DEMEDIA – DECENTRALIZED SOCIAL MEDIA PROTOCOL

2023 - 234

Project Proposal Report

Perera B.S.S.

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

Department of Information Technology

Sri Lanka Institute of Information Technology

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Declaration

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

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Acknowledgments

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Abstract

Social media, which is used by most individuals, has become an integral part of modern lifestyle. However, these social networks use centralized servers to store user data, which is an approach shown to have many disadvantages such as users having no control over their data or the platform they use.

This proposal presents a decentralized social network that utilizes the user's device as storage, while ensuring that data remains secure and authentic, with complete control over user data residing with the user. Furthermore, the implementation of a user data decentralization protocol, along with the design and deployment of a client application capable of seamless communication with other network peers via the decentralized protocol, form the central components of the proposed solution.

Keywords: social media, decentralized, peer-to-peer, protocol, distributed

Table Of Content

List Of Figures

List Of Tables

List of Abbreviations

IPFS	Interplanetary File System
AWS S3	Amazon Web Services
CDN	content delivery network

1.0 INTRODUCTION

1.1 Background

At present, social media platforms have become integral components in the lifestyles of a vast majority of individuals. Social networks have established a global presence, with the initial recognizable social network, "Six Degrees," being launched in 1997, enabling users to establish profiles and connect with other users. Today, there are numerous social networks, such as Facebook, WhatsApp, Instagram and Twitter, and their usage continues to grow [1]. These social networks are becoming popular among people due to their purpose and differences which make them compete with each other. It is imperative to examine the reasons for the increased usage of social networks. The most prevalent reason is that users desire to stay connected with others and remain updated on global events. With hectic schedules and workloads, physical interaction with others is often impractical, leading people to connect virtually, which proves more feasible. Additionally, social media is used for sharing photos and videos for entertainment and expressing opinions and ideas. Moreover, social media platforms serve as a means of researching products to purchase, prompting businesses to concentrate on online marketing and target audience acquisition. However, centralization of these social networks has led to various problems, which have recently become hot topics.

According to an article outlining several concerns in social media expressed at the Social Media Summit @ MIT [2], MIT Sloan professor Sinan Aral said “Social media is rewiring the central nervous system of humanity in real time” at the summit which brought professionals together to explore these challenges and focus on solutions, which ranged from new oversight committees to breaking up major corporations. Also, it mentions major concerns in present social media networks. The spread of false news and misinformation, the difficult balance between user privacy and platform transparency and a lack of regulation for social media companies are some of the areas that have been affected through social media at present.

With the emergence of web 3.0 in 2014 [3], people are inclined towards seeking solutions to the issues associated with web 2.0 technologies within the web 3.0 technology stack. As a result, decentralization has become a prominent factor. Decentralized culture has been established, primarily due to the evolution of cryptocurrencies, particularly Bitcoin.

As mentioned in an article discussing Web 3.0 social media platforms [4], the growth trajectory of Web 3.0 is expected to persist, as individuals progressively recognize the advantages it offers in contrast to conventional social media websites. While searching for the most suitable web3 social media platforms, it is advisable to consider a range of factors such as traditional social media platforms, social media users, decentralized

social networks, internet freedom, free speech, online networks, among other relevant considerations.

According to a review on the top decentralized social networks startups [5], Mastodon [6] and DeSo [7] are two of the most prominent decentralized social networking platforms currently under development. The fundamental goal of these social networks is to confront and overcome the issues connected with modern social media platforms by yielding the monopolistic control exerted by leading social media corporations and instead conceding power to the platform's actual users. Despite the proliferation of decentralized social media platforms presently, certain limitations and challenges still require attention. A majority of these platforms employ blockchain technology to achieve decentralization, which, as highlighted in a paper by R. Nourmohammadi and K. Zhang [8], can result in higher costs in terms of processing speed.

The main objective of this research endeavor is to construct a decentralized social network that utilizes the user's device as storage, while ensuring that data remains secure and authentic, with full control over user data residing with the user. The implementation of a user data decentralization protocol, along with the design and deployment of a client application capable of seamless communication with other network peers via the decentralized protocol, form the central components of this research project.

1.2 Literature Survey

The traditional approach to software development is to develop a software application and deploy it on a single machine. This approach is not suitable for modern applications, which are distributed in nature and are deployed on multiple machines. These applications are called distributed applications and are very complex in nature making them very difficult to develop and maintain. Many challenges faced in developing and maintaining distributed applications are related to communication between two applications, data consistency, data availability, data security, to name a few.

Communication between two applications is the basis of any distributed application and distributed applications have two main types of architecture, which are client-server architecture and peer-to-peer architecture [9]. In a client-server architecture, one application is the client and the other is the server. The client application sends a request to the server and the server application responds to the client. In peer-to-peer architecture, both the applications are peers. A peer can communicate with other peers directly and each peer has the same functionality as any other peer in the network. There is no central authority in peer-to-peer architecture.

Modern client-server architecture is based on RESTful web services [10]. RESTful web services are based on the HTTP protocol, which is stateless, meaning that the server does not remember the previous request and that it is the responsibility of the client to maintain the state of the request. Other than the HTTP protocol, there are other protocols like gRPC [11] and SOAP [12] which are used for communication between two applications.

In peer-to-peer architecture, there are a few protocols that are used for communication between two applications such as the torrent protocol [13]. Most of them are specialized for a particular purpose and are therefore not used in general-purpose applications. Moreover, these protocols are very old and not maintained [14] [15].

The research component outlined in this proposal mainly focuses on developing a new, reusable protocol for communication between two peer-to-peer applications which is based on the TCP/IP protocol.

This area has seen several successful projects in the past, which include the following projects.

- Skype
- Gnutella
- Kazaa
- eMule
- Torrent

However, most of these projects have several problems hindering their usability which will be described in the following sections.

