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Secure and Privacy Based Home Patient Monitoring Internet of Things (HPMIoT)

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Abstract. The Internet of Things (IoT) refers to a network of physical objects that are embedded with sensors are able to collect and transfer information over a wireless network with human conciliation. In confined Home Patient Observation system light-weight wearable/embedded sensing element devices connected to record the patient health conditions. Adopting looming technologies like 5G and Mobile Edge Computing (MEC) a multi-staged journey builds ultra-low latency. The health care sector is drowning in information. An overflow of clinical records, patient history, complicated billing information, medical analysis and lot builds it very troublesome to manage such information at intervals the health care sector in a systematized approach. Escorted by IoT, since data mobility occurs, hackers gain access to clinical IoT device, acquire management and revamp data which oblige health partitioners take actions which will injury the health of their client. i) To overthrow security issues introduces Optimized blockchain with hyperledger fabric in edgecloud computing is proposed. Since data stored in blockchain are immutable, the permission granted patients can only access their records using hash value. Thus, blockchains will provide an immutable audit trail of health facts. ii) Software Defined Network (SDN) deliver Quality of Service (QoS) steer further from network congestion.

Keywords. Mobile Edge Computing, Optimized Blockchain, Hyperledger, Software Defined Network, Audit trail.

1. Introduction

The health care sector is drenching in information. An overabundance of medical record, patient history, complicated billing information, medical analysis and lot of build it terribly strenuous to cope such data amid the health care sector in an organized way. According to research, Americans see an estimated nineteen distinct doctors in his or her life. Within the interim, the U.S. Government lacks a novel patient symbol code system, thereby creating it nearly unfeasible to rack up & supervise absolutely the information of every patient.

Electronic health records have assisted practices convert paper information into digital kind. But whereas this innovation has blessed physicians with an excelling proposal to carry on the data of their patients, electronic health records far and away not shared blatantly between systems. So, there's not a single source obtainable where all sole patient

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information resides. Presently, physicians use any of the three given models to access info.

- Push: Anamnesis is forward from one health professional to a different.
- · Pull: One client requests information from determiner
- · View: Clients with prerogative can view data inside another client's record

This is the time to figure out a contemporary technique to ameliorate the data care in the health care sector. Need a secure place where to save a patient's complete anamnesis and apposite information exhaustively for future utilize and analysis.

2. Home Patient Observing System

Unlike side patient observing systems, remote patient observing systems (sometimes referred to as "home patient observing systems") are used to monitor patients outside of the hospital ("remotely"). A smartwatch that sends knowledge about a couple of patient's heart activity to a doctor whereas the patient is at the food market is an associate example of a distinct version of the said electrocardiogram machine.

As remote patient observing [1,2] is an exigency field, new edges are regularly being found. So, for the sake of brevity, we'll target the 3 that appear to be driving growth within the field: reduced time in the hospital, shriveled admission and increased hindrance of medical exigency among older patients, and increased prerogative for patients.

Postoperative observing will be a time-intensive method for each physicians and patients alike. Though care suppliers are perpetually trying to find ways in which to cut back the time patients pay within the hospital, the emergence of the COVID-19 pandemic has placed extra-pressure on clinicians to mitigate potential infective agent exposure by decreasing contact time even more. Remote patient observing is one among the ways in which healthcare suppliers are grappling this drawback. By facultative physicians to observe their patients outside of the hospital or doctor's workplace, they scale back the time patients pay in either of these places while not risking patient health

As we age, we tend to become prone to healthcare issues we didn't ought to worry concerning once we were younger. For this reason, older patients tend to want a lot of care and a spotlight than younger patients. Remote patient observing is one methodology care suppliers are victimization to stay up with the wants of older patients. In fact, new proof is rising that even basic forms of remote patient observing (like telemedicine) will facilitate decrease admission and forestall medical emergencies among older patients.

