Toward Trusted Blockchain Technology in Healthcare through Security and Privacy

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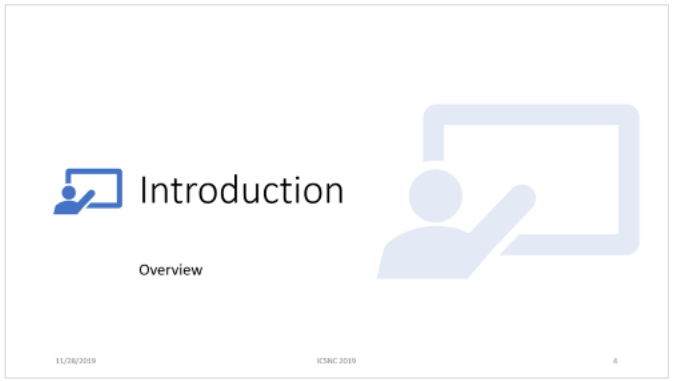
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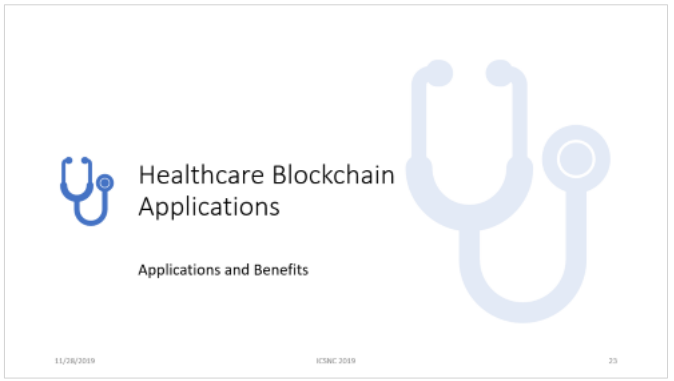
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Introduction

Overview

“No matter how you look at it, blockchain and healthcare is a match made in heaven. “ [1]

Codrin Arsene
CEO of Digital Authority Partners

Introduction

Current Healthcare System [2]

From drug supply chains to health records, everything is managed through the traditional computer and paperwork system.

Lack of reliability due to lack of parity between the parties involved in the data management system

In the healthcare sector, critical patient data and information remains scattered across different departments and systems.

Introduction

Current Healthcare System [3]

400,000 deaths.

80% due to miscommunication of patient-related data.

Manual documentation by filing 20,000 forms with an average cost of $20.

Introduction

Current Healthcare System [2]

50% of unreported clinical trials.

Up to 40% of healthcare provider data records are filled up with errors or misleading information.

$380 Healthcare data breaches cost.

This amount is expected to increase.

Introduction

The impact

- Human loss
- Financial loss

Security

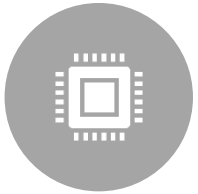
Current Healthcare System [2]

Patients don’t have any control over their data	• Identity thefts • Financial data crimes • Spamming
Healthcare industry suffers from security	• Security breaches

Introduction - Solution

Blockchain can deliver a promising solution

Making data interoperable and providing doctors with real-time access to it.



Incorporate a technology that promises to seal all the loopholes.

Securely sharing data.

Introduction - Solution

"An open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way" (Iansiti and Lakhani) [4]

Introduction - Solution

"Blockchain technology is considered as a trustless distributed ledger to collect, store, share, analyze, and validate medical data exchange among different stakeholders (such as health care organizations, providers, and patients) " (Yue and et al.)[5]

Blockchain in Healthcare

20% of US GDP on healthcare [1]

