

A Comprehensive Study on Smart City using BlockChain Technology

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Available online at: www.ijcseonline.org

Accepted: 15/Nov/2018, Published: 30/Nov/2018

Abstract - The Internet of Things (IOT) consists of, any devices from sensors to smartphones and wearable technology. IoT is all about data. While the IoT grows, data insecurity also increases. The definition involves small devices each with their own Internet Protocol (IP) address connected to other such devices via the internet. Nowadays every home and every business is connected via the Internet of Things, the next level of technology is to connect the whole city in near future. The objective of smart city is to develop an urban city with fully secured from hackers and malware attackers The IOT is a centralized system where, every source information is stored in a centralized manner which is vulnerable to software attacks and system can easily be hacked. This paper proposes building an IOT Smart city using trustworthy decentralized BlockChain technology.

Keywords - Bitcoin, Blockchain, Consensus, Cryptography, Smart contract

I. INTRODUCTION

A “Smart” city contains cumulative elements such as smart governance, smart mobility, smart living, and smart use [2] of natural resources, all taken together. The goals of the smart city are to make better use of public resources, increases the quality of services offered to citizens, and reduce operational costs of the public administrations. To achieve these goals the smart city must deploy a centralized infrastructure that provides simple and economical access to services like public services, including transportation and parking, lighting, utilities surveillance and maintenance of public areas.

The main problem in the centralized architecture is that data privacy and security. Especially the following three things [11] CIA (Confidentiality, Integrity and Availability) are the major threats in the IOT industry where the data is very sensitive. The Blockchain is the technology that enables these services in a highly secured and trusted manner without the need of centralized architecture. It is the technology which actually behind the bitcoin[4].But nowadays this technology is an emerging trend and researches are going on to apply the industries like retail, healthcare and supply chain management etc. This paper gives a survey and idea of how the smart city will be built using the Blockchain technology.

The Blockchain technology was introduced as the underlying technology behind the digital currency known as “Bitcoin”[4]. From the early stages of the internet, there have

been lots of efforts to create digital currencies, but those efforts were not successful due to “double spend” problem. It is the problem of digital money which can be spent twice. But the application of Blockchain technology makes it possible to solve the “double spend” problem without the need of intermediaries of trust over the internet. The paper discusses about the building of IOT smart city using distributed and immutable “BlockChain technology” which is a strong and inevitable technology in the upcoming decades.

Block Diagram of Centralized and Decentralized Architecture

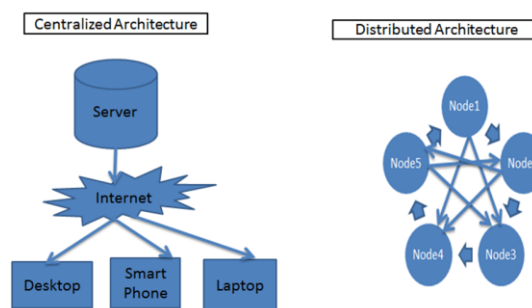


Fig. 1. Centralized and Distributed Architecture.

II. ARCHITECTURE AND COMPONENTS OF BLOCKCHAIN

The Blockchain is a digital, decentralized (distributed) and immutable ledger that keeps a record of all transaction that takes place across a peer-to-peer network. It is an interlinked and continuous blocks of record stored securely across the network. Each block is uniquely connected to the previous block via the digital signature. The central idea here is placing the trust not in a central authority like a bank, a government, or a multinational company rather in the network. The **major components** of Blockchain are as follows:

- A. Consensus
- B. Distributed Ledger
- C. Cryptography
- D. Smart contract

A. Concept of Consensus

- It works on Proof of Work [1] (PoW) Concept. The transactions are done by 'miners' who solve cryptographic puzzles to "mine" a block to add to the Blockchain
- When a miner solves the puzzle, they present the block to the network for verification and in turn receiving the newly created crypto block unit provided by the protocol as a reward.
- It is also known as mining.[4]

B. Distributed Ledger

- A distributed ledger [3] is a type of database that is shared, replicated, and synchronized among the members of a decentralized network.
- The distributed ledger records the transactions, such as the exchange of assets or data, among the participants in the network.

