AUTOMATED IoT AND BLOCKCHAIN BASED SOLAR POWER DISTRIBUTION SYSTEM

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled "**Automated IoT and Blockchain Based Solar Power Distribution System**", submitted by Md Sanwarul Haque Sourav Id: 162-15-7845, Md Abu Walid Faisal Id: 162-15-7927 and Rasel Ahmed Id: 162-15-7737 to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 07 October, 2020.

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We hereby declare that, this project has been done by us under the supervision of**, Dr. Sheak Rashed Haider Noori, Associate Professor and Associate Head, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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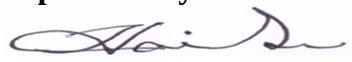

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ABSTRACT

Blockchain and IoT are the fastest growing technologies in the world right now. Blockchain gives us the security and efficiency about data and IoT gives us the comfort we want. In our traditional system the data restored by an organization is centralized and vulnerable, that concerns security issues. The combination of IoT and blockchain can prevent those issues. The evaluation of technology is so remarkable that the whole civilization depends on it now a days, and to maintain this technological race a huge amount of energy has been used from out limited resources. The process of producing energy continuously is not ecofriendly, and the world is facing ecological problems already. This report will help us to understand how to use green energy to prevent ecological imbalance and the distribution of energy through a secured platform that blockchain provides. Therefore, we are proposing a novel approach to construct a blockchain based private platform where consumers can produce solar energy and distribute among themselves without the fear of data tempering.

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CHAPTER 1

INTRODUCTION

1.1 Introduction:

By the grace of technical revaluation people reached a certain stage that they can't live a single day without it. As we are getting dependent on technology, it has some drawbacks such as centralized system, data tempering, data leakage etc. Despite having all those problems we have to use it and look for the solution. Blockchain technology gives us the solution of all the problems above.

Simply when we hear the word "Blockchain" anyone would think about chain of blocks or a sequence of block. In technological world blockchain is a decentralized system, distributed ledger that records any kind of transaction. Our automated IOT and blockchain based solar energy system will solve the electrical problems for inaccessible areas hill tracks or island. User can produce electricity for his/her own uses and can share the residue electricity with any node/ other user. It will be the secure system, all the transaction will be saved as blocks and all the ledger will be same.

1.2 Motivation

In this modern era our one of main problem is ecological imbalance. Ecological imbalance is growing faster because the vast use of natural resources. As the population is growing infinitely, one day the natural resources will be over. So we've to think how we can fulfil our needs by using minimum natural resources. That gives us the motivation to build a system that will create energy from solar power instead of gas, coal. The system will be secure by using blockchain technology.

1.3 Rationale of the Study

The main purpose of our proposed system to ensure the security of users and use of green energy.For green energy production, store and distribution can be performed with IOT. But our main goal is to confirm the security of that system. Blockchain provide the best solution of security. The main problem is still now in underdeveloped. Another problem is selection platforms are

available Ethereum, Corda, Hyperledger Fabric etc. Hyperledger Fabric is more efficient for our project.

1.4 Research Questions

1. Why are we using blockchain instead of traditional system?
2. Which platform are we using?
3. Is there any prerequisite to work with blockchain?
4. Is it possible to implement blockchain in every computer?

1.5 Expected Outcomes

The main goal of our project is to create a blockchain based IOT system where multiple users can produce energy and transmit it through a trusted environment. The users will produce electricity via solar panel and will store it. If the produced electricity is more than user's need then he can post the surplus amount into the system. The user who has scarcity can request for electricity. After approval from the seller, money transaction process will began automatically. It can be done with any cryptocurrency like ethereum, Bitcoin, Ripple etc. After transaction, transmit or electricity will be occur. All the transaction will safely recorded in a ledger. Only authorized user in a same channel can see the ledger. Every user get the same ledger, so if anyone wants to manipulate any data it will be impossible.

1.6 Project Layout

We divided our project into six chapter. Every chapter will help anyone to understand out project step by step. In first chapter we discuss about our project introduction and our motivation about implementing it. Second chapter contains the introduction about blockchain technology, so that without any knowledge anyone can understand the basic topics. Then we discussed about all the future scopes and challenges. In chapter three we discussed about our working platform and work through. How can we create blockchain network and the process of configure every element.

