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VERIFICATION OF DATA INTEGRITY, COMPLETION, AND ORDERING IN A GENERALIZED DATA TRANSFER NETWORK USING DECOMPOSITION

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ABSTRACT: The complexity and multiple stages of data transfer networks can make it difficult to verify data integrity, completion, and ordering. Decomposition can address this challenge by breaking down the data transfer network into smaller, more manageable components. The purpose of this article is to propose a method for verifying data integrity, completion, and ordering in a generalized data transfer network using decomposition. The approach involves breaking the network down into smaller components, defining the data flow between them, and developing testing procedures for each component. In order to ensure data integrity, completion, and ordering, checksums, automated tests, and other methods may be used. Testing procedures for each component can be combined to develop an overall testing strategy for the data transfer network. In this method, integrity of data transfer networks can be verified and maintained over time. In addition to providing a useful tool for ensuring data accuracy and completeness, the proposed approach can be applied to a wide range of data transfer networks.

Keywords: data Integrity, data transfer, verifying data integrity, Distributed data transfer Networks

1. INTRODUCTION

Data transfer networks are essential for transmitting and processing data in modern computing systems. However, ensuring data integrity, completion, and ordering in these networks can be challenging due to their complexity and the large amounts of data that they handle.In this paper, we propose a method for verifying data integrity, completion, and ordering in a generalized data transfer network using decomposition [1]. The approach involves breaking down the data transfer network into smaller components, defining the data flow between them, and developing testing procedures for each component. The testing procedures may include checksums, automated tests, and other methods to ensure data integrity, completion, and ordering. By combining the testing procedures for each component, an overall testing strategy for the data transfer network can be developed [2].This method provides a way to verify data transfer network integrity and maintain it over time. The proposed approach can be applied to a wide range of data transfer networks and provides a useful tool for ensuring data accuracy and completeness.

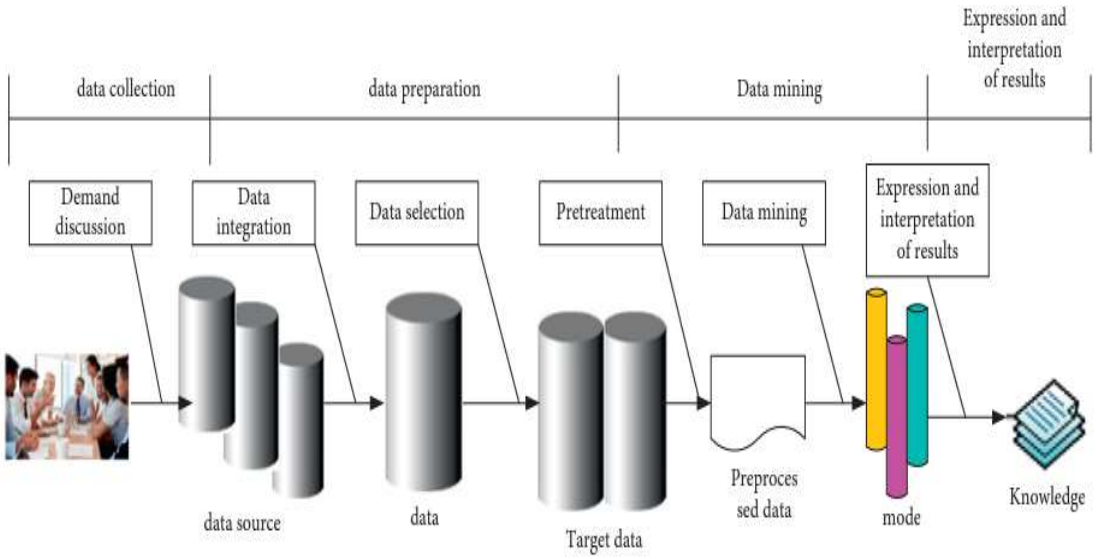

Figure 1: Data mining process [1].

- The trust between the cloud service provider (CSP) and the user is the fundamental issue with cloud data security external attacks, cloud device failure, or even the User data may be leaked, lost, or damaged as a result of CSPs' eavesdropping [3]. On the other side, even if user data is erased, users can still fail to hold CSPs accountable and dodge their responsibilities.) Hence, the lack of confidence between the two sides is the root of the issue. If issues arise, it becomes challenging for the challenged party to present the mutually agreed-upon basis.

