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An Implementation of Multiple-Blockchain Scheme for Effective Block Mining Operation

A Thesis
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By

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بسم الله الرحمن الرحيم

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Dedication

Praise be to Allah always and forever.. Praise be to Allah who we believeis good and honors us with something better than him. Praise be to Allah for my success in every step of my life and for passing my studies with success and distinction..

Thank Allah for achieving one of my husband's goals, who was and stillis the light of my path and eyes, may Allah have mercy on you...

My thanks to the first supporter and the real supporter, the dear parents (my mother and my father). If I gave them my soul, I wouldn't reward little for little without them, I wouldn't have reached this point.

My thanks to my brothers and sisters and everyone who stood and supported.

My thanks for the gift of study, my dear friends

Abstract

Blockchain is a distributed ledger system that eliminates middlemen and enables secure, open, and tamper-resistant transactions. Its basis is a decentralized network of computers, or nodes, that collaborate to validate and record transactions in a shared ledger. Blockchain technology has various applications, including but not limited to cryptocurrency, supply chain management, smart contracts, voting systems, identity management, healthcare, and financial services. However, this Technology has some drawbacks, including slow transaction validation and mining and low network scalability.

This thesis aims to expedite the problem of delays in the blockchain consensus mechanism during transaction confirmation. It offers a network simulation designed to enhance the efficiency of the Proof of Work (PoW) consensus mechanism via parallel mining. The objective is to guarantee the full utilization of processing units within the nodes by concurrently processing multiple independent transactions using the available processing units.

The proposed work includes the process of selecting two types of contracts, work distribution and reward systems. This method was implemented in two experiments, each containing all the properties needed to perform PoW, and tested using a variety of case scenarios by varying the type and number of processing units.

After the experimental assessments were finished, a comparison of the outcomes of the two trials was done. The average network throughput for the three tests (one processing unit, two processing units, and three units) in the first experiment heterogeneous, respectively, (370.84, 740.41, and 1105.53

tps). The profit rate for these tests was, respectively, (0.045, 0.091, and 0.136 bps). In the second experiment, (homogeneous) the average network Productivity was for the three tests, (341.33, 682.66, and 1003.92 tps). They are (0.0416, 0.083, and 0.124 bps) in terms of the profit rate ratio, respectively, on average the speedup ratio for three processes is equal to (2.99).

These results provided evidence of the effectiveness of the proposed approach and demonstrated the superiority of the first experiment over the second in terms of network throughput and profitability.

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Table of Acronyms

Acronyms	***Full Form***
BC	Blockchain
BFT	Byzantine Fault Tolerance
BTC	Bitcoin
bps	Bit Per Second
DApps	decentralized applications
DPoS	Delegated Proof of Stake
ETH	Ethereum
GPP	Global Parallel Processing
HEPU	Heterogeneous Processing Units
HOPU	Homogeneous Processing Units
IoT	Internet of Things
LPP	Local Parallel Processing
P2P	Peer-to-Peer
PoS	Proof of Stake
PoW	Proof of Work
PU	Processing Unit
SC	Smart Contracts
TR	Transaction

tps	Transactions Per Second
Tseq	Time in the case of sequential processing
Tpar	Time in the case of parallel processing

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Chapter One

General Introduction

1.1 Introduction

Blockchain is a peer-to-peer, decentralized distributed ledger technology the records of digital transparent, immutable, and works without the involvement of any third-party middleman[1] . Blockchain is like a book with numbered pages, with the imposition of not writing on the next page before the complete reach of the page before it, and the need for the previous page to be sealed with the same seal as the next page[2]. At its core, a blockchain is a database that is replicated across a network of computers or nodes. Each node in the network maintains a copy of the database, and all changes made to the database are recorded in a block. Once a block is added to the chain, it cannot be altered or deleted without consensus from the network[3].

The blockchain attempts to prevent the possibility of forging a previously authenticated transaction[2]. A decentralized network provides multiple advantages over a traditional centralized network, including increased system reliability and privacy. Additionally, such networks are much easier to scale and manipulate as there is no true single point of failure. The reason for the distribution and decentralization of the blockchain is interconnection and distributed processing. The P2P architecture of blockchain networks provides many advantages such as increased security compared to traditional networks based on a single server at the client. A distributed P2P network, combined with majority compatibility requirements, provides a relatively high degree of resistance to malicious activity[4][5] .

Blockchain technology has emerged as a groundbreaking solution for secure and transparent digital transactions, eliminating the need for intermediaries and enhancing trust between participants. However, despite its immense potential, the advancement and wider adoption of blockchain have been hampered by a range of constraints. One of the most prominent restrictions facing blockchain technology is scalability. As the number of transactions and users within a blockchain network grows, the system encounters challenges in processing and confirming transactions in a timely manner [6] [7]. The lack of interoperability between different blockchain platforms is another major obstacle to the widespread adoption of the technology. The presence of multiple blockchain networks, each with its own protocols and standards, hampers seamless data exchange and collaboration between systems [8]. The energy-intensive nature of blockchain technology has also drawn significant attention and posed a constraint to its widespread adoption[9]. The resource-intensive consensus mechanisms, such as Proof of Work (PoW), used in popular blockchain networks like Bitcoin, consume substantial amounts of electricity, raising concerns about environmental sustainability and cost-effectiveness. Developing more energy-efficient consensus algorithms and exploring alternative approaches, such as Proof of Stake (PoS), can help mitigate the energy consumption challenges associated with blockchain technology [10].

1.2 Statement of Problem

The network faces various challenges, including transaction execution time and processing speed. Furthermore, the underutilization of multiple cores or processors within the node and the extended time required for achieving consensus, sometimes stretching to hours in certain applications, adversely affects network efficiency. This, in turn, results in suboptimal productivity, reduced profitability, and increased time consumption. The node itself has taken steps to address the problem of idle transaction units by allocating transactions to them upon receipt.

The focus of this thesis is on the issue of delays within the Proof of Work (PoW) mechanism. The implementation of PoW consumes significant time and resources for mining nodes responsible for validating and adding blocks to the distributed ledger.

Block mining is a process that necessitates numerous attempts and consumes substantial resources. Mining nodes are tasked with solving a mathematically complex puzzle to construct a block [3].

1.3 Aim of Thesis

The aim of this study is to improve the performance of blockchain technology through the use of parallel processing, a simulation of a network aimed at accelerating the Proof of Work (PoW) consensus mechanism through parallel mining. The proposed method involves distributing transactions among free processing units inside nodes, allowing all nodes in the network to participate in the processing, By using multiple processing units on each node and assigning the transactions to the free units. The objectives of this works are:

1- Improving node productivity and profit in the network.

2- Reducing nodes processing time for consensus oftransactions.

3- Improving the overall efficiency of the network.

4- Speed up the using of Blockchain technology in a network.

1.4 Literatures Review

Recently, researchers have shown a growing interest in addressing the issue of delayed consensus mechanisms, which is closely tied to the scalability of the network. The challenge of achieving efficient consensus in the presence of network scalability concerns has attracted significant attention in the academic community.

W. Hao et.al, 2019 It has been noted that the arrangement of the peer-to-peer (P2P) blockchain network topology adversely affects the speed of transaction publishing and synchronization, consequently leading to delays in node consensus mechanisms and suboptimal network performance. In response to this issue, the researchers introduced an optimized network protocol called BlockP2P. The primary objective of BlockP2P is to minimize the overall latency of the blockchain network. This is achieved through a three-part framework.

Firstly, the BlockP2P algorithm employs the K-means algorithm to gather nearby nodes into clusters, reducing complexity and facilitating parallel propagation between clusters. By designing the network topology across the entire network, this step ensures efficient communication. Secondly, the inter-cluster topology is enhanced by constructing a Hierarchical graph with high connectivity and low diameter. This structural improvement aims to enhance the connectivity between nodes in different

clusters, further reducing network latency. Lastly, BlockP2P incorporates a data transmission mechanism designed to eliminate multiple message rounds within a single communication process. This design streamlines the synchronization of transmission processes both within clusters and between clusters[11].

A. J. Al- Musharaf et.al 2021 The peer to peer blockchain's topology is being improved to a decentralized topology (organized in clusters). This seeks to shorten the time spent broadcasting transactions and to shorten the lengthy time taken by the Proof of Work (PoW) mechanism's nodes consensus mechanism to validate transactions using parallel mining within and between clusters. The Hybrid topology is the organizational architecture that creates both intra- and inter-clustering of nodes. Transactions were broadcast both between clusters and within a cluster using the parallel broadcast mechanism. The cluster heads nodes of various network clusters serve as the foundation for this broadcast of transactions. When the cluster head nodes get the data, they broadcast it to the other nodes within their cluster before passing it on to other cluster heads. Consequently, this technology allows for quick and parallel data broadcast [12].

In 2020, S. S. Hazari and Q. H. Mahmoud, proposed a system for choosing a management, allocating work, and rewarding performance. This approach has been evaluated by varying the degree of difficulty and the quantity of validators in a variety of case scenarios. It has been formulated within a controlled experimental setting possessing all the requisite attributes essential for the execution of the Proof of Work protocol employed in the Bitcoin context. Some of the information utilized by the miners to carry out the proof of work, such as the Bitcoin index, the hash value of the previous block, and the date, are similar. While using the same transaction data but a different nonce, the content of transactions and the nonce value selected by

the miners may differ. This guarantees the prevention of redundancy among miners' tasks through the imposition of a stipulation that mandates uniform employment of identical data by all miners, with the sole exception being the nonce allocated to a particular block. Management must ensure that no two miners use the same nonce value and that all miners use the same transaction data in order to establish such an environment. A different manager, chosen among the miners, will rule each era. In this context, the interval of time between two blocks is known as an epoch. The management will choose which nonce has to be computed in this circumstance, not the miner. The administration can ensure that no two miners use the same nonce value by taking this precaution. Additionally, the manager is in charge of producing the transaction hash for each block that comes within his or her jurisdiction, which will be provided to the miners together with the nonce value [13].

In 2021, T. Mai et.al. Blockchain cannot be used as a generic platform since the consensus process requires a significant amount of processing and energy. suggest a cloud mining pool-aided IoT and blockchain (BCoT) architecture to get over this problem, where IoT devices can outsource their mining operations by renting computing resources from cloud mining pools. Additionally, the 'WoLF-PHC' algorithm, a lightweight distributed reinforcement learning system, is proposed in light of the non-cooperative interaction between various miners [14].

In 2021, Z. Raza et. al. The constructed two PoW solo mining techniques based on parallel computing that use several processes to tackle a challenging arithmetic problem using various nonce values. Since different types of attacks can affect pool mining, our suggested algorithms encourage fast solo mining rather than pool mining. Instead than changing how PoW functions fundamentally, suggested various nonce value selection ways

before conducting PoW mining across several processes. test on several levels of difficulty, calculate the time required to compute the nonce value for each level of difficulty, and compare it to suggested parallel PoW solutions. Merkle Tree (in the case of bitcoin) is substituted for the string "Parallel Computing" for experimental purposes because the performance of the suggested approach can be verified using even a short string. Instead of changing the string throughout the process, the difficulty levels were modified in order to determine the mining time for PoW and parallel PoW strategies at each difficulty level [16].

In 2021, J. A. DeNio and S. A. Ludwig proposed a method, the majority of nodes will work to validate a single block, and the remaining nodes will serve as the active manager and backup manager, respectively. The active manager will send updates to the backup managers, who will take over if the active management is unavailable. Miners will get data from the active manager. create a consensus mechanism ,To ensure that managers are chosen at random and that no node can be forced to become a manager. Two types of managers will be used: a team of support managers and an active manager. For a specific block, the active manager will make sure that no two miners acquire the same nonce values. The manager is also in charge of generating the nonce value set and the transaction hash that miners will use to try to solve the hash. the support managers' job is to organize a team and, if necessary, replace active manager In the case of a failure. To prevent a bad user from seizing control of a manager and messing with the network, the replacement should be selected at random. The management team will be a parallel network nested within the main network, and they should be in constant communication with one another to make sure they are all in sync and have the same information. If one management possesses contradictory knowledge, the other managers will remove the corrupted manager from the

team and elect a successor. The group will choose a newactive management if the current one is inactive using a semi-random selection process that gives precedence to managers with the highest computational capability [25].

Table 1.1 Summarize the Reviewed Studies

References NO	Author(s)	Research Title	Research Problem	Proposed Solution Method
[11]	W. Hao et.al (2019)	BlockP2P: Enabling Fast Blockchain Broadcast with Scalable Peer-to-PeerNetwork Topology	the arrangement of the peer-to-peer (P2P) blockchain network topology adversely affects the speed of transaction publishing and synchronization, consequently leading to delays in node consensus mechanisms and suboptimal network performance.	used protocol called BlockP2P, employs the K-means algorithm to gather nearby nodes into clusters, the inter-cluster topology is enhanced by constructing a Hierarchical graph with high connectivity and low diameter.
[13]	S.S. Hazari and Q. H. Mahmoud (2020)	Improving Transaction Speed and Scalability of Blockchain Systems via Parallel Proof of	pow Compared to otherdigital payment methods, cryptocurrency transaction verification takes a lot longer.	A system for choosing a management, allocating work, and rewarding performance. By varying the degree of difficulty and the quantity of validators, this method has been putto the test in a variety of case studies.

References NO	Author(s)	Research Title	Research problem	proposed solution method
		Work		
[12]	A.J. Al-Musharaf, et.al (2021)	Improving Blockchain Consensus Mechanismvia Network Clusters	Peer-to-peer networks have nodes connected in an unstructured (peer-to-peer) topology, which hindersthe synchronization of blockchain data and broadcast speed. Poor performance and issues with delay in the network nodes' consensus mechanism result from this.	The peer-to-peer blockchain's topology is being improved to a decentralized topology (organized topology in clusters). The Hybrid topology is the organizational architecture that creates both intra- and inter-clustering of nodes.

References NO	Author(s)	Research Title	Research problem	proposed solution method
[14]	T. Mai etal, (2021)	Cloud Mining Pool Aided Blockchain-Enabled Internet of Things: An Evolutionary Game Approach	Blockchain cannot beused as a generic platform since the consensus process requires a significant amount of processingand energy.	propose a cloud mining pool-aided BCoT architecture, the 'WoLF-PHC' algorithm, a lightweight distributed reinforcement learning system, is proposed in light of the non-cooperative interaction between various miners .

Reference	Author(s)	Research Title	Research problem	proposed solution method
[16]	Z. Raza et.al (2021)	Energy Efficient Multi processing SoloMining Algorithms for Public Blockchain Systems	different types of attacks can affect pool mining	suggested algorithms encourage fast solo mining rather than pool mining.
[25]	J.A. DeNio and S. A. Ludwig, (2021)	Improving Transaction Speed and Scalability in Blockchain Systems	in peer-to-peer network presents potential attack points. since the loss of a single node could momentarily impair network connectivity as nodes reconnect.	The majority of nodes will participate in the validation of a single block, while the remaining nodes will operate as the active manager and backup manager.

1.5 Structure of Thesis

The remaining of this thesis is organized in the following chapters:

Chapter Two: The theoretical underpinnings and fundamental ideas of blockchain technology and P2P networks are thoroughly explained.

Chapter Three: The proposed work that has been developed isdescribed.

Chapter Four: The experimental findings of the suggested work are described and discussed.

Chapter Five: Summarizes the key findings and makes some recommendations for further research.

Chapter Two

Theoretical Background

2.1 Introduction

This chapter presents a comprehensive overview of fundamental concepts and terminology associated with blockchain technology. It delves into the definition of blockchain, its operational mechanism, constituent elements, various types, as well as an analysis of its advantages and disadvantages. Moreover, the chapter provides a concise examination of the consensus mechanism and the mining process within the blockchain ecosystem. Additionally, it explores concepts pertaining to distributed networks in relation to blockchain technology.

2.2 Overview of the Blockchain

A shared ledger, such as a blockchain, is one that is safe, unchangeable,and maintained by a large number of connected computers or nodes. Without the assistance of any outside intermediaries, the blockchain can handle user transactions. Simply, having a wallet is all that is required to conduct transactions. An individual can spend cryptocurrencies like bitcoin, ethereum, etc. by using a blockchain wallet, which is simply an application. Encryption techniques (public and private keys) are used to safeguard these wallets, allowing the user to fully manage and control his transactions [18].

Blockchain is a relatively new technology that has been used in many different industries and fields [19]. Blockchain is a collection of blocks connected by hashing, and each block contains a hash as well as the previous hash, making it safe and impervious to hacking. The total of validated transactions that are packed and broadcast to the network make up each block [20][21]. Within the blockchain structure, it is common for each block to encompass a block header along with a transaction counter denoted as "Transactions" [22]. Each block has a hash, the previous block's hash, a

timestamp, and a few extra block attributes (such as version and nonce) Figure 2.1 depicts the blockchain structure. This is determined by the block design. The set of transactions in the Merkle tree are represented by the Merkle root hash, and this representation of transactions differs depending on how the blockchain implementation is built[23].

