# Education-Industry Cooperative System Based on Blockchain

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***Abstract*—Blockchain is the underlying technology of Bitcoin. It is considered a prospect by industries such as finance, education and healthcare, due to its decentralization and non-tampering features. In the current Education-Industry cooperation, substantive information asymmetry exists between universities and employing companies. Student credit systems and the historical information data chain need urgent establishment and maintenance. The paper makes use of the transparency and non-tampering features of the blockchain system to implement an Education-Industry cooperative system based on the blockchain Hyperledger framework. Using the Certificate Authority service and transactions in the Hyperledger framework, the system simulates the roles of universities and companies in the system, and enables universities and enterprises to share information transparently, which achieves information symmetry among student skill and knowledge information, demands of enterprise recruitment, and current market trends. This offers a significant attempt on the application of blockchain technology to Education-Industry cooperation as a pilot development for technology deployment.**

***Keywords—Blockchain, Hyperledger, industry, education, employment***

## I. INTRODUCTION

Recruitment and employment build a bridge between education and industry. However, the current Education-Industry cooperation needs seamless convergence among university students, educational institutions and companies, and the efficiency and transparency need to be improved. The current student credit system is not sound, with limited data dimension and incomplete historical records. On one hand, diploma fraud, academic fraud and resume fraud exactly exist, on the other hand, institutions and companies lack effective means of verification. As a result, the government and companies cannot obtain complete and credible student information, which reduces the trust between universities and companies.

Resume fraud is pervasive and has detrimental consequence, but is rarely studied despite the negative impact it can have on job-related outcomes. Christine A. Henle did a research on resume fraud from perspective of statistics, psychology, and human behavior [1]. While, this is only a way of resume fraud prediction with limited accuracy, which cannot solve the problem from the very beginning. So, we make use of the transparency features of the blockchain system to implement an Education-Industry cooperative system using Hyperledger blockchain framework, which provides an innovative and viable solution for universities and companies collaboration and information sharing. Frauds are expected to be eliminated and the trust between universities and companies can be established.

The rest of the paper is organized as follows. First, an overview of the current status of blockchain technology and the Hyperledger project is given in Section II. Then, the major pain points of the collaboration between universities and companies and the scenes in which blockchain can be applied are analyzed in Section III. The prototype system design and implementation is illustrated in Section IV. Finally, conclusions and the future work are presented in Section V and VI.

## II. BLOCKCHAIN & HYPERLEDGER

### A. Blockchain

Blockchain technology, is the underlying core technology of Bitcoin [2], and is essentially a distributed and decentralized data storage scheme. All blockchain nodes collectively maintain a set of reliable data without the need to trust each other, through the use of decentralized P2P protocols.

Blockchain is a technical scheme which verifies, transmits and exchanges data through its own distributed network and does not rely on third parties and data stores. To put it plainly, blockchain technology refers to a way of involving all participants in terms of data storage and maintenance [3]. All systems have a database behind them, and in blockchain, the database could be regarded as a huge ledger. It is important to know who has the authority to keep this ledger. In a blockchain system, members of the system have the opportunity to participate in bookkeeping. If there is any change of data within

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a certain period of time, all system members can amend the record. The system will judge the person who makes the fastest and best record during this period, write down the contents of this record to the ledger and broadcast the records to all others in the system for backup. Every member of such a system has a complete copy of the data ledger. This kind of data storage scheme is called blockchain.

Blockchain technology relies on distributed cryptography and mathematical algorithms [4]. It is hard to establish trust on the Internet without the help of any third-party intervention. Blockchain, however, can make participants reach a consensus in this environment, at very low cost. It solves the problem of how to transfer trust and value.

Due to the inherent features of de-centralization and non-tampering, the blockchain has been considered as having expansive prospects across industries such as finance, education and healthcare. However, as the blockchain has only recently been recognized, research and development are still in their infancy. Whilst some typical applications of blockchain have been developed, diverse fields are now actively exploring the value and potential of applications founded on blockchain platform. Blockchain technology will advance following the direction of blockchain 1.0 (digital currency), blockchain 2.0 (digital assets and smart contracts), to blockchain 3.0 (blockchain self-consistent organization, company), and it is suggested that eventually the blockchain society (throughout education, healthcare, science, artificial intelligence and other aspects of society) will be reached.

### *B. Hyperledger Fabric*

The Hyperledger project is the first significant exploratory development in terms of open and standard blockchain technology. With the support of the Linux Foundation, Hyperledger has attracted the participation of many technical and financial corporations. In March 2016, under the auspices of the Linux Foundation, the Hyperledger project formally incorporated the source code contributed by members of Blockstream, Digital Asset Holdings and the technical giant IBM into a new code base to form a new enterprise-level blockchain base. This code collection is called Hyperledger Fabric. Fabric aims to interchange, maintain, and retrieve information on specific assets within a consensus network. Fabric architecture supports the plugging and unplugging of modules, which will further promote the application of Smart Contracts for various business scenarios.