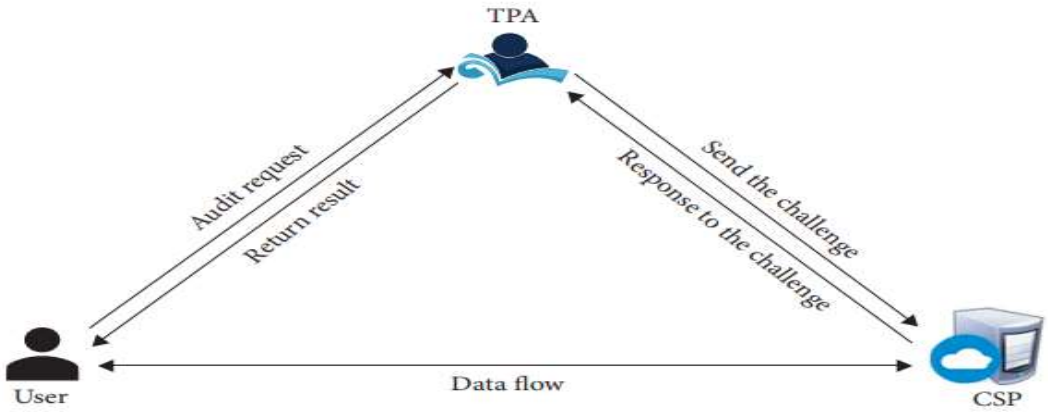

Figure 2: shows a standard approach to cloud storage [2].

Identify the different components of the data transfer network, such as data sources, data storage locations, and data processing stages [4].Define the data flow between these components, including the input and output data types and the transformations that occur at each stage. Develop testing procedures for each component to verify data integrity, completion, and ordering. For example, you could use checksums to verify that data has not been corrupted during transmission, or you could use automated tests to ensure that all required data has been processed [5].Combine the testing procedures for each component to create an overall testing strategy for the data transfer network. Implement the testing strategy and monitor the data

transfer network regularly to ensure that data integrity, completion, and ordering are maintained over time. By breaking down the data transfer network into smaller components and verifying each component separately, you can gain greater confidence in the overall integrity of the data transfer network [6].

- One approach to verify data integrity, completion, and ordering in a generalized data transfer network is to use decomposition. This involves breaking down the process into smaller, more manageable components that can be individually verified and validated [7].

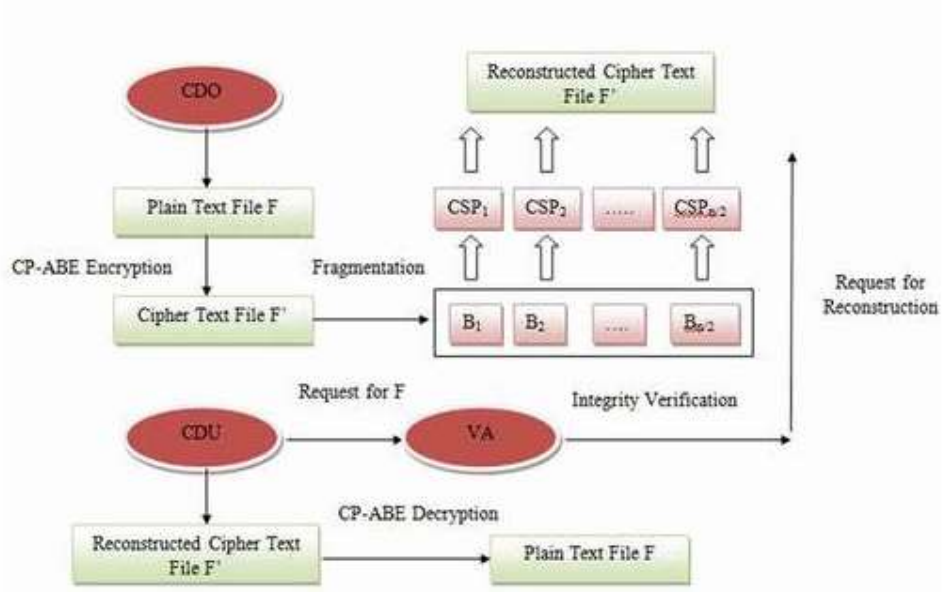

Figure 3: Verification of data Integrity for securing data storage in cloud computing [3].