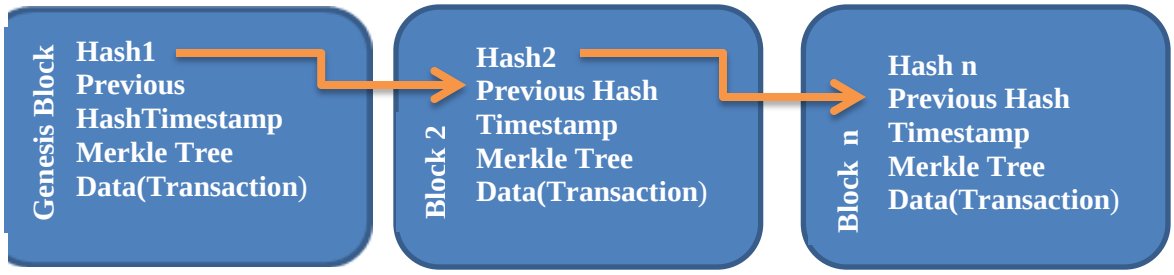

Figure 2.1 Basic Blockchain structure [12]

Figure (2.1), however, depicts the fundamental design of block on the blockchain and includes the following characteristics.

2.2.1 Hash

In blockchain technology, a hash refers to a unique digital fingerprint orcryptographic output generated from input data using a specific algorithm [29]. Hash functions are an essential component of blockchain systems and are used for various purposes, including ensuring data integrity and security. Hash functions take an input (such as a block of data) and process it through a mathematical algorithm to produce a fixed-length string of characters, which is the hash output [5]. The input data can be of any size, but the resulting hash output is always of a fixed length, regardless of the input size. Blockchain technology frequently employs hashing methods like SHA-256 (Secure Hash Algorithm 256-bit). Thesealgorithm is designed to be

computationally efficient and produce unique hash outputs for different input data [29]. Each block in the blockchain contains a hash value that is calculated based on the block's data and the hash of the previous block [28]. This results in a chain of blocks where changing any block's data would need recalculating the hash for that block and all succeeding blocks, which is computationally impossible and very obvious. [24] [26] .

2.2.2 Previous Hash

In a blockchain, the previous hash refers to the hash value of the previous block in the chain. Each block in the blockchain contains a reference to the hash of the previous block, which creates a link between blocks and forms a chronological sequence of transactions [30].

When a new block is created and added to the blockchain, its block header includes a field that stores the hash value of the previous block's header. This previous hash acts as a unique identifier for the previous block and ensures the continuity and integrity of the blockchain.

Overall, the inclusion of the previous hash in each block is a fundamental component of blockchain technology that maintains the integrity, immutability, and continuity of the blockchain's transaction history [30].

2.2.3 Timestamp

In blockchain technology, a timestamp refers to a record that refers the date and time at which a specific event or transaction occurs. Timestamp play a role in blockchain systems by providing order of events and ensuring the integrity of the data stored in the blockchain. In a blockchain, each block contains a timestamp that represents the timeat which the block was added to the blockchain [32].

2.2.4 Merkle Tree

A Merkle tree, also known as a hash tree or binary hash tree, is a data structure used in blockchain technology to efficiently verify the integrity and consistency of large sets of data. It is named after its inventor Ralph Merkle [29].

In a Merkle tree, data is organized in a hierarchical manner, where each level of the tree is formed by combining the hash values of its child nodes using a cryptographic hash function (e.g., SHA-256). The process begins with the individual data elements, also known as leaves or transactions, at the bottom level of the tree. The hash of each transaction is

calculated, and these hashes are paired together and hashed again to form the nodes of the next level. This process continues until a single hash, known as the root hash or Merkle root, is obtained at the top of the tree [29]. as show Figure 2.2.

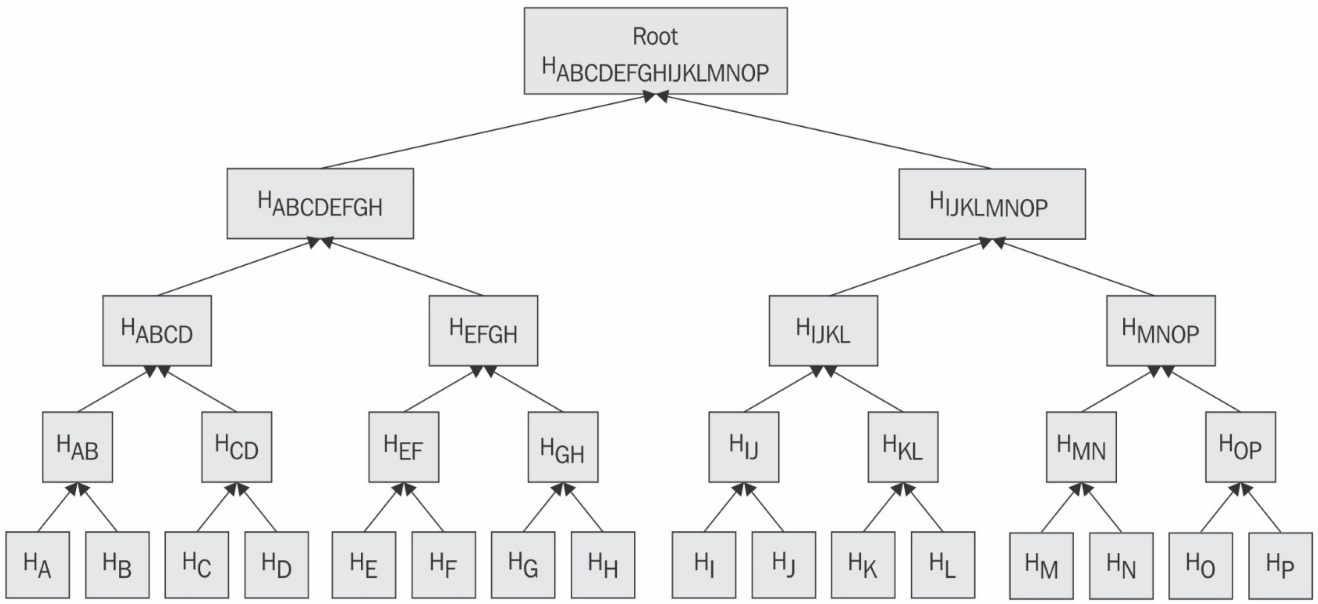

Figure 2.2 Merkle tree Structure[3]

The Merkle tree structure enables efficient verification of data integrity. Instead of comparing all the data elements individually, one can verify the integrity of a subset of the data by comparing only a few hashes. By providing the Merkle root and the corresponding hashes along the path to the specific data element, anyone can verify that the data is part of the tree and has not been tampered with. This is achieved by comparing the computed hashes with the provided hashes and the Merkle root [29] .

In the context of blockchain, Merkle trees are widely used to ensure the integrity of transactions within a block. Each block in the blockchain typically contains a Merkle tree that summarizes all the transactions in that block. The Merkle root is stored in the block header, allowing quick verification of the validity and integrity of the transactions without the need to examine each transaction individually [27].

By utilizing Merkle trees, blockchain systems can efficiently verify large sets of data and provide a secure and scalable method for confirming the integrity of the data within the blockchain network.

2.2.5 Data (Transactions)

Block transactions in the blockchain refer to the individual records of transactions that are grouped together and added to a block in the blockchain [13]. Each block in the blockchain typically contains multiple transactions, depending on the specific blockchain protocol and its block size limit. The transactions within a block are ordered and linked together through cryptographic hashes, with each transaction referencing the previous transaction in the chain. The inclusion of transactions in blocks ensures the integrity and transparency of theblockchain [25] .

The maximum block size in a blockchain can vary depending on the

specific blockchain protocol and its design parameters. In the case of the Bitcoin blockchain, which is one of the most well-known and widely used blockchain networks, the current maximum block size is 1 megabyte (MB). This block size limit was originally implemented as a measure to prevent spam attacks and ensure the efficient propagation of blocks across the network[22] ,[24].

The Genesis Block, also known as Block 0 or Block 1, is the firstblock in a blockchain network. It serves as the foundation or starting point of the entire blockchain. The Genesis Block is unique in that it does not reference any previous block since there are no prior blocks in the chain[25] [29].

2.3 Blockchain Applications

This section discusses a few of the blockchain-based applications. IoT, the supply chain, health records (including personal health record systems (PHRs), electronic medical records (EMRs), and electronic health records (EHRs)), the banking industry, and digital marketing. Figure 2.3 shows some applications of blockchain.

2.3.1 Blockchain In IOT Applications

The researchers emphasize the importance of incorporating blockchain technology into Internet of Things applications, and several contend that there are secure and transportable IoT authentication systems based on blockchain technology [33]. by offering a variety of blockchain layers The solution makes the blockchain more IoT-friendly [34]. The application of blockchain technology to mitigate security and privacy concerns in the context of Internet of Things (IoT)-enabled sustainable agriculture is an area of growing scholarly interest. In response to these challenges, a series of blockchain-driven solutions have emerged, aiming to

fortify IoT-based green agriculture. These solutions encompass a spectrum of innovative approaches, notably including the establishment of a blockchain-centric public key infrastructure (BPKI), the integration of blockchain-driven machine learning paradigms (BML), the implementation of blockchain- powered distributed key management strategies (BDKM), the deployment of blockchain-based access control mechanisms (BAC), the establishment of blockchain-derived frameworks for reputation and trust assessment (BRT), the enactment of blockchain-facilitated protocols for authentication and identification (BAI), and the integration of blockchain-enhanced Secure Software-Defined Networking(BSDN)[35][36].

2.3.2 Blockchain with Supply Chain

Numerous tracking tools, like as sensors, tags, and tracers, are used by the Ambrosus and Modum systems. The best tracking device is mostly dependent on the product. An effective monitoring system attempts to reduce the production and distribution of hazardous or subpar goods by enhancing branding and the monitoring system. Radio-Frequency Identification (RFID) is used to carry out tracking and monitoring in order to guarantee the quality and safety of food. In order to create a reliable, transparent, and secure decentralized network, the blockchain is then updated with all relevant information [37] [38].

2.3.3 Blockchain in Healthcare Applications

In the domain of healthcare, the application of blockchain technology enhances security measures [39]. The vulnerability associated with the exchange of medical data within precarious environments engenders an elevated susceptibility to malicious targeting[40]. Consequently, stakeholders within the healthcare sector endeavor to securely exchange information, thereby ensuring the safely of its integrity [41][42].

This industry uses blockchain technology because of its accuracy, security, privacy, and other distinguishing [43][44].

2.3.4 Blockchain with Banking Sector and DigitalMarketing

Considering remittances in the traditional banking sector are inefficient and the banking system is unable to respond quickly enough to the rapid environmental change of the digital age. Banks must make use of Blockchain technology to provide faster, more secure transactions, and better remittances [45][46]. Blockchain technology promises speedier payments and money transfers than conventional interbank payment systems like SWIFT. As an illustration, PayPal utilizes Blockchain technology to expedite the verification and processing of significant payments. The dependability and security of financial transactions are improved, counterfeiting is reduced, and private data is protected from bank assaults thanks to blockchain technology, which also increases security [47]. Figure 2.3 shows some applications of blockchain.

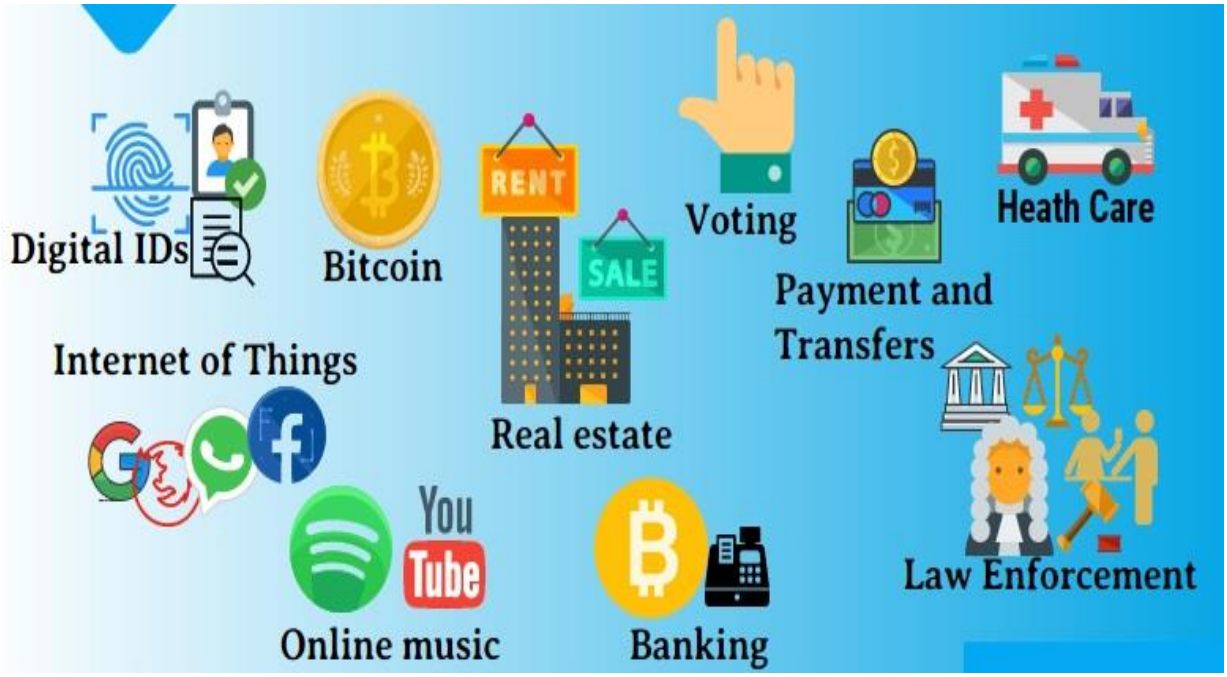

Figure 2.3 Applications of Blockchain[75]

2.4 Blockchain Platforms

Blockchain platforms refer to the software or infrastructure that enables the creation, deployment, and management of blockchain networks. These platforms provide the necessary tools, protocols, and frameworks for building decentralized applications (dApps), executing smart contracts, and supporting various blockchain use cases. One of these is Blockchain platforms [3].

2.4.1 Bitcoin

The first idea to be proposed was Bitcoin, a cryptocurrency that highlights its value through the lack of a centralized authority. A decentralized Peer-to-Peer (P2P) network of actors maintains the coin's security collectively [48].

It was introduced in a whitepaper titled "Bitcoin: A Peer-to-Peer Electronic Cash System" published in 2008 by Satoshi Nakamoto. Bitcoin is designed to operate without a central authority, such as a government or financial institution, and depend on cryptographic principles to secure transactions and control the creation of new units of the currency. It utilizes a public ledger called the blockchain to record all transactions in a transparent and immutable manner[49].

Bitcoin operates on a distributed network of computers, known as nodes, where participants can send and receive bitcoins directly without the need for intermediaries. Transactions are verified and bundled into blocks by miners, who compete to solve complex mathematical puzzles through a process called proof-of-work. Once a block is successfully mined, it is added to the blockchain, creating a permanent and sequential record of all transactions , Bitcoin makes use of the SHA-256 cryptographic algorithm. [30].

2.4.2 Ethereum

Ethereum can be defined as an open-source decentralized platform that enables the development and execution of smart contracts and decentralized applications (DApps) [49]. Ethereum is built on blockchain technology and features its native cryptocurrency called Ether (ETH). However, Ethereum distinguishes itself from Bitcoin by introducing a programmable blockchain, allowing developers to create and deploy self-executing smart contracts. Smart contracts are computer programs that automatically execute predefined agreements or rules without the need for intermediaries [50].

Key aspects of Ethereum , smart contracts: Ethereum's primary innovation is its ability to support smart contracts [51]. smart contracts are coded agreements that define the rules and conditions for transactions, ensuring their automatic execution and enforcement. These contracts are stored and executed on the Ethereum Virtual Machine (EVM), a runtime environment that runs on the network's nodes [52] .

Ethereum provides a platform for building decentralized applications or dApps. These are applications that leverage smart contracts to operate in a decentralized manner, with no central authority controlling the application's backend or data. Ethereum's blockchain serves as the underlying infrastructure for dApps, enabling transparency, immutability, and trust among participants [40].

Ethereum employed a proof-of-stake (PoS) consensus called Ethereum. PoS aims to enhance scalability, energy efficiency, and security by allowing participants to secure the network by staking their Ether holdings rather than through resource-intensive mining. Ethereum uses the Ethash algorithm .

2.5 Mining and Miners

In the realm of blockchain technology, mining and miners play a pivotal role in maintaining the security, integrity, and consensus of decentralized networks [13].

Mining, in the context of blockchain, refers to the process of validating and adding new blocks to the distributed ledger. Miners are network participants who engage in this computational endeavor, dedicating their computing resources and efforts to secure the blockchain network. The primary objectives of mining are twofold: to validate transactions and to ensure the immutability and trustworthiness of the blockchain's transaction history [13].

Miners employ specialized hardware and software tools to solve complex mathematical puzzles, known as cryptographic hash functions. These puzzles require substantial computational power and energy consumption to find a solution. Once a miner successfully solves the puzzle, they propose a new block of verified transactions to the network [25]. Other miners then verify the validity of the proposed block before it is added to the blockchain. This consensus mechanism ensures that all participants agree on the order and content of transactions, maintaining the integrity of the blockchain [30].

The POW mechanism is known as mining, and the nodes that compute the hashes are known as miners. Mining and miners play a critical role in the operation, security, and sustainability of blockchain networks[3].

Blockchain technology depends on mining and miners to validate transactions, secure the network, and maintain consensus [30]. Miners dedicate computational resources to solve complex cryptographic puzzles,

enabling them to propose new blocks of verified transactions. This consensus mechanism ensures the agreement of all participants on the state of the blockchain. each miner is a node, but not every node is also a miner [40].

