Spring 2021, Lab 4 proposal
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Lab4 Project Proposal

Distributed Blockchain System

Brief introduction:

A blockchain project will allow peers to mine blocks and add to a peer-to-peer network.

The Project will follow the ideas in modern blockchain, using unique hashes to identify each block.

Basic: The user will be able to

1. mine a block,
2. read blockchain log from peers
3. broadcast its local blockchain to the peer-to-peer network.

Improvements:

If time permits, we will finish translation and real peer-to-peer networks.

1. **Translation** will allow peers to send and receive virtual asset from other peers;
2. **real peer-to-peer networks** will use Spark Web Framework instead of the transport lib in previous Lab to implement visible BlockChain

Project route map:

BASIC/checkpoint-I: Basic BlockChain in TransportLib

Model:

1. BLOCK:

`Index` // the index in the entire chain `timestamp`// the time the block is generated `Virtual assets`// the 'money' data `Hash` // through sha256 algorithm `prevHash` // through sha256 algorithm, points to the previous hash

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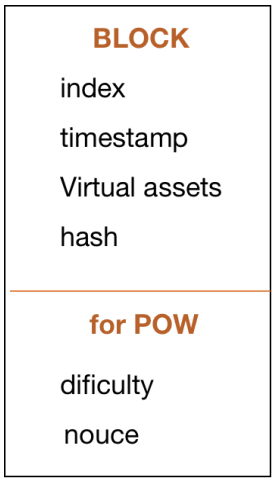
In current block design, proof of work (POW) should be added to a block. POW is introduced to increase the cost of appending a new block to the blockchain. The structure will be like:

Difficulty is an integer field indicating digits of leading zeros in a hash. The bigger the difficulty is, the harder to mine a block.

Nonce is a long number, which is used to recalculate the hash. If the new hash contains difficulty numbers of zeros, a block is mined.



2. The chain

   The block chain can be maintained by a simple ArrayList:

   `ArrayList<Block> blockChain`

3. The Peer Node

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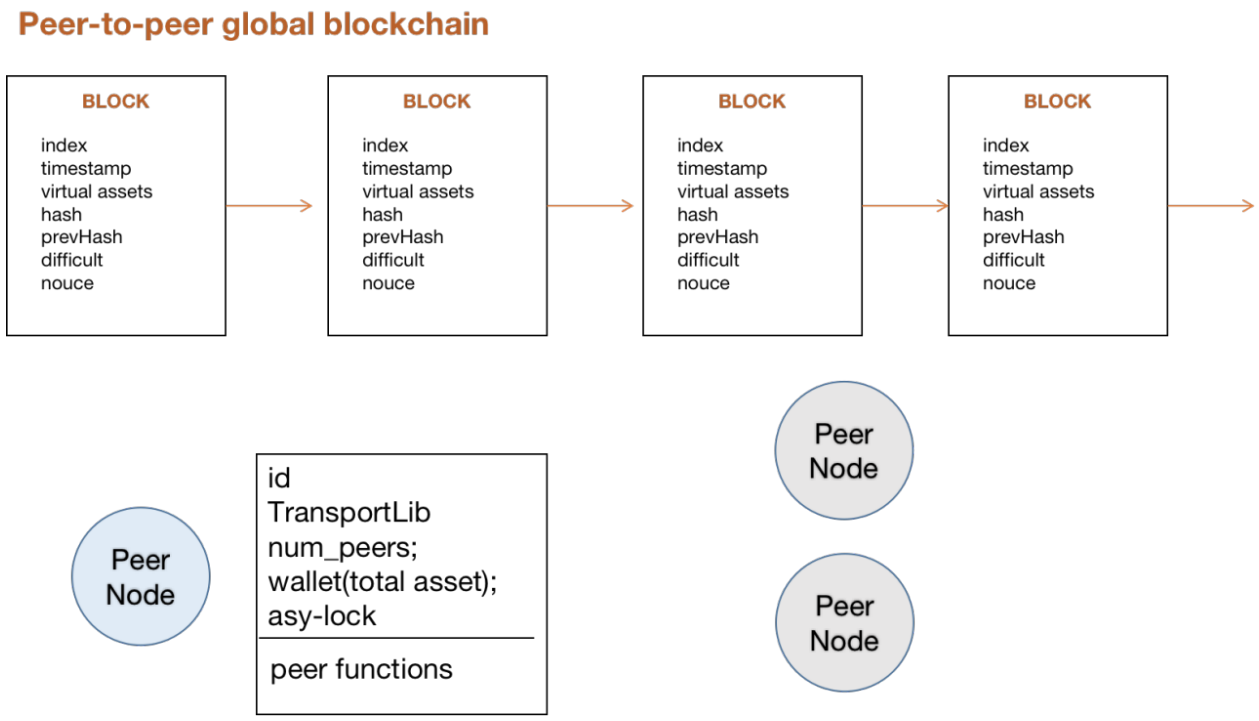

