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Collaboration of Blockchain in Healthcare 4.0

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Abstract: In current era of technology, Health record monitoring and treating the patients on-time has gained wide range of scope. Utilizing the blockchain technology, is has gained significant attention to enable remote patient monitoring. Rapid development of Healthcare 4.0 using Cloud Computing to access medical records and operations remotely has gained deliberation from the technical community from a smart city perspective. As Healthcare 4.0 enhances the healthcare experience, it successfully improves the quality, flexibility, productivity, cost-effectiveness, and dependability of healthcare services. The Internet of Health Things, medical Cyber-Physical Systems, health cloud, health fog, big data analytics, machine learning, blockchain, and smart algorithms are all integrated and used. Storing, accessing, managing these healthcare sensitive data is very important. Hence there is a need for a platform that enables to achieve secure medical data storage, sharing, and accessing. Our work mainly concentrates on the modules that are utilized to provide the treatment and maintain health record of a patient in a timely and reliable manner by the healthcare professionals using blockchain technology.

Keywords: Healthcare, blockchain, managing, flexibility, health record

I. INTRODUCTION

Healthcare is one of the most anticipated areas in the 4.0 revolution to achieve great results. The increase in the population and the rising technologies has created high expectations in the effectiveness and need of evolution in the field of healthcare. Therefore, healthcare keeps being one of the most important social and economic challenges worldwide, asking for new and more advanced solutions from science and technology. Healthcare is one of the most anticipated areas in the 4.0 revolution to achieve great results. Today's industry is more computerised than in previous decades, with x-rays and magnetic resonance imaging giving way to computed tomography and ultrasound scans, as well as electronic medical data. Rising demand for high-quality healthcare services [3], [4]; size and complexity of the healthcare value chain; the need for collaboration among healthcare providers and supporting industries and organizations; and intense competition among healthcare providers.

A significant role can play by technology while improving the quality of service for the patients. It allows data analytics to take appropriate medical decisions. Additionally, it helps to reduce the costs by the efficient allocation of medical resources such as equipment, personnel. Medical data dissemination has received the researcher's attention for novel approaches for patient treatment. The significance of medical data and the integration with its distribution has given origin to enterprise substances that consolidate, process, interpret, store, and presented the appropriate incentive distribution of data with other connected individuals (Huang et al. 2018; Aceto et al. 2013; Assis et al. 2014; O'Driscoll et al. 2013). Storing, accessing, managing these healthcare sensitive data is very important. Hence there is a need for a platform that enables to achieve secure medical data storage, sharing, and accessing in cloud service provider, several cryptography algorithms are designed. Healthcare 4.0 is instead deeply characterized by the adoption of three main paradigms: the Internet of Things, Big Data, and Cloud Computing that together are revolutionizing eHealth.

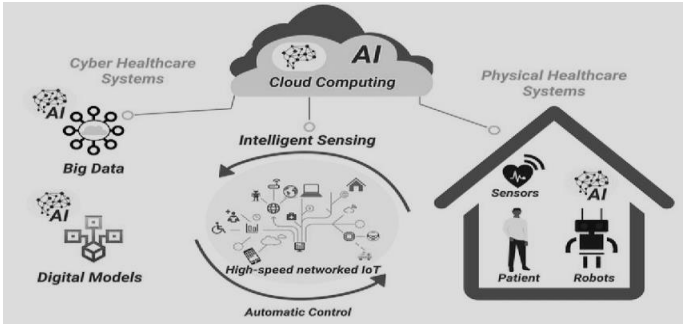

Fig 1 : Technology integration in a Healthcare 4.0 scenario. Adapted from Yang et. al [38].

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II. BACKGROUND

Some of the technologies that have led to the advancement in the field of Health 4.0 :

1 . Health Cloud :

Cloud customers get the benefit of actually unlimited resources on demand. They are capable of either deliver or leverage everything-as-a-service: the most general services are considered as Platform, Software, or Infrastructure-as-a-Service (PaaS, SaaS, and IaaS, respectively), with more differences. The cloud large scale infrastructure provides scalable and on-demand computation, data storage, and advanced software resources and services for healthcare applications [6]

2. Cyber-Physical System (HCPS)

The Health 4.0 Cyber-Physical System (HCPS) contains several types of computers, communications, storage, interfaces, biosensors, and bioactuators. The HCPS paradigm permits observing processes from the real world, as well as monitoring patients before, during and after surgical procedures using biosensors. [7]

3. Internet of Services (IoS).

When functionalities of medical and healthcare devices, systems, and organizations are provided as software services with well-defined interfaces over the Internet [1], they are referred to as IoS. The services on IoS (IoHS in healthcare) become the building blocks for new healthcare systems and to enable automation and collaboration.

