Enhancing Financial Transactions using Blockchain Technology

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***Abstract:** Blockchain technology is evolving in each area. Cryptocurrency is one of the prominent fields in which blockchain technology is used extensively. In conventional bank systems using fiat currencies such as Indian rupee, US dollar etc , there is a centralized authority like a bank which do the processing of transactions. Blockchain with its properties like decentralization, distributed, and immutability stands the way out from other transaction processing mechanisms. Moreover, with decentralization property in blockchain-based transactions makes that there is a peer-to-peer network in which one peer can able to transact with others in the network without relying on third party for validating the transactions. Instead, there are a group of miners who does the work of validation with the use of consensus protocols. The paper shows the use of blockchain technology in financial transactions with the help of tokens. The paper shows the creation of a simulated blockchain network and the transaction processing mechanism with the help of the creation of nodes. This paper shows the implementation of blockchain technology and it also shows the limitations and misconceptions involved in blockchain technology.*

***Keywords:** Blockchain, Consensus protocols Cryptography, Cryptocurrency, Transparency.*

I. INTRODUCTION

Blockchain is a chronological and constantly growing ledger where each block is linked and secured with the help of cryptography [1]. It is also defined as public ledger of all the transactions in the network or a distributed database of records [2]. Blockchain with its properties like immutability, decentralization, and distributed makes financial transactions more reliable.

A blockchain ensures the integrity of a cryptocurrency by encrypting, validating and permanently recording transactions.

Cryptocurrency:

Cryptocurrency is a type of digital asset which can be used to exchange value between parties. It is also intangible in nature. There are many cryptocurrencies present in the market:

Some of them are

1.Bitcoin.
2.Ether.
3. Ripple coin etc.

Bitcoin is a decentralized peer-to-peer digital currency [3] is the most prominent cryptocurrency underlying Blockchain technology.

Ether is a cryptocurrency generated by the Ethereum platform. It is used to compensate mining nodes for computations performed [4]. Every Ethereum account should contain ether balance in which ether may be transferred from one account to another.

Ripple is a technology that acts as both a cryptocurrency and a digital payment network for financial transactions. It was first released in 2012 and was co-founded by Chris Larsen and Jed McCaleb [5].

In a conventional financial or banking system, the hackers to take away the money or steal the money when a transaction is processing. In order Blockchain with its properties and consensus protocols makes it a reliable medium for the financial transaction. Blockchain is not only limited to financial transactions but also expanding its applications to non-financial sectors like health sector, machine learning and supply chain management [6] etc. Among these applications supply chain management is taken as a pilot project by many companies to provide data transparency to the consumers. For example, IBM in collaboration with Walmart taken it as their pilot project to reduce the frauds in the products and to provide transparency. And with the decentralization property, machine learning is enhanced to decentralized machine learning in which research is being done.

How blockchain helps in enhancing financial transactions?

The current digital economy or currency transactions depend on the centralized authority (financial institutions) like banks for processing or executing transactions.

To circumvent relying on the centralized authority. Blockchain provides a medium on which we can do a peer-to-peer transaction without any middlemen, with the help of distributed consensus. In distributed consensus mechanism, every transaction in the network is verified without comprising the privacy of nodes or persons involved in the transaction. Bitcoin is one of the cryptocurrencies developed underlying blockchain technology.

Blockchain is a chronological, permanent record of transactions which are immutable across the network.

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II. MOTIVATION

We often do transactions in our daily life, I came across a magazine in which about 1 million dollars was taken away by the hackers. This indeed, lead me to explore new technologies to impede this susceptibility of transactions, then I found that blockchain is the technology upon which cryptocurrency like bitcoin is developed to hamper the hackers in the digital transactions.