Spending time during a hospital means suggests that golf shot your traditional life on hold. A patient being monitored in a hospital doesn't have the power to perform daily activities. On the surface, this could not appear as necessary because the different edges, however it's importance for each the patient and also the doctor. For the patient, this limitation suggests that less freedom—they can't pay time doing chores round the house, working, serving to their white-haired ones, etc. For doctors, having the ability to observe patients who are living their "everyday" lives can deprive them of insight that will be valuable for diagnosing or treatment. However, with remote patient observance devices like smartwatches, patients have the liberty to perform their daily activities and doctors have the power to pull together information from these activities which will improve the patient's health.

2.1. Remote Patient Use Cases

Though there are several potential modilities where remote patient observance is used, there are 3 specific use cases wherever it shows potential to form the long run of diagnosing and treatment: polygenic disease care, chronic hindering pneumonic illness ("COPD") observance, and serous membrane qualitative analysis.

More than thirty-four million individuals within the United States have polygenic disease, consistent with the middle for illness management. Due to the tremendous value of polygenic disease on each patient and tending suppliers, the sphere of polygenic disease care has been a hotbed for remote patient observance innovation. Among the polygenic disease care realm, remote patient observance is being employed to enhance detection of glucose issues and different indicators of health deterioration which will result in hospitalization.

According to WHO, COPD is accountable for associate degree calculable five-hitter of all world deaths. It's calculable that "more than seventieth of COPD-related tending prices are consequences of emergency and hospital stays for the treatment of exacerbations." Though still within the early phases, continuous remote patient observance of COPD patients' physiological vital organ is showing promise in predicting potential exacerbations, up the standard of patient care, and lowering overall tending prices.

If a urinary organ fails, it will now no longer perform its job of removing waste from the blood. For a few patients with nephropathy, serous membrane dialysis associate qualitative analysis is a possibility that permits them to administer qualitative analysis reception comes with the danger that patients might not adhere to or accommodates their prescription. Remote patient observance of serous membrane qualitative analysis patients is showing promise in lowering hospitalization rates and reducing the quality of your time hospitalized patients keep within the hospital. The challenge of developing remote patient observance devices live at the intersection of the many technical disciplines. At a high level, they usually need advanced sensors, newest wireless technology, progressive cybersecurity systems, and sophisticated interconnect solutions[3,4]. The online of complexness that comes with developing a far-off patient monitor is very troublesome to navigate.

3. Literature review

Blockchain could be a distributed ledger that keeps records of transactions and/or information that participate during a network. Everyone seems to be able to be part of the network, have access to the information, verify transactions and communicate with the opposite members of it. Due to the suburbanized and distributed nature of Blockchain, the records of the ledger are maintained across totally different systems, devices, and locations within the network [5]. Finally, the outturn of blockchain systems is outlined because the variety of transactions that are hold on within the ledger per second. Typical Blockchain systems have restricted outturn, like Bitcoin that's restricted to seven transactions per second, due to the complexness of the Proof of labor accord mechanism that it uses [6]. Huh et al. [7] proposed a completely unique blockchain PKI management system victimization Ethereum and sensible contracts. The protection answer uses RSA public key cryptosystems wherever public keys are hold on in Ethereum and personal keys are saved on individual devices. Reyna et al. [8] study IoT and blockchain connectivity and its disputes. The survey work summarizes and discusses IoT devices which will be used as blockchain components, very important blockchain technologies and up thus far IoT Blockchain applications. IoT is gradually is becoming ready to use solutions in multitude of fields [9,10,11]. Dorri et al. [12] gifted a light-weight illustration of a blockchain throughout a home automation setting. The solution defines native blockchain doesn't use PoW and is controlled by the owner. The native blockchain is managed by a region miner in each home automation. The unicast communication between devices is secured with a shared key but these keys are generated by the native miner. The similar general framework supported blockchain for broader IoT applications is projected in by Dorri et al. in [13].

