

A Blockchain-Based Distributed Storage Network to Manage Growing Data Storage Needs

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Abstract—IoT industry has come to the fore in this modern techno-frenzy age. This has caused digital data explosion and has kept the data storage industry on its toes. The paper proposes a novel blockchain-based data storage model where users contribute the storage space of their personal electronic devices to meet the growing data storage needs. The paper dives into a decentralized system design, along with an equitable compensation model for all the storage space contributing users. The decentralized framework provides a common platform for interaction between the storage space contributors and buyers. The proposed solution provides an alternative to cloud storage which relies heavily on servers.

Keywords—Blockchain model, Decentralized storage space, Compensation model, Contributing users, IoT devices, Cloud storage, Blockchain hashing.

I. INTRODUCTION

We live in a digital ocean today. Data is everywhere. The security industry is loaded with millions of surveillance cameras that churn out billions of hours' worth of video data. Similarly, in smartphone industry, about 5.22 billion users are generating a constant stream of location data, photos, movies, and more [3]. Besides, at the start of 2021 about 4.66 billion people around the world were using the internet according to the recent stats [6]. Experts are predicting a huge spike in data at this pace, with storage needs increasing nearly 25X by the end of 2021 [3].

Today, every facet of our life is connected to the internet right from jet engines, to watches, to the tools we use in our everyday routine like fit bits, smart bands, smart fabric, and many more. With all this data, there is an inevitable need to store it somewhere. Owing to this surge in digital data, the data storage industry has seen immense growth since its inception.

Besides, the continually growing network of internet connected electronic devices (IoT) is only facilitating this data boom. Tens of billions of these IoT connected devices already exist around the world as IoT extends far beyond handheld devices and home appliances. IoT subsystems such as industrial internet and connected cities have automated the factories and revamped the urban areas along with households. Digital virtual assistants such as Amazon's Alexa and Google Assistant are bridging the gap between this network of interconnected devices and human users.

According to a recent research, there will be about 35 billion smart devices online by 2021, and that number will rise to 75 billion by 2025 [4]. Another research study by Juniper Research has found that the global number of Industrial IoT connections will reach 36.8 billion in 2025, thereby representing an overall growth rate of 107% [5]. 2020 witnessed more IoT connections like connected cars, smart

home devices than non-IoT connections like smartphones, laptops, and computers. About 21.7 billion devices were active worldwide, out of which about 11.7 billion (or 54%) were IoT device connections per a 2020 report [2].

As IoT devices continue to pile up, one can only expect the digital ocean to grow in years to come, primarily because IoT devices are meant to continually share data amongst each other over the internet, thereby providing seamless experience to its users. This implies, the future data storage needs will be difficult to cater to if the current data storage infrastructure is not expanded beyond its limits. Hence, looking at the current IoT trend there seems to be an urgent need to address the issue of data storage to facilitate the growing IoT demand and maintain a sustainable IoT frame-work for future.

II. CLOUD STORAGE

Today, industries and corporate companies across sectors have readily adopted cloud storage to address their data storage requirements as cloud storage provides numerous advantages to these corporate giants when in place.

Cloud data is basically stored on hard drives, similar to the way data is stored usually. However, this cloud-based data is stored on servers owned by big companies instead of user's personal devices (i.e. hard drive on your laptop, for example, or phone). This data is made accessible to the user via the internet.

With the continual rise in online digital content, addressing the storage need implies adding storage to the existing infrastructure. This includes addition of expensive servers which have high maintenance and configuring costs. Further, in case of failure, migrating data from one server to another is also an economically painful task. Therefore, meeting the ever growing data storage demand is an overwhelming task involving extensive monetary budget.

III. BLOCKCHAIN-BASED SECURE DECENTRALIZED STORAGE NETWORK

With the current scenario in mind, where digital data seems to be growing exponentially, we propose the usage of unused storage space of the existing electronic devices owned by users in a manner where the contributing users receive compensation for sharing their storage space. The proposed solution of utilizing existing storage space rented out by users can serve as a viable option for the vast digital ocean. It highlights the efficient usage of distributed private storage of multiple users.

The idea here is to allow everybody on the planet to rent out their unused disk space which can be attached to a blockchain registry to create a massive worldwide cloud.