III. RELATED WORK

Four Components of Bitcoin:

Every ten minutes bitcoin software issues a cryptography challenge. In this challenge miners all over the chain tries to to find a Nonce(Number used only one) which will make the hash for a specific block valid, so in order to have a valid block it has to have a sufficient leading zeros generated by the bitcoin software. So this is the cryptographic puzzle issued by the software, then bitcoin miners who are running the bitcoin software around the world compete themselves to find a Nonce (by trial and error) which satisfies the valid hash which is generated by the software shown in fig 5. If a miner solves the cryptographic puzzle then other miners across the network rallies together to checks the validity of the new block mined. If the block is verified as valid then that mined block is added to the blockchain network. Miner of the added block will get the reward in bitcoins for mining. In this manner, blocks are added to the blockchain network.

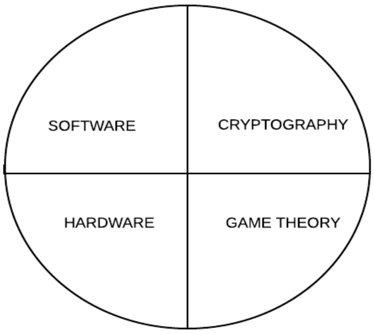


Fig 5: Components of Bitcoin.

Role of Bitcoin Miners:

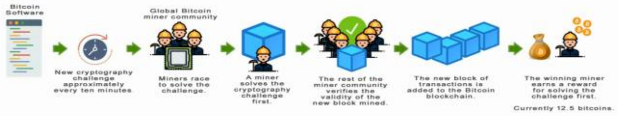

Bitcoin Software
New cryptography challenge approximately every ten minutes.
Global Bitcoin miner community
Miners race to solve the challenge.
A miner solves the cryptography challenge first.
The rest of the miner community verifies the validity of the new block mined.
The new block of transactions is added to the Bitcoin blockchain.
The winning miner earns a reward for solving the challenge first.
Currently 12.5 bitcoins.

Fig 6: Role of Bitcoin Miners.

"The role of miners is to build the blockchain records to develop or form blockchain ledger".

In the Bitcoin network, there are a group of people called miners, Anyone can to become a miner shown in fig 6. Fig 6 is from "Blockchain Fundamentals by George Levy" source. Miners use powerful computers that are specifically designed to mine Bitcoin transactions, It's an open network. Their role is to process and validates(confirm) transactions in the network. The way miners do the processing of transactions is by solving math problems (cryptographic puzzles). Every transaction in the network is cryptographically encoded and secured across the network, which ensures that nobody is tampering with the data. Across the bitcoin network, the money in Bitcoin is not created as fiat currency like the US dollar or Indian Rupee. For solving the cryptographic puzzle, the miners are rewarded with bitcoins. In this way, Bitcoins are circulated across the network.

Mining pool: It is defined as the group of miners come together as a unit and do the transactions under a name or organization is called "Mining Pool".

The energy costs involved in the mining process are huge, so we have to make sure that the amount of money that we invested in the blockchain technology should be less than the amount that we get returned by using the technology.

Consensus Protocols:

Proof of Work:

The most interesting part of the block validation in "proof of work" protocol is the condition that the SHA256 (Secure Hash Algorithm) hash of every block in the blockchain network is treated as a 256-bit number. The hash generated by the SHA-256 must be less than a dynamically adjusted target. The purpose of this is to make block creation computationally "hard", thereby preventing sybil attackers from remaking the entire blockchain in their favor [8]. Because SHA256 is designed in such a way is that it to be a completely unpredictable pseudorandom function, the only way to create a valid block for the network is by repeatedly incrementing the nonce with trial and error, and seeing if the new hash matches.