Mining involves specialized hardware and software tools that employ computational power to solve cryptographic algorithms. Different consensus mechanisms have emerged, such as proof-of-work (PoW), proof-of-stake (PoS), and variations like proof-of-authority (PoA) and delegated proof-of-stake (DPoS) [53].

Miners are incentivized for their computational efforts through block rewards and transaction fees. The specific reward structures vary across different blockchain networks [53].

Mining and miners are essential components of blockchain networks, contributing to transaction validation, consensus, and network security [13].

2.6 The Main Traits of the Blockchain

Blockchain technology encompasses several key features that distinguish it from traditional centralized systems. The following are some of the prominent features of blockchain:

2.6.1 Transparency

The blockchain provides transparency by making the transaction history visible to all participants in the network. Any changes oradditions to the blockchain are distributed and visible to all nodes, ensuring accountability and trust among participants [22].

2.6.2 Decentralization

Blockchain operates on a decentralized network of computers, called nodes, which collectively maintain the blockchain. There is no central

authority controlling the system, allowing for greater transparency, resilience, and trust [24].

2.6.3 Immutability

Once data is recorded on the blockchain, it is extremely difficult to alter or delete. Each block in the chain contains a cryptographic hash that links it to the previous block, creating a tamper-resistant and immutable record of transactions [22].

2.6.4 Privacy and Security

While blockchain provides transparency, it also supports privacy features through the use of cryptographic techniques. Participants can have pseudonymous identities and control over their personal data, allowing for selective disclosure and privacy protection [24].

2.7 Core Challenges in Blockchain

Blockchain technology, while promising, also faces several core challenges that need to be addressed for its widespread adoption and scalability. Some of the key challenges in blockchain include:

2.7.1 Scalability

Blockchain networks often struggle with scalability issues as the number of transactions and participants grows. Block size limitations, block validation times, and consensus mechanisms can hinder the throughput and speed of transactions, posing a challenge for blockchain to handle high transaction volumes efficiently[54].

2.7.2 Interoperability

Blockchain systems typically operate as separate networks, making it difficult for them to interact and share data seamlessly. Achieving interoperability between different blockchain platforms is crucial for enabling efficient data exchange and collaboration across diverse networks [8].

2.7.3 Security and Privacy

While blockchain technology provides inherent security features, itis not immune to security breaches and vulnerabilities. Issues such as 51% attacks, smart contract bugs, and privacy concerns need to be addressed to ensure robust security and privacy protections in blockchain systems [23].

2.7.4 Energy Efficiency

Some blockchain networks, especially those utilizing Proof of Work (PoW) consensus algorithms, consume a substantial amount of energy for mining and block validation. Achieving energy-efficient blockchain solutions is crucial to reduce the environmental impact andimprove sustainability [55].

2.8 Types of Blockchain

There are primarily three types of blockchains: public, private, and Semiprivate blockchains. These types differ in terms of their accessibility, control, and the level of decentralization they offer. Here's an overview of each type:

2.8.1 Public Blockchain

Public blockchains are open and decentralized networks accessible to anyone. They allow any participant to join, validate transactions, and contribute to the consensus process. Public blockchains, like Bitcoin and Ethereum, operate with a high level of transparency and security through consensus algorithms such as Proof of Work (PoW) or Proof of Stake (PoS). These blockchains typically have their native cryptocurrency and provide an open and trustless environment for conducting transactions and running decentralized applications(DApps) [4] [42][56].

2.8.2 Private Blockchain

Private blockchains, as the name suggests, are restricted networks where participation and access are limited to specific entities or individuals. They are typically managed by a single organization or a group of trusted entities. Unlike public blockchains, private blockchains may not require a cryptocurrency or mining for consensus. They offer greater control over network governance and may provide higher transaction throughput and privacy. Private blockchains are commonly used in enterprise settings for applications such as supply chain management, document verification, and inter- organizational collaboration[4] [57].

2.8.3 Consortium (Federated) Blockchain

Consortium blockchains are a hybrid model that combines elements of both public and private blockchains. In a consortiumblockchain, multiple organizations or entities form a consortium and jointly operate and maintain the blockchain network. The consensus processis controlled by a limited number of pre-selected validators or nodes, typically representing the consortium members. Consortium blockchains offer a balance between decentralization and control, making them suitable for industries or sectors where multiple entities need to collaborate while maintaining a certain degree of trust and privacy. They are often used in financial institutions, healthcarenetworks, and supply chain ecosystems [55].

It's important to note that within each type, there can be variations and customization based on specific requirements and use cases. Additionally, hybrid blockchain models have also emerged, combining characteristics of multiple types to address specific needs. The choice of blockchain type depends on factors such as the level of desired decentralization, security, privacy, scalability, and the specific requirements of the intended applications or participants.

2.9 Consensus Mechanisms

Consensus mechanisms are the protocols or algorithms used in blockchain networks to achieve agreement among participants on the validity of transactions and the order in which they are added to the blockchain. Consensus mechanisms ensure the integrity and consistency of the blockchain's transaction history.

Here are some commonly used consensus mechanisms in blockchain:

2.9.1 Proof of Work (PoW)

In the Proof of Work consensus mechanism, participants (miners) compete to solve complex mathematical puzzles to validate transactions and create new blocks. The first miner to solve the puzzle earns the right to add the block to the blockchain [58]. PoW requires substantial computational power and energy consumption, and it is utilized in popular cryptocurrencies like Bitcoin and Ethereum.

Miners gather pending transactions from the network and package them into blocks. They then use their computational power to solve the mathematical puzzle associated with the current block. The solution to the puzzle, known as the "proof," requires substantial computational effort and is resource-intensive[59].

Once a miner finds a valid solution, they broadcast it to the network for verification. Other nodes in the network then validate the solution by independently verifying the calculations. If the solution is deemed valid, the block is added to the blockchain, and the miner is rewarded with newly minted cryptocurrency (e.g., Bitcoin) and transaction fees associated with the included transactions [40].

Proof of Work provides security by making it extremely difficult and

resource-intensive for malicious actors to change the blockchain's transaction history. Proof of Work has been effective in securing public blockchain networks, but it has drawbacks such as high energy consumption and limited scalability due to the computational requirements. As a result, alternative consensus mechanisms like Proof of Stake (PoS) and Practical Byzantine Fault Tolerance (PBFT) have been developed to address these issues in more energy-efficient and scalable ways.

2.9.2 Proof of Stake(POS)

Proof of Stake (PoS) is a consensus mechanism used in blockchain networks to achieve agreement and validate transactions. It is an alternative to the Proof of Work (PoW) consensus mechanism and aims to address some of the drawbacks associated with PoW, such as high energy consumption and limited scalability [40].

In a Proof of Stake system, participants (also known as validators) are chosen to create new blocks and validate transactions based on the number of cryptocurrency units they hold and "stake" in the network. Validators are selected in a deterministic manner, usually based on a combination of factors like their stake size, age of coins held, or a combination of both[60].

Validators who hold a certain amount of cryptocurrency can lock up or "stake" their coins as collateral. This stake serves as proof that they have a financial interest in maintaining the network's security and correctness. Validators take turns being selected to create new blocks, and the chance of selection is proportional to their stake. The more coins a validator holds and stakes, the higher the probability of being chosen to create a block [61].

Validators are responsible for validating transactions and ensuring their correctness. When a validator creates a block, they include a cryptographic signature or proof of their validation. Other validators canthen independently verify the validity of the block and its transactions. Once a

block is added to the blockchain and a certain number of subsequent blocks are added on top, it becomes "final" and cannot be reversed or altered [62].

Proof of Stake achieves consensus by relying on the economic incentives of validators. Validators who behave maliciously or try to manipulate the blockchain risk losing their staked coins as a penalty. This economic disincentive serves as a security mechanism to discourage fraudulent behavior and protect the integrity of thenetwork[62].

Proof of Stake offers several advantages over Proof of Work. It requires significantly less computational power and energy consumption since block creation is not based on solving complex puzzles.

It allows for faster block confirmation times and higher transaction throughput, making it more scalable. Additionally, PoS reduces the risk of centralization that can occur with PoW, as it does not solely rely on computational power but factors in the stake held by participants [63].

It's important to note that different variations and enhancements of Proof of Stake exist, such as Delegated Proof of Stake (DPoS) and Byzantine Fault Tolerance (BFT) consensus algorithms, which introduce additional features and considerations to the PoS model [22].

2.9.3 Delegated Proof of Stake (DPoS)

Is a consensus mechanism used in blockchain networks to achieve consensus and validate transactions. It is a variation of the Proof of Stake (PoS) consensus mechanism that introduces the concept of delegates who are elected by coin holders to validate transactions and create new blocks. DPoS aims to provide faster block confirmation times, higher transaction throughput, and scalability [61].

In a DPoS system, coin holders in the network vote to elect a set number of delegates or witnesses who will be responsible for block validation. The number of delegates can vary depending on the blockchain

implementation[63].

Delegates take turns producing blocks on behalf of the network. The order of block production is determined either by a fixed rotation schedule or a dynamic mechanism based on voting weight. Delegates with more votes or stake generally have a higher chance of being selected to produce blocks [64].

Once a delegate is chosen to produce a block, they are responsible for validating transactions and creating a new block. This process involves verifying the authenticity and integrity of transactions and appending them to the blockchain. The delegate signs the block with their cryptographic signature to indicate their validation [62].

After a block is produced, it is broadcasted to the network for validation by other delegates and nodes. Consensus is achieved when a sufficient number of delegates (often a two-thirds majority) validate and agree on the block's validity. Once a block is confirmed, it is added to the blockchain and becomes a part of the immutable transaction history. Delegates who successfully validate and produce blocks are rewarded with transaction fees and sometimes newly created cryptocurrency units. The reward system encourages delegates to perform their duties honestly and maintain the security and stability of the network[63].

In DPoS, coin holders have the power to elect delegates and influence the consensus process through their voting weight. The voting weight is determined by the number of coins held or staked by each coin holder. This gives coin holders a level of governance control over the network[64].

DPoS consensus offers benefits such as fast block confirmation times, high transaction throughput, and scalability. It reduces the computational and energy requirements compared to Proof of Work (PoW) consensus. It's

important to note that different implementations of DPoS may have variations in their specific mechanisms, such as the number of delegates, voting rules, or block confirmation protocols.

2.10 Blockchain Layers

Blockchain can be conceptualized as a multi-layered technology stack, consisting of different layers that work together to enable its functionality. The blockchain layers can vary depending on the specific blockchain implementation, but here are the common layers typically associated with blockchain technology:

2.10.1 Application Layer

The topmost layer is the application layer, which represents the user-facing aspect of the blockchain [65]. It includes the decentralized applications (dApps) and smart contracts that leverage the underlying blockchain infrastructure to provide various services and functionalities.This layer is where users interact with the blockchain and performtransactions or execute smart contract logic. dApps can encompass a wide range of applications, including financial services, supply chain management, gaming, social media, and more[3].

2.10.2 Consensus Layer

The consensus layer is responsible for establishing agreement among network participants on the validity and order of transactions. It defines the consensus mechanism used by the blockchain, such as Proof of Work (PoW), Proof of Stake (PoS), Practical Byzantine Fault Tolerance (PBFT), or others [66]. The consensus layer ensures that all participants have a consistent view of the blockchain are securely validated and added to the ledger [67].

2.10.3 Network Layer

The network layer handles the communication and connectivity between different nodes in the blockchain network. It facilitates the transmission of data and messages related to transactions, blocks, and other network activities [66]. This layer can utilize peer-to-peer networking protocols, to enable decentralized communication and ensure that information is propagated across the network [68].

2.10.4 Protocol Layer

The protocol layer defines the underlying rules, protocols, and standards that govern the operation of the blockchain network. It includes the blockchain protocol itself, specifying how blocks are structured, how transactions are validated, and how consensus is achieved. This layer encompasses the low-level technical details of the blockchain, including data structures, cryptographic algorithms, and validation mechanisms [69].

2.10.5 Data Layer

The data layer stores the actual data that makes up the blockchain. It consists of the distributed ledger, which records all the transactions and relevant information in a chronological and immutable manner. The data layer may include various data structures, such as the Merkletree, which organizes transaction data efficiently and enables efficient verification and retrieval of information [70].

2.10.6 Cryptographic Layer

The cryptographic layer is responsible for ensuring the security and integrity of the blockchain. It utilizes cryptographic algorithms to provide various security features, including digital signatures, hash functions, encryption, and key management. Cryptography plays a vital role

in securing transactions, validating blocks, and protecting the privacy of participants in the blockchain network [3].

It's important to note that these layers are interconnected and rely on each other to form a complete blockchain system. Each layer serves a specific purpose and contributes to the overall functionality, security, and efficiency of the blockchain technology. Different blockchain platforms may have variations in the specific layers and theirfunctionalities, but the overall concept of layering remains consistent across various blockchain implementations. Figure 2.4 shows the layers of the blockchain.

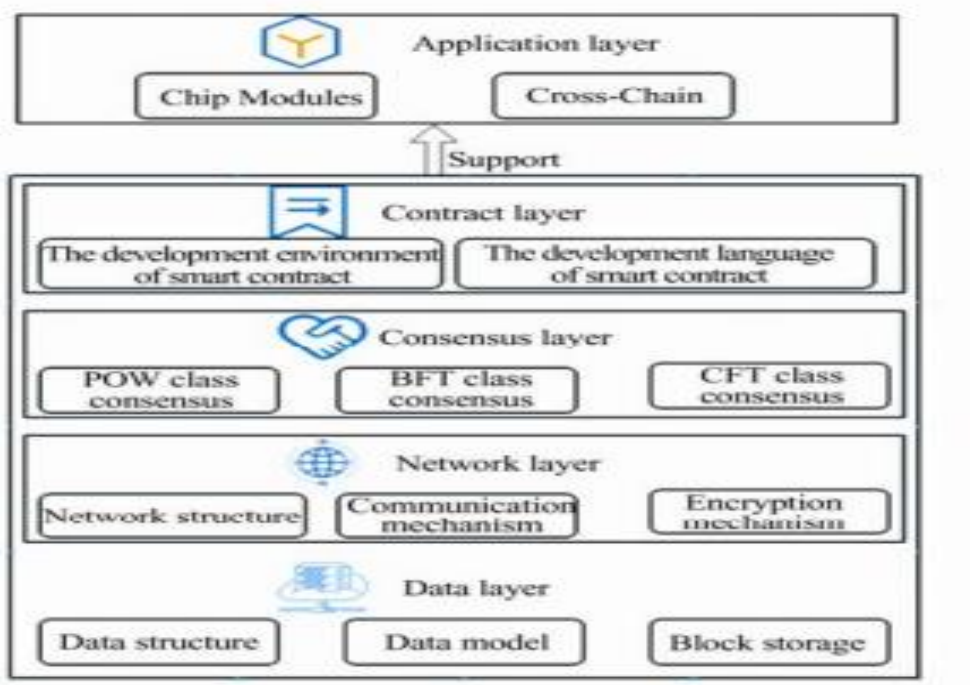

Figure 2 .4 Blockchain Layers [3]

2.11 Parallel Processing

Parallel processing is a technique that enables the execution of multiple tasks simultaneously, thereby improving system performance and productivity. In the context of blockchain technology, parallel processing can play a crucial role in enhancing the network's throughput and scalability[13].The blockchain network consists of numerous nodes that perform several critical functions, including transaction validation and block creation. These processes require considerable computational resources and can result in performance bottlenecks, especially during peak network usage. Parallel processing allows for the distribution of these tasks across multiple processors or nodes, thereby reducing processing times and improving network efficiency[12] , [13].

Moreover, the implementation of parallel processing techniques in the blockchain can increase network security by enabling nodes to process transactions concurrently, reducing the likelihood of transaction backlogs and potential network congestion. However, there are also some challenges associated with parallel processing in the blockchain. One such issue is the complexity of maintaining consensus across multiple processors, which is critical for ensuring the integrity andsecurity of the blockchain network[15]. Despite these challenges, the potential benefits of parallel processing in the blockchain are substantial. By improving network throughput, scalability, and security, parallel processing can contribute to the continued growth and development of blockchain technology, opening up new possibilities for applications in various industries. Faster problem solving is the main motivation behind employing parallel processing.

To compute the ultimate solution to the main problem, a group of processing components must cooperate [71].

