Demedia – Decentralized Social Media Protocol

Abstract—**This research introduces a decentralized social network architecture that addresses the privacy and security concerns associated with centralized social media platforms. It implies the establishment of a protocol referred to as "DeMedia," which would enable users to complete ownership over their data by keeping it locally on their devices instead of centralized servers. In order to ensure data privacy and integrity, the protocol utilizes peer-to-peer networking and cryptographic mechanisms. The DeMedia protocol aims to provide users with a more private and secure social media experience by using decentralized technologies such as peer-to-peer networking and distributed storage. It indicates user ownership and control of their data while excluding the need for expensive blockchain infrastructure. The platform also has tools for optimizing speed and preserving the integrity of user data, including data cache preservation and data integrity preservation. The proposed protocol offers a decentralized and secure social media network that provides users control and allows direct interaction without depending on centralized intermediary parties.**

Index Terms—**Peer-to-peer networking, Data integrity, Data caching, DeMedia protocol, Decentralization, Privacy, Security, Data ownership, Distributed networks**

I. Introduction

Social media has become an integral part of modern life. Today, there are numerous social networks, such as Facebook, WhatsApp, Instagram, Twitter, and others, and their usage continues to grow [1]. These platforms enable users to connect with others, share information, and stay updated on global events. The popularity of social media can be attributed to various factors, including the need for connectivity, real-time updates, entertainment, and the ability to express opinions. Additionally, businesses have shifted their marketing strategies towards online platforms, targeting specific audiences [2]. Centralization of these social networks has led to various problems, which have recently become hot topics such as the spread of false news, misinformation, privacy concerns, and the lack of regulation [3]. To address these challenges, people have turned to Web 3.0 technologies, which offer potential solutions within the decentralized framework. The progression of Web 3.0, driven by the evolution of cryptocurrencies like Bitcoin, indicates a shift towards decentralization in social media [4]. When searching for suitable Web3 social media platforms, it is crucial to consider factors such as traditional social media platforms, social media users, decentralized social networks, internet freedom, free speech, and online networks. Mastodon and DeSo are two prominent decentralized social networking platforms currently under development. These platforms aim to confront and overcome the issues associated with centralized social media by empowering users and distributing control. They seek to challenge the monopolistic control of leading social media corporations and prioritize the interests of the platform's users [5].

Despite there being many decentralized social media platforms, several limitations and challenges remain. Many of these platforms rely on blockchain technology, which can result in higher processing costs and slower speeds. Achieving scalability and efficiency while maintaining the advantages of decentralization remains an ongoing concern. Social media platforms can be broadly categorized into two types: centralized and decentralized. At the moment, the majority of social media platforms are centralized, which means that they are owned and operated by a single entity and have a central server that manages all user data and content [6]. Social media platforms, both centralized and decentralized, serve as websites or applications that enable users to create and share information, communicate with others, and participate in social networking. The platform owner holds full control over features, policies, and access to user data. While convenient and user-friendly, centralized platforms pose risks to data privacy and security. Users must trust the platform owner to handle their data responsibly, and there is always a potential for data breaches or misuse.

Decentralized social media platforms, on the other hand, distribute control and ownership among users rather than relying on a single entity [7]. Users have direct control over their data and content, enhancing privacy and security. Data and content are stored on a distributed network of computers, and decentralized social media protocols employ mechanisms like cryptographic hashing and encryption to ensure data integrity. This decentralized power and ownership provides users with greater control over their privacy, security, and decision-making. DeMedia, a decentralized social media protocol, enables users to build their own decentralized applications using its data layer and caching mechanism. Even non-technical users can easily deploy peers on their devices at low operational costs. To ensure the integrity of user data, DeMedia utilizes a cryptographic mechanism that publishes the hash of a set of hashes on the IPFS network [8]. This mechanism helps to ensure that user data cannot be tampered with or corrupted by anyone. It provides greater security and trust in the platform.

