ExChain: A University Record Exchange System

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Motivation and Contribution

- We propose a system, ExChain, that revolutionizes record keeping in the domain of higher education.
- Owing to the immutability and transparency of blockchain, our proposed system will supplement existing legacy database systems currently used to ensure the efficient, secure, accurate, and permanent management of student records.
- We investigate using blockchain as an intercommunication medium between collaborating organizations that maintain extensive, differently implemented, and differently marshaled databases.

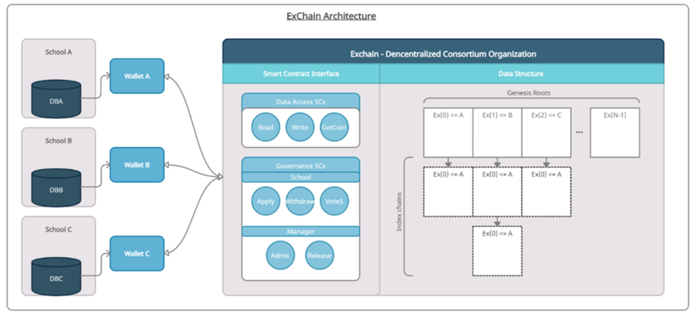
We argue using a blockchain as a global student record system to transfer student records could enable higher security and speeds than current methods

Challenges of Blockchain and ExChain

- Blockchain supplies many benefits but also presents its own challenges in security, interoperability, and computational costs
- *Security– The misconception is blockchain is more secure than other data management systems when in fact it is just as vulnerable. The main difference is its innate characteristic of immutability making all things within it permanent*
- *Interoperability– Major issues of blockchain inter-communication stems from the necessity of developing trust at the business, platform, and infrastructure levels in trustless environment. The communication between two blockchains requires the agreeance from a business perspective, platform level, and infrastructure view*
- *Computational Costs and Scalability– Generating cryptographic hashes is very quick but the lookup time for hashes will increase in proportion to the amount of blocks. The consensus algorithm also plays a huge role in incurring overhead whether it be PoW, PoS, PoAh, etc. As new students enter universities, ExChain must accommodate, introducing a demanding scalability issue*
- *Generality– Theoretically proving the advantages of ExChain could drive its integration into other settings such as health, government, and transportation*

Architectural Design

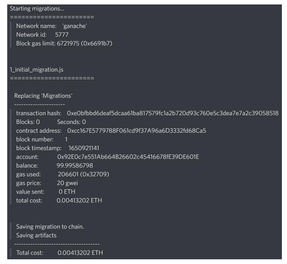
- Architecture– Each participating institution has a snapshot of their database on ExChain that is referenced with an Ethereum wallet like Metamask
- Simple Interface– Allows representatives of each member institution to read and write snapshots of their databases. They also have the privilege of reading other institutions databases if and only if a block is not being processed
- Advanced Interface– Includes each feature of the simple interface with an added governance policy. A randomly chosen manager oversees the ExChain infrastructure and can admit or release institutions from the network. Voting features for managers are executed at the end of each semester and when a new school requests to join the network



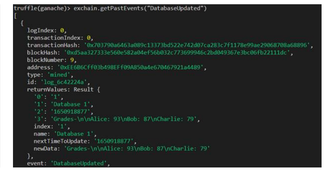
Implementation

- Environmental Setup– Demonstrated using Ganache within an Ubuntu Virtual Machine. The Truffle Framework was used to develop the necessary smart contracts
- ExChain Database– The database holds a payload, unique ID, name associated with an institution, and owner. Unix time functions are included as security measures for how soon operations can occur. Synchronization features were also added in the case of ExChain being used in a sharded setting
- Interface– The four core components included are *createDB()*, *deleteDB()*, *writeDB()*, and *readDB()*. Other helper functions include *_generateUniqueID()*, *onlyOwner*, and *_setOwner*

Experimental Results



- Left: Cost to migrate smart contracts for ExChain
- Right: Total cost to deploy ExChain smart contracts



- Left: Database 1 being read
- Right: Database 1 being updated with grades for Alice and Bob

- Left: An institution attempting to access ExChain without being a member of the network
- Right: Access denied because the institution is not a part of the ExChain network

Conclusion

- We have introduced a concept that can revolutionize record keeping and the exchange of student information through an interconnected blockchain-enabled system. It makes maintaining information easier, more efficient, accessible, and stands as a more secure form of storage. Cost-wise, we have also reduced the cost of record keeping, shown above as roughly 0.053 ETH (~$160), compared to maintaining legacy databases at ~$40,000.