ISSN: 2366-1313

Integration of IoT with other Emerging Trends in Blockchain Technologies

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Abstract—

Blockchains are tamper evident and tamper resistant digital ledgers implemented in a distributed fashion (i.e., without a central repository) and usually without a central authority (i.e., a bank, company, or government). At their basic level, they enable a community of users to record transactions in a shared ledger within that community, such that under normal operation of the Blockchain Network no transaction can be changed once published. This document provides a high-level technical overview of Blockchain Technology. The purpose is to help readers understand how Blockchain Technology works.

Blockchain is challenging the status quo of the central trust infrastructure currently prevalent in the Internet towards a design principle that is underscored by Decentralization, transparency, and trusted auditability. In ideal terms, Blockchain advocates a decentralized, transparent, and more democratic version of the Internet. Essentially being a trusted and decentralized database, Blockchain finds its applications in fields as varied as the energy sector, forestry, fisheries, mining, material recycling, air pollution monitoring, supply chain management, and their associated operations. In this paper, we present a survey of Blockchain-based network applications.

The Internet of Things(IoT) emerged as a result of technological advancements that enabled efficient wireless tiny devices. This study explores the role of IoT in various fields, identifies technological challenges and examines opportunities offered by the IoT. As the Internet of Things and 5G transform devices into intelligent machines, the future of human life is dependent on them. A complete overview of IoT and 5G technologies is provided in this paper, as well as how these technologies have the potential to change the human perspective about the digital world. Communication requirements for industrial IoT (IIoT) include a high degree of reliability, low latency, flexibility, and security. A 5G mobile technology provides these services instinctively, making it a great candidate to support IIoT scenarios. This paper examines current challenges in IoT research and potential solutions related to 5G-enabled industrial IoT.

KEYWORDS: ***C***ryptocurrency;Cyptographic hash function; asymmetric-key Cryptography; Distributed Ledger; distributed consensus algorithm; proof of work; proof of stake; round robin; proof of authority; proof of identity; proof of elapsed time; soft fork, hard fork; smart contracts; 5G, 6G, IoT, Communications, Security, Wireless Sensor Network, path loss**,** internet of things, IoT, critical factors, pre-service teachers, e-learning, technology acceptance model, Interactive Systems.

ISSN: 2366-1313

INTRODUCTION:-

Blockchains are tamper evident and tamper resistant digital ledgers implemented in a distributed fashion (i.e., without a central repository) and usually without a central authority (i.e., a bank, company or government). At their basic level, they enable a community of users to record transactions in a shared ledger within that community, such that under normal operation of the Blockchain network no transaction can be changed once the Blockchain idea was combined with several other technologies and computing concepts to create modern Cryptocurrencies: electronic cash protected through cryptographic mechanisms instead of a central repository or authority

Blockchains are distributed digital ledgers of cryptographically signed transactions that are grouped into blocks. Each block is cryptographically linked to the previous one (making it tamper evident) after validation and undergoing a consensus decision. As new blocks are added, older blocks become more difficult to modify (creating tamper resistance). New blocks are replicated across copies of the ledger within the network, and any conflicts are resolved automatically using established rules.

The Internet of Things (IoT) is the next generation of Internet technology that uses smart devices to connect the physical world and cyberspace. IoT systems are becoming more pervasive, and their widespread adoption has had a significant impact on all aspects of life for billions of people in just a few years. The Global Standards Initiative on the Internet of Things defines the IoT as “the global infrastructure for the information society that can facilitate interconnecting all types of objects, such as physical and virtual things based on the presented telecommunication protocols and technologies”. The IoT is considered an automation and analytics system as it uses networks, sensors, big data, and artificial intelligence technology to create flawless service systems. IoT pervasiveness facilitates daily tasks, enriches people’s interactions with their surroundings, and enhances social relationships with other peo-ple and items.

