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Decentralised Storage Systems for Blockchain Powered Applications

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ABSTRACT
With the advancements in data storage technologies, the methods of storing and retrieving the data from the data storage has been changed. Decentralized storage is an essential component of blockchain applications that enables the secure storage and sharing of data without relying on a centralized authority. With the growing adoption of blockchain technology, there is an increasing need for efficient and reliable decentralized storages for the blockchain applications. This paper presents data storage methods, centralized and decentralized data storage methods and related technologies and tools. Also presents comparative study on the different decentralized storages available for blockchain applications, including IPFS, Swarm, and Sia. The results of the study show that each storage system has its strengths and weaknesses and that the choice of storage solution depends on the specific requirements of the application.
Keywords- centralized storages, decentralized storages, IPFS, Swarm, Sia, blockchain technology

1. Introduction

The techniques for storing and retrieving data from data storage have evolved due to improvements in data storage technologies. Blockchain applications require decentralized storage in order to facilitate safe data sharing and storage without the need for a centralized authority. As blockchain technology becomes more widely used, the demand for dependable and effective decentralized storage systems grows. Data storage techniques, both centralized and decentralized, as well as associated technologies and tools, are presented in this study. Blockchain storage technology is essential because of the loopholes in centralized cloud storage platforms. According to PR Newswire, the data storage market is predicted to increase to $88.91 billion by next year. Hence, it is obvious that the contribution of blockchain storage technology to this growth is crucial [1]. Blockchain technology is increasingly being adopted across various industries due to its decentralized and secure nature. Blockchain-based applications require a decentralized storage solution that can store and share data without relying on a central authority. Decentralized storage is essential for ensuring the integrity and confidentiality of data in blockchain-based applications. There are several decentralized storage solutions available for blockchain-based applications, each with its strengths and weaknesses. This paper presents a comparative study of the different types of decentralized storage solutions, including IPFS, Swarm, and Sia. The study evaluates the performance, scalability, security, and usability of each storage solution to provide a comprehensive comparison. The P2P cloud storage is an interesting application of blockchain as it provides a decentralized data storage facility without involving any trusted third party or client-server architecture [2]. The decentralized data storage will help to eliminate the most traditional data failures and outages by increasing the security, privacy, and control of the data [3]. Basically the data storage is the place where the application data is stored. It may be a local storage or online storage according to the requirements of the different applications. Data storage requirements can be fulfilled by using various types of databases.

Decentralized storage refers to a data storage system that is distributed across a network of nodes, rather than being stored in a central location. In a decentralized storage system, data is broken down into smaller pieces and encrypted, and then distributed across the nodes in the network. This approach

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to storage provides several advantages over traditional centralized storage systems. Firstly, it eliminates the need for a central authority to manage and maintain the storage system, making it more resistant to censorship and data loss. Secondly, it allows for greater scalability and efficiency, as the storage capacity can be easily expanded by adding more nodes to the network. Finally, it enhances data privacy and security, as the encryption and distribution of data makes it more difficult for unauthorized parties to access and manipulate the data. Decentralized storage is a key component of many blockchain-based applications, where it is used to store and share data in a secure and tamper-proof manner. Data storage is a crucial aspect of decentralized and blockchain-based applications. These applications require a decentralized storage solution to store and share data securely and efficiently, without relying on a central authority. There are several decentralized storage solutions available for blockchain-based applications, each with its strengths and weaknesses.

2. Blockchain Storage

Blockchain storage can be defined as an innovative method by which data is securely stored in a decentralized network. This decentralized network functions by optimizing the unused hard disk storage space of users all over the globe to save files and important documents. Blockchain storage is a decentralized mechanism that serves as an alternative to traditional centralized cloud storage. Blockchain storage is able to provide effective solutions to the shortcomings that are inherent in the traditional centralized storage infrastructures. The Blockchain Storage consists of the shard data, encrypt shards, general hashes, Replicate Shards, Distribute Shards and Record Transactions. Shard Data-The sequence begins with the preparation of data that is to be stored. This preparation is done by creating data shards or segments. Encrypt Shards- After creating the shards, they are then encrypted. Generate Hashes- A special hash is generated for each of these shards. Replicate Shards- Thereafter, the process follows the creation of redundant copies for each of the shards. Distribute Shards- The process continues with the distribution of the shard replications across the decentralized nodes in the blockchain system. Record Transactions- The records of these transactions are stored in a blockchain ledger which serves as a decentralized record system of information concerning inter-party communications and transactions. The blockchain system evaluates and confirms the authenticity of these transactions by synchronizing the transactions across the nodes in the blockchain. In order to store data in blockchain, the data is customized into the form of transactions for effective storage in the blockchain. The data that is stored on the blockchain becomes a time-stamped network of secure logs of data. This is why the blockchain data stored is usually immutable and very safe. It also provides for transparency since it is made accessible to the public and all other users. In some cases, the location for data stored in the blockchain may not be permitted to be customized in a transaction form and then stored. In these cases when the blockchain does not allow this action, the data is stored in small bits on the chain via the use of addresses. Therefore, blockchain data stored in a secure network of systems is made possible when someone saves data, encodes it, and then uses it as an address to forward a transaction. This is where the data becomes stored in the blockchain. The storage location is automatically encoded into the address of the receiving system. This ensures that the data is transmitted securely.

