Blockchain Enabled Services – Survey

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Abstract. Blockchain has now emerged as a disruptive innovation with a wide range of applications. According to a recent NITI Aayog report, "Blockchain: The India Strategy towards enabling ease of living, ease of business and ease of governance", the Indian Government is preparing a strategy to deploy the distributed ledger solution to improve governance using Blockchain Technology. Since this technology can be used to facilitate direct interaction between citizens and Governments to provide tailoring services without a governmental administrator [18]. This paper presents an overview of blockchain-based applications across several domains, with the goal of developing a blockchain-enabled framework for the complete flow of vehicle data management protocol used by the Indian Road Transport Authority.

Keywords: NITI , Blockchain, vehicle data management protocol.

1 Introduction

Blockchain technology is expected to transform almost all industries & economies and it is anticipated to revolutionize various aspects of the lives of citizens. In 2030, blockchain could generate USD3 trillion per year in business and the World Economic Forum (WEF) predicts that by 2025, 10% of the global Gross Domestic Product (GDP) will be stored on blockchain [18].

Blockchain is the core technology known for bitcoin and crypto currency applications, recently experiencing an unprecedented rise in some specific areas. Blockchain provides a completely trusted environment between unknown entities to make transactions without the participation of a trusted authority.

Blockchain is considered as a disruptive technology that has the potential to significantly improve the security of IoT devices. The blockchain, as a decentralised, distributed system, validates and stores transactional data using a cryptographically linked chain of blocks. "The dispersion or distribution of functions and powers; specifically, the delegation of power from a central authority to regional and local authorities," according to the definition of decentralisation. A system that is controlled in a distributed manner can use the same concept. A decentralised system's nodes/agents are autonomous to some extent. They can connect to each other in order to send and receive data [5].Distributed systems are becoming increasingly important in technological advancements. It allows for resource sharing, high-speed communication, and fault tolerance in a geographically distributed system [6].

A blockchain is essentially a digital ledger of transactions that is duplicated and distributed across the blockchain's complete network of nodes. Each block on the chain contains a number of transactions, and whenever a new transaction occurs on the blockchain, a record of that transaction is added to the ledger of each participant. The decentralised database

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managed by several members is known as Distributed Ledger Technology (DLT). With the support of its underlying concepts such as smart contracts, this paper examines blockchain technology and the concepts that enable data security, privacy, anonymity, traceability, integrity, robustness, transparency, and trustworthiness. [2]

There are three different blockchains, which are as follows:

- public (permissionless blockchain),
- private (permissioned blockchain) and
- consortium blockchain (combination of both permissioned and permissionless blockchain).

There is no central owner who controls network access in permission-less (public) systems. To join the network and add transactions to the ledger, all that is required is a computer server with the necessary software. Each node in a P2P network owns an up-to-date copy of the entire ledger. Every time a network participant adds a new block to the ledger, it is broadcast to the rest of the network. Through an algorithmic consensus mechanism, nodes jointly validate the update. To ensure data consistency across the entire network, the new block is added to all corresponding ledgers following validation [29].The blockchain is the first completely functional distributed ledger that is totally public and permissionless. The system's ability to develop trust between unknown parties is based on the immutability of data and extends to the structure, generation, and distribution of information.

An owner is the authorised entity to pre-select network users in permissioned (Private) systems, and he or she is also the administrator of the ledger, who controls network access and enforces the ledger's rules. After receiving approval from the central administrator, nodes can connect to the network and make changes to the ledger. Identity verification is one type of access control [29].

A Consortium blockchain is built for a group of entities to maintain, read, update and share the data in a trustworthy manner where each enterprise or entity maintains nodes. It is primarily intended for enterprise customers. In such platforms, trust is enforced by means of legal contracts with the entities/enterprises. Proof-of-Work computations are not needed and the majority of the peers within the group will participate in the consensus process to achieve consensus These platforms also allow Participating enterprises to define their own rules and block structure in their platform [30].

Section 2 gives a theoretical basis by explaining the most significant components of Blockchain Technology (BCT) and describing a few blockchain-based applications from various domains.

2. Blockchain Background

Blockchain Technology is a distributed, decentralised network of nodes that is maintained by a peer-to-peer network with equal nodes. Blockchains are decentralised data structures or ledgers that may securely record digital transactions without the need for a central authority. Because a digital ledger can never be corrupted, blockchain is not simply programmed to hold financial transactions, but any type of value may be input and tracked. This ensures data durability and persistence.