II. Background and Literature Review

Decentralized social media platforms have become a prominent topic of discussion among researchers due to concerns over the monopoly held by social media corporations and the rapid increase in social media users. According to a survey done by the Global Web Index in July 2020 [9], social media usage increased by 10.5% over the previous year. Furthermore, the global number of people utilizing social media has surpassed 4.48 billion, more than doubling the figure reported in 2015. The most widely used social media platforms are based on centralized servers, which makes them vulnerable to a number of dangers. Data can be easily altered, sold, or stolen if the data owner is not actively controlling it. Blockchain technology [10] has been integrated with social media platforms to address these problems.

The future of the internet referred to as Web 3.0 [11], is expected to adopt a decentralized architecture. However, there are some challenges that restrict the decentralized Web 3.0, fully replacing the current centralized Web 2.0 infrastructure [12]. In the research field, efforts are being made to create decentralized social networks, using the Ethereum platform as a base. These efforts aim to provide higher privacy, ownership of data, and services guided by the community.

Although Ethereum and similar blockchain technologies have clear potential, they also have limitations [13]. However, current efforts are entirely focused on improving their efficiency and dealing with these limitations. It's interesting that even major companies such as Facebook and Google are exploring decentralized technologies [14]. This highlights how decentralization is becoming important for the digital future.

There are certain disadvantages associated with blockchains [15]. One challenge is the low transaction processing speed of blockchain systems. As an example, while payment systems like VISA can process about 1,667 transactions per second, the Ethereum network can only manage about 20 transactions per second [16]. The complexity of scalability increases as the number of nodes increases. On-chain storage also presents performance and cost concerns. Storing large amounts of data on-chain can be significantly more expensive compared to centralized storage solutions, affecting the synchronization of new blockchain nodes and consuming transaction throughput.

Existing decentralized social media platforms have been analyzed to identify implemented features and necessary enhancements. Social media platforms have become an integral part of people's daily lives, as most tasks now revolve around these networks. However, the centralized nature of these platforms raises concerns about data protection. Businesses often exploit user data, transferring it to third parties and profiting from it without the explicit consent of users. This issue has led to an increased interest in decentralized social media platforms, where users have greater control over their data. Decentralized social media networks distribute network resources and services, and user data and content are stored on blockchains and independent servers, removing centralized control by a single corporation.

III. Methodology

As discussed in the previous section, it is evident that traditional social media platforms encounter numerous challenges in the dynamic technological landscape and major research. To solve these challenges, DeMedia - a decentralized social media protocol - is being proposed as a ground-breaking alternative. This protocol provides a revolutionary path by allowing the establishment of decentralized social media platforms that do not rely on traditional blockchain technology to store user data. At its core, this strategy allows users to store their data on their devices and have control over the data.

A. System Overview

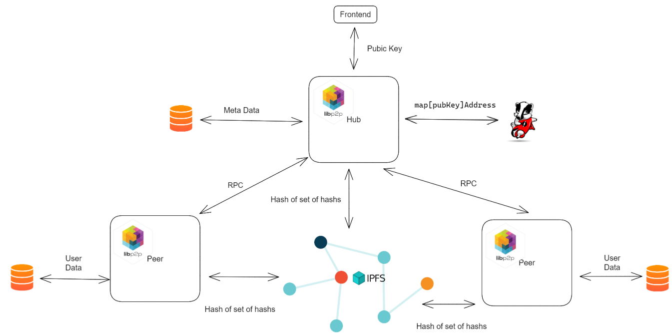

Fig. 1. Highlevel architecture Diagram

DeMedia protocol plays a major role in shaping the way individuals communicate and share information. Recognizing the growing concerns surrounding centralized control, data privacy, and security, the DeMedia protocol forms a transformative proposal for a decentralized social media platform. This paradigm shift introduces a novel structure consisting of four key components, each designed to address the limitations of conventional platforms while providing users with remarkable control over their data.

The data decentralization protocol is the core concept of the DeMedia architecture. Unlike traditional social media platforms that collect user data within centralized servers, this protocol empowers users by allowing them to store their personal information on their own devices. This significant change represents a major step towards controlling personal data, encouraging a feeling of authority that has been lacking in the current social media environment. Users can protect their privacy and strengthen their security by avoiding the drawbacks of centralized data storage. This helps them defend against data leaks and unauthorized access.

