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A BLOCKCHAIN-BASED CERTIFICATION SYSTEM FOR EDUCATION: BCERTIFICATED

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Abstract

This study is an attempt to solve the certificate validation problem in open and distance learning programs, and has been specifically designed for a professional development program provided by a state university in Turkey. The certification process of the training involves different actors (students, teachers, authorities), and the progress of trainees is tracked closely since completion of the training is based on process evaluation. Blockchain technology and smart contracts are used as a solution to document, validate, and verify the certification process. Hyperledger Fabric is used in order to develop an autonomous and decentralized system for this purpose. The users will be able to validate the certificates with this system, and this validation will have the credibility of the requested document. The codes of the prototype are also served with the GNU free software license. Methods and findings are presented and discussed in this paper.

Keywords: blockchain, open and distance learning, certification

1. INTRODUCTION

The advent of online technologies and the changing profile of learners have recently forced higher education institutions to change their modes of delivery for education in order to include more intensive use of such technologies, either to support on-campus courses with technology or in the form of fully online degree programs (Arinto, 2013; Bates, 2008). Additionally, many higher education institutions have become involved in relatively recent initiatives triggered by online technologies such as online professional development programs, open educational resources, and Massive Open Online Courses (MOOCs) at the other end of the formation (Bates, 2015). Amongst the latter initiatives, professional development programs (or so-called Certificate Programs) may occasionally be key to professional career development, since successful completion of such programs or courses may lead subsequently to promotion, reassignment or financial gain upon receipt of a printed (or, in these days, digital) certificate confirming their achievement.

Muğla Sıtkı Koçman University (MSKU), a state higher education institution in Turkey, has been integrating online technologies in the form of online on-campus courses and also fully online degree programs. It has an established online certificate program to train its faculty instructors on how to teach online, which is one of two such programs in Turkey. e-Tutor is a 14-module training program for faculty members and teachers who wish or are required to teach online classes or implement technology-enhanced instruction. Participants follow the training online and are assessed based on their performance throughout the process via quizzes, tasks, discussions, and the creation of digital artifacts (Adnan, Kalelioğlu, & Gülbahar, 2017). At the end of the program, successful participants receive a printed certificate from the university’s Distance Education Centre. There are also occasions where collaboration is seen with other universities or institutions through the participation of their faculty members, instructors or teachers, which then raises the question of validation and verification of the certification. Blockchain technology is seen as a candidate for the certificate validation problem, especially for the distance education.

Blockchain enables a decentralized system which runs as a P2P (peer-to-peer) network of nodes. The transactions are collected and recorded in a chain of blocks called the ledger. A block usually contains transaction data, a timestamp, and a hash which is a pointer to the previous block (Grech & Camilleri, 2017; Karaarslan & Akbaş, 2017). Blockchain is appropriate to use for a solution where it is necessary to provide trust between multiple parties and to share data in a decentralized way (Wüst & Gervais, 2017). In the current study, a decentralized application

called BCertificateD is proposed as a blockchain-based certification application. This paper presents and discusses the working principles and potential benefits of this solution in detail.

Blockchain system will increase the level of the security services such as availability, the fault tolerance of the system, and the integrity of the grades and generated certificates. The availability service will be increased with the number of nodes in the system. The integrity of the records will be accomplished with the immutable ledger. Every change will require a transaction and these activities will be recorded in the ledger.

In the next section, the methods and the implementation will be given. In the third section, the findings of the implementation will be given. In the last section, the result and future work will be mentioned.

2. METHOD

Firstly, the certification system for the distance education is analyzed with experts from MSKU Distance Education Center A use-case diagram of the overall system is provided in Figure 1. The requirements and possible enhancements are also identified. The procedural expectation of the Distance Education Center is a system which both records and enables the entire progress of the student to be seen throughout the program.

