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Lecture 0
Introduction to Blockchain

By Samuel Tang, TIBA

Fall 2020 @ Tsinghua University

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Goal: Where does Blockchain come from and what is it?

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Content

- The Problem
  - Is there really a problem?
- The Solution
  - History
- What is Blockchain?

Problem & Solution

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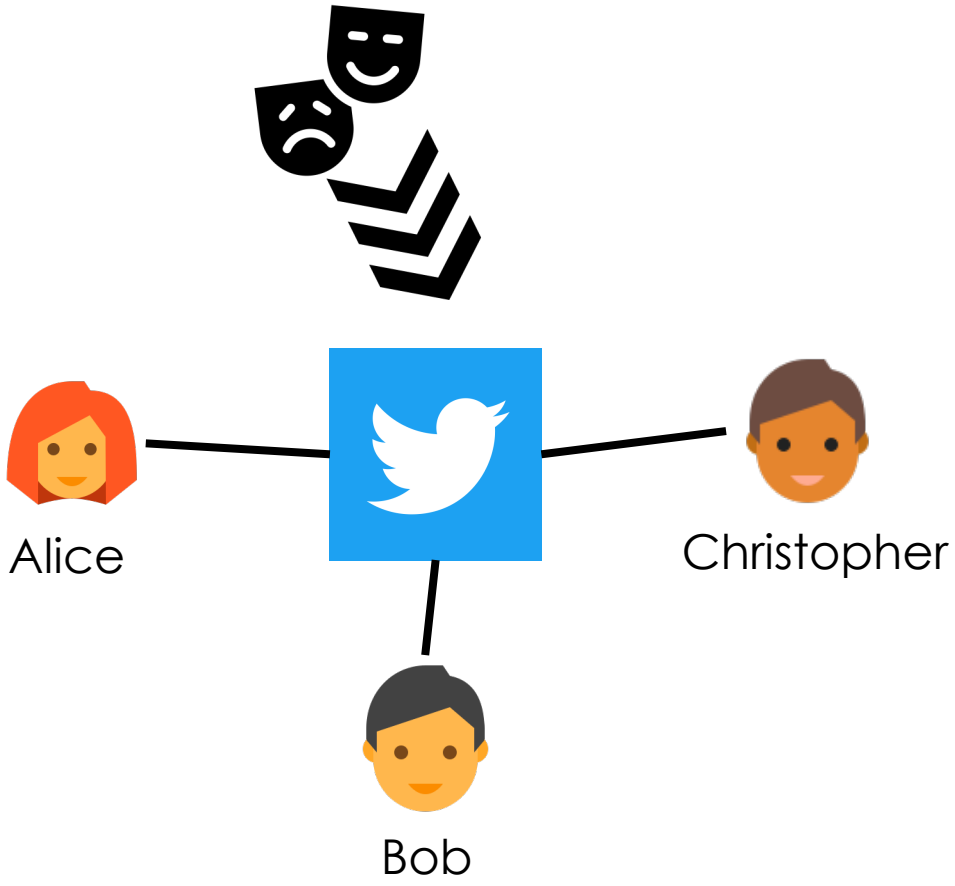
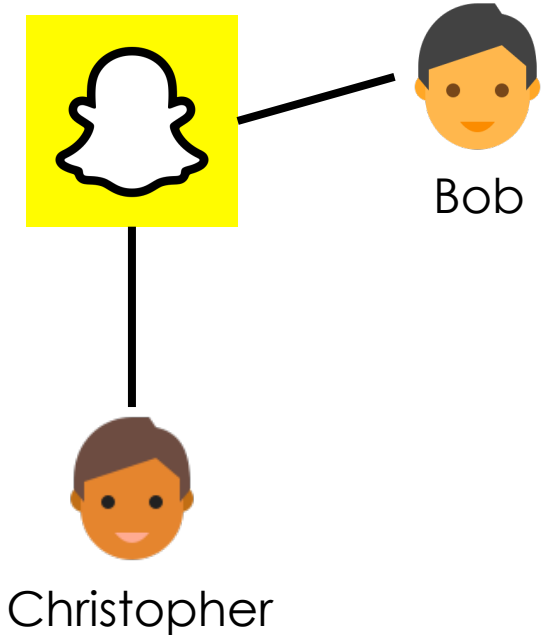
What's the problem?

