IMPROVED NETWORK FRAMEWORK FOR CLOUD MANUFACTURING THROUGH BLOCKCHAIN TECHNOLOGY

R. Yamini[1], S.Karunakaran[2], Sunil Kumar RM[3], Prathiba.L[4], Narender Chinthamu[5], Lakshmi B N[6], P Kiran Kumar[7]

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Abstract

The industrial sector has benefited greatly from modern, developing production methodologies including cloud systems, Internet of Things (IoT) enabled manufacturing, and service-oriented production, which has also transformed the commercial IT infrastructures. Nevertheless, the primary issue with centralized networked systems and 3rd parties trust management continues to plague all current paradigms. In short, the centralized network has experienced problems with privacy, reliability, profitability, and adaptability. To increase the safety and flexibility of Cloud Manufacturing (CM), the major goal of this study is to offer a decentralized peer-to-peer network model. The blockchain technology that the proposed system was built upon made it possible to create a decentralized peer-to-peer network that had high protection, stability, and well-organized cloud infrastructure. The five levels that make up the proposed architecture, known as the Blockchain Cloud Manufacturing (BCM) are the resources level, perception layer, production overlay, network level, and application layer. The idea of its design, safe information sharing, and region characterized are addressed and studied in this study. Additionally, the major components needed to achieve this proposed framework are outlined using an illustrative case study. A case study with 15 end customers, five network operators, and 32 cloud products is used to demonstrate the proposed framework. Utilizing both qualitative and statistical methodologies, the evaluation's findings demonstrate that the proposed approach can benefit CM in ways that go beyond its benefits for safety and sustainability.

Keywords: IoT, Security, cloud manufacturing, Blockchain

[1]Assistant Professor, Department of Computing Technologies, SRM Institute of Science and Technology, Kattankulathur -603203,Tamil Nadu, India,
[2]Associate Professor, Department of ECE, Vardhaman College of Engineering, Shamshabad, Hyderabad - 501218, India,
[3]Assistant Professor, School of Computer Science and Engineering, Presidency University, Bengaluru,Karnataka,India
[4]Associate Professor, MIT Art,Design and Technology University, Pune,Maharashtra, India
[5]MIT (Massachusetts Institute of Technology) CTO Candidate, Enterprise Architect
[6]Assistant Professor, Department of CSE, BMSIT and M Bangalore, Karnataka, India,
[7]Associate Professor Department of CSE, CVR College of Engineering, Ibrahimpatnam, Telangana, India,

Email: [1]yaminir@srmist.edu.in, [2]s.karunakaran@vardhaman.org, [3]sunilkumar.rm@presidencyuniversity.in, [4]prathiba.l@mituniversity.edu.in, [5]narender.chinthamu@gmail.com, [6]lakshmibn@bmsit.in, [7]sun.kindly4u@gmail.com

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1. Introduction

The IoT, cloud computing, and service-oriented architecture were highlighted as the great technical and evolutionary developments that were required for reshaping the worldwide manufacturing facilities in the 20th century [1-2]. A unique kind of industrial base has just been introduced to the manufacturing sector due to CM [3]. Based on the IoT, cloud computing, and service-oriented design, which have given the industrial sector on-demand services, CM is established. As a result, CM is defined as a fresh service-oriented production process that arranges production resources using the web and application platforms [4-5]. Additionally, it provides clients with the products they want. Furthermore, CM may be described as a manufacturing paradigm that makes use of cloud technology and IoT to migrate production resources and competencies into the cloud as services that supply whatever customers and consumers may need. The CM's primary benefit is that it gives its clients on-demand services [6]. Nevertheless, considering the CM's prospective features and benefits, it has a centralized communications system and relies on 3rd parties for management.

It might also be difficult to create a centralized control system where all manufacturing businesses will adhere to a common set of established regulations because the majority of manufacturing sectors each have their projects and business strategies [7]. A revolutionary peer-to-peer network just started developing as a blockchain and integrated into the market. Blockchain technology is a form of a decentralized, online database that can store any sort of content and establish guidelines for how it must be upgraded. It is built up in chunks and connected by a hash [8–9]. The block's information is passed through a cryptographic hash algorithm to create the hash. Any data can be quickly hashed using the perfect cryptographic hash function. Furthermore, it is challenging to determine the inputs using the hash [10]. Furthermore, any modifications to the original information could cause the hash to undergo significant and irrelevant alterations.