Chapter four covers all the all the experimental results and analysis. In chapter five we talked about the impact of our project in society and environment and about ethical aspects. We concluded our report in chapter six by discussing summary of the study and implication of future study.

CHAPTER 2

BACKGROUND STUDIES

2.1 Introduction to Blockchain

Blockchain technology will be the next big thing in industry. As internet has affected all the major industry, in the same way blockchain is affecting it. In the year of 2008, Blockchain was first introduced to us by Satashi Nakamoto (may be a group of people or can be single). It's a pseudo name. They/He introduced Bitcoin(one kind of crypocurrency) that was based on blockchain technology. Basically blockchain was introduced to build a decentralized system. In a centralized system all the information stored in a central storage, but in decentralized system no single data is the sole authority. The same ledger will be shared to everyone .This type of ledger also called the distributed ledger because every user on the network communicates with every other to behave as a single unit [1].

In a decentralized system we have two problems which are security and trust. For security purpose asymmetric cryptography is used. We know that, in decentralized system every user share their ledger with others, so there is a huge possibility of data tempering. To overcome this problem blockchain gives us a method called "Hashing". In the ledger every transaction is saved with a bunch of transaction just one block in created. Inter connection between multiple blocks creates blockchain.

2.1.1 P2P Network

P2P (peer to peer) networks mean multiple nodes are inter-connected through a network. In which we don't need a central server. Whatever technologies we use nowadays based on a central server. If we send a message to a friend using Facebook first it goes to the central server then it goes to the receiver or if we want to send money to another person we need to bank as a medium that also works like central server. On the other hand in P2P network every node works as a server.

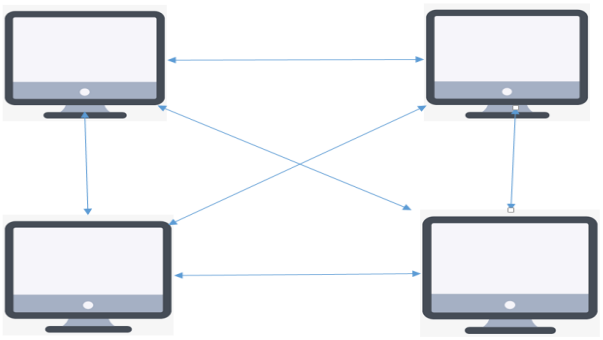

Figure 2.1. 1: P2P Network

Let's assume we have four nodes A, B, C, D and they are connected through P2P network. Suppose A contains some data, any node can download it from A at the same time. On that time they can also upload it to other nodes. To establish a P2P network we have to ensure four major things-

2.1.1.1 Confidentiality

A P2P network is built with multiple nodes. Suppose 'A' wants to send a message to node 'B'. This message could be a simple message or it could be confidential, whereas all the nodes are interconnected. Node 'C' and node 'D' can read the information that hampers the confidentiality between 'A' and 'B'.

2.1.1.2 Integrity

The message sent between 'A' and 'B' can be changed by any other node which is unexpected in P2P so we have to think about data integrity.

2.1.1.3 Non Repudiation

After receiving the message any node can chain that he/she didn't receive/send this message. So, in non-repudiation there will be a proof of every transaction they made.

2.1.1.4 Authentication

In authentication every node has a unique id that represent his identity. So, nobody can pretend to anyone. That's how P2P network ensure data authentication.

To solve all those problem blockchain contains cryptography.

2.1.2 Cryptography

Cryptography is basically divided into two terms. First one is 'Crypt' and second one is 'Graphy'. The meaning of crypt is hidden or secret and graphy means writing. When node 'A' sends a text to node 'B' the data must be encrypted via ciphertext (non-readable format) receiver will decrypt it via some process. The only way to encrypt or decrypt data with the help of a key. Based on this key we can evaluate cryptography into two types.