Control of Data, Single Point of Failure





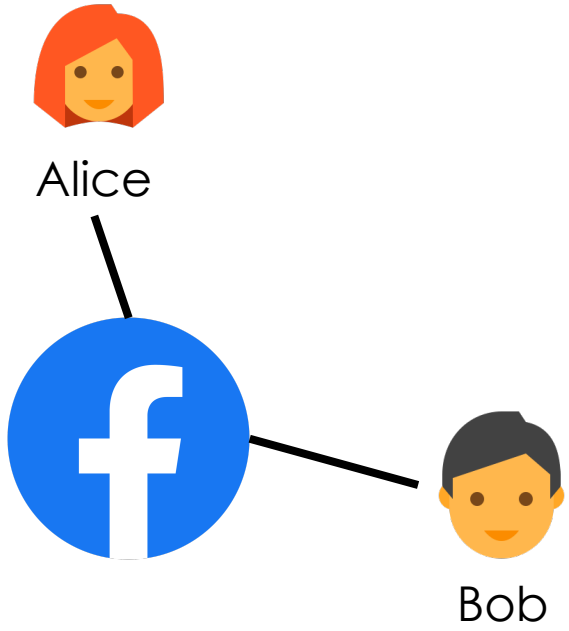


Image: https://commons.wikimedia.org/wiki/File:Facebook_Logo_(2019).png; https://play.google.com/store/apps/details?id=com.snapchat.android&hl=en_US; https://play.google.com/store/apps/details?id=com.twitter.android;

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What's the problem?