Proof of Work mechanism involves reading the values that when hashed with SHA-256 is to get the Valid hash (A block's hash with the required zero bits) for the block [2]. Indeed, Miners find the Nonce value for a block to get the required no of zero bits with the use of Proof of Work mechanism. It is clearly explained in below example.

when the two miners mine the block simultaneously, then this is the place where consensus protocol does the best work. In fig 7, when the miners mine the block it is added or relayed to the network (which is shown in orange color) and another miners who added purple block is added to the network at the same time, then there is an ambiguity within the network which chain i.e. the orange or purple chain is correct , then it checks whether which chain got the highest no of nodes and makes it as original chain. In fig 7, orange chain wins and purple network adopts it to the original chain (orange), the purple block added to the network are called "Orphan blocks". The fig 7 is from "Build Blockchain by Hadelin de Ponteves" source.

The pitfall of proof of work mechanism is 51% attack. It can be explained as when two miners mine the block simultaneously. And If more than 51% of miners in the network validates the block as illegal block as valid, then the block is going to be added to the blockchain network as a legitimate block, this is the loophole of proof of work mechanism.

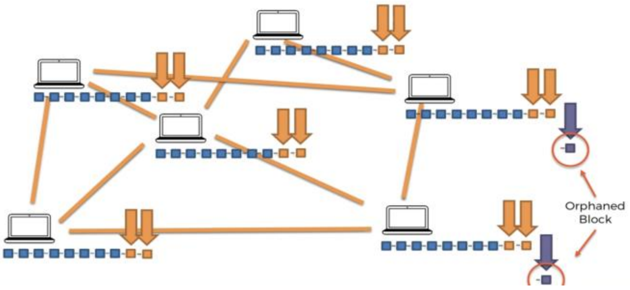


Fig 7: Representation of Consensus mechanism.

Another consensus mechanism introduced for the enhancement of proof of work is "proof of stake".

Proof of Stake: It is also used to achieve consensus in a distributed environment(system). In this mechanism the node in the network which generates a block has to provide a proof that it has access to certain amount of coins before accepted by the network. The required amount of coins (called target) is specified by the network through a adjustment process [8].

In this mechanism, miners who are going to mine the transaction has to pay(stake) initial amount for the transaction to get to him for the processing, if miners mines any illegal transaction then the amount he deposited will be lost, but there is also a loophole in this mechanism that is richer gets richer .

IV. PROPOSED METHODOLOGY

This paper illustrates methods which are used to make decentralization in financial transactions using blockchain.

We primarily have two methods which are used in this paper.

find_chain:

This invokes entire_chain method, which is used to get the entire chain of transactions that has happened till now across the network.

For example, if two nodes in the network performs a transaction, then other miners across the network validates the transaction, if the transaction is validated, then it is added to the blockchain network. Blockchain with its distributed property, the block that is validated is added to entire network, in which other nodes which did not participated in the transaction get those blocks added to their chain which provides transparency across the chain.

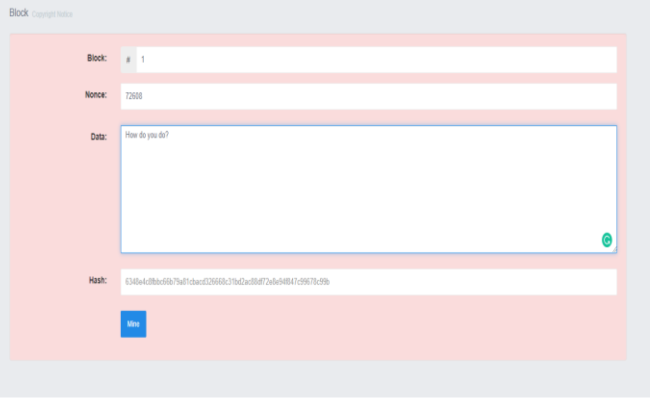
Mine_block:

Mine_block method is used to mine the block to get the valid hash with the use of proof of work mechanism. If the mined block has got the required no of leading zeros i.e if it is valid then the block which is mined gets added to the chain.

Representation of a Block in Blockchain:

In Fig 1, a block with fields like Block no, Nonce (Number used only once), Data, Hash, etc are shown.

