

Blockchain Based Vehicle Insurance Management

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Abstract— The automotive industry is blooming day by day with the advancement of technology that is helping in connecting people and non-living things. Electric vehicles and autonomous vehicles are already in the edge technology that's keeping everyone waiting to bring it on road. There is a new frontier that can lend its abilities to the experiences built around vehicles and it is the blockchain technology. Blockchain technology is an enabler. It can act as a transaction medium between interacting parties. It can also be used as a tamper-free ledger to store a history of transactions. With these two simple abilities, blockchains can enable several applications to make vehicle-related experiences better.

In this paper, we will give a diverse knowledge into how blockchain as a new trending technology will help in keeping a track of vehicle insurance management. This insurance record system can include all aspects of insurance transactions. It will act as evidence in the event of dispute.

Keywords— Blockchain, Vehicles, Security, Insurance.

I. INTRODUCTION

Blockchain has a wide variety of usage and applications, yet they have not caught up with the volume of publications. There is certain misunderstanding in terms of usage and implementation of this technology. The advancement of technology has helped everyone to make the right use of blockchain.

In what follows, I present a literature survey of blockchain applications in automotive industry. This survey highlights the leading use cases of blockchain technology in this industry.

Following that, I present a solution based on blockchain for insurance management for vehicles. I then present the design and benefits of such solution. I would also like to list down all the issues that the blockchain technology has. I will conclude the paper with future enhancements.

A. Blockchain Technology

In order to understand blockchain technology, one must understand the need and usage of record keeping or also known as ledger keeping in any firm. Record keeping has been a factor to facilitate cooperation between people in large groups and eventually contributed to the formation of large-scale societies [1]. Due to the importance and complexity of record keeping it is a task for trustable authorities. For example, a bank keeps a record of all the transactions that take place only for the sake of record keeping in case of dispute the only proof is the record that was maintained by the bank. Bank also keeps other records like activities, applications and events that take place. For vehicles, manufacturers, dealers and owner all interact with the government's vehicle agencies.

Record keeping by these agencies have always been considered as a source of truth.

A ledger is a structured list of transactions that represents the state of events, entities, activities. Since their discovery, ledgers have been proven useful for several purposes such as reconciliation, audit and issue resolution by recording a relevant history of transactions. Distributed ledger technology (DLT) is a system based on the premise of communicating ledger entries to the stakeholders. Commonly, a DLT communicates each transaction to each participant of its information network. When a new transaction is recorded by one of the nodes the changes will be shown in all the nodes present in this network. This level of replication turns every stakeholder to a witness of all the transactions. Denying or tampering the transactions becomes harder with the increasing number of witnesses.

Blockchain is a special type of DLT that contains a block of all the transactions in order to facilitate more structured communication. With the help of cryptography, each block contains the hash values of its transactions and the hash value of the pervious block. This pattern of attaching the hash values will explicitly make it a "chain". Every new block created will be appended to the chain. Participants in the network check the validity of these blocks by verifying with the hash value of the last entered block into the chain. Blockchain networks are tolerant to participants' availability. Any member of the network can be offline without impacting the network. When a participant becomes online again, it can download the blocks that are accepted when it was offline. With the hash values included and structured as a chain, it is mathematically infeasible to tamper the locks. Upon receiving a block or several blocks, a participant can validate the blocks, and identify any forgeries. With his ability to identify forgeries, blockchain is a tamper-resistant ledger.

There are multiple types of blockchain based on the participants taking part in the network. A public blockchain is where the participation is not restricted, anyone with a valid id can join and take part in the network. Participants of public blockchains are equal and anonymous behind the public-private cryptographic key pairs. The practical implementation of public blockchain has a lot of measures to be taken to ensure healthy operation of the blockchain and also to prevent malicious activities. Whereas, permissioned blockchain identifies the users and give them predefined roles and restrict their usage. This blockchain may also have restricted access to the network and lot of other rules and regulations to be followed by the participants. Forming a new block has a significant role in permissioned blockchain.

Blockchain technology is a trust provider. Participants who otherwise would not trust each other can use this

technology to create a platform for interaction. Ledger helps in keeping a good track of transactions which can be used when a dispute occurs.