A) **Hash:** A cryptographic hash function takes an arbitrary amount of data as input and outputs a hash value, which is a fixed-size output of encrypted text. The basic method that makes it secure is hashing. Because each block in the blockchain is linked to the previous

block and it forms a chain of blocks. Figure 1 shows how the blocks are linked by storing the hash of the previous block along with the block hash in the current block. A hash of the previous block's data is included in each block of a blockchain. This guarantees that the chain remains immutable, as any change to a block's data invalidates all subsequent blocks.

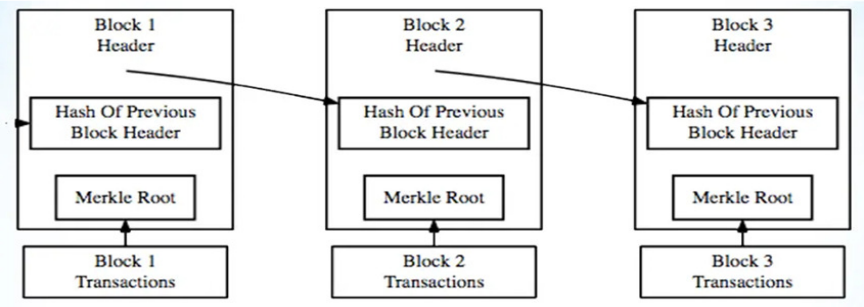

Figure1: Chaining Blocks

The block hash shown in Figure 2 represents the Merkle root hash in which every transaction in that particular block will be paired and finally a root hash is generated which will be stored in every block in the name of block hash. Cryptographic Hashing and Merkle Trees are in charge of keeping the integrity of the data on public and private Blockchain intact. The use of a Merkle tree can substantially reduce the amount of data that a trusted authority must maintain for verification purposes. It separates the data validation from the data itself, requiring little memory and a small amount of information to be transmitted over the network [27].

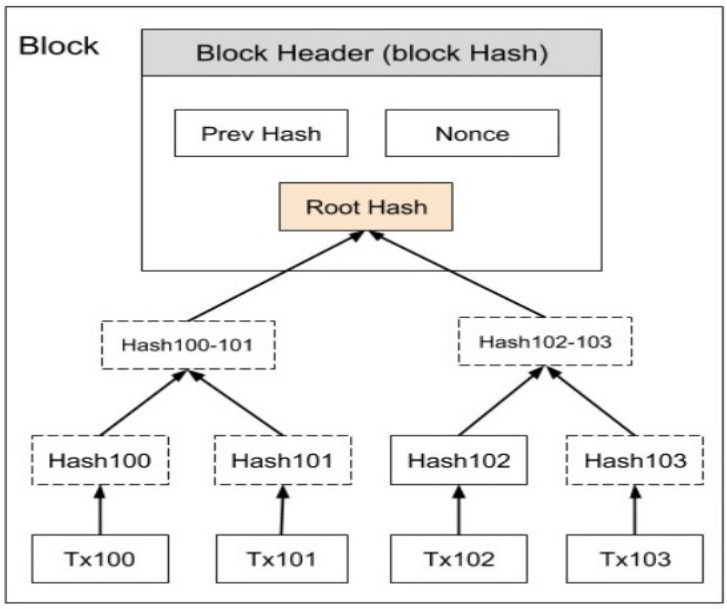

Figure 2: Transactions Hashed in a Merkle tree

Anyone could verify the transaction by re-running through the algorithm and can easily find out whether the block has been tampered with. Thus, if an adversary tries to tamper any information of a block the respective block hash would change leading to a change in the blocks which are linked to it. Hence, to tamper with one block the adversary needs to compromise with every other block following it. If a node in the network wants to make a transaction to any other node then, every other node has to verify that block (transaction) based on the consensus algorithm (discussed below). After verification every node adds the block in the blockchain.

B) **Smart contract:** Smart contracts are simply a code or program stored on a blockchain that run when predetermined conditions are met. They typically are used to automate the execution of an agreement so that all nodes in the blockchain can be immediately certain of the outcome, without any third party's involvement. The benefits of smart contract are speed, efficiency, trust, transparency and security.

C) **Blockchain Consensus Mechanism:** A consensus mechanism is a fault-tolerant technique used in blockchain systems to obtain the necessary agreement on a single transaction, such as with crypto currency. There are a variety of consensus mechanism algorithms, each of which operates on a different set of principles.

Proof of work (PoW): is a widely used consensus mechanism in crypto currency networks such as bitcoin and litecoin [23]. The basic idea behind this algorithm is to solve a complex mathematical puzzle and provide a solution quickly. Because this mathematical puzzle necessitates a large amount of computer power, the node that solves it as quickly as possible gets to mine the next block. This entire bitcoin mining system consumes a lot of energy and takes a long time to process.