There are two types models of parallel computing are (1) shared and (2) distributed models. They are explained in Figure 2.5 below

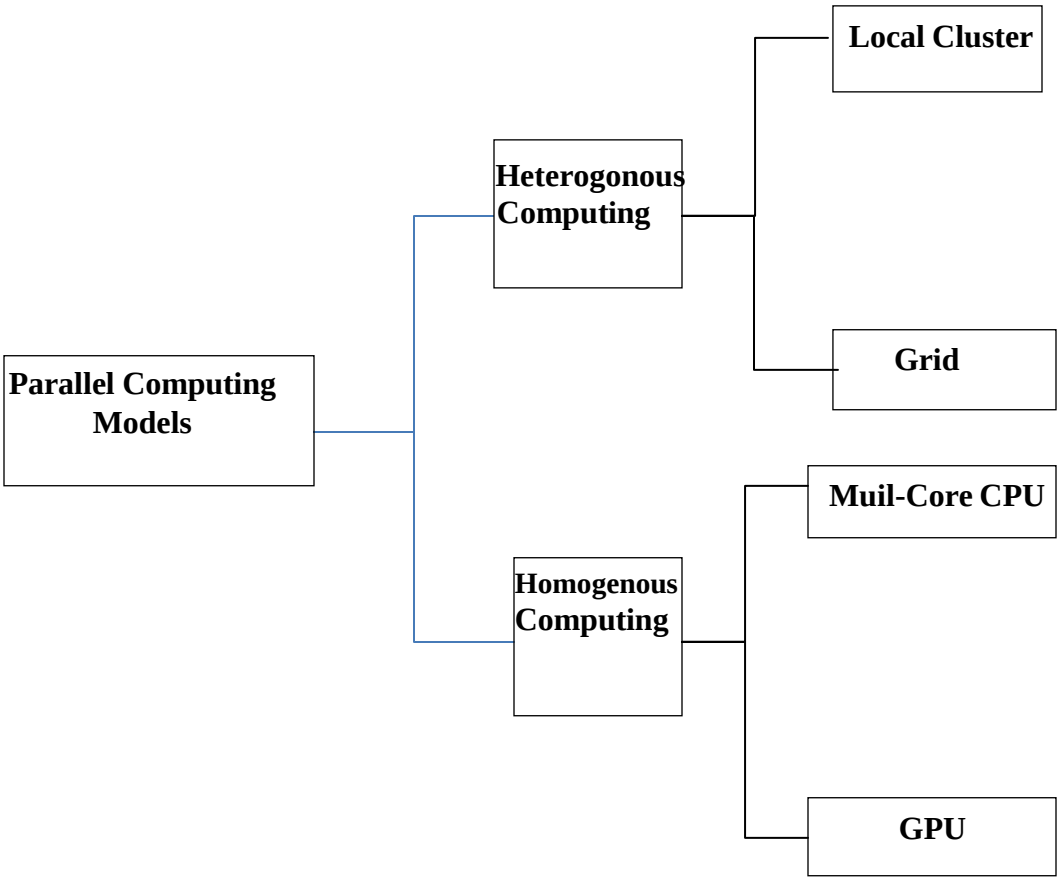

Figure 2.5: The Categorization of Models for Parallel Computing.[71]

The parallel computing architecture comprises both software and hardware resources. The hardware resources encompass three main components: (1) the processing units responsible for executing computations, (2) the memory model that handles data storage andretrieval,

and (3) the network system that facilitates interconnectivity between these processing units. On the other hand, the software resources encompass three key elements: (1) the specific operating system utilized to manage and coordinate tasks, (2) the programming language employed to develop parallel applications, and (3) the compile or runtime libraries that provide essential functions and utilities for parallel program execution [71].

There exist multiple processing elements, each equipped with its own instruction and local data memories. Different processing elements can be utilized simultaneously to execute distinct instructions on separate data fragments. MIMD (Multiple Instruction Multiple Data) machines are categorized into two types: shared memory and distributed message passing architectures. In shared memory machines, processors communicate through a shared memory model, while in distributed message passing machines, each processor possesses its own local memory, and inter communication occurs via a communication networkmodel [72].

2.12 Heterogeneous Processing Units(HEPU)

Heterogeneous processing units are a critical aspect of parallel processing, allowing for the efficient use of multiple processing units with distinct architectures and capabilities to achieve high- performance computing. In parallel processing, multiple processing units work together to perform a single task, which can be either divided into smaller sub-tasks that are processed in parallel or replicatedacross multiple processing units to increase throughput. Heterogeneous processing units are commonly used in parallel processing systems, where different types of processing units are utilized for specific types of computations[15]. In summary, heterogeneous processing units are a critical aspect of parallel processing, allowing for

the efficient use of multiple processing units with distinct architectures and capabilities to achieve high-performance computing. While they present some challenges, the benefits of heterogeneous processing units make them an essential tool for modern computing systems[15] and [16]. Such as GPU or CPU with different specifications.

2.12.1 Local Cluster

A local cluster comprises independent computers interconnected by a high-speed local area network (LAN) with low latency and ample bandwidth. Communication between nodes is accomplished throughmessage passing. A master node oversees the scheduling and management of other nodes within the cluster. Homogeneity is maintained among computing nodes, as they possess identical specifications in terms of computing power and memory. Additionally, all nodes in the cluster operate on the same operating system [72].

2.12.2 Grid (Distributed Clusters)

A grid entails a collection of computing clusters situated at distinct sites and interconnected via a wide area network (WAN). Each cluster within the grid is composed of homogeneous nodes, but nodes across different clusters may exhibit hardware and software variations. These differences encompass factors such as computing power, memorysize, operating system, and network characteristics such as latency and bandwidth. Consequently, heterogeneous computing resources spanning a wide range are concurrently available for utilization by multiple users [71].

2.13 Homogeneous Processing Units(HOPU)

In parallel processing, homogeneous processing units refer to a computing architecture that consists of identical or nearly identical processing units. In such a system, each processing unit has the same instruction set architecture, clock speed, and memory configuration. Homogeneous processing units are commonly used in parallel processing systems, where multiple processing units work together to perform a single task [15]. In these systems, each processing unit is responsible fora specific portion of the computation, and the results are combined to produce the final output. Homogeneous processing units have several advantages, including simplicity of programming and load balancing. However, homogeneous processing units also have limitations, such as limited scalability and a lack of flexibility. While they have some limitations, homogeneous processing units are widely used in many parallel processing applications due to their simplicity and ease of use[15] and [16]. Such as multi-core or CPU with similar specifications.

2.13.1 Multi-core Processor

This refers to a single chip component housing two or more processing units known as cores. Cores are interconnected through a main memory model, and each core has its own cache memory to store data [71].

2.14 Metrics Used

The work includes two experiments. In the first experiment, the processing units are heterogeneous and so differ from one another. The processing units are equivalent in the second experiment. Each experiment consists of three tests, with multiple measures being calculated in each test.

2.14.1 Throughput

A variety of metrics is used to determine the network's effectiveness and performance for the trials and testing we conducted. These metrics include the network's throughput and profit rate as well as the throughput and profit rates of each network node, In addition to speedupof network. The network is beneficial when productivity rises, and detrimental when productivity falls. A rise in the profit rate is a positive sign for the network in this scenario. A declining profit rate is a sign ofa bad network.

The throughput for each network has been calculated by the equation 2.1 [73].

$$\mathbf{THnet} = \frac{X * S}{T} \quad \ldots \qquad (2.1)$$

Where THnet is the Throughput of the network.

X : is The number of total transactions in the network

S: is Transaction Size (assuming the transaction size is 1 KB).

T :is the Highest processing time consumed by the network.

Calculate the node throughput by the equation 2.2.

$$\mathbf{THnode} = \frac{x * S}{t} \quad \ldots \qquad (2.2) .$$

Where THnode is the Throughput of the node.

x : is The number of transactions per node .

S: is Transaction Size (assuming the transaction size is 1 KB).

t : is the Processing Time for each Node.

Calculate the average profit each node by the equation 2.3.

$$\textbf{Pnode} = \frac{\boldsymbol{P}*\text{x}}{\boldsymbol{t}} \ \ldots \qquad (2.3).$$

Pnode is the Profit Average Per Node.

P is the profit of each node (assuming 10 BTC per transaction).

Calculate the average network profit in each test by Equation2. 4.

$$\boldsymbol{Pnet} = \frac{\sum \textbf{Pnode}}{\boldsymbol{N}} \ \ldots \qquad (2.4)$$

Pnet : is average network profit.

N : is the Total number of node in the network.

2.14.2 Speedup

The speedup ratio for both experiments was calculated using Equation 2.5[74].

$$\boldsymbol{Speedup} = \frac{\boldsymbol{Tseq}}{\boldsymbol{Tpar}} . \qquad (2.5)$$

Tseq is time in the case of sequential processing.

Tpar is time in the case of parallel processing.

Chapter Three

The Proposed System

3.1 Introduction

In order to improve the speed of publishing and transaction processing, this study focuses on enhancing the blockchain nodes' consensus mechanism, or PoW. A potential network expansion is also present. The suggested approach is created and initiated in a way that is decentralized (grid of heterogeneous nodes and grid of homogeneous nodes) and safe with the potential for data distribution in parallel.

Conducting two experiments is covered in this chapter; the first involves a network's of nodes with heterogeneous processing units, and the second involves a network of nodes with homogeneous processing units. Both experiments are supported by algorithms for each experiment and the parallel mining algorithm for PoW.

3.2 System Design

The major objective of the suggested approach is to shorten the time it takes for network nodes to reach consensus by addressing the issue of broadcast and Asynchronized transaction delays between blockchain nodes as well as the lengthy PoW mechanism huge mining process. Additionally, to avoid using even additional time and resources when extracting the block. The proposed work can be divided into parts:

- Architecture design of the network involved two experiments heterogeneous nodes and homogeneous nodes (once).
- Broadcast and assign transactions (repeated).
- Proof of work mining (repeated).

Figure (3.1) shows a diagram of the parts of the proposed work.

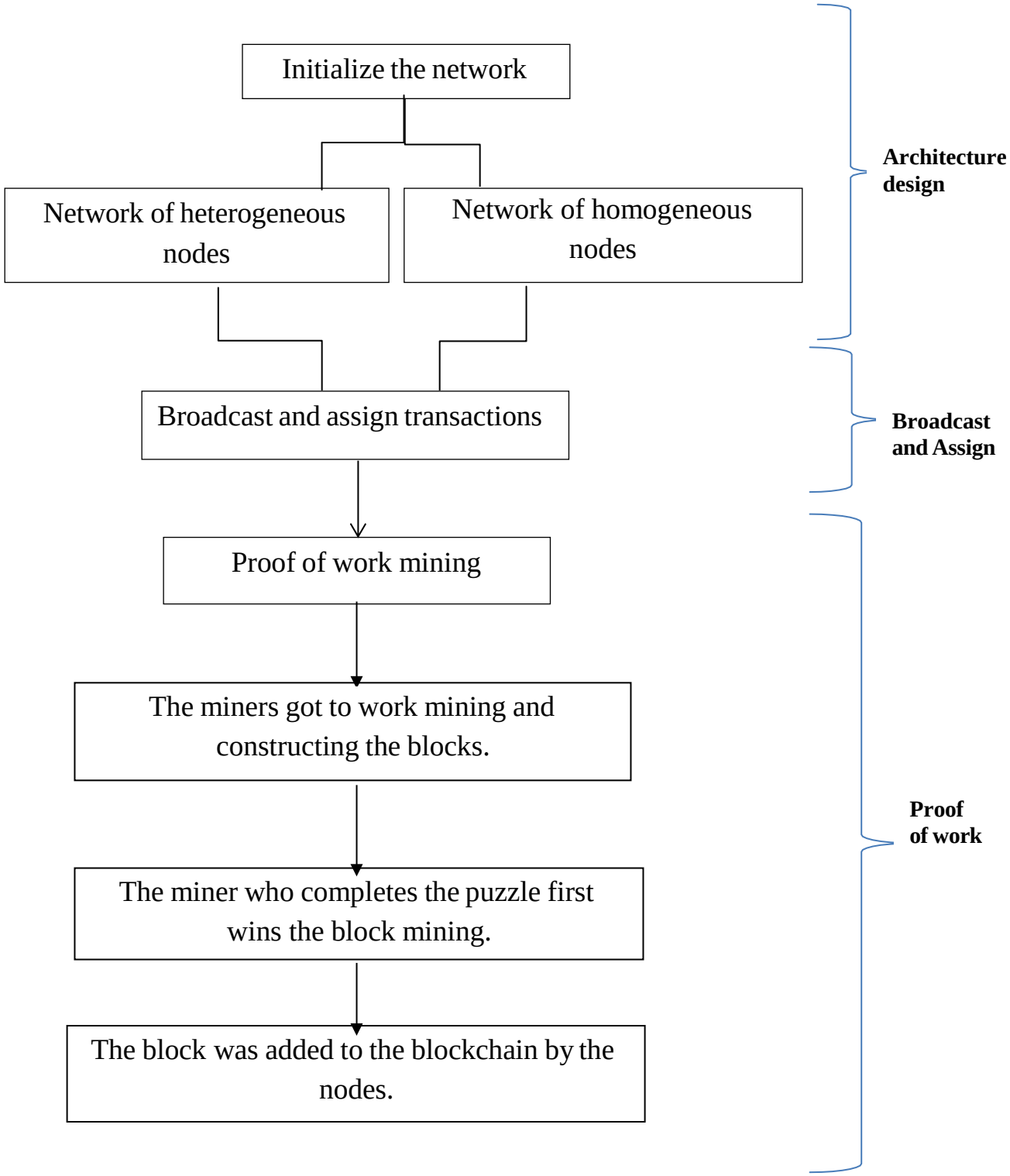

Figure 3.1 The Block Diagram of the Implementing Work.

3.2.1 Initialize the network

The proposed work is designed as follows:

- A fixed group of nodes (servers) spread across different geographies.

The proposed work was conducted on two types of network

- A network of nodes with homogeneous processing units
- A network of nodes with heterogeneous processing units

Mining nodes (miners) whose purpose is to prove the completion of the work required to create a new block for which it will be rewarded with a predetermined fee amount.

Admin node is responsible for receiving requests (transactions) from the users, distributing and broadcasting them to all nodes on the network. All nodes start processing transactions after they are received and the node that finishes first, the result is sent in the form of a blockto all nodes in the network and to the Admin node which in turn gives the solution to the user.

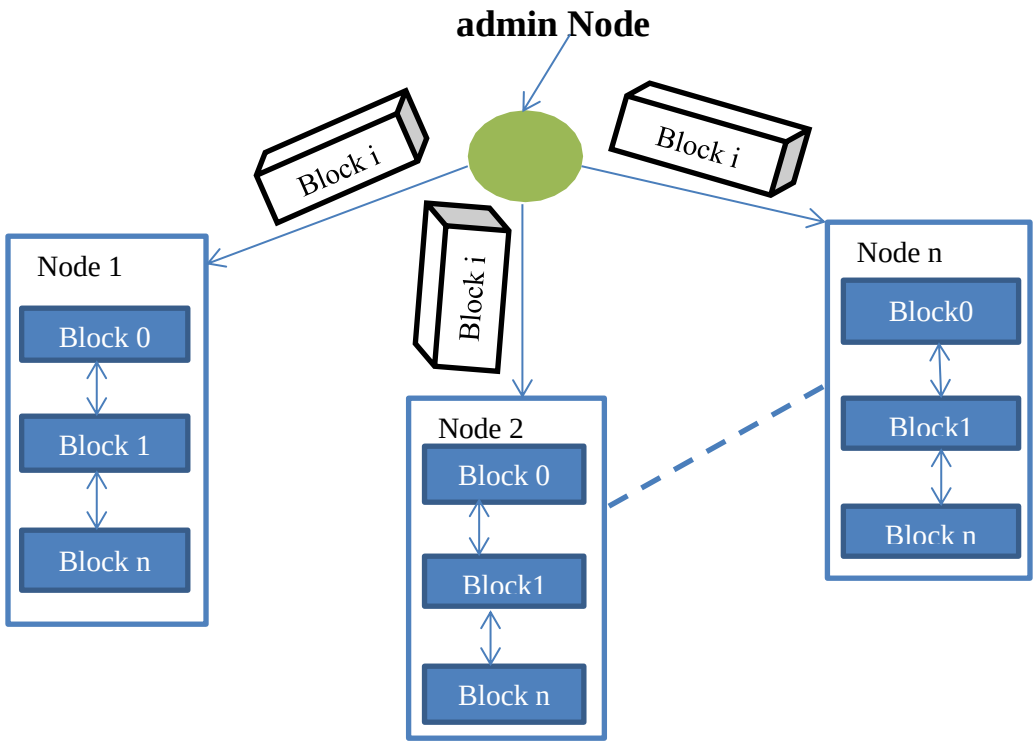

Figure 3.2 Blockchain structure

3.2.2 Broadcast and Assign Transactions

An enhanced solution method has been put out to address some of the issues and increase the effectiveness of broadcasting transactions between the nodes of the blockchain network. One of the most significant issues impeding the development and use of blockchain applications is the issue of broadcasting and delays in blockchain transactions. The broadcast of independent transactions and execution asynchronously within nodes is accomplished in the proposed work using the parallel broadcast technique.

The set of independent transactions is broadcast to the network, where each node receives the transaction. The nodes start by making sure that there are free processing units to assign transactions, so that they start executing transactions. They are executed asynchronously, meaning that each processing unit executes the transaction first packing it into a block and broadcasting it to the rest of the nodes and not waiting for the execution of the rest of the transactions. The miner who completes the puzzle first wins the block mining, the block was added to the blockchain by the nodes.

This study employed two distinct parallel processing methods. The initial method is termed local parallel processing (LPP). In LPP, nodes receive independent transactions on the number of processors at their disposal. Each node autonomously seeks an available processing unit to handle the transaction and commences its execution. These transactions are executed asynchronously within each individual node, with each processing unit initiating the implementation of its respective transaction.

The second form of parallel processing is referred to as Global Parallel Processing (GPP). In GPP, all nodes within the network simultaneously undertake transaction processing. The node that completes its task first then disseminates the result, or block, to the remaining nodes.

3.2.3 Proof of Work Mining

After the transactions have been broadcast to all nodes in the network and the processing units have been assigned to them by these nodes. The first steps of the mining process begin, where mining nodes receive transactions to put into a block.

To implement this process, the proposed work is designed, an improvement of the parallel mining method so that all mining nodes execute

the same block transaction data. This method is repeated for the rest of the transactions in the network.