B. Industry, Information and Blockchain

The automobile industry has a main focus on providing better vehicles with the maximum usage of internet. Latest vehicles also have internet built-in which helps the commuters to have direct access to the internet in their daily commute. Smart systems have been engrossed with good features that keeps the driver's focus only on road and not on the infotainment system. Voice over control systems have also been in the new trend that takes inputs from the user as a voice command and divides it into keywords and performs actions such as calling a person, rolling over the windshield, turn the A/C on or off and many more. From battery technologies to big data and AI [2], there are a lot of great tools that help this trend. This industry is committed to innovation. A European Commission report reveals an automobile manufacturer (Volkswagen) to be the top R&D investor in the world [3] in front of Microsoft, Intel and Apple. Eight of the top 23 R&D investors in the world are part of this industry [3].

The volume of collected data on vehicle-related interactions is also increasing. Previously, automotive industry defined identifying attributes such as VIN, engine number, make, model, year and color of the car. These data originate at the creation of the car, and mostly stay unchanged if the vehicle was not subject to significant reconstruction. Dynamic attributes such as ownership related data include the owner, license plate, insurance and several types of taxes. Even though it is changeable, these data do not frequently change either. In the last decade, the data we would like to retain on vehicles and their interactions increased many folds. In this decade of disruptive technologies, we need to record behaviors, interactions, and step by step history of events. It is an advantage to keep a record on who can drive the car, performance of the car, driver's driving performance, purpose of journey, odometer reading at the beginning and end, signaling patterns, and more.

II. BACKGROUND STUDY

There are several areas in the automotive industry where blockchain technology has been used and proved to be beneficial. This section will discuss the current applications of blockchain technology on automotive vehicles.

Usage of blockchains is coming to an expansive arrangement of targets. This huge arrangement of thoughts benefits that blockchain innovation is adding to the business by persuading its significant players. Mobility Open Blockchain Initiative (MOBI) [4] believes that blockchain technology is going to enable a whole range of mobility services.

A. Payments

The lightning system [5] and smart contracts are opening numerous open doors for recording sensor information in major blockchains like bitcoin. Secure correspondence and installment can be characterized between electric vehicles, charging stations and administrator enterprises utilizing

blockchains [6] [7] [8] [9]. Hybrid vehicles can likewise offer power to one another and record these exchanges on a blockchain [10].

As of now, remote charging of gadgets is viewed as a useful theme. Blockchains can be utilized to encourage this exchange [11]. Despite the fact that the usage can't, there are a few sorts of remote charging stations being talked about. There are thoughts to manufacture vehicle charging stations at traffic lights or leaving zones where charging occurs while pausing or leaving. Blockchain innovation is truly reasonable for recording such an exchange to be utilized to encourage installments.

B. Autonomous Vehicle Charging

Autonomous vehicles have a great deal to profit by a tamper free record. They can pick the charging stations utilizing blockchains [12]. So as to give a dependable record of the occasions, a blockchain can record charging station and vehicle correspondence including the affirmation of the vitality move and installment for the administration.

C. Odometer Fraud Prevention

Engine vehicles are strong items that have long lifetimes. That is the reason recycled deals are normal. The trade-in vehicle ventures serving this market are huge with a yearly business volume of several billion dollars. Just in Europe, this volume is accounted for to be 180.4 billion euros [13].

One of the most widely recognized frauds with utilized vehicles is odometer fraud. Bringing down the mileage of a vehicle by altering an odometer and would expand the apparent estimation of the vehicle and stunt purchasers to accept the vehicle is in preferred condition over it is. At the point when vehicles are shipped past state outskirts, following their history turns out to be significantly increasingly troublesome. Odometer fraud is costing Europeans as much as 9.6 billion euros starting at 2014 [14].

A blockchain intermittently recording odometer values can forestall this extortion. Such a blockchain can likewise record odometer values when a critical or saw occasion occurs. Huge occasions can be administration visits or the recharging of vehicle permit stickers.

It is sure that a vehicle odometer following stage running on blockchain innovation is gainful for recording the total lifecycle of a vehicle, illuminating the invested individuals with tamper free data, and helping the network with infused trust so as to let them arrive at an increasingly exact valuation of vehicles [15].

