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BLOCKCHAIN TECHNOLOGIES

Blockchain Technology in Healthcare
Background and Applications

Potential of Blockchain Technology

A blockchain is a distributed computer system for securely storing data, running computer programs unstoppably, and easily transferring digital assets. Blockchain offers security through cryptographic procedures – without requiring a trustee.

The highly disruptive nature of Blockchain and its impact on the economy in all industries makes it essential to understand Blockchain. Many of the expensive and currently necessary services of intermediaries such as administrations, associations, banks and notaries and other service providers are no longer needed using blockchain technology. The disruptive potential

of blockchain technology is very significant as the elimination of previously necessary steps leads to processes being vastly accelerated. This increases sales and saves costs.

This article explains blockchain technology at a simple level and demonstrates its potential for the healthcare industry.

What is Blockchain Technology?

Put simply, a blockchain is an immutable record of digital events that can be written just once and then read any number of times. It is possible to build applications with the underlying blockchain technology and to introduce additional functionalities such as smart

contracts, payment or counterfeit protection. As the Internet has made it possible to transfer information, blockchain offers the ability to transfer funds and assets.

The security of blockchain technology surpasses the security of any previously existing system. Using blockchain technology, systems can be developed that are extremely secure from hackers. In a world where hacker attacks on centralised servers are becoming increasingly common and damaging, there is an immense interest in this technology.

As blockchain based systems run over existing internet infrastructure, it has the potential to become ubiquitous. Every PC with internet connection and every smartphone allows access to this technology.

Today, many people associate blockchain with Bitcoin, one of the most widely-known implementations for transferring digital currency. But Bitcoin is just the starting point for hundreds of other applications using blockchain technology.

For the healthcare industry, blockchain technology is disruptive and brings many benefits. Nevertheless, it is not a panacea for all business problems. Rather, it is necessary to analyse current business processes and IT risks in order to create blockchain based solutions that can deliver real customer value and be productive. It is clear that the first to succeed will benefit from the disruption. Particularly in the healthcare industry, there are efforts underway to develop patents to protect concepts and technologies related to blockchain and first movers can capitalize on patent fees.

What makes Blockchain Technology so unique?

The longer the data is on the blockchain, the more immutable it becomes. Even Blockchain operators cannot manipulate the data anymore. After only 10 minutes, the cost of falsifying entries on the blockchain is several million US dollars. After 4 hours, the financial resources needed for falsification run into the billions. After 12 hours, entries on the blockchain are considered impossible to fake.

Due to the redundant data storage, the failure of individual nodes running blockchain software no longer affects the overall system. This means that if individual nodes fail, the system will continue to work. When the failed node goes back online, it updates itself automatically. Encryption techniques make it possible that even the administrator of the private blockchain server cannot see the contents of the data that is being hosted. This allows for confidentiality, security and privacy, all of which is particularly important to the healthcare sector.

Three Types of Blockchain

There are basically three types of blockchain systems that differ based on their permission rights, methods to reach consensus and transaction speed.

Public Blockchain

A public blockchain is a blockchain that anyone in the world has access to. In addition, anyone can submit a new entry to this blockchain and get it recorded.

Public blockchains are backed by economic incentives and cryptographic verification. Here, methods such as "proof of work" are applied. Due to the extremely redundant data storage in public blockchains, transactions are associated with relatively high costs. A transaction on the bitcoin blockchain currently costs between 10 Cents and 20 Euros.

Private Blockchain

A private blockchain is a blockchain in which the permission to record entries is centralized within one organization. Permissions to view entries may be shared publicly or restricted to certain parties within a business network. Possible applications for this are internal database management or auditing for a single organization. Access outside the organization is thus not necessary in many cases, although in some cases, public auditing can be made possible. Private blockchain transactions are fast and incur low to no transaction costs.

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Consortium Blockchain

A consortium blockchain is a blockchain in which the consensus process is controlled by a defined set of nodes. For example, imagine a group of ten pharmaceutical manufacturers forming a consortium. For a block to be valid, at least seven organizations would need to provide their confirmation.

An example of an application here could be a consortium blockchain for pharmaceutical companies, which have joined together to protect the industry against counterfeit drugs. In this blockchain based system, it is ensured that the business data of one company is not visible to the other. Consortium blockchains are like private blockchains in that they are fast and have lower costs, but also have the additional advantage that they work across organisations without allowing any one organisation to manipulate the data.

