Cross-Industry Blockchain Technology:

Opportunities and Challenges in Industry 4.0

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PREFACE

The book aims to shed light on Blockchain technologies which are the talk of the town in current times and have attracted a lot of potential end users. The excitements engendered by blockchain technologies completely relish the great feature of their exploitation in the facilitation and usage of cryptocurrencies. Bitcoin and Ethereum are the two most illustrious examples which foster a good future for Cryptocurrencies.

A blockchain is an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way. As a promising technique to achieve decentralized consensus, Blockchain helps achieve benefits critical to enterprises and create extraordinary opportunities for businesses to come together in new ways.

The book covers different applications of blockchain in fields including the financial sector, big data, health industry, hydroponics, and vehicle ad hoc networks. Editors are thankful to the authors for their contribution to the completion of the book.

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CHAPTER 1

Blockchain for IoT Security and Privacy: Challenges, Application Areas and Implementation Issues

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Abstract: Blockchain and IoT are the most exciting technologies in the current world, combining these two together may resolve a lot of issues. In the current scenario, we are using IoT devices in nearly everything. By the end of this era, we can presume that all of our day-to-day use devices will be smart. But with this various issue may rise like safety, security, and performance concerns of smart devices. To resolve these issues, blockchain technology has emerged as a very powerful tool. In this chapter, the basics of blockchain along with its architecture and algorithms involved are discussed. IoT challenges and related literature are also discussed along with blockchain as an efficient technology to resolve these issues. The chapter also includes the challenges in using blockchain in IoT devices.

Keywords: Blockchain, Cryptocurrency, Distributed ledgers, IoT, Proof-of-stake, Proof-of-work.

INTRODUCTION

The chapter includes the two emerging technologies, blockchain and Internet of Things (IoT). Blockchain is a distributed ledger technology that maintains immutable records leading to highly secure data, whereas IoT is the technology that became an essential part of our day-to-day life. IoT applications are used in smart homes, smart cities, industrial productions, smart grids, *etc.* Here, we discuss various IoT related issues and blockchain technology separately and then the ways in which blockchain can be used to resolve these key challenges of IoT are discussed. Out of the various challenges of IoT, the most crucial one is secu-

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rity and confidentiality, which can be resolved using blockchain. Blockchain gives power to the changing digital infrastructure which can help to evolve IoT, ranging from analytics to security. IBM took an initiative of blockchain usage incognitive IoT [1]. They used it in complex trade lanes and logistics where smart contracts can be incorporated using blockchain technology register. According to IBM, three key benefits are firstly building trust using distributed ledger-based authentication system and reducing the risk of collision and tampering, secondly by cost reduction by removing intermediate or third parties, and thirdly accelerated transaction speed by reducing settlement time from days to instantaneous decisions.

Blockchain and its Key Concepts

Blockchain is important as it brings trust to a network, and that is the main reason behind its wide usage in various areas based on trust factors. Blockchain operates with the basic concept of peer-to-peer trust factor with zero intervention from third parties. Blockchain is a decentralized ledger of all transactions across a peer-to-peer network, which means it enables the transfer of digital assets without third party intervention. Blockchain is being used in a wide range of industrial applications as listed below:

a. One of the most famous is cryptocurrency, for each blockchain. Right now, there are various cryptocurrencies in existence. Out of which the most famous one is Bitcoin. Some other are Ether, USD Digital, Bitcoin Cash, Tether, Stellar, *etc.*
b. It is used in financial transaction security in the finance industry as transactions should be open and in the form of immutable ledgers.
c. Patient's data is collected by various devices in healthcare. Such data is highly confidential and need not to be manipulated under any conditions.
d. One of the major issues with government supplies is that they do not reach the designated person or department. To maintain that, government nowadays uses blockchain in supply chain management to ensure the proper delivery of essential items.
e. Blockchain in supply chain management is also used in manufacturing and distribution to ensure an immutable ledger of items produced and distributed.
f. It is also useful in moving point of data computation from one place to another. While doing so, our data should be secured which can be easily done using blockchain.
g. Some other examples are E-voting, Key distribution, funding generation, securing public records *etc.*

The most known term in the blockchain is Bitcoin. Blockchain is confused with bitcoin, but actually bitcoin is just a cryptocurrency based on blockchain. Whether Bitcoin survives or not, concepts and algorithms of blockchain form an essential backdrop of various key security-based fields. There was a scenario in 2008-09 where major financial systems were facing issues, which led to share market crumbling. Then a person named Satoshi Nakamoto introduced digital currency. Digital currency is an asset which can be transferred securely over internet. This new currency introduced by Satoshi Nakamoto is called Bitcoin [2]. Cryptocurrency is in controversy due to the reason that it does not need any central authority like bank to transfer assets [3]. Thus, many people and countries still do not authenticate it. Bitcoin uses various algorithms for verification, validation and consensus protocol for each transaction.

