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Resource-Conscious Secure Storage Model for Ethereum-Based Decentralized Clouds

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ABSTRACT: As statistics is the backbone of the digital financial system dependence on centralized cloud storage structures makes users prone to troubles concerning statistics breaches operational price and lack of control this paper examines the deployment of a decentralized cloud storage DCS framework with the use of interplanetary file system IPFS and Ethereum blockchain clever contracts to triumph over those drawbacks the gadget proposed here improves protection and information availability by incorporating aes-256 encryption sharding of records and decentralized metadata control by the introduction of a working prototype based on react.js, Ethereum wallet, ether.js and solidity this mission illustrates the viability of a decentralized statistics garage whilst resolving troubles with latency user adoption and value effectiveness experimental consequences affirm enhancements in safety and availability establishing a strong platform for additional research on decentralized storage architectures

KEYWORDS: Decentralized Cloud Storage, IPFS, Blockchain, AES-256 Encryption, Smart Contracts, Data Sharding, Ethereum.

I. INTRODUCTION

The exponential growth of data in the digital age requires the detection of secure, talented, and scalable data storage solutions. Traditional centralized cloud storage systems, despite their ubiquity, face challenges related to scalability, single points of failure, errors, data violations, and costs. Users and organizations often lack full control over their data in centralized systems

Decentralized Cloud Storage (DCS) has emerged as a promising alternative for addressing these challenges. The network has been distributed to utilize blockchain technology, providing strong data storage with enhanced security, privacy, and efficiency. This shift aligns with global trends towards decentralization across various fields, supported by advancements in blockchain and distributed systems. Government policy articles and think tank reports emphasize the importance of data in general and the necessity to mitigate the risks associated with centralized architectures.

For example, white papers from the EU's GDPR initiative stress the need for privacy-focused data solutions, while reports from the Electronics and Information Technology (MeITY) and the Indian Ministry highlight the increasing significance of decentralized architecture in achieving digital infrastructure.

II. LITERATURE SURVEY.

The project rests on several basic works that are missing in centralized systems, and identifies decentralized alternatives

Renuka Prasad Pasupulati and Dr. Jordan Shropshire (2020) were contrary to centralized and decentralized cloud architecture in terms of performance, scalability, and flexibility dimensions. Centralized architecture (eg AWS) provides customized data processing and storage, but there are single points for errors and regulatory challenges. Decentralized models through technologies such as IPF and blockchain improve data accuracy and ownership, although they are challenged by high delays and bandwidth barriers.

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Khan et al. (2022) ECC, IPF, and Ethereum suggest a secure decentralized storage model based on smart contracts. Their approach guarantees safe storage of encrypted data and open access control, although high Ethereum gas costs are a matter of scalability. Team-2 solutions and non-standard symbols are proposed to reduce the cost of transactions.

Bacis et al. (2023) Current privacy and accessibility methods based on all-or-some transformation (Aont) and fountain code. These are safe ways to secure computer pieces and provide the opportunity for partial recovery, but are computationally expensive and are not suitable for low-power environments. Deployment of real-world needs to be adapted

Year	Title	Authors	Description	Drawbacks
2023	Dynamic Allocation for Resource Protection in Decentralized Cloud Storage	Enrico Bacis, Sabrina De Capitani di Vimercati, Sara Foresti, Stefano Paraboschi, Marco Rosa, Pierangela Samarati	Enhances confidentiality and availability of data using AONT and fountain codes.	High computation cost.
2022	Proposed Model for Secured Data Storage in Decentralized Cloud by Blockchain Ethereum	Nabeel Khan, Hanan Aljoaey, Mujahid Tabassum, Ali Farzamnia, Tripti Sharma, Yew Hoe Tung	Model using ECC encryption and IPFS for data distribution and storage using contracts running on Ethereum.	High gas fees for payment and sharing operations.
2022	Towards Decentralized Cloud Storage with IPFS: Opportunities, Challenges, and Future Considerations	Trinh Viet Doan, Yiannis Psaras, Jorg Ott, Vaibhav Bajpai	IPFS is used as a building block for decentralized data storage with censorship resistance.	Data stored on IPFS is not permanent.
2020	Analysis of Centralized and Decentralized Cloud Architectures	Renuka Prasad Pasupulati, Dr. Jordan Shropshire	Analyzes the cloud and distributed systems from the design, storage, networking, and computing perspectives.	High bandwidth and latency issues prevent real-time applications.

