BLOCKCHAIN USE IN HEALTHCARE: EXPLORING OPPORTUNITIES AND CHALLENGES

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Abstract. *In the grand scope of things, the blockchain technology is quite young, thus making it subject to future developments of new use cases, meanwhile it has already proven itself as a viable alternative to solve existing and upcoming business challenges. One key industry that is starting to implement the blockchain as a security and validation method is the healthcare sector, where a decentralized ledger can be used to address critical conundrums related to remote healthcare access, emergency protocols and data integrity. This research paper dives into the existing challenges that the medical space is exposed to and the intricate use cases of this technology in drug production, validation and prescription as well as in patient data privacy. The blockchain as well as any other working mechanisms has its advantages and drawbacks, in this research paper we will explore the known vulnerabilities and methods to mitigate them ensuring a stable and secure platform to be used in the healthcare industry, that creates a trusted and free of fraud solution for medical professionals to utilize.*

Keywords: *consent management, electronic health records, immutable ledger, pharmaceutical supply chain, patient data privacy*

Introduction

The appearance of Blockchain technology created a unique point in time in the space of data management and security, although still quite young, it has proven it`s immense potential to revolutionize diverse business mechanisms. One industry where the Blockchain is starting to be implemented is the healthcare sector.

The main principles which a blockchain operates by, such as decentralization, immutability and consensus, are the exact reason to why the concept of a distributed ledger system works and has a real-world use in every industry in order to provide secure and tamperproof transactions. In a world where patient data privacy and integrity are of prime importance, a system like the blockchain is a must, it allows the implementation of consent based data access and mitigates the risk of transaction interference, thus setting the ground for a secure and trusted industry.

The blockchain provides a mechanism where any sort of third party doesn`t have control over the data stored, making it a safe decentralized solution, ensuring trust between both parties of a transaction through a peer-to-peer sustained validation.

EHR and patient data management

Given the fact that each year the amount of data, that is being processed in a digital maner, rises exponentially, and more governamental institutions adopt some sort of digitalisation oriented agenda, the need for a safe and convenient method of storing said data becomes paramount. In the medical field, patient data privacy legislation and the need for untamperable health records, imply that the needed solution should correspond to today`s standards of cybersecurity. The proposed mechanism that fits the mentioned above criteria is the Blockchain with it`s potential use in electronic health records and patient data management. The ability to store and secure vital information about a patient is extremely valuable to any data-based industry, more so in the healthcare sector, where this technology is able to provide a efective and robust solution. Fig.1 presents a structure which utilises the blockchain in healthcare data management.

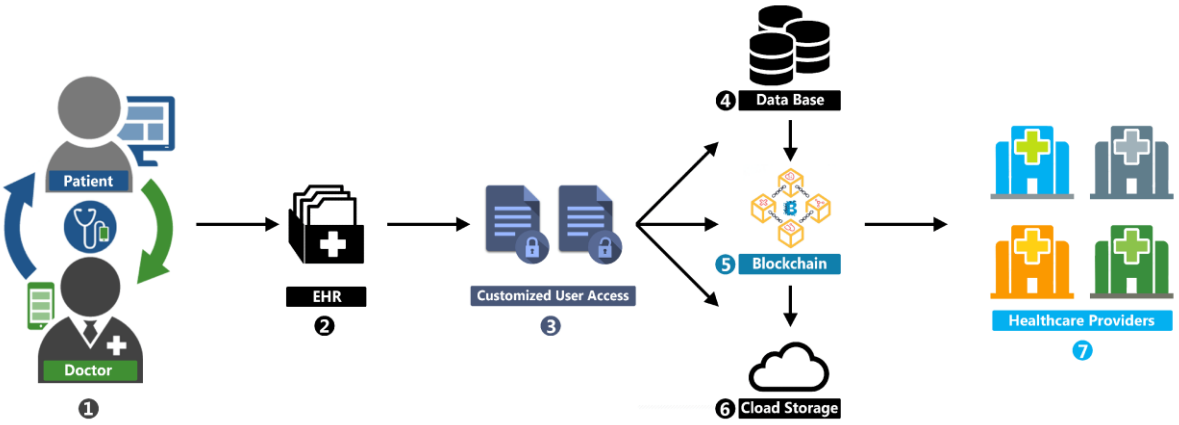

Figure 1. Healthcare data management in blockchain [1]

1. Patient-Doctor interactions, such as medical examinations, prescriptions, surgeries, and so on, generate the base data that needs to be stored.
2. The initial data is processed and used to create a unique Electronic Health Record for each patient.
3. Sensitive user data access policies are being taken into account to create custom ownership and control, that is granted only to said patient, meaning that any third party that wants to gain access to that information needs to request the approval of the owner.
4. This is the main step in this structure, where a database and a cloud storage solution are set in place to keep the information in a distributed manner and the blockchain, which allows for the authentication and safekeeping of that data for future use.
5. Healthcare-providing institutions and professionals are integrated into a network through which they can access vital data about patients, at an instant regardless of their location and the time of the day.

This is how it is possible to implement the blockchain to create a countrywide network of patient data, made accessible to every medical professional, of course respecting the legislation and policies regarding personal information privacy via a set of rules and access barriers made to ensure that every piece of confidential data is requested directly from its owner. The nature of the blockchain makes every single transaction ever recorded irreversible and safe from future tampering, thus creating a safe and solid database for keeping safe records about vital specifics of each patient, things like allergies, medical procedures, anomalies, past illnesses, data for creating patterns and predicting the progression of existing diseases.

