

COVID-19 Digital Vaccination Passport Based on Blockchain with its own Cryptocurrency as a Reward and Mobile App for its Use

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† Presented at the 4th XoveTIC Conference, A Coruña, Spain, October 2021.

Abstract: Due to the recent outbreak of the COVID-19 pandemic, everybody's life has changed dramatically and society went through new stages accompanied by new needs. This article details a solution for one of such needs, since it provides a system of digital certificates for the secure storage and sharing of medical data related to COVID-19, with the goal of demonstrating immunity or lack of viral infection in a unequivocal, unbreakable and secure way. The proposed system is based on Blockchain and its inherent benefits, developing also a decentralized, mobile and multiplatform app for its use and an incentive system with a customized cryptocurrency in order to reward the users who use it.

Keywords: Blockchain; Smart Contract; Ethereum; Cryptocurrency; COVID-19; Digital vaccination passport; Immunity certificate; Distributed mobile application; Kotlin Mobile Multiplatform.

1. Introduction

Due to the global health emergency COVID-19 declared by the WHO (*World Health Organization*) in 2020, a series of new stages and problems have appeared in our society that have to be faced. In particular, this paper describes a solution for one of them: the storage and use of all medical information regarding COVID-19. Such a solution consists in a decentralized blockchain-based secure system with automated intelligence for the storage of the most relevant COVID-19 medical information (vaccines and tests) and includes a cross-platform mobile decentralized app (*Dapp*) to make use of the system and a cryptocurrency to offer a way to incentivize the users who employ the system. The purpose of the project is to benefit all parts involved in its use and to improve the current pandemic situation from a public health perspective by providing a means to demonstrate immunity or lack of viral infection in order to alleviate or eliminate certain social constraints caused by the pandemic. It will also benefit health authorities by creating a compact, unbreakable and homogeneous system for storing all COVID-19 information, with a high degree of scalability and potential for future exploitation. Finally, it will benefit business whose normal operations are affected by the pandemic (e.g., restaurants, hotels, pubs) by creating sanitary-safe environments and by providing a greater economic gain from easing of restrictions (e.g., increased seating spots and opening hours), as well as by implementing its own commerce system that can be used as an incentive to be exploited by both parties, customer and business.

To the knowledge of the authors, the proposed solution, as described, has not been previously proposed in the literature, although similar projects are available that implement the different parts of the system, such as different approaches to provide COVID-19 certificates, the use of blockchain-based medical information and incentives [1] or the management of private blockchains, smart contracts and cryptocurrencies [2,3].

Citation: de los Santos Nodar, M.A.; Fernández-Caramés, T.M. COVID-19 Digital Vaccination Passport Based on Blockchain with its own Cryptocurrency as a Reward and Mobile App for its Use. *Preprints* 2021, 1, 0. <https://doi.org/>

Received:

Accepted:

Published:

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

2. Design and Implementation

Figure 1 depicts a diagram of the communications architecture of the proposed system, showing the main modules together with their components and the relationships among them. Specifically, the following modules, implemented parts and their respective technologies can be distinguished:

- A private Ethereum blockchain created with Geth. The configuration of the system was performed with a JSON files that defines its *Genesis Block*. It was deployed along with several mining nodes that accept different types of transactions.
- Smart contracts. They were developed in Solidity with the Remix online IDE. Smart contracts implement all the functionality of the system. It is worth highlighting the following: the medical record contract, which was devised to consult the information of medical records or to write and/or to update such data; the cryptocurrency smart contract, which enables the creation of an incentive system that also allows trading; and finally, the Faucet smart contract, created to supply the demand of Ether to the different users of the system.
- Two cross-platform mobile Dapps developed with Kotlin in KMM (*Kotlin Mobile Multiplatform*) to modularize the project and divide the functionality on the Blockchain: reading for patients and writing for CDCs (*Centers for Disease Control*).

