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Blockchain Applications with Permissioned Distributed Ledger Technology

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Abstract

Blockchain is currently a technology that has been attracting a lot of attention both in academia and industry. Several areas of expertise are benefiting from blockchain due to its characteristics, such as data security, decentralization, traceability and immutability. The objective of this work is to present the use of a blockchain allowed with the implementation of a prototype in the context of e-health applications. Preliminary results indicate that blockchain can be well used for e-health applications, integrating with other technologies.

1 Introduction

Blockchain is a technology that is currently increasingly strengthening as a distributed database technology, becoming widespread both in academia and in industry. With the popularization of the digital currency Bitcoin proposed by Satoshi Nakamoto [8], several sectors became target of research for the insertion of this technology in applications that need characteristics, such as: decentralization, reliability, traceability and immutability [12].

Blockchain technology is a decentralized network (P2P) that has its own layer of protocol messages for node communication. Transactions stored on the network are encrypted and stored in blocks. Each block has a reference to the previous block, which allows a temporal ordering of transactions [5]. According to the use and development of blockchains networks in different fields, two types of blockchains have arisen that are used according to the needs of each application, which are: Permissionless Blockchains (public), characterized by the permission that is given to any network participant to read or send transactions, and Permissioned Blockchains, which are characterized by the need that the nodes have to be accepted in the network to carry out operations. This last type of blockchain is used when data preservation is necessary, such as in the health sector [1].

In literature, several articles have dedicated themselves to implementing solutions using blockchain technology [7] [6]. In [7], the authors proposed the permissioned blockchain platform Hyperledger Fabric for the safe and reliable sharing of electronic patient records. As a result of the proposed work, it was shown that Hyperledger removes the lack of trust between health centers, doctors, public health departments and hospitals. The authors of [6] focused on allowing an increase in the degree of confidence patient health data. This solution was proposed through an architectural solution based on blockchain for granting permission to access health data obtained from a Patient Monitoring System (SMRP).

E-health has increasingly explored the monitoring technologies to improve the efficiency of healthcare professionals in treating patient [9]. The objective of this work is to present the use of applications with permissioned blockchains, in the context of e-health domain, and present an experiment that uses the Hyperledger Fabric blockchain platform [3].

This work is divided into the following sections: Section 2 presents the methodology and design of the experiment; in Section 3, the results are shown; and finally, in Section 4 the conclusion is presented.

2 Methodology and Design of Experiment

In 2015, a collaborative project of the Linux Foundation emerged that aims to develop several open source frameworks and tools for permissioned blockchains in a modular way, called Hyperledger. The use of permissioned DLTs (Distributed Ledger Technology), such as Hyperledger, is justified by the need that solutions require some features, such as: data security, faster transactions and reliable network of participants. Notable cases of these applications are: supply chain, property registration and patents [4].

Hyperledger Fabric is one of the technologies of Hyperledger. In this technology, it is possible to implement a modular and pluggable architecture in which it allows the use of several programming languages for the implementation of smart contracts used by applications. With Fabric, it is also possible for a network to contain chains of isolated blocks that allow the partition of different participants and executable codes for smart contracts [10].

Smart contracts, in Fabric called chaincodes, are executable codes, invoked by a client application outside the network, responsible for leveraging blockchain technology. They are a collection of code and data deployed using cryptographically signed transactions on the blockchain network [2] [13].

In this work, smart contracts (chaincodes) are used to perform operations of insertion and reading of information in a Hyperledger Fabric network. This information is related to the identification of patients. The application that interacts with the blockchain network has the responsibility to collect data that comes from patients and store it on the network, simulating the creation of an electronic medical record. With this action, it is possible that the information will become practically immutable and used in audits, provided that access to this data is requested and authorized.

The use of blockchain technology in applications like these allows the monitoring of the history of medical visits, the study of the development of diseases and even the assessment of people's quality of life, as it facilitates the management of consultations in health institutions [11].

For this article, the prototype of an application that inserts data from a patient into the Hyperledger network was implemented, with the purpose of simulating the registration of electronic medical records. In this application, it is possible to carry out transactions responsible for the registration of a new patient, recovery of all registered patients and the search for the history of medical records by the patient ID.

