Blockchain: An Introduction

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FUTURE OF PRIVACY FORUM

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Our learning journey today

What a blockchain is and how it works

Types of blockchains

Use case: cryptocurrencies

Blockchain as a “platform”

“Smart contracts”

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A blockchain in one sentence

An “append only transaction log”

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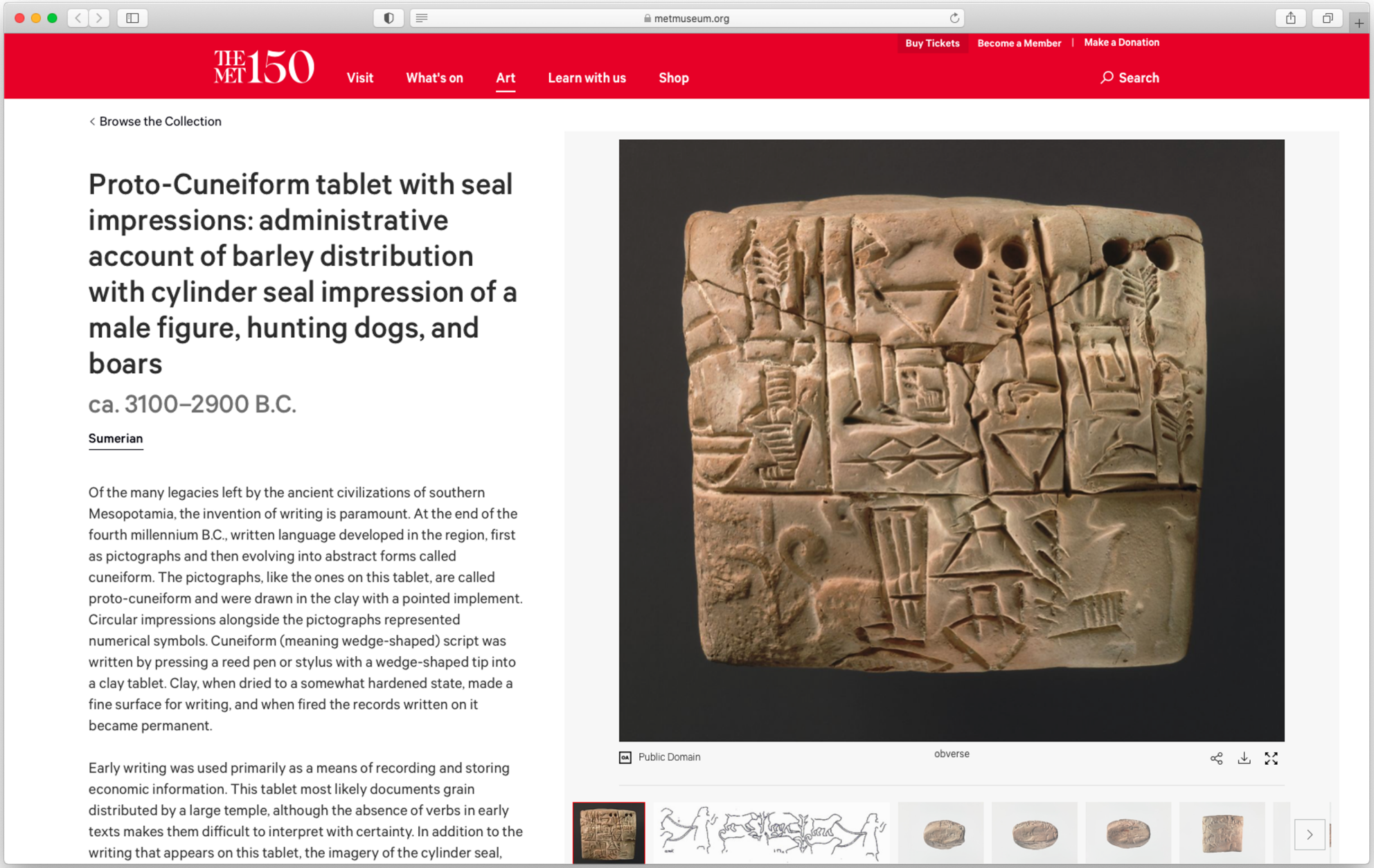
Recordkeeping



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FIRST BANK OF WIKI

1425 JAMES ST, PO BOX 4000
VICTORIA BC V8X 3X4 1-800-555-5555

CHEQUING ACCOUNT STATEMENT
Page : 1 of 1

JOHN JONES
1643 DUNDAS ST W APT 27
TORONTO ON M6K 1V2

Statement period	Account No.
2003-10-09 to 2003-11-08	00005-123-456-7

Date	Description	Ref.	Withdrawals	Deposits	Balance
2003-10-08	Previous balance				0.55
2003-10-14	Payroll Deposit - HOTEL			694.81	695.36
2003-10-14	Web Bill Payment - MASTERCARD	9685	200.00		495.36
2003-10-16	ATM Withdrawal - INTERAC	3990	21.25		474.11
2003-10-16	Fees - Interac		1.50		472.61
2003-10-20	Interac Purchase - ELECTRONICS	1975	2.99		469.62
2003-10-21	Web Bill Payment - AMEX	3314	300.00		169.62
2003-10-22	ATM Withdrawal - FIRST BANK	0064	100.00		69.62
2003-10-23	Interac Purchase - SUPERMARKET	1559	29.08		40.54
2003-10-24	Interac Refund - ELECTRONICS	1975		2.99	43.53
2003-10-27	Telephone Bill Payment - VISA	2475	6.77		36.76
2003-10-28	Payroll Deposit - HOTEL			694.81	731.57
2003-10-30	Web Funds Transfer - From SAVINGS	2620		50.00	781.57
2003-11-03	Pre-Auth. Payment - INSURANCE		33.55		748.02
2003-11-03	Cheque No. - 409		100.00		648.02
2003-11-06	Mortgage Payment		710.49		-62.47
2003-11-07	Fees - Overdraft		5.00		-67.47
2003-11-08	Fees - Monthly		5.00		-72.47
	*** Totals ***		1,515.63	1,442.61	

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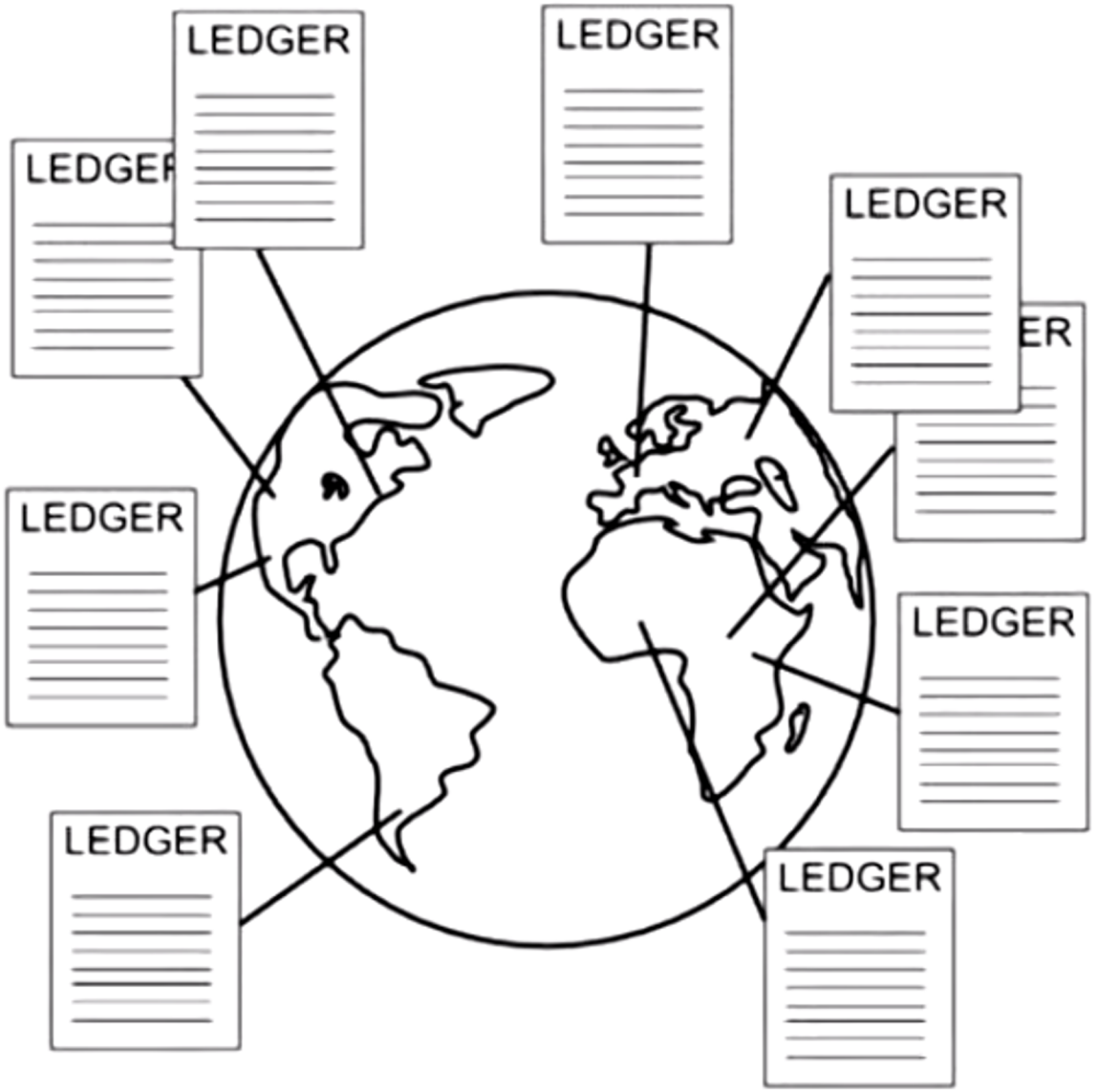

