# Professional Blockchain Course

Key Concepts

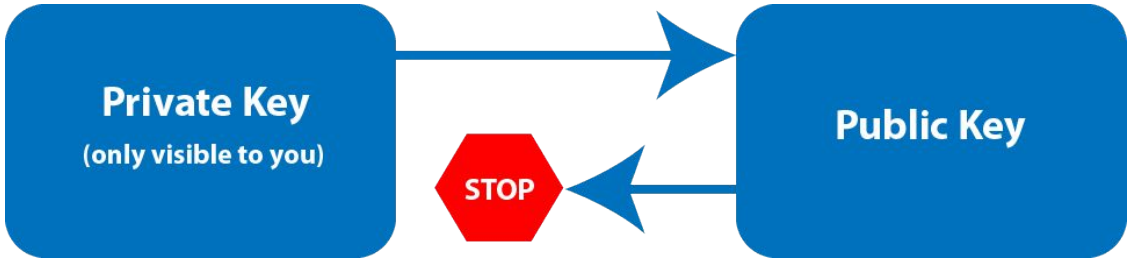
# Keys

# Private Keys

- Private Key is used to generate a signature for each transaction over the blockchain.
- The generated signature is used to confirm that the transaction has come from a specific user, and also prevents the transaction from being altered by any malign entity.
- In simple words - “Private Keys are used to sign the cryptocurrencies you send to others.”
- If someone obtains your private key, they would be able to send your cryptocurrencies to themselves, which has happened in most of the hacks around the world.
- Example: **L34EXrFCuxQCorfE66sxQe8Tyh71SyU8cc9z7HnbEWwW8YsgbvTw**

# Public Keys

- The Private Key is used to derive the Public Key mathematically.
- Public Keys are practically irreversible, i.e., you can easily derive public key from the private key, but it would take millions of years to do the vice versa.
- Public Keys can be distributed to everyone.
- Example:
  **0237F49F4CCF760BF5FA993616E63B7B2A8611AB71AE7630386738B3BC4D1B84FD**



# Addresses

- A cryptocurrency address in a core is a representation of the public key.
- One-way cryptographic hash functions are used to derive address from the public key.
- For example in Bitcoin, the algorithms that are being used to generate a bitcoin address from the public key are the Secure Hash Algorithm 256 (SHA-256) and the RACE Integrity Primitives Evaluation Message Digest 160 (RIPEMD-160)
- The address appears typically in a transaction between two parties, with the address signifying the recipient of the funds.
- Example: **1JPgMJuAvYJU6mxxbJdmf1XBd7bBPdPV3a**

Private Key

Large, randomly generated number

Public Key

Generated from Private key

Address

Generated from Public key

# Transactions

- Transactions are records of data in chronological order
- Transactions are stored in a Merkle tree inside the Block.
- The transactions, when submitted, are picked up by the blockchain network and is inserted into a ‘pool of unconfirmed transactions.’ The transaction pool is a collection of all the transactions on that network that have not been confirmed yet.
- Miners on the network select transactions from this pool and add them to their ‘block.’
- Transactions also contain metadata information which can be utilized to store data over the Blockchain.

# What are Blocks?

- A Block is a container data structure which contains a set of confirmed transactions.
- A block could contain different information, and a chain of these blocks evolves into a blockchain as long as it links one and the other.
- The blocks are stored on the hard drives of many miners spread across the globe on a peer to peer network.
- In the Bitcoin algorithm, a block is created every 10 minutes. All the transactions happening over the network within 10 minutes interval are crunched into that block and added to the chain.

# Structure of Blocks

All blocks in the Blockchain are composed of a header, identifiers and a long list of transactions. The structure of a block is as follows:

- Block Header
- Block identifiers
- Merkle Trees

# Structure of Blocks

An Example of Bitcoin Blockchain

| Field | Description | Size |
|---|---|---|
| Magic No | value always 0xD9B4BEF9 | 4 bytes |
| Blocksize | number of bytes following up to end of block | 4 bytes |
| Blockheader | consists of 6 items | 80 bytes |
| Transaction Counter | positive integer VI = VarInt | 1 - 9 bytes |
| Transactions | The (non empty) list of transactions | Transaction counter-many transactions |

# Block Header

The header contains metadata about a block. There are three different sets of metadata:

- The previous block hash. In a blockchain, every block is inherited from the last block because we use the previous block's hash to create the new block's hash.
- Mining competition for the network. For every block to be part of the blockchain, it needs to be given a valid hash. This contains the values for the timestamp, the nonce, and the difficulty.
- Merkle tree root. This is a data structure to summarise the transactions inside the block.