Working of Blockchain

Centralized *vs*. decentralized system: Consider a scenario where any person wants to buy something using credit card. This process has many stages including verification of the transaction by credit card authority, payment gateways, banks involved *etc.* This is an example of centralized system where everyone is connected with other with some legal process Now consider a scenario where a person directly wants to deal with another person irrespective of their location. Here these two people are going to be peers among which we need to establish a transaction in a decentralized way, which means transaction between two persons who are not at the same location and not a part of a centralized system and do not know each other. This is basic concept of decentralized system. The major issue with such systems is trust. We can build trust by framing a process to validate, verify and confirm transaction which should be a tamper proof. The overall process of doing so will include recording the transaction in distributed ledger system, making it tamper proof, creating a chain and finally implementing a consensus protocol for agreement on the verified transaction to be added in the ledger . This individual transaction is called blocks and to make it secure, a chain of blocks is created, that's why this concept is named as blockchain. Whenever one person transfers a certain amount to others, they keep a ledger of that transaction, but to provide trust, the other person called peers comes into the picture. All these people involved also keep a copy of the ledger. This is the basic concept of an immutable distributed ledger defined in a blockchain process. Similarly, verification methods are also involved and implemented using peers. Summarizing, blockchain uses a decentralized peer-to-peer system using collective trust model for validating and verifying a distributed transaction.

CHAPTER 2

Distributed Ledger Technology and its Potential Applications – Financial Sector

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Abstract: The concept of blockchain has shown tremendous potential and growth in the last decade. The terms such as blockchain and digital ledger technology are used interchangeably. Many research efforts have been madto explain and harness the benefits of digital ledger technology for the financial sector. Digital currency or cryptocurrency is a technological currency based on the block chain concept.

Keywords: Bitcoin, Blockchain, Digital Currencies, Digital Ledger Technology, Financial Inclusion, Financial Sector, Smart Contracts.

INTRODUCTION

DLT utilizes existing peer-to-peer technologies such as the internet telephony, emails, file sharing and the internet. A benchmark paper written by an anonymous person “Satoshi Nakamoto” in 2008, “Bitcoin: A Peer-to-Peer Electronic Cash System”, presented a unique methodology of funds transfer using the P2P technique named “Bitcoin”. The technology described in Nakamoto’s paper was referred to as Blockchain, which explains a novel way of storing and organizing information and transactions. Other forms of information transfer and transaction technologies were devised and the term “Distributed Ledger Technology” was invented. DLT records and shares data across ledgers (multiple data stores), each controlled and managed by distributing computing devices and having the same replica of data records. These computing devices are referred to as nodes. DTL can be understood as a distributed database that possesses unique properties. Blockchain is a special type of DLT that utilises algorithms and cryptography techniques to generate and validate append-only growing data structures. The data

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structure acts as a ledger in the form of transaction blocks (chain), is referred to as a blockchain. One of the nodes create a new data block, which contains the multiple transaction records.

One of the nodes initiates database addition, which in turn generates a new data "block" having multiple records of the transactions. This new block information (in encrypted format) is distributed across the network to maintain data privacy. This block validity is determined by every network participant using a consensus mechanism (algorithmic validation method). Post validation, a new block is added to the respective ledgers of all participants. Using this method, each change to the ledger leads to a ledger replication across the entire network and the entire identical ledger is available to each network member at any point of the time. This technique can be utilized for any digital transaction record. See Fig. (**1**) ("Dubai Aims to Be A City Built on Blockchain". By Nikhil Lokhade, 24 Apr 2017, Wall Street Journal https://www.wsj.com/articles/dubai-aims-to-be-a-city-built-on-blockchain-1493086080).