In summary the problems discussed in existing projects can be condensed into the following set of issues.

- Lack of good documentation or none at all.
- Restrictive licensing or no license to be found.
- Old with the last update more than a decade away.
- Not easy to reach point of contact.
- Closed source (product) or the source doesn't exist anymore.
- No specification.
- Implementation does not expose a friendly API.
- Tightly coupled with a specific use.

1.2.1 Skype

Skype [16] is a proprietary peer-to-peer Internet telephony service that allows users to communicate with others via the Internet using voice calls, video calls, and instant messaging. It uses a centralized server which helps the system sign up new users as well as authenticating existing users with user ID and password information. The super node is a peer with higher bandwidth and CPU power and is used to improve scalability. The super nodes do the heavy lifting for the Skype service, and it is considered a disadvantage as the service relies on these super nodes, not a centralized server.

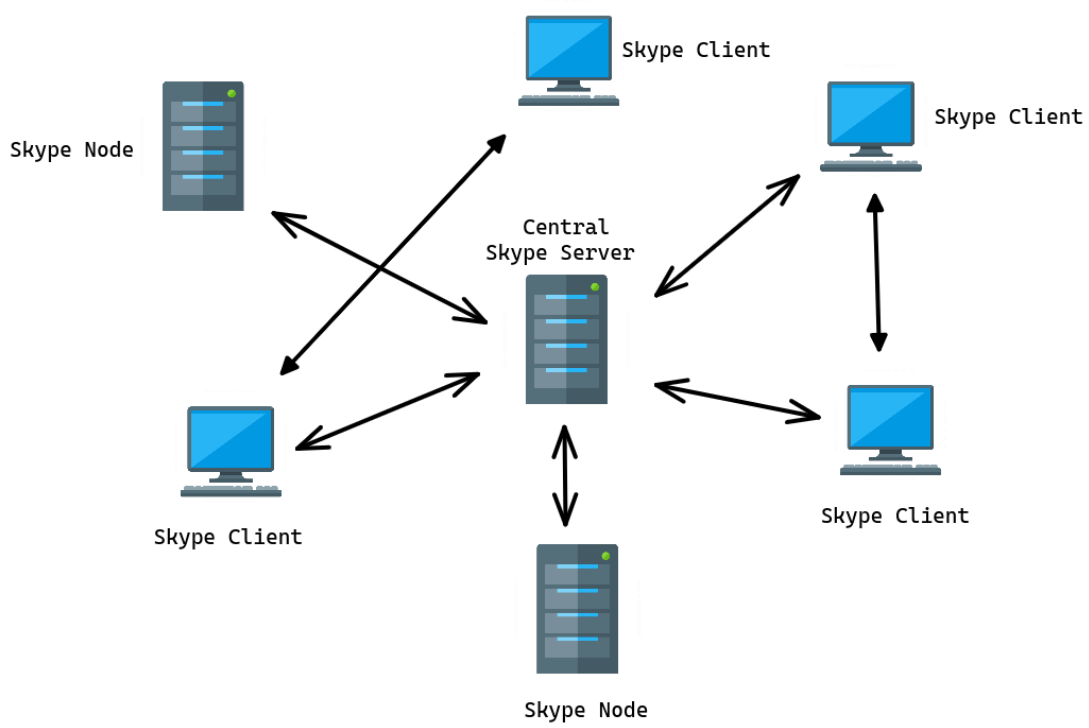

Figure 1.2.1.1: Overall System architecture of Skype

According to Microsoft Store [17] Link, the software release information are as follows:

- Initial release: August 29, 2003
- Latest release: 20 January 2023
- License: Proprietary

1.2.2 Gnutella

Gnutella [14] is a peer-to-peer file-sharing network using the TCP/IP stack for communication. Nodes on the network can be either clients or servers and four types of messages are used in the Gnutella protocol. Ping, Pong, Query, and Query Hit.

Flooding is used to propagate messages with each message having a Time to Live (TTL) field. When TTL reaches zero, the message is dropped. A drawback of flooding is that it floods the network with a large number of messages, this does not scale well. According to the last stable specification [18], the last update was in 2001.