Purpose and Scope

This document provides a high-level technical overview of Blockchain technology. It looks at different categories of implementation approaches. It discusses the components of Blockchain technology and provides diagrams and examples when possible. It discusses, at a high-level, some consensus models used in Blockchain networks. It also provides an overview of how Blockchain technology changes (known as forking) affect the Blockchain network. It provides details on how Blockchain Technology was extended beyond attestable transactions to include attestable application processes known as smart contracts. It also touches on some of the limitations and misconceptions surrounding the technology. Finally, this document presents several areas that organizations should consider when investigating Blockchain Technology. It is intended to help readers to understand the technologies which comprise Blockchain networks.

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Challenges in Blockchain Technology

There are a few challenges associated with the Blockchain Networks. There is huge storage requirement as the validation process involves the whole Blockchain. Only a few transactions can be performed per second due to fixed block size which in turn causes increased transaction delays and high transaction fee. If the block size is increased, it will cause additional delay in block propagation. Moreover, it is possible to generate fake blocks by the network nodes or generate transactions that are reverse confirmed. Rapid generation of blocks is possible by increased power consumption, resulting in legitimate blocks not being able to get their share of Blockchain network resources. An important challenge of Blockchain networks is the energy consumption. These transactions consume huge amount of energy.

As per our discussion in above paragraph, the block chain technology offers very comfort solutions like transparency, decentralization, integrity, immutability, and security without requiring any centralized trusted authority. However, some challenging issues are to be addressed for various applications. Energy Consumption: - To validate the transaction for insertion into network Proofof-Work mechanism is used, which requires lot of computational power for the processing of complex mathematical puzzles. Scalability: - Ability to handle plenty number of nodes at a time is challenging task for this technology. It also involves complication calculation for single transaction which may slow down performance. Privacy: - As it is open ledger, anyone can view the contents, which might be beneficial in many applications, but in case of sensitive application it becomes liability. Lack of Talent: - Currently, there are few employees to build decentralized block chain. Educating employees to work with block chain will be lengthy process. Security: - Security is another crucial topic here. We have a tendency to all skills each block chain technology boasts regarding its security.

Blockchain architecture The Blockchain is a sequence of blocks, which holds a complete list of transaction records like conventional public ledger. Figure 1 illustrates an example of a Blockchain. Each block points to the immediately previous block via a reference that is essentially a hash value of the previous block called parent block.

History of Bitcoin

In year 2008, a private or event creating underneath the name out of Satoshi Nakamoto distributed a paper entitled “Bitcoin: A Peer-To-Peer Electronic money System”. This paper delineate a disseminated version of the electronic money that will empower on-line parts to be sent significantly starting with one collection then onto the subsequent while not encountering a fund association. Bitcoin was the essential affirmation of this thought. Directly word processed financial standards is that the make certain is employed to depict all frameworks and mediums of exchange that usages cryptography to grapple trades as against those structures wherever the trades area unit redirected through a gathered sure in part.