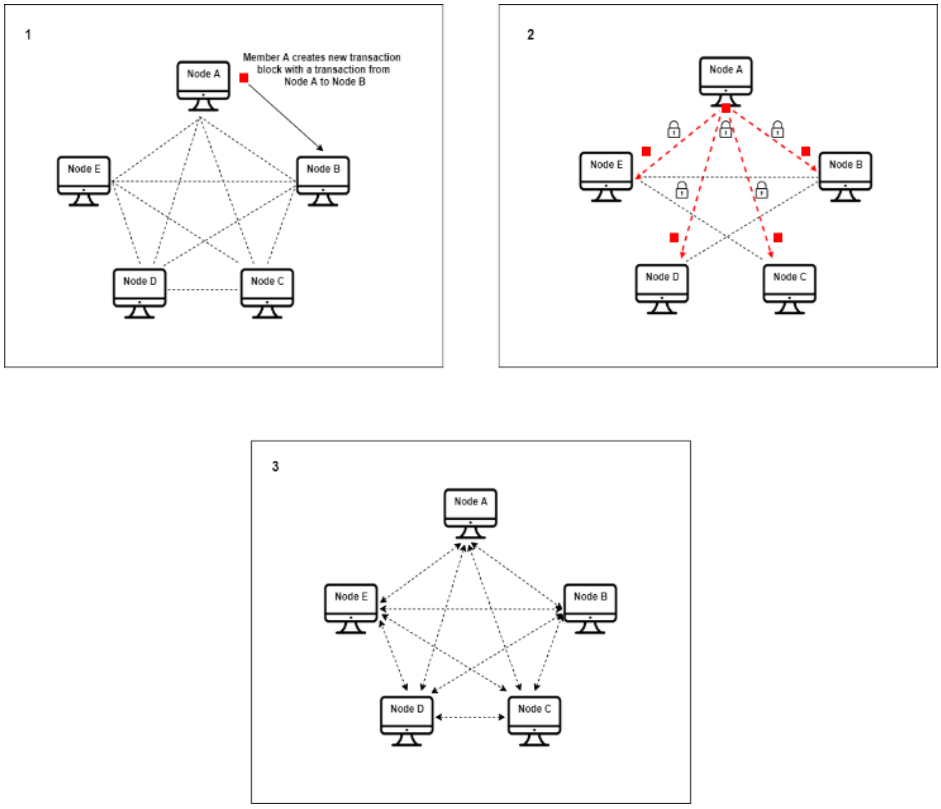

Fig. (1). Working of Blockchain based DTL.

1. DLT systems based on blockchain constitute an append-only data blocks chain. One of the nodes initiates new additions to the database and creates a new data block with multiple records of transactions.

2. Information is shared across the network about the new data blocks. The transaction details contain encrypted data.

3. All network participants use a "consensus mechanism" to determine the block's validity. Post validation, each participant adds a new data block to their respective ledger so that a full identical copy of the entire ledger is being replicated across the entire network.

Two characteristics of a DLT-based solution are:

i. It eliminates the need for centralized record keeping, storing, recording and distributing digital information across the self-managed counterparties.
ii. It also eliminates double-spend which means the same token cannot be distributed to multiple counterparties.

RECENT WORK IN DLT

The monetary policies of an economy are controlled by the central bank. A central bank controls the relevant economic management tools of an economy. The central bank's duty is to control money supply in an economy and deployment of monetary policies including interest rates management, keeping price stable for essential commodities [1]. Central banks have monopoly on the currency issuance for a given economy [2]. The emergence of Bitcoin in 2009 [3] motivated the concept of an alternative currency mode as a digital currency or crypto currency. This new form of alternative currency can be managed by private sector players or individual. Post bitcoin invention, private sector organizations or individuals have issued more than five thousand crypto currencies [4] in the last decade. The common attribute of these currencies is that they are based on digital ledger technology and are not controlled by any tangible resource. The currencies included Bitcoin [3], Stellar [5], Ripple [6], Ethereum [7], Tether [8] and others.

The strict regulations and law of land requirements for the financial market are creating challenges for decentralized digital currencies. Keeping this in view of the growth and opportunities in digital currencies, central banks are investing in the research and development of digital currencies backed by central banks and governments to preserve monetary policy and financial market stability [9, 10]. The Bank for International Settlements (BIS) conducted a recent survey [11] to analyse efforts by central banks on central bank digital currency research projects.

CHAPTER 3

Implementation of Blockchain Technology for Big Data

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Abstract: The focus of this chapter is to provide brief knowledge about the concept and advantages of integrating Big Data and blockchain technology. As we are focusing on the blockchain and Big Data, it is suitable to introduce Big Data before exploring its interactions with blockchain. The blockchain technology is introduced and then the interaction between blockchain technology and Big Data is focused, in order to gain a clear understanding of how blockchain technology is used for Big Data. Thereafter, the different applications of blockchain and Big Data are explored.

Keywords: Big Data, Big Data analytics, Blockchain.

INTRODUCTION

The invention of technology led to a period of important revolutionary reforms. The present era is continuously shifting towards the technology and the environment both. The information systems (IT) environment should therefore adopt research and application strategies to deal with future changes regardless of the circumstances and pace of the transformation. The latest IT developments can be summed up as large flows, such as blockchain, machine learning, and Big Data. Blockchain is a processing system for data exchange that distributes and preserves all data handled by network active participants. Blockchain, Cryptocurrency and Big Data are three major areas of the digital world-disrupting, intense passion, and challenging business strategies and activities around the planet. Since its introduction, the advent of Big Data has created various challenges and opportunities, by turning data into a quality source.

Moreover, blockchain technology itself is being examined as a possible basis for making business processes more profitable and efficient. The blockchain is tech-

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nically a public distributed ledger that contains all the transactions performed in the program. This is available on a P2P network, where a copy of the blockchain ledger is stored on every complete node. No central authority is responsible for managing the blockchain database. This concept of getting a database only between the system's actual and equal users sets the strategy for creating the so-called: “decentralized loyalty” [1]. Blockchain has the features of decentralization, non-tamper ability and fully programmable that can definitely deal with the security problems of Big Data storage, in particular for the safety of personal information that has a huge amount of secret information, and must be controlled and supported by government and large corporations [2 - 4]. The blockchain consists of many data blocks connected together in the sequence of incubation period, and the block size can be created by the consensus protocol of each node, and protection is guaranteed by the encryption technology. If a node tries to mess with a block, it is difficult to imagine the block to the entire network through the consensus process [5]. The operating history of each block can be traced by Markel tree and time stamp [6].