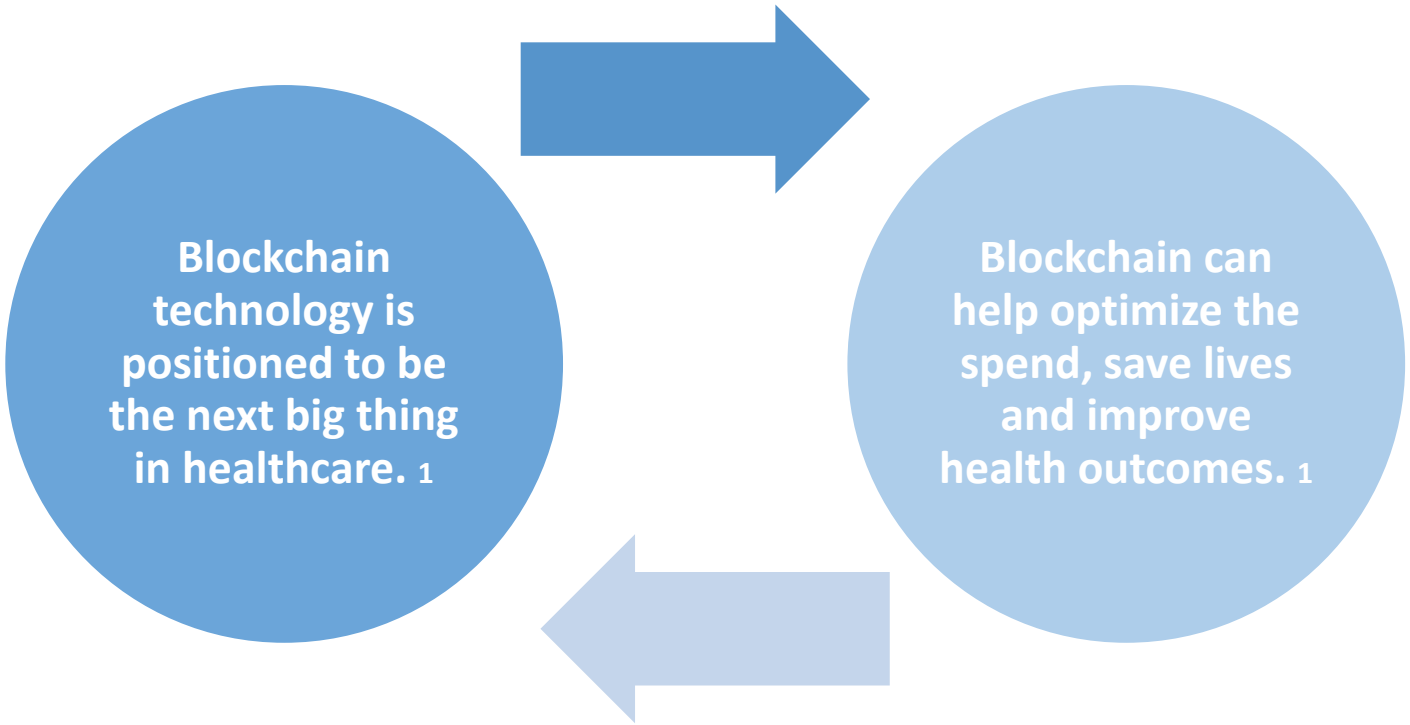
2020

- 1 in every 5 healthcare organizations use blockchain for information management and patient identity purposes. [2]
- 16% of healthcare executives implement blockchain solution. [3]
- 56% adopt blockchain. [3]

2025

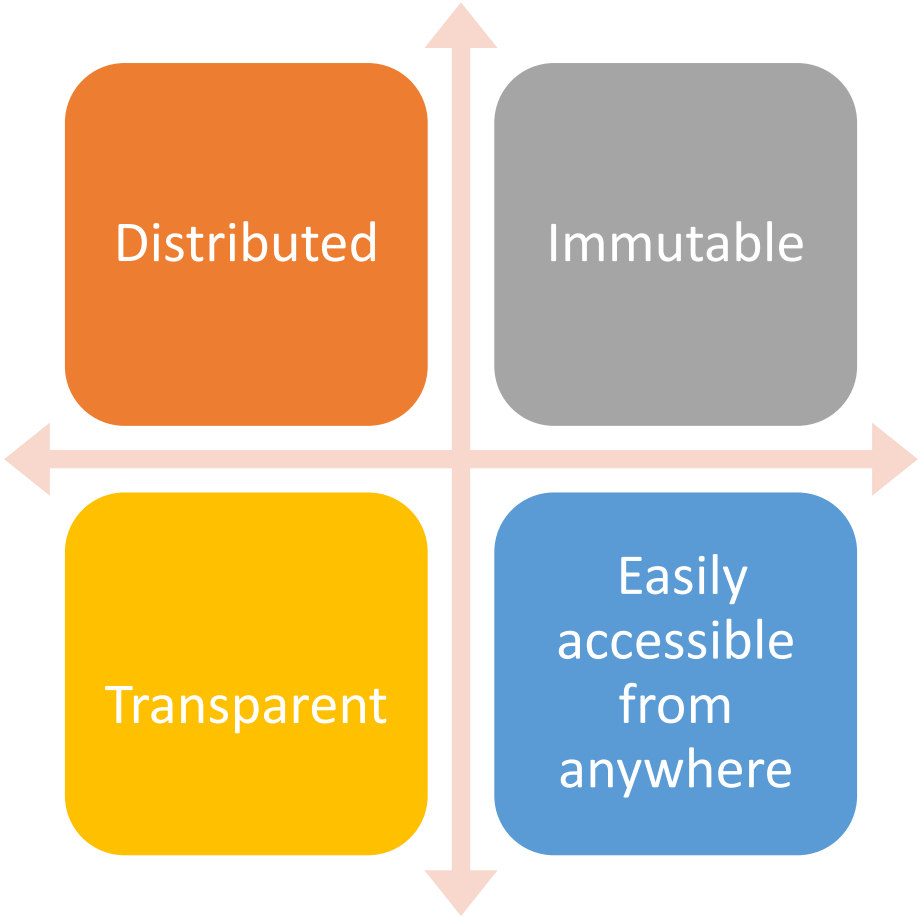
- 55% deploy blockchain for commercial purposes. [2]
- valuation of blockchain jump from $170 million to $5.61 billion. [2]