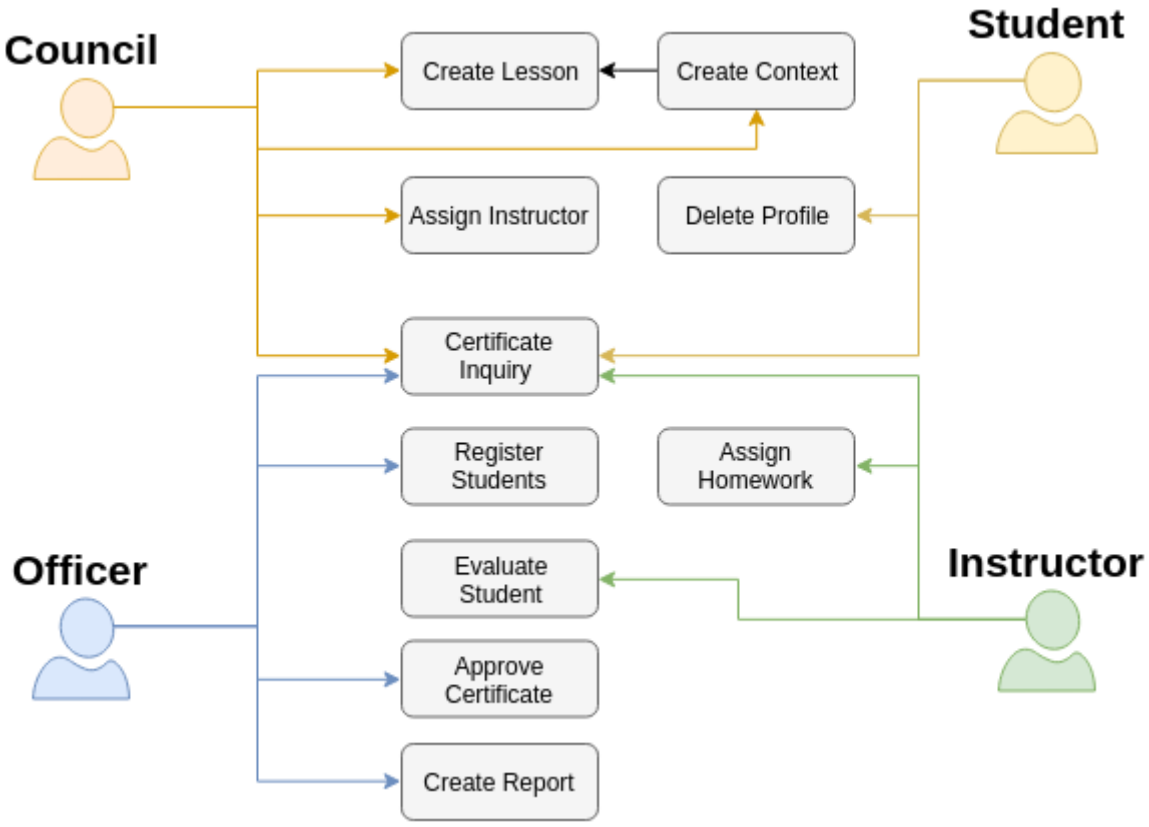

Fig. 1. Use-Case Diagram of the Certification Process

Hyperledger Fabric and Composer were selected for the solution. Hyperledger is an open-source blockchain platform and an umbrella project of the Linux Foundation, which hosts several different varieties of blockchain environments and is also an incubator for the blockchain technologies. It has distributed ledger technologies (DLT) such as Sawtooth, Burrow, Fabric, and Iroha, and tools such as Composer, Cello, Explorer, and Quilt. Employing Fabric together with Composer is a good combination for effective solutions, due to its basic coding and deployment. Ethereum, which is another popular public blockchain platform, requires tokens like cryptocurrency to approve transactions and to maintain the system, but Hyperledger Fabric has no such requirement. Also, the network settings for many types of organizations , channels which need blockchain solutions for the issue of “trust” can effectively be configured. Hyperledger Fabric has three node types:

- Client – any user involved in the transaction
- Orderers – used for transaction distribution
- Peers – used for keeping the ledger

In the implementation, an ordinary PC is used to host an orderer and a peer node. These nodes are ran as separate containers in the Docker platform and wait on different ports. The certification process diagram of the BCertifieD system is given in Figure 2. Installation of the environment is explained in detail in the Github repo page (see https://github.com/MSKU-BcRG/Hyperledger_Composer_Fabric_Kurulum_Rehberi), and the details of the implementation are given in the project Github repo page (see https://github.com/MSKU-BcRG/BCertificateD).

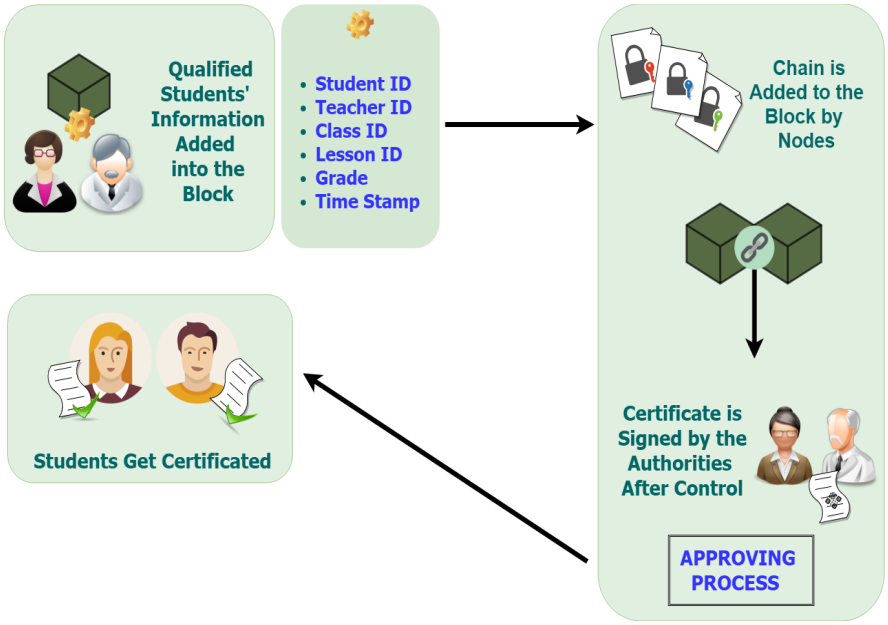

Fig. 2. BCertificateD Certification Process Diagram

The project is coded in a JavaScript-like language of the Hyperledger Fabric environment. A special code which will run on the peer node is also needed to control data on the blockchain. This code is called the chaincode and is similar to the smart contract of the Ethereum. User-defined chaincode is encapsulated in a Docker container. Chaincode can be written in high-level programming languages like Go or Java by using advantages of the Docker. The activity logs of the chaincode are kept as records on a ledger in order to track the system (Cachin, 2016).