A typical ledger looks something like this:

Distributed Ledger

S.No	Transaction Date and Time	Transaction Detail	Reference #	Transaction Amount(Initial Amount-1000)	Credit	Balance
1	12/09/2018	Ticket booking	10001	1000	500	500
2	14/09/2018	Power Consumed	10002	2000		600
3	20/09/2018	Wifi-Data	10003	500		100

Fig. 2. Distributed Ledger.

C. Cryptography

- The Public Key Cryptography [6] is used for cryptographic system which relies on a pair of keys, a private key which is kept secret and a public key which is broadcasted out to the network.
- This system helps to ensure the authenticity and integrity of a message by relying on advanced cryptographic techniques.

- Sign (Message, Private Key) -> Signature
- Verify (Message, Public Key, Signature) -> True/False

D. Smart Contracts

- A smart contract [4] is software that stores the rules and conditions for the terms of an agreement, automatically verifies fulfilment, and then executes the agreed terms.
- Since a smart contract eliminates the reliance on a third party when establishing business relations, the parties making an agreement can transact directly with each other.

III. HOW SMART CITY IS INITIATED BY BLOCKCHAIN TECHNOLOGY

The main objective is to develop an urban smart city prototype with fully secured from hackers and malware attackers by using decentralized Blockchain technology. To make the city smart everything should be connected to the internet which is known as IOT. The Internet of Things (IoT) involves the network of devices each with their own Internet Protocol(IP) address, connected to other such devices via the internet. Most of the things connected to the IOT are actually simple devices that are often referred to as smart devices.

IOT becomes smart when apply in the areas like water management, waste management, shopping, parking, energy management, home, transportation and governance etc. A smart city starts with a smart infrastructure. It is built on the collection of various types of data which is in huge volume. The city includes the necessary sensor devices, of various types and a communication network to link them all together. All these sensors have to be connected to a central system that monitors and analyses the data in real time.

The devices which are connected to the central system the following things are considered as major threats [2].

- Threats on security of the data.
- Threats on confidentiality and integrity of data.
- Threats on Complete Failure
- Threats on availability of data
- Threats on authentication and authorization of data

IV. HOW BLOCKCHAIN WORKS

Blockchain works by validating the transaction through a distributed network in order to create a verified and immutable ledger. The main concept of the block chain is to deploy the trusted nodes for verification and validation process by replacing the centralized trusted third party. Whenever a node wants to make a transaction to the particular node in a network, source node is to broadcast the message to all the nodes. The other nodes which are not involved in the transaction should verify and validate the two nodes and make the new block added into the existing chain.

That's why the name is called as "Blockchain". This process is verified and secured by cryptography [6].

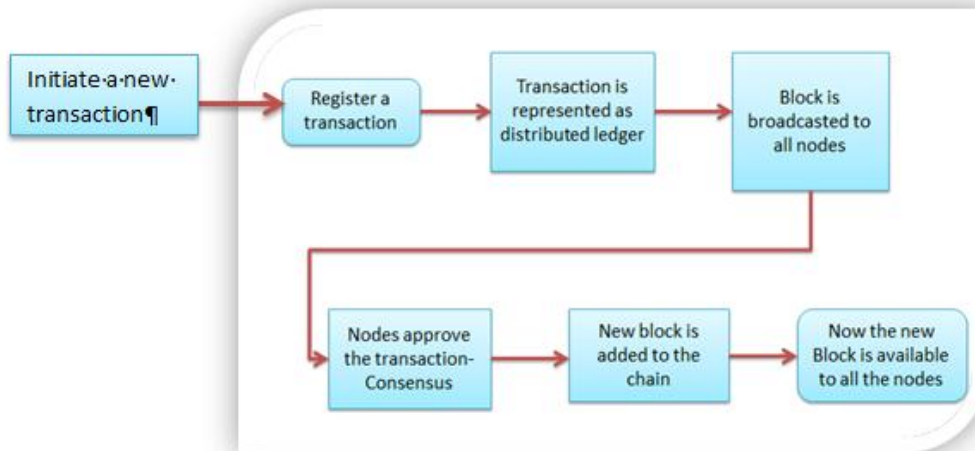


Fig. 3. Blockchain working Process.