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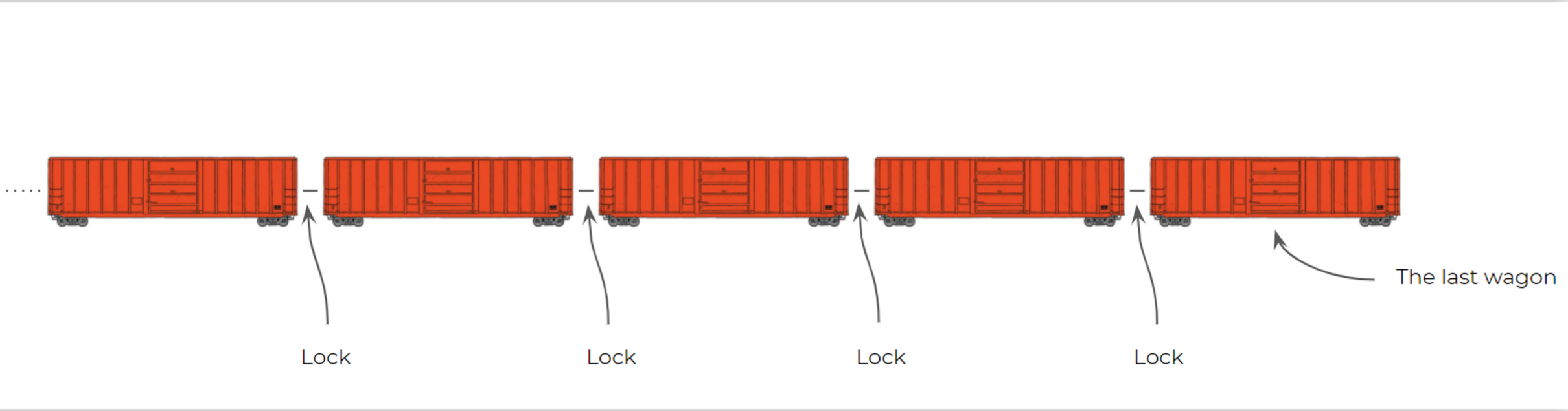

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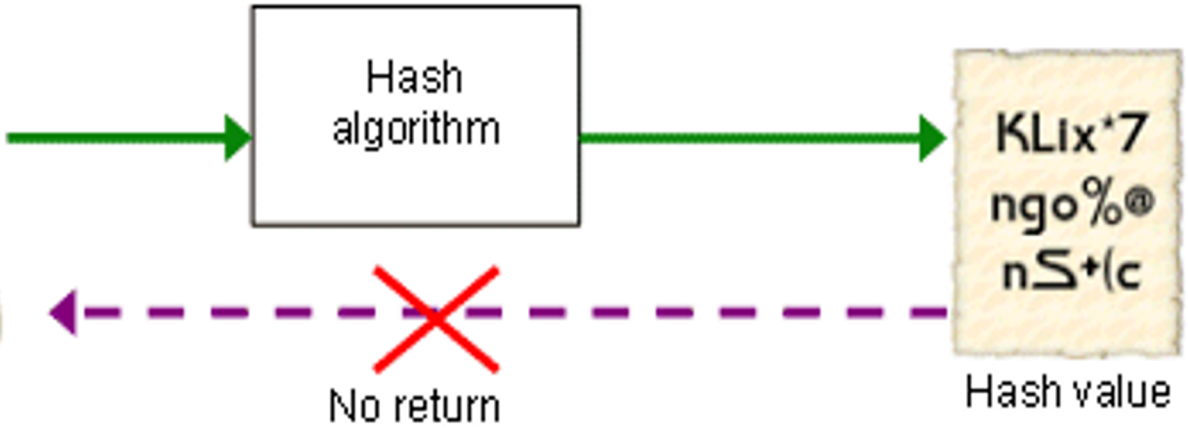
The cryptographic hash function



Unique for structured data

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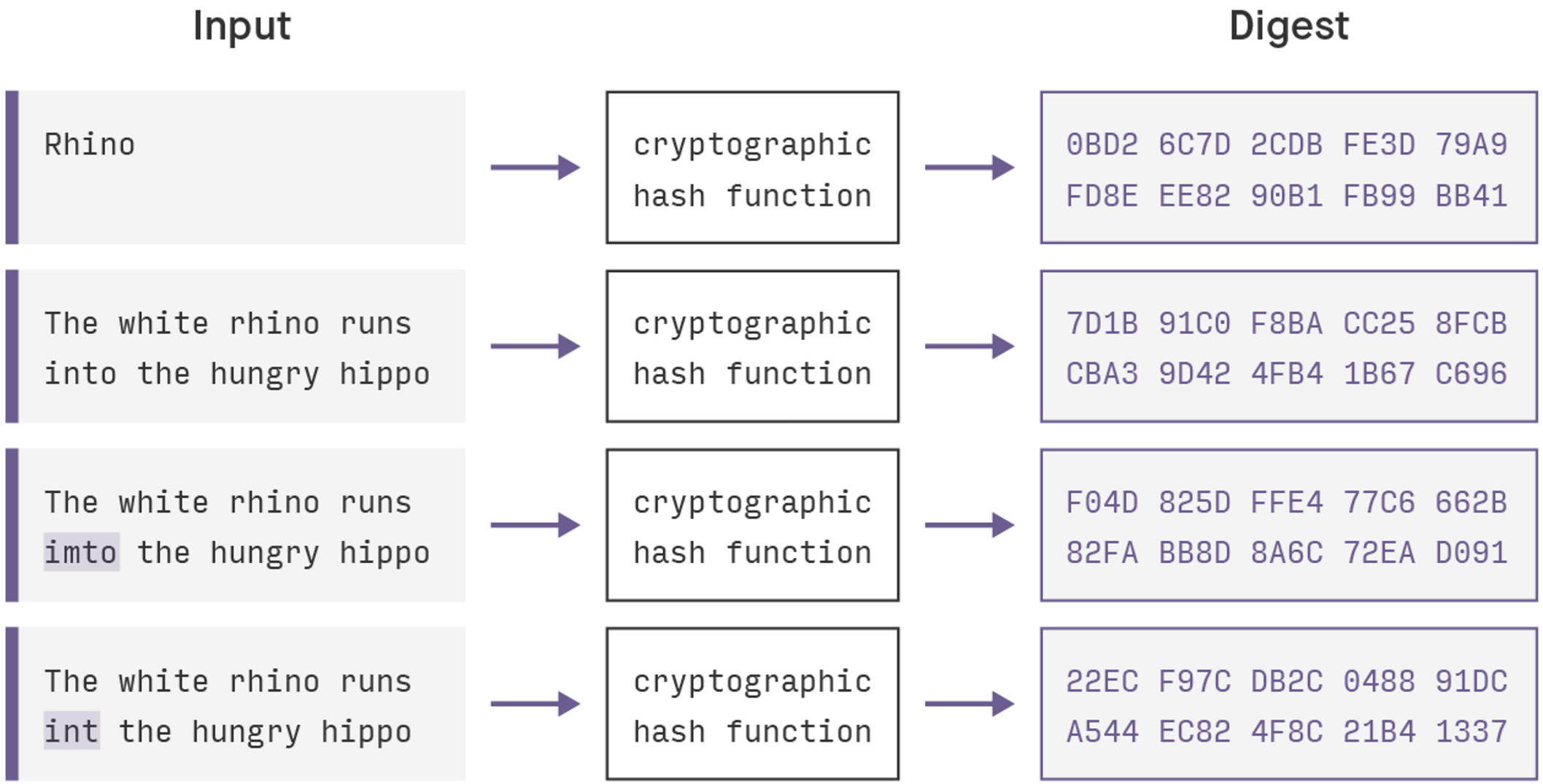