2.1.2.1 Symmetric Key Cryptography

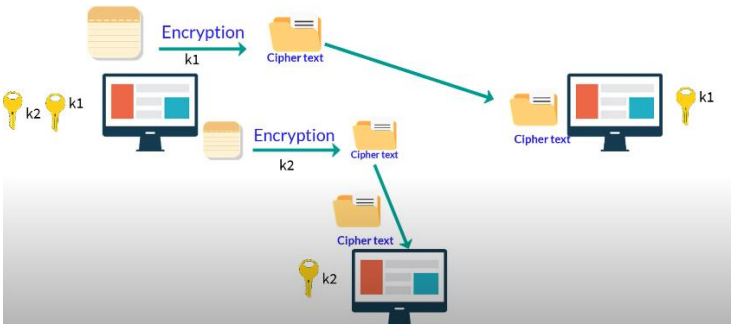

Figure 2.1.2. 1: Symmetric Key Cryptography

If node 'A' wants to send message to node 'B', it will encrypt the message with key K1. When the message will delivered to node 'B' it will be decrypted using the same key K1. Now, node 'A' wants to send some information to node 'C', it can't use the K1 key. They have to use different

key. As the number of nodes are increasing the keys are also increasing. It is very difficult to maintain all the keys with a huge number of nodes.

2.1.2.2 Asymmetric Key Cryptography

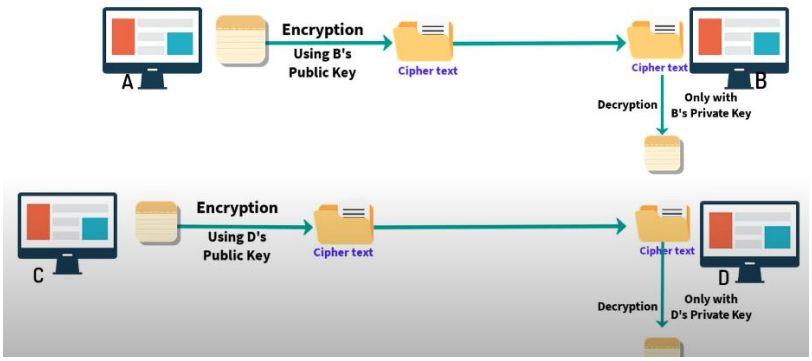

Figure 2.1.2. 2 : Asymmetric Key Cryptography

If node 'A' want to send data to node 'B' then for encryption the sender will use the receiver's public key. And if the receiver 'B' want to see the data then 'B' will decrypt it with its private key.

2.2 Related Works

Blockchain is a new technology, besides it is too complex. People usually use blockchain to maintain database or in money transaction for security issues. But its impact can be huge in real world. Very few IoT and blockchain based projects are running right now. Most of them are pilot project or beta version.

'Chronicled' developed a supply chain project with the combination of IoT and blockchain. In their system they implemented blockchain into their IoT devices. So that customers can track the products in real-time position. Here blockchain performing to secure the data [2].

'Filament' launched a blockchain based hardware and software system that can easily emerge with IOT products. They use the system to maintain their construction, transportation, manufacturing and energy. Their main purpose to keep the data secure and communicate each department quickly [2].

A company called 'HYPR' use a decentralized network for connected ATM's, locks cars and homes. The company stores biometric data, password and card number on their blockchain by decentralizing [3].

2.3 Comparative Analysis and Summary

Our project concerns about the security of users, that's why we are using hyperledger fabric framework to develop this project. Every organization need some rules and regulations to maintain everything in disciplined way. Hyperladger fabric gives us the ability to write those rules according to the users. The main benefit is its open source platform. We can easily add a new user to the existing network without any security corners. No need extra mining and easily applicable with IoT devices. Any other blockchain platform doesn't cover such areas in efficient way. That's why we are using hyperledger fabric in our project.

2.4 Scope of the Problem

Our project gives the opportunity to produce their own electricity and can share the extra with others. It will spread the awareness of using green energy. But our main goal is to maintain the user's security with the help of blockchain. As blockchain contains cryptocurrency, so the dependency of physical currency will be reduced.

2.5 Challenges

Working with a new technology is always tough. We know that blockchain is a under developing technology, so there are no fixed template to begin. We didn't find any trusted resources that can help us through our project. Limited companies are implementing blockchain and their resources are private. They don't share them publicly. Blockchain ledger stores all the transaction or any command of all uses, so users need huge storage and a computer with installed blockchain system in it. The most important thing, a good computing computer is needed which is so expensive. Another problem is selecting platform because every blockchain framework is used for different tasks. First we tried 'Ethereum' platform [4]. Ethereum didn't fulfil our demands for the project. We're looking for our suitable platform. Then we found Hyperledger Fabric that solves our need [5].

CHAPTER 3

METHODOLOGY

3.1 Research Subject and Instrumentation

The goal of our project is to produce energy and distribute it properly among the connected systems with the user's information.

