

Security and Power Consumption for Data Availability in Personalized Internet of Things with Cloud-based User Healthcare Applications

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Article History:

Received: 08-08-2024

Revised: 29-09-2024

Accepted: 10-10-2024

Abstract:

Personalized Healthcare is a brand-new patient-centred healthcare strategy that seeks to enhance the current healthcare system. E-health services are provided via personalized healthcare systems to meet the medical and support needs of the aging population. A significant development in the Big Data age is the Internet of Things (IOT), which, through enhanced services, provides a number of good engineering scenarios. Healthcare systems are now using analytics over IOT data streams as a resource of user data to find additional information, forecast early diagnosis, and make decisions in life-threatening situations. The IOT design is examined in this book, with a focus on systems that are internet. Because factors like accuracy and power consumption are important IOT concerns, research initiatives that are involved in boosting the performance of IOT-based healthcare systems are examined. The IOT-based healthcare system with cloud technology is thoroughly studied in this paper's data management procedures. The effectiveness of the IOT-based healthcare system is described, along with its benefits and drawbacks. The majority of research studies are effective at identifying various symptoms and can correctly forecast diseases. The IOT-based healthcare system created specifically for seniors is an effective way to keep track of their medical conditions. The main drawbacks of the current systems are their high power consumption, lack of resources, and security problems brought on by the use of several devices.

Keywords: security and power consumption; internet of things (IoT); healthcare systems; cloud technology; IoT.

1. INTRODUCTION

A vast amount of information is produced by the medical sector, including records for in-patients and out-patients, lab findings, database administration, medical image processing, medical examinations, doctor consultations, monitoring patients, etc. If the patient is not exposed to a return visit, these data are typically maintained in hard copy form, deemed waste, and are removed after a specified amount

of time. Today, however, all patient data is digitalized to collect important data from the information provided by patients to improve the level of medical care provided and lower treatment costs. "This enormous volume of information gathered from the healthcare profession was recognized with potential and supportive ideas for a wider range of healthcare tasks with the strategic decision making, disease monitoring, and healthcare systems," the author writes in his article [1].

Big data, or extremely large amounts of data, are sophisticated collections of digital documents that are virtually impossible to manage with current technology, programming, information management tools, and algorithms. Due to the variety in the kinds of data that are collected and the length of time needed to process them, a large amount of data, particularly in the field of health care, is overwhelming and huge. As a result, the medical industry's big data is made up of information about patients' health and the therapies they get. Big data analytics refers to the analytic approaches used to analyze the knowledge contained in a large amount of data. When combined with analysis tools, big data enables the most deliberate advancements in business analytics today.

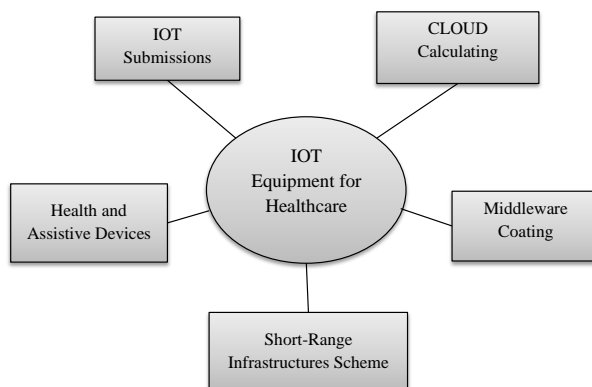


Figure 1.1. IOT-based home health surveillance systems' key components

Big Data analytics, which is characterized by the six Vs of volume, variety, speed, truthfulness, veracity, and instability, has emerged as an effective solution for the procedure of plentiful statistics and to enhance executive. Volume, or the amount of information used and evaluated to produce the intended outcome, is the key characteristic. A variety of data sources, such as sensors, scanners, cell phones, encoders, videos, emails, social media, and the web, is raised by this system. The type of data kept, analysed, and processed is referred to as variety. Text, photos, video, audio, geometrical data, and combinations of these types of data are all examples of data types. Veracity is used to describe if data accuracy is sufficient for big data. In terms of efficiently collecting, digesting, and helping the information, Big Data also presents a challenge. Cloud technology develops as a critical support to collect and analyse the resource data, accessible from any place through the web, to tackle the challenges of Big Data. Gaining access to cloud storage of resources divided into open, corporate, and mixed clouds. The public cloud's resources are available for third parties to use, distribute, and process. Resources can be accessed by the company using a cloud service [2].