4. Health Big Data Analytics.

Huge amount of data accumulate in healthcare systems over time. These become the input for decision making and future planning applications. Big data analytics offer advanced mechanisms to discover health trends, correlations, and insights from this data. This helps enhance healthcare services, systems, and treatment procedures; reduce healthcare costs; enhance healthcare services quality; and provide information to facilitate public health decisions and provide personalized treatments for individuals [2].

OBJECTIVES OF HEALTH CARE 4.0

- Providing health services to the patient with an improvised performance and reliability.
- Patients data must be secured which gains the confidence over the system.
- User friendly tools that is more effective in usage with respect to the healthcare professionals and the patients.
- Should provide remote access to the patient information, such that timely diagnosis and treatment can be provided to the patients without unnecessary delays.
- Must preserve the patient health record for a longer duration which can enforce or help in the field of research and future reference to these data by the healthcare professionals.
- It should provide a well sophisticated maintenance and continuous monitoring over the healthcare records and tools, and must provide the operational benefits in cost effective manner.

BACKGROUND OF BLOCK CHAIN

Blockchain technology is most simply defined as a decentralized, distributed ledger that records the provenance of a digital asset. By inherent design, the data on a blockchain is unable to be modified, which makes it a legitimate disruptor for industries like payments, cyber security and healthcare.

A simple analogy for understanding blockchain technology is a Google Doc. When we create a document and share it with a group of people, the document is distributed instead of copied or transferred. This creates a decentralized distribution chain that gives everyone access to the document at the same time. No one is locked out awaiting changes from another party, while all modifications to the doc are being recorded in real-time, making changes completely transparent.A blockchain is a database that stores encrypted blocks of data then chains them together to form a chronological single-source-of-truth for the data.

- Digital assets are distributed instead of copied or transferred, creating an immutable record of an asset

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- The asset is decentralized, allowing full real-time access and transparency to the public
- A transparent ledger of changes preserves integrity of the document, which creates trust in the asset.
- Blockchain's inherent security measures and public ledger make it a prime technology for almost every single sector

Every chain consists of multiple blocks and each block has three basic elements: Block, Miners and Nodes

- The data in the block.
- A 32-bit whole number called a nonce. The nonce is randomly generated when a block is created, which then generates a block header hash.
- The hash is a 256-bit number wedded to the nonce. It must start with a huge number of zeroes (i.e., be extremely small).
- Miners create new blocks on the chain through a process called mining.
- In a blockchain every block has its own unique nonce and hash, but also references the hash of the previous block in the chain, so mining a block isn't easy, especially on large chains.
- Nodes - Every node has its own copy of the blockchain and the network must algorithmically approve any newly mined block for the chain to be updated, trusted and verified. Since blockchains are transparent, every action in the ledger can be easily checked and viewed

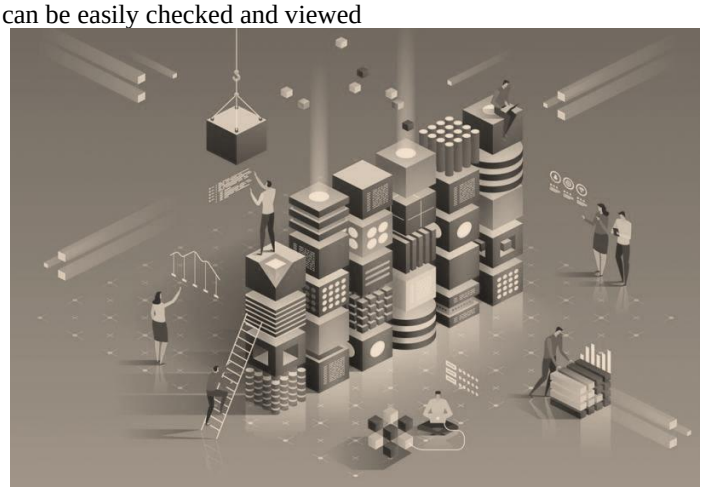

Fig. 2 Blockchain

III. HEALTHCARE 4.0 USING BLOCKCHAIN

Fig. 3 Features of Blockchain HealthCare Domain

The proposed system contains the following modules that enforce the effective monitoring of patient health record:

- Patient Application : Patients will access the system, present their needs and the system will automatically walk them through all the necessary steps and seamlessly move the relevant data from their medical records among the different entities involved like doctors, nurses, laboratories, and pharmacies. Patient also provides access of his health record to the healthcare professionals.