The blockchain in Hyperledger Fabric can be understood in the model of state-machine replication, where a service maintains some state and clients invoke operations that transform the state and generate outputs. The blockchain emulates a "trusted" computing service through a distributed protocol, run by nodes connected over the Internet. The nodes share the common goal of running the service but do not necessarily trust each other. The architecture of the Hyperledger Fabric is shown below as Fig. 1, which contains three major components: Blockchain, Chaincode and Membership [5].

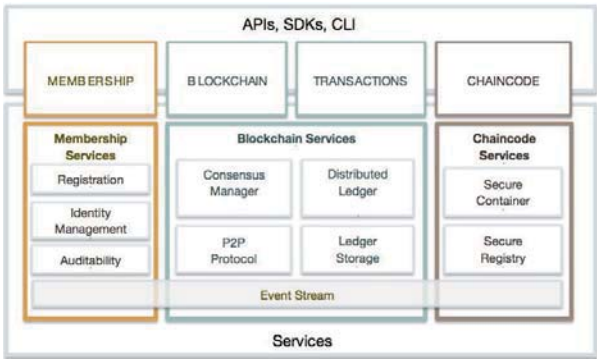


Fig. 1. Architecture of Hyperledger Fabric

- Block: A group of confirmed transactions, ready to join the blockchain.
- Blockchain: A chain structure made up of multiple blocks, each block contains the hash of the previous block content, except the first block.
- Certificate Authority(CA): Responsible for authority management, also called Member Service or Identity Service.
- Chaincode: The application logic code on blockchain, derived from a Smart Contract, running in an isolated container environment.
- Ledger: Contains the blockchain (with all transaction information), and the World State.
- Orderer: Responsible for consensus service, sorts unconfirmed transactions, gives the global order for confirming.
- Transaction: Calls some functions on the Ledger, functions implemented in Chaincode.
- World State: A key-value database, helps Chaincode to store the global status of transactions.

## III. BLOCKCHAIN IN EDUCATION-INDUSTRY COOPERATIVE WORK

Education and employment aim to achieve seamless convergence between the students, educational institutions and companies, in order to improve the efficiency and transparency of education and employment agencies [6]. The transparency of a blockchain system is fully applicable to student credit management, employment, academic, qualification certificate and other Education-Industry cooperation.

As the current student credit system is not strong enough, and the historical information data chain has not been established, government and enterprises cannot obtain complete and effective information, and students thus cannot easily and fairly enjoy the service they deserve. On one hand, academic fraud, thesis fraud and resume fraud are serious, on the other hand, employment institutions do not have proper means of verification, so they suffer from the loss of information

asymmetry, causing mistrust among universities, enterprises, and institutions. In addition, there are often copyright disputes and academic disputes on the Internet relating to academic experiments. Scholars and researchers lack the awareness of intellectual property protection, which may reduce the enthusiasm of academic research.

Blockchain technology can greatly optimize existing operational solutions, and effectively simplify the process and improve efficiency [7], avoiding information opacity and fraud. It can facilitate tracking all positive and negative behavior records of students during the campus period by using distributed ledgers to record cross-regional and cross-institutional student information, building a healthy credit ecology. Students with good records may gain additional incentives.

Blockchain can provide the digital proof of academic achievement, and authority evidence for academic disputes and thus reduce the costs of manpower and time. At the same time, this digital proof can be seamlessly integrated with existing applications, adding a unique timestamp identity proof for each text, picture, audio and video. This ensures integrity and consistency of the data and protects intellectual property rights [8].

In the case of educational certificates, a student credit platform based on blockchain can create a digital file containing basic information, and then use the private key of the user to sign the contents of the certificate, and then add a signature to the certificate itself. According to the hash value created, the contents of the certificate can be verified. Finally, the user can use the private key in the blockchain to create a digital record and ensure the consistency of both user information and certificate content. The educational institutions can use their own private keys to sign a digital certificate with the whole information record to be stored in the blockchain with a unique hash value. Then at each authorization and query, the certificate can be triggered and verified by the smart contract and the multi-signature. This ensures that there will not be malicious queries, and the transaction will give the digital certificate to students or employer companies.

For Education-Industry cooperation this is a win-win process between educational institutions and employer enterprises. Now one of the problems of education is that skills information of students and knowledge systems are not symmetrical with the skill demands of the market and employer enterprises. Seamless convergence may be achieved with blockchain technology, which can effectively promote cooperation between universities and enterprises.