The following are some of the research's primary goals:

- IOT-based health monitoring architecture is added to the IOT healthcare applications.
- In the Big Data age, an emphasis on healthcare surveillance systems
- Using a smartphone, participatory healthcare programs are evaluated.

- Investigating the present issues with the individualized health sector.
- Presentation about a potential fix for the issues with real-time healthcare surveillance.

The essay is divided into the following sections, which are organised as follows. Section 2 presents the research on the relevant prior work. The characteristics of the proposed system, including its proposed system architecture, implementation model, components of the graph-based technique, and data analysis, are explained in Section 3. In Section 4, the system's effectiveness is assessed, and the implementation environment is described. Section 5 presents the answer.

2. RELATED WORKS

Aceto, G., Persico, V., & Pescapé et.al [3] the accessibility of everywhere and any moment connection is changing the world we live in today. It is now possible to provide new healthcare services or enhance the effectiveness of those that already exist thanks to the unprecedented widespread use of wireless and mobile innovations, including in developing countries, the availability of affordable, small-scale wireless sensors, and the cost-effective services provided by new device facilities (like enormous-scale datacenters utilizing virtual machines). Examples include helping those who suffer from obesity or other chronic illnesses, as well as the ageing population, through extensive analysis of vast amounts of digital information, which is being driven by the assimilation of smartphone devices into clinical practice and the rising accessibility and caliber of healthcare software packages known as mobile apps. The concept of P4 Medicine, or prediction, preventive, personalized, and participative medicine is proof of the profound change in medicine that these new technologies have made possible.

Philip, N. Y., Rodrigues, J. J., Wang et.al [4] one of the key components of the system design IOT is used for in-home monitoring devices. The interaction of these subsystems' functional units is shown in Figure 1.1. The storage server, extracting features make up the program's cloud core. The medical hub manages communication with the hospital, wearing gadgets and sensors, the transmission distribution of the treatment plan to the designated recipient and monitoring of the patient's vital signs. Hub applications for healthcare professionals to communicate with medical workers to facilitate patient care. In IoT-based at-home health surveillance systems, the patient's and healthcare specialist's hubs communicate with the cloud hub using an extensible and secure Cloud Telecommunications API (for instance, depending on Restful internet services).

Ahamed, F., & Farid et al [5] in the current state of medicine, doctors frequently recommend medications based on trial and mistake and a one-size-fits-all strategy. Nevertheless, not everyone reacts to drugs in the same manner. While the majority of individuals may respond to a specific treatment and dose, a small number of patients may experience only a minor response or serious side effects from the same medication. About 60% of the time do individuals fill and take medicines as directed, according to certain research. There are numerous possible causes, including a rising skepticism of the medical establishment and a culture that is increasingly worried about medication and its adverse effects. PH can simultaneously lower costs while raising the quality of practice. Additionally, it can aid in predicting the best course of treatment for a certain person with the least harm.

Marques, G., Pitarma, R., M. Garcia et.al [6] IoT designs describe how physical things that have sensory capabilities are linked to the Internet. Through distinctive addressing techniques with interaction and cooperative capabilities, these elements can be accessed. IoT settings also incorporate a variety of different gadgets, such as embedded systems, detectors, actuator, mobile phones, and smartwatches. IoT infrastructures must be designed and built using open-source platforms, hardware, and improved software programmers for big data, consultancy, management, and preservation. The users of these IoT devices are taken into account in IoT designs, and they should contribute and cooperate with IoT systems. Therefore, human senses must be considered in IoT design, and individuals must be seen as an essential part of the system. It can improve healthcare systems and enable patients to stay at home and receive real-time supervision rather than being admitted to nursing homes or hospitals.

Nazir, S., Ali, Y., Ullah, et.al [7] IoT technologies have a wide spectrum of uses in the healthcare industry. IoT development has an impact on contemporary healthcare from an economic and social standpoint. The Android market offers a variety of mobile applications for usage with various health-related problems. The patient can assess, monitor, and record their physical state using the applications indicators including heart rate, blood glucose levels, and pulse rate. Because they allow for mobility and personal privacy, phones are frequently used by patients and medical staff.