For the mining node, after the transactions in the block are verified, the competition to mine the block begins, the faster node wins in trying to solve the puzzle, which takes a lot of trial and error to produce a valid PoW as the winner gets to claim the reward, so the node adds Winning the block to the current blockchain. Then it sends the block to the rest of the nodes, in addition to sending it to the admin node responsible for sending the solution to the user. For mining nodes, except for the winning mining node, these nodes are working and after receiving the block to verify the claim and stop mining their block, update the existing blockchain with the new block.

3.3 Sequential Processing

Typically, one transaction is received at a time, and that transaction is then sent to all network nodes. All nodes (miners) start competing with each other to solve this transaction. The faster node collects the result into a block and broadcasts it to other nodes in the network. Then the rewards are collected. The contract returns to work again, and you get a new transaction, which means that every time one transaction is processed in a state where there is a dependency when executing transactions, this is considered the normal state, as shown in the following Figure 3.3

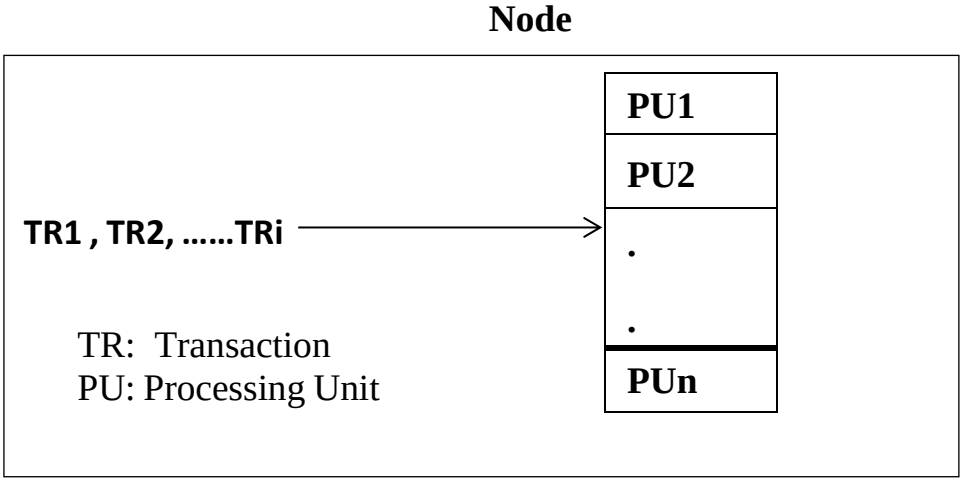

Figure 3.3 Sequential Processing (Dependently Execution)

Computers have often used sequential processing, which executes transactions and actions one at a time.

There won't be much of an effect on the network's throughput and stability if there are few transactions and they are all independent from one another when they are handled sequentially.

But if the transactions are independent ,their number is large and their execution is sequential - there will be a waste of time , energy and resources since the nodes contain processing units that are not fully exploited and benefited from.

The results were tested in the scenario of a single transaction being processed serially and simultaneously in parallel across all networknodes. In the following tests, many transactions were processed simultaneously, and the results were compared in Chapter 4.

3.4 Proposed System

Only one transaction is typically executed at a time Even when an independent transaction exists.

A practical way was suggested to enable the node to process many independent transactions at once, By utilizing all processing units within each node, as each node has multi-core processor, thereby removing the idle state of some processing units within the nodes. the independent transactions is broadcasted, to all network nodes as shown in Figure 3.4. Since the process of performing these transactions is asynchronous inside a single node, there is no dependency between transactions, and the node assigns free processing units to execute these transactions asynchronously. Each transaction is processed separately, and the node that processes transactions more quickly groups them into blocks and broadcasts these blocks to the other nodes in the network as shown in Figure 3.5, and the profits are obtained in the mining process.

The parallelization procedure will be implemented both within and outside the node in the proposed work.

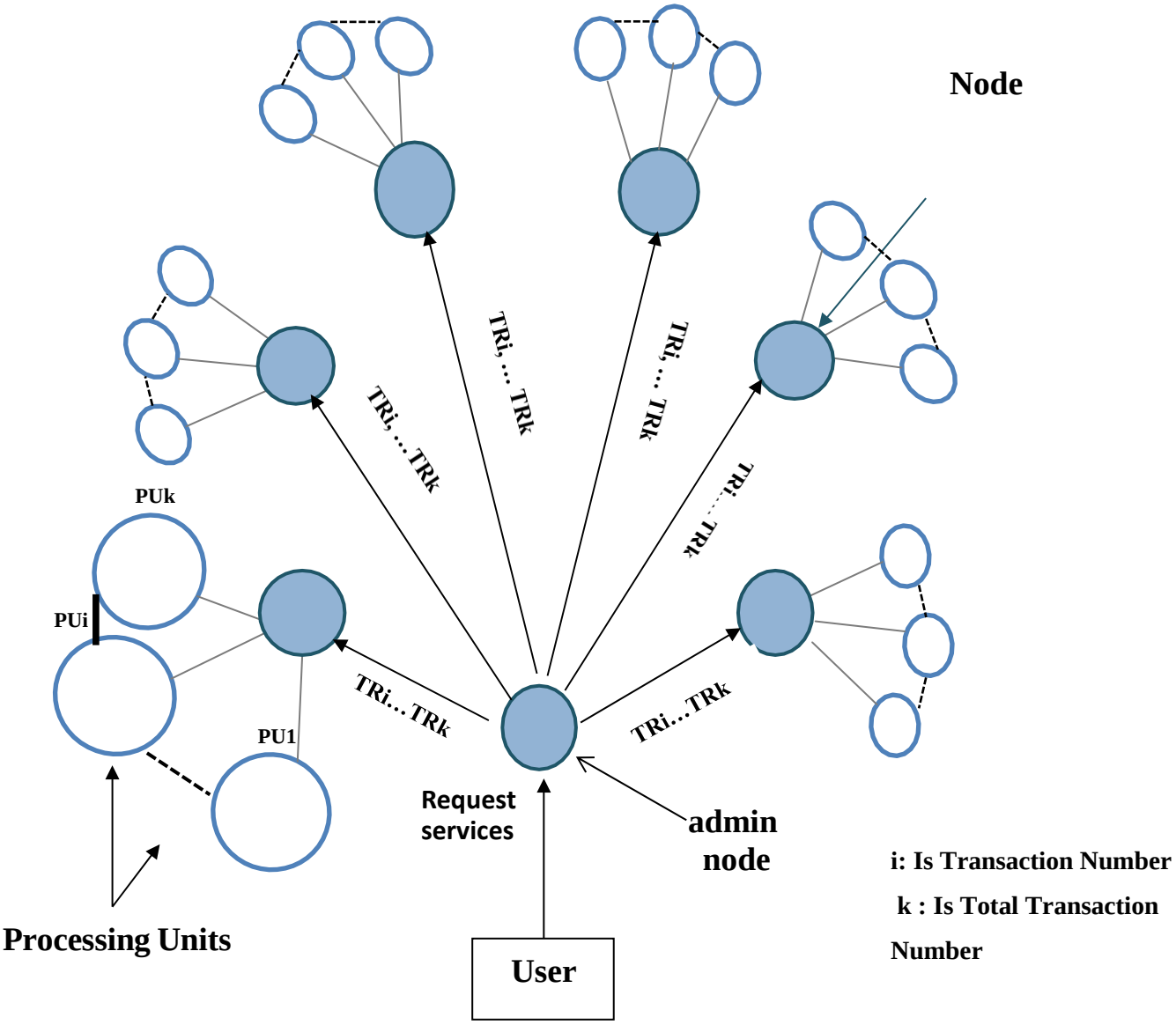

Figure 3. 4 Transaction Broadcasting

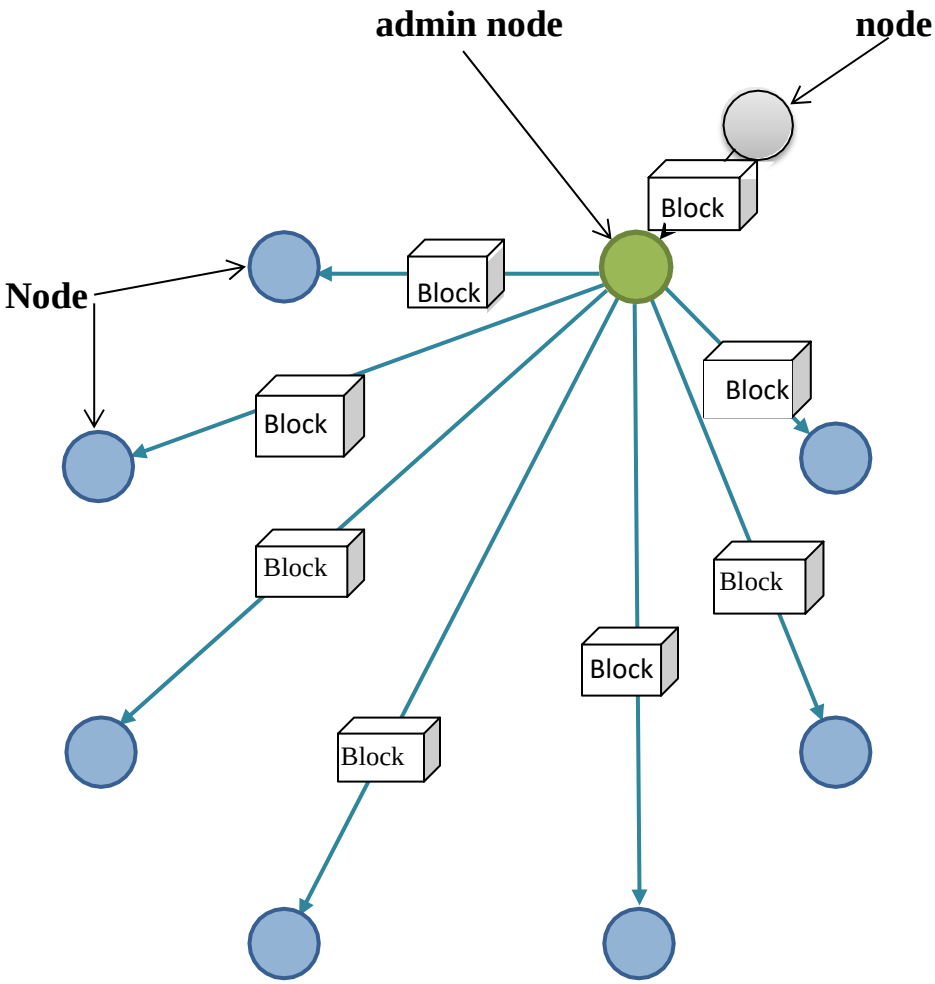

Figure 3.5 Block Broadcasting

Thus, this methodology facilitates parallel and expeditious dissemination of transactions. The general diagram of the suggested method is displayed in the accompanying as shown in Figure 3.5

Several transactions have been entered at first and then published to the network's nodes. Each node then receives transactions according to the number of processing units it has because it allots an independent transaction for each free processor, and the execution of this transaction is asynchronous, which means there is no dependency when processing transactions, so when the transaction is finished, it is placed directly in a block without having to wait for the rest of them. Because every processor is being used, there are never any idle processing units (PUs), which decreases mining time, increases throughput, and promotes system speed and profitability. These processors mine transactions with the use of pow technology, store them in blocks, broadcast them, and add them to.

3.5 The Designed Algorithms

The parallel mining approach enables every node within the network to actively participate in the processing of transactions by distributing them to nodes which are not busy. This is achieved through the utilization of multiple processing units within each node, allowing for the allocation of an empty processing unit upon receipt of a transaction. By doing so, the network is able to effectively utilize all available processing units, leading to improved productivity, reduced processing times, and overall increased network efficiency. Heterogonous Algorithm describes how transactions are distributed to nodes and mapped to heterogeneous processing units. Homogenous Algorithm shows the distribution of coefficients to nodes with homogeneous processing units.

3.5.1 The Heterogonous Algorithm

The first algorithm 3.1 works on a network of nodes with heterogeneous processing units. Transactions are distributed to all nodes in

the network. The nodes receive the transaction, then each node starts looking for a free processing unit with a short processing time (high computational power), assigns it the transaction, and starts the processing process. The faster node puts the result is in a block, the profits are collected, and after the completion of the work, it becomes free to receive a new transaction, and all nodes continue to work untilall transactions are processed.

Algorithm 3.1: Scheduling Algorithm for Heterogonous

Input : Transaction

Output : Block, profit

1- Begin

2- While true do

3- receive ← Transaction

4- Idle ← find free and min-estimated-Time processing unit

5- Assign (Transaction, Idle)

6- Block ← **consens (**Transaction)

7- Profit ← Mining (Block)

8- Free Processing Unit

9- End while

10- End

In general, this algorithm describes a continuous process of receiving transactions, finding available processing units, and assigning transactions to those units, where it performs mining operations onspecific transactions, and then releasing the processing units for the nextiteration.

3.5.2 The Homogenous Algorithm

Algorithm 3.2 shows the distribution of transactions to nodes with homogeneous processing units. The second algorithm runs on a network of nodes with homogeneous processing units. Transactions are distributed to all nodes in the network. The nodes receive the transaction, and then each node starts looking for a free processing unit, allocates the transaction to it, and starts the processing process.

The faster node puts the result into a block, the profits are collected, and after the work is done, it is free to receive a new transaction, and all nodes continue to work until all transactions are processed.

Algorithm 3.2: Scheduling Algorithm for Homogenous

Input: Transaction

Output : Block , profit

1- Begin

2- While true do

3- receive ← Transaction

4- Idle ← find free processing unit

5- Assign (Transaction, Idle)

6- Block ← **consens (**Transaction)

7- Profit ← Mining (Block)

8- Free Processing Unit

9- End while

10- End

This algorithm specifically focuses on homogeneous processing units, implying that the processing units are of the same type and have similar capabilities. The goal is to distribute the coefficients (or associated tasks) among these homogeneous processing units in an efficient manner. The algorithm continuously receives transactions, searches for the processing unit with the minimum estimated processing time, assigns the transactions to the identified idle unit, and repeats this process.

The primary difference between the two the first code It specifically looks for a "free and min-estimated-Time" processing unit (potentially the one with the shortest estimated processing time). the second code It looks for a "free processing unit" without considering the "min-estimated-Time."

This approach can result in optimized task allocation and improved utilization of processing resources.

3.5.3 Pow Algorithm

Algorithm 3.3 provides a graphical representation of the mining process executed by nodes that possess processing units. Prior to commencing transaction processing, the algorithm performs a check to determine whether a free processing unit is present within the node, after which the transaction is assigned them. The assigned processing unit subsequently initiates the mining process.

This Algorithm is repeated of working for all nodes in parallel

Algorithm 3.3: Proof of Work Algorithm

Input: Transaction, Nodes .No, Current_ time, DigitalCoin

Output: profit

1. **Begin**
2. For node ←1 to Nodes. No do
3. If (node. processing_ Unit == free)
4. **Begin**
5. node. processing_ Unit ← busy
6. Start_time =Current_time
7. **For t←1 to Transaction. time**
8. Current_ time ← Current_time+1
9. **EndFor**
10. finish_ time= Current_ time - Start_time
11. profit ← profit + finish_ time * DigitalCoin
12. node. processing_ Unit ← free
13. **End**
14. **EndFor**
15. **End**

The given algorithm represents a Proof of Work (PoW) mining algorithm. the algorithm performs PoW mining by sequentially processing transactions on each node in the system. It checks if a node's processing unit is free, and if so, it simulates the processing time for the transaction, updates the current time, calculates the profit based on the finish time, and marks the processing unit as free again. The process is repeated for all nodes in the system.

It is important to note that the algorithm assumes a fixed processing time for each unit of the transaction and incorporates a coefficient (DigitalCoin) to calculate the profit.

3.6 The Simulator

In the context of blockchain technology, a simulator is a software tool or platform used to model and simulate the behavior of blockchain networks, components, and processes without the need for an actual blockchain network. These simulators provide a controlled environment for testing, analyzing, and experimenting with various aspects of blockchain technology. Simulators are valuable for blockchain development, research, and education.

The provided Java code appears to be related to simulating transactions and a Proof of Work (PoW) consensus algorithm in a blockchain context. Below is an academic explanation of the code's functions:

1. pre( ): This method generates a random dataset of transactions and writes it to a file. It initializes a `Transaction` object for each transaction and populates attributes such as `name`, `arrivalTime`, `arrivall_orgin`, `reward`, and `consenPOW` with random values. These transactions are then serialized and written to a file for later use.

2. preHomo( ): Similar to `pre()`, this method generates a dataset of transactions, but it sets the `consenPOW` attribute of all transactions to a fixed value of 240. This appears to simulate a homogeneous network configuration where all transactions have the same PoW requirements.

3. intialization( ): This method reads the serialized transactions from the file and initializes the `ConsensusAlgorithmsTesting.tr` array with these

transactions. It also initializes an array of `Node` objects to represent network nodes. The details of `Node` are not provided in the code snippet.

4. printListTransaction( ): This method prints the details of each transaction, including its name, arrival time, arrival origin, and the consensus PoW requirements for each node in the network. It provides a visual representation of the dataset.

5. powRand( ): This method simulates the consensus process using PoW for a random dataset. It iterates through the transactions and assigns them to available nodes for processing based on the PoW requirements. Transactions are processed if a free node is available; otherwise, their arrival time is incremented.