CATEGORIES OF BLOCKCHAIN

Blockchains are categorized into three types by methods of entry, namely, Public Blockchain, Private Blockchain and Blockchain Consortium [7, 9]. The Public Blockchain is the blockchain that is the first and perhaps most extensively used. Bitcoin is a community blockchain agent. The characteristics are decentralization and not being governed or regulated by any organization. Anyone can access the Public Blockchain [8].

The Private Blockchain is a framework not available to the outside community and is only used by the organization [10]. The Blockchain Consortium is between the Private Blockchain and the Public Blockchain and is normally used in areas where multiple users work, such as businesses, states, and banks at the same time [11]. Fig. (**1**) includes the different categories of blockchain. Table **1** gives a description of public, private and federated blockchains in terms of access permission, transaction speed, performance, protection, immutability, consensus mechanism, network and asset.

Generation of Blockchain

While, blockchain has already seen three generations, but that does not mean any subsequent generation was more popular than the previous generation. Interestingly, in the highly overlapped space, all three generations continue to develop and build their own place in the industry and are attempting to emerge as

winners. Different factors can decide, which generation has the best possible opportunity. The three generations of block chain are discussed in Fig. (**2**).

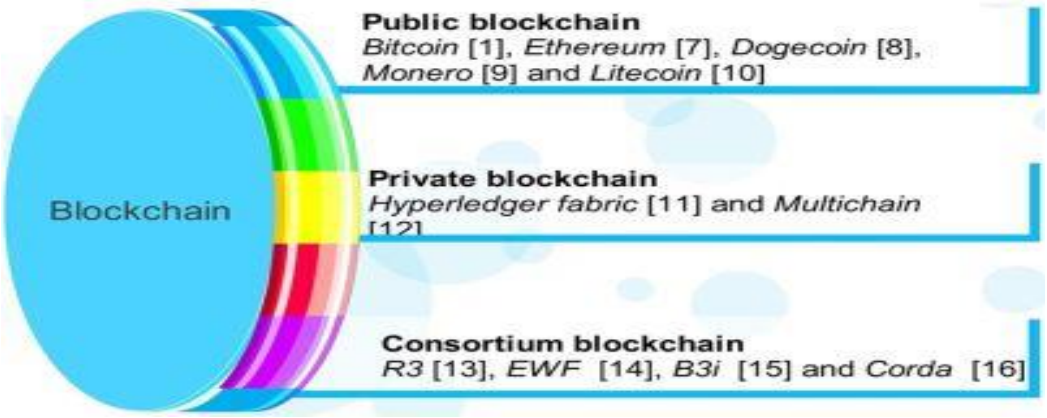

Fig. (1). Different Categories of blockchain [9].

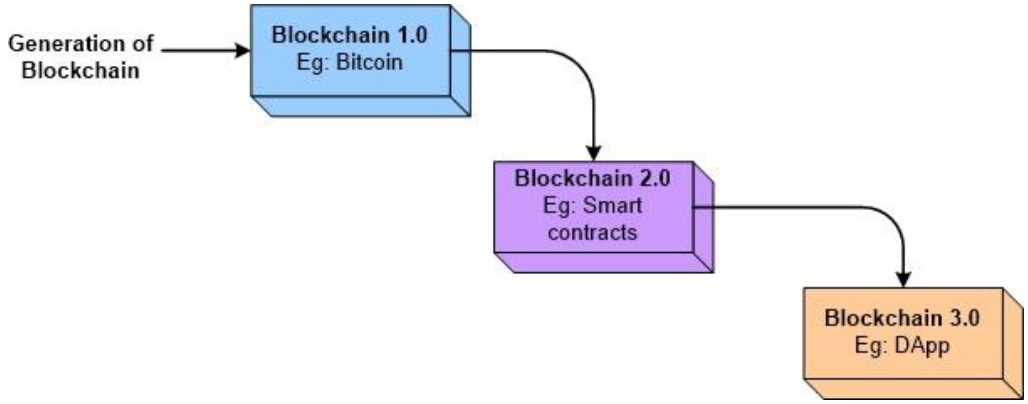

Fig. (2). Generation of blockchain

Blockchain 1.0

Each transaction is stored in the distributed ledger form in this process, so that it is open to any member in the distributed network. Bitcoin is the first digital decentralized currency, and a blockchain 1.0 technology. The fundamental technologies of Bitcoin are mining, cryptography, and the crowd ledger. A miner is an individual in this century who inquires block by figuring out the mathematical problem and gets a 12.5-Bitcoin as a reward for block verification. Security of own identity, money control, quick and automatic transaction are the characteristics of blockchain 1.0.

