

Atomic Swaps

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Abstract

Despite blockchain networks being decentralized, trading of cryptocurrencies are controlled by centralized exchanges such as Binance, Coinbase. This project explored decentralized exchange (DEX) of cryptocurrencies that allows for exchange on different blockchain networks. Hash time-locked contract, a smart contract which is locked by time and a hash function, is the main framework of the DEX method called Atomic Swaps. We implemented the algorithm for Atomic swaps using the Python programming language. Though some challenges were encountered, we explicitly explained every detail about Atomic swap and tested the implemented algorithm with the first transaction and the refund action initiated by the timelock condition.

Introduction

It is not uncommon that holders of different cryptocurrencies would want to exchange their cryptocurrencies. Cross swap is the term used to describe this exchange. To illustrate cross swap, consider Alice who has Bitcoin but wants Litecoin, she then found another individual, Bob who is interested in exchanging his Litecoin for Bitcoin. Alice then asked Bob to send his Litecoin to her after which she sends her Bitcoin to him. A problem with this type of exchange is that Alice may intentionally refuse to send the Bitcoin to Bob, so she ends up with both coins. To solve this problem, a common solution is to introduce a centralized intermediate, trusted third party, to help regulate the exchange. How about having a trustless system to successfully carry out this exchange? This trustless system is Atomic Swap. An **atomic swap** is a smart contract technology that enables the exchange of one cryptocurrency for another without using centralized intermediaries, such as exchanges.

Main idea of Atomic Swaps

The idea of Atomic swap was first introduced by Tier Nolan in 2013 on the BitcoinTalk forum. The interest of the crypto community in atomic swap began to grow in September 2017 after Charlie Lee, the founder of Litecoin, announced the successful execution of atomic swap between Litecoin and bitcoin over Twitter. Cross swap can be time-consuming and complex, not all cryptocurrency exchanges support all coins. The introduction of Atomic swaps helps to mitigate these problems with the following advantages:

- Facilitation of true decentralization of Blockchain
- Mitigation of Investors' risks
- Lower transaction fees

Atomic swaps make use of Hash Timelock Contract (HTLC), a time-bound smart contract that involves the generation of cryptographic hash functions each party must verify. Atomic swaps remove risks because the parties must acknowledge receipt of funds using the cryptographic hash function within the stipulated time period; failure to do this makes the transaction void and funds reversed.

Technical Details

Below is the algorithm we adapted to implement atomic swap:

0. Generate addresses in each blockchain.
 1. Generate random number x .
 2. Calculate $H(x)$, the hash of x .
 3. A makes transaction T_{x_1} and T_{x_2} .
 - * T_{x_1} has the following structure:
 - * Correct input from previous blocks.
 - * Condition output two cases.
 - * Pay w BTC to B 's public key in blockchain 1 if show preimage of $H(x)$ (it's x).
 - * If Output signed by A and B private keys.
 - * T_{x_2} with output Pay w BTC from T_{x_1} to A , locked 48 hours in the future, signed by A .
 4. A send to B T_{x_2} and B signs it with its private key.
 - * This transaction needs to return money back to A if B refuses to do something with T_{x_1} .
 5. B makes transaction T_{x_3} and T_{x_4} in the second blockchain with the same logic as T_{x_1} and T_{x_2} .
 - * T_{x_3} has the following structure
 - * Correct input from previous blocks
 - * Condition output two cases
 - * Pay k LTC to A 's public key in blockchain 2 if show preimage of $H(x)$ (it's x)
 - * If Output signed by A and B private keys
 - * T_{x_4} with output pay k LTC from T_{x_3} to B , locked 24 hours in the future, signed by B (to return money back)
 6. B sends to A T_{x_4} and A signs it with its private key
 7. A submits T_{x_1}
 8. B submits T_{x_3}
 9. A spends T_{x_3} by providing x (the first case of output) now B knows x
 10. B spends T_{x_1} by providing x (the first case of output)
- Emergency case
- * A or B refuses to spend T_{x_1} or T_{x_3}
 - * We have transaction T_{x_2} and T_{x_4} to return money
 - * After revealing the x , A has 24 hours and B 48 to spend the output, to the money will be taken back by T_{x_2} or T_{x_4}

Faced problems

With Litecoin we faced some problems. First of all, this cryptocurrency has no working sites for getting money. That's why it will be hard to test with it. So, we decided to use another fork of Bitcoin - BitCash. It gives some benefits, we can use the same script for two blockchains. We have to do just Tx_1 and Tx_2 .

Results

First of all we received some test coins for each blockchain network: the bitcoin one and bitcoin cash. We could not find the resource for getting tesnet Litecoins, that's why we decided on bitcoin cash. We found a way to convert bitcoin addresses to bitcoin cash, and get several money. Due to history, they have several differences in address generation. Also, we have implemented the core transactions that correspond to payment, refund and transaction with condition to choose who should take the coins, the main library we used was an official python bitcoin core. Also, we have broadcasted some transactions and successfully decoded its outputs. However we faced the problem of correct implementation for the inputs for refund and payment transactions as the default bitcoin network has a fixed input and it's impossible using old versions to vary an input script. The SegWit could help us, but as we mentioned before the bitcoin cash does not support this improvement. So, we've made the templates for all transactions that could be decoded. The result of decoding is correct one the problem was only in broadcasting. **Please look in the provided notebook for more details:** [Source code](#)

Team Contribution

All team members read extensively about atomic swaps to understand what is expected of the team, to speed up the works on the project each member was assigned to carry out the individual activities highlighted below:

Ilya Selnitsky worked assiduously on the implementation of the atomic swap algorithm on python.

Anastasia Smeshko also worked assiduously on the implementation of the atomic swap algorithm.

Nikita Mokrov made amazing presentation slides and helped with the base code algorithm.

Emmanuel Akeweje worked actively on writing the project report.

References

1. https://en.bitcoin.it/wiki/Atomic_swap
2. <https://github.com/decred/atomicswap/>
3. [Investopedia](#)
4. [Forbes](#)
5. [Bitcoin Core](#)