Jagadeeswari, V., Subramaniaswamy et.al [8] Users' lives are made more comfortable by IoT sensors and devices which also offer a workable answer to healthcare applications including measuring the blood bp, pulse rate, diabetes, residential care, and vitals like ECG and EEG. To better comprehend the changes in older individuals' health status and to encourage self-management of their health, visualizing how wearable technology will be used in the healthcare system is useful. The elderly are ready to get health advice using wearable technology to raise their level of living healthily way. Security is also essential to the healthcare firm's success. IoT sensors, actuators, and security in healthcare applications have been the subject of recent research that is worthwhile to examine.

Ali, A., Rahim, H. A., Pasha Et.al [9] Three layers make up our suggested system architecture. The topology of this network is three layers. The user layer is the bottom layer, followed by the local domain, the global domain, and the global domain. The private blockchain is activated in response to a request from a user who wishes to put policies in the blockchain. The Genesis block is the first block in the blockchain. It has never had a hash address before. It is thought to have a hash address of zero. The local contract is activated and creates a new block in the domain to store the policies for access control if the user wants to store them there. A new block is added to the global internet and the policies are stored there instead, triggering the global consensus protocol.

3. METHODS AND MATERIALS

In this part, we go into great depth about our suggested strategy. For a consumer query thread, we propose and build a blockchain-based sub-module, a health smart contract sub-module, and a health databases sub-module.

Healthcare Systems Using Internet of Things Technologies:

To improve access to medical and health information globally, healthcare systems are essential. Aging populations can now more easily access healthcare thanks to technological advancements, which also offer new opportunities and ways to analyse and understand medicinal facts. Despite everything that healthcare systems offer, there is still complicated and significant outstanding question about the privacy and security of patient data. Other significant issues facing healthcare systems include normalisation, network configuration, business models, quality of service (QoS), and data security, to name a few. Several research areas, Open-source platforms, wireless technology, and wearable and mobile sensors, among others, are relevant to the development of health systems (Figure 3.1). Many medical systems use wireless communication technology to transmit data and integrate wearable and mobile sensors used to gather data and analyse human physiological factors. Additionally, open-source platforms offer a wide range of functionality for device administration and protection in addition to supporting data storage, visualisation, and analysis. This section seeks to provide a detailed overview of the most significant IOT related research [6].

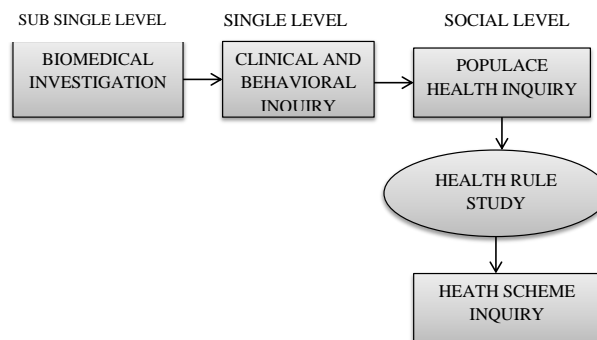


Figure 3.1 Essential research areas for healthcare systems

One of the key information and communication paradigms is represented by IoT. It has three separate points of view, as depicted in Figure 3.2: things-oriented vision, web-oriented vision, and semantic-oriented vision. A global network of interconnected objects that saves, arranges, and facilitates data searches is referred to as semantically oriented vision. The vision of things refers to Internet-connected, intelligent, autonomous devices that are used in our daily life. The networked systems with a unique address and support for industry-standard protocols are the main emphasis of the Internet-oriented strategy.