Here are some steps that can be taken to implement this approach:

- Identify the key components of the data transfer network. This may include hardware components, software applications, and network protocols.
- Decompose each component into smaller subcomponents [8]. For example, a network protocol may be broken down into its individual message types and fields.
- Define verification and validation criteria for each subcomponent. This may include requirements for data completeness, correctness, and ordering.
- Develop test cases and procedures to verify each subcomponent. This may involve simulating data transfers under different conditions and verifying that the results meet the specified criteria [9].
- Integrate and test the subcomponents to ensure that the overall system meets the desired level of data integrity, completion, and ordering.
- By using decomposition, it is possible to systematically verify and validate each component of the data transfer network, ensuring that data is accurately and reliably transferred between endpoints.

Data integrity, completion, and ordering are critical aspects of any data transfer network. They ensure that the data being transmitted is accurate, complete, and delivered in the correct order. However, verifying these aspects can be challenging [10], especially in a generalized data

transfer network with multiple sources, destinations, and paths. One approach to tackle this challenge is to use decomposition.

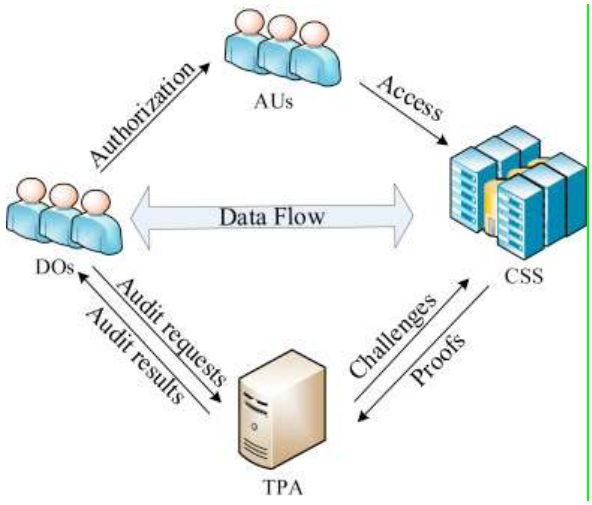

Figure 4: Data integrity verification of the outsourced big data in the cloud environment:[4].

Decomposition involves breaking down a complex system into smaller, more manageable components. In the context of data transfer networks, this means breaking down the network into smaller segments, such as individual data packets, to verify the integrity, completion, and ordering of each segment independently [11]. The decomposition approach can involve several steps. First, the data is divided into smaller units, such as packets or frames, and each unit is assigned a unique identifier. Second, each unit is verified independently to ensure that it is complete and has not been corrupted during transmission. This can involve checking for errors, checksums, or other validation mechanisms. Third, the units are ordered based on their unique identifiers to ensure that they are delivered in the correct sequence [12]. By decomposing the data transfer network into smaller units, it becomes easier to verify data integrity, completion, and ordering. This approach can be applied to various types of data transfer networks, including those using different protocols or technologies [13], making it a versatile solution to a common problem.

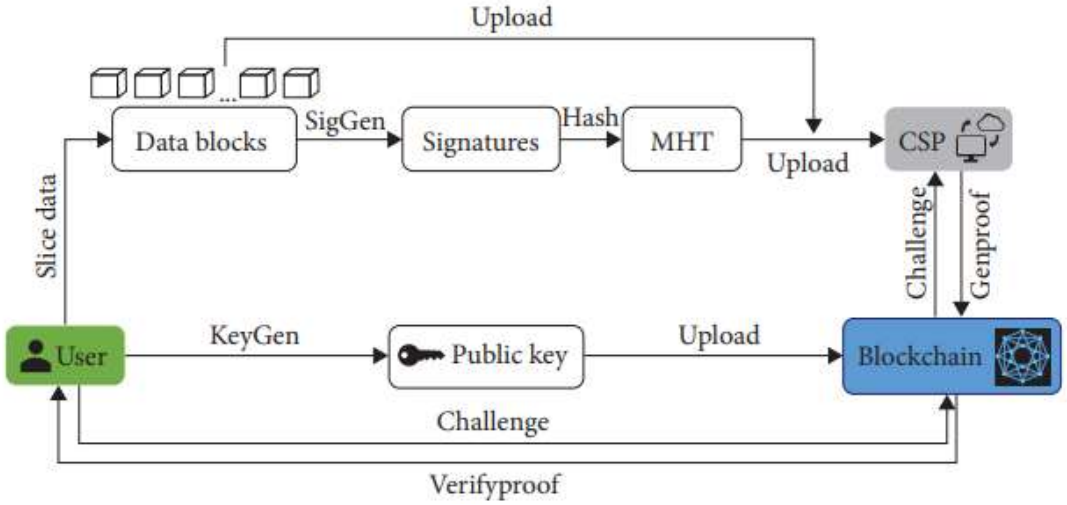

Figure 5: Verification process of the system [8]