Blockchain in Healthcare



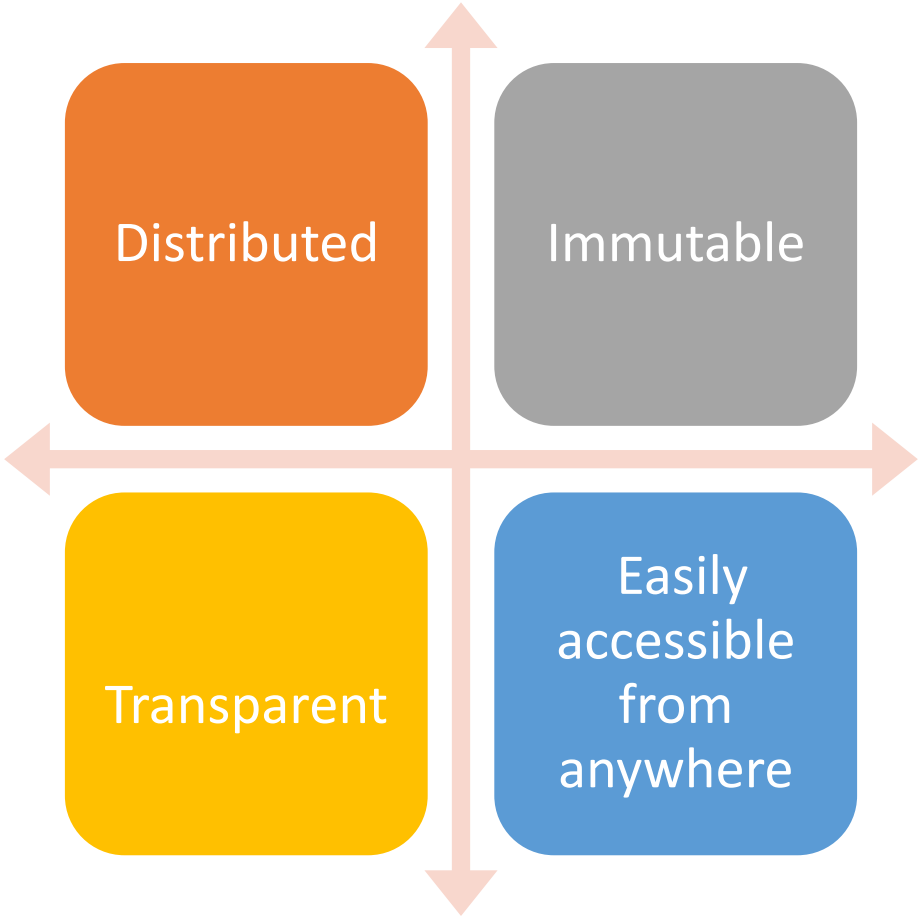
Blockchain Features

Blockchain features 6



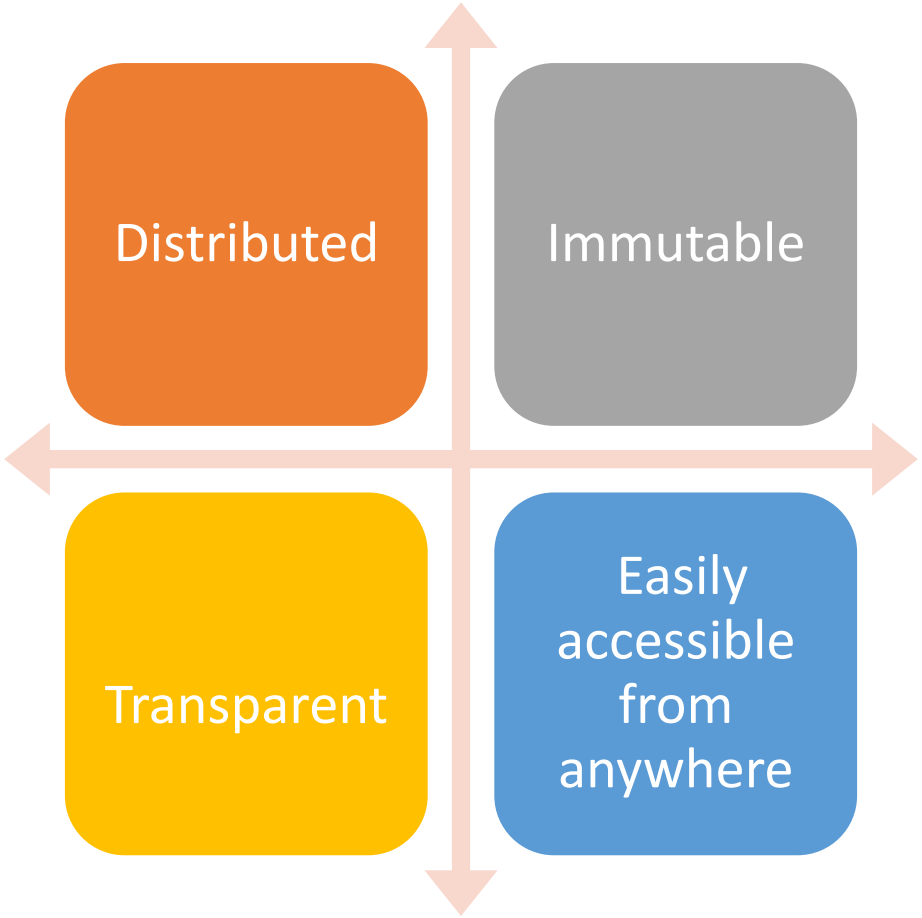
Blockchain Features

The data can be accessed, monitored, stored, and updated on multiple systems.

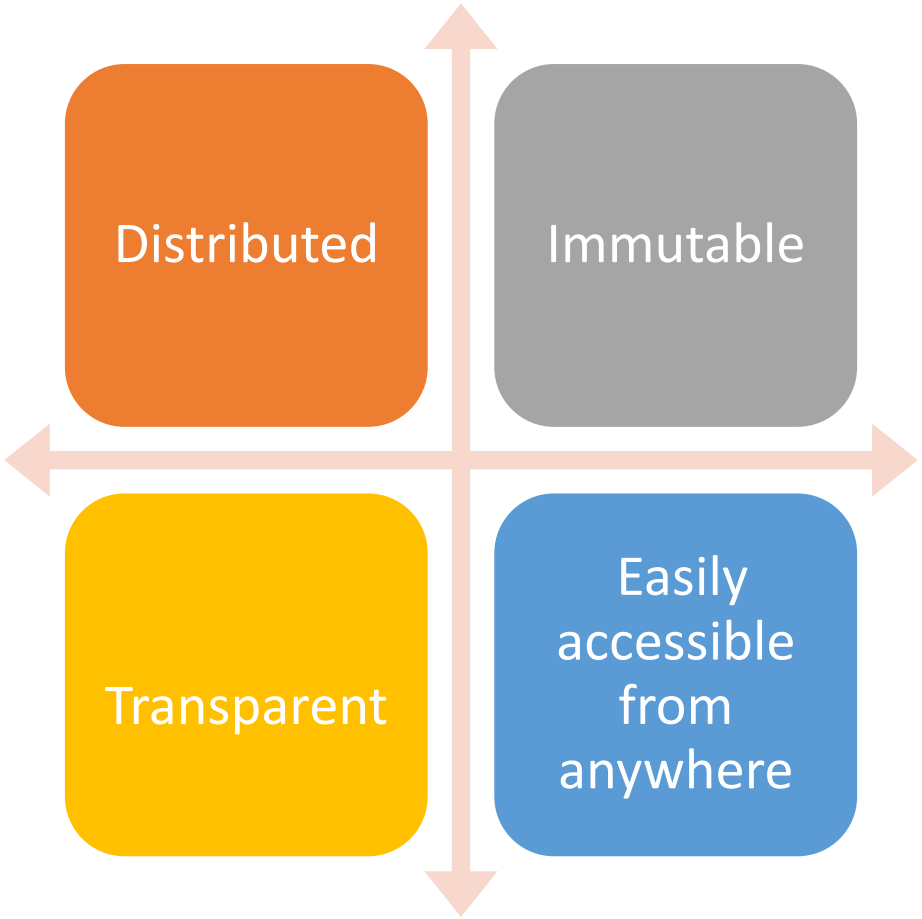


Blockchain Features

The transparent nature of blockchains could certainly prevent data from being altered or stolen

