Compress-Store on Blockchain: A Decentralized Data Processing and Immutable Storage for Multimedia Streaming

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Abstract—Decentralization for data storage is a challenging problem for blockchain-based solutions as the blocksize plays the key role for scalability. In addition, specific requirements of multimedia data calls for various changes in the blockchain technology internals. Considering one of the most popular applications of secure multimedia streaming, i.e., video surveillance, it is not clear how to judiciously encode incentivization, immutability and compression into a viable ecosystem. In this study, we provide a genuine scheme that achieves this encoding for a video surveillance application. The proposed scheme provides a novel integration of data compression, immutable off-chain data storage using a new consensus protocol namely, proof of work storage (PoWS) in order to enable fully useful work to be performed by the miner nodes of the network. The proposed idea is the first step towards achieving greener application of blockchain-based environment to the video storage business that utilizes system resources efficiently.

Index Terms—DLT, Blockchain, data compression, PoW, PoS, multimedia, decentralization.

1 Introduction

CCORDING to recent estimations, there will be over 20 billion connected devices by 2020, all of which will generate and then require management, storage, and retrieval of large size of data [1]. Connected devices, combined with consumer-based applications and the increasing need to share data across different business lines, are all playing their part in increasing demand for processing and data storage. Some of these data inherently requires immutability and calls for long term retention. For instance, think about government archiving or another popular example of video/data surveillance. Businesses desiring to launch new, data-driven applications are bound to confront with incredible amount of time, effort and coordination to provision new databases today. Now we begin to see dominant commercial and revenue dependency on data which leads to large volumes being stored in vulnerable centralized databases (even in the cloud), creating privacy and durability risks at a scale seldom seen before in history.

Today, the dominant practice in unstructured data storage is based on a local or remote single system architecture or cloud-based file/block/object storages (such as Amozon S3 [2] etc.) which are still highly centralized. Although they can be distributed, they are still in governance of a single body of management and hence these systems are definitely considered as a beacon for hackers (both external and internal) looking to attack. They also have many points of failure should the managing company's ecosystem is affected by an unpredictable system error or experiences down time as a result of a power outage. In addition, data type being stored has an immense effect on the management decisions. For example, multimedia sources are time dependent series of

data and must carefully be protected and communicated by paying attention to streaming requirements. In contrast, decentralized storage doesnt encounter these problems because it utilizes geographically distributed anonymous or permitted individual nodes, either regionally or globally. Hence, meeting point of any applications based on decentralized video involves several challenges to tackle. One of the proven distributed paradigm for storage is known as Distributed Ledger Technology (DLT) [3].

DLT can be implemented using different consensus algorithms to ascertain that the world view of each node is the same. Old traditional way is centered around voting-based consensus such as Paxos [4] then the more understandable version that goes with the name Raft [5]. Most recently, random consensus algorithms have gained popularity. One of the consensus approaches to DLT that became quite common in decentralized cryptocurrency market is blockchain [6]. Considering some open-source public blockchains (such as bitcoin [7] and Ethereum [8]), the set of transactions that are stored within the linked-list of blocks generates a type of decentralized database or storage of structured data. However due to scalability concerns, the size of blocks cannot grow very large and hence it is not hard to see that these public blockchains are not designed for bulk data storage and management, and using them to do so would consume too much local space, too much time for processing and too much energy to fulfill all the executions. Let us explore some of the decentralized data storage options previously devised and implemented.