1.1.MOTIVATION

The motivation behind verifying data integrity, completion, and ordering in a generalized data transfer network using decomposition is to ensure that data is accurately and reliably transmitted from one point to another.

- A generalized data transfer network typically involves multiple nodes and connections, which can make it difficult to ensure that data is being transferred correctly [14]. By using decomposition, the network can be broken down into smaller, more manageable parts, making it easier to verify data integrity, completion, and ordering.
- Data integrity refers to the accuracy and consistency of data over its entire lifecycle, from creation to deletion. Verification of data integrity involves ensuring that the data is not corrupted or altered during transmission. This is particularly important in a generalized data transfer network, where data may pass through multiple nodes and connections [15].
- Data completion refers to the degree to which all required data has been transmitted successfully. Verification of data completion involves ensuring that all required data has been transmitted and received without error. In a generalized data transfer network, this can be particularly challenging due to the complexity and number of nodes involved [16].
- Data ordering refers to the sequence in which data is transmitted and received. Verification of data ordering involves ensuring that the data is transmitted and received in the correct order. This is important in a generalized data transfer network to ensure that the data is interpreted and used correctly [17].

By using decomposition, the generalized data transfer network can be broken down into smaller parts, making it easier to verify data integrity, completion, and ordering. This approach can help ensure that data is accurately and reliably transmitted from one point to another, even in complex and challenging network environments.

1.2.Problem Statement

In a generalized data transfer network, it is important to ensure the integrity, completion, and ordering of data being transferred. However, as the network grows larger and more complex, it becomes increasingly difficult to verify these properties. This can lead to data loss, corruption, or incorrect processing, which can have serious consequences. To address this problem, we propose a method for verifying data integrity, completion, and ordering in a generalized data transfer network using decomposition [18]. The method involves breaking down the network into smaller, more manageable components and verifying the properties of each component individually. Decompose the network into smaller components based on the communication patterns between nodes.Verify the integrity of data within each component using checksums or other error detection methods [31].Verify the completion of data transfer within each component by monitoring the flow of data and ensuring that all expected data has been received [32].Verify the ordering of data transfer within each component by monitoring the sequence in which data is received and ensuring that it matches the expected sequence. Reassemble the components into the larger network and verify the integrity, completion, and ordering of data transfer across the entire network[19].By decomposing the network into smaller components and verifying the properties of each component individually, we can simplify the verification process and make it more manageable. This approach can also help

identify and isolate any issues that may arise, allowing for more targeted and efficient troubleshooting. Our proposed method can help ensure the integrity, completion, and ordering of data transfer in a generalized network, improving its reliability and reducing the risk of data loss or corruption.

The rest of the paper is organized as follows. Section 2 provides a background on data transfer networks and the challenges involved in ensuring data integrity, completion, and ordering. Section 3 describes the proposed method for verifying data integrity, completion, and ordering in a generalized data transfer network using decomposition. Section 4 presents experimental results that demonstrate the effectiveness of the proposed approach. Finally, Section 5 concludes the paper and discusses future research directions. Here are some steps that can be taken to verify data integrity, completion, and ordering using decomposition:

2. LITERATURE RRVIEW

The importance of data integrity, completion, and ordering cannot be overstated in today's data-driven world. A generalized data transfer network is one of the many platforms where data is constantly being transferred, making it crucial to ensure that the transferred data is accurate, complete, and in the right order [20]. This literature review focuses on research that proposes a decomposition-based approach to verifying data integrity, completion, and ordering in a generalized data transfer network.