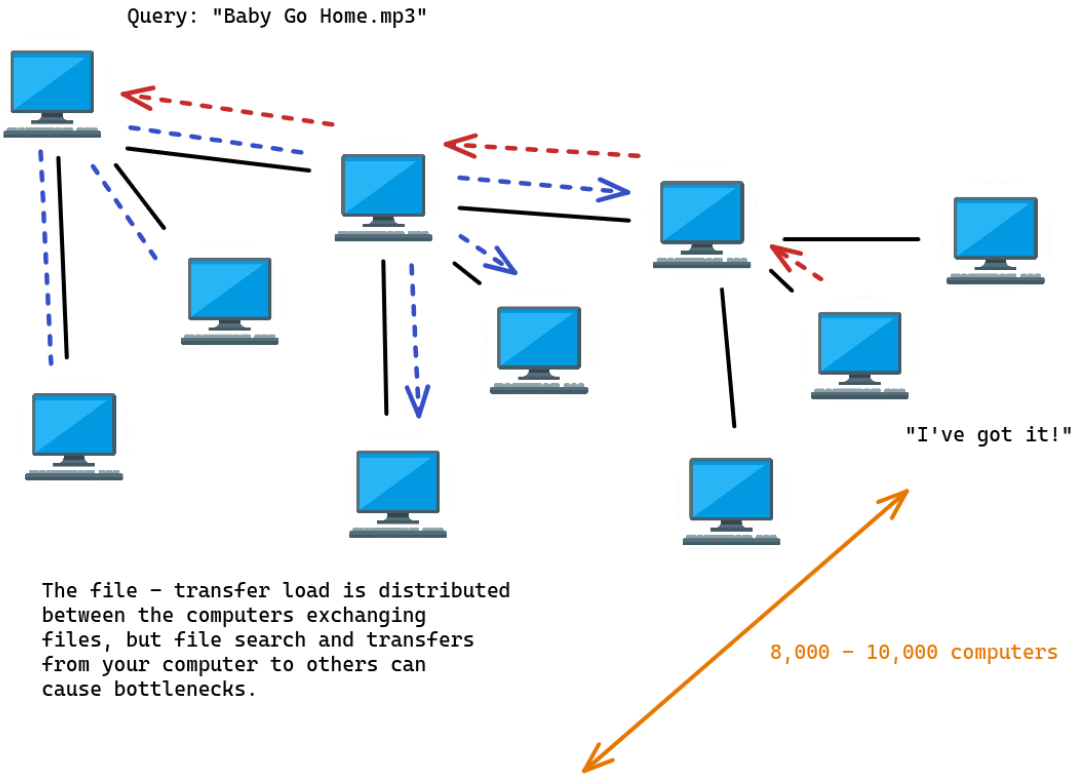

Figure 1.2.2.1: Overall System architecture of Gnutella

1.2.3 Kazaa

Kazaa [14] is a peer-to-peer file-sharing application for music, video, and other digital media files. FastTrack is the underlying protocol of Kazaa and also uses the super node concept.

Kazaa has the same problem as Skype, where it relies on a super node.

According to version details of Kazaa [19], the software release information are as follows:

- Initial release: March 1, 2001
- Latest release: 3.2.7 / 26 November 2006
- License: Proprietary

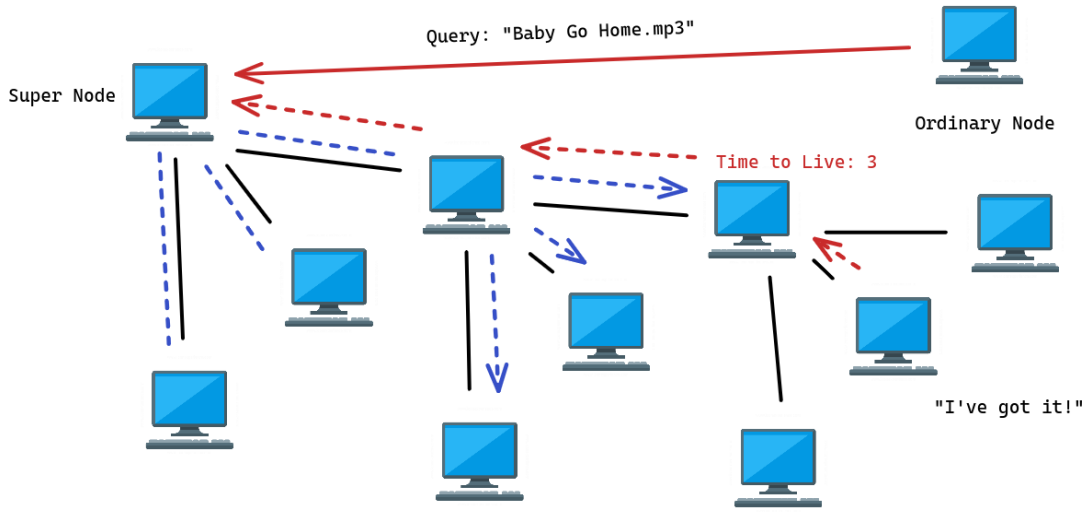

Figure 1.2.3.1: Overall System architecture of Kazaa

1.2.4 eMule

eMule [15] is a peer-to-peer file-sharing application based on the eDonkey2000 network. eMule uses a hybrid network architecture, with a centralized server for indexing and a decentralized network for file sharing.