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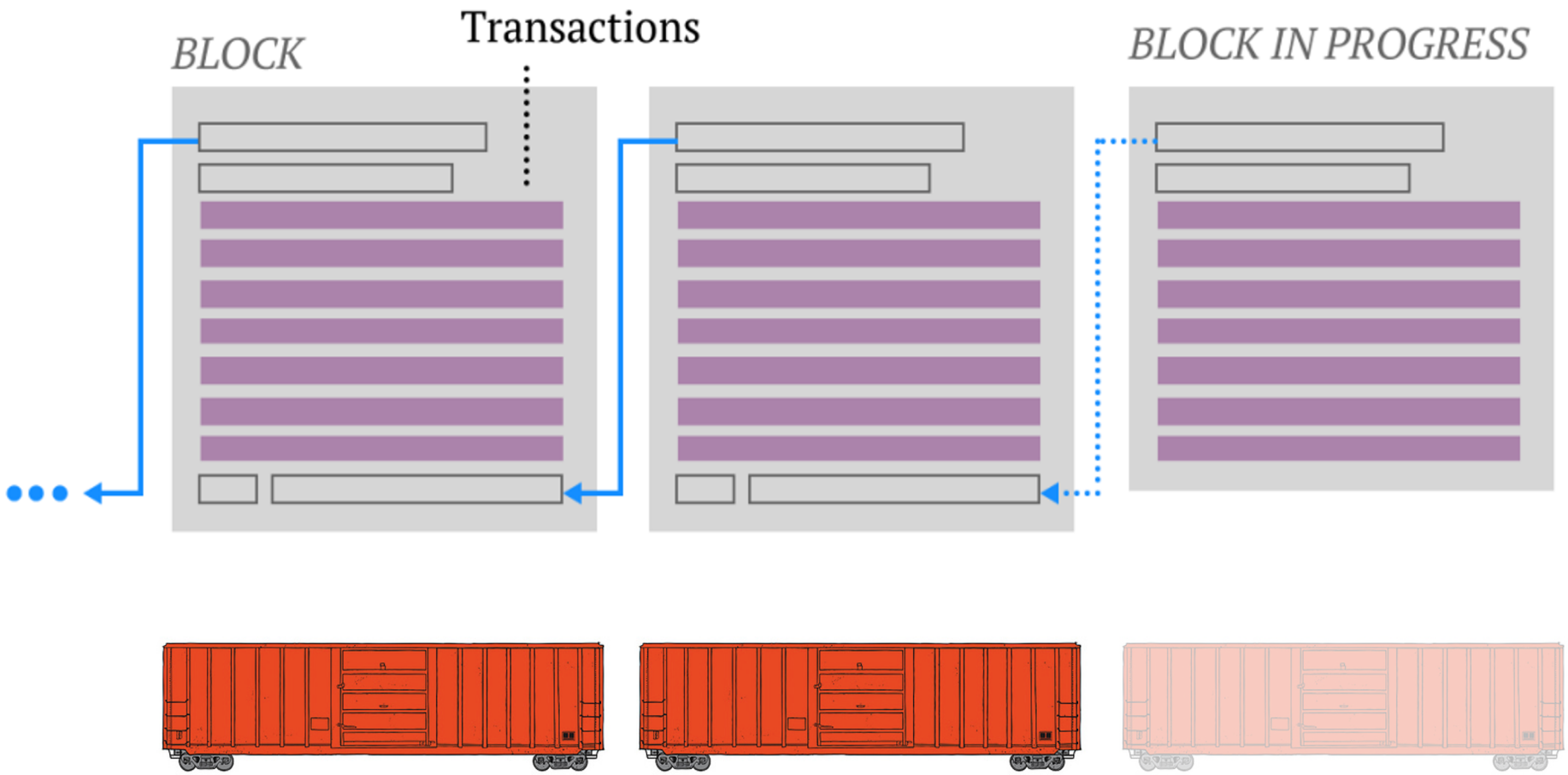

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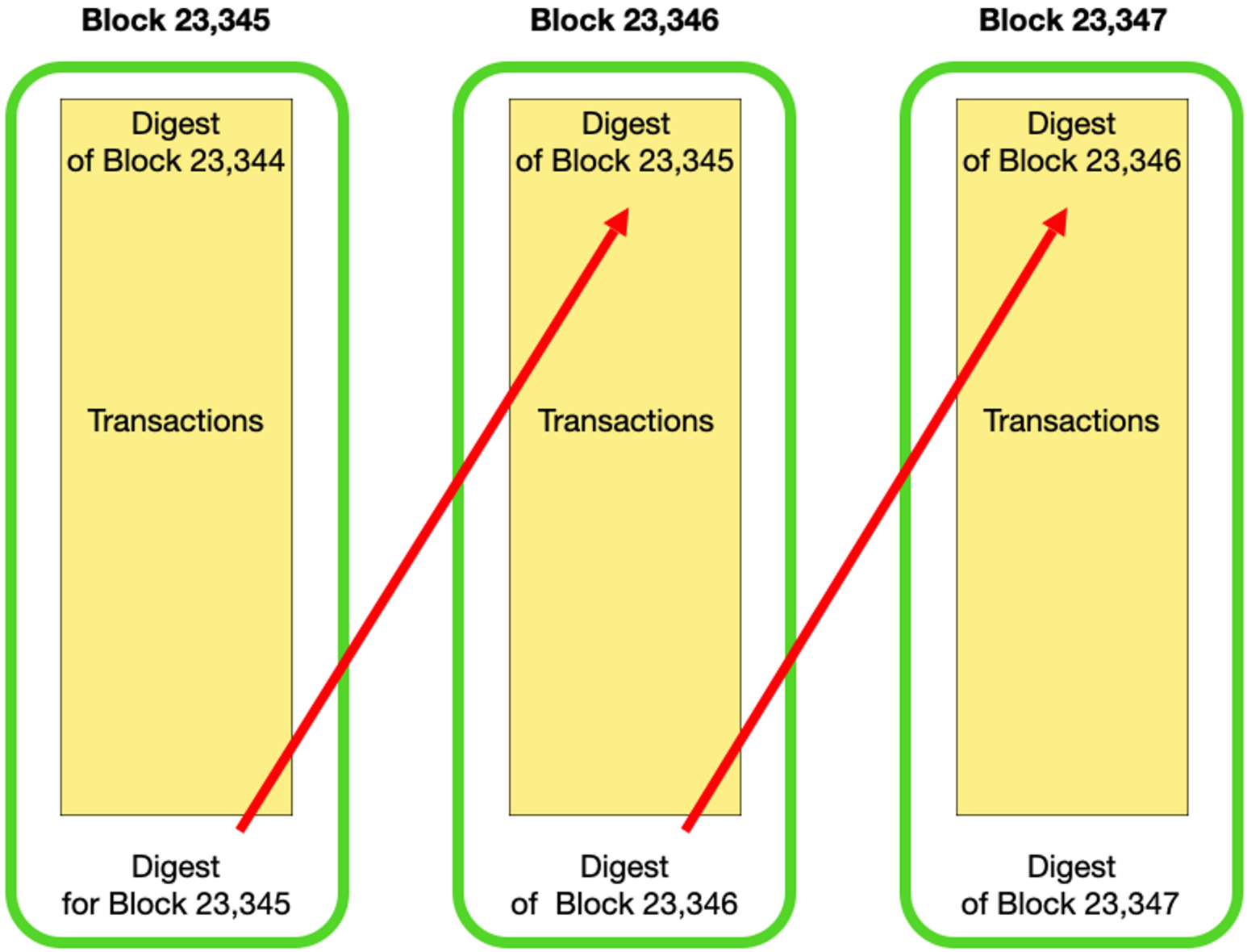

