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Blockchain Based Secure Digital Identity Verification System for Robust Documents

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Abstract
Current digital identity verification systems, like DigiLocker, predominantly rely on centralized storage and often lack robust privacy and security measures, making them susceptible to data breaches and unauthorized access. Existing digital identity verification systems, such as DigiLocker, primarily focus on providing a centralized storage solution for digital documents but often fall short in ensuring comprehensive privacy and security. These systems are vulnerable to data breaches and unauthorized access, posing significant risks to users. This paper proposes a novel approach for securely creating and verifying digital identities for shopkeepers through the integration of Blockchain technology and OTP split verification, augmented by a blockchain-based cloud server. a novel approach to integrating cloud servers as fundamental blocks within a blockchain architecture. This hybrid system leverages both traditional physical nodes and cloud servers, ensuring enhanced security, scalability, and reliability for storage. This concept introduces a hybrid system where cloud servers are integrated as fundamental blocks within a blockchain architecture, enhancing the overall security, scalability, and reliability of data storage. The proposed system enables shopkeepers to generate self-sovereign IDs that are securely stored on a decentralized, immutable blockchain, verified by government authorities to ensure authenticity. Privacy is preserved through advanced encryption techniques and regular data integrity checks. Additionally, the OTP split verification method enhances security by distributing parts of a unique OTP across multiple communication channels, reducing the risk of interception. This innovative approach offers a robust, scalable, and privacy-preserving solution for digital identity management.

Keywords: Digital identity verification, Blockchain technology, OTP split verification, Cloud-based blockchain, Self-sovereign identity, Privacy-preserving security

I. Introduction

The approach to integrating cloud servers as fundamental blocks within a blockchain architecture. This hybrid system leverages both traditional physical nodes and cloud servers, ensuring enhanced security, scalability, and reliability for storage [1]. The proposed concept introduces a hybrid system where cloud servers are integrated as fundamental blocks within a blockchain architecture, enhancing the overall security, scalability, and reliability of data storage. Physical nodes in this system are traditional blockchain nodes responsible for validating and storing transaction data across a decentralized network [2]. These nodes form the backbone of the blockchain, ensuring data integrity and security through consensus mechanisms like Proof of Work (PoW) or Proof of Stake (PoS) [3]. Each physical node independently verifies transactions, maintains a copy of the blockchain ledger and participates in the network's consensus process, contributing to the robustness and decentralization of the blockchain network [4].

In contrast, cloud-based nodes are cloud servers configured to function as blockchain nodes [5]. These nodes integrate seamlessly with the traditional physical nodes, enhancing the network's storage and security capabilities. Cloud-based nodes offer significant advantages, including on-demand scalability, high availability, and advanced security features inherent to cloud infrastructure. By acting as blockchain nodes, these cloud servers validate transactions, store blockchain data, and participate in the consensus process, thereby reinforcing the network's decentralization and resilience [6]. The blockchain-integrated cloud server is a pivotal component of this hybrid

system, providing secure storage blocks within the blockchain network by leveraging advanced encryption and security protocols to safeguard stored data. This server ensures that all digital identities and transaction data remain immutable and transparent, enhancing overall security [7]. The cloud server offers on-demand scalability, allowing the blockchain network to efficiently handle increased data loads without performance degradation. Its high availability and fault tolerance further ensure that the blockchain network remains reliable and accessible at all times, even in the face of unexpected disruptions or spikes in demand [8].

II. Literature survey

Smith and Johnson provide a comprehensive review of cloud-enhanced blockchain systems, highlighting various architectures and their applications. They discuss how cloud computing can enhance the scalability and performance of blockchain networks, making them suitable for enterprise-level applications [9]. The review covers different approaches to integrating cloud services with blockchain, such as off-chain storage and computation, and examines the impact on security, privacy, and decentralization. The authors emphasize the need for robust infrastructure and protocols to manage interactions between cloud and blockchain components effectively.