6. powHomo( ): This method simulates the consensus process using PoW for a homogeneous dataset where all transactions have the same PoW requirements. It assigns transactions to nodes based on availability without considering PoW differences since they are all the same.

7. consusPOW(): This method is responsible for assigning a transaction to a processing node. It sets the processing node as "busy," specifies the working transaction, and calculates the time when the processing unit will be free based on the transaction's PoW requirements.

The code is a simulation of a blockchain network with varying PoW requirements and the processing of transactions based on PoW. The indicate that it is designed for testing different consensus algorithms in a controlled environment.

Chapter Four

Results and Discussion

4.1 Introduction

In this Chapter the outcomes of the suggested technique are covered. After applying the suggested approaches, some experimental findings were attained. The effectiveness of the suggested technique is examined in this section using simulations. two experiments were conducted, Each experiment tests four metrics to measure the robustness of the proposed method: throughput for the network (THnet), throughput for the node (THnode), average profit per node (Pnode), average network profit (Pnet) and speedup for the network.

The data includes 500 transactions, all transactions has similar size. The profit is 10 bitcoin each transaction, number of node is 10 execution times are randomly computed between(200-240 sec)per transaction in the first experiment, (240 sec) per transaction in the second experiment. The main purpose of the proposed method is to increase network productivity, reduce execution time, and increase profits for nodes .

Table 4.1 Simulation Environment Characteristics

Processor Type	**Intel(R) Core(TM) i5-5300U CPU @ 2.30GHz 2.30**
GHz Installed RAM	**8.00 GB (7.89 GB usable)**
System Type	**64-bit operating system, x64-based processor, Windows10.**
Programming Language	**Java NetBeans IDE 8.0.2.**

4.2 Data Set

Through parallel mining, this study accelerates the Proof-of-Work (PoW) consensus mechanism by providing virtual random data for network simulation. where a homogeneous contract and another heterogeneous contract were utilized as two different sorts of nodes. A dataset consist of 10 nodes and 500 transactions was utilized to evaluate the performance of a work method that utilized parallel processing. The proposed method distributes transactions among the available processing units in each node, allowing for all processing units to be utilized efficiently. This approach was employed to enhance the overall productivity of the blockchain network, reduce processing times, and increase network efficiency. The findings of the study provide valuable insights into the benefits of using parallel processing in blockchaintechnology.

Table 4.2 Summary of the Data Set

Experiments	Number of Nodes	Number of Transactions	Size Transaction	Time of pow consensus	profit
Experiment1 (Hetro)	10	500	1 KB $8*2^{10}=8192$	200-240	10 Bitcoin/s
Experiment2 (Homo)	10	500	1 KB $8*2^{10}=8192$	240	10 Bitcoin/s

4.3 Experimental Results

Two experiments were conducted, wherein the first experiment involved a network consisting of nodes with non-uniform processing units of varying computational power, while the second experiment involved a network comprising nodes with identical processing units of equal computational power.

4.3.1 Heterogeneous Network (Scenario 1)

This subsection describes the first experiment with several tests. Let us explain the two experiments thoroughly. The experiment conducted in this study involves three test scenarios in which the arrival time of transactions in the network is zero, meaning that all transactions exist simultaneously. The test is conducted sequentially on nodes with one processing unit, two processing units, and three processing units. These processing units are heterogeneous in nature. The productivity and profit ratios of each node are calculated for each test, and a comparison is made among them. The corresponding results and analyses are presented in Figures 4.1 and 4.2.

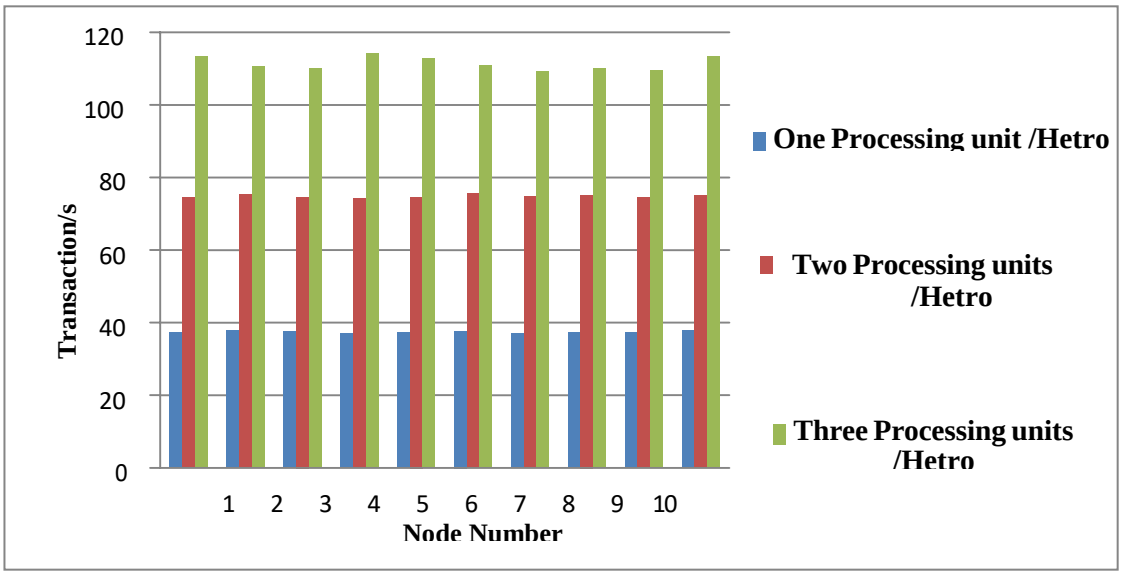

Figure 4.1 Node Throughput – Heterogeneous

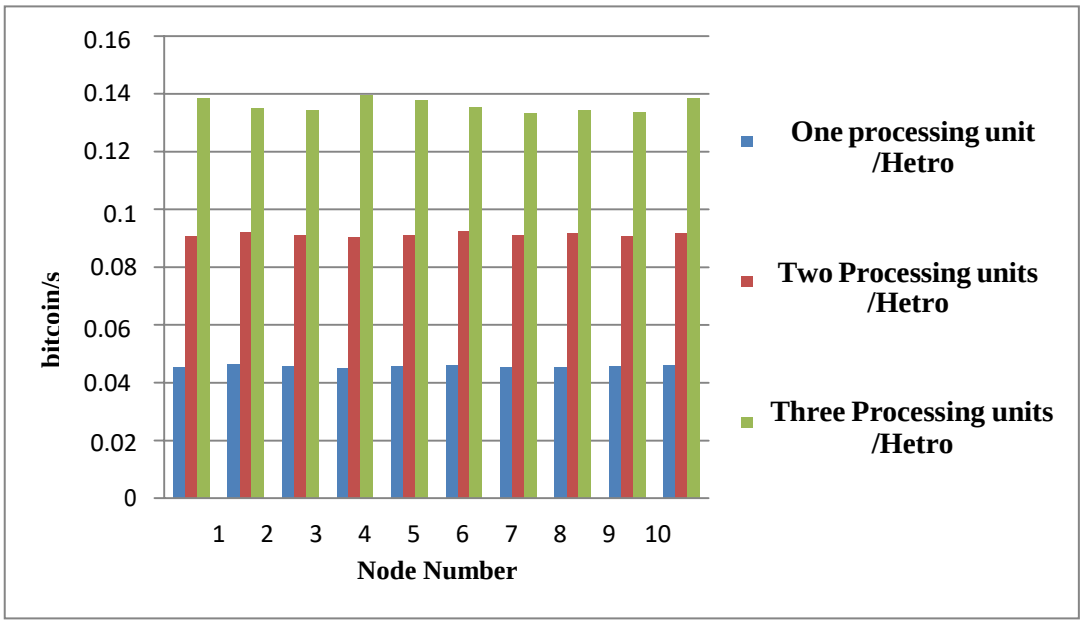

Figure 4.2. AV. Profit Per Node – Heterogeneous

Through Figure 4.1, it is clear that as the number of processors rises, each node's productivity rises as well. The productivity varies from time to time depending on the activity and efficiency of each node. Additionally, as the node's productivity rises, the percentage of profits also rises, as shown in Figure 4.2. The node1 has the highest throughput when there is just one processing unit. Its productivity value was 37.960 compared to the other nodes, and because its profit percentage was higher than that of the other nodes, its profits were (0.046 bitcoin/s). In contrast, the slower node, node3, had a productivity value of (36.911 tps) and a profit percentage of (0.045 bps). In the case of two processing units, node5 has the highest productivity and profits, as its productivity was(75.655 tps) and its profit percentage was (0.092 bps), and the lowest node is node3, whose productivity value is (74.041 tps) and its profit rate is(0.090 bps). It is noted that in both cases,

the node3 node is the least productive and profitable. In the third case, which has three processing units, node3 is the most efficient node and has the highest productivity and profit rate; its productivity was (114.275 tps) and its profit rate was (0.139 bps), and the lowest node in this case is node 6, with a productivity of (109.256 tps) and a profit rate of (0.133 bps). This leads us to the conclusion that the number of processors per node, along with their effectiveness and computing capability, determines the increase in the nodes' productivity and revenues, as shown in Figures 4.1 and 4.2. thereby boosting network throughput. The results of comparing the network throughput of the various processing units are depicted in Figure 4.3. It is observed that, as the number of processing units rises, network productivity does as well.

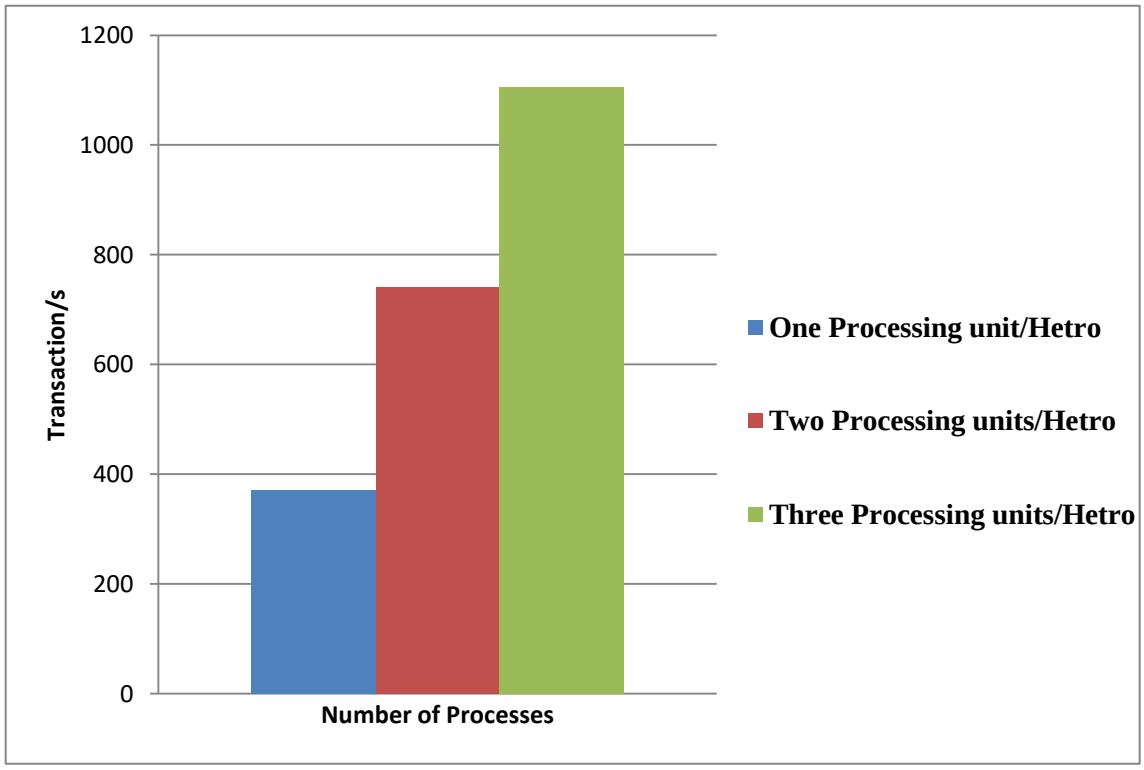

Figure 4.3. Heterogeneous Network Throughput

4.3.2 Homogeneous Network (Scenario 2)

This sub-section discusses the second experiment of the proposed method. The study conducted the following tests on the network:

The second test involved zero transaction arrival time. The experiment conducted involved three test scenarios but used homogeneous node processors. The outcome of the test was similar to the first test, with the three processing unit nodes outperforming the two processing unit and one processing unit nodes. Figure 4.4. demonstrates that the throughput of a node possessing three processing units is greater than that of a node comprising two processing units, and a node outperforms a node with one processing unit per node. This observation is also evident in the profit ratio, as illustrated in Figure 4.5.

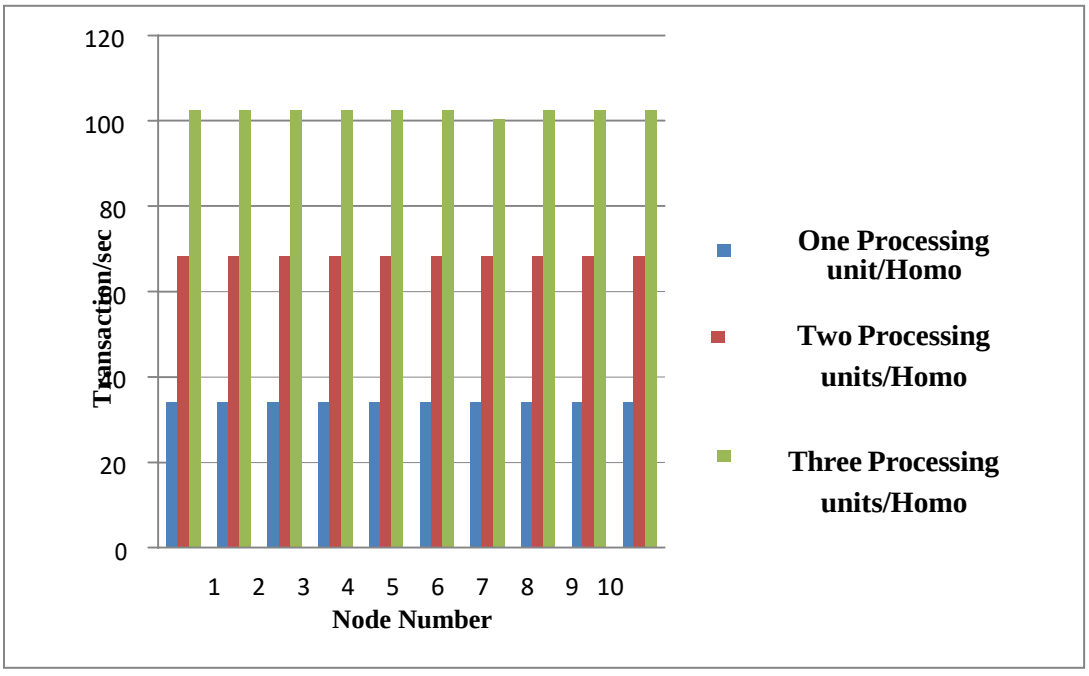

Figure 4.4. Node Throughput- Homogeneous

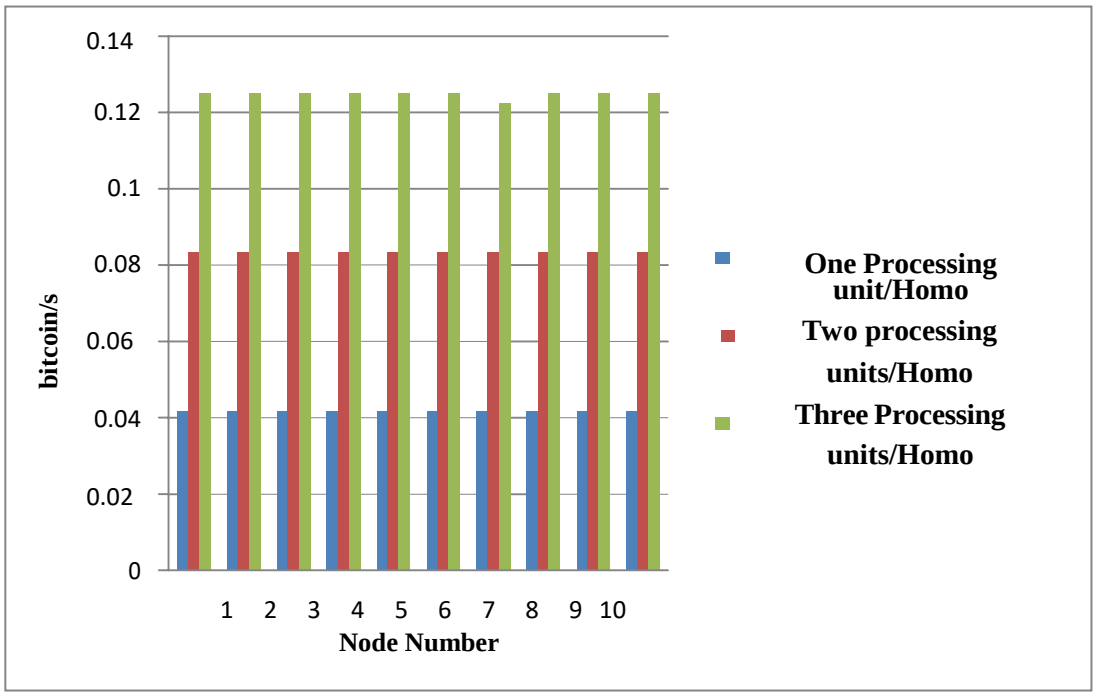

Figure 4.5. Node Av. Prof – Homogeneous

According to the aforementioned findings, the productivity of nodes among them is equal: the productivity of nodes with one processing unit is (34.133 tps), the productivity of nodes with two processing units is (68.266 tps) , and the productivity of nodes with three processing units is (102.4 tps). This means that productivity doubles with each increase in processing unit count. The same is the case with regard to profits, as they increase with the increase in network productivity. In the case of one processing unit, the percentage of profits was (0.041 bps); in the case of two processors, the percentage became (0.083 bps); and in the case of three processors, it was (0.125 bps). The above results show that in both experiments, the number of processors affected productivity andprofits in addition to the computational capacity of the processors.