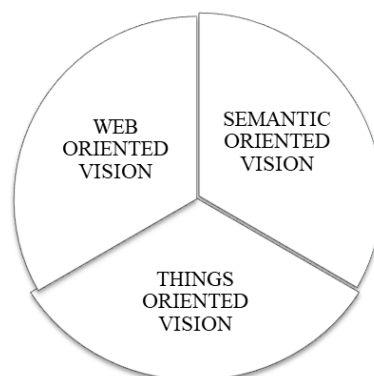


Figure 3.2. IoT futures

Applications with a single criterion are divided into the following categories:

- ***Detection of Glucose Concentrations:*** A metabolic disorder called diabetes occurs when the blood glucose level is above average for a prolonged period of time. a technique for measuring blood sugar reveals a person's specific blood glucose level and assists in making recommendations for the ideal timing of meals, necessary activity, and medication administration. For non-invasive glucose level measurement on an actual basis, an m-IOT installation technique is suggested [7].
- ***System for testing blood temperature:*** Blood pressure describes the pressure with which the heart uses to circulate blood. It is recommended to use an IoT-based method for monitoring and controlling health conditions like high cholesterol, low hemoglobin, high blood sugar, and abnormal cellular formation. It is suggested to blood pressure, hypertension, and obesity using an IOT-based health system.
- ***Tracking Core Temperature:*** Healthcare applications that detect and measure core temperature are crucial. The Telos mote fixes the body monitoring sensors and provides computations with precise and effective results. The foundation of the temperature tracking system is the IoT approach using the home network. According to the m-IoT perceived notion, the homeostatic control preservation varies according to a body's heat. It also helps with RFID module and thermal detection for tracking and measuring core temperature.
- ***System for monitoring oxygen level:*** The constant monitoring of blood oxygen with a measurement instrument called a pulse oximeter is advantageous for technology-based medical and healthcare applications. Nonin shows how the wrist worn OX2 pulse oximeter works. This gadget can connect to Bluetooth and links the sensor directly to the Moneer system. For the purpose of monitoring patients who are located far away, a low-power, low-cost pulse oximeter is presented that uses the Internet of Things. This device can continuously check on the health of the individual.
- ***Monitor for Electrocardiograms (ECG):*** ECG surveillance equipment can display ECG waveforms to the physician or consumer. Additionally, it responds to the user correctly based on the data gathered. The IOIO-OTG microprocessor uses an analogue-to-digital conversion to transform the ECG impulses to converting digital, and the binary images file is then uploaded to the cloud platform for analysis and the identification of anomalous medical issues. The biggest advantage of this gadget is that it cuts down on trips to the doctor's office and hospital emergency rooms.

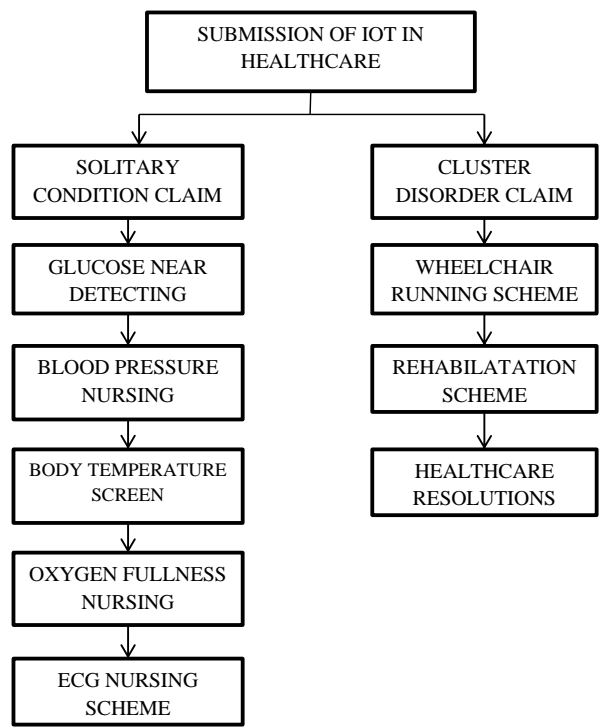


Figure 3.3. Applications in IoT-based healthcare are categorised

Healthcare industry growth in the Big Data:

Big Data have improved life quality by preventing avoidable deaths, curing disease transmission, and predicting diseases [8]. Figure 3.4 illustrates the function of big data architecture in healthcare. The system gathers data from wearable IOT sensors as well as weather, temperature, environmental, geolocation, and medical information in a variety of organized, uncontrolled, and semi-structured formats. In cloud computing, the statistics are combined and imagined. The documents are extracted, cleaned, and statistically analyzed as part of the pre-processing in the file analytics, and the choices are then sent to the doctor, remote access, and ambulances.