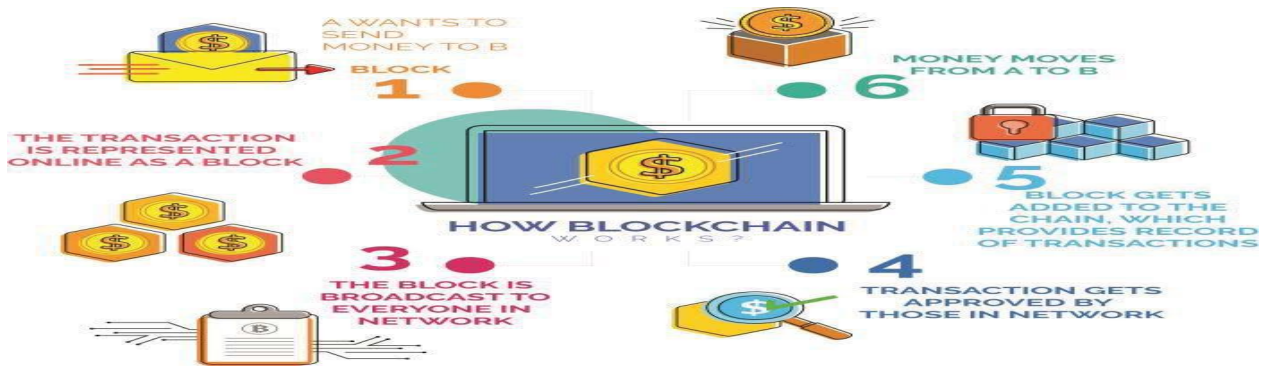
How A Blockchain Works

ISSN: 2366-1313

The Blockchain innovation has relevancy to any advanced resource exchange listed on the net. internet business is completely fixing to the fund foundations filling in because the sure third party UN agency method and intervene any electronic exchange. the work of sure third party is to approve, defend and defend exchanges. a selected level of deceit is ineluctable in on-line exchanges which requirements intercession by cash connected exchanges. This out comes in high exchange prices.

Bitcoin utilizes scientific discipline proof instead of the trust within the outsider for 2 willing partakers to execute a web exchange over the web. each exchange is secured through a processed signature. each exchange is distributed to "general society key" of the collector rigorously marked utilizing the "private key" of the sender. Keeping in mind the tip goal to burn through money, businessman of the digital cash has to demonstrate the responsibility for "private key". The part acceptive the advanced money confirms the processed signature – on these lines responsibility for "private key"- - on the exchange utilizing "the general population key" of the sender. Each exchange is communicated to every hub within the Bitcoin prepare and is then recorded in an open record when check.

Fig. 1. Working Of Blockchain



The Bitcoin tackled this issue by a framework that's as of currently loosely referred to as Blockchain development. The Bitcoin system orders trades by putting them in social occasions known as squares and a brief time later interfacing these squares through what's known as Blockchain. The trades in an exceedingly solitary square square measure thought of to own happened meantime. These squares square measure related to one {another} (like a chain) in an authentic immediate, ordered demand with every square containing the hash of the past square.

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Fig. 2. Key Features Of Blockchain

Applications:

This technology not only benefits crypto-currencies but also many different industries that need to store and manipulate huge amounts of data. Blockchain technology has the potential to support the field of financial, public and social services like land record management, asset management, educational services, energy conservation, citizen registration systems, patient management, taxations system, security and privacy enhancement of mobile devices and associated services. Here are some of the industries that employ Blockchain Technology to improve their operations: banking, Cybersecurity, academia, marketing and advertising, supply-chain management, ecommerce, voting, supply-chain networks, finance, asset management, healthcare, real estate, Internet of Things, government record keeping and health industries etc. An overview of Blockchain areas of applications and associated services is listed in Table 1.

In general, Blockchain Technology is applicable for the following conditions,

1. Digitization of assets to provide data driven business models.
2. Digitization of processes and transactions among business partners.
3. Provision of immutable records of transactions and assets.
4. Provision of decentralized, permanent and secure data storage.

Category	Applications
Financial records/models	Public and private equities, bonds, commodities, spending and trading records, microfi funding, voting rights and micro-charity
Public records	Birth, death and marriage certificates, passport, vehicle registration, voter registration, permits for business, buildings and guns, business ownership records, regulatory recor
Private records	Contracts, signatures, wills, trusts and escrows
Semi-public records	Medical records, accounting records, HR records, degrees, certificates, business ction r
Physical Asset keys	Home, hotel, car, locker, safety deposit etc.
Intangibles	Coupons, vouchers, movie tickets, patents, copyrights, trademarks, licenses for softwar movies and books
Others	Data records like sports score, weather records, spam control, sim cards, weapon unloc

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Table 1: Blockchain applications and services