D. Re-Vinning or Re-build

Auto cheats change vehicle identification number (VIN)s of vehicles to re-advertise them as perfect vehicles. A blockchain to relate the VIN to different characteristics of a vehicle can help forestall this sort of extortion. An available history record can likewise uncover whether a vehicle had a mishap where the protection auditor stamped it as harmed destroyed. Mechanics fix these vehicles with low quality or dangerous techniques by gathering principle pieces from

various vehicles and intertwining them. This fix may not be noticeable to unpracticed shoppers. Be that as it may, it tends to be dangerous in high-stress conditions, for example, fast or an impact [15].

E. Vehicle to Vehicle Communication in Intelligent Transport Systems

Inter-vehicle communication is one of the developing themes in IoT. There are a few use instances of improving the driver involvement in between vehicle correspondence. Blockchain innovation can help assemble a between vehicle correspondence framework by facilitating highlights, for example, confirmation [16]. Declarations imparted vehicle to vehicle can improve the driver's understanding. Blockchains can be utilized to record these interchanges. The validity of the got messages can be surveyed utilizing a blockchain [17]. Blockchain innovation can likewise be utilized to give motivators to this stage [18] [19].

F. Vehicle Forensics and Insurance

Connected and Automated Vehicles (CAV) adds a few new information to the potential questions. The dynamic limits of such vehicles depend on sensor information and if there should be an occurrence of an episode, the sensor information is a piece of the proof to be utilized in the choice to recognize a goal. Ongoing writing proposes legal frameworks to be based on blockchain innovation. Both B-FICA [20] and Block4Forensic [21] are recommendations for a legal sciences blockchain. Their significant difficulties are IoT information volumes and auspicious interchanges. Assortment of measurable information shows flood like attributes while then again, utilization is exceptionally uncommon and for the most part a lot sometime later.

III. NEW USE CASE

In this study, we are focusing on the new use case that will help revolutionize the auto manufacturing and insurance industries.

A. Tracking Insurance Records and Preventing Fake Proof of Insurance (Pink Slip)

Auto insurance or accident protection is compulsory in numerous nations. Every driver is committed to have protection to drive and should deliver a proof of protection possession when mentioned. In Ontario, the verification of protection structure is known as a formal notice in view of the shade of the structures gave by the insurance agencies. Drivers are the focal point of the protection-based correspondence in Ontario. Drivers give the evidence of protection inclusion when pulled over by police, purchasing/renting a vehicle, enlisting a vehicle, and while recharging the tag stickers. In every one of these events, drivers manage each gathering independently. For instance, a driver purchasing another vehicle, buy protection from the insurance agency and convey the documentation to the vehicle seller for the discharge and permitting of the vehicle.

There are a ton of manual strides during the time spent giving a proof of insurance. Manual advances and physical proof-based frameworks are available to extortion, for

example, fashioning vehicle protection cards and selling them [20]. High protection costs rouse individuals to acknowledge such dangers. There are a few use-instances of false exercises around protection records. In legitimate grounds, there are ramifications for utilizing a phony record, yet drivers wager on the powerlessness of the specialists getting to the right data speedily. Since most occurrences in which drivers are solicited to introduce evidence from protection don't arrive at authentic grounds, drivers may utilize extortion to escape an ebb and flow inconvenience circumstance. There are a few explanations behind the manual procedure to be abused between the gatherings that doesn't confide in one another. Every one of these gatherings are subject to the quality and dependability of this data. The danger of blunder in correspondence is additionally high where a driver is conveying and filling structures.

A blockchain for getting, sharing and confirming protection records will help stakeholders as a dependable sharing stage and a record of occasions. Drivers can additionally share the formal notices through the blockchain. Such a blockchain can even record this sharing occasion in the event that there is an incentive in following who mentioned to share which record and imparted to whom.

The fundamental motivations for a blockchain arrangement are the prerequisite for straightforwardness, aggregate nature of commitment and members' absence of trust to one another. A protected incorporated database arrangement of comparative reason would have difficulties in proprietorship, upkeep and administration. The irreconcilable circumstance between the gatherings would forestall an answer that would be claimed by an outer element. Decentralized arrangements, for example, blockchain are likewise stronger to the assaults as there is no single purpose of disappointment.

