Creating a Decentralized Blockchain to Store University Data and Payment of University Course Material Through the Use of a Smart Contract

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Abstract: The use of blockchain technology gives universities the opportunity to create their own blockchain. By rethinking the Bologna program applied in education, in the future, universities will be able to work together even more closely in the field of joint curriculum development. It can be observed that different universities teach the same subjects. As a result, university lecturers have even more burdens outside of teaching, as lecturers must prepare the same teaching materials for each university. The aim of the research is to create a blockchain in practice, as well as to present it in detail, where university lecturers could upload uniformly prepared teaching materials. In the long run, a unified and universally accepted university curriculum will certainly bring many advantages. If the university also wants to upload paid course content to the blockchain, a smart contract must be used. With the help of a smart contract, payments for teaching materials would be carried out in an automated manner, so additional burdens could be taken off the shoulders of universities. Since the blocks in the blockchain are closely built on top of each other, it is difficult to modify them with the educational materials stored in them. Since universities must provide students with up-to-date knowledge, the teaching materials must also be up to date. The modification of teaching materials at specified intervals could be solved using the Soft-Fork blockchain process.

Keywords: Study Material, Smart Contract, Soft-Fork

Introduction

Today, blockchain technology is still considered a novelty, even though new ideas in this area appear daily. IT professionals are still getting to know blockchain-based solutions and are trying to take advantage of its potential.

Blockchain technology has not yet spread in university education, although it is already successfully used in many areas, such as:

- Health records stored in a blockchain allow patients to make their structured data available to doctors. Such patient electronic health record databases would make entries tamper-proof while empowering patients to grant access to their electronic health records [1].

- Nowadays, many banks and other financial institutions are looking into and implementing blockchain security systems that are reducing the risk of cyber threats and fraud. The NASDAQ recently announced a plan to launch a Blockchain-based digital ledger which allows them to boost their equity management capabilities [2].

- The world is facing an expansion in the quantity and diversity of digital data that are generated by both users and machines. Blockchain technology comes providing significant solutions for the best way to store, organize, and process Big Data [3].

- Musicians can sign smart contracts with the label. The advantage of this is that by concluding decentralized and completely transparent contracts, it is possible for them to be paid on time and, in case of success, to receive even higher royalties. The smart contract implements the predetermined conditions without any external influence. Last but not least, Spotify acquired the media blockchain in 2017 [4].

To securely store and access the data, the course materials can be uniformly uploaded to the blockchain, as it can be observed that different universities do not teach the same subject in the same case. By applying blockchain technology, teaching materials can be standardized, so that lecturers do not have to process them again and again at each university. If the student was to change universities, the teaching materials would be the same as those of the previous university, so education would become even more efficient. An important part of the Bologna program is that the curriculum of the universities is similar so that when the student changes universities, the student can take the subjects he has already taken with him, so he does not have to repeat them again. Due to the use of blockchain technology, this check is not necessary, as the curriculum is uniform in all cases. It may happen that the study materials of some courses are paid for, in which case the study materials of the university blockchain can be accessed through a smart contract. Using the smart contract, the course material can be purchased automatically, without human intervention.

The research is structured according to the following structure:

- Examination of decentralized On-Chain and Off-Chain solutions for university data storage creation of an UEDSC blockchain,

- Creating a university blockchain,

- Sale of university study materials using a smart contract,

- Executing a Soft-Fork on the UDSC Blockchain.

1 Investigaiton of Available Blockchain Types from the Perspective of Storage of University's Teaching Materials

By using a decentralized data storage solution, the data is more secure than in the case of cloud-based storage, since it is distributed across a number of nodes. Furthermore, storage systems use public key encryption. Data is distributed flexibly between nodes, and smart contracts are also used automatically for the purpose of execution [5]. Advantages of decentralized data storage:

- The performance is balanced, as the nodes share the data volumes proportionally,

- High availability. Most of the hubs are available 24 hours a day. If some nodes become unavailable, the others will continue to serve the user.

- High degree of independence. Each node is independently responsible for following the rules, thus forming the blockchain ecosystem. It is not restricted by an outside person or authority and regulates its operation.

- The users' data is fragmented and then sent encrypted to the nodes. In the event of a DDoS attack, the system remains operational.

- If some nodes do not work or become unreachable in the event of an attack, the other nodes can continue to function without interruption. In the centralized system, if the central server stops, the whole system will most likely be inoperable, that's why it is data cannot be accessed [6].

There are two major implementations of decentralized blockchain-based data storage. This is the Off-Chain and On- Chain blockchains.