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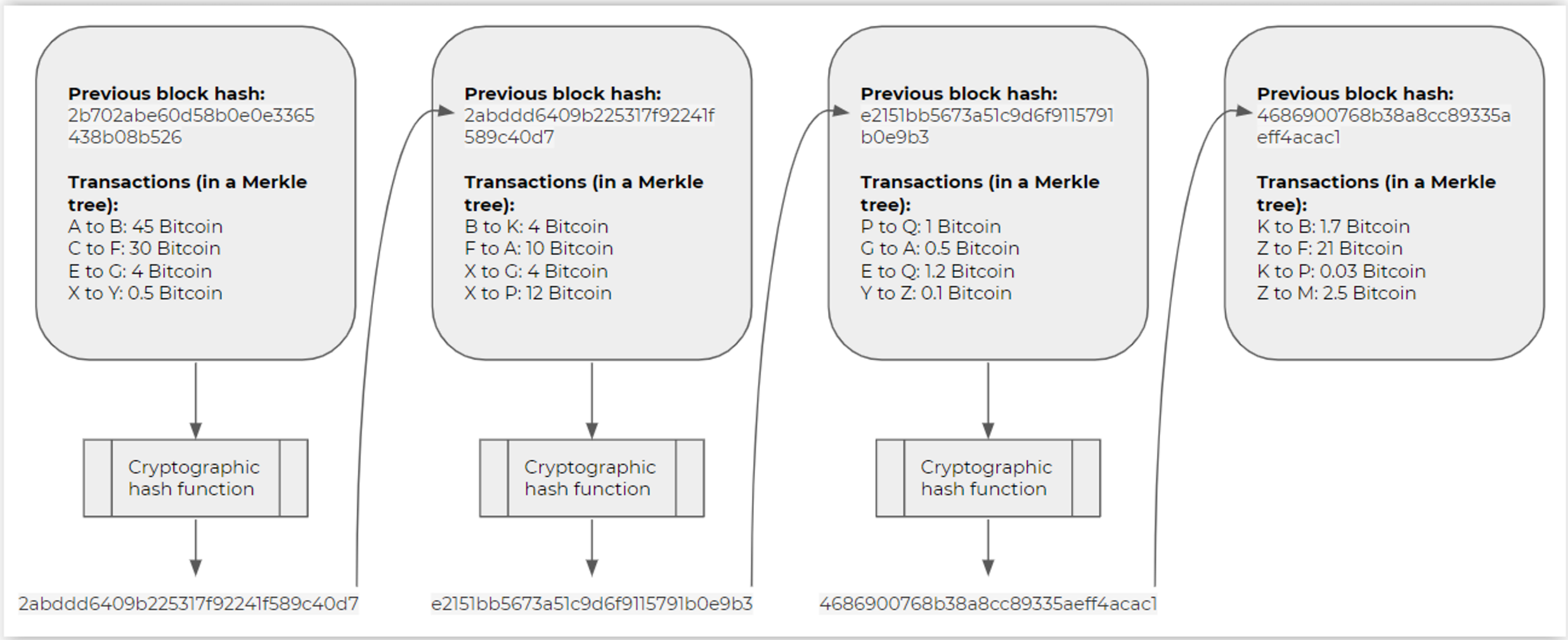

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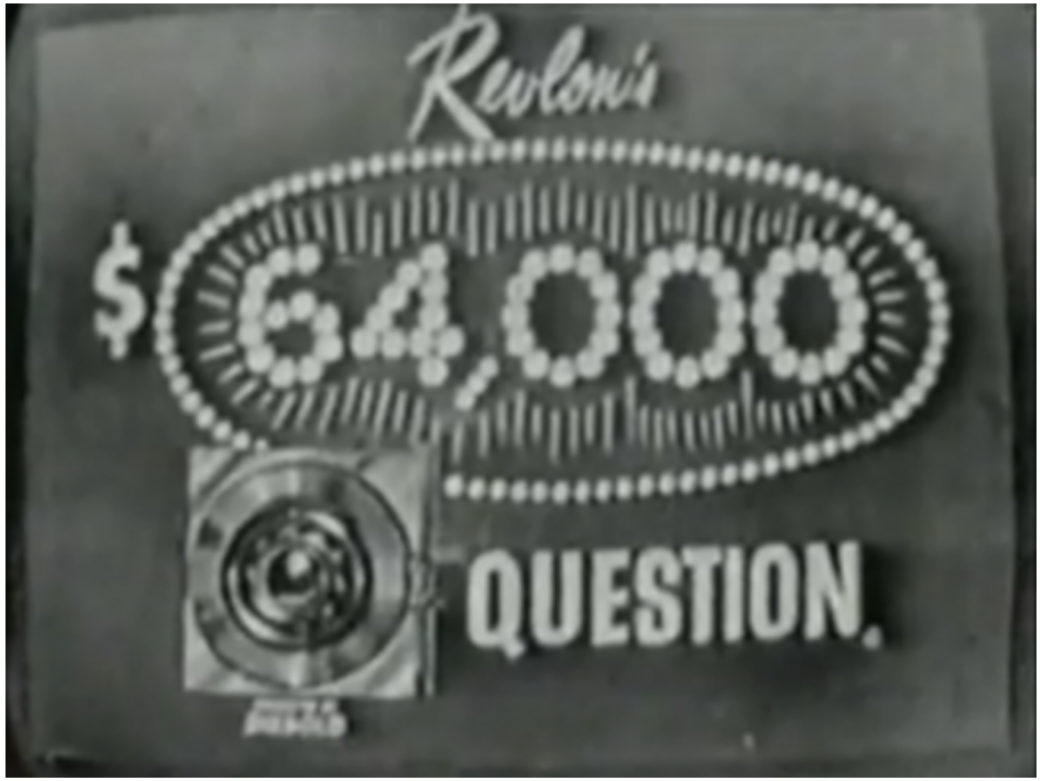
How to prevent “re-doing the whole train”?



