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INTEROPERABILITY OF BLOCKCHAIN TECHNOLOGY IN 5G ENABLED IOT

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Abstract: In this digitized world, the Internet of thing (IoT) is growing very rapidly and also most of the devices are connected to internet technology. More than 5 million IoT devices are connected in across the world and also the high-power internet access, data transfer security, decentralization, low latency etc. Is needed When several interconnected devices increase, IoT technology needs high bandwidth data communication and 5G can resolve network related issues in the IoT devices. However, 5G enabled IoT devices to suffer a lot of security-related problems due to centralization. This paper reviews the security, performance, interoperability in the IoT devices based on 5G technology and integration of Blockchain technology can impact key features of the IoT (i.e., scalability, security, immutability and auditing, information flows, traceability and interoperability, quality) in 5g-IoT devices.

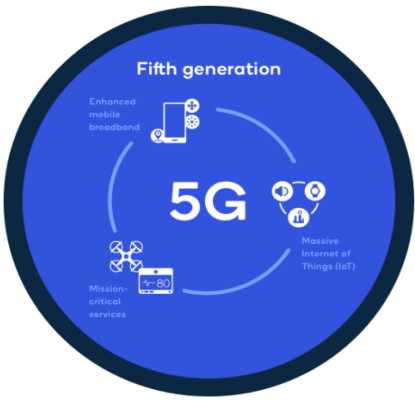
Index Terms: 5G, IoT, Blockchain, IoV

1. INTRODUCTION

5G, IoT and blockchain are three different independent techniques but together they can shape our future. 5G is the latest cellular network technology and expected to be implemented in 2020, but some countries are already tested this new technology. The data transmission rate of 5G is 10Gb per second and it offers faster internet, lower latency and greater interconnection. These advantages of 5G is enabled to interconnect more IoT devices together. The main applications of IoT are in healthcare, industrial automation, smart cities, smart cars, smart farming, smart homes, smart TVs, furniture items and vacuum cleaners etc. Smart cities and smart homes can save energy up-to 15 to 20% and as parallel to the advantages, it has a lot of security issues in the smart devices. Integration of blockchain technology with IoT can solve the security issues in smart devices. In Blockchain technology, data blocks are linked together with previous block address and it is more secure than the traditional client-server system. The main features of blockchain technology are decentralization, peer-to-peer network, enhanced security, smart contract, consensus and distributed ledger. The security issues in the IoT devices can solve to some extend by the integration of blockchain technology with 5G and IoT. This paper reviews the advantages and security issues of the integration of three technologies such as Blockchain, IoT and 5G technologies. A categorical study of recent research works in the field of the fifth generation of wireless technology is carried out in this paper. This paper is organized as in section 1.1 about 5G technology, section 1.2 about 5G and IoT, section 1.3 about 5G-IoT Architecture, section 2 about technical and security issues in 5G IoT, section 3 about blockchain technology, section 4 about Blockchain-enabled 5G-IoT, section 5 about open challenges and security issues in blockchain-enabled 5G-IoT and section 6 is the conclusion.

1.1 5G TECHNOLOGY

Is the future of next-generation which use CDMA, BDMA and millimetre wireless technologies with the speed of higher than 100MP. The important technologies behind the implementation of 5G are D2D communication, Massive Multiple Input and Output (MIMO), smart devices, millimetre wave and GFDM 1G, 2G, 3G, 4G this all led to 5G.5G is designed so that it can provide more connectivity than which was ever available before.5G technology is a unified technology, more capable air interface. 5Gis designed with increased capacity so that it can enable next-generation experiences to user, empower them with new deployment models and deliver new services. 5G is with high speeds, contains superior reliability and with negligible less latency, 5G will expand the technology like computers and mobiles ecosystem into new realms. 5G is going to make great impact to every industry, helps them making safer transportation, easily access remote healthcare, precision agriculture, also in digitized logistics and more things that are a reality.