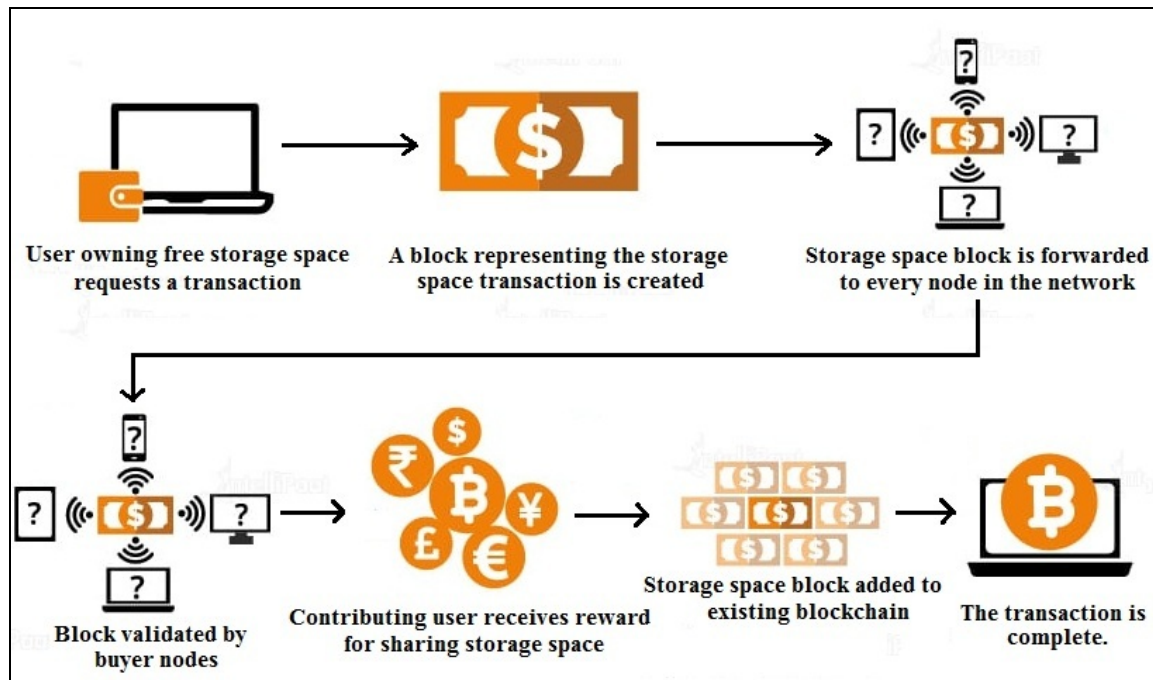


Figure 1: Architecture for Secure Decentralized Storage Network

This is similar to the peer-to-peer network, but with blockchain, it will be completely decentralized [7].

User's device storage is generally wasted a lot of times – be it smartphone, laptop, desktop, tablet, and many more. Besides, all IoT devices, smart home devices, and computing devices are already connected to the Internet, thereby making the block-chain framework easier to build and implement.

And with the supplemental compensation model, the users will be encouraged to rent out their unused storage space

I. System Architecture

The architecture of the proposed model, where a user owning free storage space on his electronic device and willing to contribute to the blockchain model, is disclosed in Figure 1.

Blockchain Hashing

Each transaction within this blockchain employs hashing function. Consider Kanade as a contributing user who shares his device storage space and has a defined block for it. Now, if he wishes to contribute more storage space to the existing blockchain, he requests a transaction, for example to contribute additional 1GB storage space. The transaction is processed by the miner via hashing.

The message sent by Kanade to the buyer is hashed through a hash function that produces a 32 bytes hash code depending on the hash function being used. The processed hash stays unique for the contents of the message. If the message is fiddled with or modified by the hacker, the hash value changes. Thereby, making it impossible to reconstruct the original message. Thus, hacking is too daunting when hash functions are at play.

Figure 2 illustrates the operation of blockchain hashing.

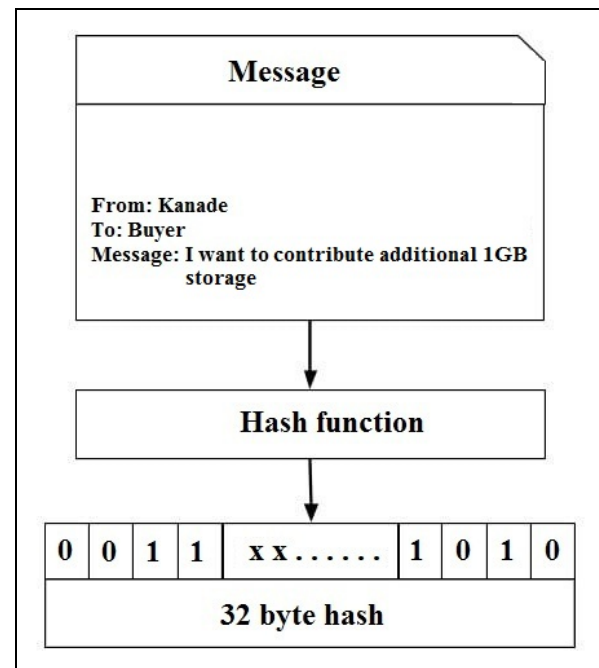


Figure 2: Blockchain Hashing

Equitable Compensation Model

In a recent work related to genomics, it is observed that the companies have adopted different models to compensate individuals who contribute their personal genomic data to research studies [1].