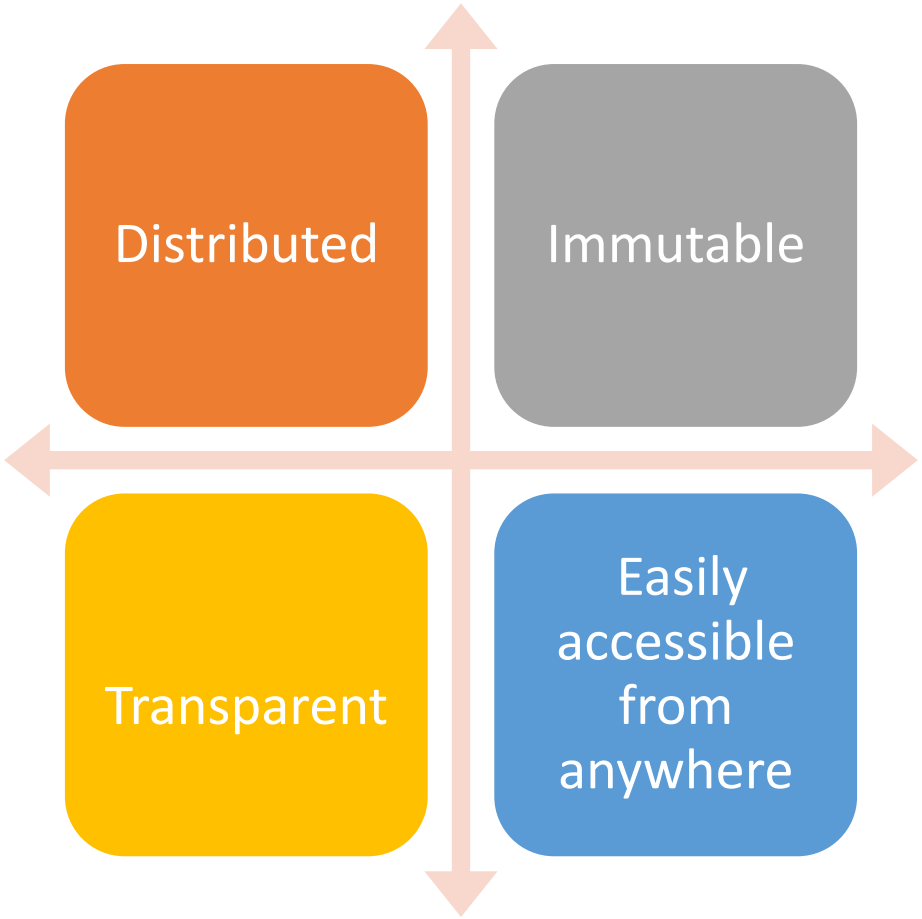


Blockchain Features



Data cannot be modified easily without having control of more than 51% of the node concurrently.

Blockchain Features



Each node on the blockchain system can access, transfer, store, and update the data safely

Blockchain Benefits

To improve healthcare for both professionals and patients by

- **Decentralizing patient health history.**
- **Tracking pharmaceuticals.**
- **Improving payment options.**
- **Reduce the time to track down information across systems**

Blockchain Security

Why Blockchain is secure [7]

Integrity-based attacks

Controlling who should, and who shouldn't see patient data.

Controlling access duration through encryption is key

Healthcare Blockchain Applications

Applications and Benefits

Entities

Hospitals

Insurance companies

Patients

Doctors

Suppliers

Researchers

Applications

Drug traceability

Patient data management

Clinical trials

Genomic Medicine

Drug Traceability

Drug fraud is a major problem faced by many pharmaceutical companies [8]