Proof of stake (PoS): is a low-cost, low-energy alternative to the Proof of Work (PoW) algorithm. Ethereum's consensus algorithm has moved from PoW to PoS.. Instead of investing expensive hardware to solve a complex puzzle, the PoS consensus algorithm validates transactions using crypto currency held as a stake. The greater the quantity of coins held as a stake, the greater the possibility of getting chance for the validation. As a result, it uses an incentive system to urge validators to achieve an agreement.

Proof of Authority(POA): is a modified Proof of Stake mechanism in which an individual's identity is used as a stake value. It's also a reputation-based algorithm, in which the validator's network identification determines whether or not he or she can validate the transaction and collect rewards. Rather than financial capital, the stakes are social capital. PoA consensus is inherently centralized once validators are identified. As a result, private and consortium blockchain are the ideal fit.

3. Blockchain Platforms

The following subsection discusses the details of the various blockchain platforms.

A)Bitcoin: The world's first distributed crypto currency, it runs on a peer-to-peer network with no central server or third party, and it was the first to introduce the blockchain technology and platform [3]. The blockchain network is responsible for the coordination of transactions and the issuance of bitcoins [3]. To verify transactions, Bitcoin uses the PoW consensus protocol, which requires a lot of energy.

B) Ethereum: Ethereum is a blockchain-based platform that allows anybody to design and use decentralised apps based on smart contracts [7]. Ethereum focuses on the ability to manage digital assets automatically, and to do so, it offers smart contracts or properties, which make creating asset management programmes easier than using the Bitcoin Blockchain's programming language [25]. The PoW consensus protocol is also used by Ethereum..

C) Zcash: is a decentralised and open-source cryptocurrency with transaction privacy and anonymity. [12] Despite the fact that senders and recipients are represented in the Bitcoin Blockchain by hashed addresses, thorough investigation and inspection can nevertheless connect or track transactions with adequate transaction data [13–16]. To address this, Zcash uses the zk-SNARK zero-knowledge proof algorithm, which ensures that the sender, receiver, and amount of a transaction remain private even on a publically available blockchain network, enhancing transaction privacy or anonymity while securely verifying transactions to prevent double-spending. This level is used in healthcare applications.

D) Ripple: is a low-latency blockchain network that atomically records and settles transactions on a distributed database. Ripple solves the Byzantine Generals' Problem and the Sybil Attack using the Ripple Consensus Protocol Algorithm, which is a low-latency alternative to the high-latency Bitcoin Blockchain PoW [19,20]. Only the "Chosen Validators" validate the blocks to enable for low-latency transactions. The current distributed ledger is "closed" and the most recent one is used when an agreement is reached. Ripple currencies are "pre-mined," which means they can't be created during the consensus process [21], and Permissioned networks are used by the majority of healthcare applications..

E) HyperLedger: Hyperledger is a permissioned, cross-industry open-source blockchain technology. [22] It is a consortium Blockchain that allows us to create a private channel if a transaction requires it, in which only a group of business-related organisations can join through a membership service provider, and the entire network is built up from the network's agents who are owned and contributed by those organisations. Peer nodes serve as hosts for ledgers and smart contracts. Smart contracts would outline how transactions will be enforced autonomously. The ledger is a tamper-proof, sequential record of transactions (state transitions). Transactions results are validated and committed to the blockchain and the latest key-value pairs are stored [1]. PoW is not supported by Hyperledger and the privacy protection is yet to be included in Hyperledger.

As the brief summaries show, no platform is perfect, and the greatest characteristics may be incorporated by the platforms in the future. it is unlikely that numerous platforms will become very relevant to healthcare. Ethereum and Hyperledger are at the top of the list, likely to be utilized for healthcare applications, because they integrate the most significant characteristics at the present.

4. Blockchain Based Applications

A consortium Blockchain based on Ethereum or Hyperledger has been proposed s in **autonomous driving** for securing the process quality in manufacturing chain [8]. Researchers have started a number of studies to see how blockchain technology can help solve problems in healthcare, banking, finance, real estate, and government administration [4], and we've compiled a list of recent Blockchain applications as well as the underlying blockchain technologies for implementation. A **supply chain traceability** system is designed to model manufacturing processes and this system uses smart contracts for the prototypical

implementation of the Ethereum Virtual Machine [9]. The agricultural supply chain's track and trace is addressed via a strategy that makes use of the Ethereum Blockchain and smart contracts. Using consensus methods, this system eradicates the requirement for a centralized authority and middlemen, thus permitting business transactions among all the stakeholders in the supply chain ecosystem. With connections to a decentralized interplanetary file system, all transactions are documented and kept in the Blockchain.[10] The prototype of a **food safety traceability system** was implemented on the Ethereum Blockchain.An enterprise-level smart contract was designed for having trusted interaction among the participants[11].