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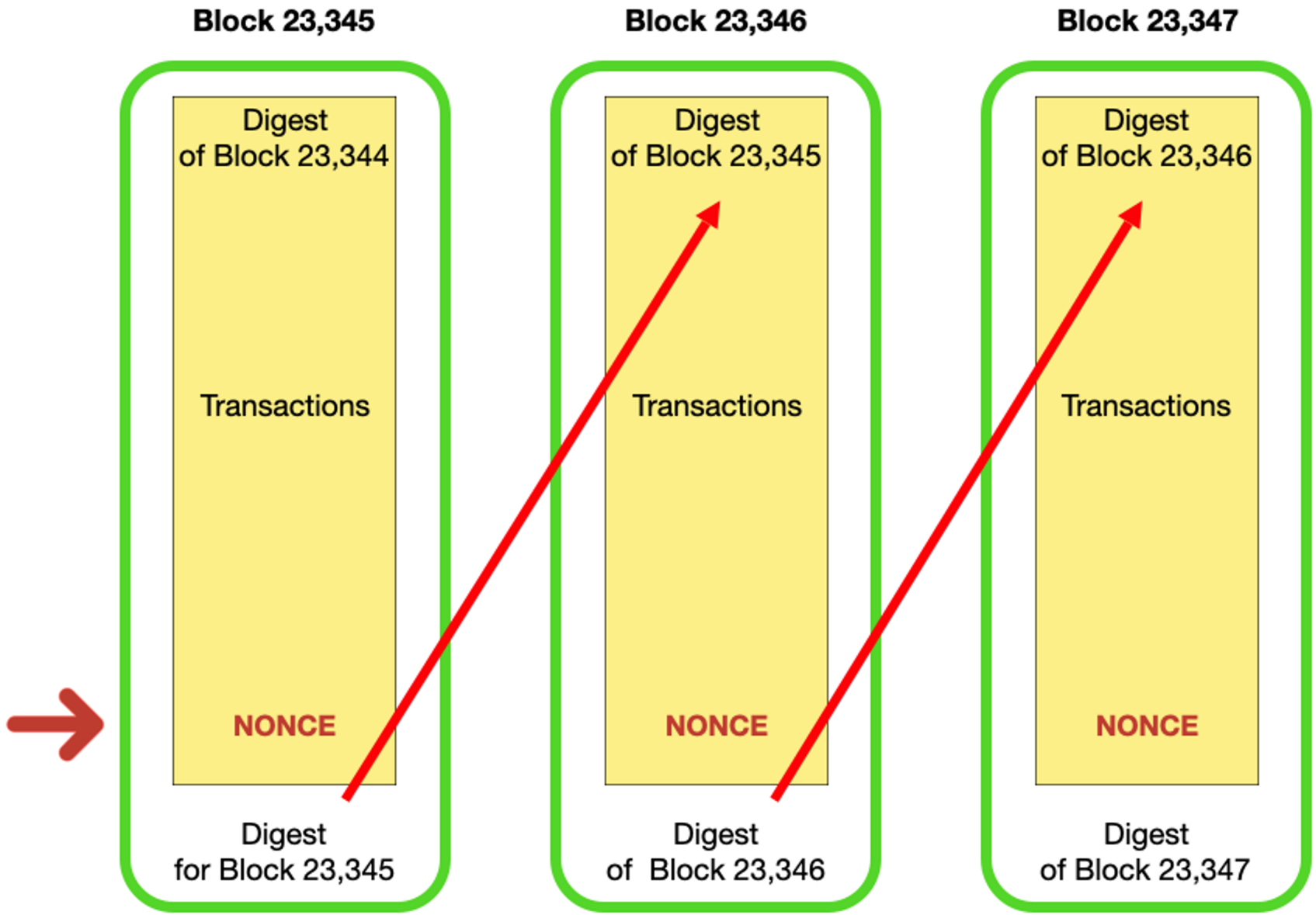
Adding “proof of work”

- Think of it as a ***time cost*** - in essence impose a 10 minute delay on the addition of a new block
- Make re-calculation, and thus change, (almost) impossible

The “**nonce**”



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A sample SHA-256 hash digest:

`1312af178c253f84028d480a6adc1e25e81caa44c749ec81976192e2ec934c64`

(This is really nothing more than a number between 1 and 2^256 in hexadecimal format)

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The type of hash we are looking for:

0000000000000000b42d99c81156d3a17228d6e1eef4139be78e948a9332a7d8

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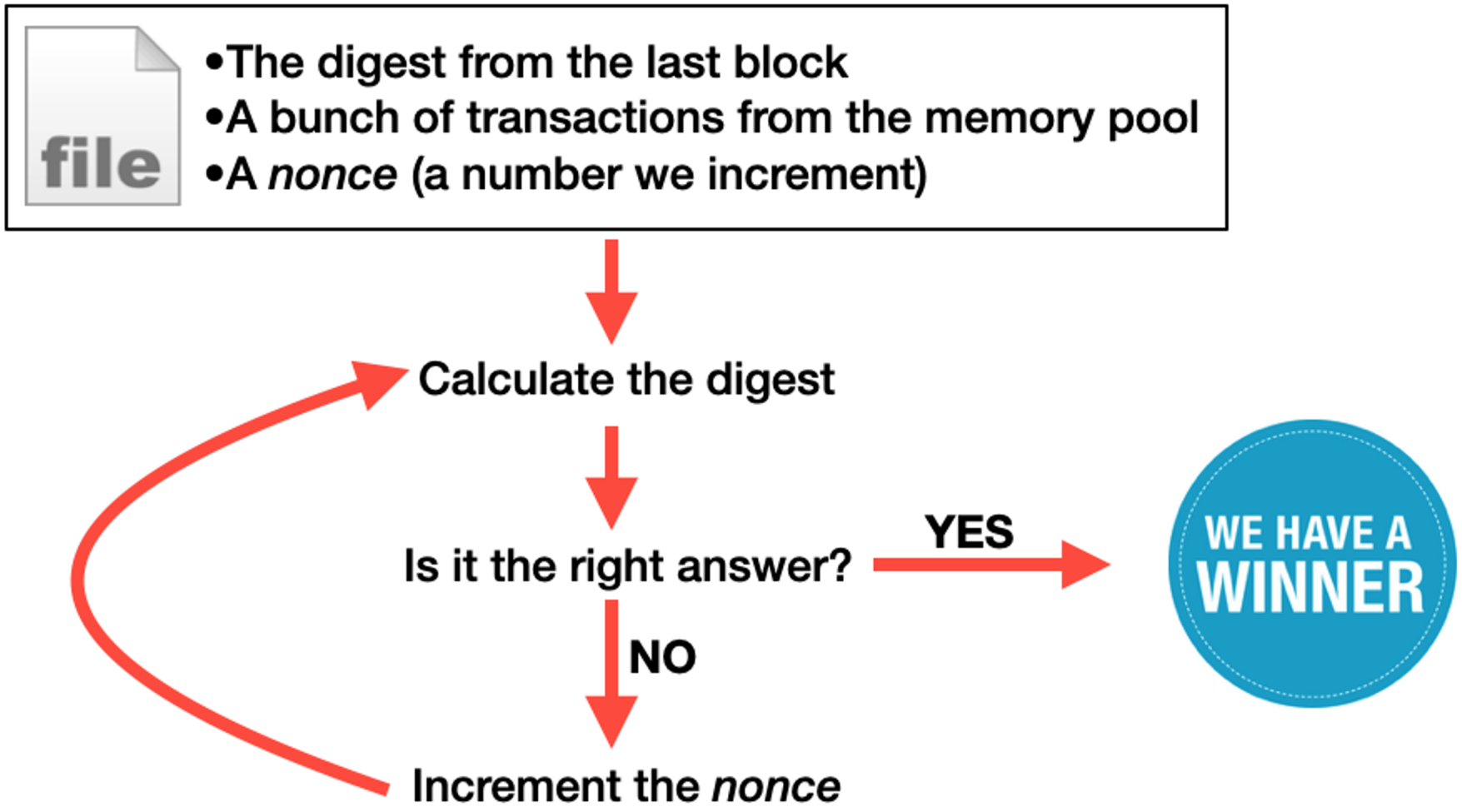
Retrying with a different nonce: "mining"



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When a winner is found

1. The winning node messages all other nodes: I found a winner!
2. Other nodes verify the hash and if OK accept the new block
3. Once 51% of all nodes have accepted the block, it is “confirmed”
4. The winning node gets a reward (currently 6.75 bitcoin)
5. Start all over again!

