# A Novel Big Data Intelligence Analytics Framework for 5G-Enabled IoT Healthcare

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***Abstract*—Intelligent networking is a concept that enables 5G, the Internet of Things (IoT) and artificial intelligence (AI) to combine as a way to accelerate technological innovation and develop new revolutionary digital services. In the intelligent connectivity vision, the digital information gathered by the machines, devices and sensors which make up the IoT is analysed and contextualized. It is anticipated that the high availability of 5G and its inclusion of a large number of connections would help promote the production of wearable devices used to monitor the different biometric parameters of the wearer. Since these are AI-based health systems, the data obtained from these devices will be analysed in order to assess a patient's current health status. This paper presents a detailed design for the development of intelligent data analytics and mobile computer-assisted healthcare systems.The proposed advanced PoS consensus algorithm provides better performance than other existing algorithms.**

***Keywords*—Big data analytics; 5G-enabled; IoT healthcare; fog computing; confidentiality**

## I. Introduction

According to the HIS market, by 2035, the Fifth Generation (5G) of wireless transmission technology will enable more than $1 trillion worth of products and services for the healthcare sector. The main features focused on in 5G technology, for example, significant increase in speed, coverage, enhanced capacity, network energy and power, and increased bandwidth, impact across many divisions in big data analytics. For people who have diabetes a comprehensive sensing analysis is available. Many mechanisms and personalized building models using 5G smart diabetes testing of smart clothing and smart monitoring using smartphones and using big data clouds are suggested for patients as part of their personalized solution for diabetes monitoring in healthcare. Here, an overall comprehensive process regarding blockchain-based 5G-enabled IoT and also various challenges and integration with blockchain industrial automation with the 5G-enabled IoT are presented. In addition, existing gaps in scalability, interoperability and other challenges in 5G blockchain are discussed. The deficiencies in 5G from all the communication devices and drones and particularly in the field of healthcare are identified and these problems will be overcome with the help of ultra-high reliability.

### A. Motivation and Scope

The scope of 5G definition relates to potential uses and how those likely affect healthcare. The Internet of Medical Things (IoMT) focuses on the impact of 5G on providers, hospital systems, medical device companies, pharmacy companies and telehealth. Several key companies plan to launch 5G systems as well as 5G wireless networks in healthcare products. In the long term, in the healthcare sector, 5G will help to profoundly transform remote diagnostics and consultations. 5G enables the IoT to have a more powerful bandwidth combined with lower latency; 5G will be the main focus of technologies such as Augmented Reality and Virtual Reality in the healthcare sector. Furthermore, 5G will allow widespread deployment of Artificial Intelligence (AI) which will transform the healthcare sector from manual to smart automation.

Blockchain and 5G are the most hyped technologies emerging in the common marketplace. As mentioned, several features are available in blockchain with 5G, including decentralized approach, immutability, allows localized availability, cost efficiency and security. Also, challenges regarding blockchain with 5G integration focus mostly on scalability of blockchain which needs improvement to deal with the high number of devices and each device must have a unique address. Furthermore, after the 5G technology is deployed worldwide, it is expected that the technology will allow medical professionals to be able to exchange data with patients instantaneously from anywhere. It is an easy way for hospital-like monitoring in patient's homes similar to how intensive care units are monitored nowadays. Blockchain technology is perhaps the silver bullet needed for industry. The blockchain functions as a distributed transaction ledger for various IoT transactions. The blockchain platform supports and uses simple key management systems. The Ethereum platform is capable of managing a more fine-grained way used in many IoT devices with successful smart Turing complete code.

### B. Research Contribution

In this paper, we proposed a 5G-enabled blockchain e-healthcare framework. The focus of this framework is a patient e-health management system. E-Health introduced the fog/edge used for easy access of medical data, as well as patient safety and privacy concern. Blockchain is deployed in the e-health system. This consist of three interfaces (1) Near Processing Layer, (2) Far Processing Layer and (3) Data Sensing Layer, and an agent Migration Handler (MH) used to monitor and transfer tasks which will help to locate the client. The current healthcare system is not patient friendly because patients must continually spend time monitoring their illness instead of resting, which is inconvenient for the patients. Wasted patient time has been reduced in our proposed system.