3 Results

In this section, the results of the application prototype mentioned above will be presented.

In Figure 1, it is possible to analyze the application prototype. In Figure 1(a), the fields that collect the patient's data are presented, which are: ID (acting as the key of the transaction), Name, Age, Institution (represents the health institution in which the patient is visiting), Information; Document (this field makes it possible to upload a file to complement the medical record information, only the link to that file will be stored on the network).

Figure 1(b) shows a list of patients that are stored in the Hyperledger network. Even if there is more than one registration with the same ID, the search for a transaction will return the data informed in the last transaction of the searched key.

Figure 1(c) shows the transaction history. For this function, the Hyperledger network returns, linked to each transaction, a value called timestamp that indicates the time stamp in which that transaction occurred. Through this feature it is possible to obtain a patient's history

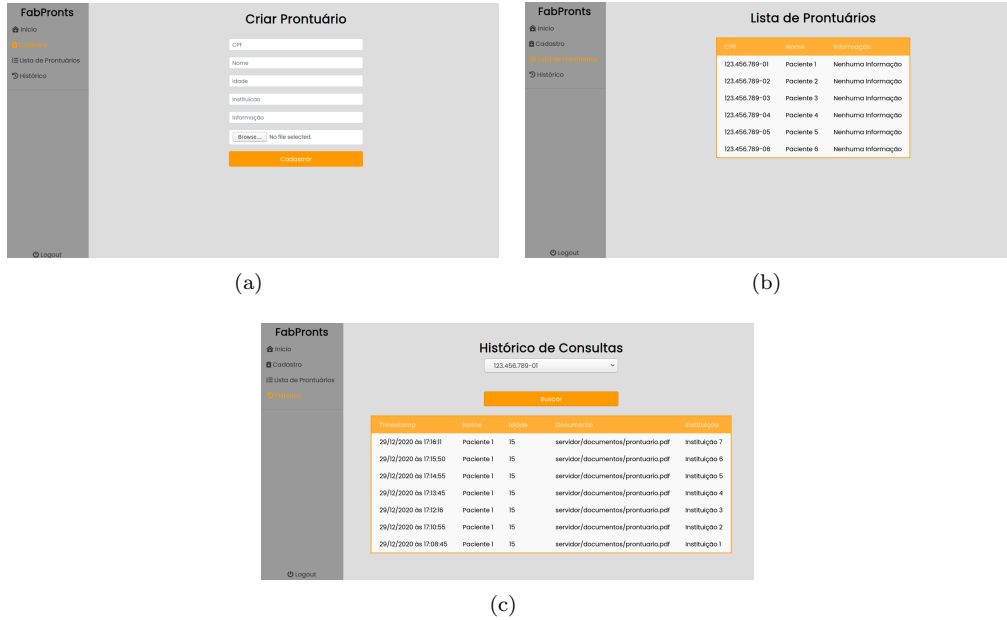


Figure 1: Application screens (in brazilian portuguese)



Figure 2: Data returned from the Hyperledger Fabric network

by searching for the key. In Figure 1(c), transactions with time marks are shown for the patient with ID 123.456.789-01.

All three operations carried out with the network discussed in the previous paragraphs were done by executing chaincode executable codes, implemented in the javascript language.

Figure 2 presents the return obtained after the execution of the operations with the network. In Figure 2(a), part of the network response is shown when a request is made to list all transfers and in the Figure 2(b), the answer that contains the history of the patient whose ID is 123.456.789-01.

4 Conclusion

This work presented the use of a permissioned blockchain through an application prototype that performs the registration of electronic medical records. The focus of the prototype was to use the Hyperledger Fabric platform to track medical visits by patients in healthcare institutions. This research is at an early stage, but preliminary results indicate that blockchain can be well used for e-health applications, integrating with other technologies.

This work collaborates with the disclosure of permissioned blockchains and their applications. As future work, it is planned to complete the implementation of the application and verify the performance of the network with different workloads.

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