Table 3.1. 2 Research Subject and Instrumentation

IoT	Solar
	Arduino uno
	Rechargeable Battery
BlockChain	High Configure PC
	HyperLedger Fabric
	Linux OS
	Docker
	Go Language

3.1.1 Hyperledger Fabric

Hyperledger fabric is enterprise based private blockchain platform. This platform gives us the ability to create a network with any kinds of rules and regulations that every party agrees to.Even multiple organizations can do business with one another through hyperledger fabric. Any new user can be a part of any network if each and every member agrees.

Some major components of hyperledger fabric:

i. Peer

ii. Channel

iii. Chaincode

iv. Orderer

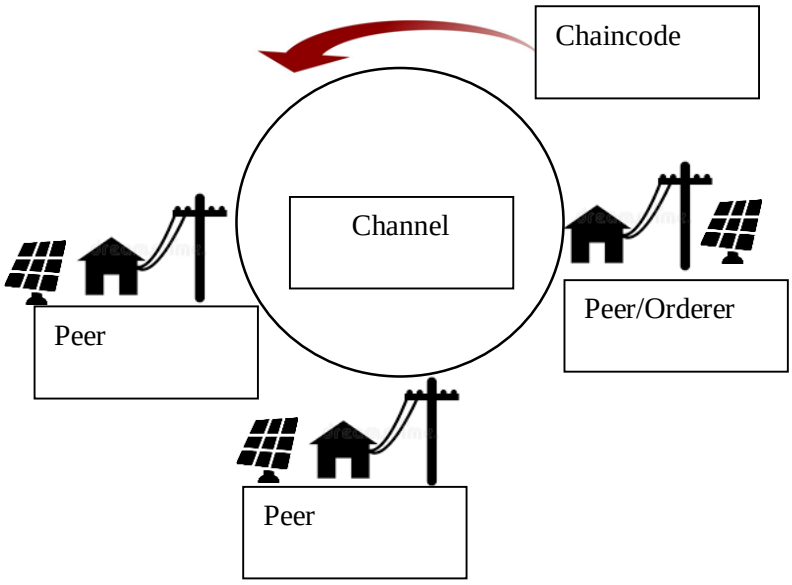

Figure 3.1.1. 1: Components of Hyperledger

Peer: Peers are basically all the nodes that are connected through the network. Only peers can accept or decline any kind of operation and update the ledger. Every peer holds a copy of ledger.

Channel: When you build a network it will contain multiple peers. But if they are not connected then they can't share anything. So, every peer needs to connect through a channel to share information or for transaction.

Chaincode: Chaincode is basically rules and regulations and policies about every user and for any kind of transaction. Suppose, we have 3 peers. Peer 'A' wants to transmit energy to peer 'B', if the policy says that to execute any operation every peer must be agreed first. So if one denies this transaction it will be terminated. The chaincode must be installed in every peer. Without chaincode peers can't do anything in a network. Channel contains the chaincode.

Orderer: The main role of orderer is to provide order of operations. Before anything committed inside the ledger it must pass through orderer. Orderer creates the blocks that will be stored into the blockchain. Orderer verifys all the necessary certificates, cryptographic materials, policies then order it for store into blockchain.

Transaction Workflow:

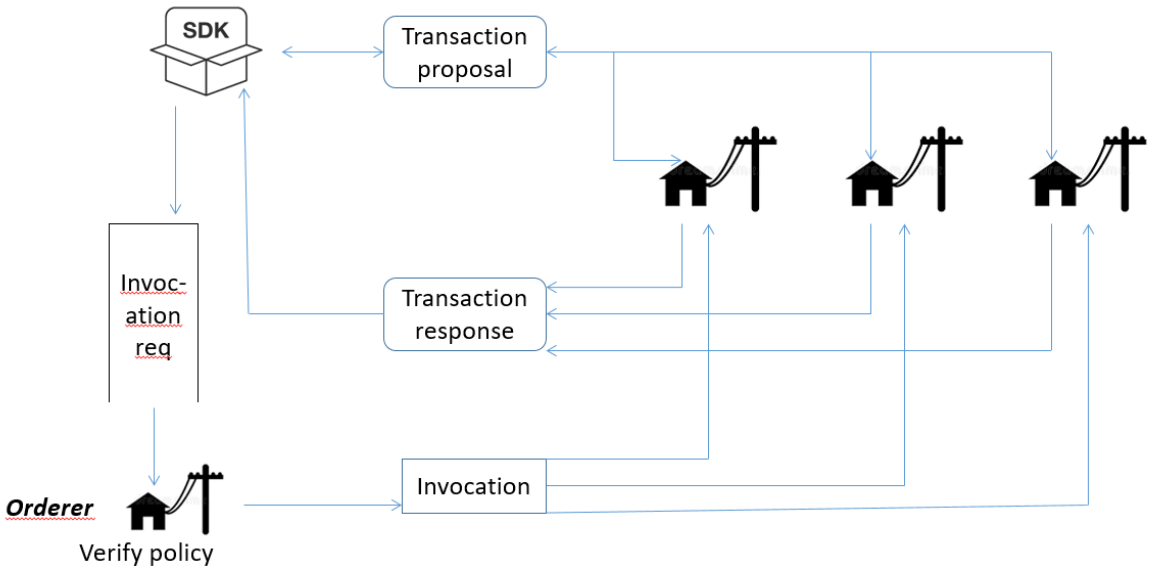

Figure 3.1.1. 2: Transaction Workflow

3.2 Energy Production and Distribution

By using solar panel electricity will be produced and it will be stored in a battery. Every node will be connected through wire. System will provide an average rate of electricity used by owner. So that user can know how much electricity he/she needed. User can request for electricity if he has scarcity. User who has residue electricity can share with him. The transaction record will be stored in blockchain ledger.