Blockchain 2.0

CHAPTER 4

Hydroponics Monitoring System Based on IoT and Blockchain

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Abstract: Since blockchain is the central technology of bitcoin, block chain has gained a lot of attention in recent years. Its applications are expanding in a variety of fields, including Internet of Things (IoT) defense, banking, industries, and medical centre. Furthermore, IoT has grown in popularity because of its widespread usage in smart homes and urban developments around the world. This paper presents the design of an automated system for a greenhouse focusing mainly on Hydroponics. Along with the design, the purpose of this study is monitoring, control, and visualization of the data. This project addresses some of the issues in traditional farming. Issues like incapability of agriculture due to small and fragmented land holdings, risk in using manures and pesticides, and lack of mechanization. The segments of this project include the main module (referred to as AGMS), the cloud, and the end user. The data visualization is done through a website that will acquire it from a Wi-Fi module through APIs. The study also includes social media alerts to platforms like Twitter and mail.

Keywords: API, Blockchain, MCU, Server.

INTRODUCTION

As we know, agriculture is the main requirement above anything else and the traditional practices are just degrading over time. The Indian Agriculture sector accounts for 18% of total GDP (Gross Domestic Product) still, there is no major development in the agricultural practices followed in the country. There are, however, some modern techniques like Hydroponics, Aeroponics and Vertical Farming..

Agriculture is the world's major source of food. Throughout the history, it has been a critical parameter to the advancement of civilizations. According to the United Nations (UN), the world's population will rise by 2 billion people to 7.8

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billion by 2050, implying that the planet will need to feed around 11 billion people by the end of the century.

As shown in Fig. (**1**), there have been four distinct revolutions in agricultural development: 1) age of traditional agriculture with human and animal power, 2) age of mechanized agriculture with rumbling sounds, 3) age of automated agriculture with high-speed development, and 4) age of smart agriculture with emerging technologies. As a result, smart farming provides a technologically-assisted road to sustainability. It entails the use of ICTs in the cyber-physical cycle of farm management, utilizing technologies such as the Internet of Things (IoT), cloud computing, robotics, and artificial intelligence (AI).

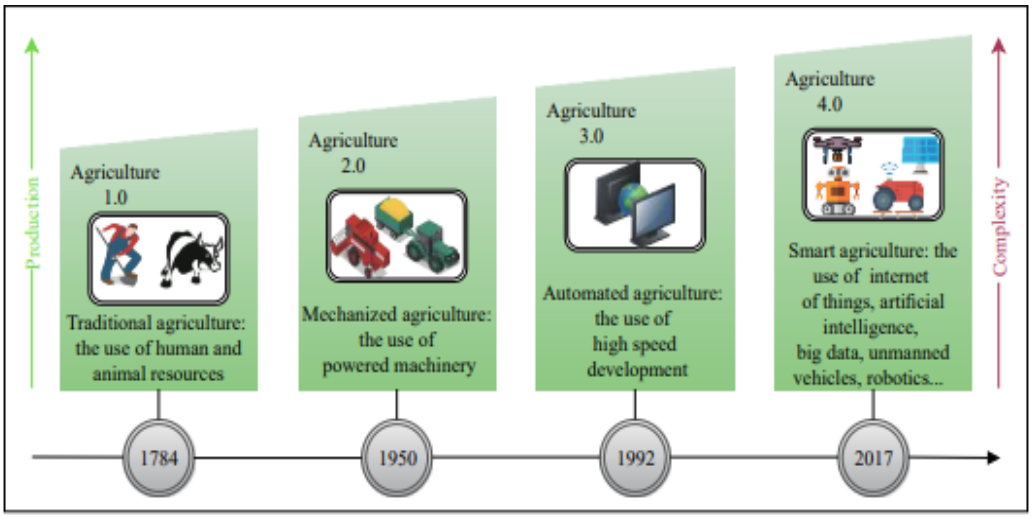

Fig. (1). The four agricultural revolutions.

Smart farming is a sustainable farming technique that enhances operational precision by giving each plant or animal exactly what it needs to thrive in the best possible way, maximizing overall performance while reducing waste, inputs, and pollutants. While smart agriculture is an advanced tech, it simply takes field circumstances into account. Smart farming, on the other hand, goes a step further by management responsibilities of data, which is reinforced by context and situational awareness and driven by real-time events.

Smart farming profited in the early years by advances in new technologies such as the Internet of Things, low-cost and enhanced sensors, actuators, and microprocessors, high-bandwidth wireless technologies, cloud-based ICT systems, Big Data analysis, AI, and robots. Farm equipment is no longer the only

source of data; new services exist that transform data into action. The use of IoT in agriculture attempts to equip farmers with the tools they need to help them make better decisions and automate their processes by providing goods, knowledge, and services that improve productivity, quality, and profit.