Healthcare: Blockchain has a huge potential in healthcare. Because of the anonymization that is integrated into Blockchain based medical records and these medical data can be utilised in clinical trials after obtaining permissions from patients[31]. Furthermore, blockchain ensures the integrity of data produced for clinical studies. Blockchain in healthcare has been proposed as a means of hoarding, sharing, and reacquiring remotely-collected biomedical data [33]. It is simple to replicate research using blockchain-based data because blockchain is transparent and public in nature [32]. Remotely monitoring a patient's condition outside of traditional healthcare settings like a hospital requires the collection of biomedical data via body area sensors (or IoT devices) and mobile devices, which is possible only with Blockchain. Insurance claim processing is another sector of healthcare which uses blockchain to facilitate insurance claims using the characteristics of blockchain such as transparency, verifiability, decentralisation and immutability of information [34].

Internet of Things: The Internet of Things (IoT) is a network of heterogeneous linked devices that work together to create environments that improve the way we do business, interact, and live. [35]. Blockchain seems to provide the capabilities needed to improve the security of IoT devices by defining a framework for trustworthy transaction processing and allowing IoT devices to communicate with greater transparency and auditability. The use of blockchain, also known as distributed ledger technology (DLT), in the Internet of Things would allow devices to operate independently and perform transactions using smart contracts. [28]

Finance: When opposed to traditional systems, blockchain-based financial systems have a number of significant technical advantages. At a modest fee, private individuals can benefit from increased security for online electronic cash payments without relying on Trust [24] and can hold control of their financial assets. Blockchain technology has the potential to enable speedier international payment, minimize administrative costs, and substantially reduce the risk of fraud for large organizations. Santander Bank - United Kingdom has introduced a pilot application for international payments.

Government and the Public Sector: Objective of an e-government system is to deliver all the public services to citizens without giving any space for religion, region, social status, etc, Such e-government system ensures that all the services are transparent and every citizen is included and benefited from this [17]. The advantages of using blockchain technology for public services, administration and E-governances are ubiquitous. It is very important to adopt the right blockchain solutions in Government services and public administration. For that Governments should work out policies to deploy decentralised networks to connect the various societal agents for sharing information in a secure way. So that innovative services can be delivered to the citizens and state government agencies by the Government. Use cases of blockchain in governance have been extended to identity management, land registration, voting and Vehicle Data Management.

Figure 3 highlights some of the promising areas where deployment of blockchain technology will transform these sectors enormously with robustness and secure trust among the public.

Figure 3. Blockchain Applications

5. Existing System For Vehicle Data Management And Its Challenges

Indian citizens perform transactions such as, new vehicle registration, change of ownership, request for permit and payment of road tax through the centralized system managed by the Ministry. The vehicle registration and other related vehicle data management activities in India are cumbersome taking a long way and since it involves multiple stages, consisting of vehicle registration, various certification services, managing the complete vehicle history, etc., which may include multiple parties each of them working at different stages of the vehicle's lifecycle which in turn makes it difficult to manage, and may also lead to data manipulation , data duplication and can cause security issues as an effect of which some of the confidential information may be disclosed. Vehicles data are spread across states and the respective state transport authority is responsible to manage the data, which is a tedious process to collaborate them together in case of emergencies.

VAHAN: "The Integrated Solution for Vehicle Registration" is an online vehicle system to take care of Vehicle Registration, tax payments , renewal, fitness and permits services. Currently it is being operated and managed by the Ministry of Road Transport & Highways to enable the processes atRegional Transport Offices and District Transport Offices

to be computerized. There are security and privacy concerns regarding these centralized systems as they are always susceptible to being attacked and inherently insecure and costly.

Challenges

- One of the major issues with the existing vehicle data management system is that the information about the vehicles are stored and managed manually by multiple agencies, there might be possibilities that those information could be manipulated, duplicated and chances of being lost and Criminals may commit fraud by creating fake ownership deeds, which could allow them to sell the vehicles.
- Another important issue in India is the difficulty in coordinating the Government agencies, public organizations and citizens for collecting information to solve emergency issues such as vehicle theft, vehicle accidents and vehicles used by terrorists and criminals.

The Ministry of transport handles high volume activities, which needs a great human workforce for performing vehicle registration and linking it with other public service providers such as Insurance agencies. Since the current systems are insecure, costly and time consuming manual work, there is a need for a real time fraud-proof decentralized trust system that is automatic, offers more secure, easier and cost-effective structures.