Lee, Kim, and Park survey the landscape of self-sovereign identity management on blockchain, focusing on its benefits and challenges [10]. They explore various blockchain platforms and their suitability for managing digital identities autonomously. The survey covers topics like decentralized identifiers (DIDs), verifiable credentials, and the integration of zero-knowledge proofs for privacy-preserving identity verification. The authors analyze existing solutions and propose future research directions to improve the scalability, security, and interoperability of self-sovereign identity systems.

Gupta and Singh present a study on secured document storage and sharing using blockchain and the InterPlanetary File System (IPFS) [11]. They introduce a hybrid approach that leverages blockchain for data integrity and IPFS for efficient and decentralized file storage. The study discusses various security mechanisms, including access control and encryption techniques, to ensure confidentiality and integrity of documents stored in a distributed environment. The authors evaluate the performance and scalability of their proposed solution through experimental results and outline potential applications in sectors requiring secure document management.

Wang et al. present a cloud-based blockchain framework designed to facilitate privacy-preserving data sharing. Their approach integrates cloud computing with blockchain technology to enhance data security and scalability [12]. The framework utilizes cryptographic techniques and smart contracts to enforce data access control and privacy policies. The authors discuss the implementation details and evaluate the framework's performance in terms of throughput and latency. They highlight the potential applications in sectors like healthcare and finance where data security and privacy are paramount.

Patel and Desai propose a self-sovereign identity management system based on blockchain technology [13]. They present a novel architecture that allows individuals to manage their digital identities autonomously and securely. The system leverages blockchain's immutability and decentralized nature to ensure authenticity and integrity of identity credentials. The authors discuss the integration of zero-knowledge proofs and biometric authentication for enhanced security and privacy. They provide insights into the system's implementation and its potential impact on identity management practices.

Sharma et al. propose a secured document storage and access control system using blockchain and cloud computing [14]. Their approach ensures data confidentiality, integrity, and availability by combining blockchain's transparency and cloud computing's scalability. The authors introduce a decentralized access control mechanism that uses smart contracts to enforce fine-grained access policies. They evaluate the system's performance and security features, demonstrating its applicability in scenarios requiring secure document management and collaboration.

Kumar and Jain present a comprehensive review of blockchain-based cloud storage systems. They analyze various architectures and technologies used to build secure and scalable cloud storage solutions based on blockchain [15]. The review covers topics such as data integrity, confidentiality, and access control mechanisms. The authors discuss the integration of blockchain with cloud computing to achieve enhanced security and decentralized data management. They outline current challenges and future research directions in this emerging field.

Mishra et al. propose a decentralized and self-sovereign identity management system leveraging blockchain and artificial intelligence (AI). Their system enables individuals to control their identities securely without relying on central authorities [16]. The authors integrate AI algorithms for identity verification and risk assessment, enhancing the system's usability and security. They evaluate the system's performance and discuss its potential applications in digital identity verification and access management.

Li et al. propose a novel blockchain-based framework for secured document storage and sharing in the cloud. Their framework enhances data security and privacy by leveraging blockchain's tamper-proof ledger and decentralized consensus mechanism [17]. The authors introduce a distributed access control model using smart contracts to manage document permissions securely. They evaluate the framework's performance and scalability, demonstrating its effectiveness in ensuring data integrity and confidentiality in cloud-based environments.

III. Secure Digital Identity Verification System Including Cloud As Blocks For Robust Documents

This hybrid block structure distributes transaction data and blocks across both physical and cloud-based nodes, ensuring redundancy and data integrity as multiple copies of the data are maintained across the network [18]. Both physical and cloud nodes participate in the consensus mechanism, collaboratively validating transactions and adding new blocks to the blockchain. This hybrid approach combines the strengths of traditional and cloud-based nodes, creating a more resilient and secure blockchain network that can adapt to varying workloads and operational conditions.

Enhanced security features are designed to protect data and maintain privacy. All data stored on cloud-based nodes is encrypted, ensuring that sensitive information remains confidential and secure from unauthorized access. Access to these cloud-based nodes is further protected by Multi-Factor Authentication (MFA), which requires users to verify their identity through multiple authentication methods, adding an additional layer of security against unauthorized access [19]. Regular security audits are conducted on cloud nodes to ensure they comply with the latest security standards and protocols, continuously improving the network's security posture and mitigating potential vulnerabilities.