Hydroponics is a method of growing plants on a water surface without the need for soil. The nutrients plants get, otherwise when grown in soil, are given manually as per the requirement. The major advantage of this method is the time required for the growth and the absence of any fertilizers in the process. When done in a very small area, hydroponics does not require an automated system, but when done for mass production, an automated system is vital. Automated Greenhouse Monitoring System provides the automation, control and visualization for hydroponics. The automation is done by a programmable Microcontroller Unit connected to various sensors required for plant growth. The control is by the MCU along with the end user interface. The complete process is run through a cloud server, which will always be active and send alert and warning to the end user interface which comprises a website and data visualization through numbers and graphs.

The main effort on the cloud is data transmission at a very low data rate so that this project has a vast reach. The end user part is simple, taking into consideration that farmers can use this with zero effort. The system addresses the problems like the monitoring and control of any automated system without the need of human intervention.

DISCUSSION

Hydroponics

There are various methods to perform hydroponics, the best and the most efficient one being NFT (Nutrient Film Technique) method. This technique is very much popular for its simple yet efficient design. The NFT is often used to grow fast-growing plants like lettuce and spinach. Apart from these, commercially, green herbs and strawberries can be grown with this method.

In this technique, a very shallow nutrient solution is poured down the tubing. This tubing is adjusted at a slant and consists of a hole on the upper side of the house, for which the small containers consisting of the seed/saplings are needed. These containers are net pots to contain plants and the growing media like coconut fibre and dried grass. The various parts of the NFT system consist of a reservoir for the nutrient solution, a nutrient pump for the nutrients up to the tubing, tubes to distribute water from the pump to the growing pots, pots to contain plants/seeds

CHAPTER 5

Recent Trends in IoT Healthcare-based Blockchain Solutions

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Abstract: This review revolves around the idea of inculcating and amalgamating all the possible forte of healthcare that can be governed and handled by Blockchain Technology (BCT). Relating back to all the archaic systems involved in the healthcare sector, the entire process was quite slow and many a time leads to a significant amount of delay in any process, be it report of the patient, tracking data from the smart watch, ruling out appointment from a doctor, medicine prescription and many more. BCT in fusion with the Internet of Things (IoT), leads to generating a completely revolutionary and robust system that expands its range from very minute detail to a completely new horizon. As predicted by 2022, more than 18 billion devices will be available across the world; thus, managing this data that is related to healthcare, devising BCT for same can yield some exponential results in advancement in health care sector. This entire healthcare data is quite vulnerable to all the cyber-attacks and all the collected valuable information may be at a huge risk; hence by deploying BCT, security can be greatly increased. BCT is nothing but an immutable time stamp series of records, just like an array working; when even one of the blocks is initialized with any value of information, that piece of information will remain there forever. This review attempts to group together all such various fields that can be brought under a single umbrella covering the range of fields that can be governed by BCT in accordance with IoT for the development of health care sector.

Keywords: Blockchain Technology, Internet of Things, Hash Code, Healthcare, Protocols.

INTRODUCTION

The recent advances for the promotion of the crypto currency-based ledger system known as Block Chain Technology (BCT) have taken a huge leap in IoT and health care. As everything is web controlled so making use of BCT and IoT to

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govern the health sector would be a good opportunity to make this entire system of health care more robust and highly efficient. Internet of Things (IoT) is nothing but a sphere of interconnectivity of devices *via* the internet so that each and every device can be controlled through web. It encompasses a broad range of applications such as health management, smart homes, traffic, agriculture, and weather monitoring to name just a few because its growth is quite humungous at a particular speed. IoT devices are quite light [1] and thus lead to shallow energy footprints. Having just this less amount of energy, the most of it is completely utilized in the main function that the device performs. Hence, leaving very few amount of energy for applications such as security and privacy. This opens the path for BCT as it overcomes the problem mentioned before as it is secure, distributed, immutable, transparent, *etc.* The protocols governing BCT make the information secure in the form of block transactions that simply correlate with the respective application. Once this chain of blocks is completely filled, it appends to other chains *via* a process called as mining process and this process is performed by specific nodes called as miners. Although BCT deployment is not easy as it seems as there are various problems associated with it. Deploying BCT and IoT for the application such as healthcare is quite promising and these are well equipped. A system proposed [1] for Remote Patient Monitoring (RPM) is mainly focused on providing health care facilities other than hospitals. The whole concept is about an IoT wearable device that the patient wears and the device provides all the vital information *via* cloud protected by BCT, to the respective health care center. Although there are various problems associated with IoT like network overhead delay, mismanagement of the data and many more but BCT very effectively overcomes all these problems. BCT encompasses various positive points including privacy, trustworthiness, smart contracts, DDoS notification and mitigation but other problems may persist as bandwidth limit, network issues and many more. Before critically analyzing every aspect discussed so far, let us dive into its very basics.