An elective arrangement could have been putting away a similar data in a centralized database. Despite the fact that the innovation for this arrangement is accessible for long time there are a few reasons that there is no such usage. Principle reason is the trouble of administration, obligation, the executives and organization of such a focal framework. Unlimited inquiries beginning with "Who will." finishes in no gathering handling previously mentioned troubles. Blockchain arrangement proposes freedom in joining and aggregate activities dependent on popularity-based practices to work. Equivalent rights, duties and cost misleads each significant member. People would profit by better help quality and mechanization of the framework. If there should be an occurrence of a debate, all gatherings profit by equity that better quality proof brings. Circulated nature of the blockchain additionally increment its dependability and accessibility. Disseminated the executives would ensure no gathering without any assistance alters the information particularly where there is irreconcilable circumstance between the gatherings. Circulated frameworks are stronger against forswearing of administration assaults or administration blackouts.

IV. DESIGN

The answer for the challenges in following protection records is making a blockchain stage to empower all members to convey, offer and record data. We have a staged way to deal with the creation turn out. The main stage will be the protection records as depicted right now. The accompanying stage will incorporate an all-inclusive arrangement of abilities focusing on vehicle-based data including telematics.

A.

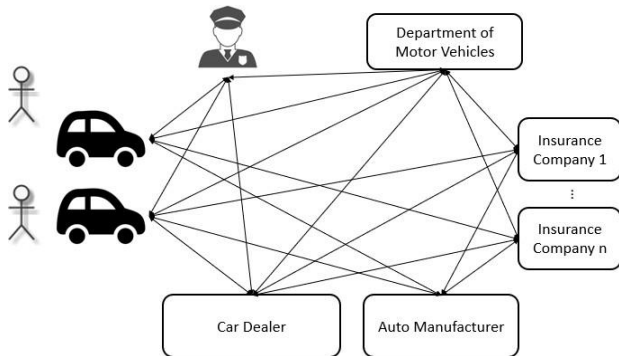


Fig. 1. Participants of the blockchain based solution

The investment in the proposed blockchain organize is as delineated in the Fig. 1. Members incorporate individual drivers, business associations, for example, insurance agencies, and governments offices.

Individual drivers are key members right now. Like in many frameworks, benefits gave to the people and their adjustment to the new stage will characterize the accomplishment of this task. Despite the fact that people who don't claim a vehicle can get to this framework, we anticipate that most people should be drivers with vehicles, buying protection, and utilizing the interfaces gave by the framework. Contingent upon the security rules and concerns, people can be a full hub right now in all correspondence, or they can be permitted to get to as it were constrained data by means of their protection office. We examine this issue further in the security segment. As of now, we accept they are an immediate member in the framework.

Organizations will reveal incredible open doors with the blockchain to improve their information assortment and exactness. Organizations, for example, makers and vendors are noteworthy supporters of this framework. Producers can improve their image picture by adding to this task. Right now, sellers are under commitment to check whether clients have protection for the vehicles they are purchasing or renting. This check is profoundly reliant on manual advances and paper-based correspondence. Selection of the new blockchain arrangement will take out the requirement for pointless danger of data assembling through manual channels. Additionally, later on, organizations can essentially profit by item-based telematics. Administration updates and execution checking of the vehicles are a portion of the conceivable use cases for this data.

Insurance agencies have a few advantages to their business because of the nature of information gathered with the blockchain. Above all else, forestalling protection misrepresentation means more business for the insurance agencies. Expulsion of formal notices and all other manual types of conveying the protection data not exclusively will spare from paper mailing administrations, yet additionally

gather dependable data if there should arise an occurrence of episodes. Protection clients will show signs of improvement administration by utilizing the electronic correspondence and sharing of data. The blockchain will record every significant occasion. Partners can utilize a portion of this data later on for deciding advancements and evaluating.

Government organizations are another arrangement of supporters of the framework as they can gather solid data rapidly by utilizing the innovation. Governments for the most part rely upon intentional information conveyed to them. For instance, during the permit sticker restoration, drivers deliberately give their protection subtleties, for example, the insurance agency and strategy number. The blockchain can altogether improve the nature of such information where governments get a similar data straightforwardly from the blockchain without the danger of mistyping. Legal counselors can likewise be members of this blockchain. They can utilize the record data if there should be an occurrence of a question.