The second important aspect of the DeMedia architecture focuses on peer-to-peer communication. By leveraging this approach, the architecture facilitates direct interaction between users through a dedicated communication hub. This new approach reduces the significant dependence on centralized servers that often serve as intermediaries in conventional platforms. Consequently, communication speed and efficiency are significantly enhanced, enabling real-time interactions without the bottlenecks introduced by intermediaries. This streamlined communication is not only a testament to the technical prowess of the DeMedia architecture but also a testament to its commitment to expediting the flow of information.

The third component of the DeMedia architecture is decentralized data storage. This aspect is fulfilled by the utilization of the Interplanetary File System (IPFS), a technology that establishes a secure and fault-tolerant decentralized file-sharing network. The adoption of IPFS ensures that the platform's data storage is distributed across a network of interconnected nodes, mitigating the risks associated with a single point of failure. As a result, the architecture enhances the platform's resilience against potential outages or attacks, and maintain uninterrupted access to shared content.

The last component of the DeMedia architecture is the emphasis on data integrity within a decentralized network. This critical element endorse the commitment to maintain the security, reliability, and tamper-proof nature of the stored data. Utlizing advanced cryptographic techniques and fortified security measures, the architecture takes an uncompromising stance on data integrity. As a result, the platform promote an environment where users can confidently engage in online activities, knowing that their contributions and interactions remain unaltered and authentic.

The DeMedia architecture's ultimate aspiration is to redefine the landscape of social media by embracing decentralization while prioritizing privacy, security, and user data control. As the digital world evolves, the necessity for platforms that support these values becomes even more essential. By offering users control over their data, facilitating direct communication pathways, utilizing advanced decentralized data storage techniques, and safeguarding data integrity, the architecture stands as proof of the possibilities that arise at the nexus of technology and user-centric design.

B. Peer-to-peer Communication

Peers play a crucial role in facilitating communication within this decentralized landscape. Acting as clients, they connect users to a central hub, enabling seamless content sharing and exchange. Users have the freedom to host their own hubs or connect to hubs operated by third-party entities. This decentralized hosting approach ensures a diverse and inclusive network, enabling a rich exchange of ideas and perspectives.

The peer-to-peer communication mechanism is the backbone of the decentralized social media protocol. It allows users to establish connections with one another through a network of peers. These peers, also referred to as clients, act as intermediaries, enabling users to interact with a central hub where content is shared and distributed.

By connecting directly to hubs using peers, users enhanced privacy and control over their data. Furthermore, the decentralized nature of peer-to-peer communication fosters an inclusive and diverse network. Users from various backgrounds and regions can connect and share their content freely, enriching the social media experience with a wide range of perspectives and ideas.

C. Decentralized Communication

The hub acts as the central communication point, orchestrating smooth interactions between peers. By retrieving aggregated metadata from peers, the hub facilitates the distribution of user data to other connected peers interested in the specific context. This decentralized communication architecture mitigates risks associated with data centralization and censorship, promoting free and unrestricted connection.

In decentralized social media, hubs emerge as the facilitators of seamless communication between peers. The hub, often referred to as the central point of interaction, plays a major role in enabling users to connect and share their content with others across the network.

In this decentralized communication model, hubs do not possess centralized authority or control over user data. Instead, they act as neutral facilitators, enabling content to flow freely between connected peers. This decentralization mitigates the risks associated with data centralization, ensuring that no single entity can direct the flow of information or impose censorship.

D. Data Integrity Preservation

The most important thing is ensuring the security and authenticity of user data. This comprehensive approach empowers users with robust control over their data, protecting it from tampering and unauthorized access.

When users share their content with the hub, the data signing process comes into play. This process involves the creation of a unique signature that incorporates various elements, including peer metadata, content specifics, and hub metadata. This signature acts as a digital signature, guaranteeing the authenticity and integrity of the shared content.

With this comprehensive approach to data signing, users retain full control over their data even after it has been shared within the network. The signature serves as a digital fingerprint, allowing users to verify the origin and integrity of their content at any given time.

Users can rest assured that their content remains unaltered and secure within the social media ecosystem, empowering them with a sense of trust and ownership over their digital environment.