When we insert any data into the Data field than the “Hash” corresponding with that block changes, to get the valid hash we have to mine the block. In fig 1 we have shown the above illustration where we inserted “How do you do” in the Data Field” then hash changed.


Block Copyright Notice

Block: # 1

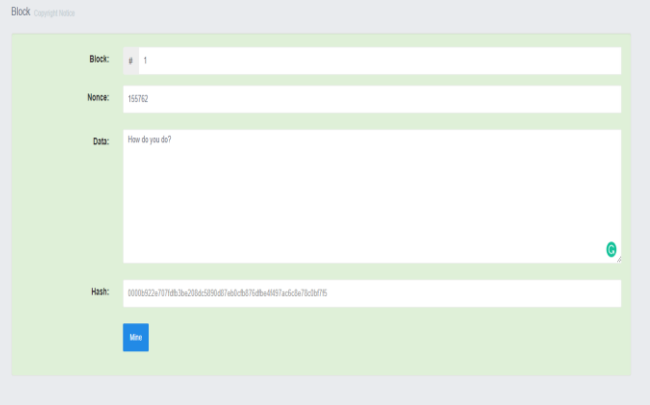
Nonce: 72608

Data: How do you do?

Hash: 6348e4c8bbc66b79a81cbacd326668c31bd2ac88df72e8e94f847c99678c99b

Fig 1: Representation of a block in Blockchain

In order to get the valid hash, we have to mine that specific block. In fig 2, we mined the block to get the valid hash


Block Copyright Notice

Block: # 1

Nonce: 155762

Data: How do you do?

Hash: 0000b922e707fdfb3be208dc5890d87eb0cfb876dfbe4f497ac6c8e78c0bf7f5

Fig 2: Mining of the block to get valid Hash

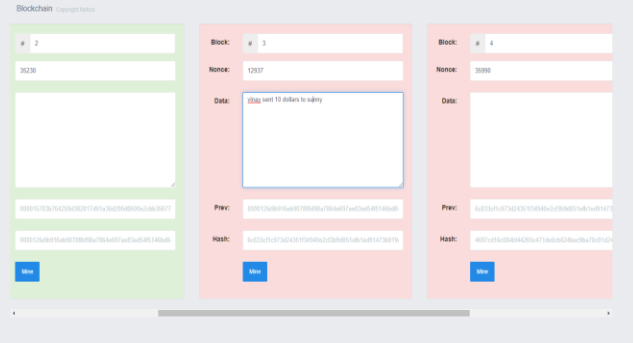
when we change the data field for certain block then the hash for that specific block is changed which would affect the rest of the blocks after the changed block.

Representation of Blockchain:

The name "Blockchain" itself suggests that it is the chain of blocks, so here the chain is maintained between the blocks with the use of "Hash" generated for that block. In Blockchain, every block in the network is attached with the previous blocks with the help of the "previous_hash" field for the block which is shown in Fig 3.

For example, we have a chain of 1000 blocks, if any hacker wants to tamper the data of 500 block, then the "Hash" field for that specific block is changed which would in turn affect the blocks from 501 to 1000, as 501 linked with 500 with the prev_hash field(which is "hash" of the 500 block which is changed due to tampering of data) likewise 502 is linked with 501,503 with 502, so every block above the 500 blocks is changed which is one of core property of the blockchain implementation in financial transactions.

In fig 3, we have entered data “vinay sent 10 dollars to sunny”in block no: 3.