Key Functions:

Some basic functions of a block chain should be:

Blockchain implements synchronous copy of ledger through p2p technology
Blockchain increases the cost of information dissemination and reduces the rate of information dissemination by increasing the Prove-of-work(pow)
Blockchain uses the length of the blockchain to judge the credibility of the data

1. Generate and mine Block:

A function to generate uniquely identifiable data according to the block data and maintain chain integrity.

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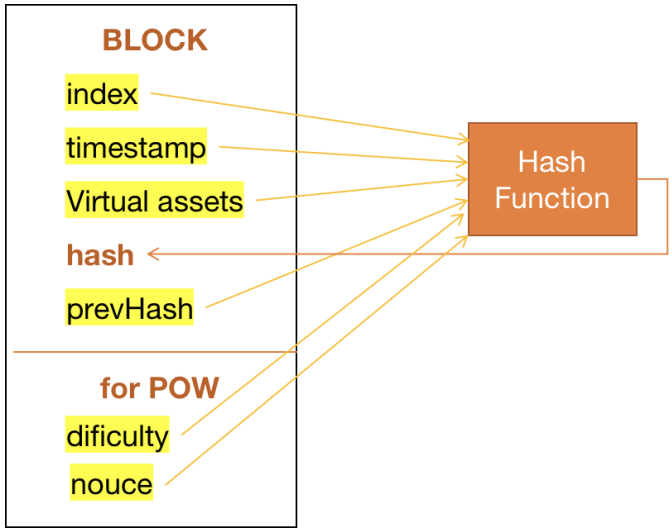
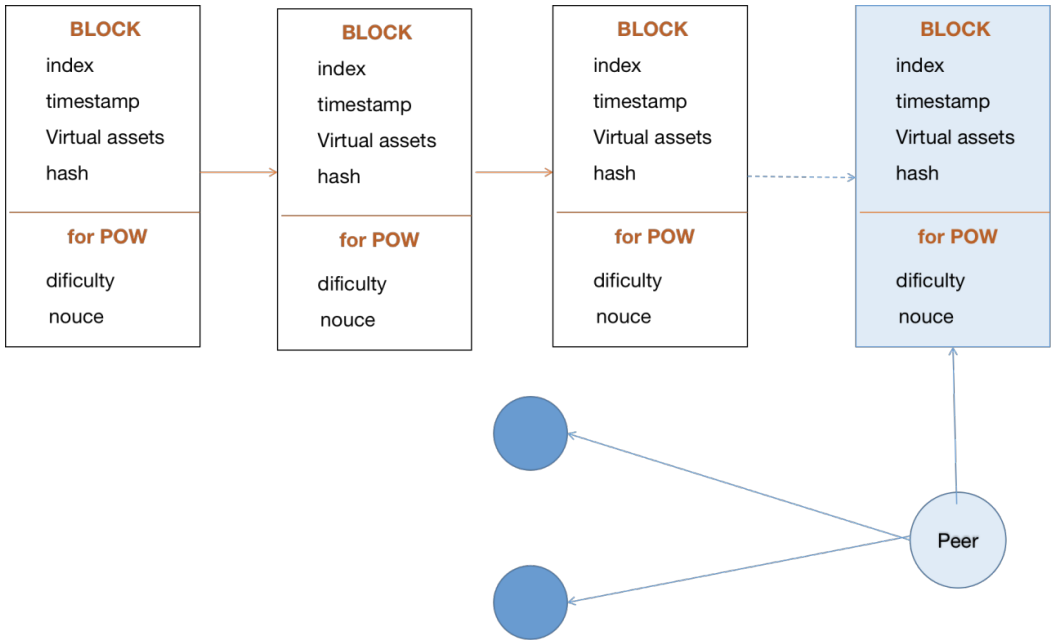


As to generating a block, it is often called ‘mining’.

To mine a block, we need to calculate hash based on all the information contained in the block, except the difficulty field. The work is done by enumerating all possible long `nonce` and calculating it’s hash, until it starts with a difficulty Number of Zeros.