2. Related Works

Blockchain is a decentralized, cryptographically blockchain platform with an unchangeable database [11]. The P2P repeating feature of the blockchain network allows for the distribution of a blockchain that is refreshed every time a block of payment is accepted to be confirmed. In the past few years, blockchain technology and distributed ledgers have emerged as significant innovative developments [12]. However, there isn't yet a unified, universally recognized definition of blockchain technology or distributed ledgers. Frequently, they are referred to as "an free software system that provides reliable, irreversible transactions records held in public information, decentralized, networked, autonomous ledgers".

Three distinct kinds of public blockchains occur in terms of privacy and information sharing, and they are as follows: public blockchains, where anybody on the internet may access and submit events, bitcoins, and other digital currencies [13–15]. The collaborative blockchain uses agreement to manage the network's terminals and is partially hidden. The final one is the personal blockchain, which resembles a centralized structure for growing an organization [16]. To utilize this technology across a variety of sectors, some researchers have lately proposed blockchain-based solutions [17].In terms of cloud computing, the decentralized system is an altogether novel idea. The deployment of the P2P computing services offered on the cloud network depends heavily on decentralization in cloud computing [18]. Framework for decentralized cloud industry based on the self-directed work method is made feasible by blockchain technology in this regard, but the technology lacks safety and sustainability due to the proposed architecture's lack of common modeling and standardized communications [19].

Utilizing the existing work on blockchain cloud technology, we created blockchain cloud production, which allows all stakeholders to preserve an ever-evolving database of interconnections that is secure, durable, and impenetrable without the requirement for a centralized authority [20]. Every public cloud keeps a private version of the ledger and the services provided in this arrangement, which does not register services remotely. To connect the block and deliver their services through a public blockchain to end users, every cloud hosting needs a blockchain. Every participant in the blockchain-based cloud manufacturing system broadcasts and logs operations. A blockage is proposed if a different cloud provider requests to upgrade the network [21]. A negotiation method is then used by the network's stakeholders to decide on a single reputable version of these blocks. Whenever a block has been agreed upon by everyone, it is nearly difficult to change or eliminate it.

As a result, several benefits are evident, including adaptability. Blockchain is a P2P network, allowing for the incorporation of numerous connected computers. Privacy is supplied by blockchain, which also offers ledged and sensible contacts for communications [22]. Due to the lack of a centralized structure, fault tolerance ensures that a few networks malfunctioning would not cause the entire system to collapse. Versatility; every cloud manufacturing instance can function

either autonomously or independently [23]. The planned structure is divided into two sections. Initially, the client component is the CM's end-user level. This is only shortly described, as it is not the primary objective of the study [24]. The core network, P2P internet protocol, and cloud manufacturing surface are the 3 primary levels that make up this architecture's major part, the blockchain cloud production.

The actual implementations of cloud systems in business are severely constrained by a few major issues that persist despite the extensive study on the subject. Mention the main problems with cloud manufacturing, including the absence of global security and safety regulations [25]. The trusted problem includes human-to-human, human-to-machine, and machine-to-machine affiliations. The security problem suggests that the operations on the cloud manufacturing system must be protected against cyber security threats, harmful prevarications, and data corruption. Another prerequisite is a convenient payment system that works for global cloud manufacturing. Different currency systems across the globe represent the financial problem, and frequently, financial conversion is severely supervised.

3. Proposed architecture

For such safe and decentralized resource exchange and reliable connection among service providers and customers, we include a structure based on the BC and CM. In Figure 1, the layout is shown. The resource layer, perception layer, manufacturing service provider layer, infrastructure layer, and application layer are the five key components that makeup BCM. The production layer's competencies and actual production resources are both considered to be in the resource layer. The equipment sources and program sources make up the two main categories of this layer's elements. Machines, robotics, and the system for handling materials make up physical hardware. Computational approaches, low-level configuration tools, data collection apps, etc. are all examples of software applications [26]. The capability to complete a performing a particular task or research with the aid of the pertinent production resources and data is reflected in the manufacturing capacity, which is created using equipment, humans, and expertise.

