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Design of A Credible Blockchain-based E-health Records (CB-EHRs) Platform

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Outline

- Background
- Research Question
- Related Work
- Platform Design
- Testing and Evaluation
- Summary and Conclusion

Background

In the 2016 EHRs study [1], researchers examined 15,285 physicians in 28 different departments. Figure 1 present an overview of the result of their study.

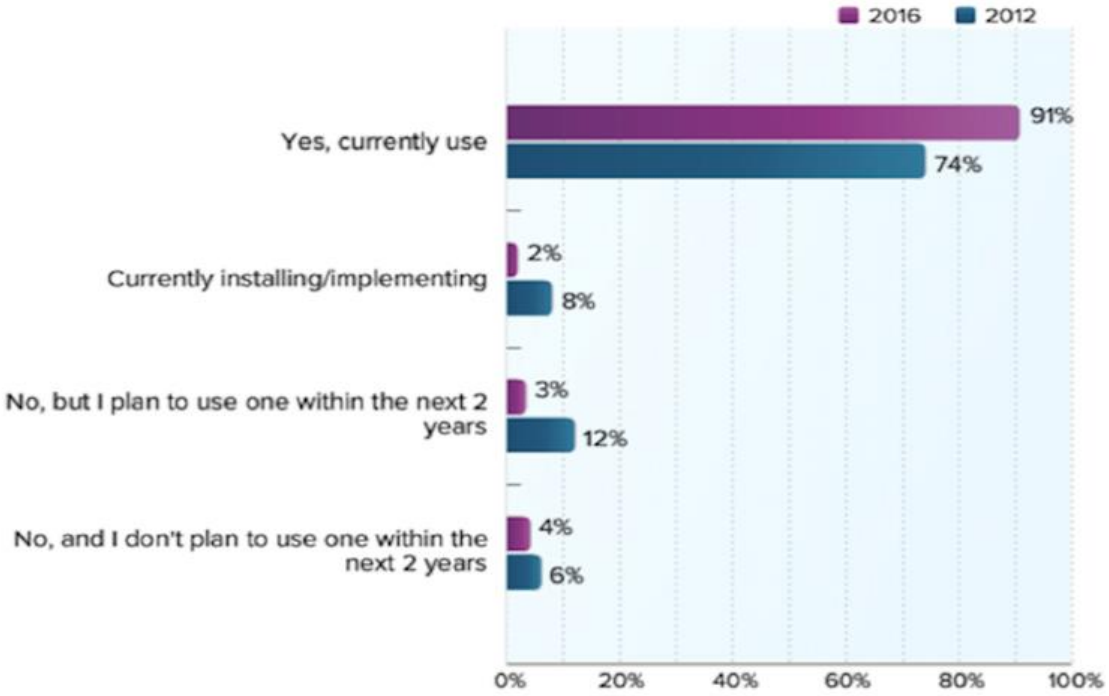
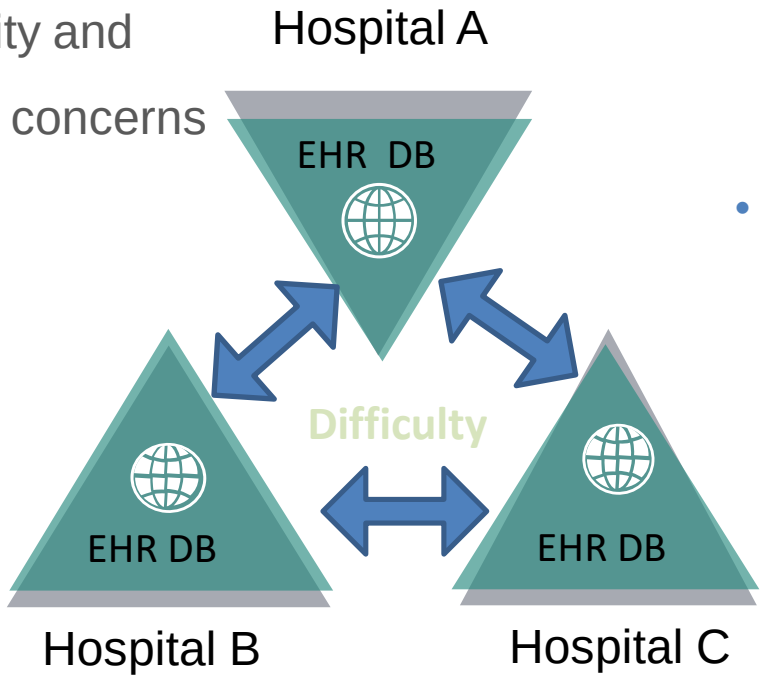


Figure 1 – An assessment of the use of EHRs between 2012 and 2016 [1]

Problem Statement & Research Question

- Difficulty in medical data sharing
- Information security and privacy protection concerns



- How to solve the problem of data sharing between different systems?
- How to protect the privacy of users and the security of medical data?