1.1 Storing data on the blockchain:

Blockchains are immutable constructs and hence do not allow random access for write and frequent changes. Also, only limited number of blocks can be securely added to the chain for a given time period, which makes the throughput

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Project	Smart Contracts	Multi-region redundancy	Feature	Consensus	Scalability (1-3)
Sia	Yes	Yes	Archieving, Very decentralized own BC	BFT	2
Storj	No	Yes	Object,ECC encrypted, sharded, DHT, ETH	Proof of Retrievablity	1
ETH Swarm	Yes	Yes	DHT, ETH	Proof of Retrievablity	1
FileCoin	Yes	Yes	IPFS, Replication	Proof of Replication	1-2
MaidSafe	No	Yes	No Blockchain	Close group consensus	3

TABLE 1

Some decentralized cloud data storage projects centered around distributed technologies. Provided is a rough and relative estimation of scalability using a range of 1-3. Larger the number is, better scalability it possesses. BC: Blockchain. BFT: Byzantine Fault Tolerance

fail to meet most of the data storage requirements. In addition, since the size of the data might be arbitrarily large and *full nodes* are supposed to store the entire blockchain, the capacity required storing it will eventually exceed the persistent storage space of many full nodes of the network [9]. Thus, only a specific set of nodes in the network would be able to hold the entire blockchain. This in turn will lead to centralization problem i.e., only few nodes will dominate the database system which in turn will cause loss of security because only couple of known and capable nodes will be able to actively participating in the mining process.

1.2 Peer-2-peer file systems:

This approach is based on sharing files on client computers and uniting them using a global file system interface. This technology utilizes a similar protocol to BitTorrent [10] and Distributed Hash Table (DHT) concepts. Unlike IPs and ports, the data contents will be content addressable using hashes of the content allowing separation of storage location and data. Data is available only if the nodes storing the copies are online. Once the data content is replicated enough number of times, the availability/reliability of data is no longer a concern. DHT-based technology serves only static files which can not be modified or removed once uploaded. The deletion of files cannot be ensured as this technology is not intended to do so. In other words, the number of copies are not determined by the system but rather the request pattern on that data by the network nodes. Lastly, the stored files cannot be searched by their meaningful content. One of the well known successful implementations of this idea is known as InterPlanetary File System (IPFS) [11].

1.3 Decentralized Cloud File Storages:

Most of these systems resemble to centralized cloud file storages such as Dropbox [12]. Peers in the network offer their unused persistent storage space for rent and gets rewards in return for providing data storage space and services. Some of the examples include Sia [13], Storj [14], Swarm [15], Filecoin [16] and MaidSafe [17] which are listed and summarized in Table 1 based on the technologies they are made of. These storage systems provide highly reliable, enormous capacity with varying degrees of access latency and security. As can be seen most of them are based on an implementation of blockchain technology and backed by some kind of incentivization, so these projects serve static files only, no content search is allowed (unless a specific feature gets added as they are all evolving projects) and, since they are built on peers or anonymous rented hardware, they are not free of charge. All these projects are optimized

for file storage (show decent performance with file accesses) but fairly fall short in accommodating for time-series data (such as Multimedia or IoT data etc.) An example of such data include append-only data streams, with a single writer and lots of readers. Although recently few attempts are made towards creating data storage and sharing ecosystems for IoT systems, none adequately addresses the streaming data requirements [18].

1.4 Blockchain-based solutions for copyright Protection and Video Hashing:

Blockchain technology is very attractive solution for online electronic notary services, document certification, proof of ownership and authenticity. Most of such initiatives targeted mobile devices and application development environments whereas the blockchain formed the back-end registrar for document hashes and related information etc. In some of these applications, decentralized database systems are preferred (such as BigChainDB [19] or TiesDB) and the rest use content-addressable decentralized options (such as IPFS). Examples include initiatives such as Block Notary, Stampery [20], Verif-y [21]. On the other hand, there are also available video sharing and video streaming services based on blockchains [22]. These services verify ownership of each video content as a whole. LIVEPEER for instance is structured for broadcasting by transcoding video source into all formats and bitrates. Flixxo and Viuly are video sharing platforms [23], in a way competitor projects to Youtube Inc., by offering an entirely decentralized platform in which, contrary to their competitor cloud-based providers, not only content generators are rewarded but also are the content viewers as well. Viuly is based on Ethereum smart contracts and hence do not possess their own blockchain implementation. There are also relatively new projects which combine different technologies to offer video content delivery, sharing, incentivization, security at the same time (e.g., CoinTube [24]). As a matter of fact, many of these initiatives can be classified as one of the following combinations as shown in Figure 1. By choosing an open source project for each layer, one can put together a decentralized application (Dapp) and announce an ICO easily if any sort of incentivization is desired.