Different systems different standards

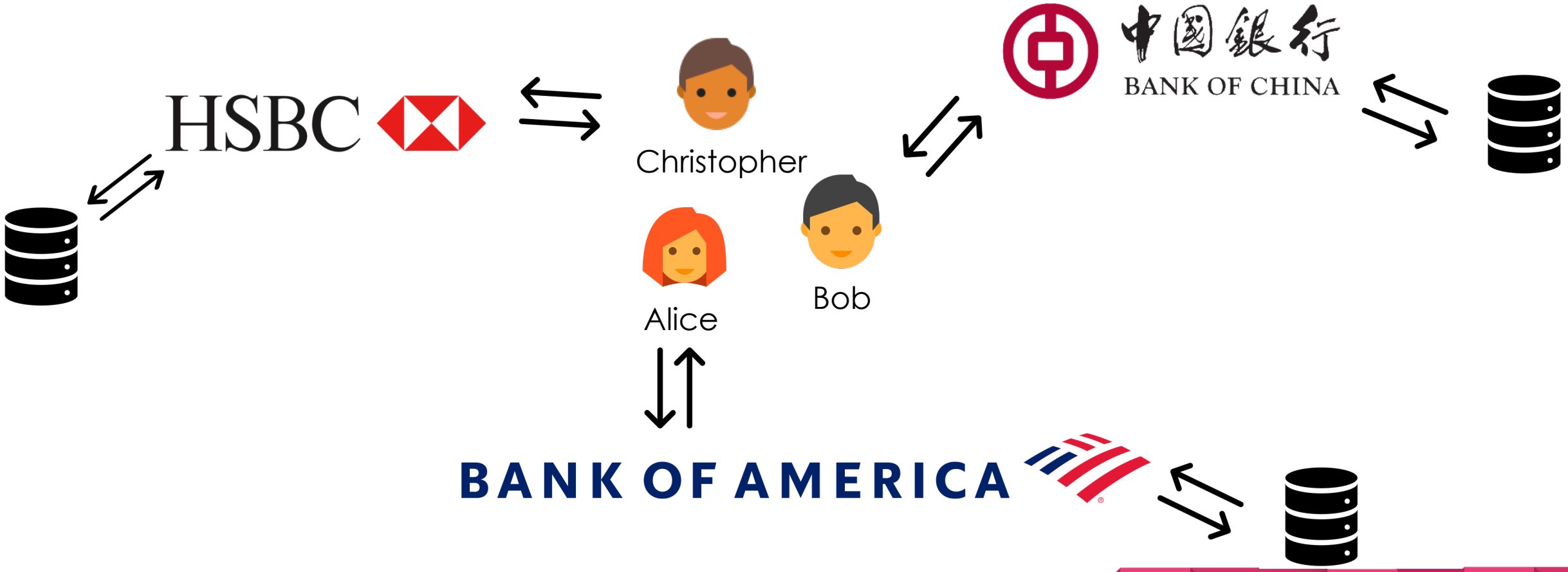

Image: https://secure.bankofamerica.com/login/sign-in/signOnV2Screen.go; http://www.finncham.com.hk/membership/member-directory/17159/bank-of-china-hong-kong/; https://www.theclimategroup.org/partner/hsbc-holdings-plc;

What's the problem?

Reduced Value Transferred

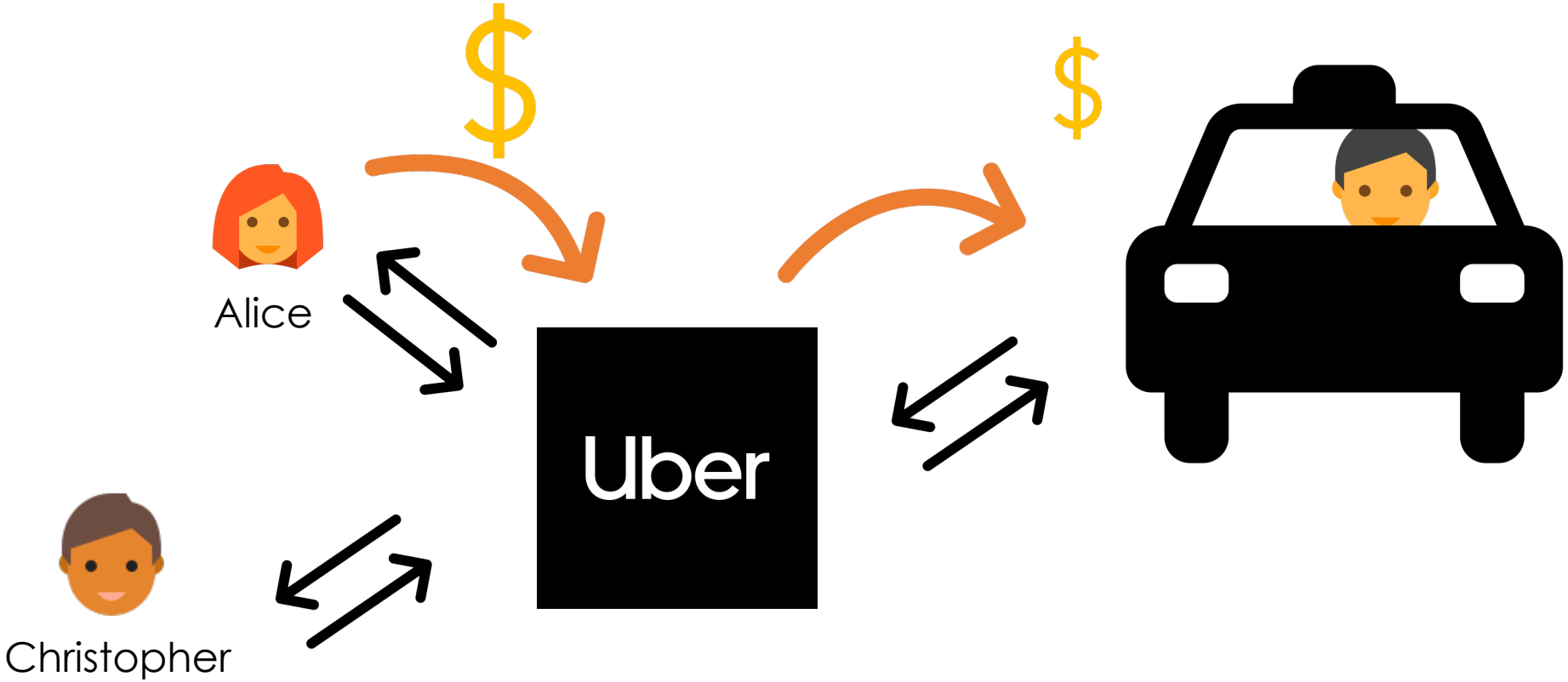

Image: https://play.google.com/store/apps/details?id=com.ubercab&hl=en_US;

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What's the problem?