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- Membership service provider : It keeps track of all the nodes / participants taking part in this block chain enabled healthcare system. It is also responsible to issue Certificate of Authenticity.
- Hyperledger fabric blockchain network : The network is created from the definition of the consortium including its clients, peers, channels, and ordering service(s). The ordering service is the administration point for the network because it contains the configuration for the channel(s) within the network.

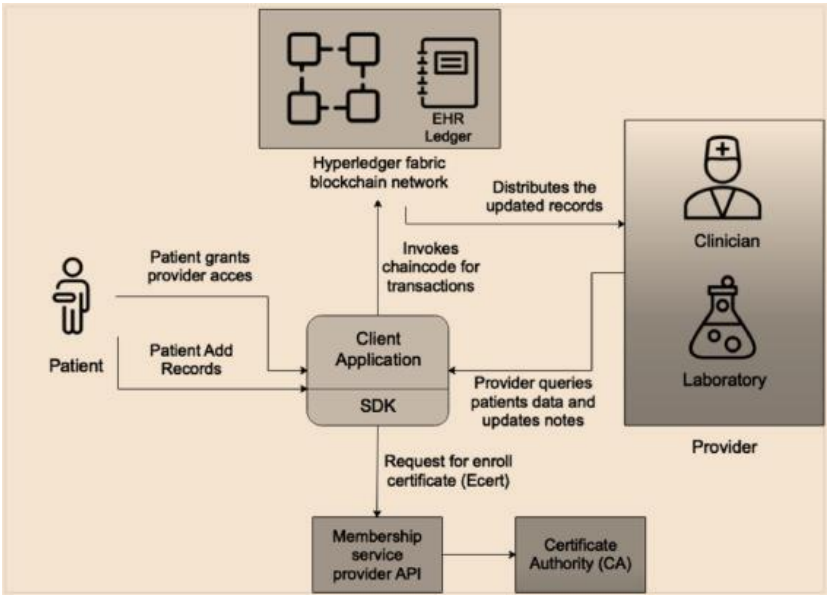

Fig. 4 Modules of HealthCare 4.0 using Blockchain

When the patient is in need of treatemnet, in such situations, if there is a blockchain registry where the patient's data is stored, the healthcare professionals / clinicians can identify if the patient was treated at other clinics or another immediate healthcare hospitals. If the healthcare professionals have all these information readily available, they can have a better understanding over the patients conditions, overall health of the patient, his treatment history and investigations they had undergone, which will drastically reduce unnecessary duplication and avoid irrelevant, superfluous and redundant avenues of investigation. This will result in time saving and reduced capital expenses that incur to the patients. It also increases the efficiency and timely treatment of the patient. These abilities are what gives blockchain the potential to dramatically impact the efficiency and costs of healthcare delivery. Fundamental problems experiences in healthcare delivery include lack of management of data, and how data can be made verifiable, immutable, and distributed. Blockchain technology, therefore, can be used to provide automated database services for aggregated and secure data.

Various stage of directing a patient to the healthcare professionals:

- In the first stage, healthcare providers have direct connection to the blockchain; all clinical data is tracked and stored in the existing health IT systems.
- Request to the patient for accessing the information is sent by the professional. Various data related to patients, using Patient IDs, is transmitted to the blockchain network via API.
- In the blockchain system, a smart contract is then used to execute the inward transactions.
- All transactions are committed in the blockchain network using patient public IDs that do not contain personal information. The blocks are created and chained through the immutable ledger.
- All transactions are then committed and uniquely identifiable. The database of blocks stores only non-identifiable patient data, such as gender, age, and illnesses, etc.
- Clinical data is analyzed to uncover new insights.
- Finally, if the patient wishes to share his/her identity with the healthcare provider, they can share their private key. This is how the provider can then access the patient's data and provide solutions or care for identified symptoms.
- Obviously, the data remains confidential to those who do not have the private key of the patient.

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IV. CONCLUSION

HealthCare 4.0 greatly aims towards automated targeting to treat patients in a timely manner. Health 4.0 is one of the areas that are extremely beneficial to the society in need. In this paper we mainly focus on the system to enhance the treatment of the patient health record. It mainly focuses on monitoring and treating the patient using blockchain technology. Health Care 4.0, identify multiple research challenges and opportunities of Health Care 4.0 in terms of data, model, dynamics, and integration, and outline the implications of people, process, system and health outcomes.

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BIOGRAPHY

Sushma V has been awarded with B.E and M.Tech degree from Visvesvaraya Technological University. Currently she is working as Assistant Professor in ATME College of Engineering, Mysuru. Her research interests include optimization in sensor networks, data transmission and security in cloud computing.

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