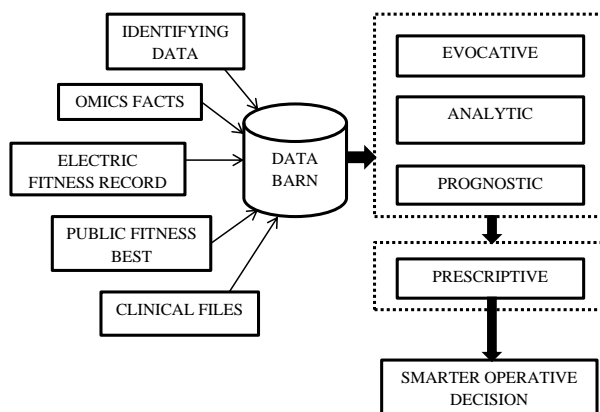


Figure 3.4. Big data analytics workflow

Wearable sensor technologies continuously observe the users and collect Big Data, which is a significant volume of both structured and unstructured data. It is a difficult procedure to separate useful information from vast amounts of data for decision-making. More latency is caused by cloud

computing, which is used to manage and store data on a remote server located online. Before the cloud, a fog layer is added to collect, analyse, and process the information to enhance efficiency and decrease latency. To make a swift judgement in real-time, the data are finally saved in the cloud. IOT devices are linked to a network to gather and exchange big data.

The patient sub-operation modules are described in Algorithm 1. The process involves asking an administrator for a private key to log into a patient node. After receiving permission to use the blockchain, the patient can view, publish, and remove access to the PHR. The module employs its features in this method as the identifying factor when determining if an authorised user is a patient. The doctor identifier (QID), the bitcoin blockchain (CM), and the password (UName) are all used in the following formula. The PHR was encrypted using a ring signature. Our accessibility control procedures are founded on individuals and characteristics. Access is allowed if a user satisfies both the identification and characteristic conditions; alternatively, admission is refused [9].

ALGORITHM 1: Medical Node

1. Enter: M admin requested QV and key.
2. Receiver: access to QHL transactions as a result.
3. Initial population: QHL must be a legitimate node. QHL is competent to read, edit, give, and cancel FHR information.
4. method Patient(Q_ID)
5. however (True) would
6. If (Q=CM), therefore
7. When (QHL is not present CM), therefore
8. create_{records}(Q_{jd}, QREC₁, C_m)
9. Otherwise
10. update_{records}(Q_{jd}, QREC₁, C_m)
11. reader_{records}(Q_{jd}, QREC₁, D_{id}, M_{id})
12. Close if
13. Otherwise
14. NO_{exist}(QID)
15. close if
16. if (visiter(Q_{jd}, QREC₁, D_{id}, M_{id})) therefore
17. QID = medrecorder(QID)
18. If(Q-DI QHL(C_N))therefore
19. Granted recorder(Q_{jd}, D_{ID}, K_{id}, M_{id})
20. Close
21. D_{ID}, K_{id} ← NOTICED(medical recorder does not work)
22. Close if
23. If(Q_{jd}, D_{ID}, K_{id} treatment – complete(QID))therefore
24. Close if
25. M_{ID}, K_{id} ← NOTICED(Q_{ID} voluntary revoke QID)

26. Revoked_{records}($Q_{jd}, QREC_1, D_{id}, M_{id}$)
27. close if
28. Close
29. No visited
30. Close if
31. End procedure

The flexibility to move is a key feature of IoT across all technologies. Mechanical architecture is a significant aspect that affects how moving objects move. IoT networking is crucial for the navigation of the robots. A motion equation describes the motion of a technological system as a function of time and prospective multivariate regression. Equation (1) reads as follows [10].

$$E(p(m), p1(m), p2(m), l(m), m) = 0, \quad (1)$$

The input variables (dof) of the robotic are then calculated using Grubler's equations (Formulas (2)–(4)) as continues to follow:

$$eof = t(M - 1) - \sum_{j=2}^i d_j \quad (2)$$

$$eof = t(M - 1) - \sum_{j=2}^i (t - g_j) \quad (3)$$

$$eof = t(M - 1 - i) + \sum_{j=2}^i g_j \quad (4)$$

Only when all joint restrictions are independent are the equations kept in place. If they are not, the formulas provide a lower limit on the total number of freedom degrees. The robots have M links in the formulas above, and M1 is the maximum number of freedom degrees for the objects without joints.