Centralization is the enemy … ?

- **Centralized** means:
  - Easy to maintain and update
  - Fast & Efficient in its closed system
    - Single source of reference & truth in its own system
  - Less work on most people
  - Different systems different standards
  - Control of data
    - No guarantee of personal privacy
  - Take a cut of the value transferred
  - Single point of failure

Image: https://medium.com/distributed-economy/what-is-the-difference-between-decentralized-and-distributed-systems-f4190a5c6462

Is there a problem?

"Data is the oil of the 21st century."

Source: https://www.youtube.com/watch?v=uaaC57tcci0; https://www.youtube.com/watch?v=iX8GxLP1FHo;

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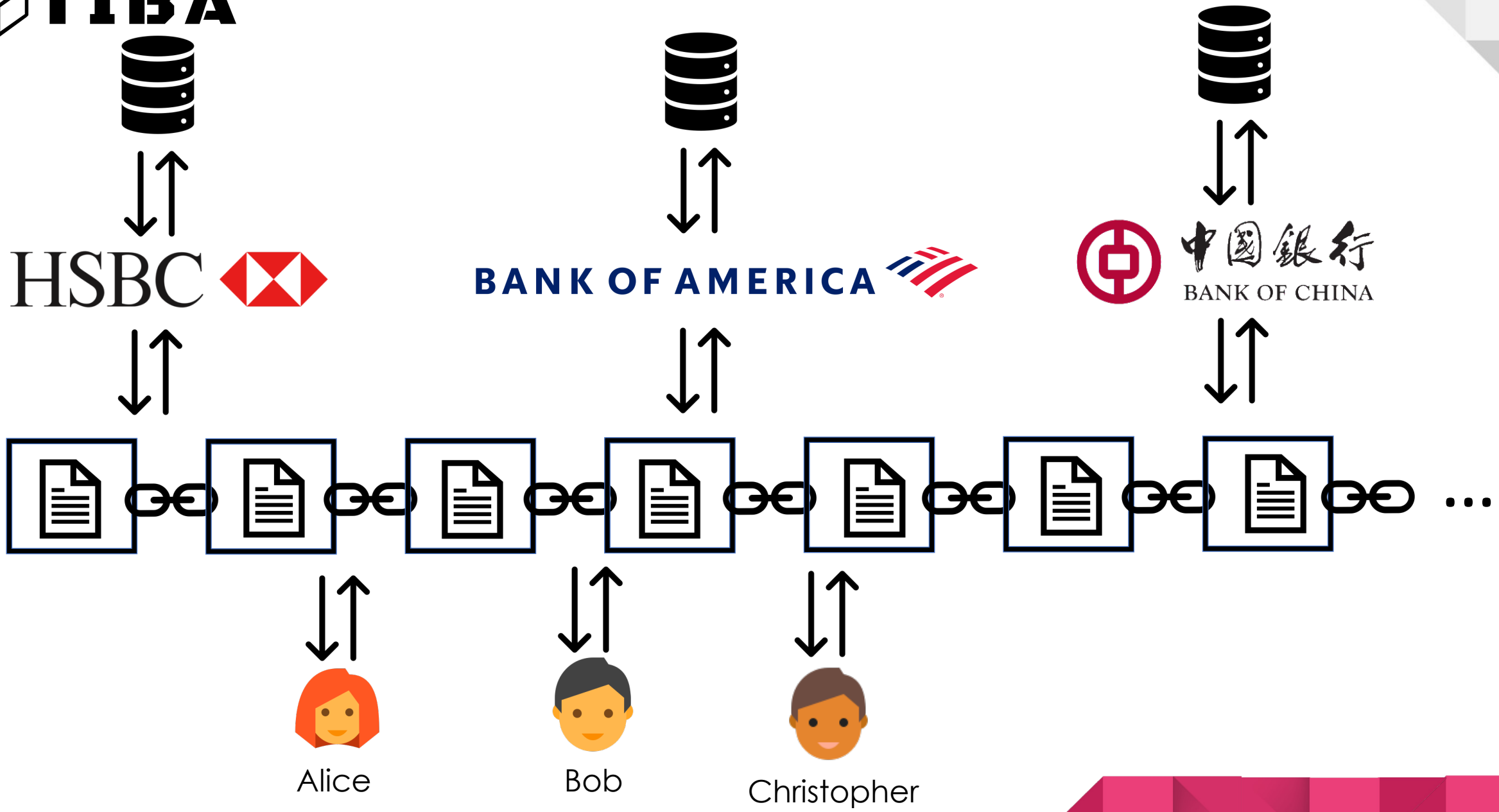