Table 1: Literature survey review

III. METHODOLOGY

The decentralized cloud storage system is structured to leverage a modular architecture that ensures data security efficiency and scalability the design integrates key components such as data sharding encryption peer-to-peer networks and blockchain-based metadata storage a user-friendly interface bridges the technical backend with seamless interactions for file upload sharing and retrieval each module is carefully orchestrated to handle distributed data storage and secure access the below diagrams illustrate the interactions between the local file system IPFS blockchain and the user interface.

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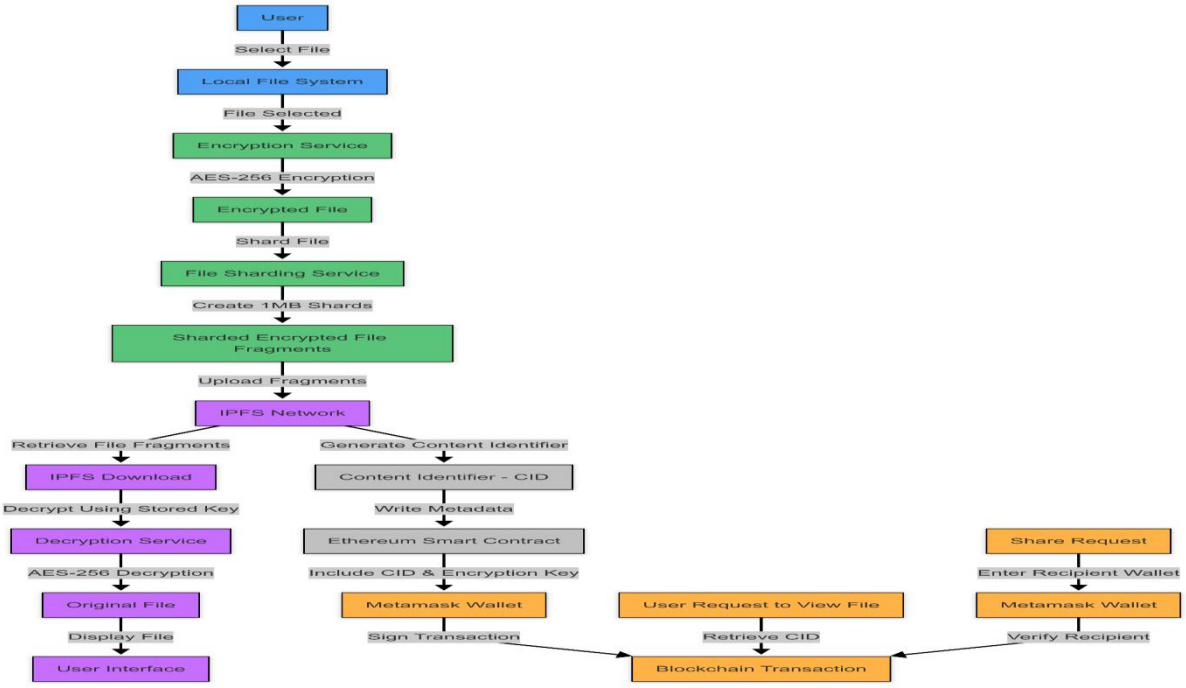

Fig 1: The end-to-end process of file storage, retrieval, and sharing in a decentralized cloud storage system

IV. IMPLEMENTATION

The project implementation began with defining the system architecture and selecting the technology stack. The front end was developed using react.js to create a responsive web interface for users to upload, view, and manage files. An Ethereum wallet was integrated for user authentication and transaction management, allowing secure interactions with the Ethereum blockchain.

