the scope of this component are listed below:

- Performance

Decentralized social media platforms require a well-designed architecture and efficient algorithms to handle the demands of a distributed network.

- Fault tolerance

Decentralized social media networks must be fast and responsive, requiring a well-designed architecture and efficient algorithms to handle the demands of a distributed network.

- Scalability

As more people join a decentralized social media network, the system must be able to scale in order to meet the increased demand. This necessitates a flexible design that can add more nodes and resources as needed without impacting the system's overall performance or availability.

- Availability

Users should be able to access decentralized social media sites even if individual nodes go offline or network outages occur, requiring mechanisms for redundancy and fault tolerance.

- Usability

A good decentralized social media network should be simple to use and navigate, with simple instructions and user-friendly interfaces. This necessitates user experience design and testing, as well as ongoing improvements in response to user feedback.

- Better developer experience

A decentralized social media platform should provide a developer-friendly environment with a well-documented API, open-source tools and libraries, and support for major programming languages and frameworks to drive adoption and creativity.

6.0 PERSONAL AND FACULTIES

Student Number	Name	Tasks
IT20157432	Abeykoon A.W.Y.I.K.	• Conduct a comprehensive review of data caching mechanisms and associated research. • Assess the opportunities and challenges present in existing data caching mechanisms. • Determine the potential enhancements and new capabilities that could be integrated into a mechanism for data caching in a peer-to-peer network. • Implement a mechanism to cache data in a peer-to peer network with the identified modifications while adhering to best practices.

Table 6.1: Description of personnel and facilities

7.0 BUDGET

The project's initial phase does not entail any budgeted tasks as the requirement-gathering process is accomplished through analysis and review of previous work conducted for research or field study purposes. As the recommended technologies and tools are open source and do not incur any costs, their utilization is free of charge. However, expenses are incurred during the development phase, as it necessitates using cloud service providers' services.

Task	Estimated budget (in LKR)
Documenting and Planning	8,000
Cloud services	21,000
Other (Internet, Travelling and etc.)	5,000
Total	**34,000**

Table 7.1: Budget

8.0 Commercialization

DeMedia is focused on creating an open-source protocol that makes it easier to build self-hosted, decentralized social media sites. The project seeks to offer a free foundation concept that anyone interested in building a decentralized social media platform can use.

DeMedia will provide two paid models in addition to its free model: a membership-based subscription model and an advertising-based income model. The host can control these paid models, which enables them to make money on their site. DeMedia is therefore a research project with a particular interest in commercializing the creation of decentralized social media networks.

The project involves creating a variety of monetization mechanisms that hosts may use to make money from their platforms, allowing the technology to be commercialized.

DeMedia is focused on developing a technology that can support the creation of decentralized social media platforms, which is crucial to understand in order to further explain the monetization component of the project. DeMedia makes it simpler for people or organizations to develop their own social media platforms that are not governed by a single entity by offering a free base concept.

However, there must be a mechanism to make money in order to maintain and expand these platforms. Here's where the two premium models that DeMedia provides are useful. Hosts are able to charge customers for access to exclusive features or content on their platform because of the subscription-based membership model. This income can be utilized to pay for the platform's hosting and upkeep expenses.

The advertising-based income model, on the other hand, enables hosts to make money by showing adverts on their platform. Advertisers may be charged by hosts to have their adverts displayed on the platform, and this money may be used to pay for hosting and upkeep expenses as well as to make a profit.

As a summary of the proposed system, DeMedia enables the commercialization of decentralized social media platforms by supplying technology that enables anyone to develop their own platform as well as monetization approaches that enable hosts to make money and maintain their platforms. This might result in a more varied and decentralized social media ecosystem with additional platforms serving specialized markets and communities.

9.0 CONCLUSION

Finally, the decentralized social media protocol is rapidly expanding, with several protocols vying for dominance. However, as previously discussed, many of these protocols have significant difficulties in areas such as scalability and data storage. After careful consideration, IPFS emerges as one of the best solutions for storage management with a caching mechanism. Because of its decentralized approach to data storage and ability to cache frequently accessed data, it is a dependable and scalable solution for social media platforms. IPFS is likely to play an increasingly vital role in the future of social media as the decentralized social media protocol develops.

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GLOSSARY

- Caching: the process of storing data in a temporary storage location for quick access and retrieval.
- Blockchain: A decentralized, distributed digital ledger that records transactions across multiple devices and networks.
- Distributed caching: a caching mechanism in which data is stored across multiple nodes in a decentralized network.
- Content-addressable storage: a mechanism in which data is stored based on its content rather than its location, allowing for efficient retrieval and distribution.
- Content Delivery Network (CDN): a distributed caching system that stores and delivers content to end-users based on their geographic location, reducing latency, and improving performance.
- Peer-to-peer (P2P) caching: a decentralized caching mechanism in which nodes in a network cache data for each other, reducing the load on the network and improving performance.