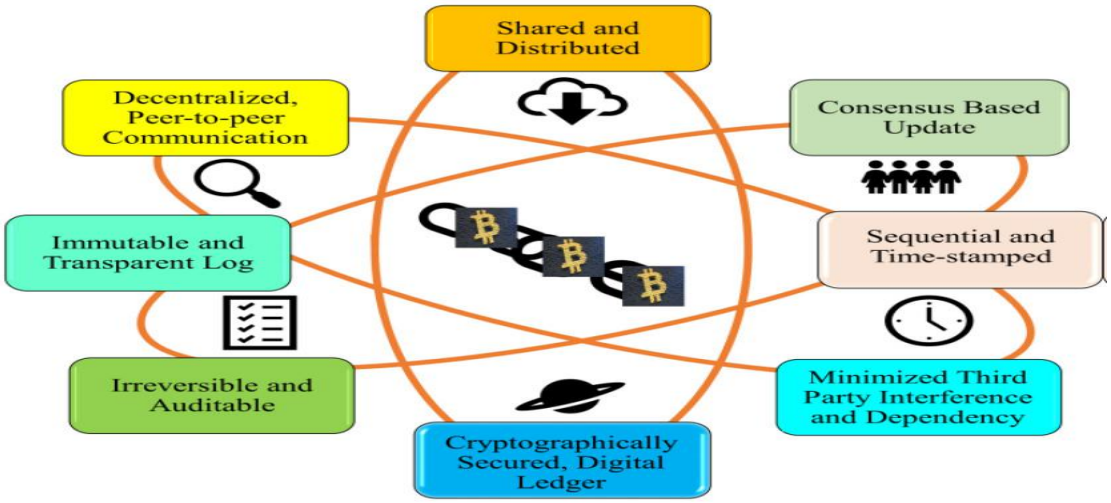
BLOCKCHAIN IN IOT

The IOT is dynamically obtaining the chance to be customary advancement in each the consumer and also the endeavor area. This specific essential has provoke makes an attempt towards localized IoT stages. The Blockchain development energizes the execution of localized IoT stages, for example, moored and trustworthy in knowledge exchange and moreover record keeping. In such an overview, the Blockchain fills in because the general record, keeping a trustworthy in record of the in depth range of messages changed between splendid devices ina very localized IoT topology.

Key characteristics of Blockchain

Some of the characteristics of Blockchain networks are illustrated in Figure 3. It is impossible for hackers to hack these network nodes as cryptographic techniques have been deployed to secure it. Each transaction is authenticated and validated using digital signature based on cryptographic algorithms. The Blockchain network is decentralized in nature which makes it more transparent and reliable for the storage and transfer of important data, currency, financial transaction or any valuable record. Each transaction is validated using a timestamp which makes it possible to trace and verify previous records by accessing any network node. It helps in improving transparency of data stored on the network. Each user interacts with the network with a generated address. A certain amount of user privacy is preserved as there is no central entity that stores user's private information. It is possible to perform anonymous transactions on the Blockchain Network. It only requires the network address of the receiver to perform the transactions.

Figure 3. Blockchain characteristics



A transaction can be performed between any two peers directly without interference of any central entity. It results in reduced operation and development cost of servers. Any falsification in data can be detected easily as each broadcasted block will be validated by other network nodes. The record cannot be altered without the consensus of group members, which makes Blockchain transactions more reliable and persistent. The network nodes verify transactions collectively. Any financial transaction made on the network is confirmed and secured using cryptographic algorithms. Once a transaction has been verified by the network, it is placed in a block in a way that newer blocks are placed under previous blocks of financial transactions.

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In summary, Blockchain has following key Characteristics.