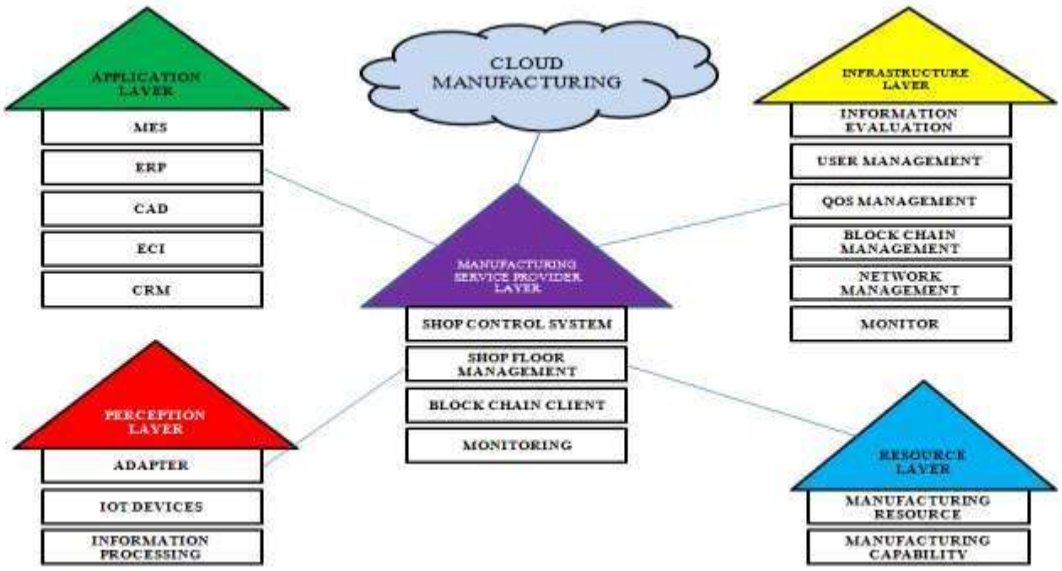

Figure 1: Proposed architecture

In addition to delivering services, the production service provider layer is principally liable for two things: First and foremost, it is in charge of transforming raw to hash format and saving it on the block that is formed. The BCN, which is present in the level below, must be connected, and that is its second duty. The blockchain clients, which connect to the system and keep track of the transaction and blocks, are a crucial part of this system. The primary distinction between CM and BCM is the ability to communicate with various providers of services and end consumers indirectly and through a decentralized system from this level. The blockchain application starts a peer-to-peer connection with some other components in the proposed system, changes the file formats to hash values, and encapsulates hash data to generate a block on the BCN for distribution on the networks. Figure 2 sequential chart demonstrates how all of the parts of the proposed platform are connected for illustrative purposes of this portion. In this diagram, the device threshold sends information to the perceptual layer via IoT, where it is preprocessed and given functionality before being

sent to the middle layer, or MSPL. Using this information, a blockchain customer was created, and a correlation was made between the MSPL's existing network and the cloud provider sending the MSPL's modify facility to the cloud.