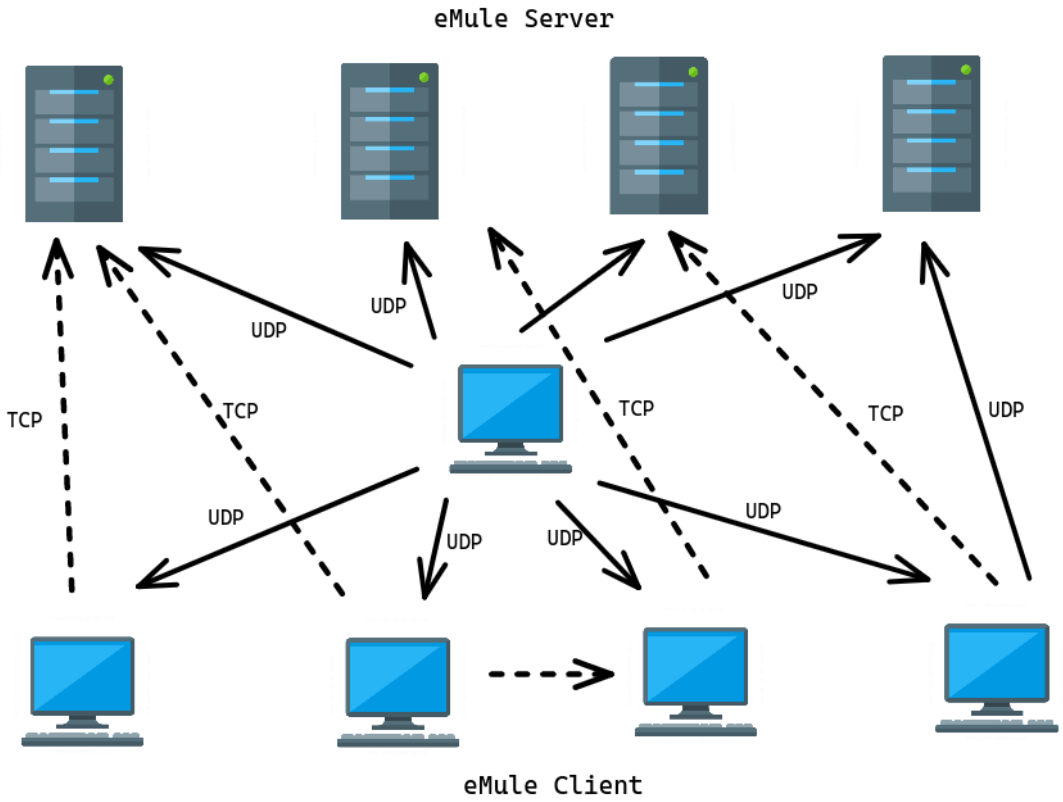

Figure 1.2.4.1: Overall System architecture of eMule

1.2.5 Torrent

BitTorrent [13] is a peer-to-peer file-sharing protocol that is used to distribute data and electronic files over the Internet. It is one of the most common protocols for transferring large files, such as digital video files containing TV shows or video clips or digital audio files containing songs. When a user downloads a file using the BitTorrent protocol, the user becomes a seeder after the download is complete. The user can then upload the file to other users, thus becoming a leecher. With that, a file can have multiple seeders and leechers at the same time.

However, the BitTorrent protocol is specifically designed for file sharing, therefore it is not suitable for general-purpose communication.

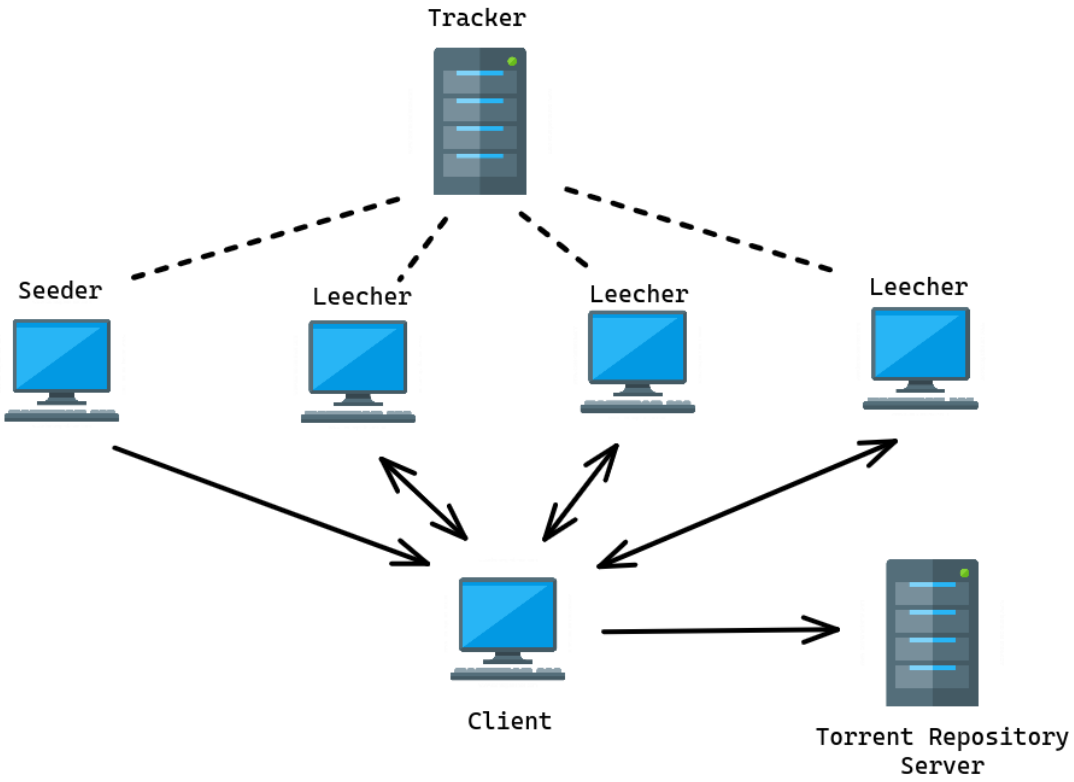

Figure 1.2.5.1: Overall System architecture of Torrent

1.3 Research Gap

The main goal of this research component is to develop a novel and reusable peer-to-peer communication protocol suitable for general-purpose communication due to most of the existing peer-to-peer protocols being designed for specific purposes, such as file sharing, and are therefore not suitable for general-purpose communication.

Skype is proprietary [17] and it relies on a super node [16] . Therefore, it is unsuitable for general-purpose communication and the super node makes it centralized.

Gnutella has open specification [18] however, it has problems such as flooding [14] and Time to Live (TTL), and according to the protocol's official sources [18] , it is no longer maintained.

Like Gnutella, Torrent is also open source, but it is specifically designed for file sharing and unsuitable for general-purpose communication.

Kazaa [19] and eMule [20] are no longer maintained either, according to their respective sources.

The observations mentioned above show that although much research has been done in this area and applications have been developed, none of them is suitable for general-purpose communication, and where each attempt has failed to be suitable for this purpose can be simplified as shown in the table below.

	Skype	Gnutella	Kazaa	eMule	Torrent
Live	Yes	No	No	No	Yes
Open source	No	Yes	No	Yes	Yes
Documented	No	Yes	No	No	Yes
Scalable	No	No	No	No	Yes
General purpose	No	No	No	No	No

Table 1.3.1: A simplification of how existing solutions are not suitable as a general-purpose communication protocol.

Therefore, developing a reusable, open-source, decentralized, peer-to-peer communication protocol is the main goal of this research component described in this proposal.

1.0 RESEARCH PROBLEM

After decades of protocol development, the Internet is still plagued by several fundamental problems. Most protocols are designed for client-server architecture and are not suitable for peer-to-peer architecture peer-to-peer applications face scalability issues as well and while there are a few methods to scale peer-to-peer applications, they have their drawbacks. Furthermore, most of the existing peer-to-peer protocols are designed for specific purposes, such as file sharing, and are not suitable for general-purpose communication. Other problems seen in such protocols include them not being open source and most of them not being maintained anymore.

