LibChain

Distributed library management system based on the blockchain technology.

Atos IT Challenge 2017 - Blockchain

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Executive Summary

LibChain envisions modernised procedures to borrow books from libraries. Leveraging the blockchain technology, patrons can lend library books directly to other patrons without bringing it back to the library first. Such transactions can be made regardless of the registration library, as long as the patrons are registered with a participating library. Furthermore, the system supports interlibrary borrowing procedures. Taking into account that LibChain aims to extend current library services, implementing such a system allows a more comfortable and efficient way for patrons to interact with the libraries' ecosystem.

Motivation

In our modern digitalised world, retrieving information is much easier and quicker than ever before. Even though information can be retrieved from various sources, it remains important to provide a reliable source of knowledge which libraries fulfill. Libraries have been slow to adopt newer technologies in their services. Borrowing a book, for instance, maintains the same procedure from decades ago in which all borrowed books must return to the library before they can be borrowed again. Moreover, often cooperation between libraries lacks, which results in multiple registrations from patrons to borrow books from different libraries. Patrons, as well as libraries, can benefit from a system that makes such procedures easier and quicker. To this end, the blockchain technology offers a transparent management of resources that libraries can use to deliver such system in a safe and convenient way. Because of the blockchain there is no need for a central authority for two parties to have a trustful transaction.

In Germany alone there are approximately 10 thousand libraries with a catalogue of over 375 million different items in a variety of formats of which books are the majority **[3]**. In Europe there are approximately 1.8 billion different items and worldwide there are almost 2.5 billion **[4]**. Libraries fulfill an important task: In a free and enlightened society, they enable people to acquire knowledge by themselves and offer them the opportunity of forming an opinion of their own. That is why our society commits to spending great amounts of money on the upkeep of libraries and their inventory.

In 2015 German libraries spent about 433 million euros alone for the preservation and extension of the libraries' stock **[3]**. However, there is a big problem: having books on a shelf makes no sense on its own. It is important that libraries encourage and entice people to make use of their service. One of the obstacles to realising that vision is the way libraries have historically been structured. The libraries' ecosystem is decentrally organised with each library having its own administration and to the best of our knowledge there are no

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common lending systems. Therefore partnerships amongst libraries tend to be complex.

We propose a solution to **remove bureaucratic obstacles** for both the users and providers of library services. To lower these bureaucratic barriers we present a **decentralised lending system** on a blockchain that easily **integrates into existing systems**. According to Crosby et al. **[2]**, the blockchain stands for transparency, upholds a trustworthy system on which nobody trusts each other nor shall, and runs completely decentralised on a peer-to-peer network. In the proposed solution libraries could easily participate in a secure and transparent lending system, in which transactions are stored on a common shared blockchain alongside a book catalogue from all cooperating libraries. For the user it would be possible to find and borrow, as well as transfer books and their associated liability without needing to strictly bring it back to the library, thus in a much more convenient way.

Example: To understand the idea of the proposed solution let us consider that Alice wants to borrow a book from library A (LibA) and she is registered with library B (LibB). LibA and LibB cooperate through our system. LibA can, without knowing Alice's real identity, trust her request and verify the entitlement of the action. Therefore, Alice can proceed to borrow the book with the loan's transaction being stored on the blockchain.

After a week, Bob, who is registered with library C (LibC), wants to borrow the same book Alice currently has. Bob can contact Alice through the system – without knowing Alice's real identity – to ask whether she could give him the book.

As Alice does not need it anymore, she can use the system to make a transaction on the blockchain to transfer the loan with its obligations to Bob. She can meet and give the book directly to Bob without bringing it back to the library.

Thanks to the blockchain, the libraries are able to verify and identify the current holder of the books at any given time.

Libraries and mobile services

In a survey conducted in 2012 by Pew Internet several findings related to young adults in the United States (ages 16-29) and library's usage underline the importance of mobile services in libraries. Among the participating young adults 65% owned a smartphone and 18% visited a public library's website or accessed library resources in a period of 12 months. Moreover, 42% of the young adults stated that they would very likely use a cell app to access library services and 44% stated that libraries should move most library services online **[6]**.

In 2016, a more recent survey has been conducted by the same research project with similar results and more detailed information on the usage of the library's websites and mobile apps. The library's websites or mobile apps saw an increase on its usage, as now 27% of the participants accessed the library and 58% of those searched a library's catalogue **[5]**.

Boopsie[1], the world leading company that develops mobile library apps, has served 4,000 libraries worldwide and 500,000 unique users per month. These numbers are important to remark the widespread usage of library apps, even if they have to download a different app from each library.