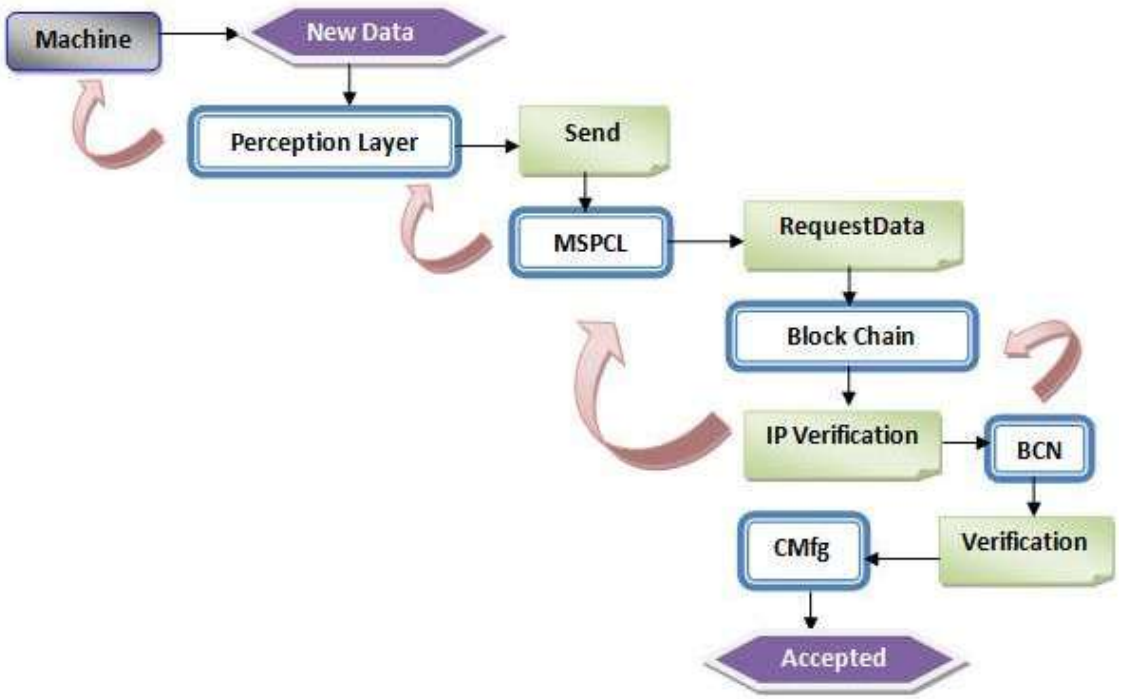

Figure 2: Communication of layers

The nodes rely on building cooperation to achieve a technological benefit by encouraging all the decentralized nodes to agree on the veracity of the information. Numerous different blockchain systems found on the AP help to build this confidence among the nodes. Following the creation of a fresh block, MP performs networking stimulation, which enhances the network's information verification system. In the final section, CP bundles a variety of scripts, techniques, and smart contracts that are crucial block promoters in the blockchain and play a vital role in every block. Figure 3 shows the sensible connections on the chain of blocks through all the BCN. Blocks and annotations utilized the smart contract for HD on the block accessibility and validation.

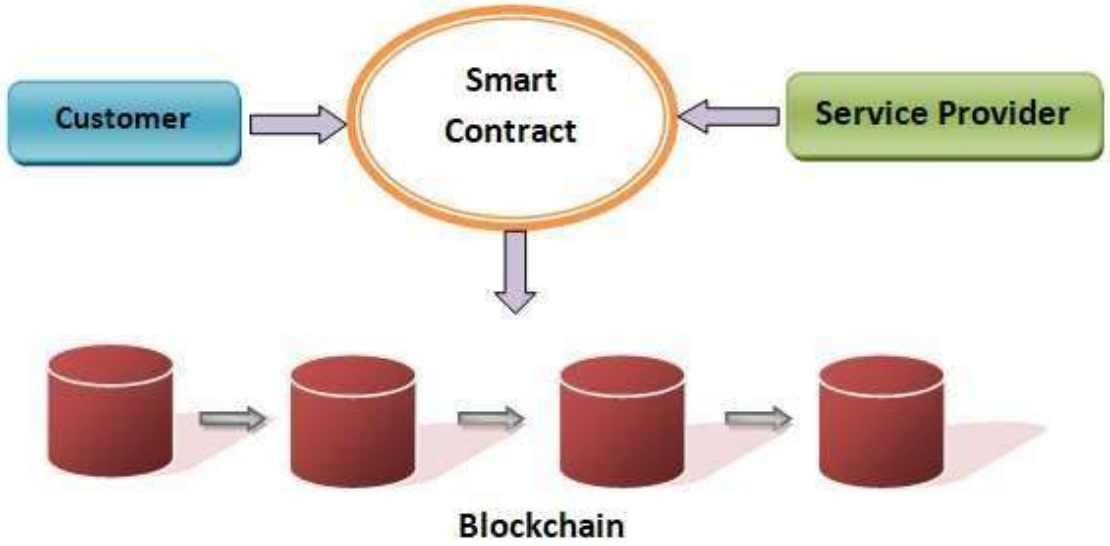

Figure 3: Smart contact in the blockchain

4. Results and discussion

Every customer should register with the system and set up a working account with two-step authentication, which adds a level of safety to the account. Customers can release requests on the structure after registering and receiving a payment amount. Using the case study, the end user prepares data and publishes requests for component production through the use of production service suppliers. After publishing and taking into account smart contracts, manufacturing service providers can find different requests for the parts to be produced in the structure after decrypting product information including manufacturing data, quality information, deadline, and other information. Since every production network operator uses secret key technology to deliver deals to end customers, clients can only access these deals, leading customers to choose the highest offer and transmit their acknowledgment to the chosen production service supplier. Every production provider sends various benefits on its functionality to the structure with unique manufacturing costs, deadlines, and payment options. Smart Contact is a straightforward transaction protocol among clients and the product provider in this network. This system interface and procedure are depicted in Figure. 4 for both end users and production service providers. According to Figure 4, every user has a unique identification number. Figure 5 showed the specifics of the process for the consumer user's query and approved proposals by the production service supplier for improved comprehension of the system. The production service provider C's bid was approved by the end user since its costs of production were lower than that of other service suppliers. In Figure 5, you can see that the end user's account address has been accepted by wallet information manufacturing provider A. Additionally, the cost of energy is seen as taxation and platforms subscription fee that each customer must spend about their services.