$$g: \begin{bmatrix} \sin\emptyset & \cos\emptyset \\ \cos\emptyset & \sin\emptyset \end{bmatrix} \begin{matrix} y1 \\ x1 \end{matrix} + \frac{\partial y}{\partial x} \quad (5)$$

Where M is the transform between ($y1, y2$) and the two frames [$\emptyset1, \emptyset2$], and is the rotations between the two consecutive frames ($t1, t2$)

$$g1(r1, r2) = D(|s1 - s2|, |t1 - t2|), \quad (6)$$

$$g2(r1, r2) = D\sqrt{(s1 - s2)(t1 - t2)}, \quad (7)$$

$$g3(r1, r2) = D|s1 - s2|, |t1 - t2| + (D - 3c) \min(|y1 - y2|, |t1 - t2|), \quad (8)$$

Depending on the elevation of angle, a range of gaze orientations are available for the robotic. It takes longer to compute when there are more gaze directions. For vision-based navigating, the appropriate connectivity of characteristic lines among image pairs as described in Equation is calculated using an evaluation function N (9).

$$N = \alpha \sum_{j=1}^{m1} d_j + \beta \sum_{j=1}^{m1} k_j + \gamma \sum_{j=0}^{m2} Q_j \quad (9)$$

Where k_j is the difference in absolute location interval? Q_j Is the characteristic lines' absolute horizontal variance value in both the parallel candidate picture and the first image. The values for each phrase and; $\sum_{j=0}^{m2} Q_j$. When a communication is absent from a characteristic line in the second picture, the penalty value is k_j . M1 signifies the amount of characteristic lines, while the second

graphic shows potential candidates. M2 is how many feature lines there are in the second image without any interaction.

$$F_c^p = F_l^p + F_{tx}^p + F_{sl}^p = \left(mI^{jl} + \frac{(j_{tx} + j_{tx})M}{s} + m^p \right) U, \quad (10)$$

Where m^p stands for packet size, S is for datagram rate, U is for node voltage mI^{jl} , And F_{sl}^p represents the current and energy used while listening. The present taken and electricity used while transmitting are designated as F_c^p and F_l^p . The current drawn and energy used while receiving are designated as F_{tx}^p and F_{sl}^p . The power drawn and power used during sleeping are designated as F_c^p and F_{sl}^p .

4. IMPLEMENTATION AND EXPERIMENTAL RESULTS

Using the Tester web API and Node.js, we put our suggested smart contracts and security systems policies into practice. Similar to this, we tested our simulations with N = 60, 100, 300, 500, and 700 nodes from concurrent requests. We limited the overall number of requests and policies to 700 and 1,000, respectively. In our first simulation, 200 nodes were used to test the outcomes. Figure 4.1 displays the simulation outcomes with a 340 ms average authentication time. The "access management policy" took 220 ms even though we had the permission time set to 40 ms. We also noted that the delegating and revoking operations under our suggested policy took 67 milliseconds. By simulating 300 to 700 rounds, respectively, we were able to obtain notable gains both in the experiment and with our suggested strategy.

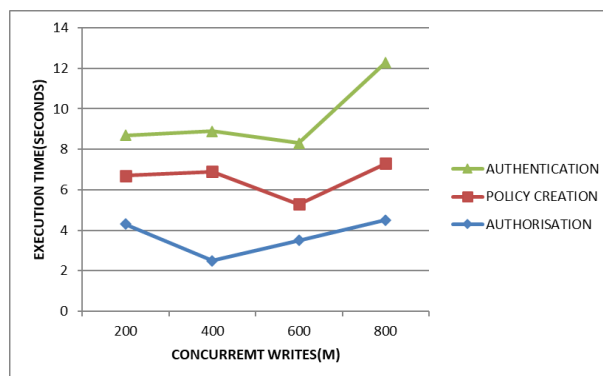


Figure 4.1. Simulated findings of our proposed access controls

Figures 4.1 and 4.2 present the outcomes, respectively. The earlier-mentioned recommended policies were also put to the test for the N = 100 to 700 client rounds that were used. The findings demonstrate that when the number of simultaneous requests rose, the proposed framework's throughput also increased. Compared to the various benchmark approaches already in use, our suggested method offers an effective access control strategy.