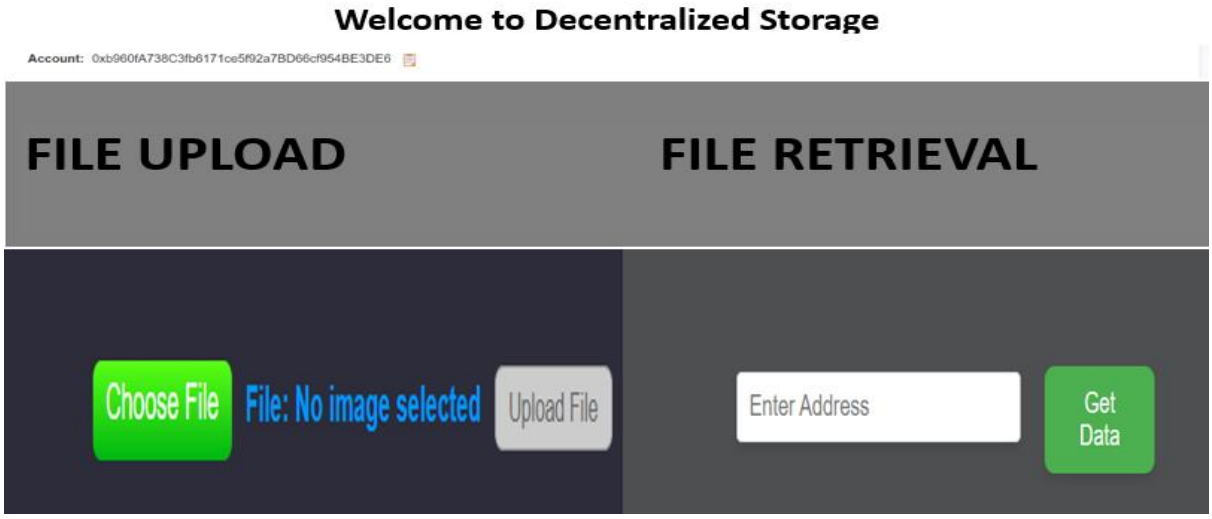

Fig.2: Home page after authentication

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File handling involves multiple steps when a user uploads a file the system first encrypts the file using AES-256 encryption to ensure confidentiality the system prompts the users to confirm the blockchain transaction with the appropriate Ethereum gas fee which makes the system transparent and secures each operation like uploading file metadata is explicitly authorized and signed by the Ethereum wallet of the user before starting the process on the Ethereum network file retrieval follows a reverse process the encrypted shards are fetched from IPFS using the stored CIDs reconstructed and decrypted using the AES key the UI displays the file to the user after successful decryption and assembly.

Fig 3: Shows the file retrieval

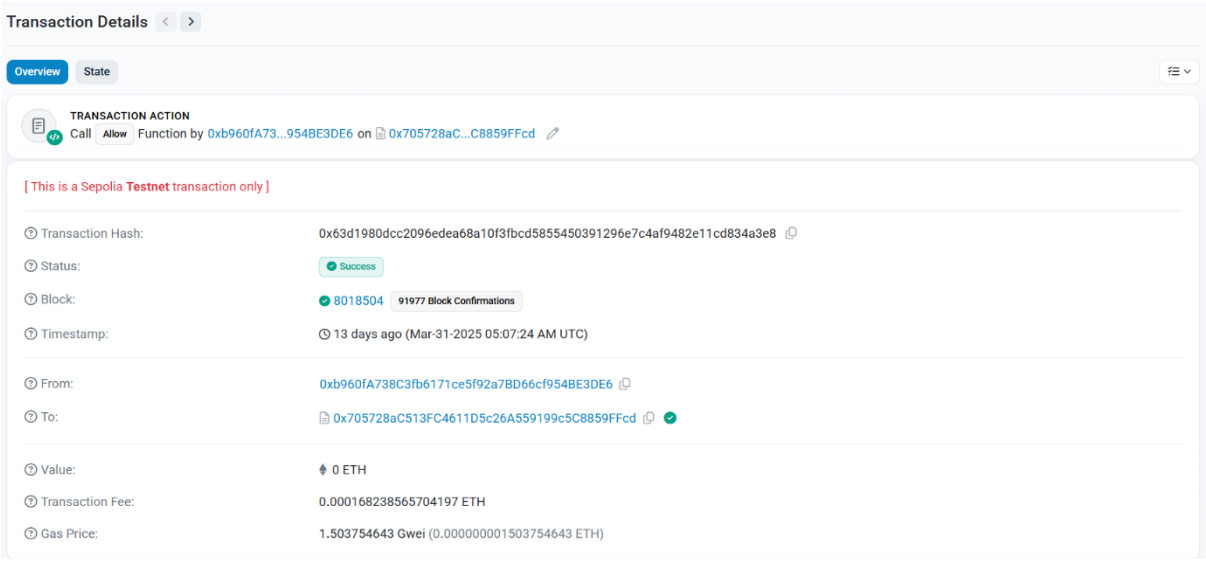

Fig 4: Transaction details

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This modular implementation ensures that data storage, encryption, access control, and user interface remain decoupled and maintainable. It allows users to store and retrieve files in a secure, transparent, and decentralized manner.

V. CONCLUSION AND FUTURE WORK

This project successfully implements a decentralized cloud storage system using IPFS for distributed storage AES-256 for encryption and Ethereum smart contracts for secure access control the integration with Ethereum wallet and a react.js-based UI provides users with a secure and intuitive experience the system ensures confidentiality availability and decentralization addressing the key limitations of traditional cloud storage solutions experimental evaluation confirmed reliable file upload encryption shard distribution and metadata management on the blockchain access control through smart contracts and blockchain transaction through Ethereum wallet worked as intended.

For future development, the system can be enhanced by incorporating layer-2 solutions like Polygon to reduce gas costs, persistent pinning, or integration with filecoin can improve long-term data availability.

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