E. Decentralized storage of media objects

In social media, the storage and sharing of media objects, such as images, videos, and audio files, poses a significant challenge. The size of these media objects can degrade network performance and seamless data exchange.

To overcome this challenge, the decentralized social media protocol adopts a suitable solution: a decentralized filesystem. This filesystem, known as the InterPlanetary File System (IPFS), transforms the storing and sharing of media items in the social media platform.

The IPFS operates on a peer-to-peer architecture, wherein media objects are distributed and stored across multiple nodes within the network. Each media object receives a unique identifier, allowing users to access it efficiently from various sources. This decentralized approach to data storage not only enhances scalability and efficiency but also ensures that media objects are securely accessible, even in the absence of a central server.

By leveraging the IPFS, the protocol removes the bottleneck associated with centralized data storage, enabling unrestricted and seamless data exchange. Users can share and access media objects without experiencing delays or performance issues, enabling a seamless and enriching social media experience.

IV. Results and Discussions

This section presents the outcomes of the research and the practical application of the protocol, followed by a detailed discussion highlighting the findings' significance and their implications for the future of social media architecture.

A. Protocol effectiveness and usability assessment

The development of a demo social media platform provided a practical framework to evaluate the effectiveness and usability of the DeMedia protocol. Through the deployment and testing of this platform, the protocol's features and mechanisms were put to the test in a real-world setting. Users engaged with the platform interacted with peers, and shared content, thereby simulating the actual usage scenario. This usability assessment served as a validation of the protocol's design principles and its applicability to real-life social media interactions.

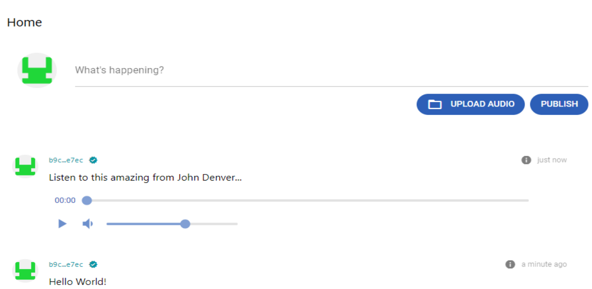

Fig. 2. Screen capture of the demo social media platform

B. Panel for Hub and Peer Data Representation

An admin panel was created within the demo platform to showcase the inner workings of the protocol. This panel visually represented the decentralized communication architecture, demonstrating how hubs serve as intermediaries between peers and facilitate content sharing. Users could view hub details and the peer connections established through the hub. This visual representation enhanced user understanding of the protocol's distributed nature and emphasized the absence of centralized control.

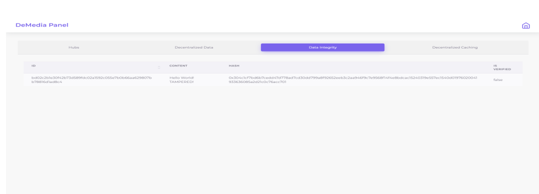

Fig. 3. Screen capture of the demo admin panel

C. Data Integrity Verification

The protocol's commitment to data integrity was demonstrated through a verification mechanism built into the demo platform. Hubs can verify the integrity of the data stored on user devices by checking the cryptographic signatures associated with users' content, generated when the content is stored on the device and published to the network. This verification process provided the platform users with a tangible assurance of shared data's authenticity and unaltered nature. This feature provided users control over their data and demonstrated the cryptographic techniques that enable the protocol's data integrity strategies.

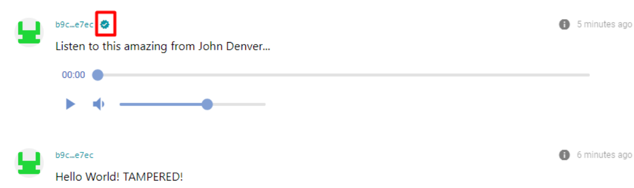

Fig. 4. Representation of data integrity

D. IPFS Media Object Caching

Integrating the InterPlanetary File System (IPFS) for media object storage was an important architectural aspect of the protocol. In the demo platform, media objects were cached on IPFS, allowing users to access and share content efficiently. This caching mechanism showcased the protocol's ability to leverage decentralized data storage while ensuring seamless content retrieval. The media object caching capability shows the protocol's scalability and potential to reduce demand for network resources and control the cache handed over to the user.