### C. Organization

In Section 2 the literature survey and comparison of existing ideas with 5G technology in healthcare and blockchain is presented, in Section 3 our idea is proposed in a detailed manner, in Section 4 the performance analysis of the proposed model with graphs is discussed, and conclusions and future work in the healthcare sector are presented in Section 5.

## II. Related Work

Some studies discussed by Hossain et al. proposed an emotion detection methodology in the healthcare system. They used IoT devices to capture emotion images and speech recognition processes separately, and calculated the value of the detected emotion and validated it [1]. Latif et al. discussed the 5G wireless technology along with emerging technologies that will transform the healthcare system, specifically 5G with cloud computing and 5G with artificial intelligence, and in terms of economist and high potential pitfalls in development of the 5G health revolution [2]. Similarly, Nasri et al. proposed a smart mobile IoT healthcare system using 5G and smart phones to monitor patient's health risk factors. WBSN data was used to monitor and track patient pulse, temperature and oxygen in blood as well as other vital parameters of the patients [3].

Ahad et al. discussed diabetes diagnosis with the solution of comprehensive sensing analysis. They suggested patients could have personalized solutions for diabetes monitoring in healthcare, including many mechanisms and personalized building models using 5G smart diabetes testing on smart clothing and smart monitoring using smartphones and big data clouds [4].

Further, Mistry et al. [5] presented a comprehensive review on blockchain-based 5G-enabled IoT and various challenges stemming from integration with blockchain industrial automation and the 5G-enabled IoT. A comparison of existing gaps between the scalability, interoperability and other challenges in 5G blockchain was also presented. Ullah et al. discussed the driving with wireless industry and developing the next generation of technology so that mobile technology generation has improved facilities to be efficient in wireless fields. Vehicle-to-everything (V2X) will impact in 5G with all the communication and drones and particularly in the field of healthcare, and they identified deficiencies and overcame those problem with the help of ultra-high reliability [6].

Furthermore, Li discussed how the next generation of wireless remote technology will be useful for healthcare in existing models with respect to the expenses of healthcare services and the imbalance of medical resources and inefficient healthcare system administration. To overcome this, the IoT, big data analysis,artificial intelligence technology and 5G wireless are used to improve patient quality of healthcare service, and the cost inferable method is focused on [7].

Sigwele et al. proposed an information and communication technology utilizing IoT to limit medical errors and cost of healthcare. They discussed the IEE5GG with smartphone gateway connection to save energy, which is executed with the help of MEC while considering QoS and battery level CPU load, and resulting with an energy efficient framework [8].

Chen et al. proposed a 5G-C-sys for healthcare that aims at ultra-low latency in cognitive application and high reliability. They also developed a prototype platform for 5G-C-sys incorporated with speech recognition and emotion detection for the effectiveness in healthcare-based 5G C-sys technology [9].

Similarly, Boban et al. analysed the requirement in 5G technology and identified the gaps with the existing technologies. They overcame the challenges with drone and communication technologies [10].

Latif et al. discussed how 5G technologies, AI, IoT and Big data will revolutionize healthcare, and they provided an overview of how machine learning algorithms are integrated and able to detect the anomalies in the healthcare system. The authors also investigated remote consultation in e-health [11]. Lakshmanan et al. proposed a hybrid approach in combining PSO and ACO & BCO on routing protocol and applying the K-Means algorithm for clustering the nodes [12].

Furthermore, Manoj et al. [13] discussed a congestion adaptive navigation for emergency situations. They also used sensors for locating using GPS and then server takes an action using PIR in emergency areas. Logeswari discusses the analysis of packets having the fuzzy logic based on the greedy routing protocol. Two characteristics input metrics and fuzzy decision making system in VANETs were used [14].

Gomathi et al. [15] proposed an energy efficient routing protocol using wireless sensors with dynamic clustering UWSN routing technique. This will be helpful for researchers due to reduced power consumption, response time, avoids overload and improves throughput of the network. Vignesh et al. discussed fewer deployments in the cloud storage with low cost replication, higher availability and better performance in geo-replicated systems by data centres with these benefits [16].