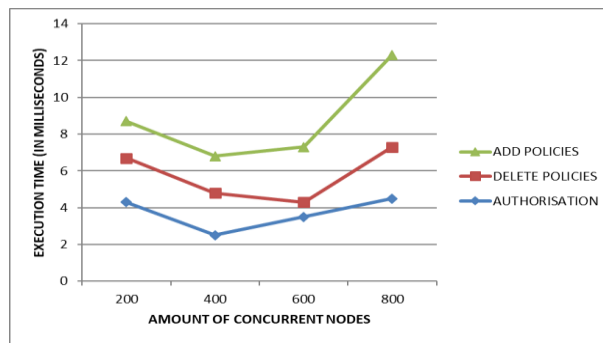


Figure 4.2. Simulation findings of our proposed access controls

The execution times for the authentication process and policy formation were not significantly impacted by the growth in the number of policies, as shown in Figure 4.2. The time needed to find a particular policy in a long chain of policies grew, but so did the times for user authorisation and policy revocation. We also ran tests for the delegation, authorisation, and user authentication policies. Our policies were further broken down into formation and revoke procedures. We conducted simulations with $N = 100$ to 3000 simultaneous requests and analysed the results of our tests for the identical requests. The total number of active requests is displayed as N . With $p = 3000$, the maximum number of assignment policies was maintained constant. 300 simulated client requests were tried simultaneously at first.

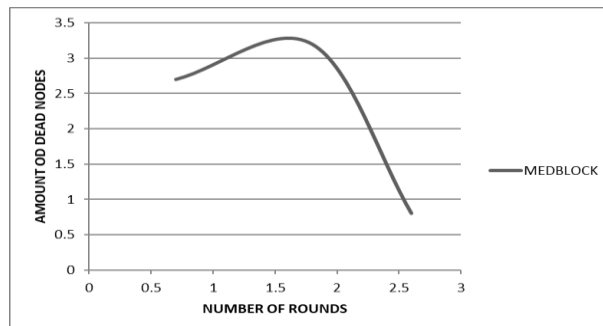


Figure 4.3. Comparative examinations of the benchmark models and the suggested flexible strategies for the cross-domain issue

A comparison between the number of dead nodes and the quantity of rounds is shown in Figure 4.3. The simulation results demonstrate that there are fewer dead nodes than planned and Medlock.

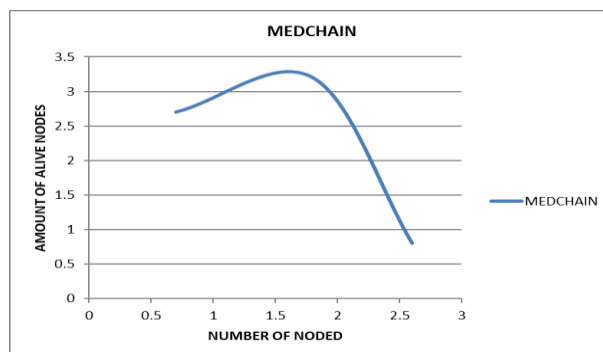


Figure 4.4. Results from simulations based on comparisons between the proposed model and the benchmark flexible strategies for cross-domain systems

Based on simulations, Figure 4.4 shows the total number of rounds and the total amount of live rounds. Our studies lasted up to 600 rounds, and at that point, 4000 live nodes were present. It is clear from the simulations that the suggested strategy results in more live nodes for a given number of rounds. As a result, our suggested framework is more effective than the benchmark systems.

5. CONCLUSION

As smart IoT devices, sensors, cloud computing, and cloud technology advance, and smartphone, the healthcare system has also advanced. A healthcare application was created for patient-centric forecast, treatment, diagnostics, and therapy. The healthcare ecosystem has evolved as an innovation in the Big Data era with effective decision-making and support for a new way of life. Rural patient evaluation monitoring using IOT and big data analytics using the information from 550 sightings shows improved prediction and the precision of the health monitoring and the service's delivery's shorter latency. As part of future work, we want to add homomorphic encryption to the current healthcare system to make it more secure while also creating and testing an algorithm for an enhanced plan in a real-world healthcare environment. For the upcoming wave of safe medical software, we also intend to research the potential of attribute-based security mechanisms.

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