According to the Health Research Funding Organization [8]**:**

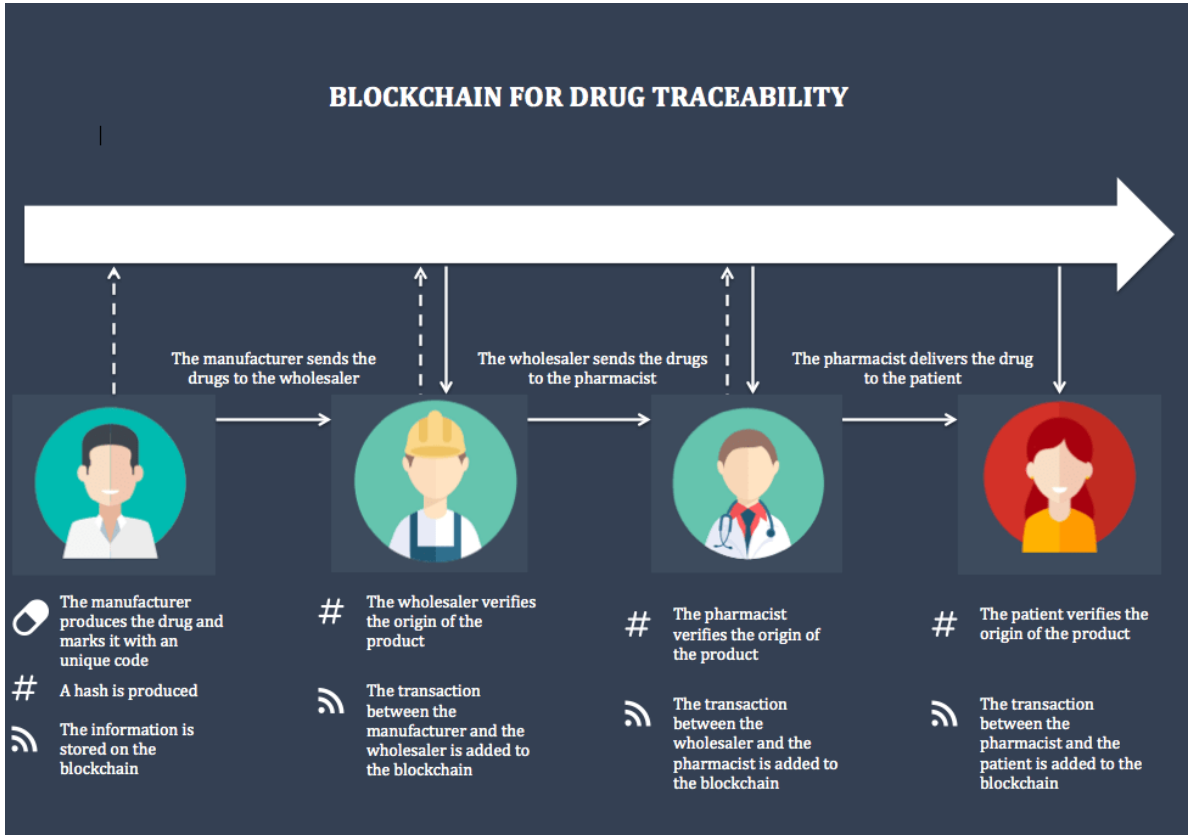
10% to 30% of drugs are fake

it’s the underground economy is $200 billion annually.

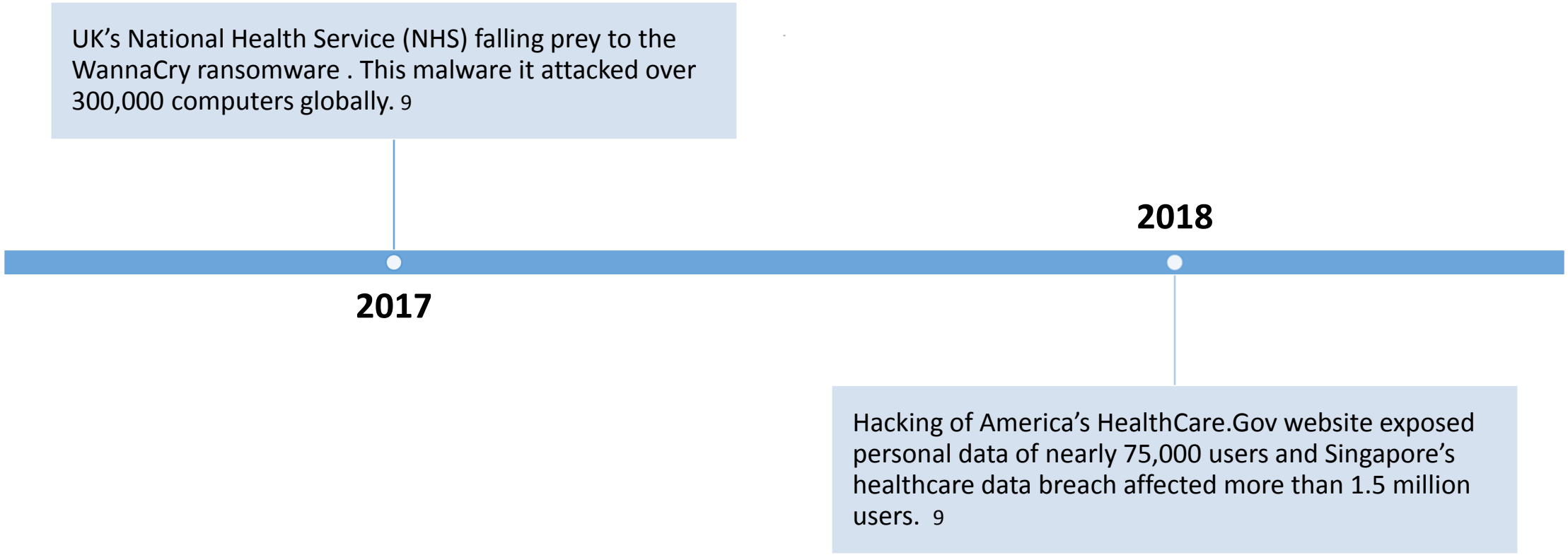
16% of the counterfeit drugs contain the wrong ingredients.