V. SMART CITY IMPLEMENTATION IDEA USING BLOCKCHAIN

The underlying architecture comprises of three layers:

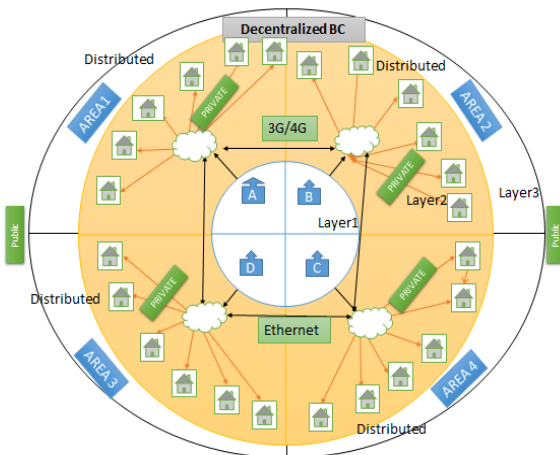


Fig. 4. Smart City Architecture.

The city is divided into four areas it works like the following:

The layer1 consists of the four nodes which connect the network and communicate with each other using Ethernet and 3G/4G technologies. This is the decentralized network which connects all the nodes in its corresponding area network in a distributed manner. (Blockchain technology If any node in area1 wants to communicate with any other node3 (in area3) in the network it'll be published to every other node present in the network. Then the particular node is validated by miners (nodes (2, 4) validating particular two nodes) and communication is done in the network. Then the data is recorded and stored in a distributed ledger.

The layer2 consists of the individual home, office and shops etc which is having the distributed network data. The node in area1 is having homes, offices, shops etc which connects in distributed fashion and the information is stored in distributed ledger. Similarly all other areas are having the same kinds of technology. Each node in layer2 is validated by other nodes in layer2 of that particular area. This is the private cloud whose data is to be protected and maintained by the single entity of layer1. This connection is like the concept of overlay[11] discussed. This is the private network which is separated from other networks available in all other areas. This is the core idea of building smart city using Blockchain technology.

VI. CHALLENGES & OPPORTUNITIES OF BLOCKCHAIN

- Literatures such as [1] and [11] say that the Blockchain is computationally expensive and involve high bandwidth overhead and delays.
- Nevertheless, applying the cryptography protocols on IOT devices is a challengeable; else, it will slow down the devices to the extent of being unusable.
- IOT devices like wireless sensor's RFID tags, NFC tags, smart cards, M2M micro controller have constraints on the amount of energy available to them, these devices have very limited RAM and ROM, available for cryptography.

VII. CONCLUSION AND FUTURE SCOPE OF BLOCKCHAIN

The development of IOT increases the risk of privacy, security and confidentiality [4] of the data. This paper discussed the issues of IOT and how they can be overcome by the emerging Blockchain technology. While building IOT using Blockchain, it is definitely a super structure and no one can break the system easily. But the Blockchain is a new, imminent and exploring area which needs lots and lots of

experiments and results yet to be developed. At this point of time, there have been no detailed results in literature on this technology as research is still going on. Furthermore, in future, the performance and functionality of the smart city model may be proposed using suitable simulation techniques.

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Authors Profile

Mrs. R. Anitha pursued Bachelor of Computer Science and Engineering from Periyar University in 2004 and completed her Master of Engineering from Anna University in the year 2008. She is currently interested and will do the research in the area of IOT and Blockchain technology.