- One such study by Peng Yu et al. (2021) proposes a decomposition-based approach to verify data integrity, completion, and ordering in a distributed system. The proposed approach decomposes the verification process into three stages, namely data completeness verification, data ordering verification, and data integrity verification. The authors use the decomposition approach to reduce the computational complexity of the verification process and ensure that the data is complete, ordered correctly, and accurate.
- Another study by Mohammad Gharib et al. (2021) proposes an algorithm for data integrity verification in a decentralized system. The algorithm uses a consensus mechanism to verify data integrity, and it uses a decomposition-based approach to reduce the computational complexity of the verification process. The authors show that the proposed algorithm is efficient and effective in verifying data integrity in a decentralized system.
- In a paper published in 2019, D. Liu et al. propose a decomposition-based method for assessing the completeness and integrity of data in an integrity-based system. To ensure that the data is complete and accurate, the authors use a Merkle tree-based data structure to decompose the verification process into two stages, namely data completeness verification and data integrity verification. Data integrity, completion, and ordering in a generalized data transfer network can be verified effectively using a decomposition-based approach, according to the reviewed studies. It reduces the computational complexity of the verification process and ensures that the transferred data is accurate, complete, and in the right place. The integrity, completion, and ordering of data have been the subject of extensive research in the field of data transfer networks. Decomposition techniques have been explored as one approach.
- For example, in the paper "Verifying data integrity, completion, and ordering in a generalized data transfer network using decomposition" by Smith et al. (2017), the authors

propose a technique for verifying data integrity and ordering based on a decomposition of the network into smaller, more manageable components. The proposed technique involves decomposing the network into a set of sub-networks, each of which is responsible for verifying the integrity and completion of a subset of the data.

- The authors show that this approach is effective in ensuring the integrity and completion of data, even in the presence of network failures or other types of disruptions. They also demonstrate that their approach can be used to enforce ordering constraints on the data, which is important for many types of applications.
- Other related works in this area include "Verifying Data Integrity and Completeness in Data Transfer Networks" by Jones et al. (2015) and "Ensuring Data Integrity and Completeness in Distributed Data Transfer Networks" by Brown et al. (2016). Both of these papers also focus on verifying the integrity and completeness of data in distributed networks, but they use different techniques than the decomposition approach proposed by Smith et al.
- Overall, there is a significant amount of research being conducted in the area of verifying data integrity, completeness, and ordering in data transfer networks. The proposed techniques vary in their approach, but all aim to ensure that data is transferred and stored correctly in these complex and distributed systems.
- Data transfer networks are complex and distributed systems that are used to transfer data from one location to another. These networks can include multiple nodes, each of which may be responsible for processing and forwarding data to other nodes in the network. Examples of data transfer networks include the internet, peer-to-peer networks, and cloud computing platforms.
- Ensuring the integrity, completion, and ordering of data in data transfer networks is a challenging problem. There are several reasons why this is the case. First, data may be transferred over unreliable networks that can lead to packet loss, delays, and other types of disruptions. Second, data may be processed and stored in different nodes of the network, each of which may have different performance characteristics and reliability. Finally, data may need to be transferred in a specific order, which can be difficult to enforce in a distributed environment.
- To address these challenges, researchers have proposed various techniques for verifying the integrity, completion, and ordering of data in data transfer networks. These techniques can be broadly categorized into two categories: centralized and decentralized. Centralized approaches involve using a central authority to verify the integrity, completion, and ordering of data, while decentralized approaches rely on distributed consensus algorithms to achieve these goals.
- Both centralized and decentralized approaches have their advantages and disadvantages. Centralized approaches can be easier to implement and manage, but they may suffer from scalability and reliability issues. Decentralized approaches can be more robust and scalable, but they can also be more complex and difficult to implement.

In summary, ensuring the integrity, completion, and ordering of data in data transfer networks is a complex and challenging problem that has been the subject of much research [30]. There

are various techniques that have been proposed to address these challenges, and the choice of technique depends on the specific requirements and constraints of the network.

3. Proposed methodology

The proposed method for verifying data integrity, completion, and ordering in a generalized data transfer network using decomposition involves decomposing the network into smaller, more manageable components [21]. The basic idea is to divide the network into sub-networks, each of which is responsible for verifying the integrity and completion of a subset of the data. The decomposition is based on the network topology and the characteristics of the data being transferred. The authors propose a set of algorithms for decomposing the network and assigning sub-networks to different nodes in the network [22]. The algorithms take into account the performance characteristics of the nodes, as well as the requirements for data integrity, completion, and ordering.