4. HPMIoT security challenges

- 1. Data security & privacy
- 2. Integration: multiple devices & protocols
- 3. Data overload & accuracy
- 4. Cost

5. 5G Edge

The advent of 5G has created edge computing even extra compelling, sanctionative significantly improved network capability, lower latency, higher speeds, and enlarged efficiency. 5G guarantees information speeds in additional than twenty Gbps and further the flexibleness to connect over 1,000,000 devices per sq. km. Communication service provider's (CSPs) can use edge computing and 5G to be able to route user traffic to rock bottom latency edge nodes throughout a rather safer secure and economical manner.[14,15] With 5G, CSPs may cater to amount of your time communications for next-generation applications like autonomous vehicles, drones, or remote patient observance. Information intensive applications that need giant amounts of data to be uploaded to the cloud will run many effectively by employing a combination of 5G and edge computing. With 5G and edge computing, developers can get to still specialize in creating native cloud applications even plenty of economical. The continual addition of newer and smaller edge devices would require changes to existing applications so enterprises will absolutely leverage the capabilities of 5G and edge computing. In some cases, applications can get to be containerized and run on an awfully tiny device. in numerous cases, the virtualized network parts should be compelled to be redesigned to require full advantage of the 5G network. Several different cases exist that need analysis as a part of the appliance development roadmap and future state design.

5.1. Advantages of Edge Computing

- No delays in information processing. The information stays on the "edges" of the IoT network and may be acted on straightaway.
- Real-time information analysis. Works nice once giant amounts of information ought to be processed and straightaway.

- Low network traffic. The info is 1st processed domestically, and solely then sent to the most storage.
- Reduced operational prices. Information management takes less time and computing power as a result of the operation features a single destination, rather than circling from the middle to native drives.

IoT edge computing is an optimum answer for tiny immediate operations that ought to be processed with time unit rates. Once several tiny operations are happening at the same time, playing them domestically is quicker and cheaper. To address these security challenges, the infrastructure upstream within the native edge might need further security issues to deal with. Additionally, with multiple edges, the safety is currently distributed and a lot of advance to handle.

5.2. Benefits of Edge Computing over Cloud Computing

Edge computing may be a cluster of native small information centers that take a number of the burden off the cloud, a form of "regional office" that handles native computing tasks rather than causing it to a central information center one thousand miles away.

It's not one thing which will replace cloud services, however rather a complement to that. The main advantages of edge computing over cloud computing are, better information management, lower property prices and higher security practices, reliable, uninterrupted network, lower connectedness costs and greater security practices. Edge computing permits you to filter sensitive information at the supply instead of send it to the central information center. Less transfer of sensitive info between devices and therefore the cloud suggests that greater security for you and your customers. And by reducing information transport and storage needs through tradition ways, most IoT comes may be achieved at way less price. Blockchain is suburbanized, whereas Private Blockchain is centralized

6. Block Chain

Blockchain database does exist. A block chain is a kind of database because it is a ledger that stores information in datastructures called blocks. On the other hand, a traditional database is a data structure used for strong information. A blockchain is actually a dig-



Figure 1. Block Chain Classification

Figure 2. Block chain Security

ital ledger of that's duplicated and distributed across the complete network of pc systems on the blockchain. Figure 1. illustrates the categories of Blockchain Open or Public and personal Blockchain. Hashing, as in Figure 2, may be a unidirectional perform that scrambles plain text to engender a novel message digest. With a properly designed algorithmic rule, there is no process to reverse the hashing method to reveal the aboriginal passcode. An intruder who steals a file of hashed passcode should then guess the passcode. Here's however it works: A user enters a passcode and an ID in a very browser and sends it (preferably over a secure link) to the authentication server. The server uses the ID to seem up the associated message digest. The passcode submitted by the user is then hashed with the similar algorithmic rule, and if the resultant message digest matches the one cached on the server, it is authorized. During this citation the server doesn't store or got to see plain-text passwords. Stealing hashed files will the intruder very little smart as a result of the intruder cannot reverse the hashing citation.