Applications in the Healthcare Industry

Beyond the financial services industry, blockchain applications are emerging in the healthcare industry. Health authorities, governments and service providers are vigorously evaluating new opportunities offered by blockchain technology.

Health Data Exchange

Patient data is currently distributed in multiple siloed structures across digital databases and paper based systems. Many of these systems are not compatible with each other making communication and information sharing either complex or nearly impossible.

Blockchain based IT systems provide solutions for secure health data with interoperability, integrity and confidentiality. This would allow seamless access to both historical data and real-time patient data, while eliminating the hassle and cost of data reconciliation. Using blockchain technology, data silos can be eliminated. Healthcare data, such as electronic health records, can be securely stored, exchanged, and managed via the blockchain. The patient has control over their personal health data which is accessed securely using blockchain technology - without middlemen and intermediaries. Patients chose the provider of their choice and provide access to their personal records and they also have the possibility to revoke access as needed. All these steps can be documented transparently in the blockchain.

More interoperability through blockchain technology saves costs and even improves data protection.

Patients also benefit as the quality of care can be improved.

Medication Planning

To ensure optimal patient care, a reliable medication plan is essential. This ensures that patients do not take two drugs with hazardous interactions. In the past, there have been cases of fatal drug combinations that have led to death.

Smart contracts based on blockchain technology can provide reliable medication planning. Newly prescribed prescriptions are automatically matched with the existing medication prescriptions using smart contracts. Only when a drug combination is considered safe, will the new drug be validated using blockchain technology and issued. Verification can be automated by accessing an external database from a smart contract that lists all known drug interactions. The history of the patient's medication usage is immutably stored on the blockchain and can be tracked at any time.

Accounting Management

Blockchain based systems provide realistic solutions to minimize fraudulent medical billing. It is estimated that ten percent of healthcare costs are incorrectly incurred and result from over-billing or billing for undelivered services. For example, the service description of the medical staff being used for billing could be programmed using Smart Contracts and stored transparently on the blockchain.

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By automating payment processing, blockchain systems can eliminate middlemen as well as reduce both administrative costs and time needed for service providers. In addition, the billing of the hospital with the patients' health insurer can be done automatically. Finally, the payments between health insurance and the service providers can be automated.

Medical Research

Blockchain technology makes it possible to create unaltered records of clinical trials, protocols, and timestamped results to potentially address the issues of counterfeiting, data theft, and selective reporting, thereby reducing the frequency of fraud and errors in clinical trial records.

In addition, blockchain based systems can help facilitate unprecedented collaboration between participants and researchers to drive innovation in medical research in areas such as precision medicine and population health management.

The so-called multi-party computation makes it possible to calculate a result from encrypted data records so that only the doctor and the respective patient are informed of the result. This is one way big data analysis can be done without compromising patient privacy. A central authority as a trustee of the data is no longer necessary. Pharmaceutical companies can protect their intellectual property and still contribute to data analytics and intelligence gathering.

Optimizing the Supply Chain

The pharma supply chain organizes the development, production and delivery of medicines. Both ingredients and ready-made drugs are transferred across several parties. This means a lot of contracting, which costs time and money. Blockchain technology can help optimize production, rights management, revenue sharing, patent rights and drug delivery. The pharmaceutical supply chain is international, as production has been outsourced to many countries. Blockchain technology works across borders and internationally, so it can track the entire manufacturing and delivery process across companies.

Using blockchain technology, contracts can be digitized and processes can be accelerated. As with Bitcoin, blockchain technology can be used to limit quantity of drugs produced. It can thus be ensured that an overseas contract manufacturer can only produce and label the quantity as agreed in the contractual terms. The amount of active ingredients can be easily distributed across tablets of different dosages and automatically ensured that only the commissioned amount is produced. Overall, blockchain technology can help pharma companies to spend less resources on producing and delivering medicines.

Counterfeit Protection of Medicines

The World Health Organization (WHO) estimates that worldwide, ten percent of all drugs are counterfeit or of lesser quality. In some regions, it is up to 50 percent. Based on industry estimates, pharmaceutical companies around the world lose $ 200 billion a year in drug counterfeiting.

Consumers want to be sure that the medicines they take contain the right ingredients at the correct dosages. For counterfeit drugs, this is hardly ever the case. Blockchain based systems can be used to create a guarantee of origin, ensuring that a given supply of medication comes from a factory or from a particular manufacturer. Linking the physical security features to the digital blockchain backend can provide the same level of trust for the supply chain as currency or financial assets.