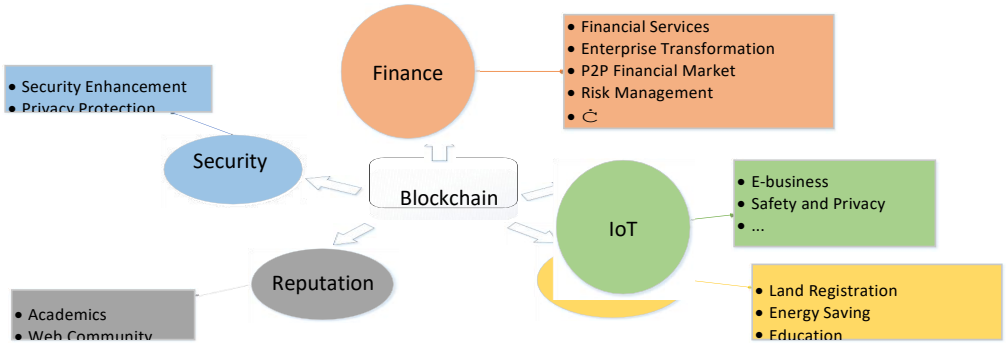
- *Decentralisation.* In conventional centralised transaction systems, each transaction needs to be validated through the central trusted agency (e.g., the central bank) inevitably resulting the cost and the performance bottlenecks at the central servers. Differently, a transaction in the Blockchain network can be conducted between any two peers (P2P) without the authentication by the central agency. In this manner, Blockchain can significantly reduce the server costs and mitigate the performance bottlenecks at the central server.
- *Persistency.* Since each of the transactions spreading across the network needs to be confirmed and recorded in blocks distributed in the whole network, it is nearly impossible to tamper. Additionally, each broadcasted block would be validated by other nodes and transactions would be checked. So any falsification could be detected easily.
- *Anonymity.* Each user can interact with the Blockchain network with a generated address. Further, a user could generate many addresses to avoid identity exposure. There is no longer any central party keeping users' private information. This mechanism preserves a certain amount of privacy on the transactions included in the Blockchain. Note that Blockchain cannot guarantee the perfect privacy preservation due to the intrinsic constraint.
- *Auditability.* Since each of the transactions on the blockchain is validated and recorded with a timestamp, users can easily verify and trace the previous records through accessing any node in the distributed network. In Bitcoin blockchain, each transaction could be traced to previous transactions iteratively. It improves the traceability and the transparency of the data stored in the blockchain.

Applications of Blockchain

There is a diverse of applications of Blockchain Technology.

Figure 4 Illustrates 5 representative application domains of the Blockchain.

Figure 4 Representative application domains of Blockchain (see online version for colours)



Finance

- *Financial services*. The emergency of blockchain systems such as Bitcoin (Nakamoto,) and (hyperledger,) has brought a huge impact on traditional financial and business services. Peters et al. discussed that Bblockchain has

ISSN: 2366-1313

the potential to disrupt the world of banking. Blockchain Technology could be applied to many areas including clearing and settlement of financial assets etc. Besides, Morini showed that there are real business cases like collateralization of financial derivatives that could leverage Blockchain to reduce costs and risks. Blockchain has also caught tremendous attention in the eyes of large software companies: Microsoft Azure and IBM are beginning to offer Blockchain-as-a-Service.