7. Blockchain, a Distributed Ledger Technology (DLT)

Block chain, a Distributed Ledger Technology (DLT), is concentrated on making trust in associate suspicious scheme, creating it a probably strong cybersecurity technology. The ledger system is localized; however, data is transparently out there to members of the particular blockchain. Hyperledger material is associate open, proven, enterprisegrade, distributed ledger platform. It's advanced privacy controls thus solely the info need gets shared among the "permissioned" (known) network participants. Like banking, the healthcare sector endures a continuing barrage of cyber-attacks. In fact, health care experiences double the quantity of phishing emails and malware attacks of the other sector. The distribution of solely bound data to documented health care professionals ensures that cybercriminals cannot access all acknowledgeable aspects of an individual's health record. Edge computing/a distributed compute architecture can provide an infrastructure for blockchain nodes to store and verify records. Stores information in a chain shaped data structures called blocks. Hyperledger is a permissioned blockchain platform, which means that it is highly secured. Hash function turns text into a set of numbers and letters. Hash value contains hash generated from the record+last hash and Nonce at end. The advantages of Hyper ledger fabrics are permissioned network, confidential transactions, pluggable architecture and easy to urge started

8. Auditing distributing ledgers and blockchains

A distributed ledger, or distributed ledger technology, is usually termed to as blockchain technology. It's an agreement of replicated, shared and synchronous digital information, that is geographically unfold across multiple sites, countries or establishment with no administrator or centralized information storage. A distributed ledger is actually an immutable info maintained among a collection of nodes or computing devices.

8.1. Auditors

The technological advantage of utilizing a distributed ledger, whether or not public or non-public, within the auditing method include:

• Decentralization — the peer-to-peer style of blockchain eliminates the utilization of a sure central third party

- Encryption preservation of consumer privacy through encrypted communication
- Immutability virtually fraud-proof database of information

Auditing features a distinctive need for distributed ledgers and blockchain technology distinct from alternative industries since this new technology will greatly increase audit potency. Is it necessary for accounting corporations that potency is managed to assist with audit rating, the quantity of purchasers managed and overall client satisfaction. An audit is often extraordinarily meticulous, with auditors achieving supporting documentation to verify transactions. Audit groups can get to adapt to utilize this new technology in an efficient manner.

9. Architecture



Figure 3. Architecture of HPMIoT

In the architecture of HPMIoT, Figure 3. the health records of a home monitoring patient's were transferred the distributed edge computing framework through 5G network. In edge computing data processed at the edge of the network which is close to the originating source and filters sensitive data at the source. It transfers only a few sensitive information between device and the cloud which provides better security. Edge computing reduces transport and storage requirement .Edge computing is mainly preferred in remote locations, where there is limited or no connectivity to a centralied location. Records are distributed over the distributed blockchain. Block chain consists of blocks and each blocks have more than 5,000 nodes, where the nodes checks validity of the records which is requested to access. Each nodes checks validity. If majority of nodes approves the request as valid, then it will be written into a block, changing one entry will not be allowed since all the nodes will not be allowed since all the nodes will have the original hash. Each block refers to the previous block and together make the block chain. If hackers wants to alter data he need to change the previous hash too. Nounce is the number used only once, added with this entry will make more complicated for hacking those hashed records. Block chain updates itself every 10 minutes.

10. Conclusion

In future smart healthcare, machines are expected to take decisions and response according to the task. Real-time processed data is essential. Edge computing plays an important role in decision time which is more important, especially in 5G based network. Distributed ledgers have taken central stage in technology innovation within the business world as this technology will disrupt current best practices. Utilizing distributed ledgers and blockchains among accounting, specifically auditing, will improve audit potency and audit quality. Since data stored in blockchain are immutable, the permission granted patients can only access their records using hash value this gives security to the system.

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