According to these observations, the following questions have been identified as problems of the existing peer-to-peer protocols, which this research component aims to answer:

- What is the best way to communicate in a peer-to-peer network?
- How can a peer-to-peer communication network be scaled?
- How can a general-purpose peer-to-peer protocol be implemented?

2.0 OBJECTIVES

3.1 Main Objectives

The key intention of the proposed solution is to provide a development of a new decentralized social media protocol which keeps user data on the user's device while providing a smooth user experience. The component described in this proposal aims to develop a new, reusable peer-to-peer communication protocol that is suitable for general-purpose communication and will be helpful for the communication between the users' devices and the social media platform.

3.2 Specific Objective

The objective of creating a reusable peer-to-peer communication protocol for general purpose communication would be achieved through the following sub-objectives.

- Design an RPC (Remote Procedure Call) style full duplex communication protocol.

In RPC, developers can define their own data structures and functions and then use RPC to call the functions remotely. RPC uses a binary format to exchange data and is a full duplex communication protocol, which means that both the client and the server can send and receive messages at the same time.

- Use a key-value store to keep track of peers.

Key-value store is a data structure that maps keys to values and this structure can be used to maintain a list of peers used to keep track of peers and their IP addresses. When a peer joins the network, it is added to the key-value store, and is removed from the store when a peer leaves the network.

- Utilizing third-party storage providers for file sharing.

Sharing files via RPC call is not efficient. Therefore, third-party storage providers can be used to share files and integrating third-party storage providers with the new peer-to-peer communication protocol will make it more efficient. The Third-party storage providers can be used to share files, images, videos, and other types of data. This way, the peer-to-peer communication protocol and file sharing will be separated.

- Implement protocol with flexibility for any kind of peer-to-peer communication.

Developers should be able to change the protocol as they want and build their own applications on top of the protocol. The protocol should be flexible enough to be used for any kind of peer-to-peer communication.

3.0 METHODOLOGY

4.1 Requirement Gathering

The initial stage of this research component is to collect the requirements for the new data decentralization protocol as well as the new client that will be created to use the protocol and connect to a peer-to-peer network. The requirements are derived from current peer-to-peer applications and peer-to-peer protocols. Furthermore, previous research on existing data decentralization techniques and client programs for connecting to a peer-to-peer network has been reviewed and this analysis helps to identify the challenges in present research and the improvements that need to be made.

4.2 Feasibility Study

4.2.1 Technical Feasibility

Developing a client application capable of communicating with network nodes and peers will take precedence. Additionally, the client should be able to store user data securely on the user's native device storage. As the currently proposed technology stack can implement a client capable of including the features mentioned above, this approach can be considered technically feasible.

4.2.1 Schedule Feasibility

This research component is expected to be completed in approximately ten months, and the work has been structured accordingly. A Gantt chart has been developed to demonstrate the work to be completed within specific time frames. The Gantt chart representation of how work is broken down into manageable tasks can be found in section 4.7 of this proposal.

After contemplating the factors mentioned above, this component can be considered schedule feasible.

4.3 Proposed System Design

4.3.1 System Overview Diagram (Overall)

The following image depicts a high-level architectural perspective of the presented social network platform.

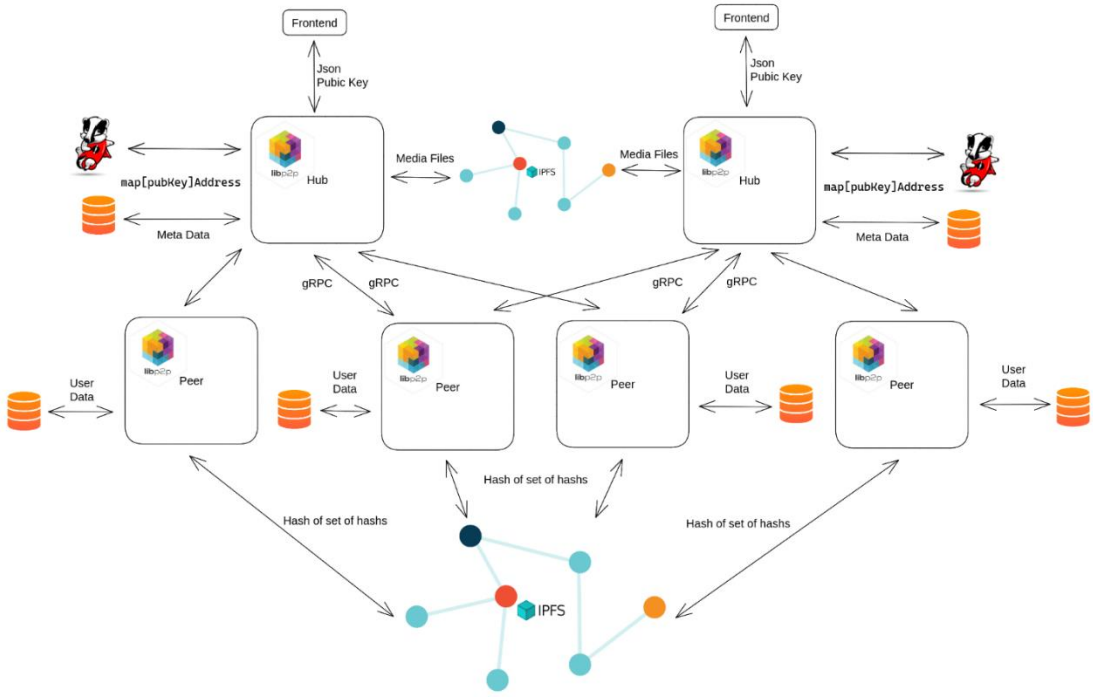

Figure 4.3.1.1: High Level architecture diagram (Overall)

This diagram provides an overview of the under-consideration DeMedia architecture. DeMedia comprises of four major components: data decentralization protocol, peer-to- peer communication, decentralized data storage, and data integrity in a decentralized network. A social network platform will be built with InterPlanetary File System (IPFS) to display these features. This infrastructure will consist of hubs, peers, and a decentralized data storage network.