To the best of our knowledge, a solution, similar to Boopsie's apps but with blockchain technology, has not been proposed before, as trustworthy instances were hard to confirm. Since one of the blockchain's principles is to establish a platform in which no trust is needed, the libraries can now lend books and still keep control over the possession of the books. Another advantage of this blockchain's principle for users that had borrowed a book from a library is that they lend it to another user of participating libraries. In a too decentralised system such as the libraries' ecosystem the blockchain will not make the ecosystem centralised, but rather securely decentralised with a shared database.

Furthermore, the adoption of library mobile apps is a promising opportunity for libraries since the apps can be easily integrated into the libraries ecosystem and as no existing services need to be replaced. The main usage of library apps focuses on assistance or extension of existing services. Hence **LibChain** is designed to **operate alongside the existing library services** to allow an **easy integration** and **early benefits** from the advantages.

LibChain

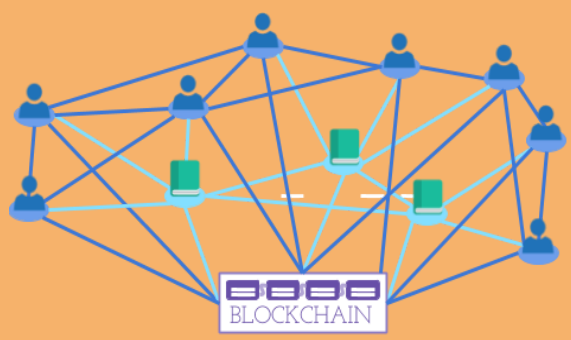
LibChain's vision embraces an establishment of a libraries' ecosystem that share a book's database and in which every user, regardless of registration's library, can borrow, reserve, and request books from any participant library or from any user that borrowed a book from a cooperating library.

The core idea behind LibChain from a technical standpoint is to represent individual books and loans from libraries with so called coloured coins. Coloured coins are used to represent real world assets by addresses in the blockchain and applications. Companies like Everledger[2] have successfully used them to track real world assets such as diamonds, artwork and other high value fraud targets in a permanent, decentralised fashion. In addition, metadata can be stored within a coloured coin. In LibChain, this metadata could contain information about how often the book can be passed on

[1] http://www.boopsie.com/
[2] http://www.everledger.io/

between users, the loan period and the home library of the book. By adding LibChain on top of an existing blockchain technology like Ethereum[3], we can use smart contracts that will act as decentralised applications in our system. To communicate between the different actors in the system the Whisper[4] protocol will be used. The Whisper protocol gives us signed and encrypted messaging that enables secure communications between parties in our system. The transaction keys are used to address users and topics will be assigned to further filter requests and invoke the appropriate response.

Having a transparent and permanent record of the books' usage can be advantageous for publicly funded libraries that have to be accountable for their expenditures; the publicly funded libraries make up 47% of libraries in the world **[4]**. Since all valid transactions of books would be written on the blockchain, they would be open to the public. This is an advantage in that it can allow easier oversight from the public, but at the same time the privacy of the users of the libraries would need to be upheld. According to the consumer barometer by Google **[1]**, mobile users do care about privacy protection which implies that for a better acceptance of the system privacy must be taken into account. To avoid disclosing personal information without neglecting transparency, on each user's transaction a new key-pair needs to be generated. Therefore, this key-pair needs to be known to the library in which the user is registered, to keep track of their books and avoid any fraudulent users to steal the books.



In LibChain's architecture there are 2 main actors: **libraries** and **users**. Both communicate with the **blockchain**: (1) users to look up for a book and store their transactions and (2) libraries to look up for current holder of books. We map the typical library use cases to the blockchain to provide innovative features in a comfortable and secure manner.

Furthermore, the blockchain must run on top of the existing system. For libraries this means that any existing system can be kept and LibChain will integrate as another layer on top of it. This will help libraries deploy LibChain and make it more feasible for libraries to choose LibChain rather than

[3] https://github.com/ethereum/wiki/wiki/White-Paper
[4] https://github.com/ethereum/wiki/wiki/Whisper