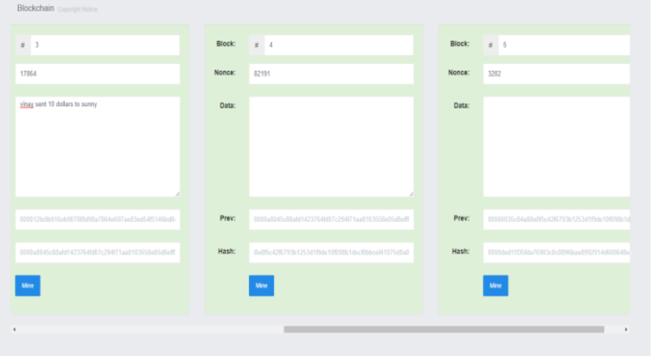


```
#  2
35230
000015783b764259d382017d91a36d206d0600e2cbb35677
000012fa9b916eb9078f8d98a7864e697ae83ed54f5146bd8-

Block:  #  3
Nonce:  12937
Data:   vinay sent 10 dollars to sunny
Prev:   000012fa9b916eb9078f8d98a7864e697ae83ed54f5146bd8-
Hash:   6c833cf1c973d24351f34940e2cf3b9d051efb1ed91473b019-

Block:  #  4
Nonce:  35990
Data:
Prev:   6c833cf1c973d24351f34940e2cf3b9d051efb1ed91473
Hash:   4697cd16c084bf44265c471de0cb824bec9ba70c01d24
```

Fig 3: Representation of Chain of Blocks before mining

Then automatically the hash for that specific block is changed which would in turn affected the hash for above blocks(i.e block no's 4,5 etc which is shown in pink colour) as we discussed in the above example.

After mining the block no's from 4,5 etc which is shown in fig 4, we get valid hash for each block with which we link every block together with prev_hash of the blocks.



```
#  3
17864
vinay sent 10 dollars to sunny
000012fa9b916eb9078f8d98a7864e697ae83ed54f5146bd8-
0000a8045c88afd1423764fd07c294f71aa8103558e05d8eff

Block:  #  4
Nonce:  82191
Data:
Prev:   0000a8045c88afd1423764fd07c294f71aa8103558e05d8eff
Hash:   8e8f5c42f6793b1253d1f9de10f098b1decf0bbcef41075d0a0

Block:  #  5
Nonce:  3282
Data:
Prev:   00006035c84a88e8f5c42f6793b1253d1f9de10f098b1d
Hash:   0000dad11f35fda76903c0c0896bae8992914d608648e
```

Fig 4: Representation of Chain of Blocks after Mining

The figures 1,2,3 and 4 are from toolssuperdatascience.com source.

Smart Contracts:

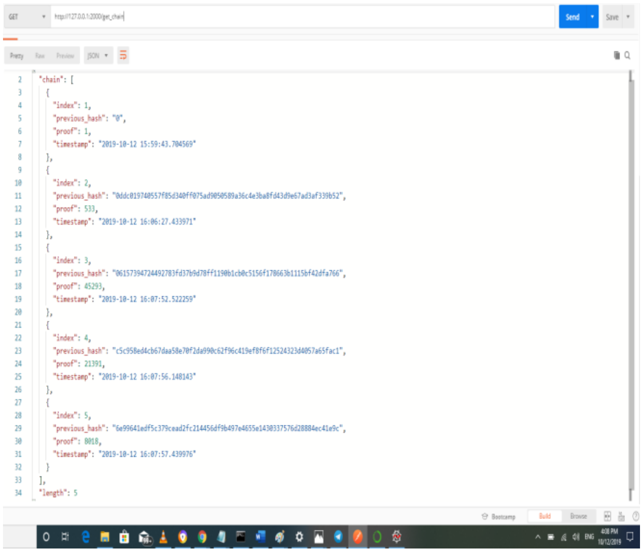
Smart contracts are the one of the emerging applications of the blockchain technology. It is defined as a computer program that takes a set of rules or agreements that a contract would possess and it is automated and built it on the blockchain platform. The program (smart contract) is immutable and self-executing across the network. As there is no centralized authority like a financial institution, there is no third-party for tampering of data. And Smart contract also reduces the cost involved in maintaining the contracts.

V. RESULT AND DISCUSSION

Building Simulated Blockchain Network:

A simulated blockchain network is built with the help of Postman, an API (Application Program Interface). And the Flask- A Web framework that is used to encompasses the simulated blockchain. A File named "nodes.json" is created to store the address of the nodes, which want participates in the transactions across the network.