3.3 Flow Chart and Use Case Diagram of Proposed System

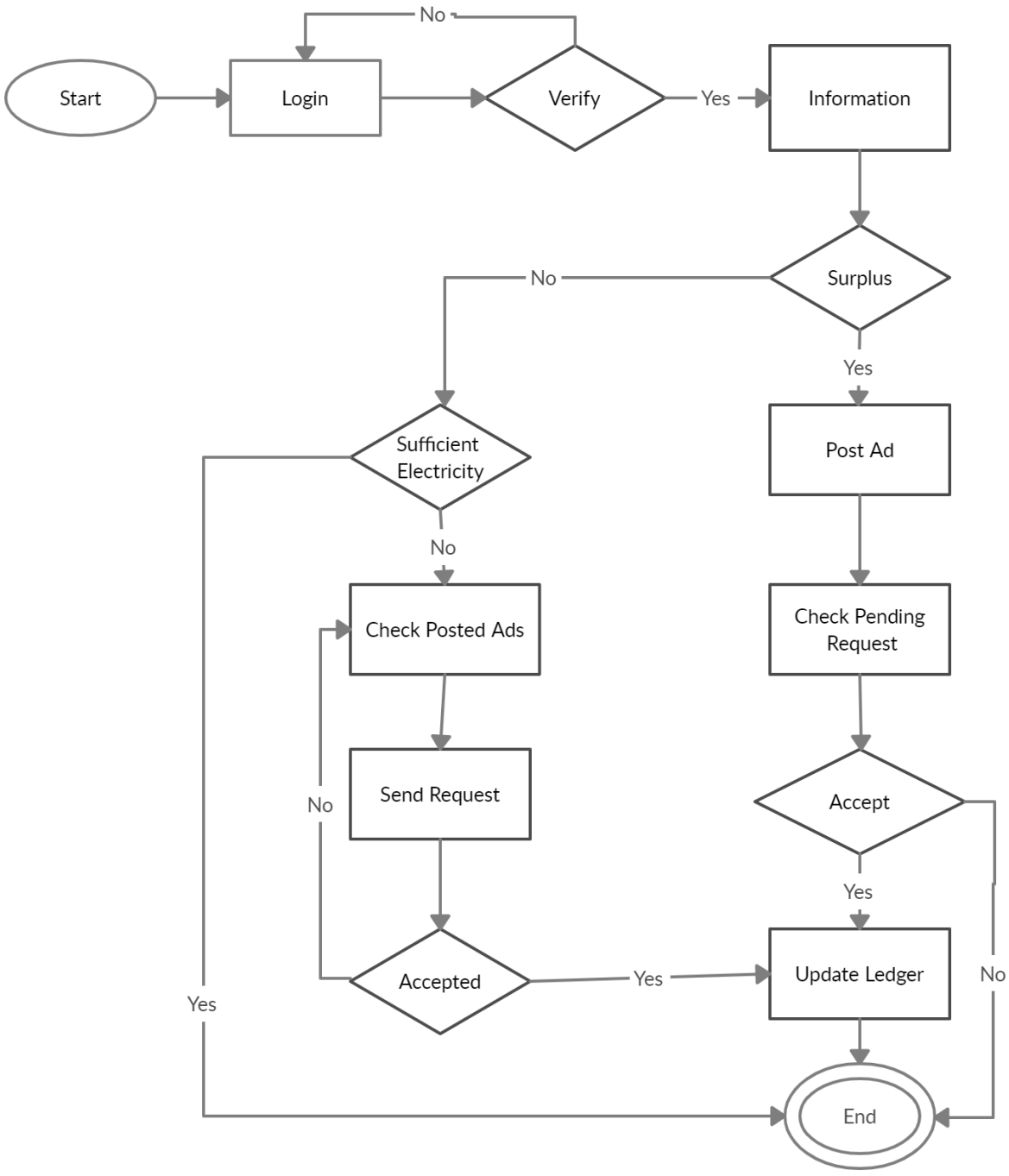

Figure 3.3. 1: FlowChart

Figure 3.3. 2: Use Case Diagram

3.4 Build Network and Environment System

Hyperledger platform works really well for iOS or Linux based operating system. For windows it is very complex to begin. We need to setup an environment basically a virtual Linux OS. We need to download docker [4] and install it. We also need to install latest GO [5] language version to write chaincode. After that we have to install node.js latest versionand windows git [6]. By using PowerShell on windows 10 we used native docker distribution.

```
git config --global core.autocrlf false
git config --global core.longpaths true
```

Figure 3.4. 1: Docker

```
git config --get core.autocrlf
git config --get core.longpaths
```

Figure 3.4. 2: Docker

Then download platform specific binaries by this command.

```
curl -sSL https://bit.ly/2ysbOFE | bash -s
```

Figure 3.4. 3: Specific Binaries

After that two files will be created.

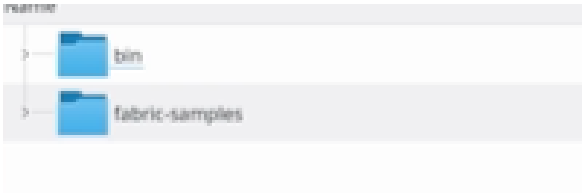

Figure 3.4. 4: Network Folders

Or primary network is created. Now we have to go to first network file through command prompt and generate network artifacts where all the certificates and crypto materials will be created.

./byfn.sh -m generate

This command will create a folder named "crypto-config" that contains all the certificates, crypto materials, public keys, private keys for all the network. This files are very sensitive and any kind of unwanted changes will cause problems for the network.

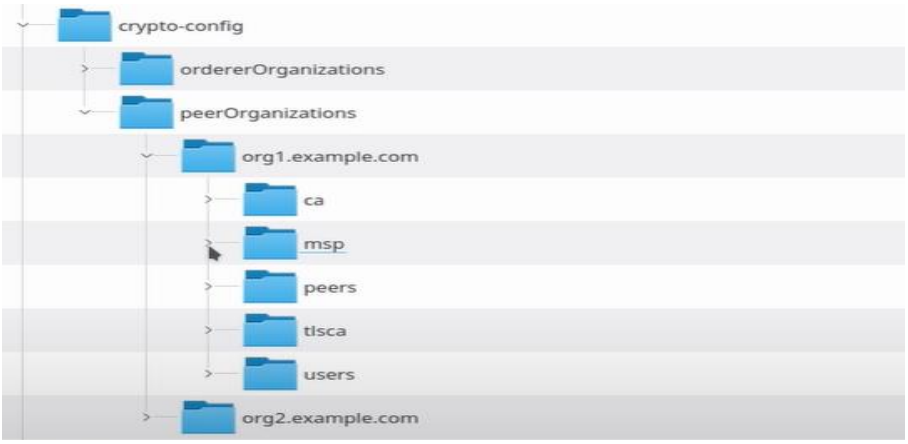

Figure 3.4. 5: Network Folders

The network is ready to run. By this command the network will be launched.