It is more affordable than cloud storage. It does not require buying any equipment or software to run there is no need to hire broad admin resources. It offers higher transparency than the cloud provider the transactions are always immutable, verifiable, and tamper-resistant. It is highly available and more fault-tolerant. Blockchain offers better security to the data stored on the decentralized ledger.

The everlasting nature of blockchain is considered as one of its challenges. The provision of network security is done by the miners. The indestructibility of blockchain storage can be considered as a disadvantage to flexibility procedures. The varying mode of performance is another factor that serves as one of the challenges of blockchain storage. Blockchain requires signature verification. Without the verification of this peculiarity, the system is a mousetrap. Consensus mechanisms remain one of the major challenges of the blockchain industry as a whole. There are different consensus mechanisms, and this affects the operation of the blockchain network. The redundancy that

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characterizes the process of blockchain storage has been considered by some as needless duplications that hinder the system's efficiency.

3. Decentralized Storage Platforms for blockchain applications-

3.1 Swarm

This blockchain storage platform aims to provide a maximally decentralized and redundant store for Etherum's public record. Its major objective is to aid the storage and distribution of dapp code and data, as well as blockchain data. It is resistant to Distributed Denial of Service It has a zero downtime. It is fault intolerant. It features a good incentive system that permits trading resources for payment. It is censorship-resistant.

3.2 IPFS

This simply means the Interplanetary File System. Basically, IPFS functions as a file-sharing platform that is targeted at restructuring the process by which information and data are being distributed all over the world. IPFS is the platform to store the data on distributed systems. It is useful for decentralized applications development. IPFS uses content based addressing to access the files. In IPFS we can access the content by the hash and the hash represents the file and not the location where the file is stored. It's the responsibility of the IPFS network to collect the bits and pieces of the file and deliver them to the user. Hash addressing makes the content immutable. Does not disappear like the current HTTP protocol. Saves bandwidth by collecting content from multiple nodes and pieces instead of from one server. Access to content "offline" or in low connectivity 3rd world or rural areas, in the same sense that git works offline. IPFS is Censorship resistant and Caters to the decentralization ethos. It can effectively store and manage files. It tracks the versions of these files over time. It features a Self-certifying File System (SFS). SFS is a distributed file-sharing system that does not need any special authentication for the exchange of data to take place. Using IPFS we can securely get access to transactions with the transparency of the blockchain storage.

3.3Sia

The most prominent characteristic of Sia is that it provides cost-effective and efficient methods of utilizing data systems that are free to access by all users and at the same time not under the control of any single company. It segments the files into 30 divisions before distributing it to hosts across the globe. This helps to ensure that no single host is responsible for a single point of malfunction. This optimizes the general system uptime and redundancy. It utilizes smart contracts in sending the files. This allows for the creation of cryptographic service level agreements (SLAs) that are consequently stored on the Sia blockchain. It does not require any intermediary or other forms of third-parties. In fact, renters and hosts transact with Siacoin.

3.4 Storj

This is one of the foremost decentralized, end-to-end encrypted cloud storage systems that have been introduced. Its major objective is to eliminate censorship, unauthorized data monitoring, and downtime. It connects renters and farmers (the computer selling space) through a Distributed Hash Table (DHT). This system helps to organize contract offers from both parties to a vast group of nodes. It is "publish-subscribe" model that prompts a node to sign an incomplete contract and publish it to the network. In response, other nodes can subscribe to interesting contracts.

3.5 Maidsafe

This is a self-governed distributed network for data storage that provides Secure Access for Everyone. It is extremely reliable, immutable, and available. Secured retrieval of data is made possible through a secure routing and addressing network. An encrypted file is peculiar to the encryption keys. This makes it highly secure and impossible to be decrypted by the vaults in which they are stored. It gives ownership to the server operators and not to whoever might have created the data.

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4. Methodology & Analysis:

Comparison of the various available decentralized storages is presented in terms of types, features, benefits, working, technology, platform, compatibility and integration.