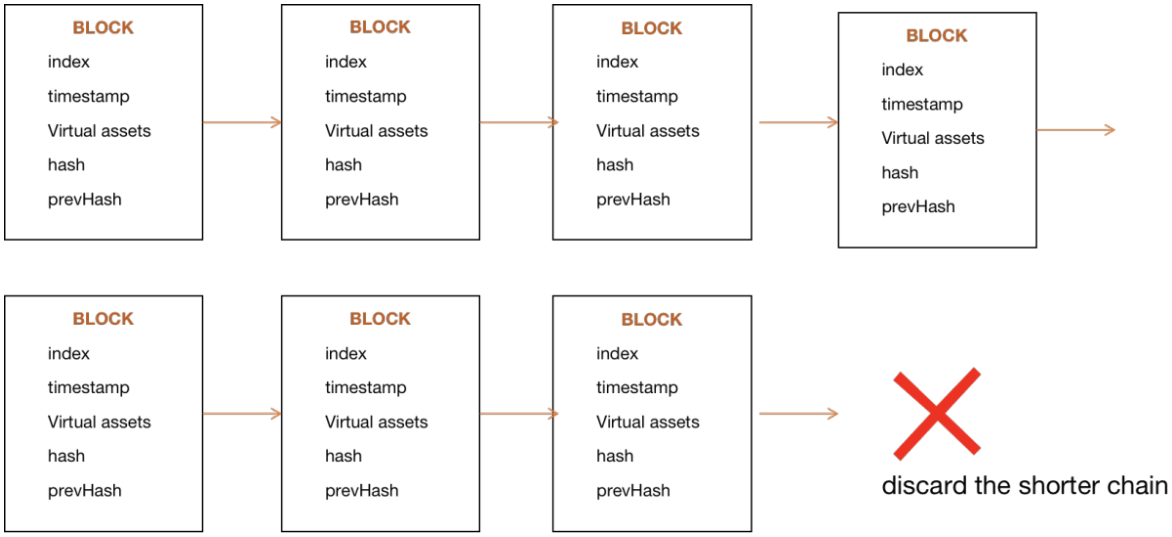
2. Validate blocks , Read and write blockchain

A peer should be able to read the current blockchain and apply to append new blocks to it. After a new block is mined, a user should be able to broadcast it to all peers in the peer network.



3. Global approve/discard conflict chains.

   As there may be many users trying to modify the blockchain, we should have schemas to keep the blockchain consistent and free of race conditions



Transport Layer:

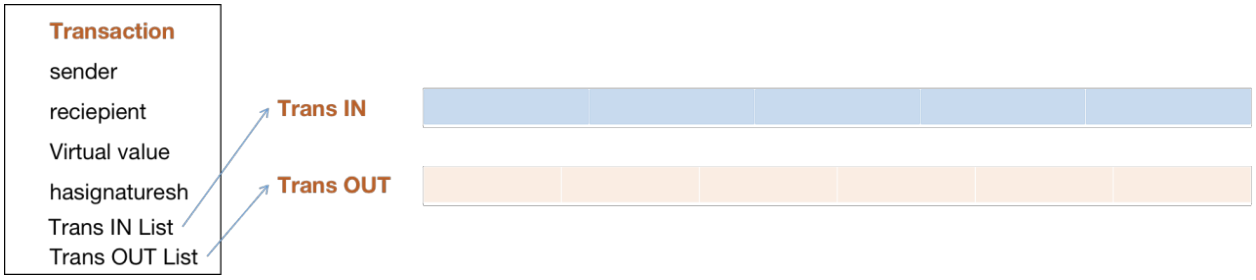
Basic: Transport Layer in previous lab(TransportLib)

If time permits: Transaction/checkpoint-II:

In a peer-to-peer network, a peer should be able to send money(virtual assets) to another. The sender and recipient should be the PublicKey of a peer.