./network.sh –up

Figure 3.4. 6: Command Network

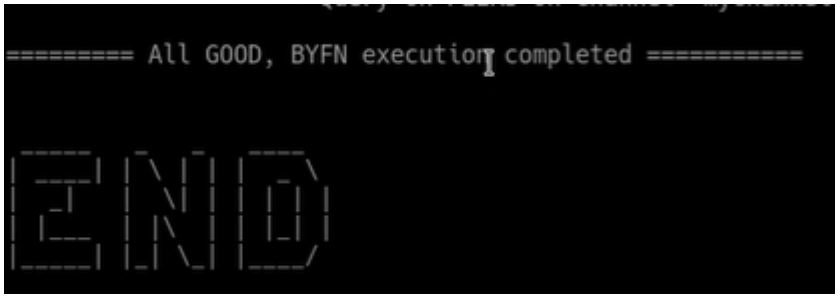

Figure 3.4. 7: Command Network

After giving this command the network will start like first picture and after few moments the process terminate with a message “END”. If the process doesn’t show “END” that means there are some errors in our network.

CHAPTER 4

TESTING DEVELOPED BLOCKCHAIN NETWORK

4.1 Experimental Results & Analysis

As there are no errors in our network so we have successfully establish our network. This is the primary network, so we have to work on creating channels, peers, orderer and certificate generation.

Figure 4.1. 1: Crypto Config

This is the “crypto config” file where we have to select the orderer and the peers of an organization. As it is a beginner level project so we have used only one orderer but for industry level project we need more orderer to implement it. Because orderer maintains the sequence of transactions and check their certificate before confirmation. An organization may contains n (any number) numbers of peers and they can connect with each other only if they belongs to same organization. So we have to declare which peer belongs to which organization.

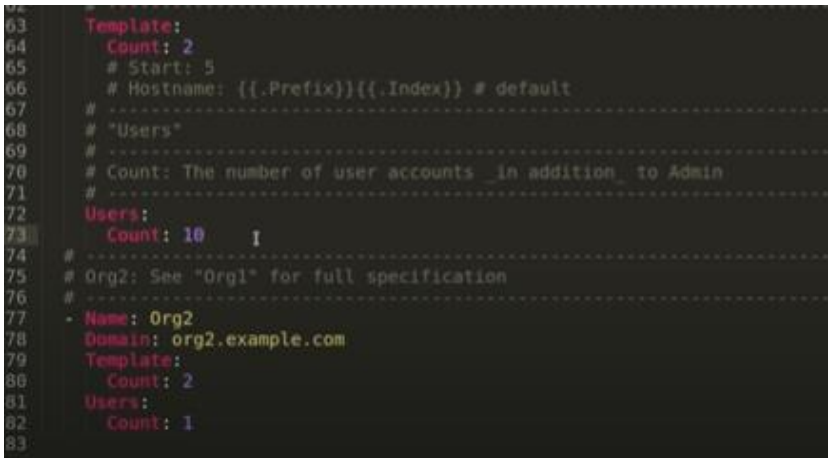

Figure 4.1. 2: Crypto Config

Now we have to generate certificate through template, template count represents how many certificate we need to generate for peers. Users count represents how many users we have.

Genesis Block Configuration

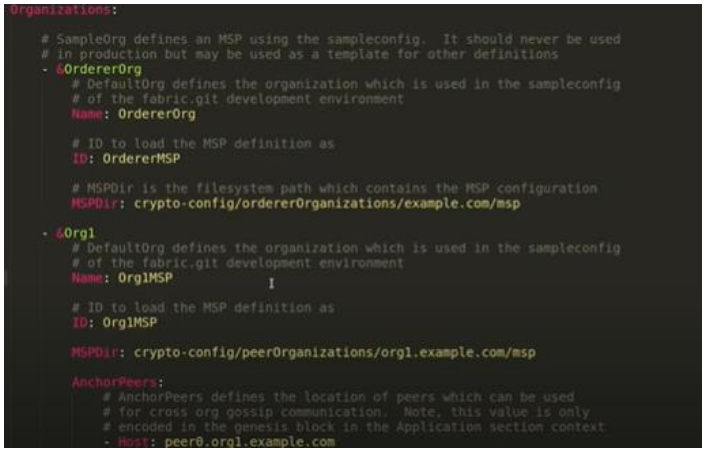

Figure 4.1. 3: Genesis Block Configuration

In genesis block configuration we have to configure all the organization present in a network. We have to provide organization name, MSP id, and those MSP id will be located through a directory we provide. This directory contains all the certificates we need to complete a transaction.