V. PLATFORM

Since we need separate jobs for members of the blockchain arrange, a permissioned blockchain is a solid match for our concern. Consequently, we began structuring a blockchain arrangement dependent on Hyperledger. Hyperledger is an item set of open source apparatuses or tools and libraries expected to shape a blockchain. A blockchain venture in Hyperledger comprises of the accompanying elements: "Insurance Record" and "Insurance Sharing Record" TABLE I. presents these substances with an agent set of properties. In future activities, adding more ascribes pertinent to future use cases will improve the general arrangement.

A. Assets

The primary resources right now be the record of protection and the sharing record of protection. The protection record will be the essential record in the blockchain speaking to the confirmation of protection. Sellers will make this record at the hour of vehicle deals. VIN and vehicle explicit subtleties will be added to the record. Seller will set the status as "Instated" for this unique record. Following this underlying record, the driver will impart this record to insurance agencies by sharing the driver open key. Since the insurance agency gets to blockchain records, they can find and access all the insurance records that have a place with this particular driver. Accepting the following stage will be finishing the offer of the insurance, the insurance agency would enter fields identified with the protection business, for example, the "Insurance agency", "Policy Number", "Start Date" and "Expiry Date". At the point when any organization gives new information into the framework, related records must have their mark to approve that an approved member gave this update. The sharing record of insurance is the record for the occasion of a driver imparting her protection data to another gathering. This commonly happens when there is a mishap and verification of protection is to be shared.

TABLE I. ASSETS AND ATTRIBUTES

Asset Name	Attributes
Insurance Record	Insurance Company, Policy Number, Driver Public Key, Status, Start Date, Expiry Date, VIN, Make, Model, Year, Dealer Signature, Insurance Company Signature
Insurance Sharing Record	Driver Public Key, Shared-With Key, Incident Code, Expiry Date

B. Smart Contracts and Automation

One of the most significant highlights of the blockchain systems is mechanized handling through shrewd agreements or automated processing through smart contracts. As much as the blockchains are utilized to store exchanges, they can be utilized to make agreements to create exchanges in the system.

There can be a few use cases for smart agreements. Smart agreements can help execute maker reviews for every vehicle. A user Interface (UI) can show this data to the vehicle. The vehicle proprietor/driver may react to this with choices. All activities would be recorded on the blockchain to be alter free. There can be no disavowal of the connection and reactions.

Because of cryptographic forms of money and other monetary progressions in the blockchain innovation, even protection installments can be overseen on the blockchain. There can be keen agreements that make an installment relying upon the vehicle's use insights and driver's presentation that month. The driver ought to have the option to acknowledge and execute such agreements from the User Interface (UI) given by the vehicle.

TABLE II. lists the transactions. From this list of transactions, the insurance expiry event is the only one that can be automated with smart contracts by our blockchain solution.

Transaction Name	Description
Insurance Creation Event	A new insurance record is requested. Identification information for the car would be recorded. Status will be "Initialized".
Insurance Creation Event	Insurance company completes the preparation of the insurance. New information such as policy number, start and end date are added. Status will be "Active".
Insurance Expiry Events	Expiry date specified for an insurance record has been passed. A record will be created with status "Expired".
Insurance Information Shared	Owner of an insurance record provided permission to share this record with another participant.

C. Interface

1) Purchase of a Vehicle

Buying another vehicle is a utilization case that incorporates a few manual cooperation's. After a driver chooses to purchase a vehicle, she needs to gather the data and speak with an insurance agency to buy protection for the vehicle. With the protection data, the driver contacts the vendor so as to finish the buy. Every one of these means and potential blunders on the calls can be supplanted with the accompanying stream in Fig. 2.

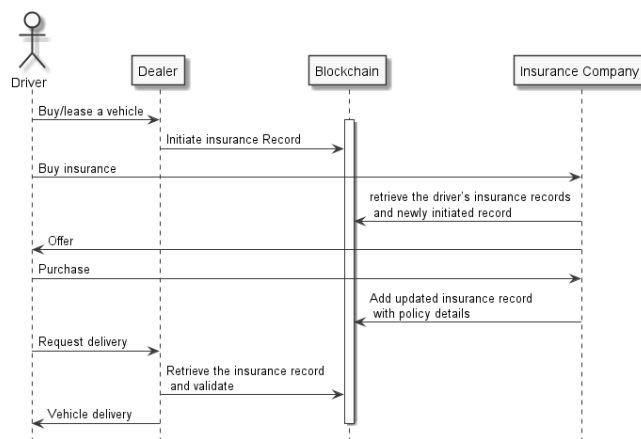


Fig. 2. Sequence of steps while purchasing/leasing a new vehicle

2) After an Incident

One of the fundamental use cases with respect to various untrusting gatherings is the engine vehicle mishap use case. At the point when a little mishap occurs, drivers should trade verification of protection archives (formal notices), and contact their protection with data they gathered. They ordinarily need to spell a few coded data on the telephone with their insurance agency. The accompanying stream in Fig. 3 replaces this manual information move and related blunders with a blockchain based stream.