This is the initial steps for the Fifth generation (5G) technology and the connectivity speed is up to 25Mps. The main advantages of 5G are high data transmission, lower latency, support virtual private network, high bandwidth etc. The main application area of 5G is in the health sector, mobile industry, IoT, artificial intelligence etc. 5G will connect every corner of human life with technology through communication networks. So it is important and needs to be protected sensitive data from cyber-attack. The main security threats in 5G technologies are DoS attack, saturation attacks, scanning attacks, timing attacks, a man in the middle attack, user identity theft, hijacking attacks etc. So when 5G technology is integrating with IoT and blockchain application, it needs security, Interoperability. The following sections are discussing IoT, blockchain and its integration.

1.2 5G AND IOT:

Internet of things (IoT) is the interconnection between physical devices, vehicles, building etc and data sharing by electronic or sensors embedded in these devices. As a parallel to the increment of IoT devices, they need a high-speed internet connection and secure environment. With the help of 5G technology IoT can connect billions of devices without the human interaction between them. The main requirements of IoT are high data rate, virtual reality or augmented reality, high definition video streaming and network scalability. Some IoT application needs lower latency, reliability, high coverage, highly protected security, low energy solution and a massive number of device connectivity.

1.3 5G IoT Architecture:

Consists of the business layer, application layer, support layer, connectivity/edge computing layer and recognition layer. IoT physical object such as smartphones, smart wearable, smart vehicles etc and hardware devices such as sensors, controllers or other data capturing devices from IoT is included in the recognition layer. The main function of this layer is collected information from IoT devices and recognise the IoT environment. Communication protocols and networks are defined in the connectivity/edge computing layer and the main functionality of this layer is connectivity. Support layer

supports the above and below layers for connectivity and it includes cloud computing powers, data analysis ability, and other intelligent computing ability. The application layer supports different applications such as smart home, smart grid, smart healthcare, smart transportation, smart wearable, etc. Business layer manages all IoT systems. In each layer, there are a lot of security issues like hardware vulnerabilities, network security and software security.

2. TECHNICAL AND SECURITY ISSUES IN 5G-IoT:

IoT is the interconnection between computing devices, digital machines, mechanical devices, or any other object that can transfer data across through network without human interaction or Computer. According to Gartner forecasts, in 2020 the world will use 20.4 billion devices. When the connectivity of the device increases it faces a lot of technical issues and cyber-attacks. The main technical and security issues in 5G IoT architecture are scalability, network management, interoperability, lack of standards, latency, heterogeneity, security assurance, identity, privacy concerns and authentication. Some sort of security-related issues can solve by integrating blockchain technology with IoT application. User privacy can also be an important issue to systems based on 5G-based IoT. Since all this are known to deal with users and data in large numbers, so, to ensure that each user will only have access to only his/her data is essential. Privacy to data collection, data sharing and management and data security matters are the remaining open research issues which are to be fulfilled. 5G will increase data transfer speeds, which implies higher threats of malicious file transfers. Data exfiltration or large malicious file transfers could more easily escape notice With high transfer rates. As much as information is available in 5G-based IoT

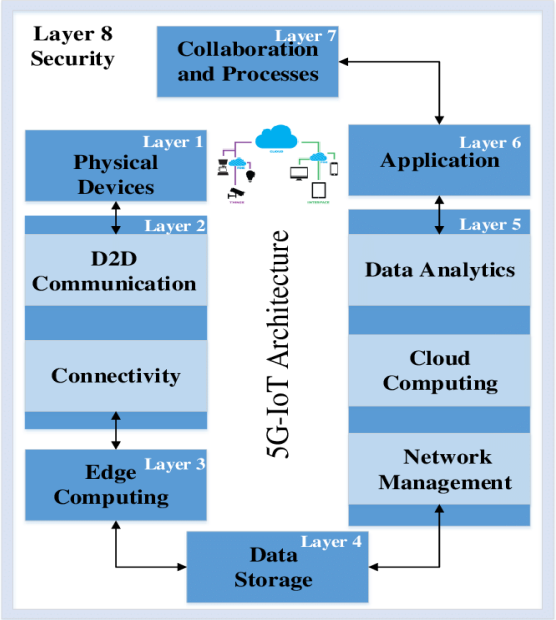


Fig: 2.1.1 5G-IoT Architecture

systems it may be personal data, there is a requirement to support restrictive handling and anonymity of personal information. According to, there are several areas where advances are required:

1. Cryptographic techniques which are enable to store process and share the protected data without giving access of information content to other parties
2. Also, techniques are required which support Privacy by Designing concepts, also by including data minimisation, identification, anonymity and authentication.
3. Fine-grain and self-configuring having access to control mechanism which is emulating the real world. Also, several privacy implications which are arising from pervasiveness and ubiquity of all 5G-based IoT devices where further research is required, including:
   A. Preserving the privacy of location, where location inferred from things which are associated with people.
   B. Also, individuals would wish to keep private personal information inference to prevent it through IoT-related exchanges observation.
   C. Keeping the information as possibly local by using decentralised computing and key management.

3. Blockchain Technology Overview

Blockchain is the growing list of blocks or chains linked together by the cryptographic hash function. It is fundamentally distributed database of records. It has a public ledger for handling all transaction related to different parties and it is decentralized. The consensus mechanism is the backbone in the blockchain technology and each transaction is verified by using consensus algorithm and after verification, it is recorded in the ledger. The transaction details recorded in the ledger is permanent and cannot erase or change recorded transaction details. The main idea of blockchain technology is started from the paper title Bitcoin: A Peer-to-Peer Electronic Cash System written by anonymous person/group of persons named as Satoshi Nakamoto at 2008. The most popular application of Blockchain technology is the bitcoin decentralized peer to peer digital currency.

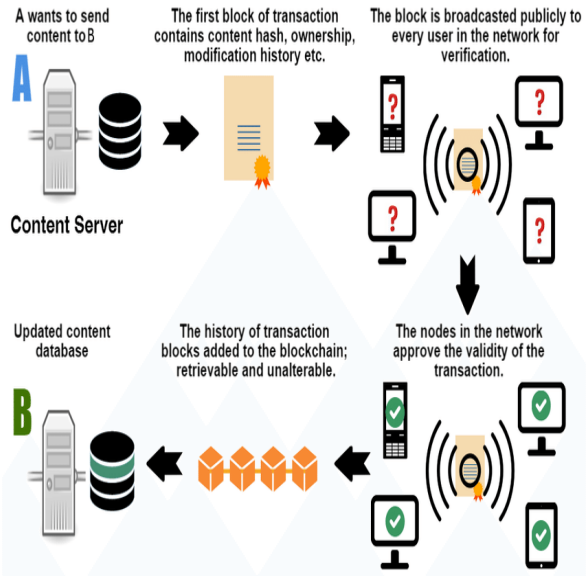


Fig : 3.1.1 Working Of Blockchain

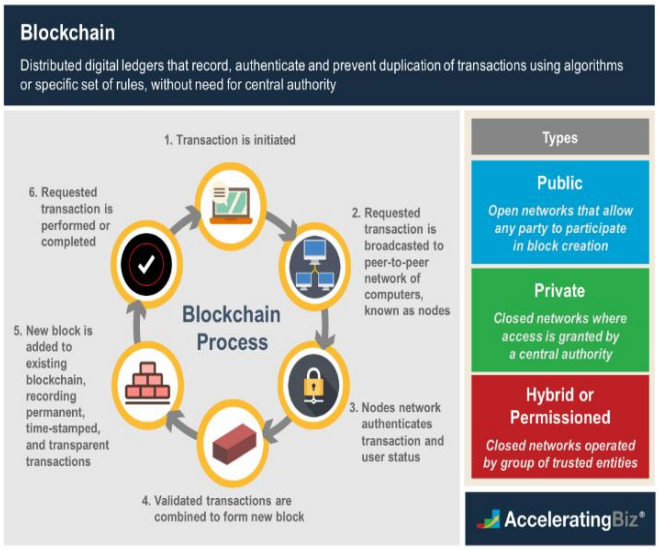


Fig :3.1.2 Types of Blockchain

A. Working of Blockchain

Blockchain is the group of blocks linked together with the cryptographic hash function of the next node. When a new transaction is requested to the blockchain, first they create a node for representing the transaction. Then this node or block is broadcast to all other nodes and all nodes validate the newly created block. If all nodes validation is completed, the new node is added in the blockchain ledger and transaction of the block is recorded.