## IV. Prototype System Design & Implementation

The prototype system aims to use Hyperledger Fabric to implement a blockchain-based Education-Industry cooperative system sharing student and employer information. The first step is to set up and deploy a Hyperledger Fabric blockchain network. Hyperledger Fabric CA was utilized as the Certificate Authority in the system, and a single-node Hyperledger Fabric Orderer as the Ordering Service. Two organizations were simulated with Hyperledger Fabric Peer with two nodes per organization. SpringBoot was used to build the system background service layer, the front-end user interface was effected using AngularJS. Functions including storing, modifying and querying the blockchain data are achieved.

### A. System Architecture

The system architecture layers are shown in Fig. 2. Hyperledger Fabric platform underlies the whole system using blockchain technology as data storage. Then, Hyperledger Fabric CA provides the Authorization Service. The Hyperledger Fabric ChainCode Service is adopted to fulfill smart contracts based on the blockchain. On top of Hyperledger, is the authority authentication module, student information management module, recruitment information management module and the block information management module. The system provides a web interface, and a command line interface for manipulating Hyperledger Fabric from the bottom side.

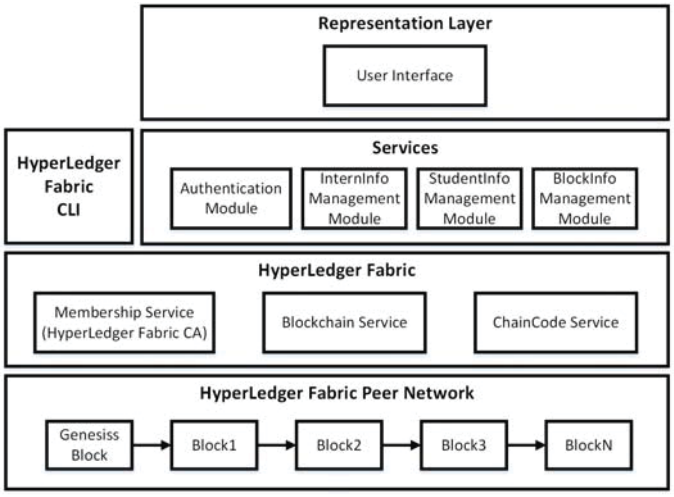


Fig. 2. Prototype System Architecture Layers

According to the data flow shown in Fig. 3, users can do identity authentication through the web interface and obtain the certificate from the Hyperledger Fabric CA Server with a valid user ID and password. Validated users can interact with the system through the web interface or the provided command line interface. Users can query or manipulate the blockchain information, student information or recruitment information depending on the authorization of the user.

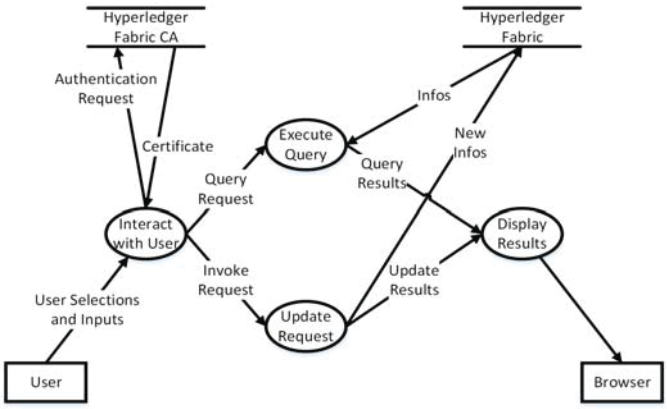


Fig. 3. System Data Flow Diagram

### *B. Data Structure*

The data structure of our prototype system is shown in Fig. 4, according to the roles of users we have divided and the functions we have designed.

- The affiliation in User indicates the organization name of the user, and mspid means member service provider ID.
- Enrollment contains the certificate information that the user acquires from the Hyperledger Fabric CA Server for subsequent authentication of the Hyperledger Fabric network.
- InternInfo represents the internship experience of the user.
- The educationQualifications in StudentInfo indicates previous education experience.
- RecruitmentInfo represents company recruitment information. HeadCnt represents the expected staffing demand, and contact is the contact person of the company.
- BlockInfo represents the block meta data in the blockchain. Number is the block number, previousHash is the hash value of the previous block, and data contains the non-decoded block meta data stored by the block.

```
User: {
    name : String
    roles : Set<String>
    affiliation : String
    enrollment : Enrollment
    mspid : String
}
StudentInfo: {
    id : String
    name : String
    university : String
    degree : Enrollment
    start : String
    end : String
    educationQulifications : List< String>
    internInfos : List<InterInfo>
}
BlockInfo: {
    number : Long
    previousHash : String
    data : String
}
RecruitmentInfo: {
    company : String
    department : String
    position : String
    description : String
    headCnt : int
    start : String
    end : String
    contact : String
}
InternInfo: {
    studentId : String
    name : String
    workingId : String
    company : String
    department : String
    position : String
    start : String
    end : String
}
Enrollment: {
    privateKey : PrivateKey
    cert : String
    publickey : String
}
```