Ishwarya proposed a project to reduce congestion in traffic and calculated current traffic with normal. If anything unusual is detected, then emergency vehicles pass through the signals; thus, solving the traffic problems [17]. Sivasangari et al. [18] compared security and privacy using fog computing. They also used the fog computing principle to use a smart gateway for an improved big data health monitoring system. Suganthi et al. discussed security improvement for web based banking and the authentication using fingerprints to avoid hacking or for fault detection [19]. Deepa et al. proposed an idea of detecting road damage by image processing in smart phones and sending the co-ordinate point to the cloud and from the cloud a user can see the road where the damages are because it will show on a map. From this, they can avoid accidents and so on [20]. Keerthi et al. [21] used convolutional neural networks (CNN) to identify dangerous lung disease tumours. The CNN technique has many features and can provide standard representation pneumonic radiological complexity, fluctuation and classification of lung nodule. Sivasangari et al. [22] proposed major concerns about WBAN regarding the security and privacy of the healthcare sector. The patient health data should reach the physician at the right time. Security has the greatest impact on the lives of humans, and an effective model SEKBAN that ensures security data based on ECG signal was implemented. Indira et al. [23] implemented an efficient hybrid detection using a wireless sensor network. Wireless devices are spatially distributed over sensors and physical changes. The device network includes multiple detection over sensors with lightweight transport.

Tao et al. [24] discussed V2G technology for enabling renewable energy sources providing power in a smart grid. They proposed a fog and cloud hybrid model. Vilalta et al. compares the existing approach with the new proposed technologies and distributed field. This paper discussed TelcoFog's benefits and dynamic deployment with low latency, and managing orchestration architecture for TelcoFog service infrastructure [25]. Furthermore, Chaudhary et al. focused on challenges for future demands in integrated fog computing and cloud computing in the 5G environment, in collaboration with SDN, NFV and NSC. They also performed data analytics with device mobility, as well as discussed challenges and potential attacks on the data shared in 5G [26].

Ku et al. [27] discussed advances in the fog radio access network and fog–cloud based in hybrid system issues. GPP is used for communication and computational processing, and it is also used as a simulator for experimental tests. Furthermore, Yang et al. [28] proposed an SDN-enabled approach for cloud–fog interoperation in 5G, and aimed at quality of optimized network usage. Crosby et al. [29] shared, in terms of blockchain technology, all criteria that satisfy specific application in both sectors regarding finance. There are many opportunities for revolution in disruptive technology. The digital currency Bitcoin is highly controversial, but blockchain has proved to be useful and has found many applications.

Risius et al. discussed a framework in blockchain which they divided into three group activities and four level of analysis. This paper addresses research predominantly focused on new technologies in blockchain [30].

Dinh et al. proposed a survey about untangling blockchain data processing with its challenges, and they analysed four dimensions in production as well as research systems—distributed ledger, smart contract, cryptography and consensus protocol. They also conducted comprehensive evaluation for major systems such as BlockBench, Parity and Ethereum, and found blockchain performance closer to the database [31].

Huh et al. [32-45] discussed how to manage IoT devices using blockchain to easily control and configure IoT devices. They also used the RSA algorithm which is capable of managing devices with secret keys. They used Ethereum blockchain for coding in an efficient way [33-37].

## III. Proposed Work

Fog/Edge computing is tackled by eHealth systems for an easy way of accessing and processing medical data, and ensuring the privacy and safety of patients. All Fog and Cloud have their administers interested in handling medical data that violates the privacy of patients. Blockchain deployed over Fog and Cloud will allow patient data processing and storage. The eHealth architecture consists of three interface levels: sensing, near processing, and far processing. Multiple instances of a Patient Manager include 3-level structures. The Agent Migration Handler (MH) uses Profile Monitoring to transfer a task or execute the task internally, which collects profile information from remote agents.