4.3.2 System Overview Diagram (Individual)

The following image depicts a high-level architectural perspective of the presented social network platform.

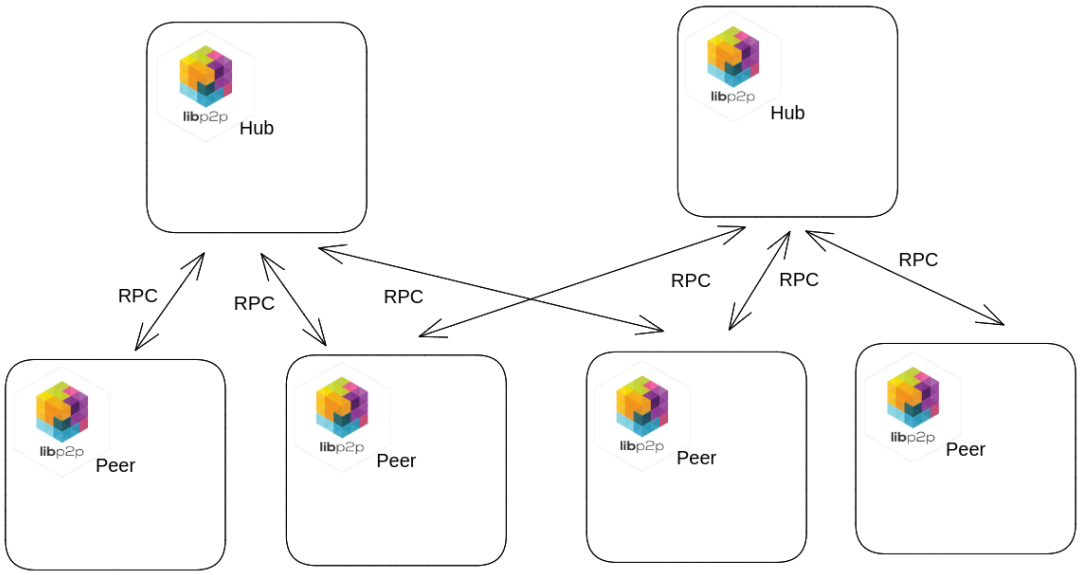

Figure 4.3.2.1: High Level architecture diagram (Component)

This component aims to develop the protocol to facilitate information decentralization along with a client program to demonstrate the protocol's capabilities. Primarily, it will be able to establish communication with hubs to connect to other peers in the network and securely store user data on the user's device. It will also display the connection information with hubs and peers.

4.4 Novelty

The novelty aspect of this research is implementing a peer-to-peer communication protocol for a decentralized social media platform. The majority of existing peer-to-peer communication protocols are designed for a specific purpose, but this research proposes a new approach by developing a general-purpose peer-to-peer communication protocol.

This new protocol is innovative because it provides support for both textual and binary content therefore it can be used for any kind of peer-to-peer communication. Additionally, it provides developers with greater control over the protocol, which is an essential aspect of developing new applications.

Another novelty aspect of this research is the integration of a key-value store to keep track of peers. This key-value store will be used to keep track of peers and their IP addresses. When a peer joins the network, it is added to the key-value store and is removed from the store when a peer leaves the network.

Overall, the novelty aspect of this research lies in its approach to peer-to-peer communication and its implementation of a peer-to-peer communication protocol. The proposed approach addresses the limitations of existing protocols, provides enhanced security and privacy, and offers developers greater control over the protocol.

4.5 Software Development Life Cycle (SDLC)

The SCRUM framework, an Agile software development framework, will be used as the primary software project management framework throughout the research. The reason to choose agile methodology over other software project management methodologies such as Lean, Waterfall model, and Six Sigma is because it is best adapted for rapid and effective software development. According to the article [21], SCRUM is a popular agile framework because it defines the systems development process as a loose collection of activities combining the finest tools and techniques a development team can devise to create a system.

According to additional information in the same article [21] , SCRUM implies that the systems development process is unpredictable, complex and can only be described as an overall progression.