Drug Traceability

Blockchain solution in Drug Traceability 8

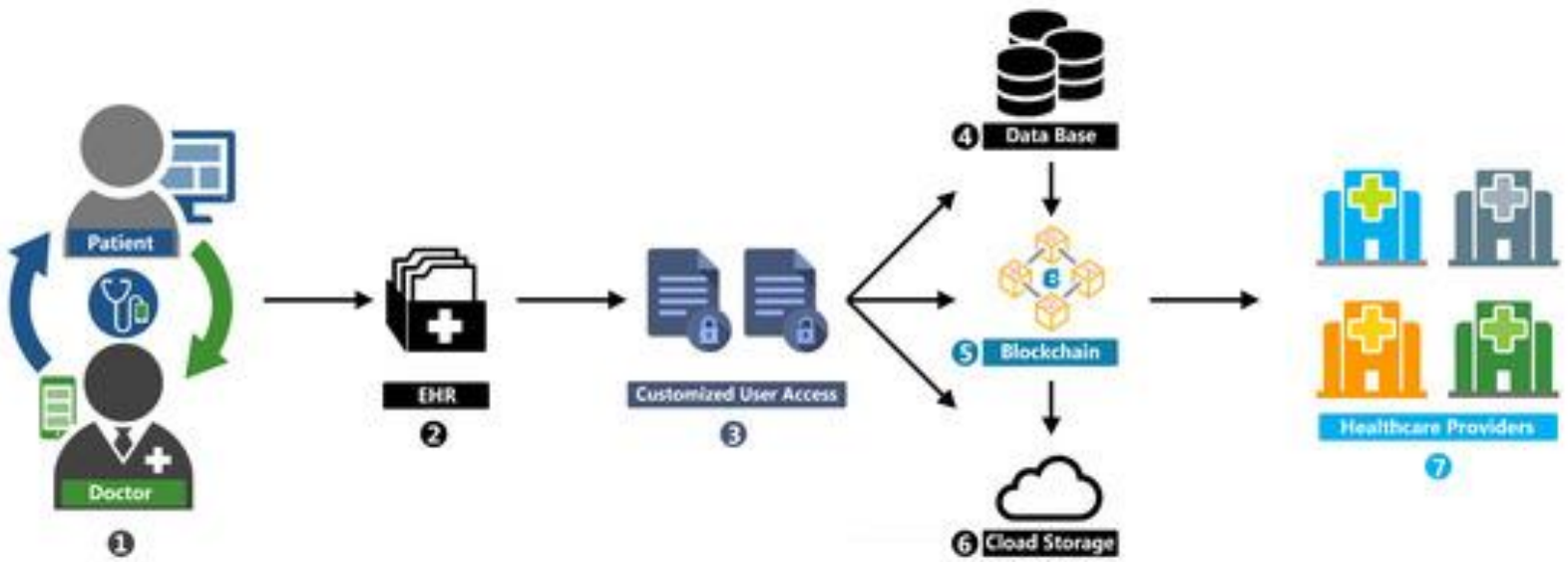


Patient Data Management



Patient Data Management

Blockchain solution in Patient Data Management 10



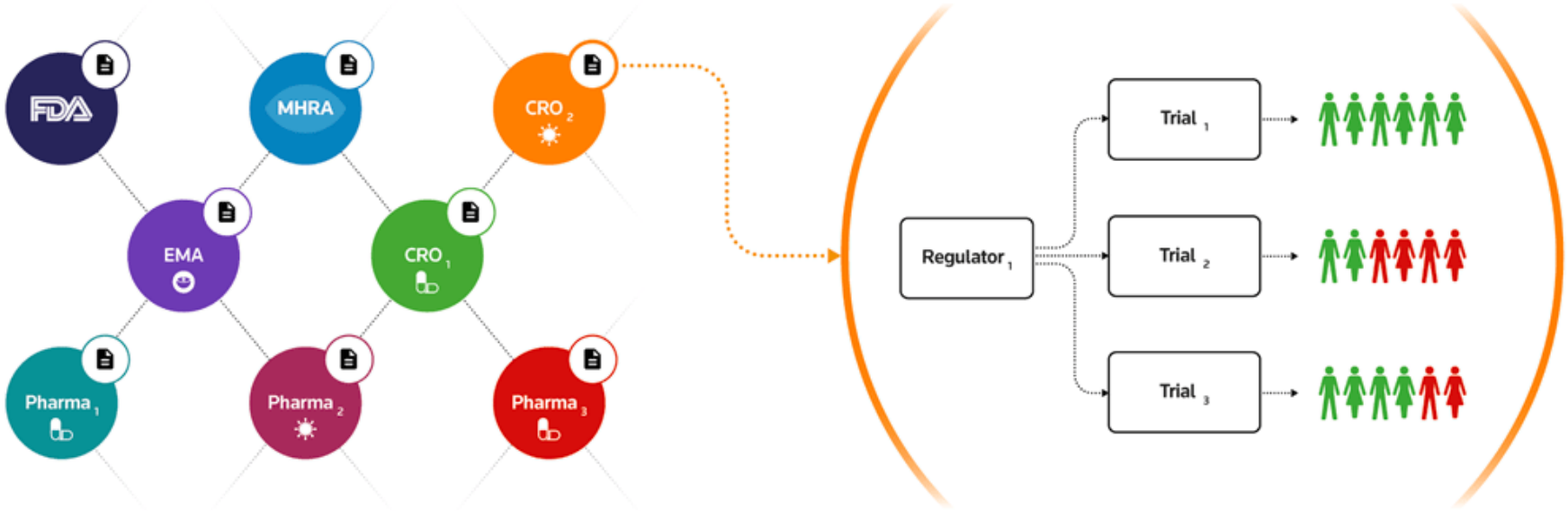
Clinical Trials

Researchers often hide or modify their collected data and information in order to change the outcome. 2

In a survey of authors of clinical drug trials, 17% of them reported that they were personally aware of intentional fabrication in research. 11

Clinical Trials

Blockchain solution in Clinical Trials 12



Genomic Medicine

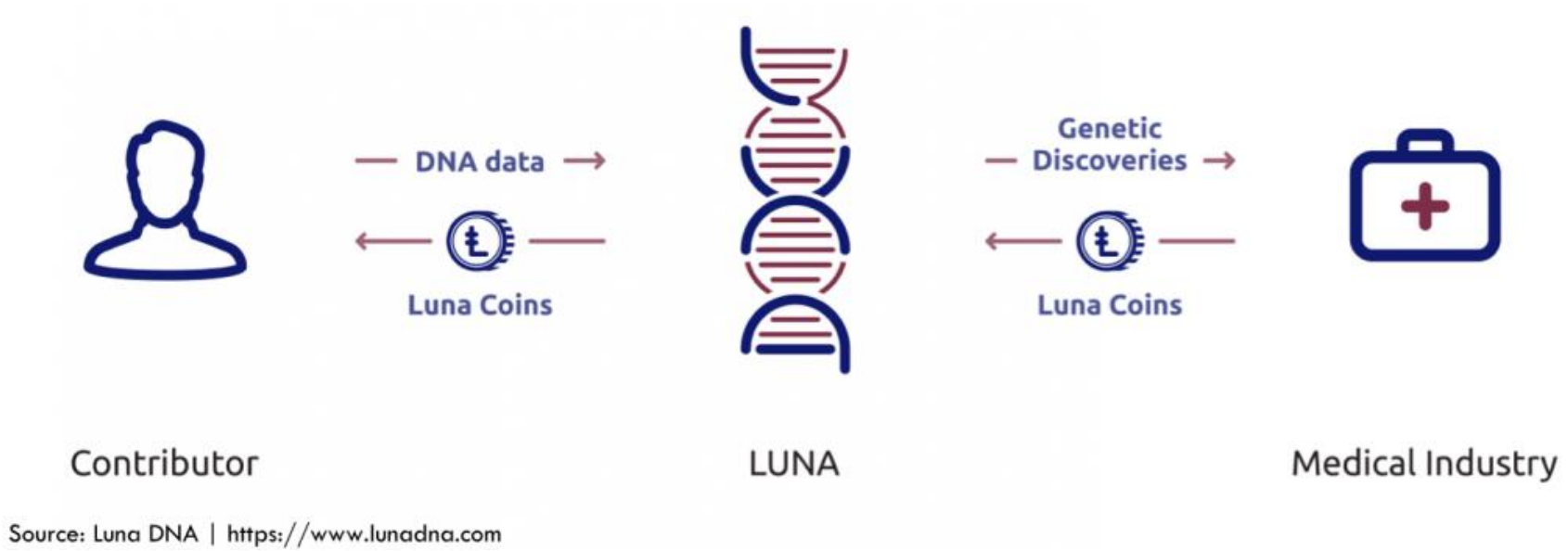
2018: The Federal Trade Commission announced that they were investigating popular DNA testing companies. [13]

The investigation stems over concerns on

- how these types of companies are handling personal information and genetic data
- how they share that data with third parties.

