LIFELINE – Emergency Patient Data in a Distributed Manner

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***Abstract*— In the case of medical emergencies where the victim cannot respond to questions, the first responders risk harming the patient if they are not aware of the underlaying conditions and medication. Vulnerable people often carry accessories that contain critical information, either in plain text or in the form of smartphone-scannable codes that redirect to webpages. The problem with relying on internet servers alone is that they can be unresponsive in the time of need. Lifeline aims to solve this problem by using blockchain to store vital backup data.**

Keywords*— *Quick Response code, Distributed Data, Healthcare, Health Emergency, Blockchain, Ethereum, Mobile Apps

I. INTRODUCTION

Compared to regular paper records, the Electronic Health Records (EHRs) offer plenty of advantages. Unfortunately, equipment is susceptible to unexpected failure that can strike during an emergency, possibly leading to preventable injury or even death. Keeping data redundancies on multiple servers can be impractical for small companies and doesn't fully protect from targeted cyberattacks.

We will present in this paper the Lifeline application, which uses the Ethereum blockchain to store vital backup data in case the main database is down. In chapter II there are listed the important technical features, in chapter III it is presented the state of the art in the domain and in chapter IV are shown the implementation details.

II. TECHNIC BACKGROUND

A. QR codes

A Quick Response (QR) code is a two-dimensional barcode composed of black and white boxes arranged in a square grid.

B. Blockchain

Invented for the use in crypto-currencies, a blockchain is a digital append-only ledger of information, with decentralized management instead of a central authority.

C. Smart contracts

Smart contracts are programs stored and ran on a blockchain. They have a specific address on the chain, where they keep stored data and code that states when and what to run.

III. STATE OF THE ART

A. Electronic Health Records on blockchain

Health records are sensitive pieces of information that often need to be accessed by doctors or institutions. Traditionally, EHRs are stored independently by hospitals, hence sharing the files is a hard process.

A novel approach, not yet implemented on a significant scale, is storing EHRs on a blockchain, with the use of smart contracts.

B. Emergency medical information on accessories

The first MedicAlert ID bracelet was designed in 1956, after the daughter of Dr. Marion Collins, the founder of MedicAlert, had a near-fatal allergic reaction to a tetanus antitoxin, administered while the father was out of town. On the bracelet were engraved an emblem of the Rod of Asclepius, the predominant medical symbol, along with the list of allergies.

More modern such accessories contain a QR code that, when scanned, produces an internet link to a page with ample information. In this way, the information stored does not have a hard size limit and can be easily modified. All providers require subscriptions in order to host the data.

As most people nowadays carry around phones with cellular data, access to the internet would not be a problem. On the other hand, the database may be unresponsive due to local power outages, crashes, server overloading or even cyberattacks. This would be unacceptable to happen during an emergency.

IV. PROPOSED METHOD

As a backup for when the main servers are unavailable, Lifeline keeps data considered vital on the Ethereum blockchain, inside the storage of a smart contract. Due to the nature of Ethereum, the data is distributed among a large number of nodes, making it extremely improbable to get no response.

Information may be written or changed at any time on the blockchain, without passing through the main servers, at an ETH cost proportional to the content length plus the base transaction fee. Because node owners may read the data stored by the contract, the text needs to be encrypted, which means that any small change made will completely change the output and that the actual size of the stored data may be larger.

An important drawback of using blockchain for storage is that it can be expensive to keep large amounts of data or to modify it often. At current prices of Gas (10 Gwei) and Ethereum (~$1900), writing a text 40 characters long would cost around $3.5. The user can choose to either only use the blockchain storage or sign up for a subscription in order to store files in a regular database, which has the advantage of being able to make changes at no additional cost.

Lifeline uses ETH wallet addresses as account IDs, with authentication via MetaMask, one of the leading custodial cryptocurrency wallets. All management of data is done through the Lifeline smartphone app. When users open the app for the first time, they are guided to create or log in with a MetaMask account, which will be used for all further authentications.

From the app, the user can see his QR code, modify the critical data stored on the blockchain (Fig. 4) or upload files and edit information on the main database (Fig. 5). While access to the database is paid beforehand in the form of subscriptions, all blockchain data is pay-per-edit.

Any user may also scan another Lifeline QR code, without needing to be logged in (Fig. 6). The data stored on the blockchain is shown regardless of the Lifeline servers status, while the main database is queried separately and information is only displayed if available.