B. Types of Blockchain

Blockchain technologies are mainly classified [6] as Permissioned (Private), Permissionless (Public) and consortium. Bitcoin, Ethereum are examples of the public blockchain and it is transparent to all. A private blockchain is mainly for a specific organisation and only authorized persons can validate, issue and read transaction details. Transparency, decentralization and anonymity are the features of a private blockchain. Block stack and Multi-chain are examples of the private blockchain. A consortium blockchain is a semi-decentralized, and also controlled by a group of authorized persons with having permission to other than single entity and consensus process is able to handle a group of pre-approved nodes in the network. Hyper-ledger, Corda and Quorum are an example of this network.

C. Characteristics and Application:

The two main characteristics of blockchain technology are distributed, decentralized, smart contract, trust, transparency, immutability, security and anonymity. Due to these features, most of the online transactions are come up with blockchain technology. The main advantage is there is no need for intermediate in these transactions and all the history of transactions are recorded. A smart contract is set of a computer program stored in the blockchain and it is executed automatically when some condition is met. The Blockchain technology has application in both financial and non-financial areas. Blockchain application in non-financial are notary public, in non-financial are notary public, music industry, signed document validation, decentralized storage, decentralized IoT and blockchain-based anti-counterfeit solutions.

D. Blockchain enabled 5G-IoT:

As parallel usage of IoT devices also increases. According to the Gartner [14] forecasts, it becomes 20.4 billion connected devices at the 2020 years. The main challenges of IoT are decentralization, compatibility, privacy and vulnerability in security problems. Most of these challenges can solve by integrating blockchain technology with 5G enabled IoT. Blockchain is distributed ledger and the main highlight of this technology is decentralization, it removes the intermediate in between the transaction.

Blockchain can revolutionize IoT with an open, trusted, and auditable sharing platform, where any information exchanged is reliable and traceable. Here some of integration benefits which are given as follows:

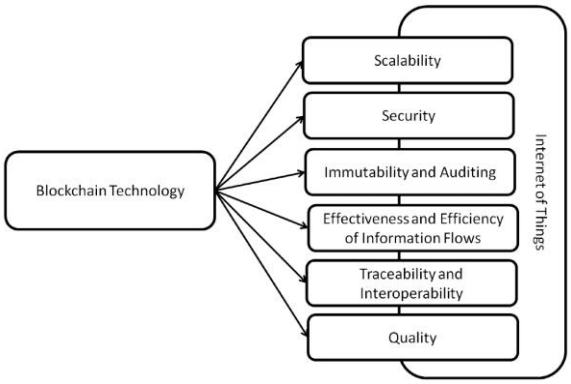
Scalability and Decentralization: The paradigm that shift to decentralized from centralized can eliminate any single points of failure that can improves the fault tolerance. This also prevents resources oligarchy, where a few powerful corporations can control the processing and collection of data of a people in large number.

Identity: The use of a common (or universal) blockchain allows better identification of each device. It can also be able to trace the origin of any required information after being immutable, Moreover, it can also provide a trusted means for authentication and authorization of IoT devices.

Autonomy: After using blockchain, all devices can interact with each other without the involvement of any intermediary. It can pave the way to develop device-agnostic IoT-based industrial applications.

Security: With the help of smart contracts, information exchanges are treated as a transaction, which provides secure inter-device communication.

Reliability: This integration which enables the users to check and verify the authenticity of all transaction with acertainty and this also provides accountability.