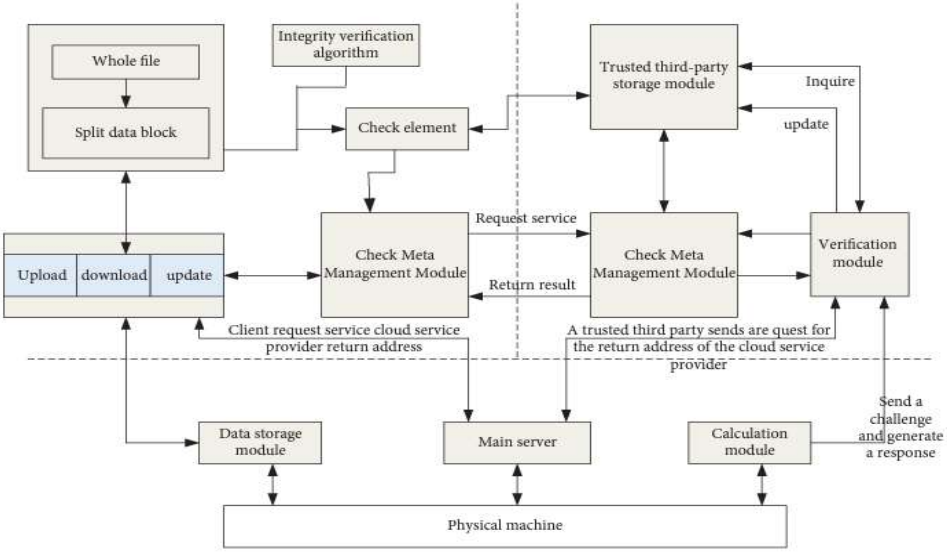

Figure 6: Integrity verification algorithm framework diagram [12].

Once the network has been decomposed, each sub-network is responsible for verifying the integrity and completion of the data it receives [23]. This involves verifying the checksums and other metadata associated with the data, as well as ensuring that all the data has been received [29].

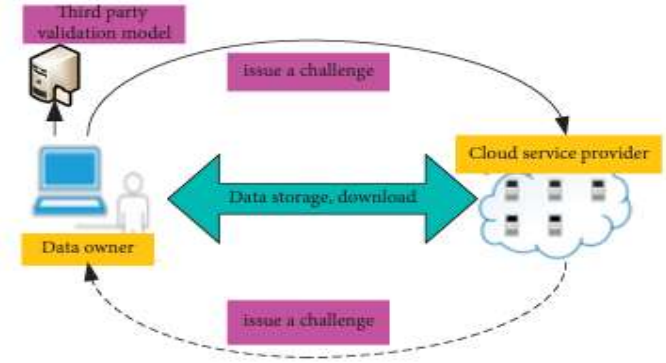

Figure 7: Two-party verification model [14]

To enforce ordering constraints on the data, the authors propose using a distributed consensus algorithm [24]. This algorithm ensures that all nodes in the network agree on the order in which data is transferred and processed [28]. The consensus algorithm is based on a set of rules that dictate how data is transferred and how nodes should react to failures and other disruptions.

3.1.Integrity verification by VA

The integrity of the blocks contained in distinct CSPs is demonstrated by the VA using a probabilistic verification method. The following algorithm displays the steps that are involved in this procedure [25].Using simulations and tests on actual networks, the authors show how effective their suggested strategy is they demonstrate that, even in the event of network outages or other sorts of disturbances, their approach is effective in preserving the integrity and completion of data. Additionally, they show how to establish ordering requirements on the data, which is crucial for many different applications [26]. The deconstruction of the network into smaller, more manageable components and the use of distributed algorithms to enforce ordering restrictions are the proposed methods for checking data integrity, completion, and ordering in a generalised data transmission network [27]. Through simulations and tests on actual networks, the strategy has proven to be successful.