Genomic Medicine

Blockchain solution in Genomic Medicine 14



Healthcare Blockchain Security

Security Aspects

Genomic Medicine

- Decentralization
- Authentication
- Authorization
- Data Integrity
- Peer to peer
- Cryptographic protocol for communication

Attacks

"New age security attacks are emerging, which are very sophisticated and can cause huge irreparable damages" [15]

Abilash Soundarajan
business development strategist at Aruba

Attacks

"When hundreds of thousands of patients manage access to their health data with a blockchain and billions of dollars in claims payments through a blockchain then there are huge incentives to attack a blockchain." [16]

Robert Miller

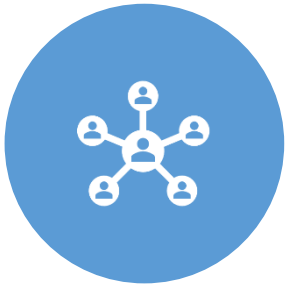
Security

Blockchain Security Attacks 16

Consensus algorithm

Peer selection algorithm

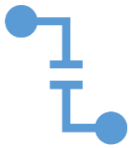
Participants involved (Honest vs Dishonest)



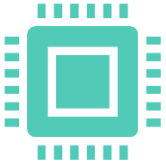
Broader network cyberattacks

Security

Blockchain Security Attacks 15



Peer-to-peer network-based attacks



Consensus & Ledger-based attacks

Smart Contract-based attacks

Wallet-based attacks

Peer-to-Peer Network-based Attacks

Eclipse attack

- Attacking a decentralized network through which an attacker seeks to isolate and attack a specific users. [15]

Sybil attack

- One person tries to take over the network by creating multiple accounts. [15]

Consensus Mechanism and Mining-based Attacks

Selfish mining attack

- Attempts to withhold an effectively validated block from being broadcast to the rest of network. 15

Mining malware

- Software programs take over a computer's resources. 15

51% attack

- Group of miners controls at least 51% of the blockchain network. 15

Timejack attack

- Attacker manipulate the timestamp. 15

Finney attack

- Attacker creates two transactions: one for victim and one for themselves. 15

Smart Contract-based Attacks

The DAO attack

- Decentralized Autonomous Organization was an ambitious feature of Ethereum. A company called Slock started crowdfunding for a project called “The DAO”. The crowdfunding got an overwhelming response, collecting 12.7 million Ether, valued at $150 million then ($2 billion today). [15]

Wallet-based Attack

Parity Multisig Wallet Attack

- The case of a vulnerability with the parity client wallet hacked by an attacker resulting in holding up of 500,000 Ether ($77 million today). Wallet contracts are additional logic than can be built on user wallets for regular automated payments. [15]

Trusted Blockchain Technology

Security Solution

Trust

"Blockchain technology is beneficial in specific industries where people can't trust one another." [17]