Related Work

Table 2: Related Work

Researcher / Company	Date	Thesis / Project
Haas S, Wohlgemuth S, Echizen I	Jan, 2011	Aspects of privacy for electronic health records[2]
MH Yarmand , K Sartipi , DG Down	Jan, 2013	Behavior-based access control for distributed healthcare systems[3]
Researcher / Company （Blockchain）	**Date**	**Thesis / Project**
Gem , Philips	May, 2016	Gem works with Philips Healthcare in the creation of the Philips Blockchain lab.[4]
Drew Ivan	Aug, 2017	Moving toward a blockchain-based method for the secure storage of patient records [5]

Blockchain Technology

- The concept of blockchain
- Features
- PKI and digital signature
- Consensus mechanism

- Proof of Work (PoW)
- Proof of Stake (POS)
- Ripple Protocol of Consensus Algorithm (RPCA)
- Practical Byzantine Fault Tolerance (PBFT)
- Delegated Proof of Stake (DPoS)
- Delegated Byzantine Fault Tolerance (dBFT)

Platform Design

- Platform architecture

(i) The user interface layer is used to display data and receive user's input information.

(ii) Business logic layer is used to provide data conversion between actual users and blockchain, and to encapsulate user data into virtual assets and transactions.

(iii) Data access layer contains a unique blockchain and a P2P network.