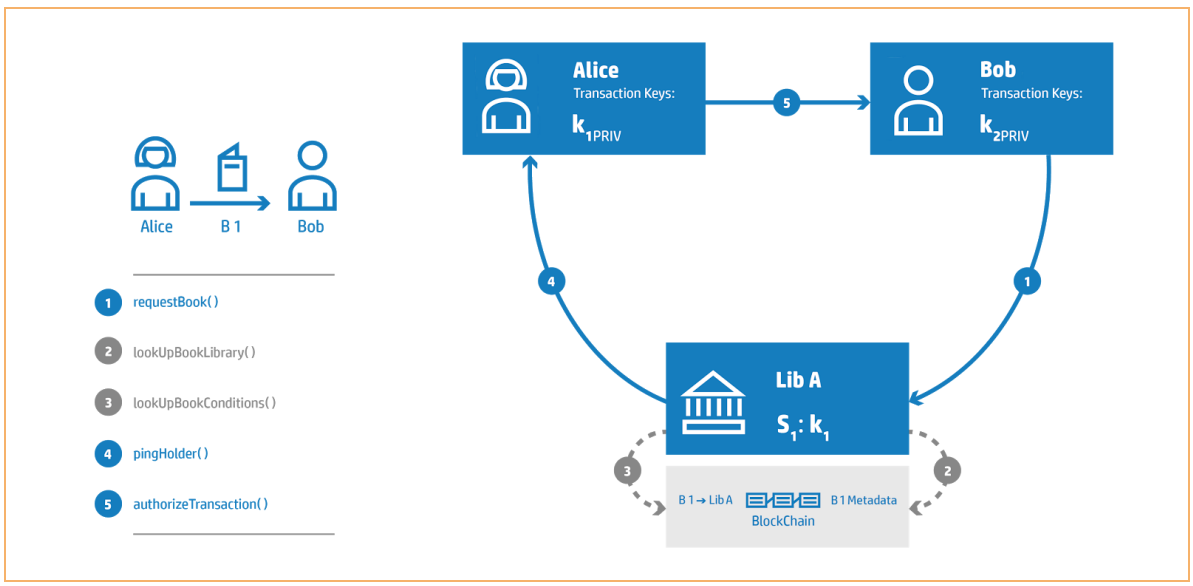
replacing an already proven system altogether. This also implies that to borrow books no extra registration must be explicitly made. Especially due to potential concerns that some users may refuse to use the software, either because of the absence of a mobile device or disagreement with the software. Thus the libraries will be able to create one-use accounts managed by the system. The registration for willing participants is only required while signing up to the system.

Outlook: The idea of having blockchain secured library transactions can be moved even further to support digital content like ebooks, scientific publications or any other media. This enables a more precise accounting because instead of having expensive flat-rate contracts with the digital publishers a pay-per-loan model can be implemented. Such a model would decrease the costs since the number of necessary digital copies can be easily derived by the stored transactions in the blockchain and future contracts can adapt to that.

In the following subsections we demonstrate the blockchain transactions that are invoked when books are loaned by the users.

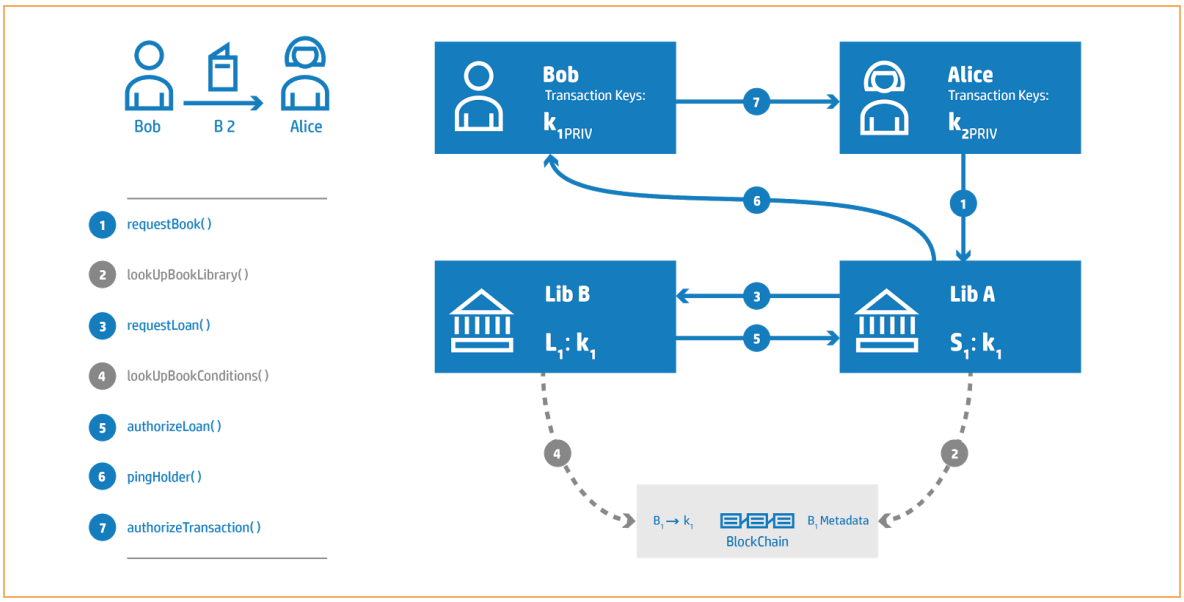
User to User loan

In the following we will look at some user to user book exchange scenarios.