Healthcare

A professional field, particularly of science that is a sheer management and improvement of health through appropriate history taking, prevention, diagnosis, standard procedures, treatment, and ensuring recovery of various ailments in people is known as Healthcare [2]. We have witnessed the advancement trend in the medical sector and it is enumerated to have the most impact on the business and society for the next 35 years. Healthcare has a very wide spectrum – from having large glass like structures providing every medical facility in the urban areas to struggling for a decent treatment in rural areas. Looking on the development being made in the Healthcare sector, this gap is expected to widen in the future years [3]. There is a buzz that a day will come when AI (Artificial

Intelligence) driven robots will operate on patients. For now, it may seem as a long shot but nevertheless steps have already been taken so as to proliferate this domain of AI for decisions in treatment [4]. New and automated technologies are being introduced in the hospitals that work using IoT and are able to analyze the patient's health status every time. Now we are taking into account various new factors emphasizing on health, like steps per day, water intake per day, number of floors climbed, and average walking speed [5]. Finding new and innovative reforms in this paradigm is quite tedious and requires huge deal of iterations. So, discovering new reforms has now extended beyond the boundaries for healthcare practices as they are being developed since 1950s. Although these prior reforms just focused on improving the safety and quality of healthcare, now the reforms are made to improve the quality of service ranging from local organization level to decision level organizations. More importantly, these are not only the tools that are driving healthcare sector to reach greater heights, but the organizational factors are also important to implement and sustain the new paradigm [6]. The most important factor affecting healthcare is diversity of the people. This brings in the theme of World Health Organization (WHO) for 2018 "Universal Health Coverage – Everyone, Everywhere". Many factors like social, political, financial, geographical and cultural, affect the availability of all facilities for the people [7]. Even if somehow or someway, all these facilities are made available, what guarantees that it is given to them regularly and a constant check is kept on the patients? The first idea that strikes our mind is 'Manpower' and more or less many may run out of 'Manpower'. So, the follow up solution is 'Accountability' – *the patients expect a certain standard of treatment due to a particular conduct*. They should be able to trust the personnel in front of them with their sensitive information.

In recent years, with digitization creating an umbrella in this tech world, many health care centers are now shifting towards Big Data and IoT for the welfare of their patients and monitoring them continuously – '*remote patient monitoring'* [8]. This remote monitoring is increasing at a very faster rate from 7.1 Million in 2016 to an estimated 50.2 Million in 2021 [9]. The information and data so gathered may be vitals or records, is being stored and monitored on a regular basis thus in return giving birth to HIE – *Healthcare Information Interchange*. Determining which trials and methods are used on one patient at a place makes it useful for a doctor to implement it at another place on a person having the same problem, by checking the records [10]. By implementing this method, new treatments can be found and doctors can learn more about the disease, thus developing a *precision medicine*. This new paradigm of healthcare is preventing and predicting diseases beforehand using the data being collected from regular monitoring of the patients. By training multiple Machine Learning models, we can predict for which disease the patient is more vulnerable and doctors can treat that

CHAPTER 6

Blockchain Technology-based System in Vehicular Ad-hoc Network

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Abstract: Among the various technologies that are constructing the pillars deep in the field of engineering, ad-hoc networks are one of the major fields of research. On the grounds of history, Mobile ad-hoc Networks (MANETs) played a prominent role in battlefield communication and other important applications, but another emerging network named as Vehicular ad-hoc Networks (VANETs) offered wireless communication led to its popular usage that resulted in the major deployment of ad-hoc networks. However, in VANET, secure message transmission is still a challenge, so we propose a local blockchain to disseminate the message in vehicular networks to improve the security issues. The public blockchain technique in VANET ensures trust-based secure message transmission in the Vehicular ad-hoc Network.

Keywords: Blockchain, Message dissemination, Secure Network, Vehicular Networks.

INTRODUCTION

Ad-hoc is derived from a Latin word that signifies ‘formed for’. A network [1] consisting of various independent individual devices sharing and exchanging information for communicating with each other resulting in the formation of a multi-hop radio network is termed as ad-hoc network. During communication, if one party, who is interested in communicating with the other party that is far away, needs an intermediary to exchange the information, for this purpose, ad-hoc network came into existence. It implies that if the desired target node is distantly located and is unapproachable then the message is transmitted *via* other nodes. Generally, the ad-hoc networks follow a multi-hop fashion of communication where each host can also be a router. Besides the consequences such as dynamic

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topology and above-listed issues, wireless ad-hoc networks have given tremendous applications to the world in the name of MANET and VANET [2, 3]. These networks are advantageous as they can use the unlicensed frequency spectrum and have a good network; due to which sending and distributing information also become very easy. The clustering algorithms discussed will eliminate the number of issues from the network. A highway is divided into two lanes where vehicular nodes (cars/ other vehicles) move with different velocities. Fig. (**1**) represents the ad-hoc network structure.