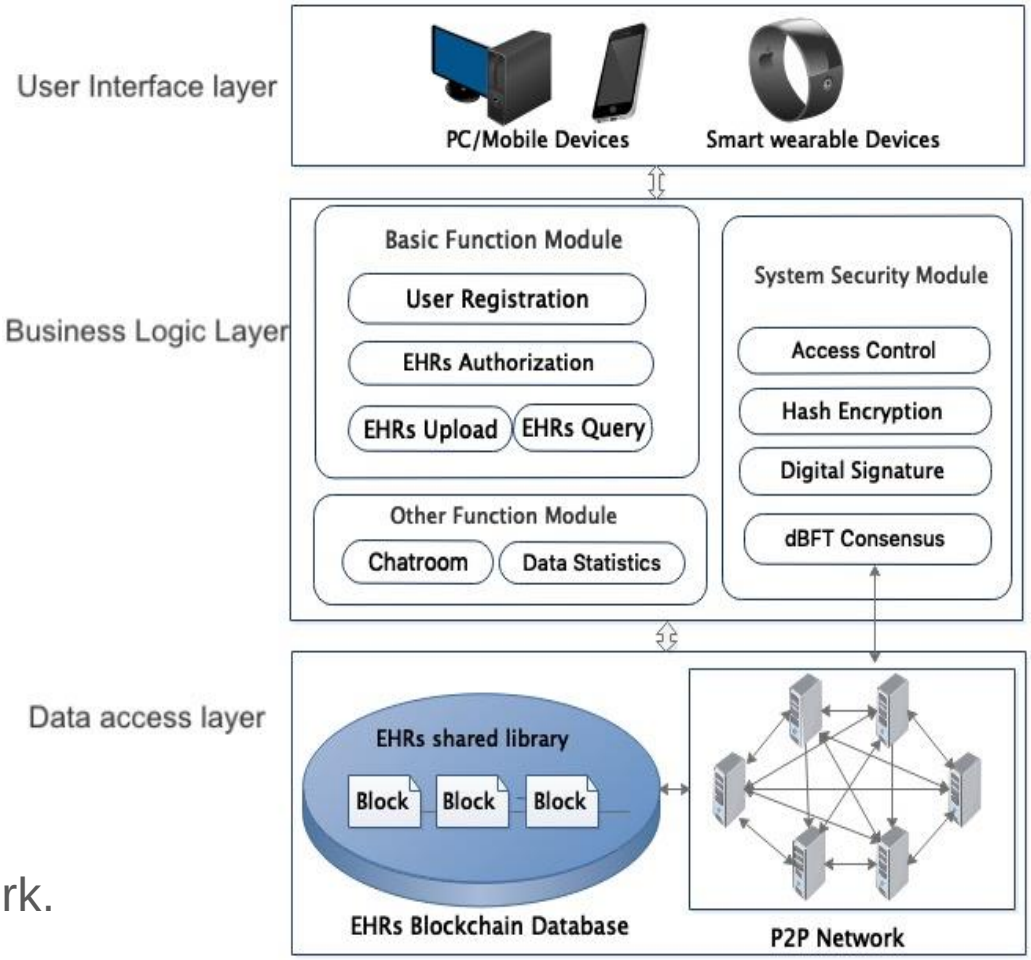


Figure 2 – The overall framework of the CB-EHRs platform

Platform Design

- Network structure

Each node in the network has the complete EHRs data replication. According to the rules of the alliance chain, the nodes in the blockchain network are composed of various medical institutions throughout the country.

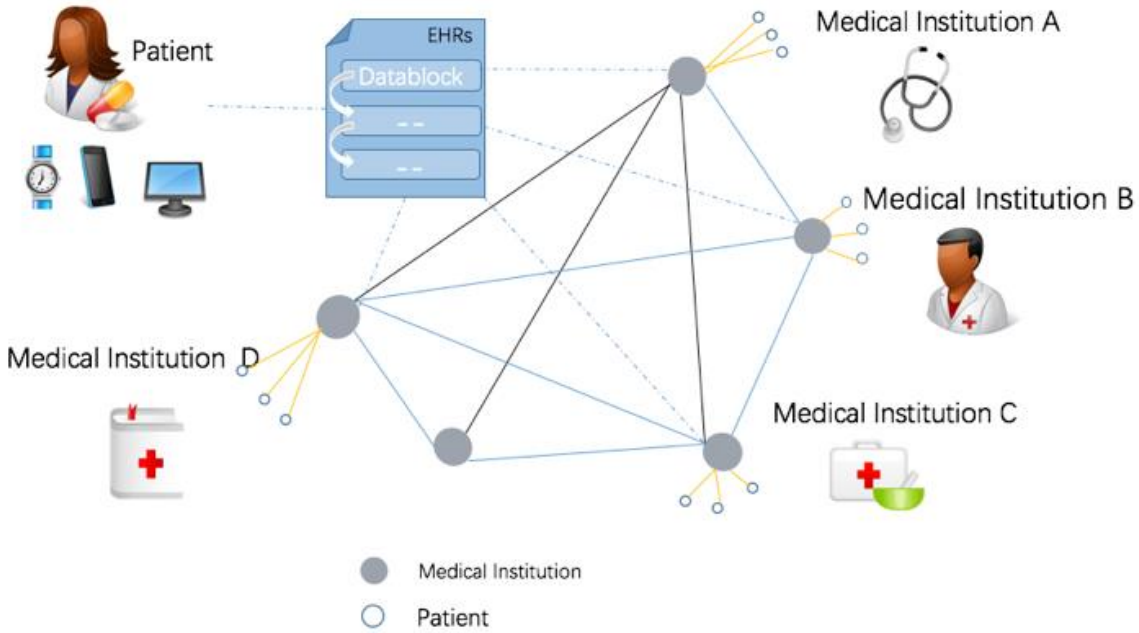


Figure 3 – Blockchain EHRs distributed in the network

Platform Design

- **Consensus mechanism in the platform**

The choice of consensus algorithm is motivated by the application scenario.

Table 2 Comparison of Consensus Mechanisms [6][7][8]

Consensus mechanism	PoW	PoS	DPoS	RPCA	PBFT	dBFT
Scenes	Public chain	Public chain Alliance chain	Public chain Alliance chain	Public chain	Alliance chain	Alliance chain
Accounting nodes	All nodes	All nodes	Select representative nodes	All nodes	Static selection	Dynamic selection
Response time	About 10 minutes	1 minute	<1 minute	<1 minute	<1 minute	<1 minute
Ideal state of Transaction Per Second (TPS)	7 TPS	300 TPS	500 TPS	>10 thousand TPS	1000 TPS	1000 TPS
Fault tolerance	50%	50%	50%	20%	33%	33%