The implementation of this system begins with configuring cloud servers to function as blockchain nodes, integrating them with existing physical nodes to ensure transaction data is synchronized across the entire network. This synchronization ensures consistency and redundancy, as both physical and cloud-based nodes maintain up-to-date copies of the blockchain ledger. New blocks are created and validated by both physical and cloud-based nodes, leveraging the storage capabilities of both node types to ensure that blocks are redundantly stored across the network. Both physical and cloud nodes participate in the network's consensus mechanism, collaboratively validating transactions and ensuring the integrity of the blockchain. Regular data integrity checks are performed to maintain consistency across the network, ensuring that all nodes have accurate and up-to-date copies of the blockchain ledger. All data on cloud nodes is encrypted, and access is controlled through MFA, with regular security audits ensuring that cloud nodes meet the highest security standards.

This system offers several advantages over traditional blockchain systems. The integration of cloud-based nodes adds an additional layer of security, with advanced encryption and MFA reducing the risk of data breaches. Cloud nodes provide on-demand scalability, allowing the blockchain network to efficiently handle increased data loads without compromising performance. Cloud infrastructure ensures high availability and fault tolerance, keeping the blockchain network robust and reliable. By distributing data across both physical and cloud-based nodes, the system ensures redundancy and integrity, minimizing the risk of data loss. The integration of cloud servers as blocks within a blockchain architecture offers a hybrid solution that enhances security, scalability, and reliability for data storage. By leveraging the strengths of both traditional physical nodes and cloud-based nodes, this system provides a robust, secure, and efficient blockchain network suitable for various applications, including digital identity verification, financial transactions, and data management. This approach addresses the limitations of traditional blockchain systems and paves the way for future advancements in secure and scalable blockchain technology.

Pseudo code for Cloud integrated Blockchain based secured storage

```
// Define the structure of a blockchain node
```

```
class BlockchainNode:
    def __init__(self, node_id, node_type):
        self.node_id = node_id
        self.node_type = node_type
        self.ledger = []
        self.current_transactions = []
    def add_transaction(self, transaction):
        self.current_transactions.append(transaction)
    def create_new_block(self):
        new_block = {
            'index': len(self.ledger) + 1,
            'transactions': self.current_transactions,
            'previous_hash': self.get_last_block_hash(),
            'timestamp': current_time()
        }
        self.current_transactions = []
        self.ledger.append(new_block)
        return new_block
    def get_last_block_hash(self):
        if self.ledger:
            return hash(self.ledger[-1])
        return None
// Initialize blockchain nodes (both physical and cloud-based)
nodes = []
// Function to initialize nodes
def initialize_nodes(node_count, cloud_count):
    for i in range(node_count):
        nodes.append(BlockchainNode(i, "physical"))
    for i in range(cloud_count):
        nodes.append(BlockchainNode(node_count + i, "cloud"))
// Function to distribute transaction data and blocks
def distribute_data(transaction):
    for node in nodes:
        node.add_transaction(transaction)
// Function to create new blocks in all nodes
def create_blocks():
    for node in nodes:
        node.create_new_block()
// Consensus mechanism involving both physical and cloud-based nodes
def consensus():
    longest_chain = max(nodes, key=lambda node: len(node.ledger)).ledger
    for node in nodes:
        node.ledger = longest_chain
// Data encryption
def encrypt_data(data):
    // Implement encryption logic
    return encrypted_data
// Multi-Factor Authentication (MFA) for cloud nodes
def verify_access(node):
    if node.node_type == "cloud":
```

```
        // Implement MFA logic
        return mfa_verified
    return True
// Regular security audits
def perform_security_audit(node):
    // Implement security audit logic
    return audit_results
// Node integration setup
initialize_nodes(node_count=5, cloud_count=3)
// Example of adding a transaction and distributing it
transaction = {
    'sender': 'A',
    'recipient': 'B',
    'amount': 10,
    'timestamp': current_time()
}
distribute_data(transaction)
create_blocks()
consensus()
encrypted_transaction = encrypt_data(transaction)
// Example of verifying access to a cloud node
for node in nodes:
    if node.node_type == "cloud":
        if verify_access(node):
            // Access granted
            pass
// Example of performing security audits
for node in nodes:
    perform_security_audit(node)
```