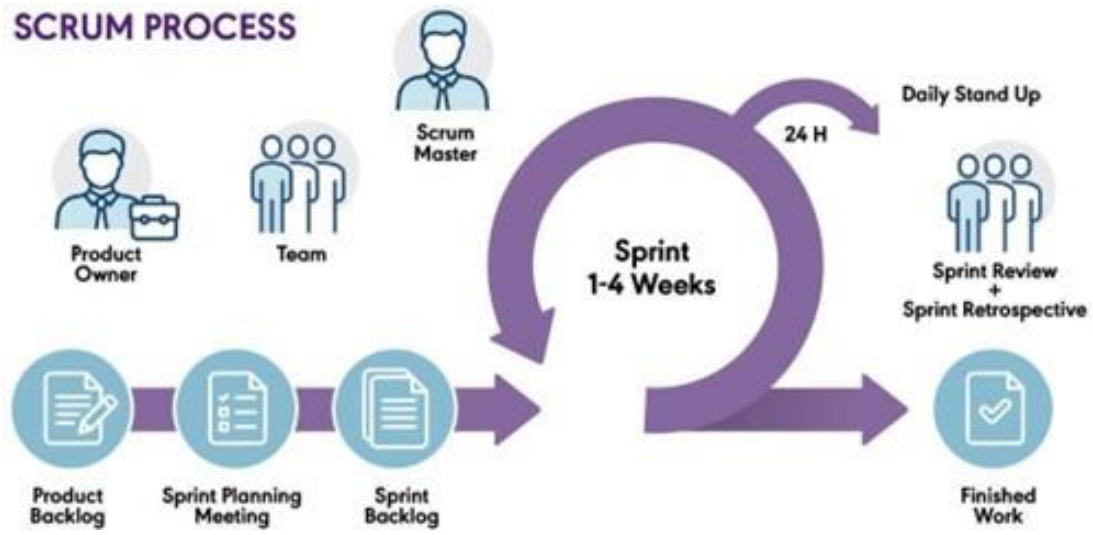

Figure 4.5.1: SCRUM process

A systematic allocation and organization of the work have been used to achieve the research's outlined objectives and achieve the desired outcomes. A detailed schedule, complete with a Gantt chart, has been made to give each part of the research sufficient time to be finished on time. In addition, the selection of appropriate technologies to effectively implement the proposed solution and demonstrate the intended results of this research has been carefully considered. As evidenced by the detailed preparation and strategic decisions made throughout this research, each step has been taken to ensure a well-structured and systematic approach to achieving the research objectives.

4.6 Work Breakdown Structure

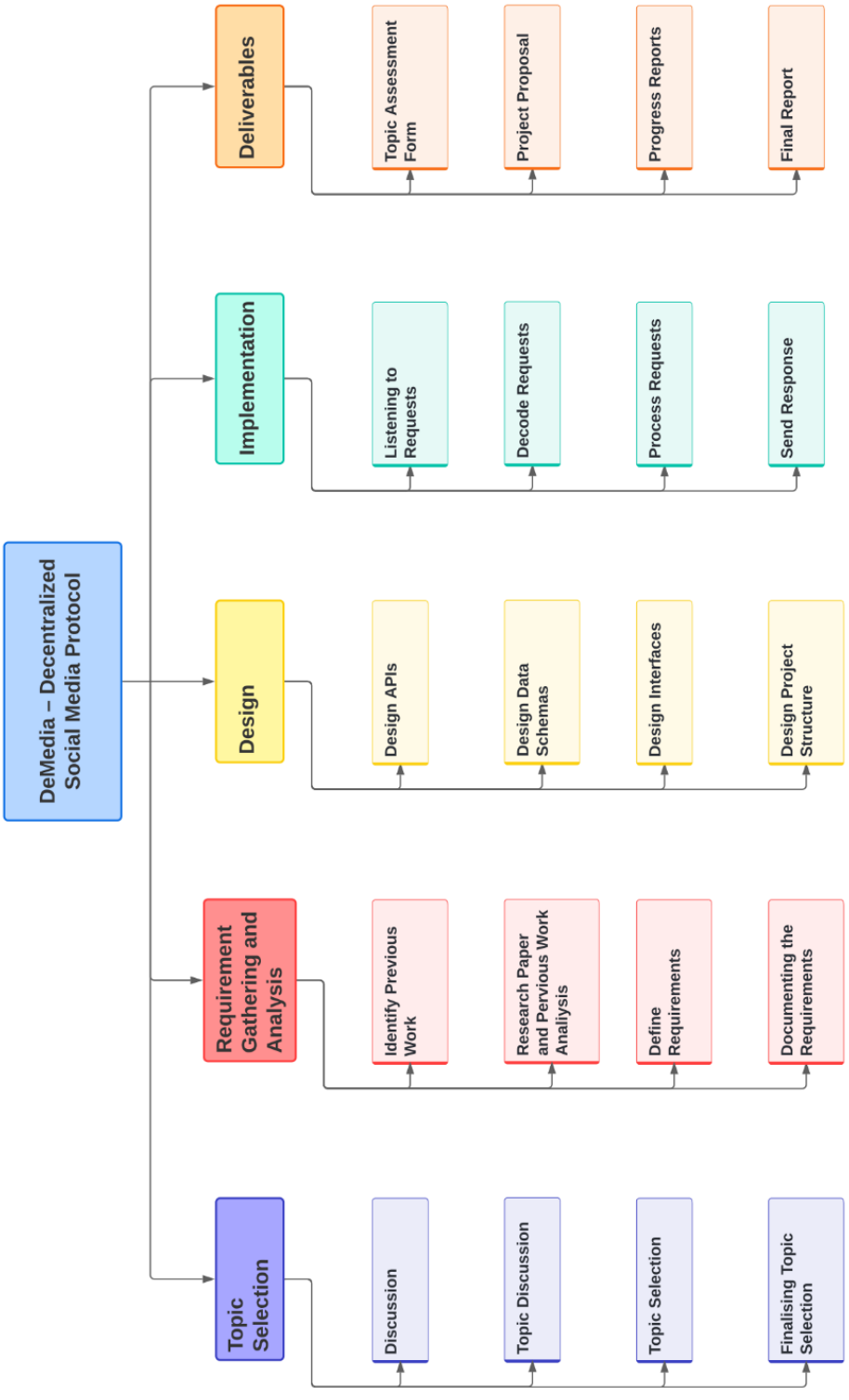

Figure 4.6.1: Work Breakdown Structure (WBS)