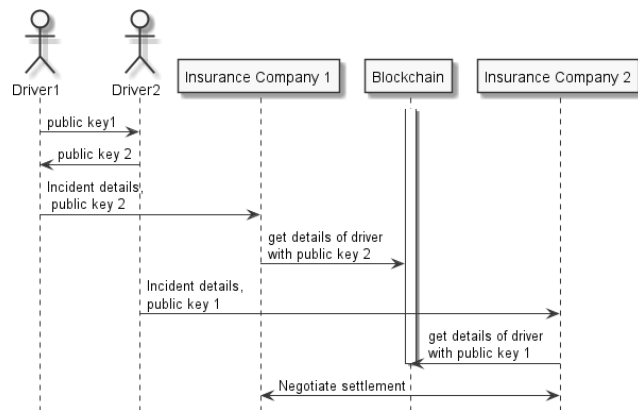


Fig. 3. Sequence of steps happening after an accident

3) Police Control

An accommodation highlight of the new blockchain framework will be imparting records to every invested individual, for example, the police. At the point when a vehicle is pulled over and the verification of protection is mentioned, the driver can let the cop get to the report with a key as delineated in Fig. 4.

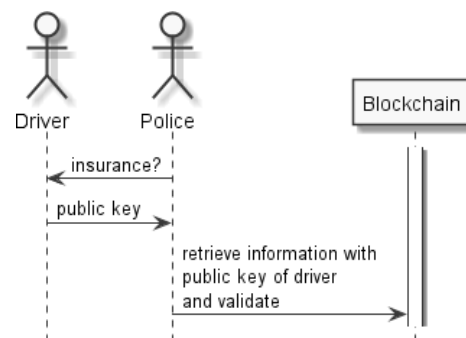


Fig. 4. Sequence of steps during a police control

VI. CONCLUSION

There are a few use instances of blockchain innovation in the vehicle industry. We have introduced the assortment, benefits, and issues of these arrangements in an overview position so as to comprehend the business just as the blockchain selection. Blockchain innovation encourages better assistance where all members need a straightforward and open condition to share data.

Our commitment is the new use case for making a vehicle protection record utilizing blockchain to share the vehicle protection records. We likewise contribute the advanced resource configuration, savvy contract mechanization structure and communication plan. We propose utilizing blockchain innovation to catch the subtleties of the protection where a few entertainers are teaming up, and a few partners are relying upon. We give subtleties on how members can profit by straightforwardness with this situation as well as how a blockchain can encourage straightforwardness. Through this arrangement, we show that blockchain innovation can be utilized as a correspondence medium between in any case untrusting parties.

A future heading for our exploration would be the associated vehicles and telematics parts of the car business. Associated vehicles will carry various chances to vehicle industry. The information gathered will be gainful for makers, protection, proprietors what's more, governments. Insurance agencies can exploit this innovative front and begin offering limits to intentionally given dependable data. At the point when a blockchain has the record, its alter free element secures all gatherings. Protection organizations, people or some other outsider can't change the records once recorded. Since the records in a blockchain are relentless uncertainly, this framework can be an ideal driving history to be utilized for quite a long time to come. People can introduce their open keys or mark to another insurance agency to get better limits. Youthful driver projects may consider the record to demonstrate the development of the driver. Driver's permit reestablishment can think about this history. It very well may be transferable between states to help permit trade in the event that the proprietor moves to another state. In further cases, the records can help the court in cases identified with the standard of conduct of the drivers. The equivalent blockchain can be utilized to record liquor levels of the driver with appropriate embellishments gave. A further use-case would be recording full occasion logs including subtleties like breaking and flagging conduct for additional examination. We accept all these new highlights can be created on our present usage of the protection record blockchain.

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