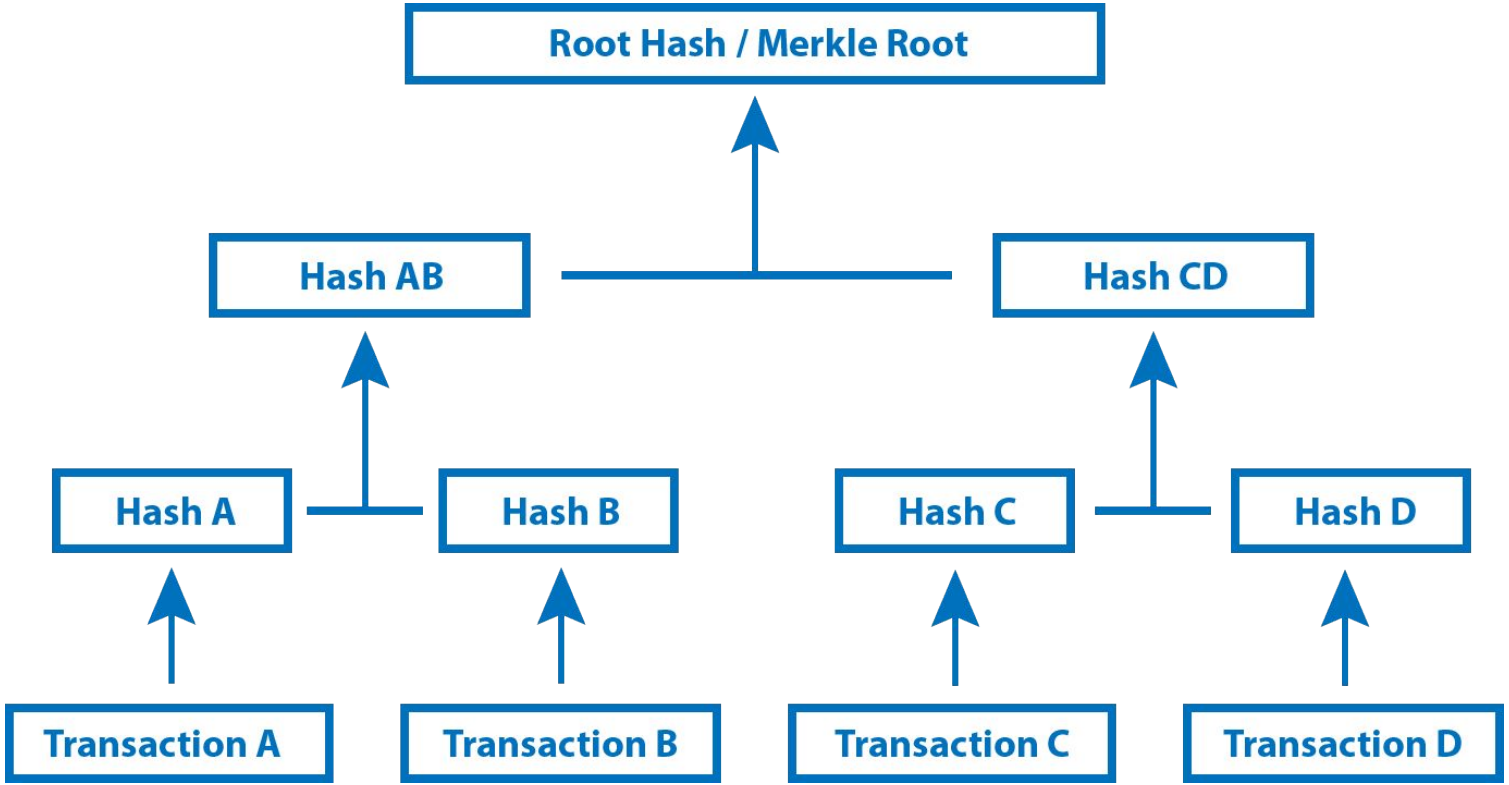
# Block Identifier

- To identify a block, we need to have a cryptographic hash, a digital signature. This is created by hashing the block header twice with the SHA256 algorithm in case of Bitcoin Blockchain. You can use different hash functions for your Blockchain.
- Every block uses the last block's hash to construct its hash.
- Another way to identify a specific block is the block height. This is the position of the block in the blockchain.
- For example, if we say the block is in the 7312 position. This means that there are 7311 blocks before this one.