Secure Code Deployment: A manufacturer can also trace the update history easily as being an immutable ledger. Moreover, it also allows them to update IoT devices securely.

1. Scalability:

Comparing cryptocurrencies mining nodes, IoT devices like sensors have limited computing ability, which is both computationally expensive and difficult to improve. Several Solutions of Blockchain have been developed and introduced so that it can address the scalability requirements of supply chain and IoT. Consensus mechanisms and Blockchain structures depending on the industry type might Future Internet 2019, 11, 161 9 of 22 be less or more compatible with IoT applications. Consortium or private Blockchains are viewed as highly beneficial for many supply chain applications in this regard, because they have a limited number nodes and it can apply Fig: 3.1.3 Advantages of Blockchain Technology

data filtering to IoT to increase the Blockchain scalability. Applications can also integrate the IoT networks to smart contracts and also it benefit to enhanced scalability with a capacity of transactions of tens of thousands per second. The evolution of Blockchain architecture had leads to the emergence of 'off-chain' scaling solutions. These inclusion of so-called sidechains, that are chains which can run in parallel of the Blockchain and allow the value transfer between them. The ever-increasing data which is generated from IoT devices with supply chain can be encrypted and is stored to sidechains, and a reference to them which can be added into the main Blockchain. This functionality helps to significantly reduce the storage complexity by offloading the data from a Blockchain in terms of transactions processed. Inter-Blockchain communication promises higher levels of scalability although in its infancy and also with a lack of interoperability standards.

2. Security:

With the increasing proliferation of exchange partner relationships and the complexity of supply chains, firms are taking effort to secure their data and information exchanges also the integrity of their physical objects to protect against theft and various forms of illicit trade with including diversion and counterfeiting.

Blockchain facilitates the resolution of all several security challenges which are inherent in IoT devices and in networks, like unique device trust management and identification between different devices, information and data provenance which tracks access control and authentication, and accountability in IoT-based applications. The security mechanism mitigates the risk of a single point of failure which are under the Blockchain system due to its decentralization approach.

3. Immutability and Auditing:

The integration of Blockchain technology with IoT devices advances supply chain automation and creates an ecosystem consisting of immutable transactions that allow for improved audit. Supply chains always exchange partners which are gained from the combination of application of IoT and Blockchain through auditable and safe transactional data exchange within a massively context-aware and heterogeneous setting. When connected on a network, smart IoT devices can consistently and autonomously push data into the Blockchain platform, creating an immutable and auditable transactional history which is useful for product traceability, recall, product provenance, and authentication purposes. Blockchain technology, thus, enables a fine-grained audit capability where sensor values can add additional trust incorporating real-time and immutable data. These all characteristics sparked the IoT technology providers attention who are adapting their IoT network-based solutions to Blockchain-based technology.

4. Effectiveness and Efficiency of Information:

Flows which Blockchain applications that can create new opportunities so that it can track the physical assets and also goods with multi-party supply chains. Supply chain of exchange partners which is verified, will be informed about their relevant products, merchandise, asset, whether it is online, in-transit or in-store. Components or end consumer products, firms attain better control of their supply chains when informed about the movement of physical assets like totes, pallets, shipping containers, raw materials or ingredients. Blockchain technology also positively impacts the efficiency, effectiveness and integrity of information that flows in IoT solutions.

5. Traceability and Interoperability:

Blockchain technology is already used in combination with tamper-evident RFID-tags to aid in the verification of the provenance (e.g., geographic source or origin) and authenticity of bottles of fine wine. The tags are affixed to the cork and aim to eliminate attempts to refill wine bottles with a cheaper product. By logging all the data on Blockchain and crosschecking the provenance and traceability of the wine bottles, all consumers can verify the full history and authenticity of the purchased wine by just inputting the product ID in the system. Any food or drink absolute certainty on the authenticity can only be achieved using science-based analytical testing methods of the product itself in spite of to rely on overt or covert security features on the outer package. Several projects are in development to apply a combination of Blockchain and IoT for enhanced traceability and interoperability. Blockchain technology positively impacts the traceability and interoperability of IoT solutions.