IV. Result and Performance Analysis

Current digital identity verification systems, such as DigiLocker, predominantly rely on centralized storage solutions, which pose significant risks to user privacy and security. These systems often lack robust measures to prevent unauthorized access and are susceptible to data breaches. The centralized nature of these systems makes them a single point of failure, compromising user data integrity and confidentiality. To address these challenges, we propose a novel approach that integrates Blockchain technology and OTP split verification for digital identity management. Our system aims to provide enhanced security, scalability, and privacy for shopkeepers generating self-sovereign IDs.

Blockchain technology is leveraged to create a decentralized and immutable ledger for storing digital identities. This ensures that once a digital identity is verified and stored on the blockchain, it cannot be altered or tampered with. Government authorities can verify these identities to ensure authenticity, thereby enhancing trust in the system. OTP split verification is employed to enhance security during the digital identity creation and verification process. This method distributes parts of a unique OTP across multiple communication channels, reducing the risk of interception and unauthorized access. This ensures that even if one channel is compromised, the entire OTP cannot be intercepted, thereby enhancing the overall security of the digital identity management system.

Advanced encryption techniques are used to preserve user privacy. These techniques ensure that sensitive information stored on the blockchain remains confidential and is accessible only to authorized entities. Regular data integrity checks are performed to detect any unauthorized changes to the stored digital identities, maintaining the integrity and trustworthiness of the system. To evaluate the proposed system, we conducted several experiments to assess its performance in terms of security, scalability, and reliability: There are various attack

scenarios, including attempts to compromise the OTP split verification process and unauthorized attempts to access the blockchain-stored digital identities. Results showed that the proposed system effectively mitigates these security risks.

The system's ability to handle a large volume of digital identity creation and verification requests. The integration of cloud servers as fundamental blocks within the blockchain architecture allowed the system to scale horizontally, accommodating increased demand without compromising performance. The reliability of the system under different network conditions and load levels. The hybrid architecture of traditional physical nodes and cloud servers ensured high availability and fault tolerance, minimizing downtime and ensuring continuous access to digital identity verification services.

Metrics	Proposed System Blockchain + OTP Split	Traditional Systems Centralized Storage Solutions
Security	High	Low
Resistance to breaches	✓	✗
Tamper resistance	✓	✗
Privacy preservation	✓	✗
Scalability	High	Moderate
Ability to handle volume	✓	✓
Horizontal scaling	✓	✗
Reliability	High	Moderate
Availability	✓	✓
Fault tolerance	✓	✗
Downtime	Low	High
Performance	Efficient	Decentralized performance
Attack scenario simulation	✓	✗
Large volume handling	✓	✓
Network condition handling	✓	✗

V. Conclusion

In conclusion, the proposed approach combining Blockchain technology and OTP split verification offers a robust, scalable, and privacy-preserving solution for digital identity management. By leveraging blockchain's decentralized and immutable nature, along with OTP split verification for enhanced security, the system addresses the limitations of current centralized digital identity verification systems. Experimental results demonstrate the effectiveness of the proposed system in providing secure, scalable, and reliable digital identity management services for shopkeepers, ensuring their self-sovereignty and protecting user. In conclusion, the proposed digital identity verification system represents a significant advancement over current centralized solutions like DigiLocker. By integrating Blockchain technology and OTP split verification, augmented by a blockchain-based cloud server, the system enhances security, scalability, and privacy for shopkeepers generating self-sovereign IDs. The use of Blockchain ensures decentralized and immutable storage of digital identities, while OTP split verification adds an extra layer of security by distributing parts of a unique OTP across multiple channels. Advanced encryption techniques and regular data integrity checks further safeguard user privacy and ensure the reliability of stored information. Experimental evaluations demonstrate the system's effectiveness in mitigating security risks, handling scalability challenges, and maintaining high reliability under varying network conditions. This innovative approach not only addresses the vulnerabilities of current digital identity verification systems but also lays the foundation for broader applications in secure document storage and access control.

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