Despite all these new technologies centered around open source platforms, todays technologies requirements vary at a great scale as we move from one application to another. For instance, we can note that none of these studies

- a. Guarantee the originality of uploaded files, integrity and authenticity of the video content.
- b. No verification process for recorded/uploaded videos is explicitly defined.

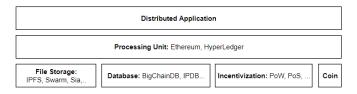


Fig. 1.: Layers of Functionality for a decentralized/Incentivized Computer System. PoW: Proof of Work, PoS:Proof of Stake. Coin represents some form of currency used to incentivize the system.

- c. No supporting proof of time, location, other sensor data to help the verification process of the video authenticity.
- d. No genuine immutability (that comprises the full content of data) concept other than the linked list of hashing offered by classical blockchains.
- e. No genuine consensus best fitted for video processing/surveillance data and applications.

To address some of these issues, PROVER project (though ICO) and few later publications ([25]) has recently be crowdsold and attracted attention since this service addressed a, b and c to some degree. According to PROVER, mobile device users use Swype ID by moving their cell phone in a specific direction (generated pseudorandomly by the application) to generate code and hashes of the content to be stored in the blockchain. PROVER do not care about where the original content of the data is stored or for some reason whether it is erased. It is particularly designed for checking authenticity and integrity which alone opens up a wide range of applications including video surveillance. However, PROVER is powered by Ethereum or NEM blockchains [26] which have their own consensus algorithms predetermined and run by their own development environments (PoW for Ethereum at the time of writing this paper and PoI: Proof of Importance for NEM). In addition PROVER does treat the video files as a whole and do not use its differentiating features that can be combined with blockchain to provide more efficient and useful recording experience which will contribute to scalability and flexibility of the overall system. In this disclosure, we will be presenting general architectural components when combined together will best fit in video streaming and surveillance applications.

The organization of the paper is as follows. In Section 2., we introduce the compress-store architecture and provide the details of the proposed system. In Section 3, we dive into the details of the implementation and system-level decisions. We also provide advantages and disadvantages of the proposed scheme compared to the state-of-the-art. Finally, section 4 concludes the paper with few future directions.

2 COMPRESS-STORE ARCHITECTURE

We propose to use blockchain for metadata (description of which will follow later) storage while the bulk of data is stored off-chain using a distributed hash table system. The off-chain choice is completely arbitrary and could be replaced with existing cloud services such as Azure [27] or S3 [2]. However, we provide desirable properties of a

blockchain applied to bulk data as well such as chaining blocks before moving it to off-chain storage. Here are some properties of the proposed compress-store system; (a) Mining/Consensus is based on the novel Proof-of-WorkStore(PoWS) concept which we will detail later, (b) processing/Compression will be decentralized and some compression related parameters will be stored in blockchain for later verification of recording time, recording place, various sensor information and (c) data is selectively chained and encrypted. We will detail these properties of the system next.

2.1 Consensus: Proof of WorkStore (PoWS)

Bitcoins network uses Proof of Work (PoW) consensus algorithm in which the blocks are mined by solving a mathematical challenge [28], [7]. This challenge enables the network nodes to reach a consensus and the network in return rewards those nodes who participated in system maintenance and security by offering their CPU resources and solving the challenge. However, there are a couple of problems with the original concept of PoW:

- It leads to exceedingly much and useless energy/power consumption. Zero efficiency results due to finding a solution to a mathematical puzzle that means no useful work is done. PoW is used to sustain the security of the network run in a public domain.
- The time it takes to show PoW depends on a time-dependent difficulty level. This level increases over time as more miners participate in the ever-growing network. Increased difficulty level will lead to block mining process to slow down. Also in order to limit the chain forking to a minimum, average time between two mining instants is adjusted to meet some criterion. Such adjustments leads to low transaction throughput performance as the size of the block (and hence the number of transactions that it contains) is usually not larger than 1MB (in the Bitcoin case similar sizes apply for other popular public blockchains).
- In deflationary crypto ecosystems, when mining rewards cease, only transcation fees will incentivize
 the system. Once these fees drop, the number of
 miners will decline for service leading to unsecure
 and unprotected system.

The other alternative applicable methods include proof of stake(PoS), proof of Space (PoSpace), proof of Stoage(PoS) and proof of Importance (PoI) etc [29]. and none of which require elevated CPU and ASIC requirements for better throughput performance and green decentralization. In Proof of Storage (PoS), miners have to show a proof for enough storage space to store the corresponding data and will have to guarantee that it never erases data in their local or remotely owned storage slots. There are few ways of implementing PoS in literature depending on what is exactly being achieved. Some of PoS schemes include Proof of Retrievability, Provable Data possession, Proof of Replication and the most common implementations to all is to use cryptographic operations and periodic auditing protocols [30].

Since the ideal decentralized computer system is expected to establish both decentralized computing and storage at the same time, it is essential that we provide in our video surveillance system (1) Video Processing (compression in our particular case) (2) Data storage (3) Immutability and (4) Security. Video compression has two advantages: first it requires some form of computation due to video processing (transformation, quantization and coding) and this can be done in a decentralized fashion and yet does not pose a lot of useless computations as in original PoW and the difficulty only changes as new compression algorithms and techniques or new quality requirements are integrated/imposed into/onto the network. This will form the proof of work part of our consensus, namely PoWS. The second advantage is that since raw video files would be compressed at a specified quality, we can save a lot of storage space. This does not only mean that we will be saving storage resources but also computation resources that might be due to encryption, digital signature generation etc. Note that one other advantage comes at no cost from the incentivization point of view, because miners may want to choose high compression performance to be able to find storage place quickly and hence be successful at mining process. This will lead to total storage of the system to be used wisely.

Video files are bulky and it is always hard to deal with large volumes of data. In the compress-store architecture, the data storage is provided off-chain using a distributed hash table system. One possible realization is the content-addressed data chunk storage technologies such as IPFS. In that case the data location is represented by a unique hash and we separate the content location in the network and the IP/port number of the server. However, all location pointers will be stored in the blockchain. Finally since the metadata is stored in the blockchain, it is immutable and cannot be changed by any easy means.

The main idea behind inserting some kind of PoW into our system is first to dramatically increase the scalability of the system and it would make really hard to generate compressed sequences of thousands of frames in a relatively short time (unless application specific hardware is used. However, keep in mind that video encoders comes in great variety of parameter selections and algorithmic differences) which discourages attackers and allows the network to use the proposed system in the public domain.

2.2 Throughput of the Surveillance System

In one application of the proposed idea, miners compress video frames. Video files are typically partitioned into Group of Pictures (GOP) and each is processed indepdent of the other. Hence we define throughput to be the processed frames committed to the blockchain per second. In a typical scenario, a GOP can contain 25 pictures and each block can describe around 5 GOPs at the same time. If each block is verified and added to blockchain every 10 secs, this makes 12.5 frames or pictures per second (pps). This is extremely slow rate compared to the level of video generation by the system in a typical surveillance application. Obvious way to improve throughput is to increase GOP size at the expense of lesser quality compression and larger storage

requirement. Another popular way to alleviate this is the method of sharding [31] that is also being considered to solve the scalability issues of popular public blockchains such as Ethereum. In that scheme, miners choose a GOP or a consecutive group of GOPs pseudorandomly and work on their compression workload. This would allow parallelism in the network and hence would ensure better throughput performance. However implementation of such a scheme might be a bit tricky.