If Lifeline is not installed, one may also use the code with any QR code scanner, in which case they will be taken to a website that displays the information like the app would (Fig. 6). This means that communication with the blockchain is not direct, unlike the app, as the libraries required to access the blockchain would be impossible to fit inside a QR code. The website that the link points to is just a static page that contains all JavaScript code necessary to query the smart contract and main database from the device, avoiding server-side computing. Multiple such servers could be set up at a low cost, for redundancy and failure protection.

The link contained in the QR code would be of the form: https://lifelineid.com/query?id={}&key={}. When scanning the code with the app, only the wallet address (id) and the key are extracted from the link, while the rest is discarded.

The data stored on the blockchain and on the main servers is encrypted using the RSA algorithm, with encryption happening on the users phone, so that the private key never leaves the user and no one can tamper with the information. The public key is also only stored inside the QR code, to protect all sensitive info from mass data breaches.

The QR code is offered free of charge, with the option to print it on a physical ID card or etch it onto an accessory for a small fee.

V. Conclusions

Lifeline is the solution we propose to save the lives of people in need, a reliable application based on a distributed and decentralized network, combining cutting-edge technology with cost efficiency.

This app can be a vital tool in the life-saving process, due to its 24/7 failproof availability, instant data response and the fact that the complex architecture behind the app is complemented by an easy-to-understand user interface.

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References

[1] K. C. Liao and W. H. Lee. "A novel user authentication scheme based on QR-code." Journal of networks 5(8), pp. 937-941

[2] "The Merge", 09-Aug.-2022, [Online], Available: https://ethereum.org/en/upgrades/merge/. [Accessed 13-Aug.-2022]

[3] "Ethereum development documentation". [Online], Available: https://ethereum.org/en/developers/docs/. [Accessed 13-Aug.-2022]

[4] "Our Story", [Online], Available: https://www.medicalert.org/about/our-story/. [Accessed 13-Aug.-2022]

[5] L. Morton, S. Murad, R. Z. Omar, et al. "Importance of emergency identification schemes", EMJ 2002, 19, pp. 584-586.

[6] L. Blaney-Koen, "Medical Identification Bracelets", Journal of Patient Safety: March 2008, Volume 4, Issue 1, pp. 50

[7] "Mymdband", [Online], Available: https://www.mymdband.com/, [Accessed 13-Aug.-2022]

[8] [Online]. Available: https://icemedalert.com/, [Accessed 13-Aug.-2022]

[9] K. Czuszynski and J. Ruminski, "Interaction with medical data using QR-codes," 2014 7th International Conference on Human System Interactions (HSI), 2014, pp. 182-187

[10] S. Dube, S. Ndlovu, T. Nyathi, and K. Sibanda, "QR Code Based Patient Medical Health Records Transmission: Zimbabwean Case", 2015, 10.28945/2233, pp. 521-530

[11] B. Swathi, N. Swathi, Sonali, H. S. Archana, and K. Sanjeev, "QR Based Emergency Information Access In Medical Field", IRJET Volume 7, Issue 6, June 2020, pp. 2113-2116

[12] S. Nayak, A. Hossain, F. Mirza, M. A. Naeem, and N. Jamil, "E-BRACE: A Secure Electronic Health Record Access Method in Medical Emergency". In: Bajwa, I., Kamareddine, F., Costa, A. (eds) Intelligent Technologies and Applications. INTAP 2018. Communications in Computer and Information Science, vol 932. Springer, Singapore.

[13] A. Dubovitskaya, Z. Xu, S. Ryu, M. Schumacher, F. Wang, "Secure and Trustable Electronic Medical Records Sharing using Blockchain". AMIA Annu Symp Proc. 2018; pp. 650-659

[14] Y. Chen, S. Ding, Z. Xu et al. "Blockchain-Based Medical Records Secure Storage and Medical Service Framework". J Med Syst 43, 5, 2019.

[15] C. Pirtle and J. Ehrenfeld, "Blockchain for Healthcare: The Next Generation of Medical Records?". J Med Syst 42, 172, 2018

[16] A. Shahnaz, U. Qamar and A. Khalid, "Using Blockchain for Electronic Health Records," in IEEE Access, vol. 7, pp. 147782-147795, 2019.

[17] V. Uzun and S. Bilgin, "Evaluation and implementation of QR Code Identity Tag system for Healthcare in Turkey". SpringerPlus 5, 1454, 2016.

[18] V. Uzun, "QR-Code Based Hospital Systems for Healthcare in Turkey," 2016 IEEE 40th Annual Computer Software and Applications Conference (COMPSAC), 2016, pp. 71-76.

[19] A. A. Mamun, S. Azam and C. Gritti, "Blockchain-Based Electronic Health Records Management: A Comprehensive Review and Future Research Direction," in IEEE Access, vol. 10, pp. 5768-5789, 2022.