Hyperledger Fabric provides a permissioned blockchain which is used to form Hyperledger Fabric Business Network. It has role-based permission settings in order to manage rules for accessing or changing the data on the system. This is an important difference when compared to permissionless networks such as Ethereum and Bitcoin which have no such features. The rules management on Hyperledger Fabric provide privacy and security automatically. Nodes which are a part of the Business Network can be added with permission by the authorities. The chaincode also has rules for the user roles as called participant. These rules determine who can view or change the data. There are various specific options to configure the rules, so it has the advantage of avoiding data manipulation. The BCertificateD system is coded as Chaincode with a few rules defined. There are certain user roles as participant within the system such as student and teacher. The following code is an example of a rule that provides access to the students to only their own certificates.

```
rule StudentsCanReadTheirCertificate {
   description: "Allow all students to have read access to their certificate"
   participant(m): "org.bcrg.msku.Student"
   operation: READ
   resource(v): "org.bcrg.msku.CertificateTrancastion"
   condition: (m.p_id==v.Student.p_id)
   action: ALLOW }
```

3. FINDINGS

The BCertificateD system prototype works on Hyperledger Fabric. Whilst requiring more effort to build, Hyperledger Fabric-based projects are more stable, and can also be said to be distinctly different to other education-based Ethereum platform blockchain projects (e.g., EdgeCoin, see https://www.edgecoin.io/; KryptEd, see http://www.krypted.org/; or ODEM, see https://odem.io/). To the best of the authors' knowledge, there are no other Hyperledger Fabric framework-based education projects.

The system prototype currently works on one peer. As future work, additional peers will be added in order to increase the availability of the system. Privacy of personal data is achieved with the permissions rules. Whilst currently deemed to be sufficient, additional security measures are planned to be implemented in the future.

4. CONCLUSIONS

A blockchain-based certification system was implemented on the Hyperledger Fabric environment. This project is one of the first live blockchain implementations by the MSKU Blockchain Research Group (BcRG). Detailed descriptions of the environment installation and the codes of the project are shared in Github with GNU free software license. The implementation tests are promising, and the solution is planned to be used for distance education by the MSKU Distance Education Centre in 2019.

The proposed system increases the availability, fault tolerance and integrity of the certification process. Future work will include increasing the privacy and assuring authenticity of the data. Turkey's personal data protection law (KVKK) and the European Union's General Data Protection Regulation (GDPR) emphasizes the need for privacy of personal data and defines the penalties where this is abused or improperly exploited. The digital signature will also be implemented for authenticity.

5. REFERENCES

Adnan, M., Kalelioğlu, F., & Gülbahar, Y. (2017). Assessment of a multinational online faculty development program on online teaching: Reflections of candidate etutors. *Turkish Online Journal of Distance Education-TOJDE, 18*(1), 22-38.

Arinto, P. (2013). A framework for developing competencies in open and distance e-learning. *The International Review of Research in Open and Distributed Learning, 14*(1), 167-185. Retrieved from http://www.irrodl.org/index.php/irrodl/article/view/1393/2433.

Bates, A. W. (2015). *Teaching in a Digital Age: Guidelines for Designing Teaching and Learning.* Vancouver BC: Tony Bates Associates. ISBN: 978-0-9952692-0-0.

Bates, T. (2008). Transforming distance education through new technologies. In T. Evans, M. Haughey, & D. Murphy (Eds.), *International Handbook of Distance Education* (pp. 217-236). Bradford, UK: Emerald.

Cachin, C. (2016, July). *Architecture of the hyperledger blockchain fabric*. Paper presented at the Workshop on Distributed Cryptocurrencies and Consensus Ledgers (DCCL 2016), Chicago, IL. Retrieved from https://www.zurich.ibm.com/dccl/papers/cachin_dccl.pdf.

Grech, A., & Camilleri, A. F. (2017). *Blockchain in Education. 132 S. (JRC Science for Policy Report).* URN: urn:nbn:de:0111-pedocs-150132. Luxembourg: Publications Office of the European Union.

Karaarslan, E., & Akbaş, M. F. (2017). *Blockchain Based Cyber Security Systems* (Turkish). *Uluslararası Bilgi Güvenliği Mühendisliği Dergisi, 3*(2), 16-21. DOI: 10.18640/ubgmd.373297.

Wüst, K., & Gervais, A. (2017). *Do you need a Blockchain?* IACR Cryptology ePrint Archive 2017: 375.

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