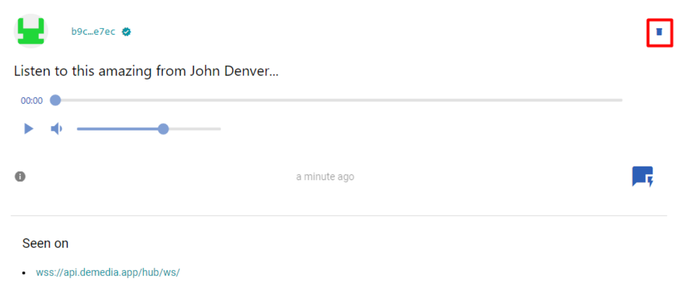

Fig. 5. Ability to remove the cache from the IPFS

E. Benchmark Tests and Performance Evaluation

By conducting thorough benchmark testing and rigorous performance evaluation, significant insights have been obtained regarding the operational efficiency of the DeMedia protocol. It was observed that certain aspects of DeMedia's performance were marginally below initial expectations, warranting attention for further optimization in pursuing enhanced network efficiency.

METHOD	REST	IPFS/DEMEDIA
REST API Call vs DeMedia API Call	182.883684ms	432.263605ms
Direct DB Fetch vs DB Fetch Through DeMedia	3.353261ms	432.263605ms
Direct DB Fetch vs REST API Call	3.353261ms	182.883684ms
Time Elapsed To Fetch Image 01	36.62113ms	23.011138ms
Time Elapsed To Fetch Image 02	4.819432ms	9.295224ms

Fig. 6. Benchmark test results

In the benchmark testing, DeMedia API calls and traditional REST API calls were compared. Additionally, the performance of data retrieval was examined, comparing the speed of fetching data directly from the DeMedia database to traditional database retrieval methods. The outcomes showed that although DeMedia performed effectively, there was a deviation from the expected efficiency expectations.

This variation indicates a significant field for future research and development. Optimization of network efficiency remains a critical path for DeMedia to reach its full potential in real-world applications. To address this issue, the protocol's complexities will be refined, procedures will be streamlined, and network interactions will be fine-tuned to achieve adequate performance and responsiveness.

The benchmark test results, together with the practical development and testing of the demo social media platform, highlight the transformational potential of the DeMedia decentralized social media protocol. These findings emphasize its viability and usability in real-world scenarios. At the same time, the observations gained through benchmark testing and performance evaluation provide a degree of realism to the assessment of operational efficiency.

The usability assessment demonstrated through the demo platform validated the protocol's design principles and emphasized its applicability in authentic social networking contexts. The integration of the hub panel and data integrity verification mechanisms not only facilitated the transparency but also highlighted the protocol's commitment to enabling user control and ensuring data authenticity.

Integrating the InterPlanetary File System (IPFS) for media object caching effectively addressed the data storage and retrieval challenges. It provided the scalability and efficiency of protocol in storing media objects.

V. Conclusion

In conclusion, this research introduces the DeMedia protocol, a decentralized social network protocol that addresses the privacy and security concerns inherent to centralized social media platforms. The protocol's innovative approach enables users to retain full ownership of their data by storing it locally on their devices, mitigating vulnerabilities associated with centralized servers. Employing peer-to-peer networking and cryptographic techniques ensures data privacy and integrity. By leveraging decentralized technologies like peer-to-peer networking and IPFS, the DeMedia protocol offers users a more secure and private social media experience. This approach empowers users with data ownership and control while negating the necessity for costly blockchain infrastructure. The protocol also features tools for optimizing data storage and maintaining data integrity, such as data cache and integrity preservation. Ultimately, the proposed protocol establishes a secure and decentralized social media network that grants users autonomy and facilitates direct interactions, freeing them from reliance on centralized intermediaries. This advancement holds substantial potential for revolutionizing the landscape of social media architecture.

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