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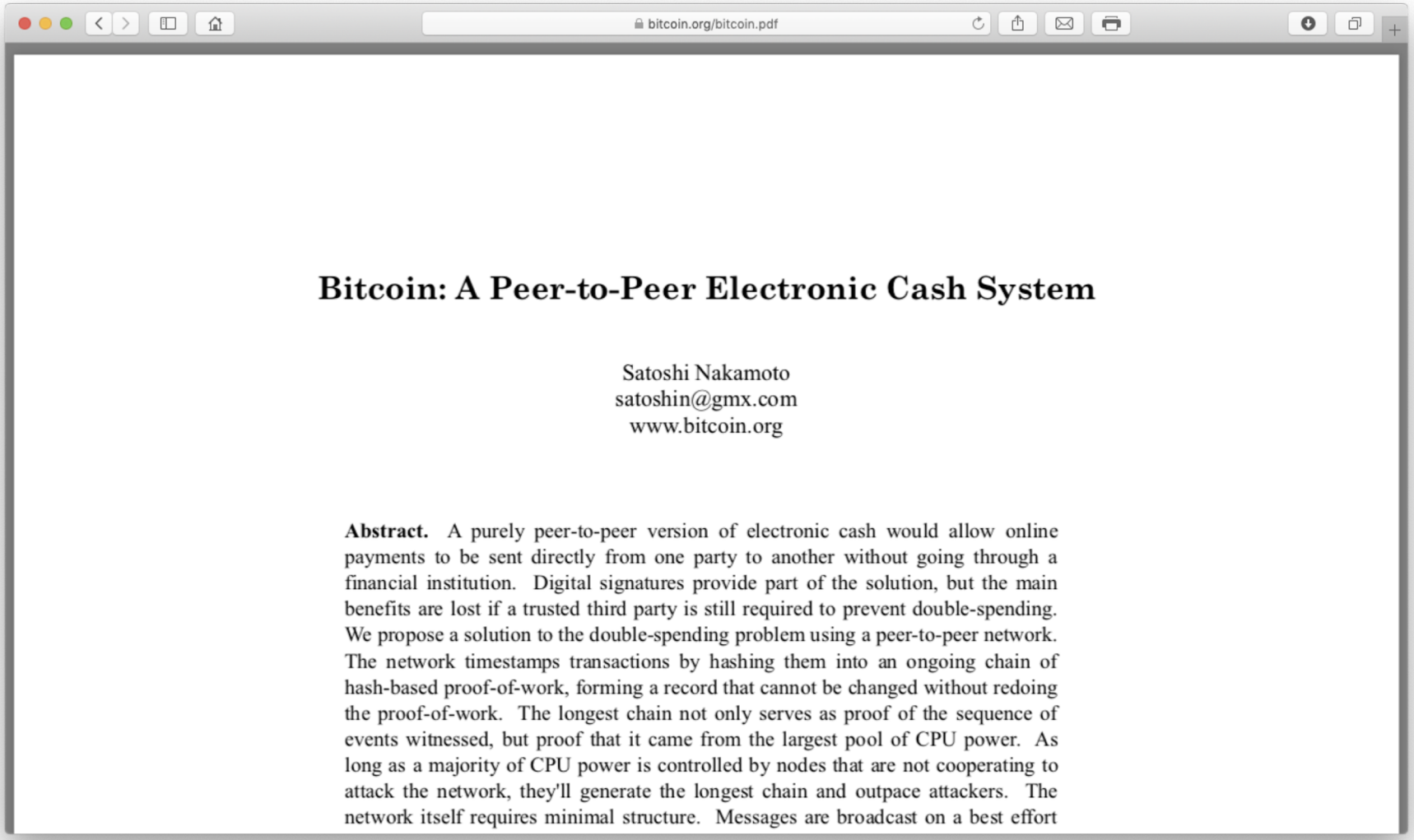
Use case: cryptocurrencies



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From: Satoshi Nakamoto <satoshi <at> vistomail.com>
Subject: Bitcoin P2P e-cash paper
Newsgroups: gmane.comp.encryption.general
Date: 2008-10-31 18:10:00 GMT

I've been working on a new electronic cash system that's fully peer-to-peer, with no trusted third party.
The paper is available at: http://www.bitcoin.org/bitcoin.pdf
The main properties:
Double-spending is prevented with a peer-to-peer network.
No mint or other trusted parties.
Participants can be anonymous.
New coins are made from Hashcash style proof-of-work.
The proof-of-work for new coin generation also powers the network to prevent double-spending.

Bitcoin: A Peer-to-Peer Electronic Cash System
Abstract. A purely peer-to-peer version of electronic cash [...]

Satoshi Nakamoto

The Cryptography Mailing List

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- Transactions are authorized by the owner's **private** key (can be stored in a *digital wallet*)

- Ownership on the blockchain is tracked by the owner's **public** key address, e.g.:

0x9A134Ce4BBd8c7b3A262774Fafd60B7f7ce3655B

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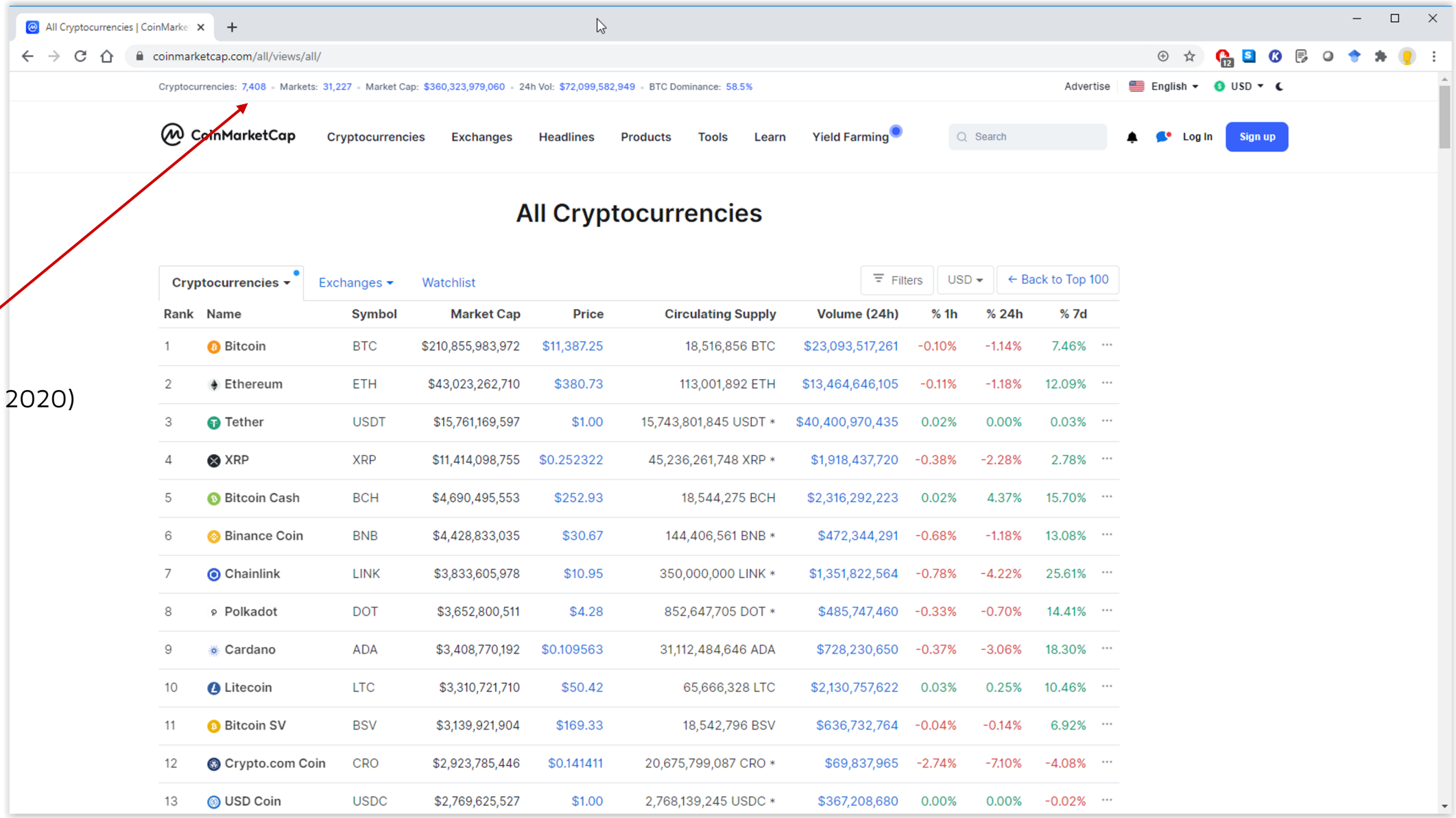
7,408 (as of 14 oct 2020)