6. Quality:

Blockchain technology addresses the problem of data and information quality existing in other information technology platforms Apart from providing a decentralized migration path for IoT data. It complements the need for maintaining consistent data provenance that describes where the data of interest originates, who owns the data and what transformations were made to the data. In this way, the metadata which is posted on the Blockchain is protected from unauthorized and compromise disclosure.

Blockchain technology positively impacts the quality and integrity of IoT solutions.

4. Blockchain Application in 5G enabled IoT:

- **Smart City:**

A smart city uses centralized services and interconnected networks it has a lot of advantages and as parallel, the potential threats are security and privacy. For securing the smart city application integrating blockchain technology with IoT is the best solution. A security framework of blockchain-enabled IoT has proposed Kama nashis and this framework solves the issues of reliability, scalability, security, centralization and efficiency.

Biswas et al.proposed a blockchain-based security framework which allowed the entities to communicate in a smart city while preserving privacy and security. They aimed to tackle various security threats which are discussed as follows:

Availability threats: a concerned with non authorized upholding of the resources. Integrity threats: a concerned with non-authorized modification to the data. For example, manipulation or data corruption. Confidentiality threats: a concerned with private information disclosure by any unauthorized entity.

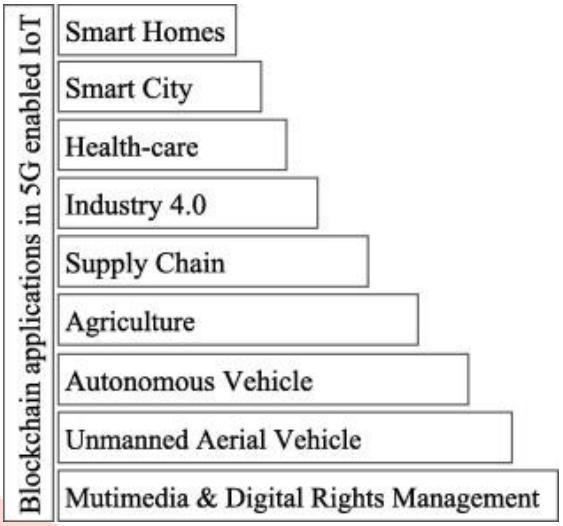


Fig 3.1.4 Applications of Blockchain technology

Authenticity threats: a concerned that can gain access to a sensitive data not having proper authorization. Accountability threats: a concerned with repudiation of reception or transmission of messages by entity.

- **Smart Home:**

Smart home consists of smart door lock, smart lighting, video surveillance, smart thermostat and smart parking. The smart home needs the infrastructure as network connectivity, sensor devices enabled by IoT and mobile application for remote connection. In the smart home system, a smart lock is very important because it protected the home from unauthorized user entry. If the smart home system uses central server there have a lot of security problems such as unauthorized, forging etc. For avoiding this security problem Han et al Ali Dorri proposed blockchain-enabled smart lock system and it gives the solution for non-repudiation and integrity. 5G enabled IoT also provides fast intrusion detection and low latency.

- **Healthcare:**

Healthcare is one of the most essential aspects of the overall development of any nation. It can be considered as an indication of a society's general well-being. With an increase in population and medical conditions, the burden on modern healthcare systems also increases in recent times. 5G-enabled IoT considered as a potential solution to alleviate the pressures on the healthcare system [55–57]. One of the solutions is remote health monitoring, which involves the usage of IoT sensor devices to measure and analyse various health parameters of a user remotely.