Yet, another approach is to make the blockchain private. In that case, the security requirements will be less of an issue due to trusted parties and hence more frequent block additions to the chain can be realized. This would eventually lead to better throughput.

2.3 Private/Public Blockchain applications

In one private blockchain implementation of the proposed idea, compression workload can completely be handled by the video generator node that we call *initiator node*. This process can alternatively be handled completely decentralized if need be. In that case, the PoW part of our system can be avoided since the participators are assumed to be trusted parties and pose no risk to the system. This way, the number of committed video frames into the blockchain can be increased dramatically and consensus can be reached a lot easily. This will eventually increase the throughput of the system. Although a form of centralization may dominate (also due to a subset of miner node selection process), all other properties of the proposed scheme will still serve a number of advantages regarding the video surveillance applications.

In one public blockchain implementation of the proposed idea, we shall use PoWS at full scale. Compared to private counterpart, there are number of differences in this case. First, we decentralize the computation by allowing miner nodes to compress and encrypt video frames, find an appropriate storage location before preparing and adding the related metadata into the blockchain. Since these are third party participators, we propose to incentivize them by coins which will help them process more videos and use storage space. We also incentivize better compression (avoid dump compression styles) because finding an appropriate storage location and space can only be found through paying the required amount using coins. Miner nodes are motivated to use better methods to be able to ask for less storage space that also meets a predefined (just like difficulty level of a Bitcoin network) quality requirement. This quality requirement may be updated as the network evolves or more miners participate. We refer the reader to the mining process for details.

3 IMPLEMENTATION AND SYSTEM DETAILS

In this section, we provide the implementation and systemlevel details. some of these details are related to verification and data storage phases. Later, we shall compare these details with the state-of-the-art.

3.1 The procedure for Verification and Storage

In our compress-store architecture, we define three types of nodes which have their own way of behavior explained below.

- 1. **Initiator nodes:** These nodes are usually equipped with video camcorders and are able to modify/edit recorded video streams. These streams can be divided into one or more groups of GOPs. The captured GOPs are usually selected to be small and they constitute the block of information to be processed by the network.
- 2. Mining nodes: These nodes are equipped with video compression tools/encoding software or hardware. They process arrived frames of a GOP and send indentification information to the network to initiate verification process. Once their work is verified, a block representing one GOP is added to the blockchain and they are rewarded with more storage space to use for mining.
- 3. Storage nodes: These nodes are responsible of storing bulk data which is in our case the compressed multimedia source files. These files are stored encrypted after compression. Storage nodes run a form of PoS algorithm to make sure that they reserved the amount of space that they promise to. Although block verification verify the availability of data and the storage space, a travelling auditing service shall be used by the network to check this verification process at a regular basis. Storage nodes receive fees once they complete all the requirements of the PoS and as long as they store the multimedia data.

Physical nodes of our peer-2-peer network can assume all these three types of node capabilities. For instance, *full nodes* can initiate video storage, mine frames and store compressed multimedia data at the same time. On the other hand, *verifier* nodes are all participating network nodes that store a copy of the blockchain.

The multimedia data itself is NOT stored in the blockchain. Instead their representative data is maintained on-chain serving as pointers to their stored locations. We define a subblock to include the following information: 1. The time GOP is generated, 2. Hash of the GOP (through Merkle root), 3. Access privileges, 4. The location of stored GOP (this does not need to be a physical address, an alternative is to use content addressing, also geographical location can be incorporated), 5. Metadata about the stored multimedia content such as compression algorithm, parameters, etc. In addition, Variety of sensor information, GOP index and order, video identification number/labeling could also be part of the subblock for further verification process. These additional information is important for the reconstruction of the video files. Once a subblock is formed it is digitally signed with initiators private key before sending in to network. Miner nodes shall collect enough number of such subblocks and the associated multimedia data frames/GOPs to start compression process immediately after such subblocks make up a predetermined block size (determined by the overall network). This predetermined block size is analogous to the block size of other crypto-networks such as Bitcoin.