In the proposed model, we explore a possibility where user shared digital storage space is compensated by providing monetary benefits to all the contributing individuals. Implying, contributing users will receive an equitable compensation for renting out their disk space.

We intend to use cryptocurrency or fiat money as a medium to settle the financial aspects between the storage space owners (contributors) and buyers.

Individuals willing to participate should fulfill certain prerequisites:

1. Users should have free storage space above a threshold on their electronic devices (for example: > 1GB)

2. Users should accept the offer and terms of the storage space buyers (for example: financial model).

As individuals abide by these rules, they would be rewarded later for sharing the storage space based on sorted financial model.

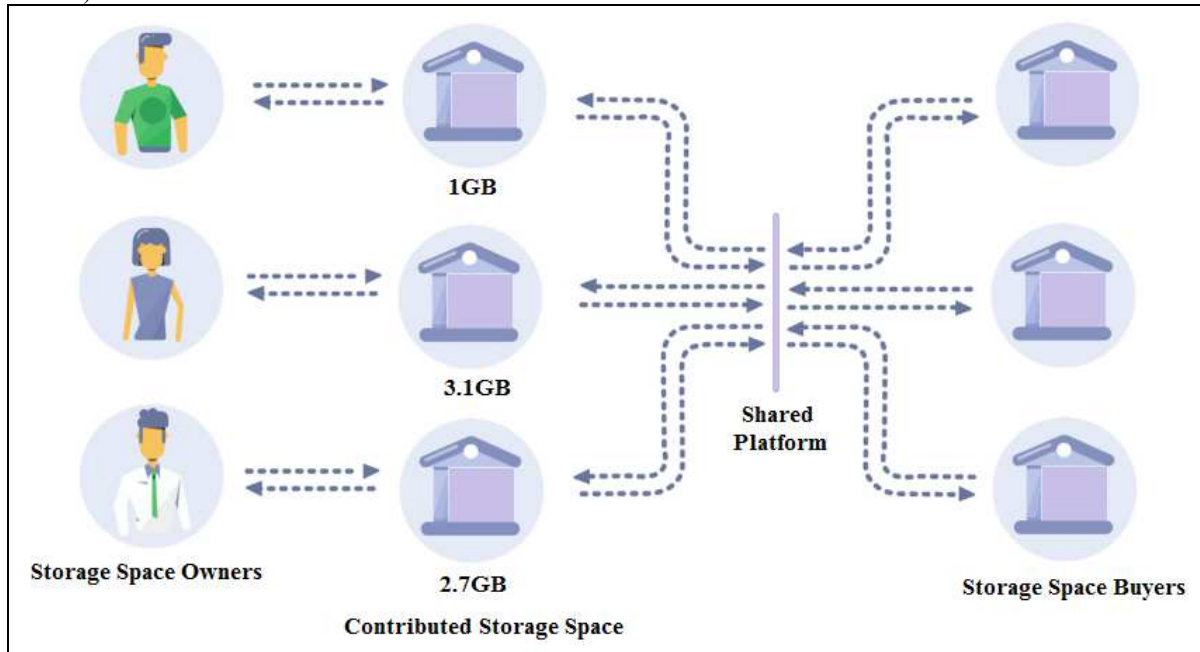


Figure 3: Blockchain Based Platform for Storage Space Sharing With Storage Buyers

Securing Data Residing in Shared Storage Space

Distributed data storage can help protect data privacy. To protect the privacy of data that resides in shared spaces across

blockchain based network, encryption-based privacy-preserving techniques will be adopted. These techniques would enable third parties to execute computations and return results without having access to plaintext data in distributed storage.