- *Enterprise transformation*. In addition to the evolution of financial and business services, Blockchain can help traditional organisations to complete the enterprise transformation smoothly. Consider an example of postal operators (POs). Since traditional postal operators (POs) act as a simple intermediary between merchants and customers, Blockchain and Cryptocurrency technology can help POs to extend their simple roles with the provision of new financial and un-financial services. In explored opportunities of arising Blockchain Technology for POs and claimed that each PO could issue their own postcoin which is a kind of colored coin of Bitcoin. Since the POs are viewed as a trusted authority by the public, postcoin could be prevailed quickly with their dense retail network. In addition, it is also shown in that Blockchain Technology offers business opportunities for POs in identity services, device management and supply chain management.
- *P2P financial market*. Blockchain could also help build a P2P financial market in a secure and reliable way. Noyes explored ways of combining peer-to-peer mechanisms and multiparty computation protocols to create a P2P financial MPC (Multiparty Computation) market. Blockchain-based MPC market allows offloading computational tasks onto a network of anonymous peer-processors.
- *Risk management*. Risk management framework plays a significant role in financial technology (FinTech) and now it can be combined with Blockchain to perform better. Pilkington provided a novel risk-management framework, in which Blockchain Technology is used to analyse investment risk in the Luxembourgish scenario. Investors who nowadays hold securities through chains of custodians tend to face the risk of any of these failings. With the help of Blockchain, investments and collaterals can be decided quickly instead of going through long-term consideration. Micheler and Heyde indicated in Micheler and von der Heyde that a new system combined with Blockchain can reduce custody risk and achieve the same level of transactional safety. Besides, Blockchain-based smart contract enables the Decentralized autonomous organisations (DAO) to engage in business-work collaborations. A highly dependable DAO-GaaS conflict model was proposed to safeguard business-semantics induced consistency rules.

Internet of things (IoT)

Internet of things (IoT), one of the most promising information and communication technologies (ICT), is ramping up recently. IoT is proposed to integrate the things (also named smart objects) into the internet and provides

ISSN: 2366-1313

users with various services. The typical killer applications of IoT include the logistic management with Radio-Frequency Identification (RFID) technology, smart homes, e-health, smart grids, Maritime Industry etc.

Blockchain technologies can potentially improve the IoT sector.

- *E-business*. Propose a new IoT E-business model and realise the transaction of smart property based on blockchain and smart contract. In this model, distributed autonomous corporations (DAC) is adopted as a decentralised transaction entity. People trade with DACs to obtain coins and exchange sensor data without any third party.
- *Safety and privacy*. Safety and privacy preservation is another important concern for IoT industry. Blockchain can also help in improving privacy in IoT applications. In particular, Hardjono and Smith proposed a privacy-preserving method for commissioning an IoT device into a cloud ecosystem. More specifically, a new architecture was proposed in Hardjono and Smith to help the device to prove its manufacturing provenance without the authentication of the third party and it is allowed to register anonymously. Besides, in IBM, IBM unveiled its proof of concept for Autonomous Decentralised Peer-to-Peer Telemetry (ADEPT), which is a system using Blockchain technologies to build a distributed network of devices. In ADEPT, appliances in the home would be able to identify operational problems and retrieve software updates on their own.

Types of Blockchain:

A Blockchain network has three types: public, private and consortium.

Public Blockchain: These networks allow anyone to join the network and execute transactions visible to every network user. There is no trust relationship among the network users before joining the network. Transaction can be verified by any node. All nodes participate in the transaction consensus process. Bitcoin and Ethereum belong to the class of public blockchain.

Private Blockchain: These networks are permission based. These are also referred to as “permissioned ledgers” and are constructed using Hyperledger Fabric which is hosted by Linux Foundation. The digital records can be encrypted and are visible only to authorized users, thus privacy requirements of the data are fulfilled. The main difference between private and public networks is user verification and authentication mechanism. In public blockchain networks, there is no trust relationship among the network nodes. Before any transaction can be performed, there is computing overhead involved in user validation which increases the time for each transaction. Contrarily, in private blockchain networks, permission based trust is involved before any transaction is made. It significantly reduces the computation overhead for running the authentication and validation algorithms. Consequently, thousands of transactions can be performed per seconds on private blockchain networks as compared to a few transactions per second in public networks. The blockchain network can be owned by a single network provider or multiple consumers. The owner of the network determines whether it is public or private in nature.

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Consortium Blockchain: In consortium networks, block authentication is performed by a set of specific nodes. It is categorized as semi private and permissioned Blockchain. It is a partially centralized system controlled by a few selector nodes, contrary to public blockchain (decentralized) and private Blockchain (centralized). Network nodes having authority can configure the data in Blockchain to be public or private. R3CEV and Hyperledger are examples of Consortium Blockchain networks.