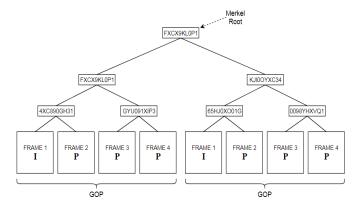


Fig. 2. An example of two GOPs and the procedure of Merkle root computation within and across GOPs.

For compression to make sense, an initiator must set a quality measure such as Mean square Error (MSE) or a peak signal to noise ratio (PSNR) or an another subjective multimedia quality indicator that will help identify that two files are the same except one of them is the compressed version. There are few technologies/algorithms that identifies two video files to be the same whether they are compressed or not. Miners time to mine a block requires the miner to complete the compression process (by going through each sub-compression steps), meet the quality measure requirement, compute the merkle hash tree of a GOP, chain the video frames, encrypt the content, find a storage node (or his own local resources) which ensures storage space required to store the compressed content (generate a proof). In order to make the size of a block even smaller, we employ Merkle hash tree of GOPs as well. The way the Merkle root is computed is shown in Figure 2.

Once this work is done, the mining node broadcasts the block/s to the network that has all the information about the GOP except the bulk data itself. All verifier nodes which receive this block begin the verification process which would involve:

- A comprehensive check whether GOPs are really stored in the designated locations. This requires preparing intelligent challenges for provers (miners) for PoS.
- A comprehensive check for the merkle hash by requesting hashes of the frames and GOPs from storage node/s.
- c. A comprehensive check for the quality measure whether it meets or not, using the uncompressed GOP data. This is to ensure that the miner nodes are legitimately compressed the multimedia file. This effort in fact characterizes a form of Proof of Compression (PoC).

Once verified, all uncompressed copies are removed from verifier node caches to open storage space for the next uncompressed GOP/s data. As can be observed, since blocks do not include transactions in our case, we keep the size of the block that contains metadata for GOP/s to around only a fraction of KBs. This is to limit the total size of the blockchain stored in all of the verifier nodes. One can realize that as we include more metadata (sensor

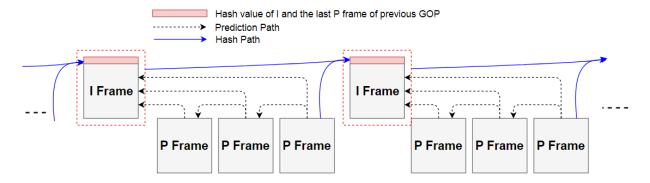


Fig. 3. Data chaining combined with video compression and predictive frame coding. .

information etc.) in the blockchain, we can increase the security, authenticity and reliability of the system at the expense of reduced scalability and throughput, which is infact the fundamental trade-off any blockchain system faces today.

Depending on the compression scheme, video frames can be predicted from each other. In a typical compression scenario, we can classify frames as I and P frames where I is intra-coded frame i.e., the image gets compressed by itself whereas P frames are predicted from the associated I frame and one previous P frame. In another compression scenario, we can have B frames that shall be predicted from two or more P frames. A GOP will contain one I frame in the beginning and all the rest would be P (and/or B) frames. In order to chain the data for immutability, I frames of a video source file are selected to contain a hash value of the previous I frame and the latest P frame in the previous GOP. Due to predictive nature of compression algorithm, P frames are automatically chained to I frames and hence are not separately chained using cryptographic functions. This will reduce the computation requirements due to hashing process as the increased size of bulk data leads to more computation to complete the hashing operation. A detailed illustration of how the prediction and the hashing are done all together in the compress-store architecture is briefly shown in Figure 3.

Next we provide the summary of steps for a full node to initiate, mine, store and verify a recorded video.