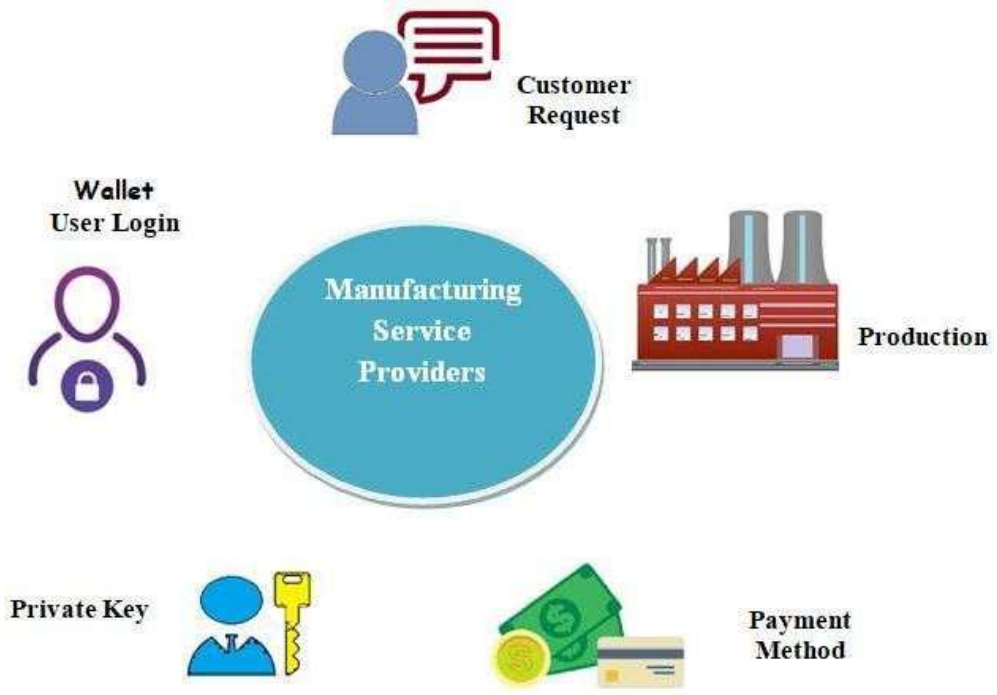

Figure 4: Workflow and interface of the proposed system

Figure 5: Process of the transaction

4.1 Performance evaluation

This study's system framework was assessed in terms of functionality using 15 clients and a case analysis that centered on BCN, which was then created using OC services. This evaluation relies on the process of creating wallets and encapsulating information on the BCN. Every wallet has a capacity somewhere between 0.5 kb and 1 MB and is created using unique wallet names. We timed every action required to build a trail network, including the creation of wallets, blocks, mining, and distribution to consumers, network connections, system stops, and connectivity deletions. So, following the completion of our experiments, we created Table 1 depending on 5, 10, and 15 end users. The very first inference made from these results and findings is that all indicators' levels are directly related to the number of end users. For instance, the amount of wallet creation for five end users is 2.1, and it gradually increases to 6.87 for 15 end users. Additionally, based on the amount that miners produced as the number of end users increased, this value gradually declined; as a result, constructed BCN is secure and exhibits great scalability.

Table 1: Average services depending on minutes for three tests with 5, 10, and 15 end - users.

Test time	End user 5	End user10	End user 15
Wallet create	2.2	3.9	6.88
Block create	0.19	0.25	0.30
Miners create	1.3	1.43	1.41
Distribute to users	1.87	2.21	3.62
Network connect	0.21	0.33	0.56
Network stop	1.4	1.8	2.79
Network delete	3.5	3.4	3.3

5. Conclusion

With a range of innovations, such as IoT, Cloud production, and others, the sophistication of the manufacturing industry has reached previously unheard-of heights. By offering everything as a utility with numerous autonomous and collaborative organizations, CM attempts to play a major role in tackling this difficulty. But the CM design that has already been created suffers from centralization. To simplify cloud manufacturing and create a new kind of trustworthy system known as blockchain manufacturing systems to create peer-to-peer and decentralized internet infrastructure for CM, this article proves how it is feasible to successfully implement blockchain technology. Therefore, we offered a BCN and CM-based design that was described in depth by considering essential parts. Five manufacturing service providers and 15 end customers are included in a research study that serves as the basis for the execution of the proposed architecture.

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