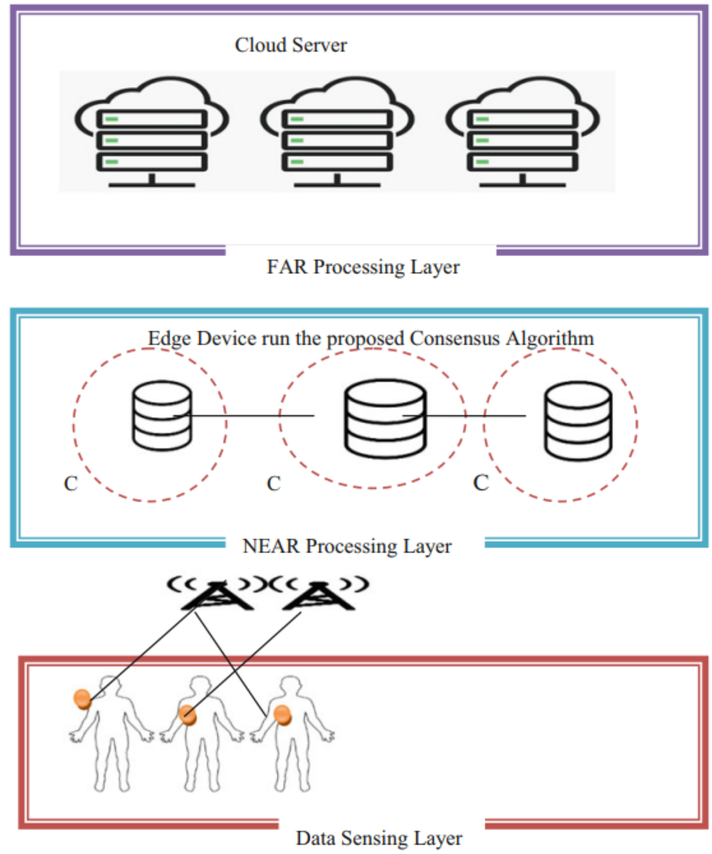


Fig. 1. Proposed Architecture.

Sensing layer: Smart devices, implantable sensors, smart watches, mobile devices and other devices monitor patients' body parameters. These applications use Bluetooth or ZigBee to convey to the mobile the physiological sign of a patient. Near processing layer: A hop away from the sensing devices of the data is where near processing level devices are generally located. Conventional switches, routers and low-profile devices are involved in the near networking layer. In a broad range of formats, healthcare facilities generate vast quantities of data, such as records, financial statements, laboratory findings, imaging tests, such as X-rays and CAD scans, and measurements of vital signs. Blockchain provides the ability to boost the data's authentication and integrity. This also helps to disseminate data inside the network or facilities. Such features have an effect on the cost, quality of data and reliability of providing health care across the system. Blockchain is an open, decentralized, intermediary-removing network. The blockchain healthcare solution does not require multiple authentication levels and provides everyone who is part of the blockchain architecture with access to the data. Data is made open and transparent for customers. Such apps will help to tackle the various issues facing the healthcare industry today. In the healthcare sector, blockchain's role is split into four stages. The proposed architecture is explained in Fig. 1.

The inspiration behind blockchain and 5G integration largely stems from the many benefits of blockchain in addressing security, protection, networking and service management issues in 5G networks. The proposed advanced Pos Consensus algorithm is described below:

**Algorithm 1** The Proposed Advanced Pos Consensus Algorithm

**Input:** Performance Transaction (PT), Reputation Transaction (RT), Stake Transaction, Agent Number (Ni) in a cluster
**Output:** Every fog agent generates PTi, STi and produce RTi from the service provider

```
Form clusters with fog nodes within a threshold range (R)
for each cluster k = 1 ∈ l do
  while Head election = true do
    for member agent i = 1 ∈ n_k of a cluster do
      Extract parameters from PT_i, RT_i to produce P_i, R_i and S_i
      P_i = 1 / (1 + e^(-Ÿ / (r × α_i)))
      R_i = 1 / (1 + e^(-r))
      S_i = 1 / (1 + e^(-c))
      f_i <- Decision Tree (P_i, S_i, R_i)
      T_i = ΔT × (1 - f_i / Σ_n^1 f_i)
      Every Member node in the cluster sets their timer (T_i)
    end for
    if (T_i) is expired then
      Then broadcast node id to the cluster for approval
    end if
    if approval count [node id] >= 2/3 × n_k then
      leader_j <- nodeid
    end if
  end while
end for
```