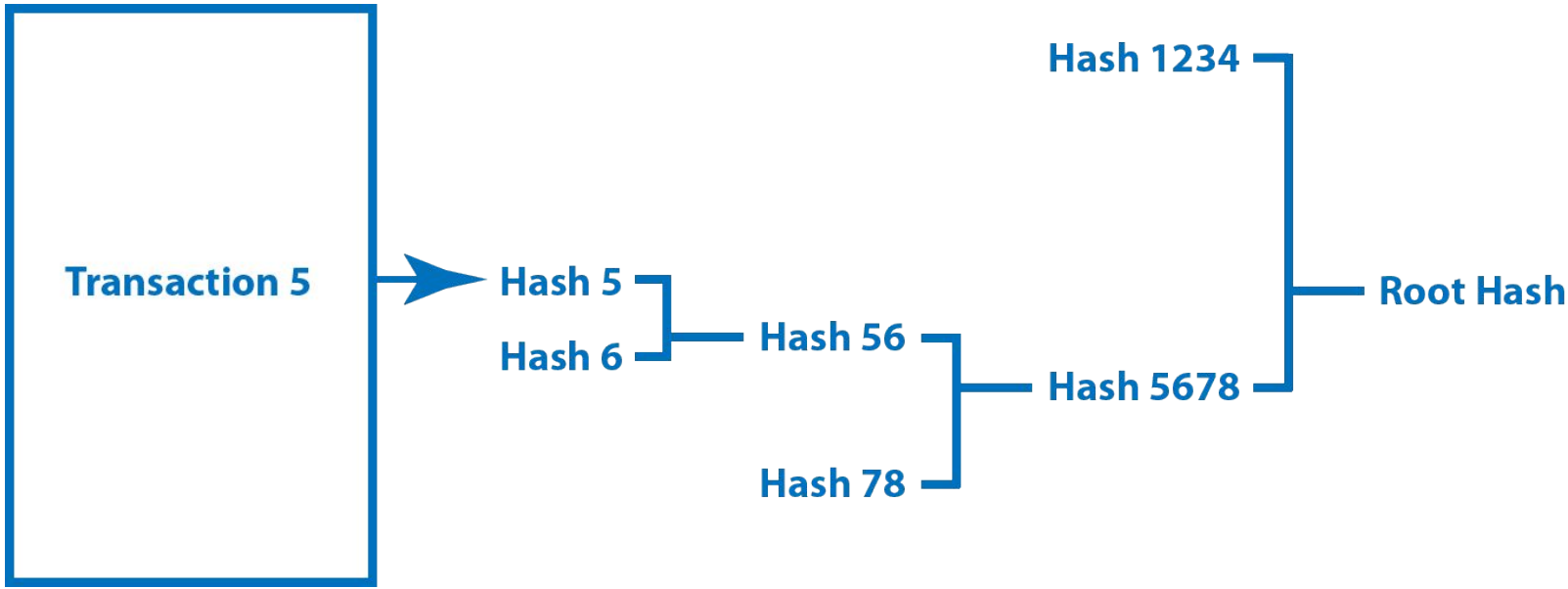
# Merkle Tree

- A Merkle tree summarizes all the transactions in a block by producing a digital fingerprint of the entire set of transactions.
- The user can verify whether or not a transaction is included in a block.
- Merkle trees are created by repeatedly hashing pairs of nodes until there is only one hash left which is called the root hash.
- Each leaf node is a hash of transactional data, and each non-leaf node is a hash of its previous hashes.
- Merkle trees are binary and therefore require an even number of leaf nodes.
- If a single detail in any of the transactions or the order of the transaction's changes, so does the Merkle Root.

# Merkle Tree



# Merkle Tree



# ADDITIONAL CONCEPTS

# HD Private Key

- Hierarchical deterministic is a type of deterministic cryptocurrency wallet derived from a known seed, which allows for the generation of child keys from the parent key.
- The child key is generated from a known seed. There is a relationship between the child and parent keys that is invisible to anyone without that seed.
- The BIP 32 protocol can generate a nearly infinite number of child keys from a deterministically-generate seed from its parent.
- You can recreate those same child keys as long as you have the seed.
- The child key can operate independently, and the parent key can monitor and control each child key.

# Mnemonics Seed

- A mnemonic seed is used to substitute either a 12, 18 or 24-word phrase for the private keys which can easily be memorized by human mind compared to hex encoded format.
- Mnemonic word phases are tied with the private keys and support wallet restoration.
- This provides additional security for the user, as well as a convenient solution to recover a wallet.
- BIP 39 introduced the mnemonic wallet implementation.
- The English wordlist for BIP 39 contains 2048 words, so to crack a 12-word phrase, it would require figuring out 2048^12 = 2^132 possible combinations under a shield of 128-bit security.

# Smart Contracts

- Smart Contracts are the digital contracts signed between two parties and stored over the immutable ledger.
- Smart contracts help you exchange money, property, shares, or anything of value in a transparent, conflict-free way while avoiding the services of a middleman.
- Contracts can be encoded on any blockchain, but Ethereum is mostly used since it gives unlimited processing capability.
- Hyperledger is also providing chain codes which are very similar to Smart Contracts.
- Example: Renting an apartment.

# THANK YOU

For more information contact
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