- A video file is streamed to the miner network nodes GOP by GOP (GOPs can be thought as transactions in crypto context and these are referred as GOP transactions in our context) where each GOP transactions (txns) is digitally signed by the issuer for authentication. This step is used to prevent potential outsourcing and authenticate the work (both for PoW and PoS). The specific format of GOP transactions are implementation-specific.
- 2) Miner nodes collect/pack a set of GOP txns, authenticate them, process them and then compose a (associated) set of subblocks to make up a block (block size determines the number of subblocks that can be bundled together) that also contains the hash of the previous block.
- In one application of proposed idea, miners PoW may include compression and encryption of the

- set of collected/packed GOP data (txns). This is referred as *processing* in step 3.
- 4) On the other hand, miners PoS include a proof for the storage of the compressed and encrypted content included with the prepared block. The storage can be provided with cloud services or any other peer of the network with local persistent storage. However, with digital signature requirement, outsourcing may be forbidden by the internal system management.
- 5) Miners place the location of the compressed data, associated hash values such as merkle tree root or leaf node hashes, compression algorithm name and parameters, quality measure, any additional data (such as proofs) that would be useful for verification into the (subblocks) blocks and broadcast it for verification.
- 6) Verifier nodes read the contents of the block and easily verify that the content is accurately compressed, properly encrypted, and stored according to a predefined quality measure (using various proofs included with blocks).
- 7) Once the verification process successfully ends, the block is added to the local blockchain. If any of the requirements is not satisfied, the block is not added to the blockchain and the verifier node moves on to the next verification process waiting in the network.

Some potential problems and workarounds: One of the risks is the following. Particularly in public domain, broadcasting the whole raw video GOP by GOP might be too bandwidth consuming and will lead to data traffic most of which is useless (except for the node that successfully fulfill all the requirements of mining). As a solution, initiator nodes may store their raw videos either locally or remotely and broadcasts the location and hash value of data for miners to download and check. This will make download speed and bandwidth be part of the equation in PoWS. In case of sharding, miners may only download GOPs that are not mined yet which will lead to efficient use of network resources.

3.2 Advantages and Differentiation compared to the state-of-the-art

First of all, the proposed scheme ensures data immutability through the blockchain as well as data chaining that connects I frames (self-compressed frames) of the compressed video as described. The predictive nature of the compression process is used to add an extra layer of chaining between different kinds of compressed video frames. Thus, any tempering on data can immediately be detected since this attempt will change all hash results in a propagated fashion. Plus, changing a block content will require all following blocks to change which will require PoWS for all GOPs covered by these blocks. This would require a large volume of computation as well as secured storage space. Secondly, the concept of PoWS does not allow our system to have a solely CPU-based mining which can lead to hardware specific implementations and hence centralization. Additionally unlike bitcoins proof of work mechanism, PoW component of PoWS does require miners to perform useful work, i.e., in an application of the proposed idea, a miner can compress a video file using his CPU and network resources. This way, miner will make his job easier when finding nodes to store the compressed content. More compression will help miners spend less for data storage and bandwidth at the expense of more CPU power. On the other end, Miners can choose to go with a simpler compression technique at the expense of larger storage space committed for the compressed content. Such variations of the proposed idea lead miners to complete the total work of PoWS at different instants of time and hence block generation happens at relatively different times. As a result of that, potential (soft) forks (in the blockchain convergence process) will be eliminated without them getting too large (lengthy) i.e., convergence of consensus will be faster.

4 CONCLUSION AND FUTURE WORK

In this study, a genuine video surveillance system based on digital ledger technology is presented. the proposed scheme uses data compression and storage as means of proofs in order to provide green consensus which would help network participants to commit their resources for useful work. Finally, the details of the proposed scheme is presented by providing comparisons to state-of-the-art schemes. As future work, we would like to extend the implementation details of the system to include image files. The application areas can be extended to include image restoration, multimedia regeneration and data mining. Finally, large-scale simulations are envisioned to demonstrate the effectiveness of the proposed idea in real test beds.

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