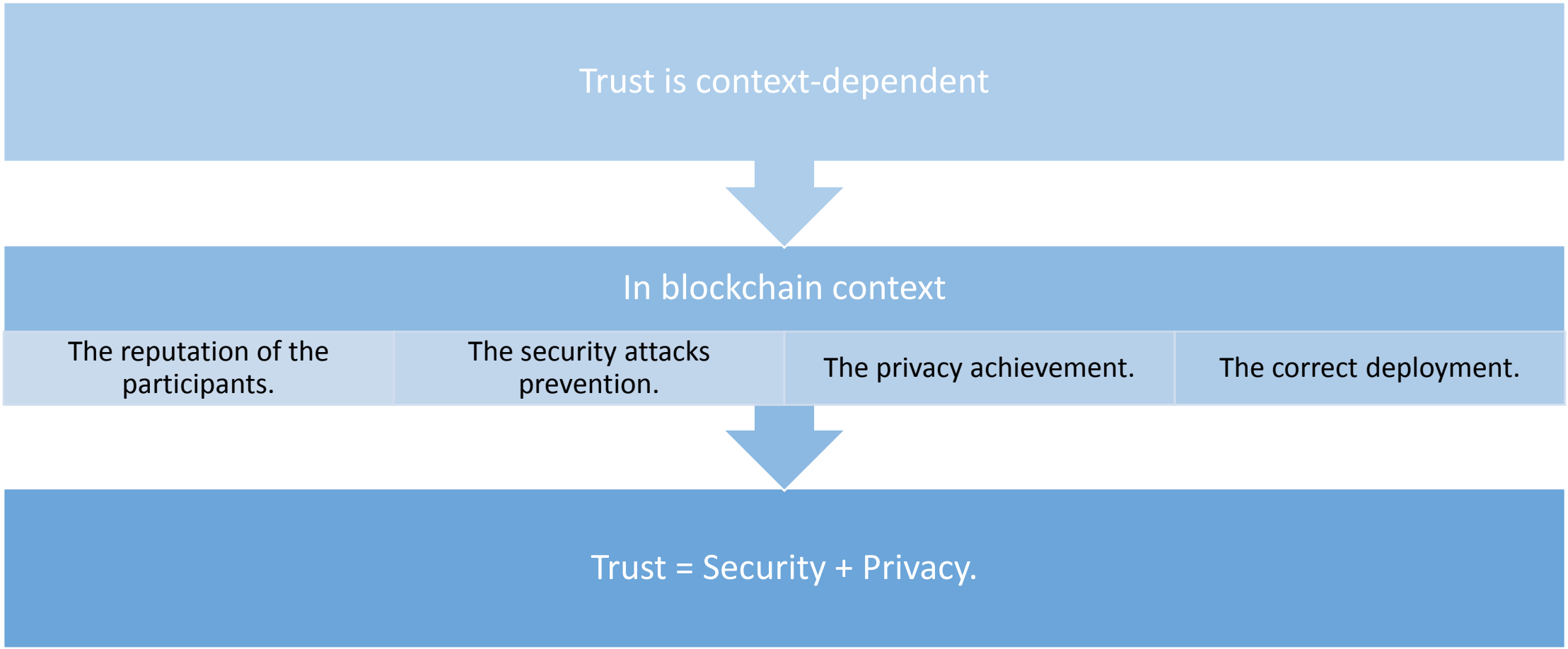
Michał Chatłas

Current security challenges

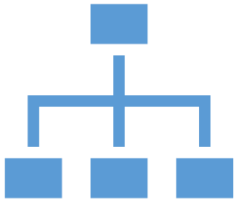
Blockchain's lingering challenges [7]

- Allowing healthcare professionals to quickly and easily access information.
- Controlling information distribution.
- Entering false data or recording a misdiagnosis.
- Adherence to HIPAA regulations.
- Security Attacks.

Trust


Trust is context-dependent
In blockchain context
The reputation of the participants.
The security attacks prevention.
The privacy achievement.
The correct deployment.
Trust = Security + Privacy.

Trust



Hierarchy of trust.

Global and local trust.

Trust model selection.

Conclusion

Ongoing work

Conclusion

Blockchain is the future of the healthcare.

Blockchain offers security and privacy.

Errors in blockchain deployment can be very harmful.

The importance of building the trust layer.

Reference

1. Codrin Arsene (2019) 'The Global “Blockchain in Healthcare” Report: the 2019 ultimate guide for every executive' . Available at: https://healthcareweekly.com/blockchain-in-healthcare-guide/ (Accessed: November 27,2019).
2. Mayank Pratap (2018) 'Blockchain in Healthcare: Opportunities, Challenges, and Applications' . Available at: https://hackernoon.com/blockchain-in-healthcare-opportunities-challenges-and-applications-d6b286da6e1f (Accessed: November 27,2019).
3. Admin (2019) 'Blockchain Technology in Healthcare in 2019'. Available at: https://www.theblockbox.io/blockchain-technology-in-healthcare-in-2019/ (Accessed: November 27,2019).
4. Iansiti M, Lakhani KR. (2017) ‘The Truth About Blockchain. Harvard Business Review.’ Boston, MA: Harvard University .
5. Yue X, Wang H, Jin D, Li M, Jiang W (2016). “Healthcare data gateways: found healthcare intelligence on blockchain with novel privacy risk control”. J Med Syst 2016 Oct;40(10):218
6. Asad Ali Siyal, Aisha Zahid Junejo,Muhammad Zawish, Kainat Ahmed, Aiman Khalil,Georgia Soursou (2009) "Applications of Blockchain Technology in Medicine and Healthcare: Challenges and Future Perspectives” Available at: https://www.mdpi.com/2410-387X/3/1/3 (Accessed: November 27,2019).
7. Jacob Dunn (2019) 'Blockchain in healthcare: how the technology could fix the industry in 2020'. Available at: https://espeoblockchain.com/blog/blockchain-in-healthcare/ (Accessed: November 27,2019).
8. Jura Protocol Media (2019) 'Blockchain & Healthcare — Drug Traceability & Data Management'. Available at: https://medium.com/@juraprotocol/blockchain-healthcare-drug-traceability-data-management-traceability-259dd7c79c24 (Accessed: November 27,2019)
9. Rebecca Clinton-Floyed (2019) 'How is blockchain impacting the healthcare industry?'. Available at: https://www.blockchain-expo.com/2019/10/blockchain/how-is-blockchain-impacting-the-healthcare-industry/ (Accessed: November 27,2019).
10. Seyednima Khezr, Md Moniruzzaman,Abdulsalam Yassine and Rachid Benlamri (2019) 'Blockchain Technology in Healthcare: A Comprehensive Review and Directions for Future Research'. Available at: https://www.mdpi.com/2076-3417/9/9/1736/htm (Accessed: November 27,2019).
11. Gupta, A. (2013) ‘Fraud and misconduct in clinical research: a concern.’ Perspect. Clin. Res. 4, 144–147.
12. Timothy Nugent, David Upton and Mihai Cimpoes (2016) 'Improving data transparency in clinical trials using blockchain smart contracts'. Available at: https://f1000research.com/articles/5-2541 (Accessed: November 27,2019).
13. Marcus baram (2018) 'The FTC is investigating DNA firms like 23andMe and Ancestry over privacy'. Available at: https://www.fastcompany.com/40580364/the-ftc-is-investigating-dna-firms-like-23andme-and-ancestry-over-privacy (Accessed: November 27,2019).
14. ARK Disrupt(2017) 'Genomics and Blockchain Converge to Understand and Overcome Disease'. Available at: https://3iq.ca/blockchain/genomics-and-blockchain-converge-to-understand-and-overcome-disease/ (Accessed: November 27,2019).
15. Abilash Soundararajan (2019) '10 Blockchain and New Age Security Attacks You Should Know'. Available at: https://blogs.arubanetworks.com/solutions/10-blockchain-and-new-age-security-attacks-you-should-know/ (Accessed: November 27,2019).
16. Robert Miller (2019) 'Blockchain community, we need to talk about security'. Available at: https://medium.com/@bertcmiller/on-blockchain-healthcare-security-f2a2783a43de (Accessed: November 27,2019).
17. Michal Chatlas (2018) 'Pros and cons of blockchain: Do I even need one?'. Available at: https://espeoblockchain.com/blog/pros-and-cons-of-blockchain/ (Accessed: November 27,2019).

Thank you