4.7 Work Breakdown Structure

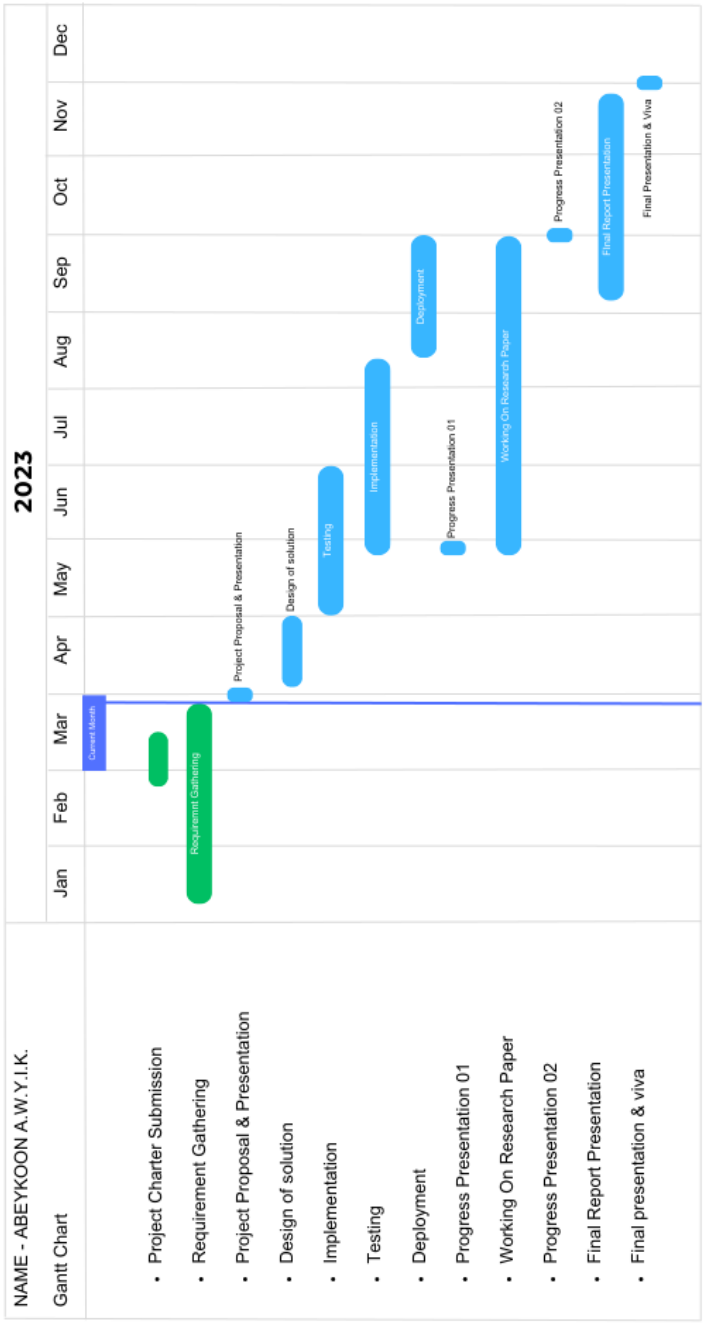

Figure 4.7.1: Gantt Chart

4.8 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 4.8.1: Proposed Tools and Technologies to be used

4.0 SOFTWARE SPECIFICATIONS

5.1 Functional Requirements

The following functional requirements are to be addressed by this component:

- Discover other peers on the network and establish connections with them.
- Should be able to transfer binary objects from one peer to another peer.
- Flexible API for integration with any peer-to-peer application

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.

5.0 DESCRIPTION OF PERSONAL AND FACILITIES

Student Number	Name	Tasks
IT29254698	Perera B.S.S.	• Implement RPC-style full duplex peer-to-peer communication protocol. • Implement a key-value store to keep track of peers. • Document the protocol. • Test the protocol.

Table 6.1: Description of personnel and facilities

6.0 PROPOSED BUDGET

The initial phase of the project does not entail any budgeted tasks as the process of requirement gathering is accomplished through an 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 the use of 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: Prposed Budget

7.0 COMMERCIALIZATION

DeMedia is focused on developing an open-source protocol that facilitates the creation of decentralized social media platforms which can be self-hosted. The project aims to provide a base model for free, which can be used by anyone interested in creating a decentralized social media platform.

In addition to the free model, DeMedia will also offer two paid models - a subscription-based membership model and an advertising-based revenue model. These paid models can be governed by the host, allowing them to generate revenue from their platform. Therefore, one could describe DeMedia as a research project focused on commercializing the development of decentralized social media platforms and this project develops a range of monetization models that can be used by hosts to generate revenue from their platforms, thereby enabling commercialization of this technology.

To further elaborate on the commercialization aspect of DeMedia, it's important to understand that the project is focused on creating a technology that can enable the development of decentralized social media platforms. By providing a free base model, DeMedia aims to make it easier for individuals or organizations to create their own social media platforms that are not controlled by a centralized authority. However, to sustain and grow these platforms, revenue generated by the two paid models offered by DeMedia are used. The subscription-based membership model allows hosts to charge users for access to premium features or content on their platform. This revenue can be used to cover the costs of hosting and maintaining the platform.

On the other hand, the advertising-based revenue model enables hosts to generate revenue by displaying advertisements on their platforms. Hosts can charge advertisers to display their advertisements on the platform, and this revenue can be used to cover the costs of hosting and maintaining the platform, as well as generating profits.

As a summary about this proposed system, DeMedia enables the commercialization of decentralized social media platforms by providing a technology that allows anyone to create their own platform, along with monetization models that enable hosts to generate revenue and sustain their platforms. This could lead to a more diverse and decentralized social media ecosystem, with a greater range of platforms catering to specific sectors and communities.

8.0 CONCLUSION

The main goal of the research component that has been detailed in this proposal is to develop a new, reusable peer-to-peer communication protocol that is suitable for general-purpose communication since many of the existing peer-to-peer protocols are designed for specific purposes, such as file sharing, and are not suitable for general-purpose communication. This component also aims to overcome the problems seen in many of the existing solutions and projects in this field such as a lack of scalability and maintenance.

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GLOSSARY

- Blockchain: A decentralized, distributed digital ledger that records transactions across multiple devices and networks.

- 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.

- Node: An object or computer in a P2P network that may communicate directly with other nodes to send and receive data.

- Protocol: A set of instructions that specify how data is transferred between hardware or software.

- Bandwidth: The quantity of data that can be sent through a network in a given amount of time.