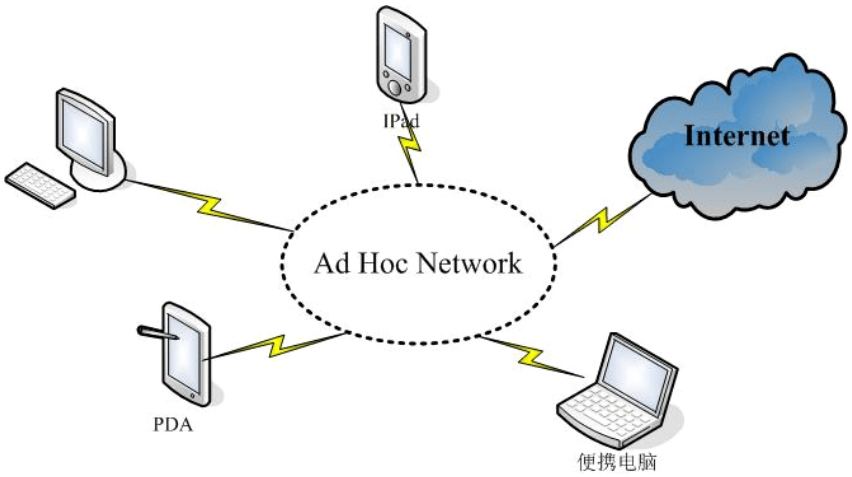

Fig. (1). Ad-hoc Network Structure.

The vehicles start forming a cluster using clustering techniques and the nodes in the cluster are called Cluster Members (CM), among which one node is chosen as the Cluster Head (CH) with the help of clustering algorithms. The clustering algorithms can reduce various efficiency-related issues in the network. There are a number of clustering techniques proposed by various researchers to facilitate the formation of clusters by applying different clustering algorithms.

ARCHITECTURE OF VANETS

As VANET creates a self-organizing wireless network using its mobile nodes, there also exists a full fledge architecture including other units RSU, OBU, and AU. VANET is a prime component of the Intelligent Transport Network that aims at improving traffic efficiency so as to provide better safety on road. VANET possesses a dynamic topology [4, 5], with frequent connections and disconnections of the vehicular nodes.

VANETs ensure:

- Traffic management
- Safety management, and
- Internet services

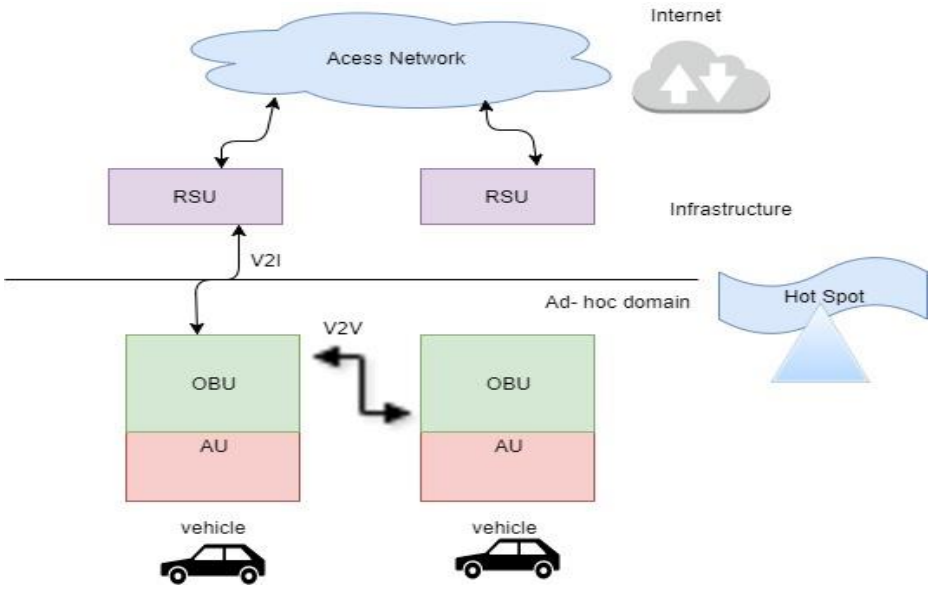

Fig. (2). VANET-general architecture.

Fig. (**2**) represents the general architecture of VANET. The VANET architecture follows Wireless Access in Vehicular Environment (WAVE) which is based on 802.11 standard protocol [6] and is used in ITS. WAVE is a specifically designed standard protocol that supports the vehicular environment and also promotes the V2V and V2I communications in 5.9 GHz band licensed for ITS. It uses the multiplexing technique of OFDM orthogonally so as to split the signals. WAVE consists of RSU and OBU, hence WAVE was adopted later. The units used in the vehicular ad hoc network [7] are represented in Table **1**.

It came into existence because fast communication was required due to the dynamic environment of vehicular scenario that demanded the high speed transfer rate [8]. Earlier the issue faced with 802.11a was its low data rate of 54 Mbps that ultimately resulted in multiple overheads. These protocols permit the vehicles to have a direct communication with no authentication before joining the network. Researchers are further emphasizing on providing the authentication and confidentiality assurance for security reasons.

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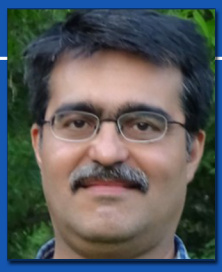

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