Model

1. Transaction unit model



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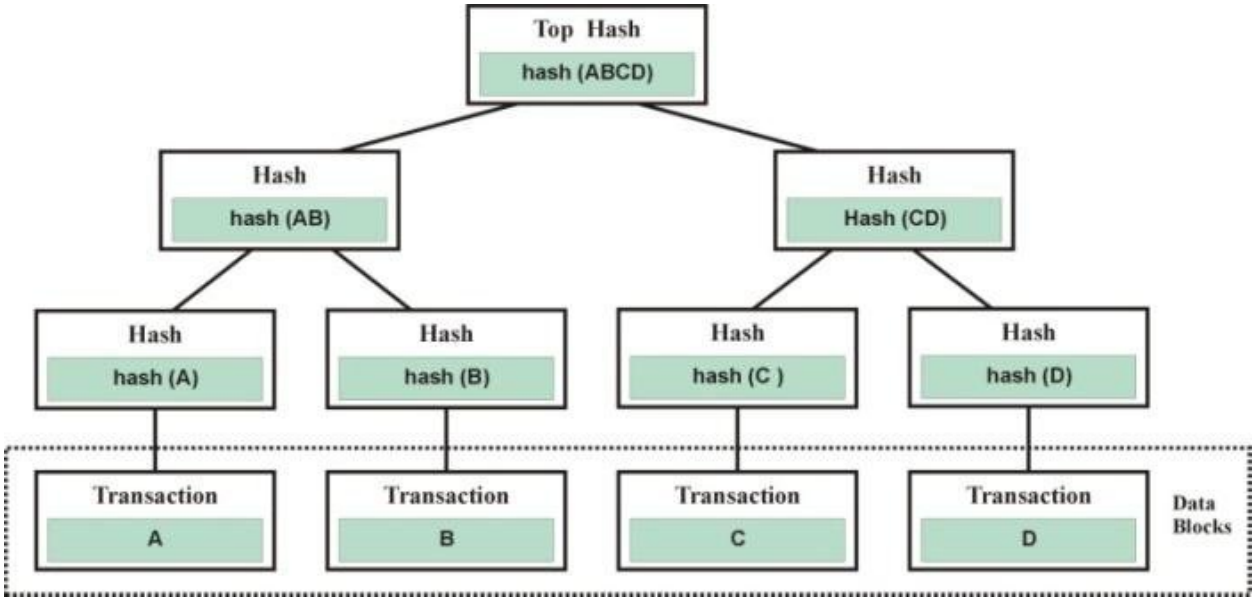
2. Merkle Tree(Hash Tree)



A Merkle tree is a binary-tree like hash tree structure.

It stores all the transactions in a block by producing a digital fingerprint of the entire set of transactions. It allows the user to verify whether a transaction can be included in a block or not.

Merkle Root is stored in the block header and makes the transaction tamper-proof.