The decentralized management of a pharma supply chain with tamper-proof technology is very useful in protecting against counterfeit medicines. Blockchain technology brings significantly better protection than the government mandated serialization solutions, according to which packaging must be provided with individual serial numbers. Blockchain based systems make it cheaper for pharmaceutical manufacturers to protect against counterfeiting and thus reduce the operational costs of fighting counterfeit drugs. Blockchain based solutions speed up the detection of counterfeits and reduce the presence of counterfeits. Overall, it is possible to completely dry out the black market for pharmaceutical counterfeits. By quickly

detecting counterfeit drugs, blockchain technology saves billions of dollars for pharmaceutical companies and redistributes the savings from tackling counterfeiting to the sale of original medicines.

Connected Medical Devices

In the healthcare sector too, players are benefiting from Internet of Things technologies. Many medical devices communicate via digital interfaces such as WLAN or Bluetooth. These are potential targets for gaining access to sensitive and personal health information. In the medical field, there are always cases in which devices have been manipulated by unauthorized persons and caused great damage. By being part of a blockchain based system, the integrity and quality of interconnected medical devices can be protected through encryption methods. The public-key-infrastructure being anchored in the blockchain ensures an overall secured communication in between the devices. Blockchain technology ensures that, on the one hand, it meets the high security requirements of the industry and, on the other hand, allows regulated access to the data. Privacy and confidentiality of end users is always protected and at the same time offering a high convenience for all parties involved.

Ransomware

The threat of ransomware attacks is omnipresent today and the implications are reported daily by the media: the computer is locked; all data is irretrievably encrypted. Even after the ransom is paid, the chances of getting the data back are low. Healthcare sector is a particularly sensitive target for these kinds of attacks.

Blockchain provides protection against ransomware attacks: data is distributed and versioned in the blockchain. Thus, it is possible to reconstruct the data in the case of a ransomware attack. Blockchain based systems offer secure authentication capabilities that protect against ransomware targets.

Cyber Security

Health data is becoming an increasingly popular target for hackers and is sold for more money than credit card numbers. The consequences of a single cyberattack can be devastating and cause huge losses.

Obviously, there is a high security risk associated with centralized ownership of medical data. In recent years, more and more companies have been affected by cyberattacks. For example, the company Quest Diagnostics, which offers diagnostic services for millions of Americans every year. In the attack on a mobile app, the health data of 34,000 people were hacked. The breach contained name, date of birth and lab results.

The second largest health insurance giant in America, Anthem, reported that the data of 78.8 million people had been compromised. The attackers gained unauthorized access to Anthem's IT system and received personal information from customers such as names, birthdays, social security numbers, addresses, e-mail addresses and employment information, including income data.

In addition to the damage to customers, the consequences for companies are incalculable. Loss of reputation and billions in costs go hand in hand with a hacker attack.

The encrypted storage of server data helps prevent theft by server hacks, as hackers only see encrypted data. The authorized persons are given the opportunity to decrypt exactly the data for which they are permitted by using a granular rights system. By means of statistical analyses, blockchain based systems can also automatically ensure that data is accessed only to the normal extent. The worst-case-scenario where all data is lost, is thus prevented.

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Summary

In order for the healthcare industry to fully benefit from blockchain technology, it is important to implement several synergistic techniques in parallel. These are IoT, digital signatures, big data and business analytics, all of these can be accelerated and secured using blockchain technology.

Everyone in the healthcare industry can benefit from blockchain technology: patients, physicians, healthcare providers, health insurance companies, and scientists. The benefits range from interoperability, speed, cost savings, data security, protection against counterfeit medicines and patient transparency to improved research opportunities.

About the Author

Michael Mertens is a computer science graduate from the University of Aachen, Germany focussing on IT security, mathematics and cryptography. He has been involved with cryptography for more than 25 years. His focus is on the combination of cost-effective IT security and the practical application of encryption. He is a recognized expert on blockchain and IT security and speaks regularly at conferences and universities.

About CryptoTec

CryptoTec has been developing and operating blockchain based systems since 2008. The company is specialised on building industry-specific commercial blockchain solutions. Main focus is on the development of high-performance transaction-based solutions and blockchain based systems where data confidentiality is critical.