Firstly, I created a general blockchain network which is shown in Fig 8.



GET http://127.0.0.1:2000/get_chain

```
  "chain": [
    {
      "index": 1,
      "previous_hash": "0",
      "proof": 1,
      "timestamp": "2019-10-12 15:59:43.704569"
    },
    {
      "index": 2,
      "previous_hash": "0ddc019740557f85d340ff075ad9050589a36c4e3ba8fd43d9e67ad3af339b52",
      "proof": 533,
      "timestamp": "2019-10-12 16:06:27.433971"
    },
    {
      "index": 3,
      "previous_hash": "06157394724492783fd37b9d78ff1190b1cb0c5156f178663b1115bf42dfa766",
      "proof": 45293,
      "timestamp": "2019-10-12 16:07:52.522259"
    },
    {
      "index": 4,
      "previous_hash": "c5c958ed4cb67daa58e70f2da990c62f96c419ef8f6f12524323d4057a65fac1",
      "proof": 21391,
      "timestamp": "2019-10-12 16:07:56.148143"
    },
    {
      "index": 5,
      "previous_hash": "6e99641edf5c379cead2fc214456df9b497e4655e1430337576d28884ec41e9c",
      "proof": 8018,
      "timestamp": "2019-10-12 16:07:57.439976"
    }
  ],
  "length": 5
```

Fig 8: Simulated Blockchain network

In this network we created 3 nodes with address (http://0.0.0.0:2001/), (http://0.0.0.0:2002/) and (http://0.0.0.0:/2003/) as Surya, Bhanu and Sandeep respectively. These 3 nodes represent 3 members across the blockchain network.

Firstly, I created a block that has to be processed by the miners. Indeed, miners do not generate hash directly, they will find the Nonce for the block to be mined with which valid hash (no of leading zeros generated by the software) for the block is generated.

As we discussed in the proposed methodology section about the methods that are involved in the transaction processing mechanism

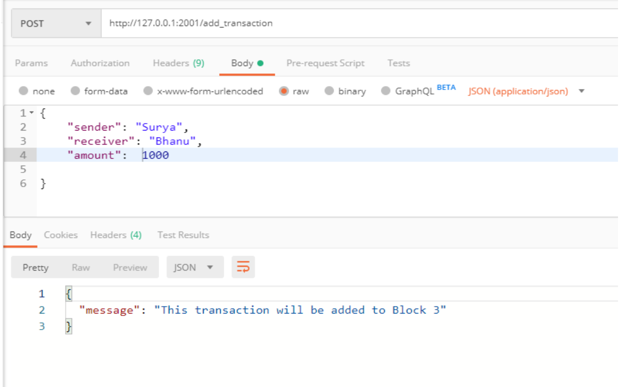
In addition to the above discussed methods, we also have JSON Files which are used in the transaction processing mechanism.

Connect_Node:

It is a JSON file, which is used to make a connection between the nodes which are going to be involved in the transaction mechanism across the network.

Add_transaction: It is a JSON file which stores the sender, receiver address and the amount to be transferred between them.

In fig 9, I added the transaction between two nodes (Sender: Surya, Receiver: Bhanu, Amount:1000) with the help of Add_transaction method.