3. The Block will have an extra field recording
`List<Transaction> transactions`

BLOCK

index

timestamp

Virtual assets

hash

for POW

dificulty

nouce

for Transaction

Transaction List

Merkel Root

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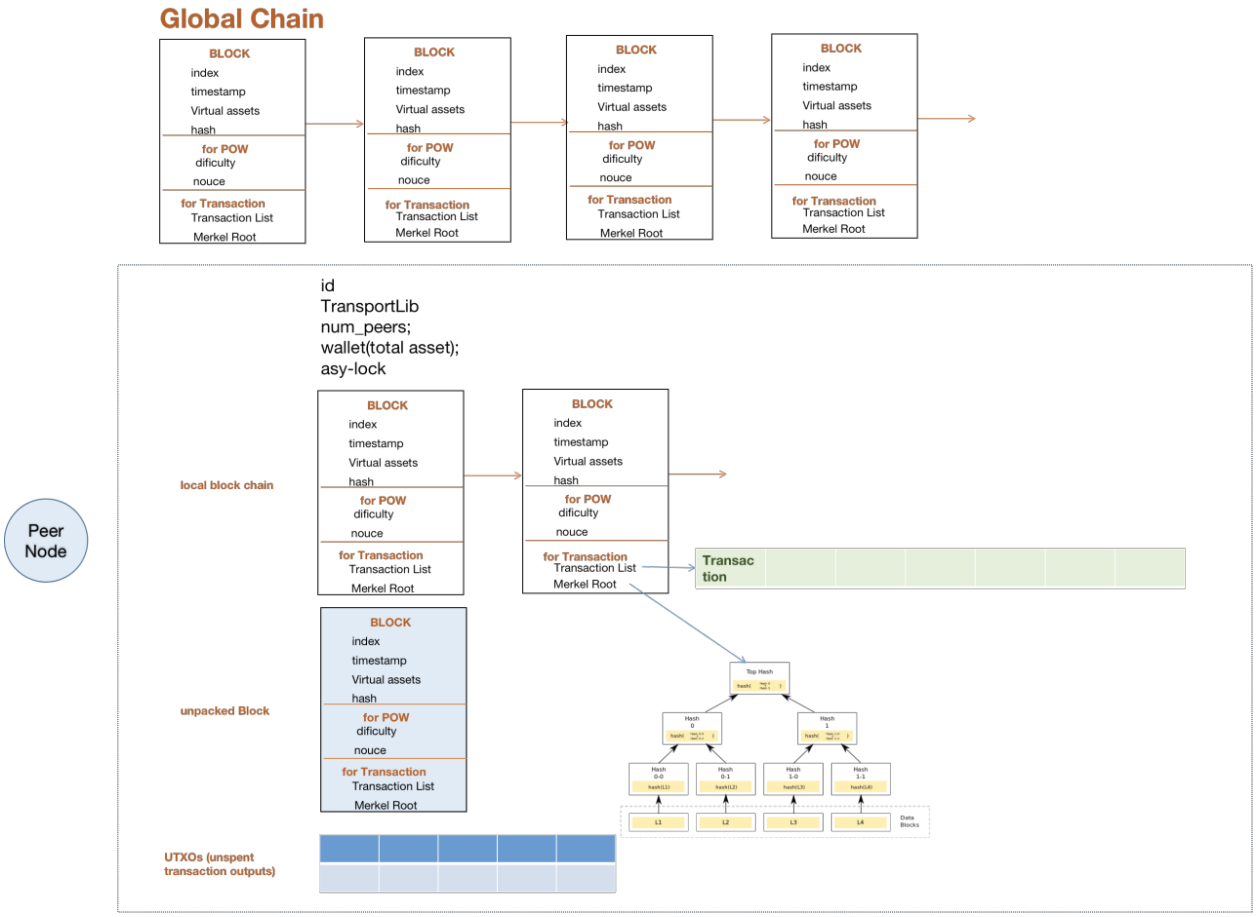
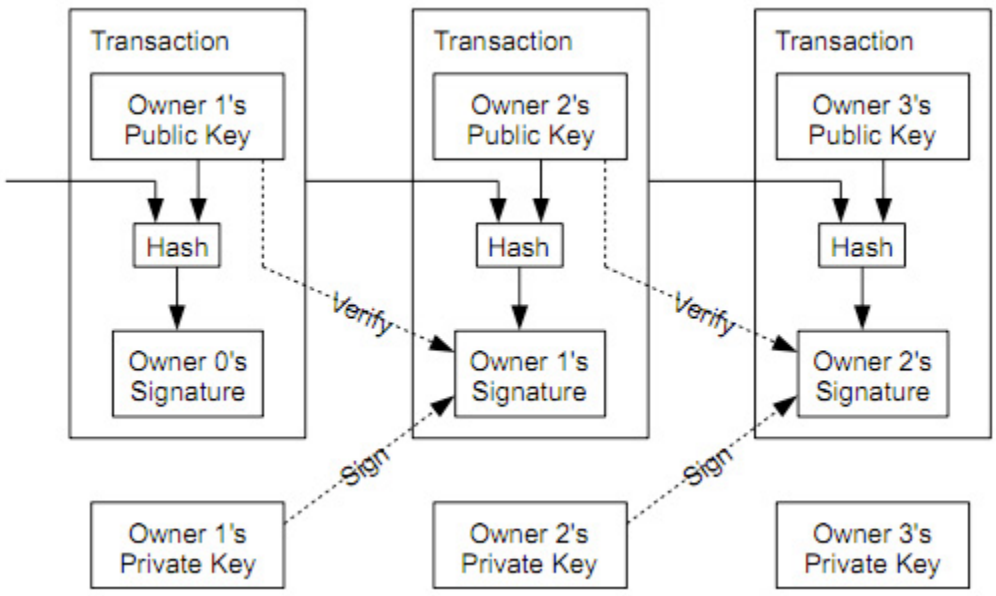
4. Peer Node



The Transaction verifying Process:



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Improvements/final:

Real Transport Layer:

real communication: Spark Web Framework (if time permits)

- A verb (get, post, put, delete, head, trace, connect, options)
- A path (/hello, /users/:name)
- A callback (request, response) -> { }

  Ref: https://sparkjava.com/documentation#cookies

Timeline:

Apr 19 - Apr 25:

1. Project build
2. Test Cases and makefile
3. Basic Implementation

Apr 26 - Apr 30:

Debug Basic

Apr 30 - May 3:

Project test
Implement transaction(or previous implementation/test)

May 4 - May 7:

Transaction test(or previous implementation/test)
Spark server test(or previous implementation/test)

May 8 6:59am:

due