Rank	Name	Symbol	Market Cap	Price	Circulating Supply	Volume (24h)	% 1h	% 24h	% 7d
1	Bitcoin	BTC	$210,855,983,972	$11,387.25	18,516,856 BTC	$23,093,517,261	-0.10%	-1.14%	7.46%
2	Ethereum	ETH	$43,023,262,710	$380.73	113,001,892 ETH	$13,464,646,105	-0.11%	-1.18%	12.09%
3	Tether	USDT	$15,761,169,597	$1.00	15,743,801,845 USDT *	$40,400,970,435	0.02%	0.00%	0.03%
4	XRP	XRP	$11,414,098,755	$0.252322	45,236,261,748 XRP *	$1,918,437,720	-0.38%	-2.28%	2.78%
5	Bitcoin Cash	BCH	$4,690,495,553	$252.93	18,544,275 BCH	$2,316,292,223	0.02%	4.37%	15.70%
6	Binance Coin	BNB	$4,428,833,035	$30.67	144,406,561 BNB *	$472,344,291	-0.68%	-1.18%	13.08%
7	Chainlink	LINK	$3,833,605,978	$10.95	350,000,000 LINK *	$1,351,822,564	-0.78%	-4.22%	25.61%
8	Polkadot	DOT	$3,652,800,511	$4.28	852,647,705 DOT *	$485,747,460	-0.33%	-0.70%	14.41%
9	Cardano	ADA	$3,408,770,192	$0.109563	31,112,484,646 ADA	$728,230,650	-0.37%	-3.06%	18.30%
10	Litecoin	LTC	$3,310,721,710	$50.42	65,666,328 LTC	$2,130,757,622	0.03%	0.25%	10.46%
11	Bitcoin SV	BSV	$3,139,921,904	$169.33	18,542,796 BSV	$636,732,764	-0.04%	-0.14%	6.92%
12	Crypto.com Coin	CRO	$2,923,785,446	$0.141411	20,675,799,087 CRO *	$69,837,965	-2.74%	-7.10%	-4.08%
13	USD Coin	USDC	$2,769,625,527	$1.00	2,768,139,245 USDC *	$367,208,680	0.00%	0.00%	-0.02%

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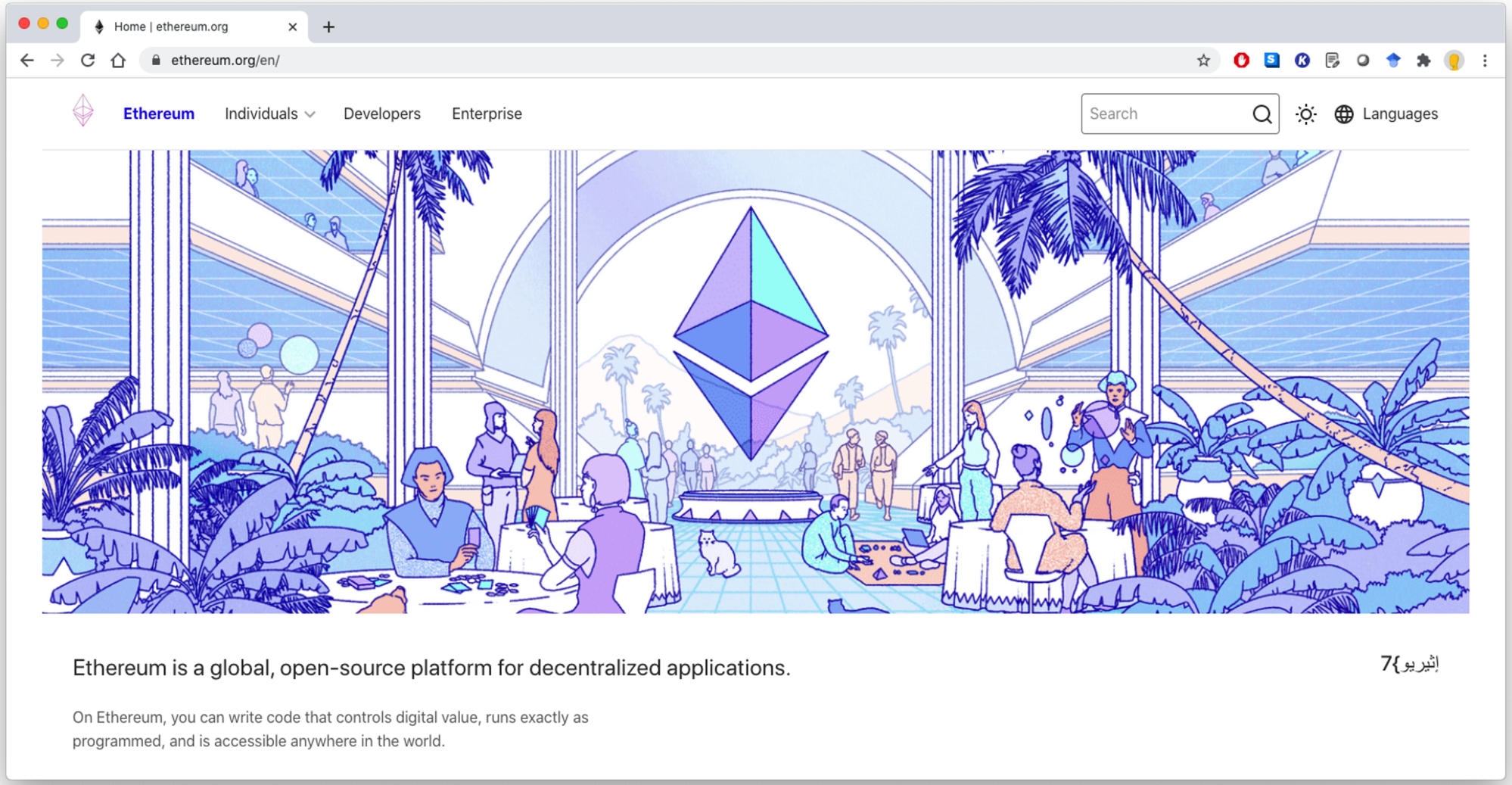
How blockchain implementations differ

- How new transactions are confirmed and added (consensus mechanisms):
  - Proof of Stake (e.g. Peercoin)
  - Byzantine Fault Tolerance (vote based) approaches (e.g. Ripple)
  - Directed Acyclic Graphs (e.g. Iota)
  - Proof of Elapsed Time
  - etc.