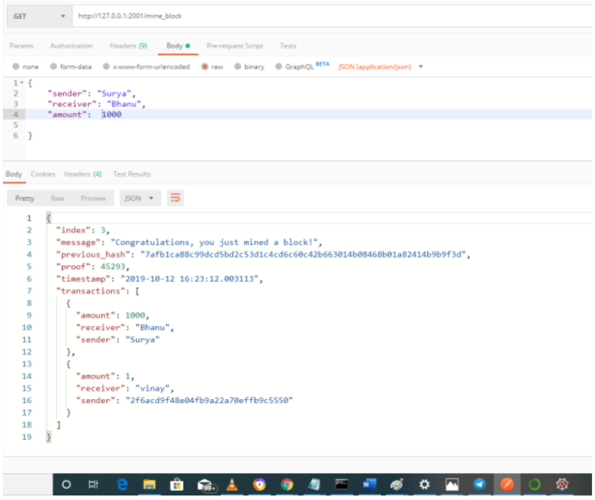
POST http://127.0.0.1:2001/add_transaction

```
{
    "sender": "Surya",
    "receiver": "Bhanu",
    "amount":  1000

}
```

```
{
  "message": "This transaction will be added to Block 3"
}
```

Fig 9: Adding of transaction between two nodes.

Moreover, we have an optional message part, which is used to send the required message about the transaction that we have done.



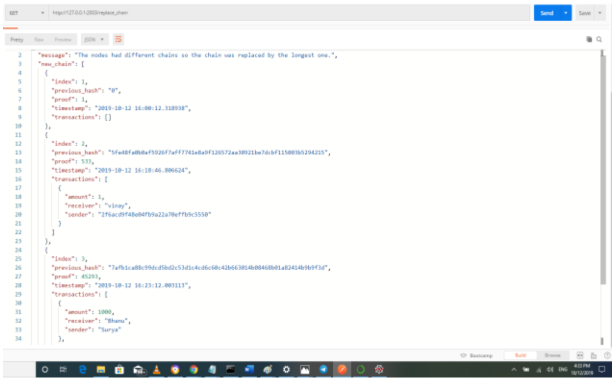
```
GET  http://127.0.0.1:2001/mine_block
Body  raw  JSON (application/json)
{
    "sender": "Surya",
    "receiver": "Bhanu",
    "amount":  1000

}
```

```
{
  "index": 3,
  "message": "Congratulations, you just mined a block!",
  "previous_hash": "7afb1ca88c99dcd5bd2c53d1c4cd6c60c42b663014b08468b01a82414b9b9f3d",
  "proof": 45293,
  "timestamp": "2019-10-12 16:23:12.003113",
  "transactions": [
    {
      "amount": 1000,
      "receiver": "Bhanu",
      "sender": "Surya"
    },
    {
      "amount": 1,
      "receiver": "vinay",
      "sender": "2f6acd9f48e04fb9a22a70effb9c5550"
    }
  ]
}
```

Fig 10: Mining the block above added transaction.

After the addition of transaction, we need to mine the block to generate the valid hash for that specific block to get transacted.

In fig 10, we mined the block and it gives the message as "Congratulations you have just mined a block"



```
GET  http://127.0.0.1:2003/replace_chain
```

```
  "message": "The nodes had different chains so the chain was replaced by the longest one.",
  "new_chain": [
    {
      "index": 1,
      "previous_hash": "0",
      "proof": 1,
      "timestamp": "2019-10-12 16:00:12.318938",
      "transactions": []
    },
    {
      "index": 2,
      "previous_hash": "5fe48fa0b0af5926f7aff7741e8a9f126572aa30921be7dcbf115003b5294215",
      "proof": 533,
      "timestamp": "2019-10-12 16:18:46.806624",
      "transactions": [
        {
          "amount": 1,
          "receiver": "vinay",
          "sender": "2f6acd9f48e04fb9a22a70effb9c5550"
        }
      ]
    },
    {
      "index": 3,
      "previous_hash": "7afb1ca88c99dcd5bd2c53d1c4cd6c60c42b663014b08468b01a82414b9b9f3d",
      "proof": 45293,
      "timestamp": "2019-10-12 16:23:12.003113",
      "transactions": [
        {
          "amount": 1000,
          "receiver": "Bhanu",
          "sender": "Surya"
        },
```

Fig 11: Node 2003 get the entire chain.

Blockchain with its distributed or openness property, even when the 2003 node (i.e Sandeep) didn't participate in the transaction, can able to get the entire chain of the network which is shown in Fig 11.