- **Internet of Vehicles (IoV):**

IOV is the network between vehicles and the internet. Main three types of IoV are Vehicles to Vehicle, Vehicles to infrastructure and Vehicles to cloud. A car connected to car, car connected to bus etc is included in the application of vehicle to vehicle. In-vehicle to a cloud application is centralized and information about the accident, vehicles private information all are stored in the cloud database. The main security challenges in IoV are sharing data among vehicles and storing information in cloud data storage. Blockchain-enabled 5G IoT can solve most of the security-related problems in message passing between vehicles or infrastructure by Proof of Work or smart contract and it also utilized energy efficiently. The main highlights of integrating these three technologies are enhanced security, integrity, authenticity and decentralization.

- **Supply chain management:**

The supply chain is the network of resources, organizations, individuals resources, and also of activities that are involved in the life cycle of a product. It starts from product creation to its sale, from the delivery of raw materials from the supplier to manufacturer, right up to its delivery to the end-user. The usual flow in a supply chain begins with the supplier, followed by the manufacturer, wholesaler, retailer, and finally to the consumer. Supply Chain Management (SCM) is the procedure to manage materials, information, and finances as they move through a process in the supply chain. The significance of supply chains, this also faces challenges, some of given as follows:

A. **Mismanagement of logistics**
B. **Lack of assets and visibility**
C. **Not handling data properly**
D. **. Not having efficient handling of stack**
E. **. an Ineffective risk management**

5. OPEN CHALLENGES AND SECURITY ISSUES IN BLOCKCHAIN ENABLED 5G IOT

as parallel to the advantages of blockchain technology, it has some limitation when integrating this technology to 5G enabled IoT. Some of the main challenges [18] are energy consumption, scalability, slower data transaction, lack of standardization, low storage capacity and low computational power. As per the different statistics, the number of IoT devices increases and it needs more battery power and energy for processing. In blockchain technology, block mining is very computationally expensive and energy needed. In the blockchain, technology data are stored in the IoT nodes and it needs more storage capacity and high computational power. This is one of the challenges of IoT devices. Some security issues in blockchain technology are Dos attacks and trust between the two nodes. Data in the Blockchain technology are anonymous but in the case of IoV needs transferring personal information and other data. It is also somewhat problematic in the blockchain-enabled IoT applications. Due to the lack of standardization, the communication of the devices through different ledgers are much more difficult.

6. CONCLUSION:

In the digitized world, the integration of different techniques within one platform is very important and it can solve different technical, network and security-related problems. IoT has a different application in our daily lives and it needs high bandwidth and interconnection due to the increase of connectivity between devices. This paper viewed the architecture, features and security-related problems of three challenging technologies such as IoT, 5G and blockchain, emerging these three technologies i.e. 5g IOT and Blockchain their interoperability. As a parallel to the advantages of blockchain-enabled 5G IoT, the opening challenges of blockchain technology are, standardization, energy utilization and regulation. Some of these current issues can solve by integrating artificial intelligent with blockchain technology.

7. REFERENCES:

[1] "Blockchain applications in the internet of things." https://www.blockchaintechnologies.com/applications/internet-ofthings-iot/

[2] I. Ahmad, T. Kumar, M. Liyanage, J. Okwuibe, M. Ylianttila, and A. Gurtov, “Overview of 5g security challenges and solutions,” IEEE Communications Standards Magazine, vol. 2, no. 1, pp. 36–43, 2018.

[3] Ishan Mistry a, Sudeep Tanwar a, Sudhanshu Tyagi b, Neeraj Kumar c “Blockchain for 5G-enabled IoT for industrial automation: A systematic review, solutions, and challenges”, 2019.

[4] Abdirahman Rageb, John G. Keogh 2 and Horst Treiblmaier “Leveraging the Internet of Things and Blockchain Technology in Supply Chain Management” Future Internet 2019, 11, 161; doi:10.3390/fi11070161.

[5] S. Nakamoto et al., “Bitcoin: A peer-to-peer electronic cash system,” 2008.

[6] M. F. K. Sial, “Blockchain technology–prospects, challenges and opportunities,”

[7] K. Biswas and V. Muthukkumarasamy, "Securing smart cities using blockchain technology," in 2016 IEEE 18th international conference on high-performance computing and communications; IEEE