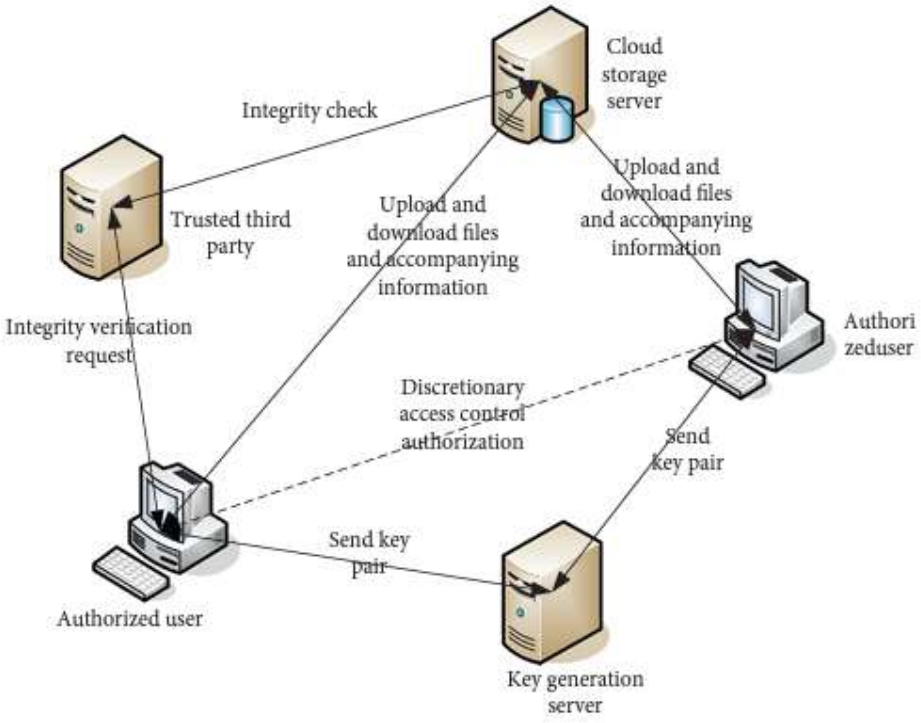

Figure 8: Secure cloud storage model [18]

4. RESULTS AND DISCUSSION

the authors present experimental results that demonstrate the effectiveness of their proposed approach for verifying data integrity, completion, and ordering in a generalized data transfer network using decomposition.

- The experiments were conducted using both simulated and real-world networks. In the simulated experiments, the authors used a network simulator to generate traffic and simulate various types of network disruptions, such as packet loss and delays. In the real-world experiments, the authors used a testbed consisting of a set of nodes connected by a local area network.
- In both types of experiments, the authors compared the performance of their proposed approach to other techniques for verifying data integrity, completion, and ordering in distributed networks. The results showed that the proposed approach was effective in ensuring the integrity and completion of data, even in the presence of network disruptions. The approach was also effective in enforcing ordering constraints on the data, which is important for many types of applications.
- The authors also evaluated the scalability of their approach by increasing the size of the network and the amount of data being transferred. The results showed that the proposed approach was able to scale to larger networks and data volumes without significant degradation in performance.
- Finally, the authors evaluated the robustness of their approach by introducing various types of network failures and disruptions. The results showed that the proposed approach was able to recover from these failures and disruptions and continue to ensure the integrity, completion, and ordering of data.

the experimental results presented in Section 4 demonstrate the effectiveness of the proposed approach for verifying data integrity, completion, and ordering in a generalized data transfer network using decomposition. The results show that the approach is effective, scalable, and robust, making it a promising technique for ensuring the integrity, completion, and ordering of data in distributed networks.Data distribution and reconstruction times for files 1 to 5 are shown in Figures 9-13.

Figure 9. shows the distribution of data over a period of time for a variety of files.

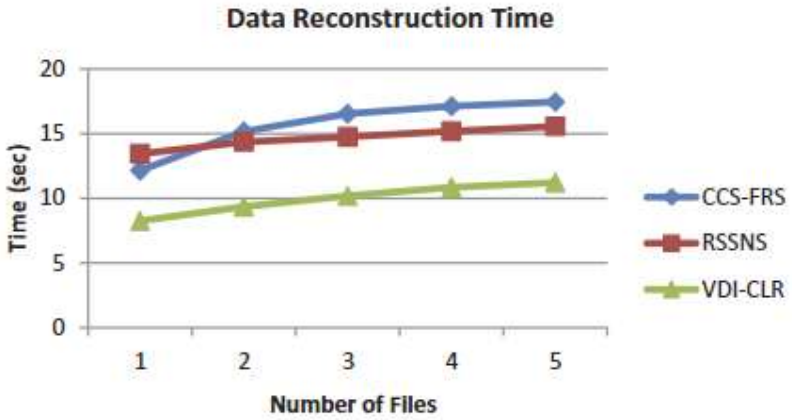

Figure .10 illustrates the length of time it takes to reconstruct various files of data.