MISCONCEPTIONS ABOUT BITCOIN AND BLOCKCHAIN:

The Following are some of misconceptions about Bitcoin and Blockchain.

1. Bitcoin is anonymous: Bitcoin is not Anonymous it is Pseudonymous i.e every transaction occurred in the bitcoin network is permanently stored in the public open blockchain. So, every time you do a transaction with your bitcoin address the rest of the world can see it.

2. Blockchain is a Database: Many people think that blockchain is a better database, but blockchain is a ledger in which each transaction is chronologically ordered, and it's property immutability makes different from any database.

3. Blockchain is Bitcoin: This is the more prominent conception that is prevalent across society. Firstly, Blockchain is a technology and Bitcoin is a cryptocurrency. Blockchain is the underlying technology for each bitcoin transaction. Blockchain is not only used for bitcoin it's expanding the applications around the healthcare sector, Supply chain management, etc.

VI. LIMITATIONS OF USING BLOCKCHAIN

Blockchain given efficacious results in the financial and non-financial sector, there are some limitations of blockchain which are discussed below.

1.Blockchain in Rudimentary Stages:

As the blockchain based bitcoin white paper is published in 2008 by Satoshi Nakamoto [2], blockchain technology is the initial stage. Many companies like IBM in collaboration with Walmart have developed a pilot project for their products to provide transparency towards its consumers, Accenture, Cognizant has been researching in this field.

2.Lack of Awareness:

There is a lack of awareness among the people about blockchain technology and its use cases. People don't know how this technology can expand to other sectors of the industry due to lack of proficiency in blockchain. However, the circumstances have been changing, blockchain technology has been developed into different sectors like machine learning (decentralized machine learning), supply chain management, health sector, etc.

3.Energy Costs:

It is estimated that the amount of energy required for an average mining pool is equal to the amount of energy used by a New Zealand country, So there are huge energy costs involved in the mining of blocks [9], so we have to take steps in order to abate the energy costs and should take alternative measures in this process.

4.Lack of professional talent:

Blockchain technology is a complex, convoluted network, there is a lack of professionalism in this field is also one of the reasons for its slow pace development. There is a lack of blockchain developers in the market which affects its normalcy. There is a huge requirement for the blockchain trainers, analysts which would, in turn, lead to the development of the blockchain network.

5.Immutability:

Immutability is one of prominent properties of blockchain which provides integrity of records across the network and ensures that there is no tampering of data, but it's tough(horrible) if one needs to make a change or do revisions about the previous transactions that were made, then that's impossible with blockchain technology.

6.Key Management:

Blockchain technology is built on Cryptography.

Cryptography involves different keys like public keys, private keys. But when one dealing with the private key you are also running the risk that somebody may lose access to their private keys, their private key can't be retrieved. so the people lost bitcoins due to lost their keys in the early days of bitcoin.

7.Scalability

Scalability is the factor where large volumes of data are handled, though bitcoin is not developed for large no of transactions, it's expanding its scalability factor. The Time required for processing is one of the key factors for its slow expansion or adaptation. A bitcoin block of transactions takes 10 minutes to get processed where normal fiat currency financial institutions take par less time for transaction processing

VII. CONCLUSION

Blockchain is evolving at a rapid pace, it's providing propitious results in every sector. As we discussed in this paper, we can decentralize the financial transactions across the network. Furthermore, there is a huge scope in the research for expanding the applications of blockchain in every sector in a reliable and effective manner. Consensus protocols like proof of work and proof of stake didn't meet up to the reliable way for processing of transactions, so new consensus protocols should be developed. One of the most significant issue that we have to overcome is the energy cost involved in mining.

so alternative measures should be taken to lessen the costs. And also in Blockchain based bitcoin the time taken to process the transactions is 10 minutes, so we have to increase the scalability by improving or developing new mechanisms with which we can process more no of transactions.

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