Platform Design

- **Platform workflow**

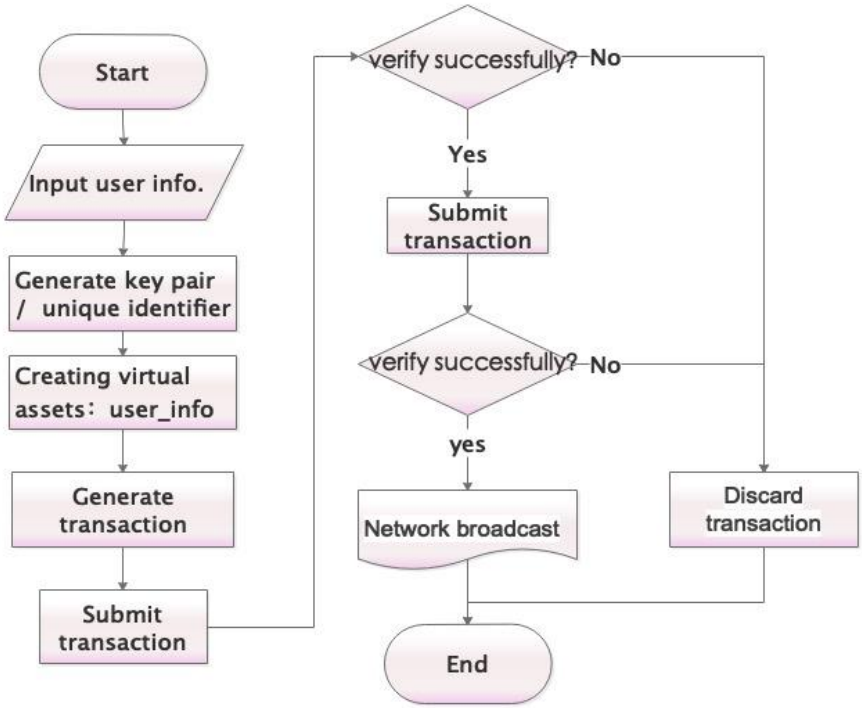


Figure 4 – Process of user registration and identity information validation

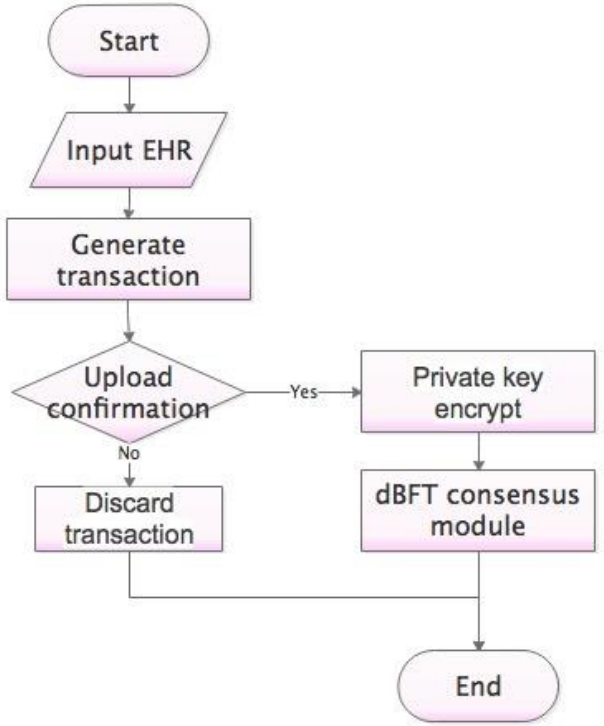


Figure 5 – Process of health record upload operation

Testing and Evaluation

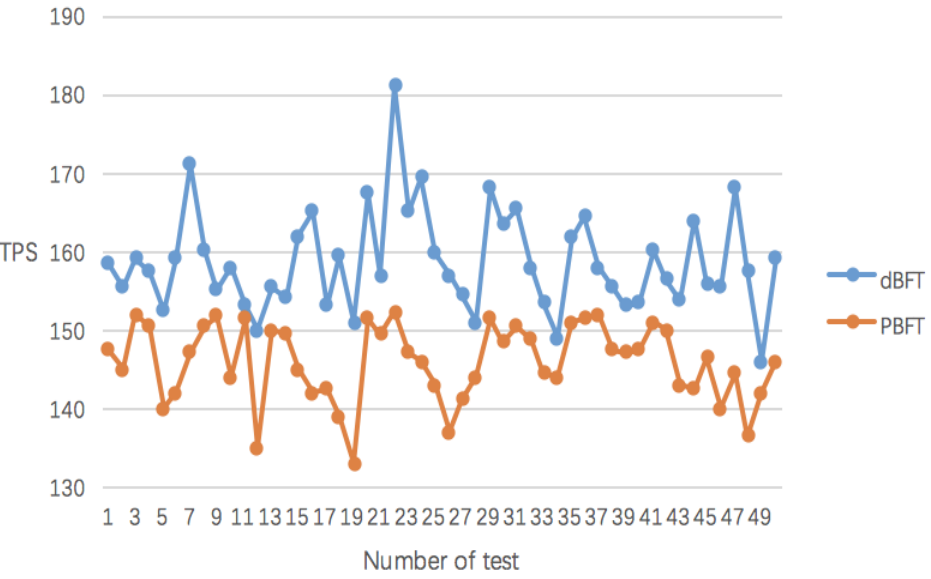


Figure 6 – Comparison result of 1000 transactions between dBFT and PBFT

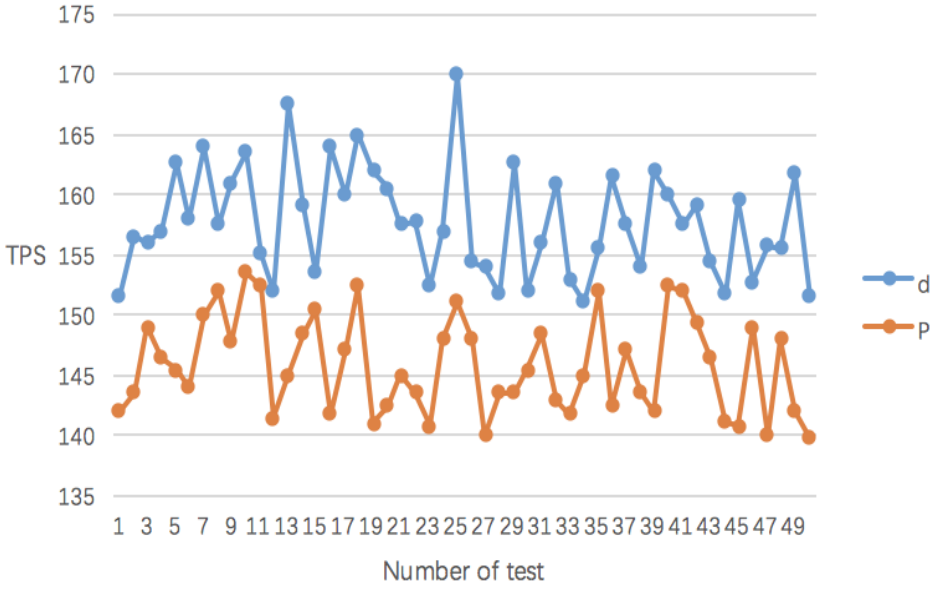


Figure 7 – Comparison result of 2000 transactions between dBFT and PBFT

Testing and Evaluation

The transaction processing efficiency of dBFT is about 9% higher than that of PBFT under the same network conditions.

Table. 3 Performance Comparison Between dBFT and PBFT

Number of nodes	dBFT / TPS			PBFT / TPS		
	500	1000	2000	500	1000	2000
4 Nodes	161.2428061	158.7006085	157.701429	146.0908167	145.9727725	145.7940789
6 Nodes	152.3872637	149.0378482	148.5736732	138.6473983	138.0394872	137.2839271
8 Nodes	134.5362843	133.3748567	131.4758392	122.3748292	121.7384793	121.1923744

Summary and Conclusion

- Our proposed CB-EHRs platform is able to address some of the problems which are prevalent in the traditional electronic health records platform. It can help medical institutions transform their data centers and meet the needs of user privacy protection, safe storage and sharing of medical data. CB-EHRs also serves to promote telemedicine which is an inevitable requirement in the current technology age.
- As an intervention and an attempt to introduce and implement blockchain technology in electronic health records, this paper only considers some key technologies. This research is still at its stage of exploration and development in this domain of interest, hence a complete system development of the proposed CB-EHRs is still underway.

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Thank you