Blockchain in pharmaceutical supply

With the huge consequences that come with the use of counterfeit or gone-bad drugs, came the need for a solution to keep track of and authenticate every step of the process which the supplies undergo before getting into the patient`s hands. Another use case for blockchain technology in the medical sector is in the pharmaceutical supply chain. Below we can see the potential method of implementation of this tehnology into the pharmaceutical supply chain infrastrucure.

First of all the manufacturer of the drugs creates a unique identification code(for example a QR code) assigning it to a node in the blockchain. Thanks to the fact that each subsequent node contains its own hash value as well as the hash of the previous node, it is virtually impossible to tamper with the already validated nodes, thus making every following transaction involving a specific batch of drugs trustful.

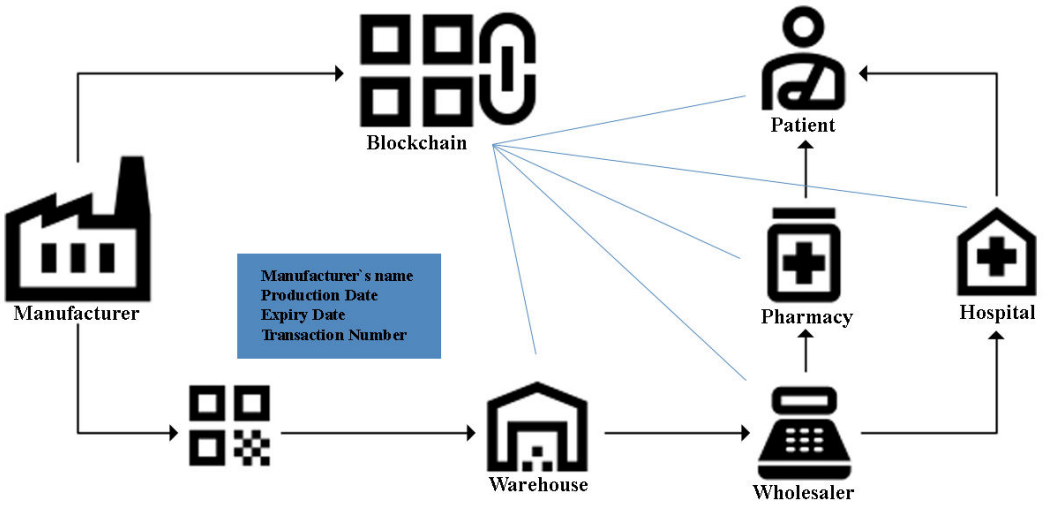

Figure 2. Blockchain implementation into supply infrastructure

The mentioned above identification code contains all the information about each and every medication, the manufacturer`s name, production and expiry date, as well as any other specifics worth mentioning. The unique code assigned to the drugs helps the identification of them on the blockchain. When the package gets stored in a warehouse, the conditions and period of storage, as well as the distributor`s signature get inputted into the blockchain.

The future commercialisation of the medicine by wholesalers, pharmacies and hospitals will be accompanied by their signature on every drug handled. By recording the transactions at each stage of the supply chain, tracking and traceability can be made possible in the drug supply chain [2].

Vulnerabilities

One of the most critical vulnerabilities that stands out, especially for newly created blockchain infrastructures, is a 51% attack. This exploit takes place when a single entity within the system gains the majority of staking or computing power, making it possible for them to single-handedly influence major decisions on the blockchain. To prevent this kind of attack, peers on the network should ensure that no single user of the mechanism has the majority stake.

The next weakness, Sybil attacks, occur when a malicious node operator creates and gains control over multiple accounts or numerous arrays of nodes, thus gaining leverage over the network layer of the blockchain, opening opportunities for future 51% attacks. In order to prevent Sybil attacks, a network should be constructed in a way that prevents any single validator on a single IP address manages more than one node.

Cryptographic attacks and private key prediction represent some of the more severe exploits of the data layer of the blockchain. Brute Force, Man-in-the-Middle, and Replay Accuser are all types of cryptographic attacks, posing risks to the key management mechanism that ensures the validity of the transactions on the ledger. Furthermore, the accounts of the participants on the blockchain can be compromised when private keys can be easily predicted, leading to unwanted actions on the victim`s account. It is essential to implement robust cryptographic practices, like the use of trusted and safe algorithms for key generation and transaction validation, in order to safeguard the system from the attacks mentioned above.

Conclusion

The blockchain, still a relatively young technology, gained a significant amount of distinction in the cybersecurity and data management space for its core principles such as Decentralization, Immutability and Consensus. Considered independently, the features it provides are not new, and most of the systems it is based on have been well known for years, the

combination of these properties, makes an outstanding choice for a wide range of purposes, which accounts for the critical interest level from various sectors [3]. A lot of traditional methods used by numerous industries are just not up to today`s standards, creating a need for a fitting solution, in this case, that is the blockchain in the medical field. In this article we proposed 2 possible implementations of this technology in the healthcare sector, namely for Electronic Health Record management and the whole process and infrastructure of the pharmaceutical supply chain. By also exploring the known vulnerabilities we can adjust and build safer blockchain networks, ensuring the integrity and safety of the stored data. The applications discussed in this paper serve as a solid building ground for future developments in the space of data management, especially in the medical sector.

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