Thus, the throughput of the network is higher in the case of three processing units compared to the throughput of the network that

has nodes that have two processing units and nodes that have oneprocessing unit, as shown in Figure 4.6.

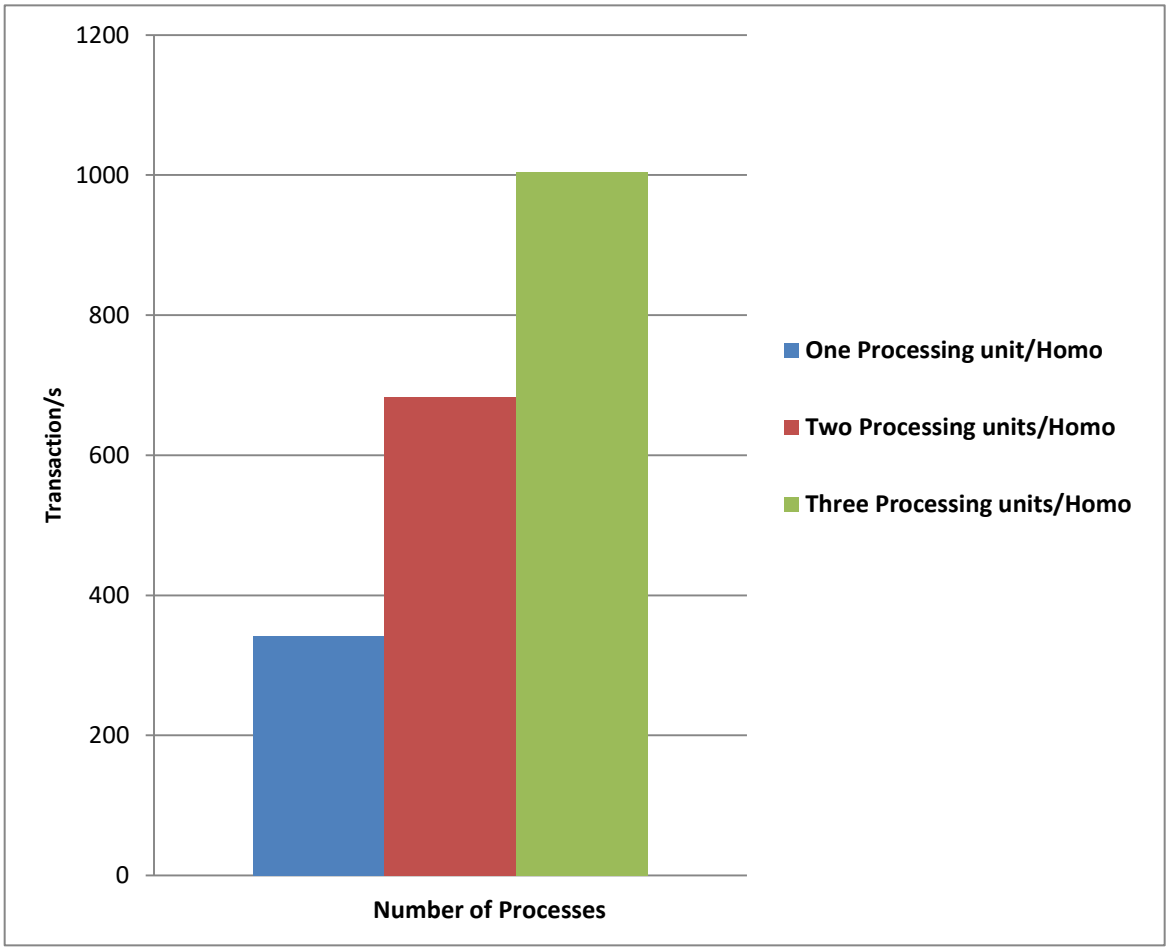

Figure 4.6 Homogeneous Network Throughput

Upon conducting individual tests on each trial and obtaining the initial findings, a comparative analysis was performed to determine the superior experiment. Specifically, the network throughput of both experiments was evaluated for one, two, and three processing units to ascertain the optimal experiment in terms of throughput. The outcomes, illustrated in Figure 4.7, were then acquired and examined.

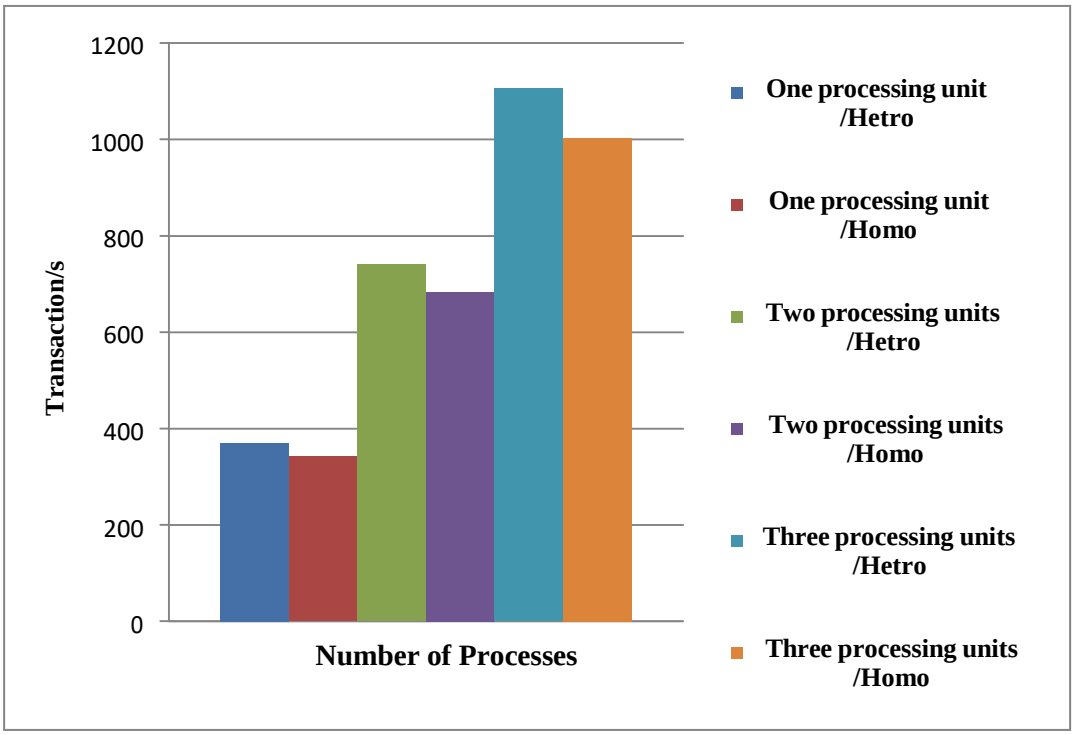

Figure 4.7. Network Throughput / Hetro-Homo

As the results indicate that the heterogeneous network surpasses the homogeneous network. As illustrated in Figure 4.7, when comparing the productivity of both experiments with one processing unit, theheterogeneous network exhibited a higher productivity level (370.846 tps) compared to the homogeneous network (341.333 tps), with a difference of (29.513 tps). Furthermore, two processing units are compared for both the heterogeneous and homogeneous networks, revealing a higher productivity level of (740.419 tps) for the heterogeneous network in contrast to (682.666 tps) for the homogeneous network, with a difference of (57.753 tps). thecomparison of three processing units, with the heterogeneous network demonstrating a productivity level of (1105.533 tps) and the homogeneous network exhibiting a level of (1003.921 tps), resulting in a difference of (101.612 tps).

Based on these findings, it is evident that the first experiment is superiorto the second in terms of network productivity.

Subsequently, the productivity rate of each node was computed for three scenarios, namely one processing unit, two processing units, and three processing units, for both experiments. The outcomes for each scenario were then compared with their respective outcomes from the other experiment. Specifically, the productivity rate of nodes was evaluated in the context of one processing unit for both the homogeneous and heterogeneous networks to determine the superior network. Additionally, the same analysis was conducted for two processing units and three processing units. The results of this analysis are presented in Figures 4.8 and 4.9.

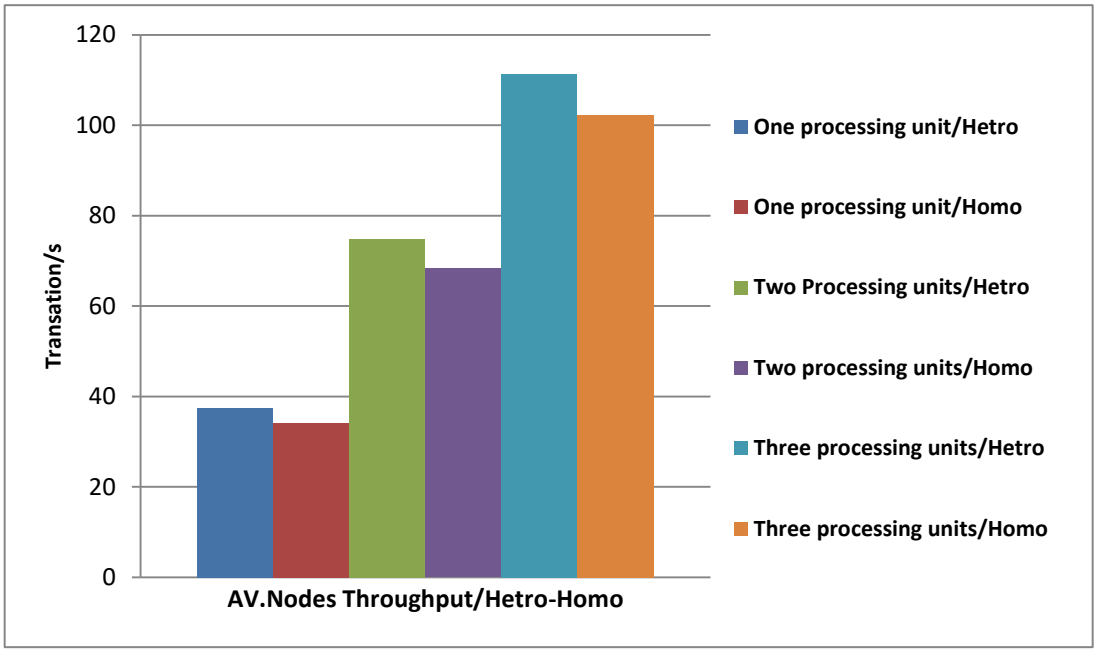

Figure 4.8 AV. Nodes Throughput/Hetro-Homo

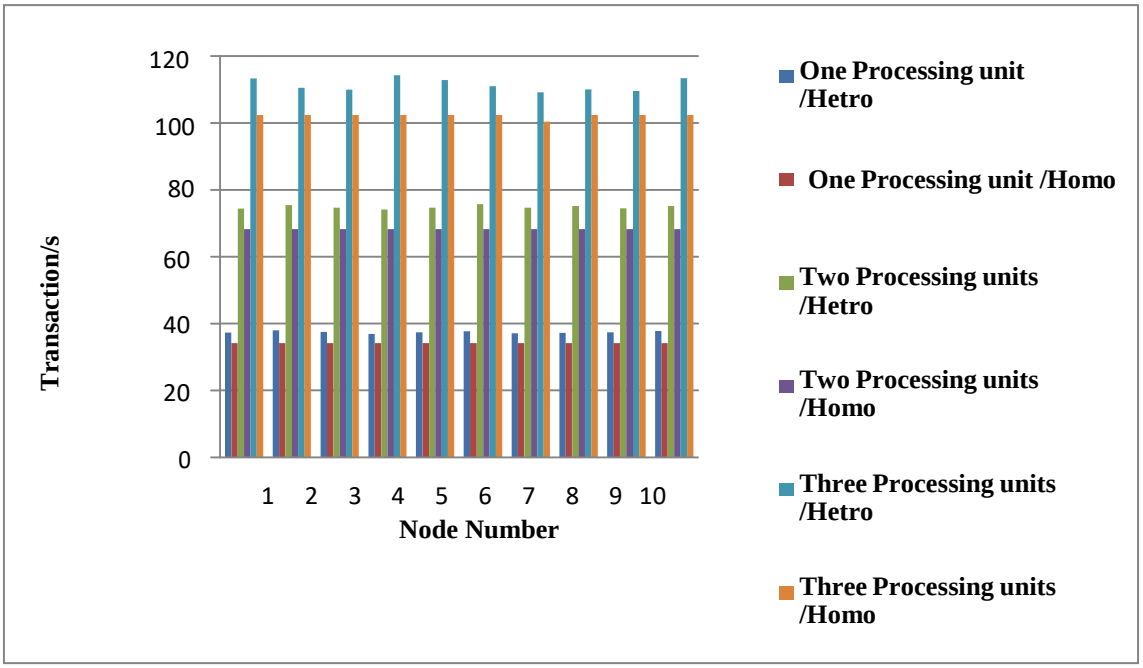

Figure 4.9 Throughput Per Node/Hetro-Homo

The above results demonstrate that the productivity of nodes in the heterogeneous network surpasses that of the homogeneous network. Figure 4.8 illustrates that the heterogeneous network outperformed the homogeneous network in the case of one processing unit. Specifically, the productivity of the heterogeneous nodes was (37.429 tps), while that of the homogeneous nodes was (34.133 tps), yielding a difference of (3.296 tps). Similar results were observed in the case of two processing units, where the average productivity of the heterogeneous nodes was (74.807 tps), compared to (68.266 tps) for the homogeneous nodes, resulting in a difference of (6.541 tps). Moreover, the productivity of the heterogeneous nodes was (111.435 tps), while that of the homogeneous nodes was (102.199 tps), resulting in a difference of (9.236 tps) in the case of three processing units. In conclusion, the analysis demonstrates that the productivity of nodes in the heterogeneous network is superior to that of the homogeneous network.

Next, we conducted a comparison of the profit rates for each node in both experiments, and Figure 4.10 illustrates that the heterogeneous node experiment had a higher profit rate compared to the homogeneous node experiment.

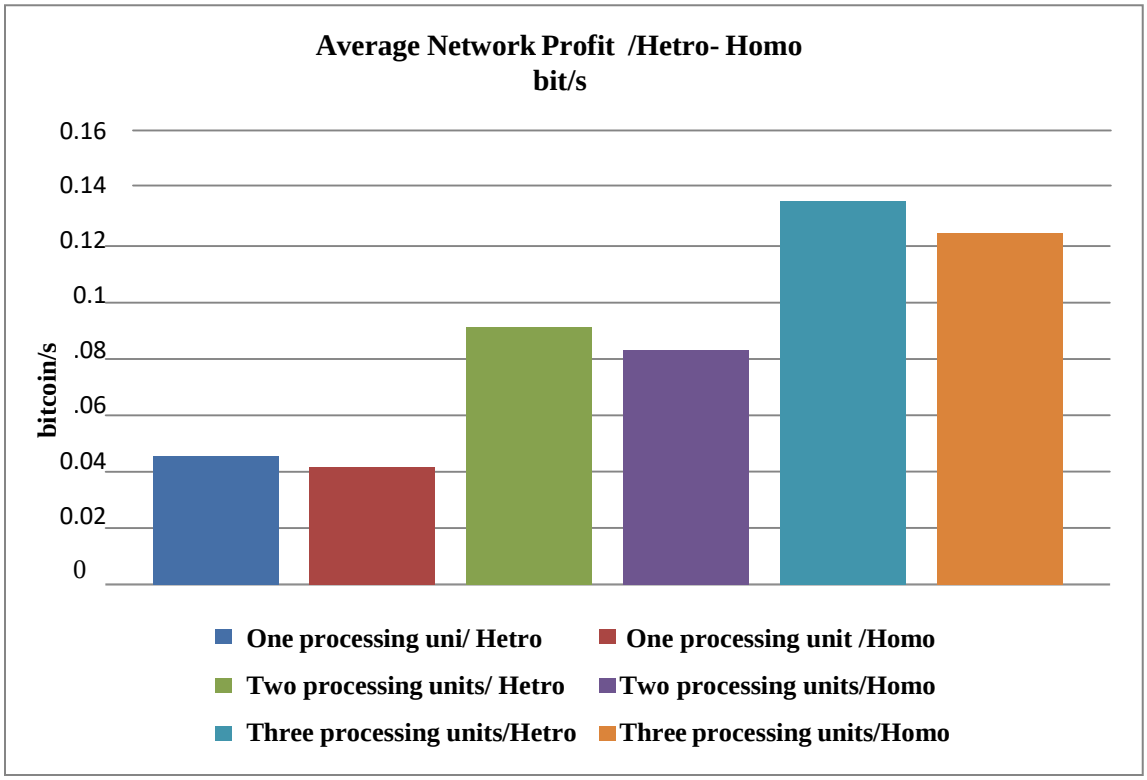

Figure 4.10 Average Network Profit /Hetro- Homo

The speedup was calculated for both experiments to ensure the efficiency of the proposed method, as shown in the following Figures 4.11 and 4.12 in the case of the first experiment (Heterogeneous).