Decentralized Storage	Type	Features	Benefits	Working	Technology	Platforms	Compatibility	Integration
IPFS	Peer-to-peer, Distributed	Content-addressed, Immutable, Versioned	High security, Fast access, Decentralized	Content-based addressing, Merkle DAG	Distributed hash table, BitTorrent protocol	Linux, macOS, Windows	Compatible with HTTP	Integrates with various blockchain protocols
Sia	Peer-to-peer, Distributed	Redundancy, Encryption, Proof-of-Storage	High security, Cost-effective, Decentralized	File sharding, Reed-Solomon coding	Blockchain-based, Proof-of-Work consensus	Linux, macOS, Windows	Compatible with HTTP	Integrates with various blockchain protocols
Storj	Peer-to-peer, Distributed	Encryption, Auditing, File-sharing	High security, Cost-effective, Decentralized	Shard-based data distribution, Storj Share	Blockchain-based, Proof-of-Replication consensus	Linux, macOS, Windows	Compatible with HTTP	Integrates with various blockchain protocols
Filecoin	Peer-to-peer, Distributed	Filecoin storage market, Proof-of-Replication	High security, High performance, Decentralized	InterPlanetary File System (IPFS), Filecoin blockchain	Proof-of-Replication consensus	Linux, macOS, Windows	Compatible with HTTP	Integrates with various blockchain protocols
Swarm	Peer-to-peer, Distribut	Immutable data,	High security, Decentra	Chunk-based storage,	Ethereum-based,	Linux, macOS,	Compatible with HTTP	Integrates with Ethereu

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	ed	Incentivization, PSS messaging	lized, Cost-effective	Swarm Bee client	Proof-of-Work consensus	Windows		m blockchain

Table 1: Comparative study on various decentralized storages

It is observed that all the solutions offer peer-to-peer and distributed storage, with various features and benefits that make them suitable for different use cases. IPFS and Swarm are more focused on content-addressed storage and messaging, while Sia, Storj, and Filecoin are more focused on redundancy, encryption, and proof-of-storage. All the solutions offer high security, decentralization, and compatibility with HTTP, with different levels of performance and ease of use. It is important to note that the choice of a particular decentralized storage solution depends on the specific needs of the application, and developers should carefully evaluate the features, benefits, and compatibility of each solution before making a decision.

Table2 : Comparison of decentralized storages in security, performance, scalability, and ease of use:

Decentralized Storage	Security	Performance	Scalability	Ease of Use
IPFS	High	Moderate	High	Moderate
Sia	High	High	High	Low
Storj	High	High	High	Moderate
Filecoin	High	High	High	Low
Swarm	High	Moderate	High	Low

It is observed that all the solutions offer high security and scalability, but there are trade-offs in terms of performance and ease of use. IPFS and Swarm are relatively easy to use but offer moderate performance, while Sia and Storj offer high performance but have a steeper learning curve. Filecoin, on the other hand, offers high performance and security but may be less user-friendly compared to other solutions. It is important to note that the choice of a particular decentralized storage solution depends on the specific needs of the application, and developers should carefully evaluate the pros and cons of each solution before making a decision.

5. Results and Discussion:

The comparative study on decentralized storages for blockchain-based applications analyzed four popular decentralized storage solutions: IPFS, Swarm, Sia, and Storj. The study compared these solutions based on several parameters, including security, performance, scalability, and ease of use.

Security is a critical aspect of decentralized storage solutions, and the study found that all four solutions provided strong security mechanisms. IPFS and Swarm used content-addressing to ensure data integrity, while Sia and Storj used encryption and redundancy to ensure data privacy and availability. Performance was another important parameter, and the study found that IPFS and Swarm performed well in terms of file retrieval speed, while Sia and Storj were slower due to their use of erasure coding and redundancy. However, Sia and Storj provided better performance in terms of overall data durability and availability. Scalability is a key requirement for any decentralized storage solution, and the study found that all four solutions were designed to be highly scalable. IPFS and Swarm used a distributed hash table to distribute data across a network of nodes, while Sia and Storj

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used a decentralized marketplace model to incentivize users to provide storage space. Ease of use was also considered in the study, and it was found that IPFS and Swarm were relatively easy to set up and use, while Sia and Storj required more technical expertise.

The study found that all four decentralized storage solutions provided strong security and scalability, but each had its own strengths and weaknesses. IPFS and Swarm were more suited for applications that required fast file retrieval, while Sia and Storj were better for applications that required high data durability and availability. The choice of a decentralized storage solution will depend on the specific needs of the application, and developers should carefully evaluate each solution based on their requirements.

6. Conclusion

In this paper we have presented the concept of blockchain storage and its need and advantages in the context of online storage scenarios. Decentralized storages provide many advantages over traditional cloud storage, including increased security, transparency, and control. By leveraging blockchain technology, these solutions ensure that data is stored securely and that users have complete control over their data. The comparative study on decentralized storages for blockchain-based applications found that there are several promising solutions available for decentralized storage. Each solution has its own strengths and weaknesses, and the choice of a particular solution depends on the specific needs of the application. Blockchain application developers can refer to this information and choose the best decentralized storage for their specific requirement according to various parameters discussed.

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