Chainpoint

A scalable protocol for anchoring data in the blockchain and generating blockchain receipts

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Abstract

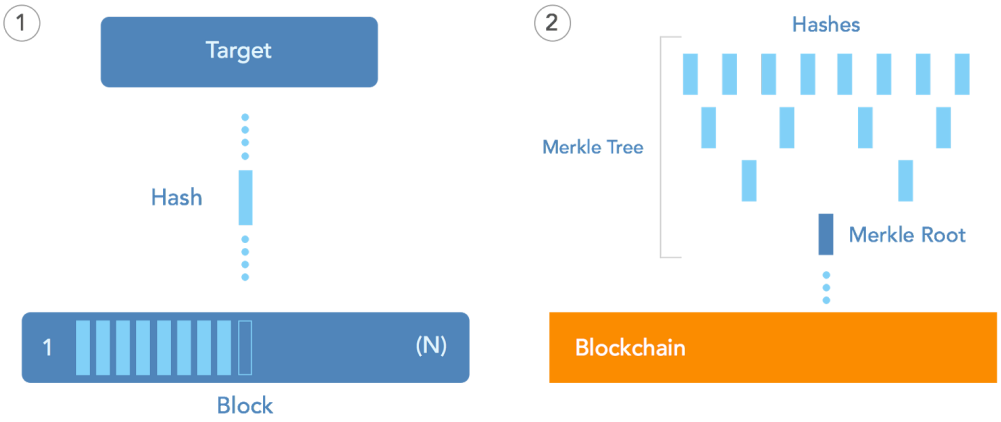
A standard for maximizing the scalability of anchoring data in the blockchain and generating blockchain receipts. Each receipt contains the information needed to verify the data without relying on a trusted third party. The original Chainpoint 1.0 specification has been updated based on a year of learning.

Introduction

The use of the Bitcoin blockchain [1] to timestamp and verify data in an immutable public ledger was pioneered by Manuel Aráoz with the creation of Proof of Existence [2]. This system, and others like it, notarize data in the blockchain by publishing a hash of the data in a Bitcoin transaction. By comparing the hash published in the blockchain with the hash of some data, it's possible to verify that the data existed at a specific time. At the time of writing, Bitcoin can handle approximately five transactions per second and each transaction costs approximately $0.09 USD [3]. These limitations make it impractical and cost prohibitive to record large volumes of data in the Bitcoin blockchain. What is needed is a scalable method to anchor data in the blockchain and a standard protocol that allows systems to read and verify the data.

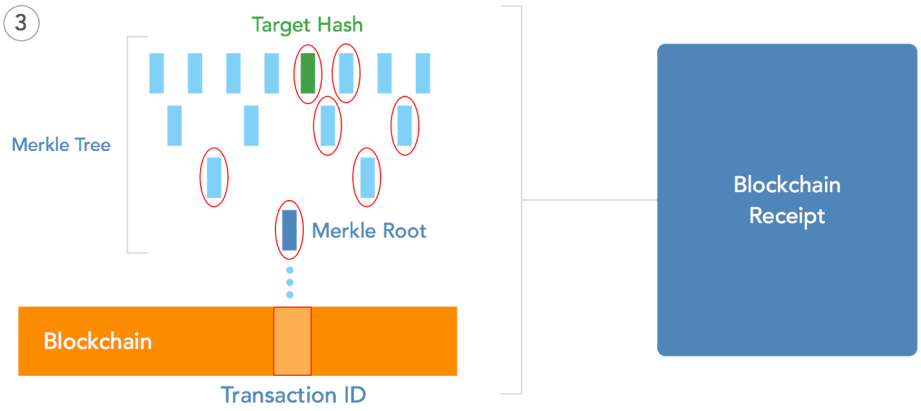
Anchoring Data in the Blockchain

To anchor data in the blockchain, we start by using a standard hashing function such as SHA-256 to generate a unique hash of the target data. Multiple hashes are assembled into a block, which is simply a list of hashes. Periodically, these blocks are used to generate a cryptographic primitive known as a Merkle Tree [4], and the Merkle Root is published in blockchain via a transaction. By collating multiple hashes into a Merkle Tree and publishing the Merkle Root, we can anchor large volumes of data in the blockchain using a single transaction.