Off-Chain does not store each individual data per node, instead it records their hash value. The actual storage of the data would take place on the university's hard drive. This data is fragmented into multiple copies before saving [7].

On-Chain is the most secure blockchain-based data storage solution, as all data is saved in every block. As a result, the operation of the network can slow down, extremely may become unavailable due to overload. In addition, the nodes preserve all data and are constantly synchronized with each other. If an attack occurs, the data will not be lost. This is an expensive but safe solution [8]. The first figure below shows the structure of the private blockchain.
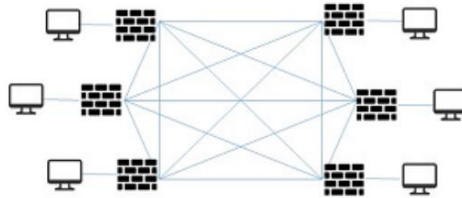
Figure 1

Private blockchain [9]

Before I create my own blockchain that is suitable for storing university data, I will examine what ready-made blockchain-based data storage solutions are available that may be suitable for storing university data. These are the following:

- File Coin and

- IPFS (InterPlanetary File System).

File Coin, like other decentralized services, has the following disadvantages:

- High volatility, therefore surrounded by considerable uncertainty,

- Difficult to scale,

- In many cases, they are slower than their centralized counterparts. The speed is very data-miner dependent [10].

The purpose of IPFS is to connect all computer systems to the same file system. It also works on a Peer-to-Peer basis. The advantage is that there is no central server and that the data is stored in different locations around the world.

Compared to other systems, it offers a high-performance block storage model in which content and destination links are located. It also combines DHT (Distributed Hash Tables) solutions with self-authenticating namespaces. The advantage is that IPFS nodes do not need to trust each other, thus reducing the possibility of failure. Its only drawback is that it does not provide a strong data protection and cryptographic solution [11].

After reviewing IPFS and File Coin data storage solutions, I have concluded that for the highest database security available, I will create my own university blockchain where I can personally control access rights to the data. To keep the On-Chain blockchain fast, I will maximize the block size to 1 MB.

2 Creation of a University Blockchain

In the case of the constitution of a self-sufficient, faculty-based blockchain, the educational institution may determine the advantageous and convenient conditions of data storage. These may be the following:

- Broader access to the blockchain in question,

- The definition of the size of blocks,

- The definition of terms of use,

- The original block (genesis block) to which will all the other blocks will connect, stays in the domain of the faculty,

- The limiting of access to the blockchain (only the authorized persons may use it),

- The definition of data protection policy,

- The blockchain may be started on multiple servers to uphold the security,

- The nodes are more easily monitored,

- The system will become more transparent,

- The eventual data compromising will be more easily identified [12;13].

When creating the university blockchain called UDSC (University Data Storage Chain), the first step is to create the genesis block. The creation of the genesis block is shown in the second figure.

```
{
   "config": { // the config block defines the settings for our custom chain and has certain attributes to
create a private blockchain
      "chainId": 987, // identifies UDSC blockchain
}
      "homesteadBlock": 0, // Homestead version was released with a few backward-incompatible
protocol changes, and therefore requires a hard fork. UDSC chain however won't be hard-forking for
these changes, so leave as 0
      "eip155Block": 0, // Homestead version was released with a few backward-incompatible protocol
changes, and therefore requires a hard fork. UDSC chain however won't be hard-forking for these
changes, so leave as 0
      "eip158Block": 0
   },
   "difficulty": "0x400", // This value is used to control the Block generation time of a Blockchain. The
higher the difficulty, the statistically more calculations a Miner must perform to discover a valid block
   "gasLimit": "0x8000000",
   "alloc": {}}
}
```

Figure 2

Creating a genesis block [14].

The faculty-based blockchain may be constituted in the following manner, presented in the third figure. This blockchain called UDSC needs to be created for the purpose of storing the university teaching materials.

University chain-util generate UDSC
the default settings would be used:
/default ~ university chain/UDSC/chainsettings.dat
chainsettings.dat include:
Database addresses [receiver (cloud storage) IP address, sender (university) IP address],
Database system addresses [receiver (university database) IP address, sender IP address],
Terms of GDPR database.
Next, the UDSC blockchain would be initialized, and the genesis block would be created
universitychain UDSC
The server will be started in those few seconds after the genesis block has been found, then the node
address needs to be connected:
UDSC@192.168.0.1:8008
After these steps, the connection can be attempted from a second server:
universitychain UDSC@192.168.0.1:8008
After the message confirming the chain has been initialized, permission is not given for connection to
the database. The address would be copied and pasted: 192.168.0.2
finally, permission for connection would be granted:
universitychain UDSC grant 192.168.0.2 connect.