A cluster within the Near Processing Layer of a certain geographic range (R). A cluster is formed by a fog/edge agent with a different patient member value, where a representative is selected to be the head of the cluster. The cluster head (also called the leader) is involved in running the blockchain consensus protocol by locking a certain amount of stake in the network. From each cluster, a cluster head (CH) is chosen, taking into account the member nodes' multi-criteria. The selection process includes the performance characteristics of a node, its reputation and the stake amount. Criteria are combined to measure a fitness value using a decision tree. The blockchain records the information of each node regarding the parameters listed, and can be retrieved from the blockchain. The performance parameters include device processing speed, storage capabilities, accessibility, variation distance coefficient and delay in transmission of an Agent. Here, MIPS processing capacities, memory space and availability are symbolized respectively as p1, p2 and p3.

T is the time interval for the selection of cluster head, and where T represents a limited random time period used to distinguish waiting time for the same fitness of the Agent. The Agent broadcasts its identifier across the cluster since its waiting time expires. The other cluster members verify the estimated fitness of the Agent and accept their approval for this Agent. In turn, every node in a cluster will participate in the PoS proposed. This consensus mechanism would be less vulnerable to an attack of 51% from each cluster than DPoS as a leader. The rich node, such as PoS, is less likely to become a cluster leader, as the cluster head is not only selected based on the locked coin.

Decision Tree is a supervised learning method which can be used for problems with classification and regression, but is preferred to solve problems with classification. It is a tree-structured classification where even the internal nodes represent the characteristics of a dataset, the branches represent the rules of decision and each leaf node represents the result.

## IV. Performance Analysis

The assessment of the proposed programme with simulation settings and evaluation metrics is defined in this section. It also addresses the effects of various parameters such as energy usage and time for block generation. Various scenarios with different configurations are visualized through graph plot. For the following parameters, the performance of the updated mechanism and the existing mechanism will be investigated. Energy consumption: energy consumption refers to the energy needed for transmission, receipt of the transaction and simulated validation of the network of a number of blocks.

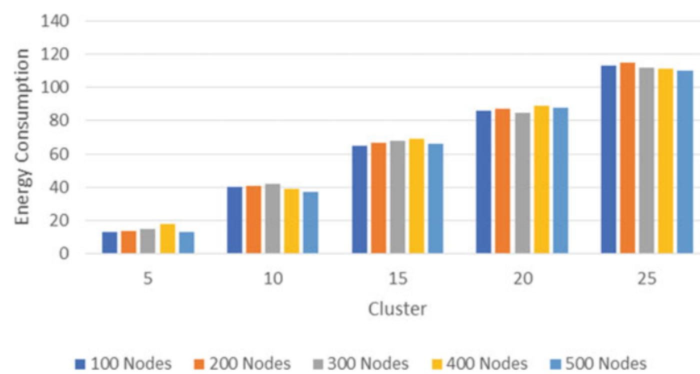


Fig. 2. Energy Consumption vs Cluster.

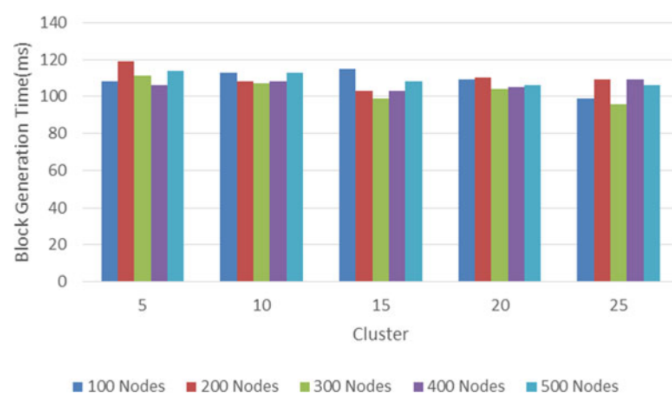


Fig. 3. Cluster vs Throughput.