Fig. 4. Prototype System Data Structure Design

### *C. System Deployment*

The basic environment of our prototype system is deployed on Hyperledger Fabric v1.0 as is shown in Fig. 5. As there is not yet stable release for Hyperledger Fabric v1.0, our system uses Docker container for Hyperledger Fabric v1.0 blockchain network deployment. The system simulates two kinds of organizations, including school organizations and other organizations. Each organization has two Hyperledger Fabric Peer nodes. In total four Peer nodes form a blockchain network. The network also contains a single-node Hyperledger Fabric Orderer as the Ordering Service provider of the system. Additionally there is a Hyperledger Fabric CA Server providing the Membership Service of the school organization.

- Hyperledger Fabric CA

  The system deploys the Hyperledger Fabric CA in a single node. The entire default school organization uses the same CA Server. The deployed version is Hyperledger Fabric CA x86_64-1.0.0-alpha.

- Hyperledger Fabric Orderer

  Our system deploys Hyperledger Fabric Orderer in Solo Mode. The entire deployment of the blockchain network uses the same Orderer consensus service. The deployed version is Hyperledger Fabric Orderer x86_64-1.0.0-alpha.

- Hyperledger Fabric Peer

  Our system simulates the deployment of two organizations, each organization has two Peer nodes. The deployed version is Hyperledger Fabric Peer x86_64-1.0.0-alpha.

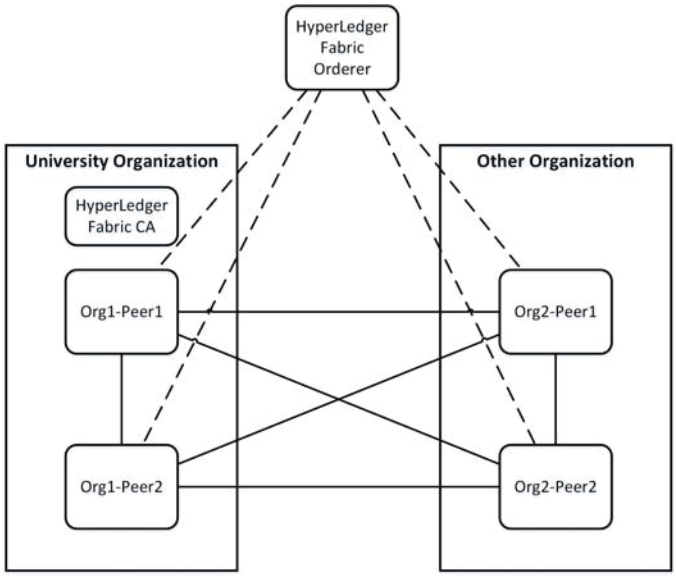


Fig. 5. Prototype System Deployment Diagram

## V. CONCLUSION

The paper addresses the current information asymmetry between universities and employer enterprises, an incomplete student credit system and that the historical information data chain is unestablished. With the help of blockchain technology, data transparency, authenticity and validity can be guaranteed. Seamless convergence is achieved among students, educational institutions and employer enterprises, which improves the efficiency and transparency of education and employment agencies. With the help of Hyperledger Fabric, we have designed and implemented an Education-Industry cooperative prototype system. The system proposes a new way for universities and enterprises to share information transparently, which achieves information symmetry among student skill and knowledge information, demands of enterprise recruitment, and current market trends. Enterprises can precisely arrange their offers, and graduate students can wisely choose available opportunities. This offers a significant attempt on the application of blockchain technology to Education-Industry cooperation as a pilot development for technology deployment.

## VI. FUTURE WORK

Our future work will be focused on the following aspects:

- The current Hyperledger Fabric CA Server and Hyperledger Fabric Orderer are deployed in single-node, which is not robust enough. Cluster deployment can be adopted in the future to achieve server load balancing. System back-up and restore will also be taken into account.
- The system needs more APIs for data importing and for external access.
- The authority authentication module of the system can be further designed with more fine-grained authority division.
- Performance problem is a common limitation of blockchain systems, so the future work can be focused on improving the performance of the system based on Hyperledger Fabric.

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