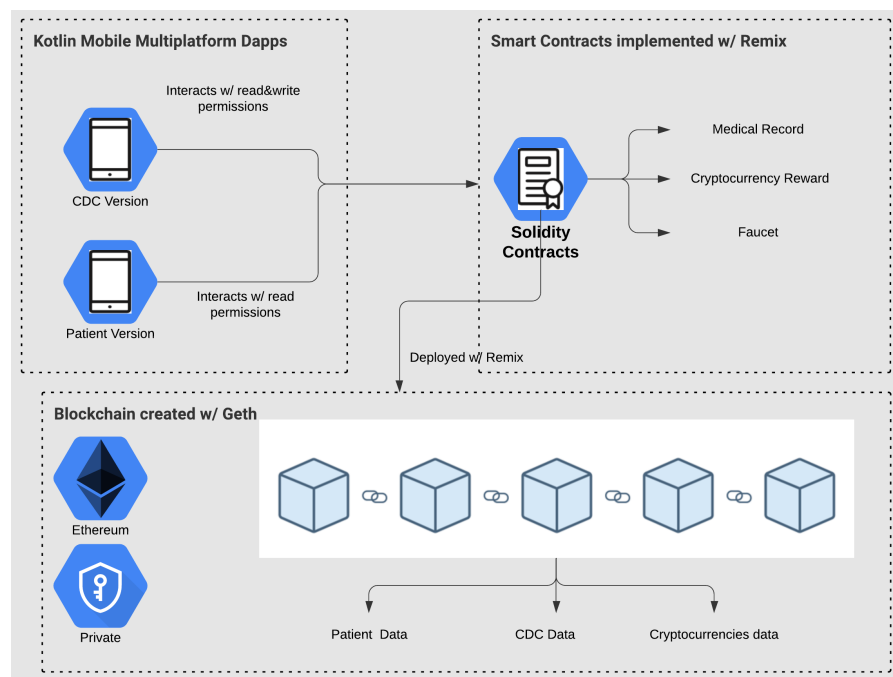


Figure 1. Architecture of the proposed project.

The development work is available on Github [4] under the *Open Source* license GNU GPLv3.

3. Examples of use

Figure 2 shows an example of the flow of different interactions of the proposed system. Four use cases are illustrated sequentially: (1) A patient accesses a CDC for the first time after downloading the app, joins the system from the CDC app and his medical record is created and (2) updated with his newly inoculated dose, receiving the corresponding incentive. Then, she/he will be able to trade with the cryptocurrency to, for instance, send it to other users (e.g., in a bar, a hotel or transferring it to a friend). Finally, (4) the patient will be able to consult her/his medical information, also receiving her/his corresponding incentive and letting access to her/his COVID-19 medical data to the user who read her/his passport.

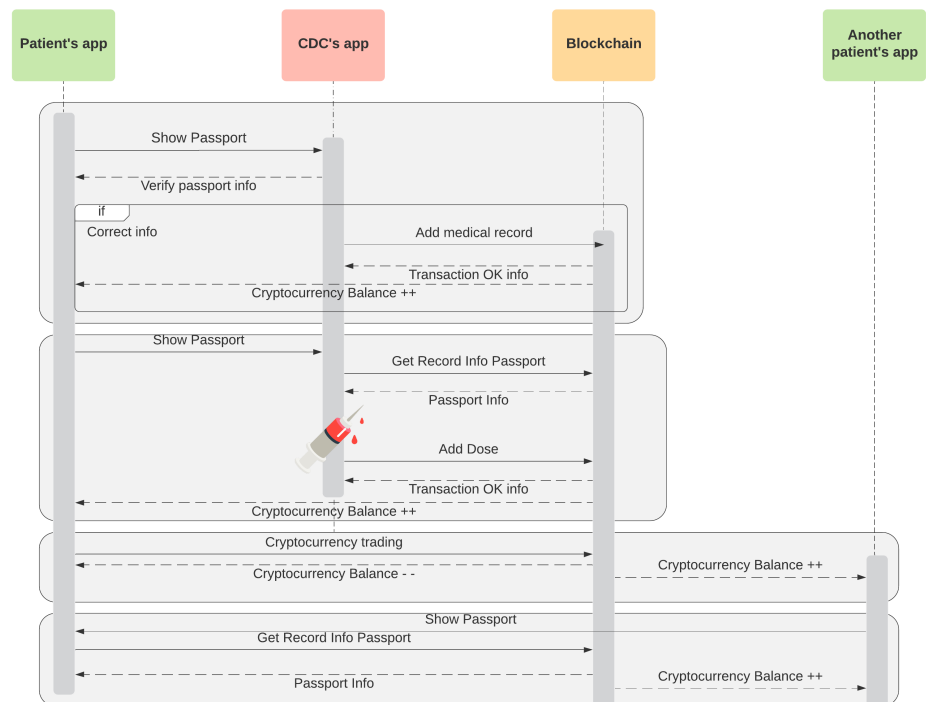


Figure 2. Sequence diagram that illustrates four use cases.

4. Discussion and Future Work

This paper described a digital passport system for COVID-19 consisting of two modules: one concerning blockchain and the other one related to the development of two cross-platform mobile Dapps. After the combination of both, the aim was to create a powerful system that improves and solves certain current situations of the COVID-19 pandemic, both from a technological perspective (as a new COVID-19 information storage system), as well as medical (favoring the creation of low health risk situations) and social (waiving restrictions as well as economically benefiting both customers and companies). These features can be provided thanks to the use of novel and disruptive technologies such as blockchain or KMM, which is in *alfa* version since the end of 2020. In addition, the proposed system has social utility, since it provides a solution to one of the nowadays problems that is being widely investigated worldwide. Finally, it is worth mentioning that future research lines will include the development of a native iOS app in KMM. In addition, it will be also analyzed how to enhance the management of network connections and how provide advance management features, like granting or auditing CDC accounts, or controlling the restrictions to obtain incentives by the patients. To conclude, it must be emphasize that the dissemination, growth and improvement of the project, motivated by the *Open Source* nature of the product, will be key for a real and large-scale hypothetical future use of it.

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