Creating Blockchain Receipts

In the real world, a receipt provides proof of a transaction. A ***blockchain receipt*** provides proof that some data existed at a specific time. It contains all the information needed to prove an individual hash was part of the Merkle Tree whose root was published in a transaction in the Blockchain. By tracing a path from the Merkle root to the target hash, we can generate a Merkle Proof that proves any one of the elements is in the Merkle tree, without having to know the entire tree. These elements can be used to create a blockchain receipt that contains, at minimum, the Target Hash, Merkle Proof, Merkle Root, and Transaction ID.



Chainpoint 2.0 Blockchain Receipt Standard:

A standardized Chainpoint receipt format allows any system to verify a receipt by checking a transaction on the blockchain and using math to verify the data. Chainpoint receipts are JSON-LD compliant.

@context	The JSON-LD Context of the document
type	The type of Chainpoint Receipt being described
targetHash	The hash value being anchored in hex string format
merkleRoot	The merkle root of the tree in hex string format
proof	An array of hash objects connecting targetHash to merkleRoot
anchors	An array of methods employed to anchor data to blockchain(s)

The anchors array contains one or more anchor objects.

type	The type of anchoring being performed
sourceId	The Id used to locate the anchored valued for the given source

Receipt types ‘ChainpointSHA256v2’ and ‘ChainpointSHA512v2’ and the anchor type ‘BTCOpReturn’ are supported in the 2.0 release. Acceptable values for receipt type and anchor types will grow over time. A list of anchor type names and descriptions is available at http://chainpoint.org

JSON example of a Chainpoint receipt:


```
{
   "@context": "https://w3id.org/chainpoint/v2",
   "type": "ChainpointSHA256v2",
   "targetHash": "5301ebaf1bf0ad076f76e43dd5eff8742e8855fa912cfa2be102ff35eeb83e87",
   "merkleRoot": "2f5f05d5a00c848eb0eb5baf410d741f3dce80c9a56ba1b715283622feb47ca4",
   "proof": [
      {  "right": "72de6fe5c8f3505b58436c86b87d2cdf7fca3a2edb485f6642e18249cedf2d68" },
      {  "right": "ba78a656108137a01f104b82a3554cedffce9f36e8a4149d68e0310b0943c09d" },
      {  "left": "18ee24150dcb1d96752a4d6dd0f20dfd8ba8c38527e40aa8509b7adecf78f9c6" }
    ],
   "anchors": [
      {
         "type": "BTCOpReturn",
         "sourceId": "ee0df617d253f12be5ab59b4b723c35aa88075df33ad0c46d8231c9df8de3d35"
      }
   ]
}
```

Verifying Blockchain Receipts

1. Concatenate targetHash and the first hash in the proof array. The right or left designation specifies which side of the concatenation that the proof hash value should be on.
2. Hash the resulting value.
3. Concatenate the resulting hash with the next hash in the proof array, using the same left and right rules.
4. Hash that value and continue the process until you've gone through each item in the proof array.
5. The final hash value should equal the merkleRoot value
6. Ensure that the merkleRoot value is stored in the transaction specified in the anchors array. In the case of type 'BTCOpReturn', ensure that the BTC transaction with the id of sourceId has the merkleRoot stored in the OP_RETURN field

Storing Blockchain Receipts

Chainpoint receipts can be stored in a centralized database or a decentralized system such as Storj or IPFS.

Anchoring In Multiple Locations

While the current Chainpoint specification is designed to utilize the Bitcoin blockchain, the protocol can support multiple blockchains. The Merkle root for a blockchain receipt could be stored in Ethereum, Factom, or any other blockchain.

Conclusion

We have outlined a scalable protocol for anchoring data in the blockchain and generating blockchain receipts. A description of the Chainpoint protocol is available at http://github.com/chainpoint.

References

[1] S. Nakamoto. Bitcoin: A peer-to-peer electronic cash system, (2009). https://bitcoin.org/bitcoin.pdf.

[2] M. Araoz. What is Proof of existence?, (2014). http://www.proofofexistence.com/about.

[3] “Transaction Fees.” Bitcoin Wiki, (2016). https://en.bitcoin.it/wiki/Transaction_fees

4] R.C. Merkle. Protocols for public key cryptosystems, (April 1980). IIn Proc. 1980 Symposium on Security and Privacy, IEEE Computer Society, pages 122-133.