In the first step the student Bob wants to receive a book from his fellow TU Berlin student Alice and sends a request to his home library. In this request the user needs to specify the specific book ID of the book he wants to receive as well as authenticating himself as a valid user to his library. Additionally he includes a key in the request that will act as wallet for the book.

Once the library (Lib A) receives the request it reads the owner/home library of the book from the metadata saved in the coloured coin. This is information publicly available in the blockchain.



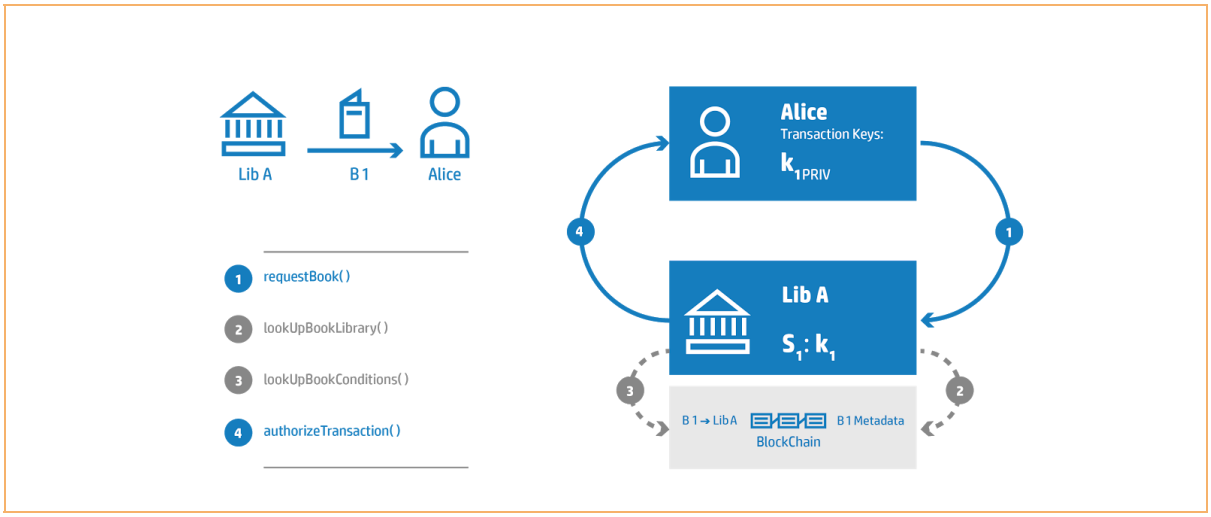
Should the library that is processing the request not be the home library of the book, it would have to then forward the request to that library. In this case Lib B will act as the owner of the book. Lib B will then respond with either an OK to signal that the book can be passed on to a new user or reject the request which will terminate the process. Lib B will also have to save the information that someone from the foreign library will hold the book.

If the registration library (LibA) of Alice gets the OK from the book's home library (LibB) it will then ping the wallet that currently holds the book in this case Alice.

Alice can now decide whether she wants to pass on the book to the wallet that was included in the ping or reject it.

Library to User loan

Currently the process has been designed in a way that library to user borrowing works essentially analogue to user to user book exchanges.



The library Lib A looks up the owner of the book in the blockchain and also checks the availability of it through the transaction information in the blockchain. If it controls the wallet that the book is currently in and confirms the loan request it can send the book coin to the requester Alice. In doing so the library saves the transaction key as a link with the user ID. This is to ensure that the library knows the true identity of the user in case he is overdue or the book gets damaged.

Project Plan

The development of the LibChain project will be split into 4 workpackages, each with a principal task and secondary features.

Workpackage 1: Requirements and overall architecture

The first workpackage contains a system requirements analysis and will be about establishing the basic infrastructure. The main features of the first workpackage are:

- Create the clients that will connect with the private ethereum blockchain
- Define data structure of the coloured coins to represent books and include needed parameters to implement library features, i.e loan period, amount of allowed user-to-user exchanges and the home library
- Build the infrastructure needed to deploy a private ethereum blockchain

Workpackage 2: Basic system implementation

In the second workpackage the first functionality of the system will be implemented. The tasks of this workpackage are:

- Implementing the library-to-user and user-to-user loan
- Implementing the block chain features, i.e sending tokens, reading from metadata
- Creating distinct library and user clients

Workpackage 3: GUI

The third workpackage focuses on the Graphical User Interface. Its tasks comprise:

- Create GUI to enable clients to use library functions
- Create GUI to allow libraries to add/remove books and retrieve data about users and books.

Workpackage 4: Edge-Cases and Presentation

The last workpackage focuses on edge-cases, improvements of performance, and user documentation. These are the currently recognised edge-cases:

- Borrowing from any library
- Passing on books to users from any library
- Reserving books

References

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