Blockchain can also be widely used in public and social services.

- *Land registration*. One of the typical blockchain applications in public services is the land registration (NRI, 2015), in which the land information such as the physical status and related rights can be registered and publicised on blockchains. Besides, any changes made on the land, such as the transfer of land or the establishment of a mortgage can be recorded and managed on blockchains consequently improve the efficiency of public services.
- *Energy saving*. Besides, blockchains can be used in green energy. Gogerty and Zitoli proposed the solarcoin to encourage the usage of renewable energies. In particular, solarcoin is a kind of digital currency rewarding solar energy producers. In addition to the usual way of getting coins through mining, solarcoins could be granted by the solarcoin foundation as long as you have generated the solar energy.
- *Education*. Blockchain is originally devised to enable currency transactions to be carried out in trustless environment. However, if we regard the learning and teaching process as the currency, Blockchain technology can potentially be applied to the online educational market. in, Blockchain learning was proposed. In Blockchain learning, blocks could be packed and placed into Blockchain by teachers and the learning achievements could be thought as coins.
- *Free-speech right*. Moreover, Blockchain can be used to secure internet infrastructure such as DNS and identities. For example, Name coin is an experimental open-source technology that improves decentralization, security, censorship resistance, privacy, and speed of DNS and identities. It protects free-speech rights online by making the web more resistant to censorship.

UTILIZATION OF BLOCKCHAIN BEYONDCRYPTOCURRENCY

Bitcoin is simply a wonderful usage of the Blockchain. Blockchain is believed to be a completely unique miracle within the area of enrolling sanctionative unfathomable applications, for example, securing and checking definitive reports together with deeds and distinctive validations, therapeutic administrations information, IoT, Cloud so on. Tapscott befittingly indicated Blockchain to be the "General Ledger", partaking numerous new applications past checking trades, for example, in: wise deeds, suburbanized and additionally self-administering affiliations/citizen driven associations et cetera.

In the cloud condition, the chronicled background of arrangement of any cloud information challenge and its ensuing assignments performed quickly square measure recorded by the information structure a part of 'Data Provenance', or, in different words of cloud information. henceforward this is often basic to allow the foremost outrageous security to {the

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information|the info|the information} birthplace for making certain its data insurance, sociology and obligation. Liang propels a Blockchain based mostly sure in cloud information birthplace define, 'ProvChain', or, in different words. Such appointment of the Blockchain in an exceedingly cloud circumstance will provide sturdy protection against records being modified afterward partaking a redesigned straightforwardness and moreover further information obligation. This furthermore grows the provision, steadfastness, assurance and at last the estimation of the birthplace information itself.

Conclusion:-

Blockchain Technology is a new tool with potential applications for organizations, enabling secure transactions without the need for a central authority. Starting in 200913, with Bitcoin leveraging Blockchain technology, there has been an increasing number of Blockchain technology-based solutions. The first applications were electronic cash systems with the distribution of a global ledger containing all transactions. These transactions are secured with cryptographic hashes, and transactions are signed and verified using asymmetric-key pairs. The transaction history efficiently and securely records a chain of events in a way that any attempt to edit or change a past transaction will also require a recalculation of all subsequent blocks of transactions. The use of Blockchain technology is still in its early stages, but it is built on widely understood and sound cryptographic principles. Currently, there is a lot of hype around the technology, and many proposed uses for it. Moving forward, it is likely that the hype will die down, and Blockchain technology will become just another tool that can be used.

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Blockchain is the development spine of Bitcoin. The passed on record value joined with security of BlockChain, makes it to a great degree charming advancement to understand the current Financial and furthermore non-cash related business issues. To the degree the advancement cares, the computerised money based mostly technical school is either within the slippy inclination of vainglorious desires or in trough of disappointment.

Blockchain technology is still new and organizations should treat Blockchain technology like they would any other technological solution at their disposal--use it only in appropriate situations

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