- Who can use the blockchain:
  - public (permissionless) blockchains
  - private (permissioned) blockchains

Blockchain as a platform



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Features

- Tracks transactions
- Is also able to store small bits of computer code ("smart contracts")
- Code runs within the Ethereum platform and changes the **state** of **variables** (think entitlements) stored on the blockchain
- Uses the ***ether*** cryptocurrency
- Also uses ***gas*** to pay for running the computer code
- Has a much shorter confirmation time (about 15 seconds)
- "DApps" are built on top of these platforms

“Smart” contracts

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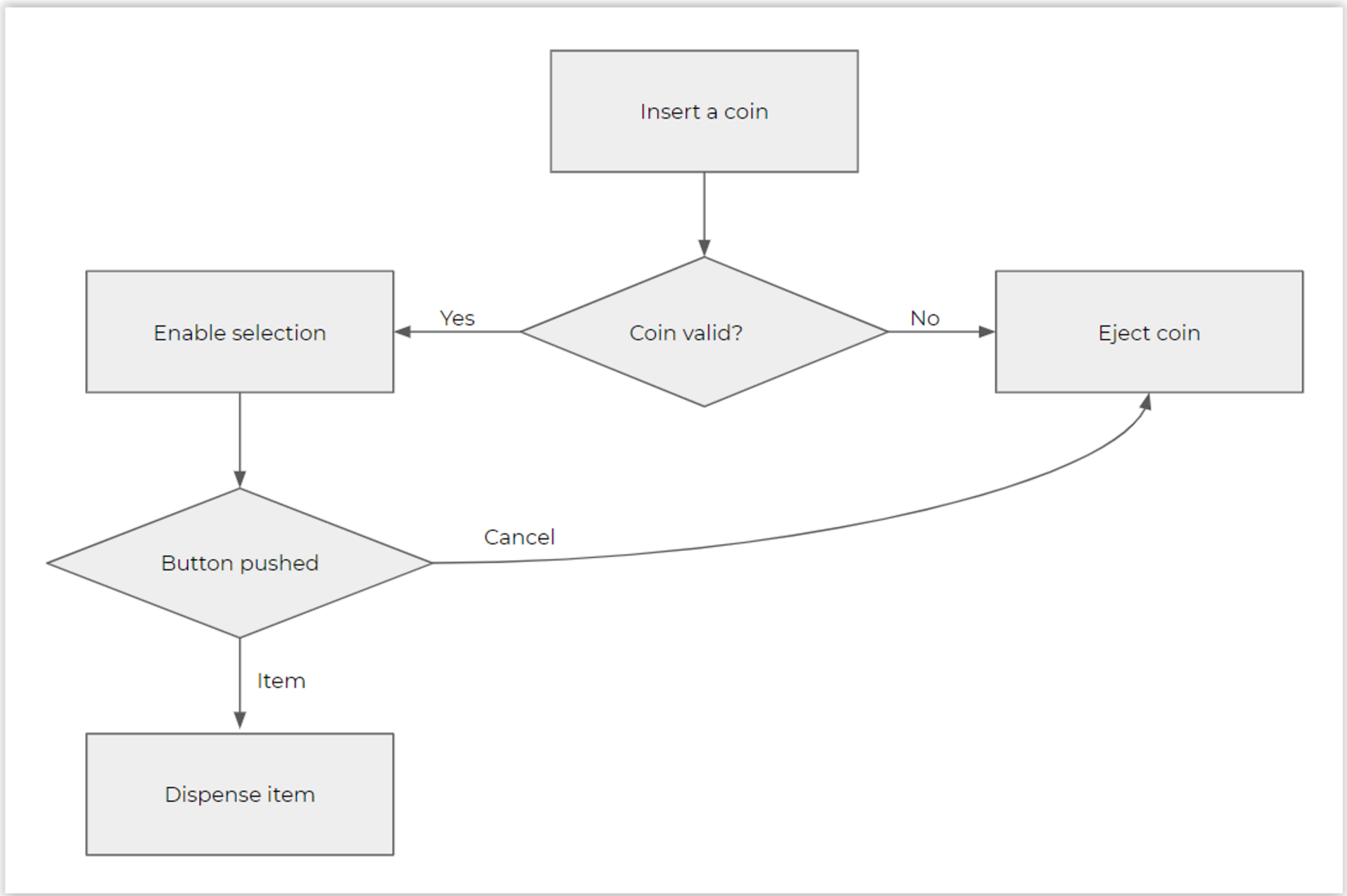

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Use case: Tokens

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```
pragma solidity ^0.4.16;

contract MyToken {
    // This creates an array with all balances
    mapping (address => uint256) public balanceOf;

    // Initializes contract with initial supply tokens to the creator of the contract
    function MyToken(
        uint256 initialSupply
    ) {
        balanceOf[msg.sender] = initialSupply;              // Give the creator all initial tokens
    }

    // Send coins
    function transfer(address _to, uint256 _value) {
        require(balanceOf[msg.sender] >= _value);           // Check if the sender has enough
        require(balanceOf[_to] + _value >= balanceOf[_to]); // Check for overflows
        balanceOf[msg.sender] -= _value;                    // Subtract from the sender
        balanceOf[_to] += _value;                           // Add the same to the recipient
    }
}
```

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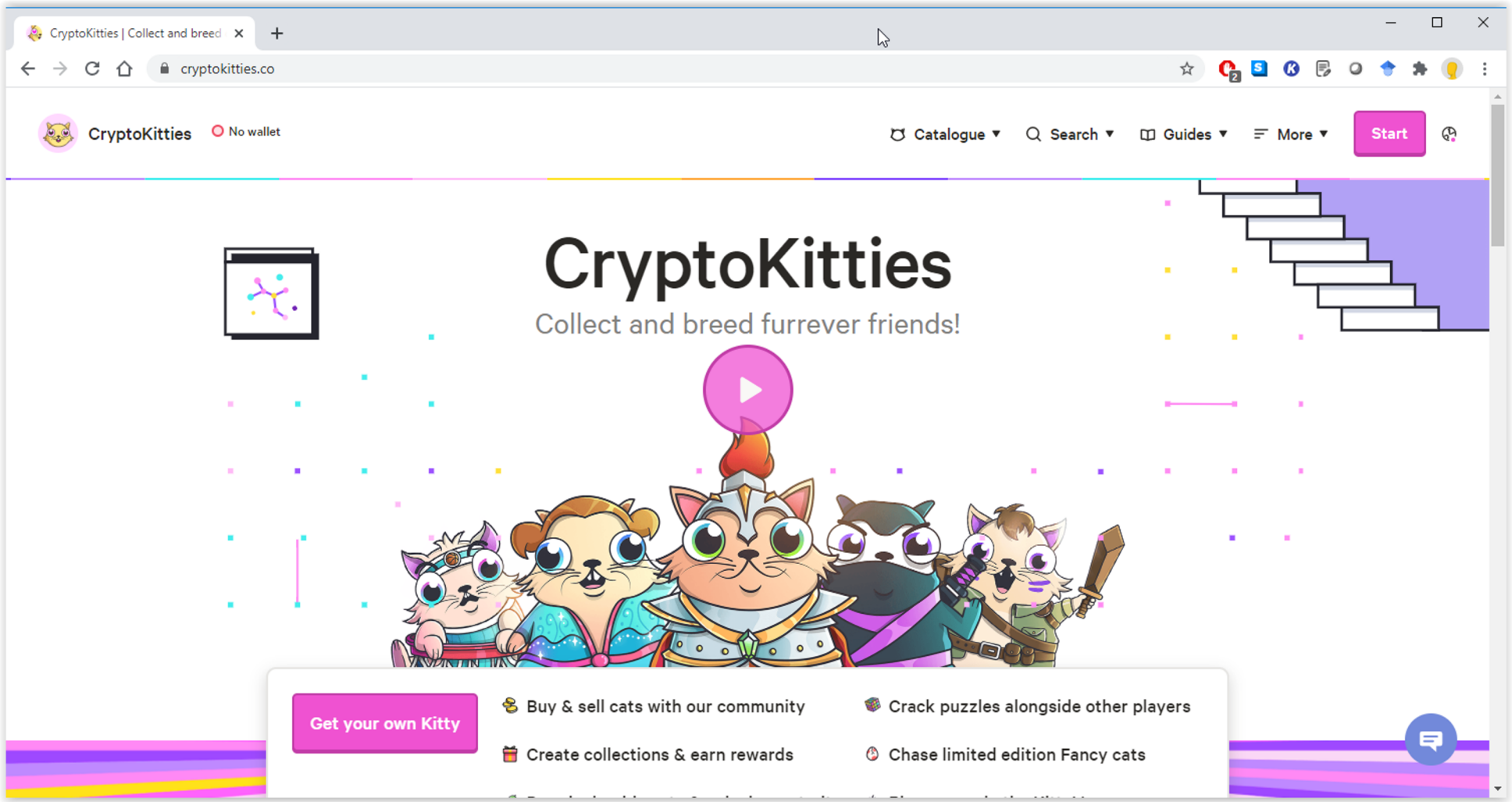
Use case: CryptoKitties



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End of the technical intro

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