

Paying your Internet, one byte at a time

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Abstract

Acknowledgements

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Introduction

Chapter 2

Background

2.1 Bitcoin Overview

Bitcoin is a decentralized digital currency system based on peer-to-peer technology. It was introduced in 2008 by Satoshi [1]. All functions, such as creation of new coins ('bitcoins'), processing and verification of transactions, are performed collectively by the network instead of a central authority. This reduces transaction costs, the need to trust a single entity and unpredictable inflation.

Important terms of the Bitcoin protocol are explained in the following sections:

Wallet

Bitcoin uses public key cryptography to authenticate transaction information. Every user has a set of public and private keys. The public key is known to others and is used to derive an address to which bitcoins can be sent. The private key is kept secret since it is required by the owner to send bitcoins. A wallet is a file that contains this set of keypairs and information about the transactions that were carried out using the keys and the current balance. There are different implementations of the Bitcoin wallet currently.

Transaction

A transaction represents a transfer of bitcoins from one address to another. If A wants to send bitcoins to B, it creates a transaction record, signs this record with his/her private key and broadcasts it to the network. A transaction record doesn't solely contain information about how many coins

need to be transferred to B. Instead, it can be considered to be a collection of ‘inputs’ and ‘outputs’. Inputs are hashes of previous transactions that provided bitcoins to A. They are used as a proof of ownership i.e. A does indeed own the bitcoins that he/she will be using in future transactions. In the output section, A puts B’s address and the amount to be transferred to B, a transaction fee (see next section) and, if the input amount is higher than amount to B, the rest of the bitcoins as an output back to A (change).

A transaction record verifies A’s ownership of bitcoins but it does not prevent A from using the same bitcoins in another transaction, a problem called ‘double-spending’. In order to ensure that A spends the bitcoins only once, the transaction record is added to a public ledger known as a block chain.

Block chain

For a transaction to be considered valid, it has to be entered into a public ledger that contains a record of all previous transactions, all the way from the time Bitcoin was introduced. This public ledger is called a block chain - it is a chain of entities called blocks, where each block contains a set of new transactions not present in the previous block.

A new block of transactions is added to the block chain by nodes called miners. When A’s transaction is broadcast to the network, it is received by miners. These miners also receive lots of other transactions that took place at the same time. Each miner performs the following operations: A Merkle tree of the transactions is created, its root is calculated and added to the block header. A hash of the last block in the current blockchain is also added to the block header, along with a timestamp. This hash helps in proving the chronology of the block chain. Finally, since several miners are working on creating a block but only one block can be added to the block chain, miners compete to get their block accepted into the chain by searching for a value. This value, when added to the block and hashed, should give a predetermined target value (a large number starting with several zeroes). Since obtaining the inputs of a hash function given its result is impossible, a miner has no choice but to keep on trying different nonces and hashing the block till the target value is obtained. This value is known as proof of work - it implies that the miner put effort into finding the value but is easy to verify by others.

The first miner that finds the value broadcasts the new block to the network. The other peers verify the value and the block is accepted and added to the block chain. Transactions that were not part of this new block will be validated in future rounds.

In the rare case of two miners finding the answers within a few seconds

from each other and introducing new blocks into the network, there is a disagreement over which is the accepted block. This leads to forks in the block chain as different nodes take different blocks and build upon them. However, there is bound to be a time when one of the forks grows longer than the others. At this point, this branch is taken a part of the block chain and all the other forks are discarded (transactions in the discarded branches have to be validated again).

The target value is determined in such a way that the solution can be found in 10 minutes on average. Note that the predetermined target value's difficulty is increased with time to account for advances in computing power. As time goes by, it becomes more and more difficult to find the nonce that hashes to the target value.

Coin creation and transaction fees

There needs to be an incentive for miners to contribute computational power and engage in creating blocks. Hence, every time a miner is successful in creating a block that is accepted into the block chain, he/she gets a reward of brand new bitcoins. The first transaction in the block is always this reward and is called a coinbase transaction. This is how new coins are introduced into the network. The number of new coins per block started off at 50 initially but halves every 210,000 blocks. This regulates the supply of new coins. In addition to this, miners get a transaction fee. The total number of bitcoins is capped at 21 million. Once this ceiling is reached, miners will earn coins only via transaction fees.

(Picture???? Maybe TBD)

2.2 Micropayment Channel

A micropayment is a transaction involving very small sums of money.

Chapter 3

Implementation

3.1 Discovery

3.2 Negotiation

3.3 Channel Establishment

3.4 Removal

Chapter 4

Evaluation

Chapter 5

Conclusion

Bibliography

[1]