6. Proposed Vehicle Life Cycle Management Using Blockchain

Our objective is to create a vehicle life cycle management system for all ecosystem partners based on blockchain. We can build a Blockchain technology enabled system for automobile manufacturers, automobile dealers ,automobile consumers, government Transport department authorities and public organizations like insurance agencies to have secured transactions and to manage vehicle life cycle data from the time of manufacturing to the time they become scrap. Blockchain functionalities can influencethe efficiencies of vehicle life cycle data management systems significantly in the administration side. With blockchain technology, the vehicle data management process becomes completely secure, easier and also speeds up the process since the data is distributed over the network and doesn't involve much of the manpower. Blockchain helps us in mitigating this effect by storing the vehicle's information in a block which would be stored in the form of a hash which helps in avoiding the security issues that prevailed in the existing system.

This proposed Blockchain - enabled Vehicles Data Management framework to provide a secure platform for various stakeholders to collaborate and share data. This also helps to track the vehicle ownership changes since registration time in a secure and a permanent way. Digitizing this proposed system will help the government to provide enhanced services to all the vehicle owners and also to both government and private agencies which would reduce the time and money. Authenticity of digital ownership documents are verified and reselling of vehicles by using fake ownership documents are eliminated by the blockchain, because of its secured data structures.

Blockchain technology, a modern technological innovation, enables tracking the ownership of a vehicle, the insurance and tax status of the vehicle. In this context, this paper aims to create a blockchain based platform for the entire flow of vehicle data management protocols followed in Indian Road Transport Authority. There is no unified vehicle's life-cycle management platform available currently for the entire country.

In this proposed system every information about the vehicles can be protected, tracked and shared simultaneously with participating stakeholders on a blockchain platform. This helps in mitigating the traditional time-consuming process and to make it secure, easier and to gain faster access. This proposed system can be built to manage vehicle Life cycle data to minimize the integrity verification time, transparency of transactions, detection of various compliances such as insurance frauds.Figure 4 shows the main stakeholders of the proposed Vehicle lifecycle management (VLCM)

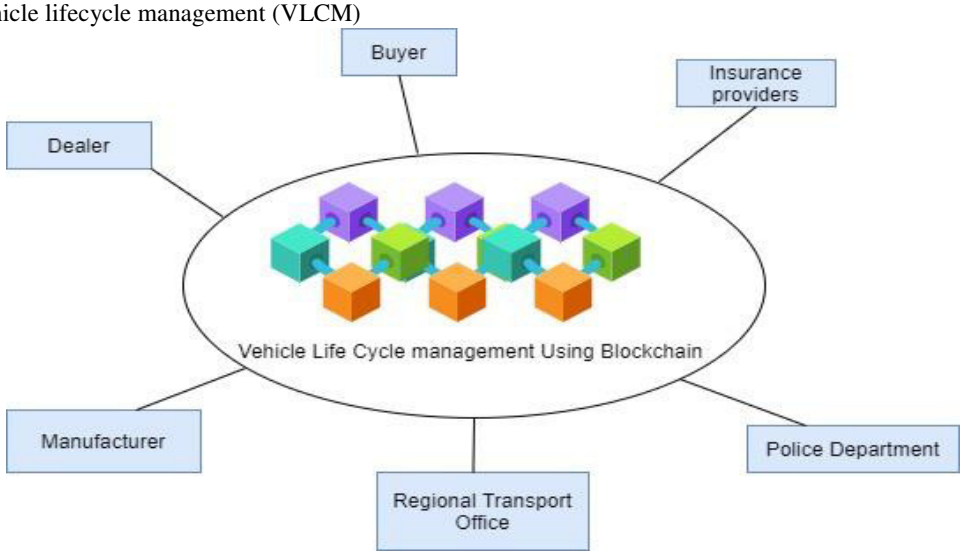

Figure 4: Vehicle Lifecycle Management (VLCM)

7. Conclusion And Future Work

Financial services, IoT, insurance, industry, logistics, transportation, communications, entertainment, healthcare, automation, and even robotics will all be transformed by blockchain technology in the twenty-first century. It is the most prominent technological advance since the creation of the Internet, and it will define future products and services in practically every industry. Based on a survey of the current literature on blockchain technology, we have proposed a Blockchain-enabled Vehicles Data Management Framework to provide a secure platform for multiple stakeholders to interact and share data in a very secure, faster and a transparent way using blockchain technology. Building a prototype for the above proposed work is an interesting topic for future work. Future work should discuss some of the key points of blockchain-based decentralised governance of the Ministry of Road Transport & Highways, its challenges and it should examine its feasibility in the Indian context.

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