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Private Blockchain System

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Outline

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2. Private vs. public blockchain
3. Proof of Authority
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6. Architecture
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Blockchains in general

- Blockchain: A distributed database that is maintained by different nodes
- They consist of 3 main building blocks:
  - The ledger consisting of a series of blocks
  - The nodes that maintain the ledger by mining and validating new blocks
  - The consensus algorithm that specifies how the nodes make decisions
- Main benefits:
  - Immutability
  - Decentralisation
  - No trusted third-party

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Private vs public Blockchain

- **Participation**
  - Nodes in private blockchains are usually controlled by one or a few organisations
  - In public blockchains everyone can join and participate
- **Performance**
  - Private blockchains are much faster
  - Public blockchains are slower because everyone can participate
- **Cryptocurrency**
  - Private blockchains usually do not have a cryptocurrency
  - Public blockchains have cryptocurrencies to support the miners

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Proof of Authority

- Originally proposed by Gavin Wood the co-founder of Ethereum in 2015
- Relies on 2 assumptions:
  - There exists a set of *N* nodes that can be identified by a unique id
  - At least *N/2 + 1* of those nodes can be trusted
- How it works
  1. In a fixed time interval a primary node is selected to propose a new block
  2. The primary node then sends the proposed block to all the other nodes
  3. The other nodes validate the proposed block
  4. Once N/2 + 1 nodes consider the proposed block as valid it will be added to the ledger

Aura Protocol

- Implementation of Parity Ethereum Client
- 2 rounds are needed before a block is added to ledger
- Nodes need to be synchronized within the same UNIX time t
- The primary node is selected as follows:

$$l = s \mod N \quad (1)$$

$$s = \frac{t}{step\_duration} \quad (2)$$

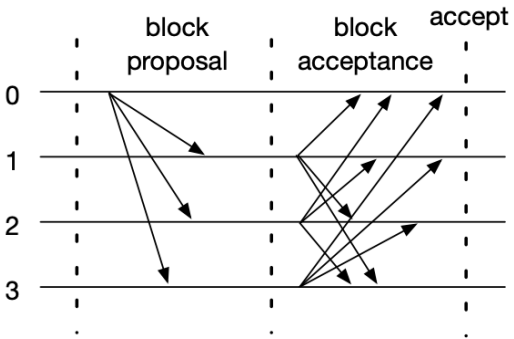
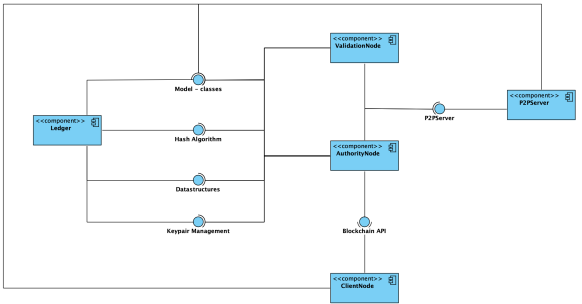


Figure from: https://eprints.soton.ac.uk/415083

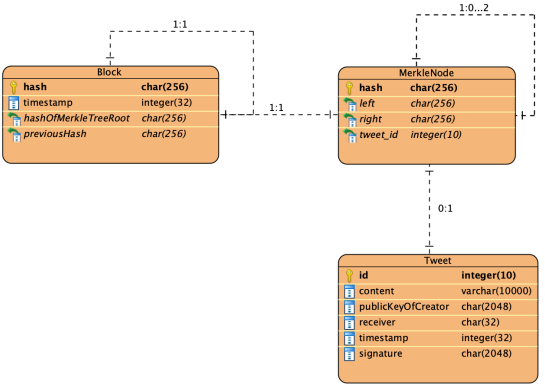
Architecture

- Component based architecture:
  - **Ledger**: data structures, model classes, hash algorithms, cryptography
  - **P2P-Server**: handles the communication between the different validation-nodes.
  - **Authority-Node**: rest-api, primary node selection
  - **Validation-Node**: block mining, block validation
  - **Client-Node**: CLI to interact with the blockchain



Ledger

- Merkle Tree:
  - Perfectly balanced binary tree
  - Only leaves contain data
  - The parent only contains the following value: *SHA256(left.hash, right.hash)*
- Hash algorithm: SHA256 with Base64 encoding
- Asymmetric encryption algorithm: RSA



ER-Diagram of the model classes

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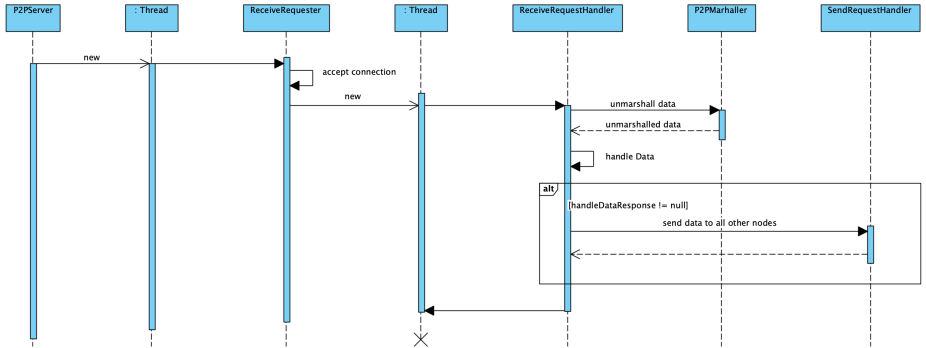
P2PServer



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Authority Node

- Provides Rest API that can be accessed by client applications
  - Posting and fetching tweets
  - Login and register
- Handles the selection of the primary node
  - The authority selects the primary node by using round robin

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Validation Node

- This is the component that actually maintains the blockchain
- Block validation and Block mining is done by the validation node
- When is a block considered valid?
  - All tweets are valid: Check if signatures are correct.
  - Valid Merkle Root: Is the Merkle root the same as the one a node gets when it creates a new Merkle tree with the same tweets?
  - Known previous Hash: Check if the previous hash of the proposed block is equal to the hash of the last added block.

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Block Mining