Block generation time: This refers to the time required for a certain number of simulated network blocks to be uploaded, constructed and validated. In the simulated network, the updated process is executed five times and the output graphs are shown with average values generated from 10 execution runs. The regular one runs on a horizontal network and is supposed to function on a hierarchical network with the modified one. For both forms of consensus structures, nodes that lock digital coins into the network engage in mining. The energy consumption and execution time necessary for the development of 100 blocks are shown in Fig. 2, provided that the variable number of nodes and clusters is taken into account.

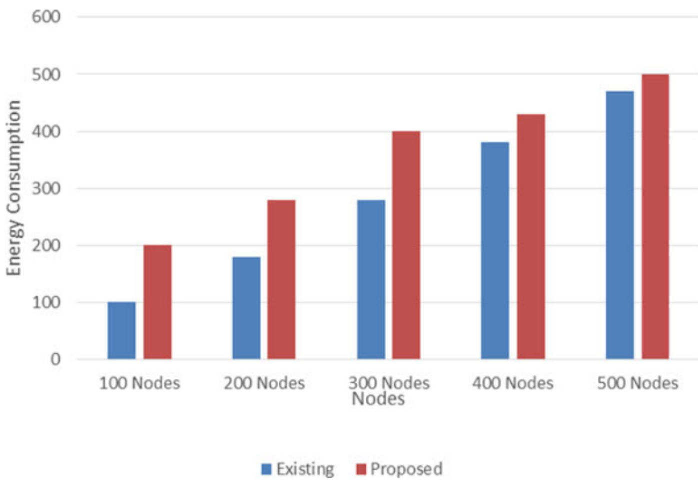


Fig. 4. Energy Consumption vs Nodes.

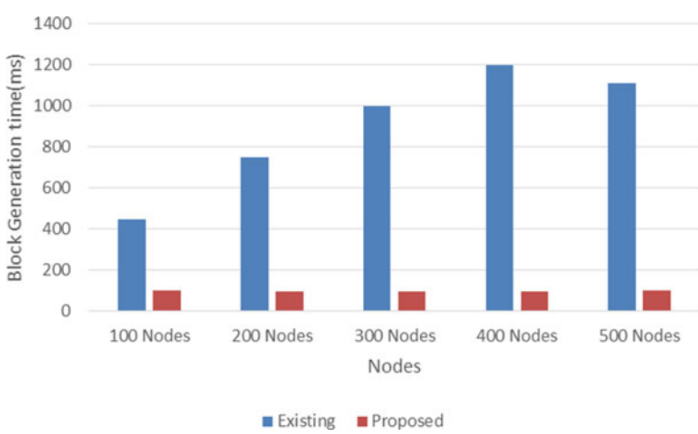


Fig. 5. Node vs Block Generation Time.

For unique clusters and nodes, the block generation time is shown in Fig. 3. The illustrated graph in Fig. 3 indicates that a pattern which is consistently lower or higher does not follow the period of block generation with a larger number of clusters. With a higher number of clusters, cluster heads collect transactions and construct blocks, with a higher number of blocks per second being generated. On the other hand, because of the delay in testing blocks, higher block generation time was also noticed for some higher cluster numbers.

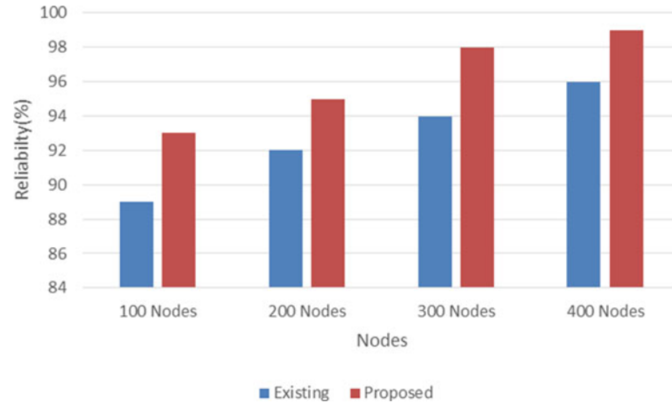


Fig. 6. Reliability vs Nodes.