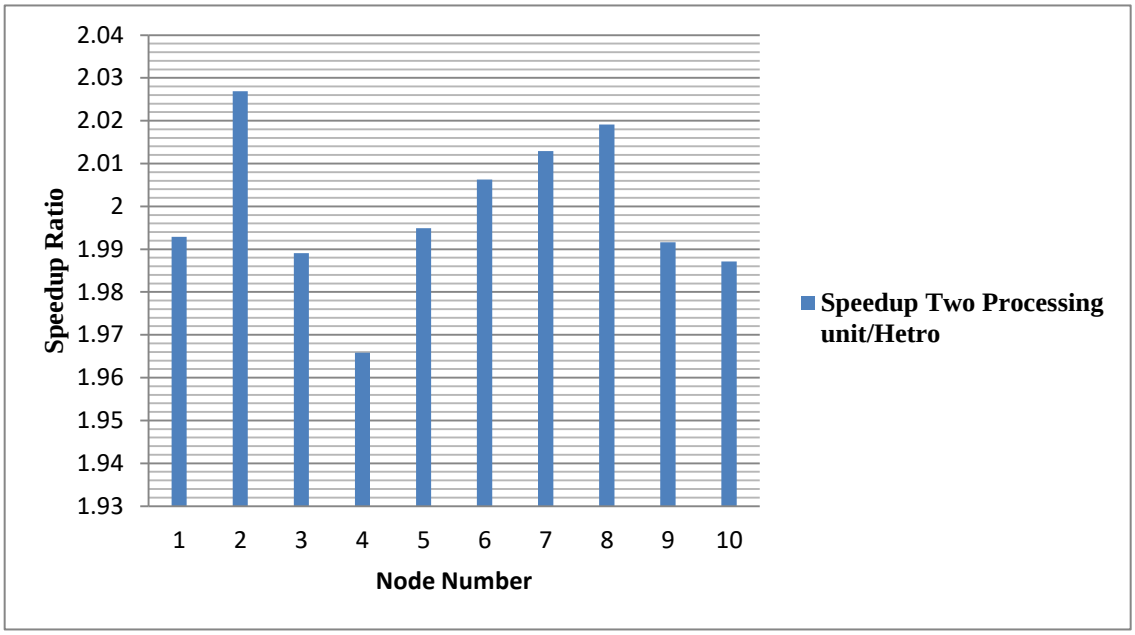

Figure 4.11 Speedup Two Processing Units/Hetro

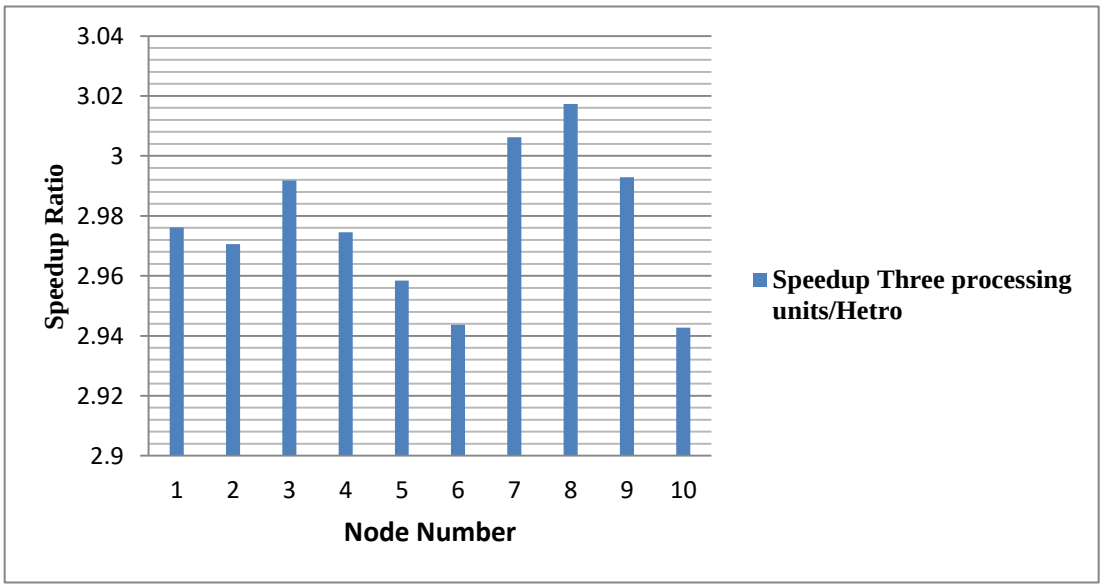

Figure 4.12 Speedup Three Processing Units/Hetro

The speedup was calculated for the second experiment (homogeneous) to ensure its efficiency and as shown in the following Figures 4.13 and 4.14

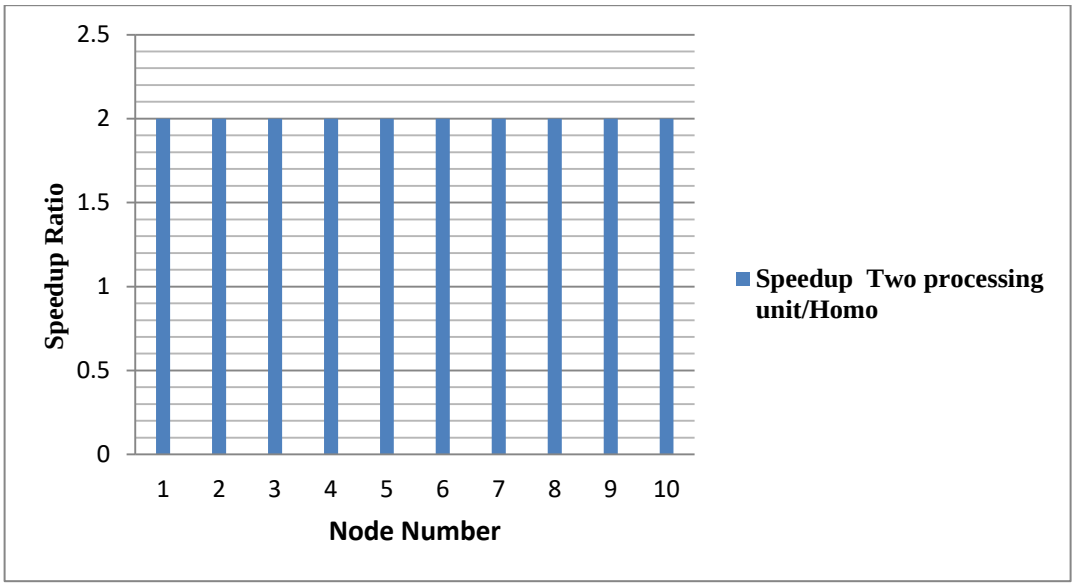

Figure 4.13 Speedup Two Processing Units/Homo

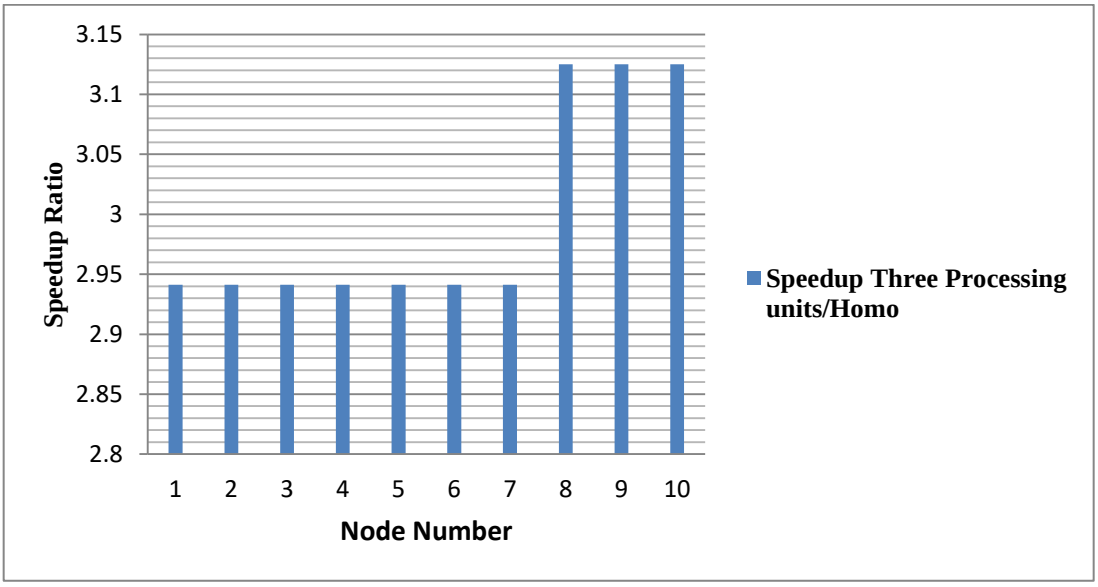

Figure 4.14 Speedup Three Processing Units/Homo

In the second experiment, we notice the case of three processing units working in each node. The result is not the same in all nodes because of the odd number of processing units. When dividing the number of transactions (500 transactions) by the number of units (3 processing units), there are some units that take fewer transactions(load unbalance). The same is the case when the network speed was calculated.

4.4 Analysis

In this chapter, the effectiveness of the suggested strategy as it applied to block mining operations is evaluated.

Through the experiments and tests conducted, where multiple metrics were calculated for each test, including the network's throughput and profit rate as well as the productivity and profit rate of each node in the network for the two experiments, it was discovered that, in addition to the node's computational capacity, the greater the number of processingunits within the node, the greater the throughput and profits As a result, the network's performance and efficiency rise. This suggests that a rising productivity level denotes a good network, whereas a falling productivity level denotes a bad network.

The outcomes of the first experiment, in which the network's nodes had different processing capabilities, were then compared to those of the second experiment, in which the network's nodes had the same capabilities. When the nodes in the first trial have one processing unit, two processing units, or three processing units, throughput and the profits rate for the network, as well as the throughput and the profits rateof each node, are all higher in all tests.

According to the aforementioned, the kind and quantity of processing units, in addition to computational capability, have a major impact on the productivity and profitability of the nodes, and thus of the network.

Chapter Five Conclusions and Future Works

5.1 Conclusions

Through this study, the following was obtained:

1. Increasing the number of processing units leads to increase the profits and productivity through the parallel processing (mining) for independenttransactions.

2. The productivity and profits of the heterogeneous network are better than those of the homogeneous network because it has processing units with high computational capabilities.

3. The arrival time affects the calculations. Zero access time was used, which means that all transactions are present. If the time is random, there may be no transactions at times and the processing units remain in a waiting state, and this leads to inaccurate processing time and thus a defect in the throughput calculation.

5.2 Future works

1- when the workload is unbalanced of a heterogeneous network is used, it will be interesting to run a scheduling algorithm to solve this problem.

2- Hybrid Consensus Models: Consider combining multiple consensus mechanisms, in a hybrid approach to balance the load and ensure secure and efficient operation with various processing unit numbers.

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الخـلاصــة

Blockchainهو نظام دفتر الأستاذ الموزع الذي يلغي الوسطاء ويتيح المعاملات الآمنة والمفتوحة والمقاومة للتلاعب. أساسها هو شبكة لا مركزية من أجهزة الكمبيوتر، أو العقد، التي تتعاون للتحقق من صحة المعاملات وتسجيلها في دفتر أستاذ مشترك. تتمتع تقنية Blockchain بالعديد من التطبيقات، بما في ذلك على سبيل المثال لا الحصر، العملات المشفرة وإدارة سلسلة التوريد والعقود الذكية وأنظمة التصويت وإدارة الهوية والرعاية الصحية والخدمات المالية. ومع ذلك، فإن هذه التكنولوجيا لها بعض العيوب، بما في ذلك بطء التحقق من صحة المعاملات والتعدين وانخفاض قابلية التوسع في الشبكة.

تهدف هذه الأطروحة إلى تسريع مشكلة التأخير في آلية تجميع blockchain أثناء تأكيد المعاملة. وهو يقدم محاكاة للشبكة مصممة لتعزيز كفاءة آلية توافق إثبات العمل (PoW) عبر التعدين الموازي. الهدف هو ضمان الاستخدام الكامل لوحدات المعالجة داخل العقد من خلال معالجة معاملات مستقلة متعددة بشكل متزامن باستخدام وحدات المعالجة المتاحة.

يتضمن العمل المقترح عملية اختيار نوعين من العقد، توزيع العمل وأنظمة المكافآت. تم تنفيذ هذه الطريقة في تجربتين، تحتوي كل منهما على جميع الخصائص اللازمة لأداء إثبات العمل(PoW) ، وتم اختبارها باستخدام مجموعة متنوعة من سيناريوهات الحالات عن طريق تغيير نوع وعدد وحدات المعالجة.

وبعد الانتهاء من التقييمات التجريبية، تم إجراء مقارنة بين نتائج التجربتين. متوسط إنتاجية الشبكة للاختبارات الثلاثة (وحدة معالجة واحدة، وحدتي معالجة، وثلاث وحدات) في التجربة الأولى غير متجانسة على التوالي (370.84، 740.41، tps1105.53). وبلغ معدل الربح لهذه الاختبارات على التوالي (0.045، 0.091، 0.136 bps). وفي التجربة الثانية (المتجانسة) بلغ متوسط إنتاجية الشبكة للاختبارات الثلاثة (341.33، 682.66، 1003.92 tps). وهي (0.0416، 0.083، 0.124 bps) من حيث نسبة معدل الربح على التوالي، وفي المتوسط تكون نسبة التسريع لثلاث عمليات تساوي (2.99).

قدمت هذه النتائج دليلا على فعالية النهج المقترح وأظهرت تفوق التجربة الأولى على الثانية من حيث إنتاجية الشبكة والربحية ونسبة التسريع.

جمهورية العرا ق

وزارة التعليم العالي والبحث العلمي

جامعة بابل – كلية العلوم للبنات

قسم علوم الحاسبات

تنفيذ سلسلة الكتل المتعددة لتعدين الكتل بشكل فعال

رسالة مقدمة الى مجلس كلية العلوم للبنات في جامعة بابل وهي جزء من

متطلبات الحصول على درجة الماجستير في علوم الحاسبات

مقدمة من قبل

رواء مهدي حميد

اشراف

الاستاذ الدكتور

سيف محمود العلاق

2023م **1445 هـ**

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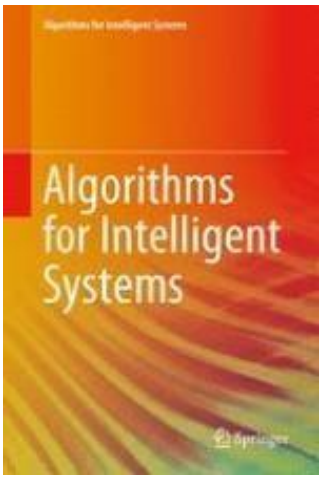

Letter of Acceptance

Paper Title: BlockChain Technology with High Performance Via Parallel Processing

Author (s): Rawaa Mahdi Hameed, and Saif Al-Alak

Congratulations!

Based on the recommendations of the Technical Program Committee of (ICIS _2023), we are pleased to inform you that your manuscript has been Accepted as a REGULAR paper. All Accepted and Registered full papers must be presented at the conference (Hybrid Mode). The proceedings of ICIS 2023 will be published in The Springer series **"Algorithms for Intelligent Systems"** [ISSN: 2524-7573; 2524-7565]. All published Papers in this series are submitted for consideration in the Web of Science (**WOS**).

We will encourage more quality submissions from you and your colleagues in the future**.**

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Survey

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Survey: Using Blockchain Technology in Smart Life Applications

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استخدام تقنية Blockchain في تطبيقات الحياة الذكية

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ABSTRACT

Background:

Blockchain is a database that is stored in chronological order in a secure and stable manner. Bitcoin was the initial application of Blockchain technology, but due to its benefits in terms of security, privacy, and autonomous control, it has been adopted by a variety of industries. Blockchain technology is created by cryptographically connecting blocks together. Because each block contains both its own hash and the one before it, no outsider can break the chain. Blockchain technology is used in a variety of industrial, commercial, security, supply chain, IoT, and others. This is because it has the advantages of controlling, organizing, and storing data. The purpose of this article is to list some of the applications and development areas of Blockchain.

Materials and Methods:

In Blockchain technology, security, stability (immutability), and decentralization are among the important things that make this technology useful in various areas of life that serve the user. These advantages were used to solve many problems facing the network, including those of productivity, processing time, and scalability. Various methods were used in the solution, including working on a change in the network structure, choosing a basic node (the manager), parallel mining, and competing with other miners.

Results:

Through recent studies, it has been shown that the Blockchain technology has been used in various fields, as it is characterized by many advantages, the most important of which are security, decentralization, and stability. Because of these advantages, it outperforms other technologies.

Conclusion:

Due to its advantages, the tendency to use blockchain technology has increased in many fields, including financial, agricultural, commercial, health, the Internet of Things, and others. It includes decentralization, distribution, reliability, and stability. There are other trends that have worked to improve the performance, efficiency, and security of the blockchain system itself, In the Internet of Things, healthcare, supply chain management, the banking sector, and digital marketing In addition to studies that include improving the efficiency, security, and development of the system.

Key words:

Blockchain , Consensus Mechanisms , Security , Performance.

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