Figure 3

The creation of an UDSC blockchain [8;12;13]

3 Payment of University Course Material Through the Use of a Smart Contract

A Smart Contract is a digital contract that controls the user's digital assets, formulating the participant's rights and obligations, and will automatically execute by computer system [9].

A smart contract is one based on blockchain technology a solution that automatically executes the conditions defined therein by bypassing an external third party as an enforcer. It only executes instructions that which are defined in advance in the contract terms. These conditions are called triggers. The following 4 conditions are required when concluding a smart contract:

- For the subject of the contract, which is actually the subject of the contract,

- To define conditions precisely. The provisions of the contract can only be implemented if they are fulfilled,

- For authentication. The subject of the contract and its conditions must be authenticated with a digital signature,

- Lastly, a blockchain is also needed where the contract can be created [15].

After the creation of the university UDSC blockchain, the course materials become accessible to students after entering the appropriate username and password. However, as part of some courses, lessons may become paid. This is especially typical for online education. If paid content is uploaded to the blockchain, then by definition it can only be accessed after payment. The smart contract is a big help in this. By applying a smart contract, paid course materials stored in the blockchain become available to students after they have been paid for them. The fourth figure below shows the smart contract-based payment method.

```
1 contract University study material {
2 uint public price ;
3 uint public university's stock ;
4 /.../
5 function updatePrice ( uint _price ){
6 if ( msg. student == university )
7 price = _price ;
8 }
9 function buy ( uint quant ) returns ( uint ){
10 if ( msg. value < quant * price || quant > stock )
11 throw ;
12 stock -= quant ;
13 /.
```

Figure 4

Sale of university study materials using a smart contract

4 Possible Soft-Fork of UDSC University Blockchain

If the lecturers want to modify the curriculum uploaded to the existing blockchain to the blockchain, then a Soft-Fork must be performed on the university UDSC blockchain to ensure the continued smooth operation of the blockchain. This means that the system Soft Fork comes to play when the system comes to a new version or new agreement, and it isn't compatible with the previous version, the new nodes couldn't agree with the old nodes. Because the computing power of new nodes has greater weight than old nodes, the old nodes will never be approved by the new nodes, but new nodes and old nodes will continue to work on the same chain. There is also a concept of compatible chains that are made when new nodes and the old nodes agree on the consensus and the new nodes can also join in with the old nodes as well [16]. The fifth figure shows the Soft-Fork of the UDSC blockchain.
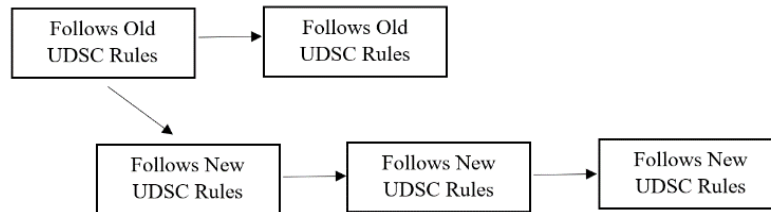
Figure 5

Soft-Fork on UDSC blockchain [17].

5 UDSC Connect with Other University Blockchain

To be able to connect a blockchain with another blockchain, you need a blockchain bridge. In general, blockchains are separate closed systems that have their own ecosystem. If we want to connect the university UDSC blockchain with another blockchain, a blockchain bridge must be used. In practice, this would mean that if the other universities also have their own blockchain, interoperability and closer cooperation could be established between them. In the case of a decentralized bridge, the main goal is that there is no need for an external party that can cheat. As a result, a smart contract and a decentralized network are needed, as well as validators who pay attention to compliance with the rules.

In addition to using the blockchain bridge, the Polkadot blockchain can also be used to connect the UDSC blockchain with other university blockchains, as Polkadot aims to create a framework between blocks that want to create a common connection between each other. Blockchains can connect to Polkadot and thus work in parallel.

Conclusions

Even though universities are open to new solutions and use modern teaching methods, the potential inherent in blockchain technology is not yet fully exploited.

By creating a unified and universally accepted university blockchain, cooperation between universities can be made even closer. The storage of uniform teaching materials in a blockchain is considered a forward-looking solution nowadays, which is currently underutilized.

By applying a smart contract, even paid content becomes available to students. Since there is a need for continuous curriculum development, the modification in the blockchain can be solved with the help of Soft-Fork.

Depending on the possibility, it would be advisable for universities to create their own common blockchain, rather than renting a ready-made blockchain suitable for data storage, since in this way they would be able to regulate the operating conditions of the blockchain and the authorizations themselves.

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