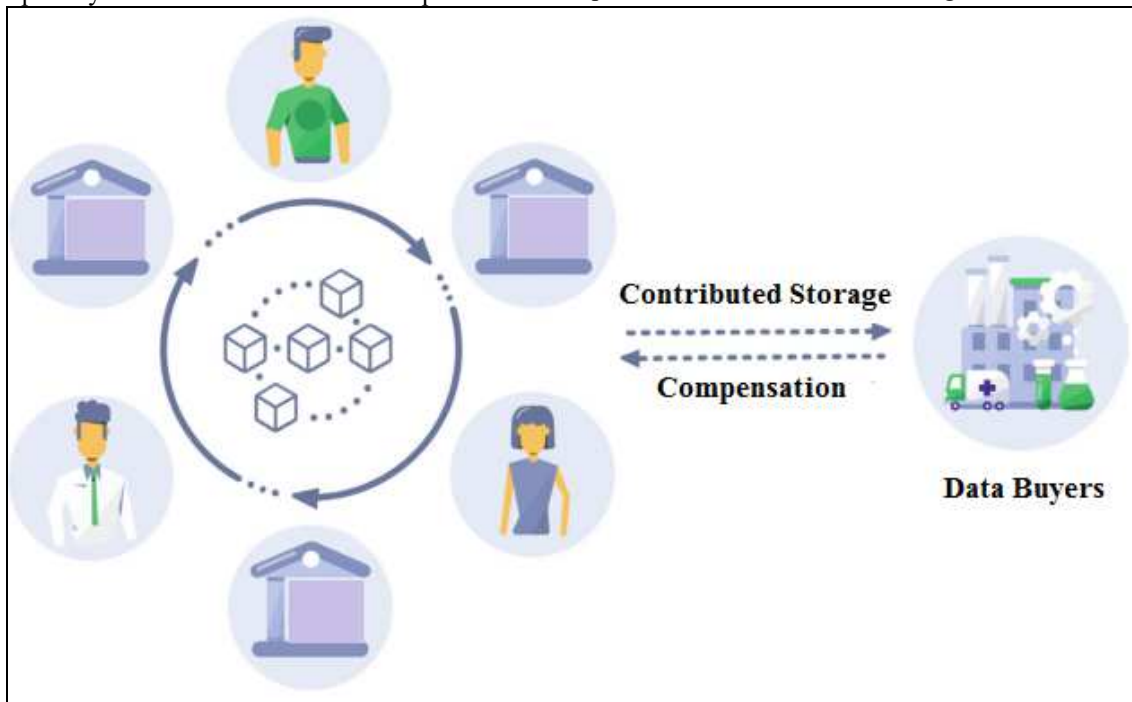


Figure 4: Blockchain Based Secure Decentralized Storage Network

IV. PRELIMINARY RESEARCH ANALYSIS

Use Case

Consider a user Tom, who has 4 electronic devices which he considers worthy of contributing storage space in the proposed blockchain-based model. The devices include smartphone, smart watch, smart thermostat and electric car. He can customize on what percentage of storage space per device he is willing to contribute based on the status of the contributing devices.

Let's say Tom decides to utilize 2GB of smartphone storage space, 1GB of smart watch storage, 1GB of thermostat storage and 1.5GB of electric car storage. Now, based on the compensation model of the buyer, Tom is liable to receive certain monetary amount for his contribution.

The terms agreed upon as per the contract between the buyer and Tom will elaborate on the financial model. Let's say, the agreed compensation is \$1.98 per GB per month. Now, if we calculate for all the contributing devices, this would amount to:

$$\text{Tom's compensation} = \$1.98 (\text{smart watch}) + \$ (2 \times 1.98) (\text{smartphone}) + \$1.98 (\text{thermostat}) + \$ (1.5 \times 1.98) (\text{car})$$

$$= \$1.98 + \$3.96 + \$1.98 + \$2.97$$

$$= \$10.89 / \text{month for 4 contributing devices.}$$

Thereby, Tom is liable to receive \$10.89 / month for 4 contributing devices. Such compensation model can motivate users to contribute more, and most importantly the proposed framework utilizes the 'generally' wasted storage space of electronic devices.

Similarly, following table enlists the compensation for multiple users based on mutually agreed price of \$1.14 per GB per month.

Table 1: Multiple users contributing their storage space

Sr. No.	Users	Contributing Device	Contributed Storage Space	Compensation per month
1	Harris	Smart lock	1GB	\$1.14
2	Donald	Smart light bulb	1.2GB	\$1.368
3	Brandy	Smart camera	2.7GB	\$3.078
4	Alice	Tablet	4.9GB	\$5.586
5	Dylan	Smart speakers	3.6GB	\$4.104

V. CONCLUSION

As the data storage industry faces the challenge of accommodating ever increasing digital data, the paper proposes a first-of-its kind solution that zeroed in on utilizing the readily available data storage space of common users by employing a block-chain-based model. The decentralized storage network would create a global storage connectivity.

The paper therefore proposes a unique solution for cloud storage as digital age takes over the world.

VI. FUTURE WORK

Considering the scope of the proposed concept, the model can be further extended decentralized sharing of compute power, or even memory.

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