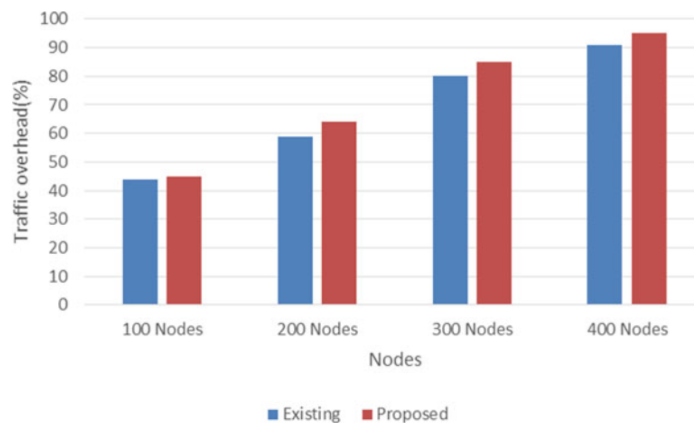


Fig. 7. Nodes vs Traffic Overhead.

In terms of power consumption and block generation time, the performance of the modified algorithm is compared to the standard one around. The revised algorithm shows a significant decrease in energy consumption compared to the regular one. A block is validated by a few selected safe miners in the updated one, but the standard one requires more than $50\%$ node participation in the block validation process, resulting in higher energy consumption. Updated energy consumption remains almost constant for a comparable number of clusters with a greater number of nodes, while energy consumption tends to increase as the number of nodes within the network increases (Fig. 4).

Fig. 5 displays the updated and standard block generation period. The graph in Fig. 5 illustrates that the time for the standard generation of blocks is greater than for the updated one. As normal, different nodes send their transactions to one leader node for validation, and to broadcast across the network, a validated block is required. The approach thus consumes higher energy and makes it possible to take a longer time for the block's network-wide casting. In addition, some good miners are selected based on reputation, results and stake in the revised one, but a miner based on investment or stake alone is regularly nominated. We have painted our architecture with an already proven architecture in terms of reliability and overhead touch. The protection protocol is correlated with these two performance metrics. The graph in Fig. 6 shows that our eHealth is more robust than the current system due to our decentralized Key Management and several three layer Patient Agent instances.

On the other hand, the diagram shown in Fig. 7 showed that our eHealth security mechanism provided greater overhead communication than the current one. An Agent needs a certain number of data encryption segments to be obtained from other neighbouring Agents to form the entire secret key. This technique activates overhead communication when exchanging hidden keys and authenticating. The relation between the different features and the current system [22] is shown in Table I. Similar to the cloud, with different protection strategies or without protection, different stakeholders deploy heterogeneous fog devices. Fog networks, through the identification and analysis of health information, are vulnerable to malicious attacks. In our architecture, the same patient agent replicated in the Mobile, Fog scheme and Cloud will protect wellbeing. To keep a Record of Malicious Attacks, sensitive medical information is analysed in the homogeneous replicated Patient Agent in order to protect the privacy or confidentiality of the patient.

A dropping assault occurs if a cluster head reduces the transactions. This is unlikely to happen because the cluster head will lose its reputation to share when it is detected as malicious. The consensus mechanism should select the malicious and cluster members who do not collect transactions for verification while the head of the cluster is down.

TABLE I. COMPARISON WITH EXISTING SYSTEM

| Criteria | Proposed | Existing system |
|---|---|---|
| Confidentiality, availability and integrity | CAI high, PA homogeneous Responsive medical data task Edge nodes, using the ring signature, blockchain maintenance for metadata ensures several PAs Availability of service | Privacy is average, integrity is high, usability is high, Low because of centralized operations of blockchain Controller |
| Secure and energy efficient migration | High | Low |
| Communication overhead | High | Medium |
| Consensus mechanism | Light weight | Medium |

## V. CONCLUSION

In this paper, we built an eHealth program that deployed several instances of a three-layer Patient Agent software: sensing, near processing and far processing layer, which make the eHealth software more stable and fault-sensitive. We also defined how to implement the Patient Agent on a 5G unit. The dedicated Patient Agent application is able to handle the resources of 5G network slices. A performance analysis has shown that the emerging eHealth program will use blockchain technology to process health data in near-real time. The implementation of blockchain healthcare technology is difficult, with vast volumes of health data constantly being transmitted from wearable sensors.

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