CHAPTER 5

IMPACT ON DIFFERENT SECTIONS

5.1 Impact on Society

User can produce their own electricity and they can share within themselves. Solar energy system also meet the demand of electricity which is growing day by day. Hyperledger based blockchain network will ensure the user security. New sectors will be created to maintain the system and for IoT devices when this system would be used widely. So, our project have not only social impact but also economic and employment impact also.

5.2 Impact on Environment

In traditional way, we need to use huge amount of natural resources to produce electricity. But in our project we're using solar panel for our electricity production. Solar power is unlimited and this is green energy. Using solar power instead of natural resources will keep our environment balance. We all know burning coal, gas, wood(cutting down from tree) increasing carbon dioxide rapidly that creates ecological imbalance problem.

5.3 Ethical Aspect

Main ethic of our project is 100% user's security, because blockchain is unhackable. For breaking a blockchain network a huge amount of computing power is needed and it is still now impossible to achieve that computational power.

Another ethical aspects is this system won't affect the ecology.

5.4 Sustainability Plan

As blockchain will be the next generation's technology, our main focus is to spread this system in remote areas and farms. We all have to raise our voice for using green energy so that people will be interested to use solar panel. People are getting aware about ecological imbalance and about their data security so there is no doubt that people can't refuse it. At least they have to think twice before rejecting our system. Some amount of money transaction might happen when electricity will be transferred from residue user to scarcity user. In this way, users needn't to spend extra money to maintain the hidden cost (Battery Charge) and they can earn money if anyone can produce huge electricity.

CHAPTER 6

CONCLUSIONS AND FUTURE SCOPES

6.1 Summary of the Study

As our work is based on IoT and blockchain, so in this report we described how to implement a blockchain based system and attach blockchain with IOT devices. We discussed about green energy and its appropriate distribution among the connected users by IoT devices. Hyperledger fabric is used as blockchain platform. It is an open source platform and used to make secure the data by making then decentralized. The main benefits of hyperledger fabric are we can develop our system according to user's demand, no need to mining and as it has no build in cryptocurrency so that we can merge any cryptocurrency.

Users can buy their required electricity by the system and the system will calculate user's daily average need. If users have residue or shortage electricity then it will be notified automatically.

6.2 Conclusion

This journey was not smooth and enjoyable. We didn't have any knowledge about blockchain. That's why we had to spend a lot of time to achieve the concepts. We learnt basic concept from "Coursera" and "YouTube". But there was no complete resource for implementation. One of our problem was selecting platform. We had spent days for "Ethereum" but it was not efficient for our project. So our all efforts was in a vain for ethereum. Then we come to know Hyperledger fabric platform. After completing the basic of it we understood that it is suitable for the project. At present our central bank doesn't accept cryptocurrency. It will be added when our authority will permit it.

6.3 Implication for Further Study

When the project will launch in industry level there will be more user. Every new user means a new node and every business have some rules and conditions have to add through chaincode. Our projects is completed through command prompt. So we have to add user interface for later userexperience.

REFERENCES

[1]Blockchain , available at <<https://en.wikipedia.org/wiki/Blockchain>>, last accessed on 21-09-2020 at 09.10 PM.

[2] Ethereum, available at << https://ethereum.org/en>>, last accessed on 20-09-2020 at 7.15 PM.

[3] Hyperledger Fabric, available at << https://www.hyperledger.org/use/fabric >>, last accessed on 20-09-2020 at 10.30 PM

[4] Docker, available at << https://docs.docker.com/docker-for-windows/ >>, last accessed on 21-09-2020 at 01.30 AM

[5] Go, available at << https://golang.org/ >>, last accessed on 19-09-2020 at 04.30 PM

[6] Git, available at << https://git-scm.com/download/win >>, last accessed on 19-09-2020 at 08.00 PM

APPENDICES

Shadow of our Project

Our journey started from summer 2019. This journey wasn't easy. Our main problem was resources. Though we overcome our problems with the help of our supervisor and our hard work. Our project gives the best security for the use of blockchain. And automated IoT base electricity transfer system increases the use of green energy. We expect that people will accept our system and will be appreciated. The mass people of our country will be used to with blockchain technology through our project.

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