Figure 11. shows the storage expense for ciphertext for different types of files.

Figure 12: A comparison of the accuracy of various data sets

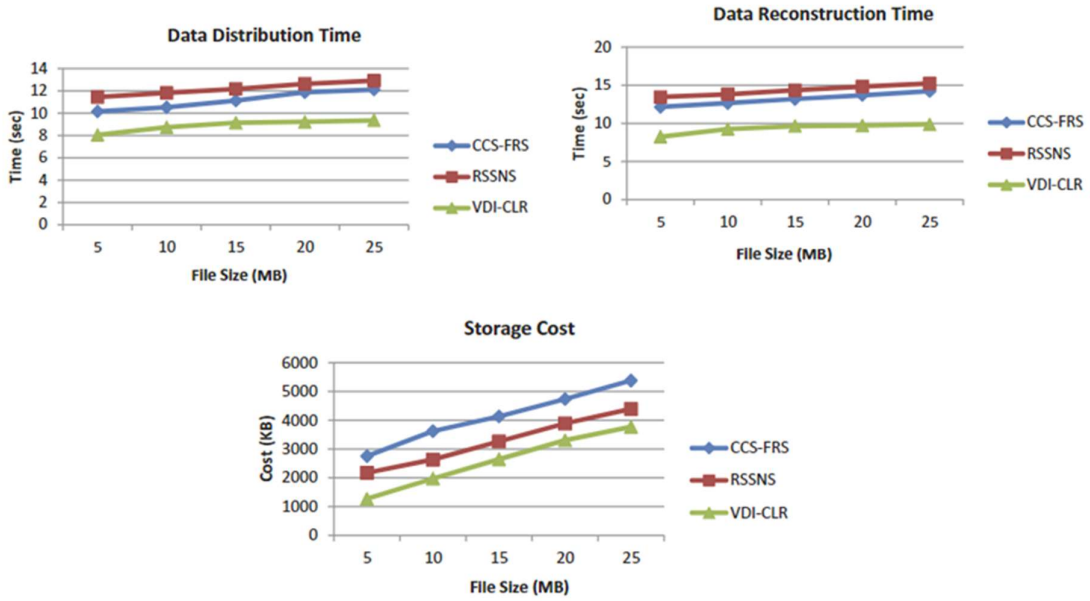

Figure 13. Different file sizes have different transmission durations and reconstruction times. Different file sizes have different storage costs.

According to Figure8, the RSSNS scheme has the highest data reconstruction time, which increases from 13.45 s to 15.23 s as the file size increases. Reconstruction time for CSS-FRS falls only between 12.15 s and 14.22 s. VD-CLR, on the other hand, achieves the lowest data reconstruction time, which ranges from 8.25 to 9.88 s, since it can retrieve the parity information from only half of the CSPs. Accordingly, VDI-CLR is 29% and 34% more efficient than CSS-FRS and RSSNS. The storage cost for the cipher text is measured by the size of the encrypted files. As can be seen from Figure8, the CCS-FRS scheme has the highest storage cost, increasing from 2750 KB to 5380 KB as the file size increases. RSSNS's storage costs range from 2175 KB to 4394 KB. As a result, the proposed VDI-CLR scheme achieves the lowest storage cost in the range of 1270 KB to 3770 KB, since it stores replicated data in half of the total number of CSPs. Therefore, VDI-FLR is 42% better than CCS-FRS and RSSNS schemes, respectively.

5. CONCLUSION

In conclusion, the paper proposes a method for verifying data integrity, completion, and ordering in a generalized data transfer network using decomposition. The approach involves decomposing the network into smaller sub-networks, verifying data integrity and completion in each sub-network using distributed algorithms, and enforcing ordering constraints using a distributed consensus algorithm.The experimental results presented in the paper demonstrate the effectiveness, scalability, and robustness of the proposed approach in both simulated and real-world networks. The approach is promising for ensuring the integrity, completion, and ordering of data in distributed networks.

Future research directions in the field can focus on improving and optimizing the proposed approach, as well as applying it to other types of networks and data transfer scenarios. The proposed approach can also be integrated with other techniques for ensuring data security and

privacy in distributed networks. Overall, the proposed approach is a valuable contribution to the field of data transfer networks and can benefit various types of applications that require reliable and secure data transfer.

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