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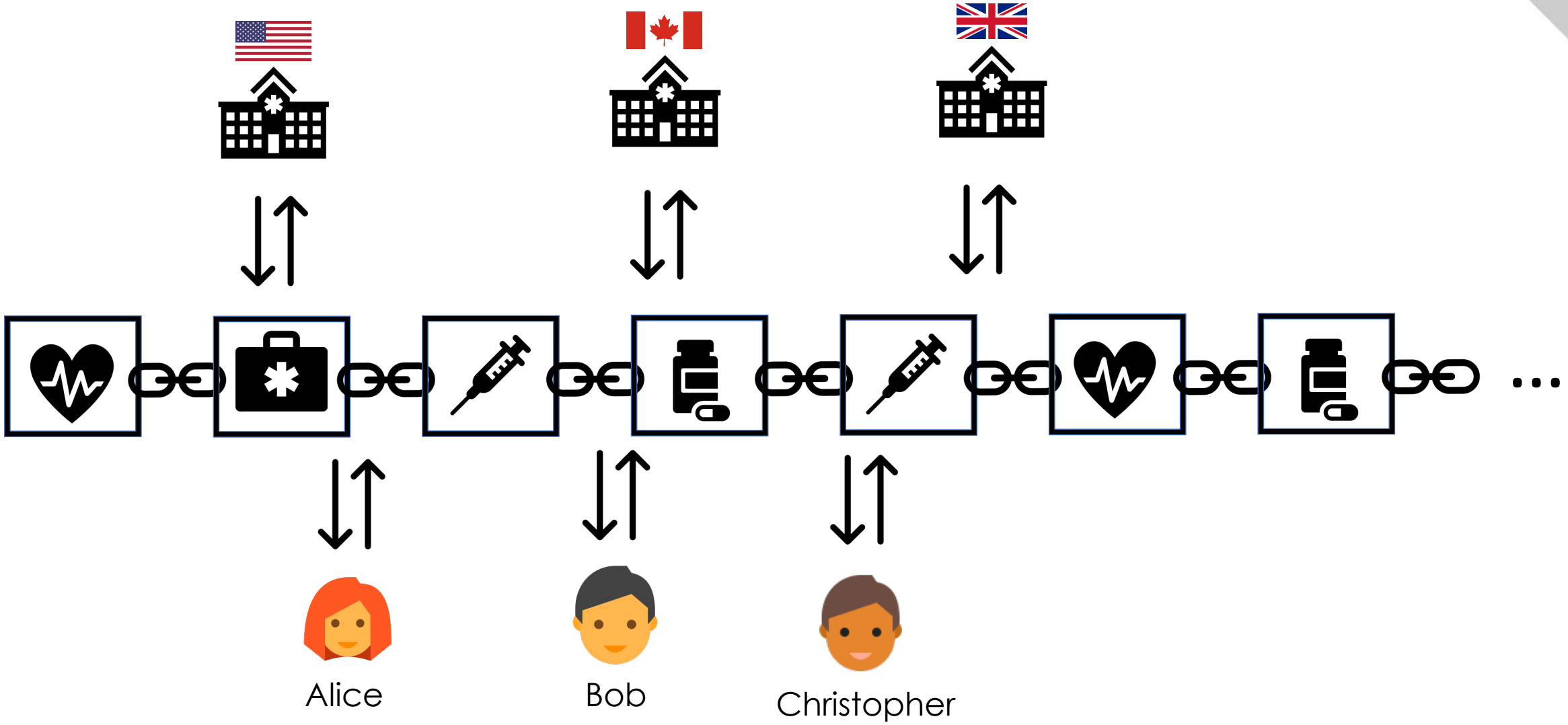
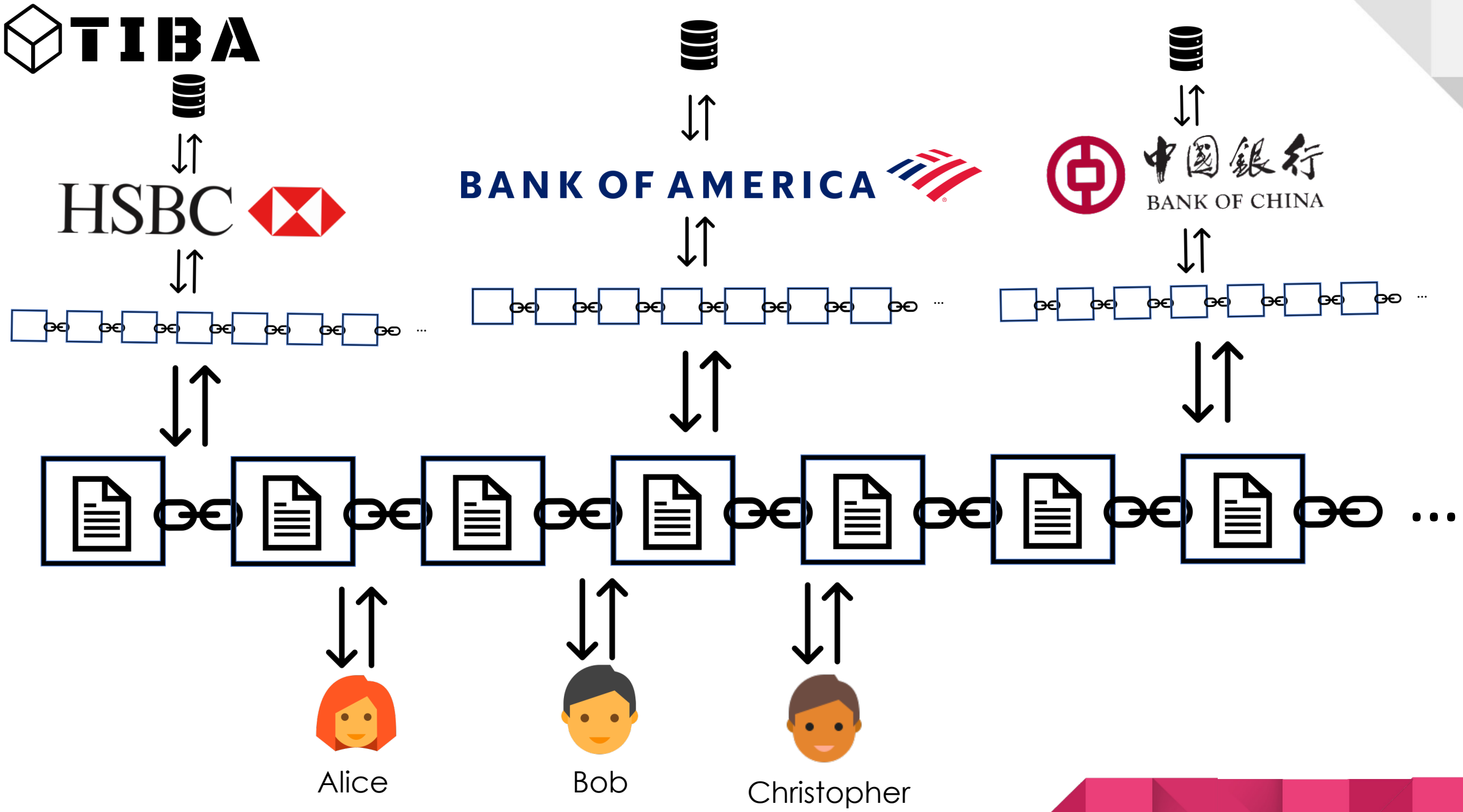


Image: https://en.wikipedia.org/wiki/Canada; https://www.countryflags.com/en/flag-of-united-states-the.html;; https://www.jetpunk.com/quizzes/flags-of-the-world-quiz;



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Q: Who decides the state of the blockchain?
(Who defines the single source of truth?)

A: a network of computers collectively reach a consensus

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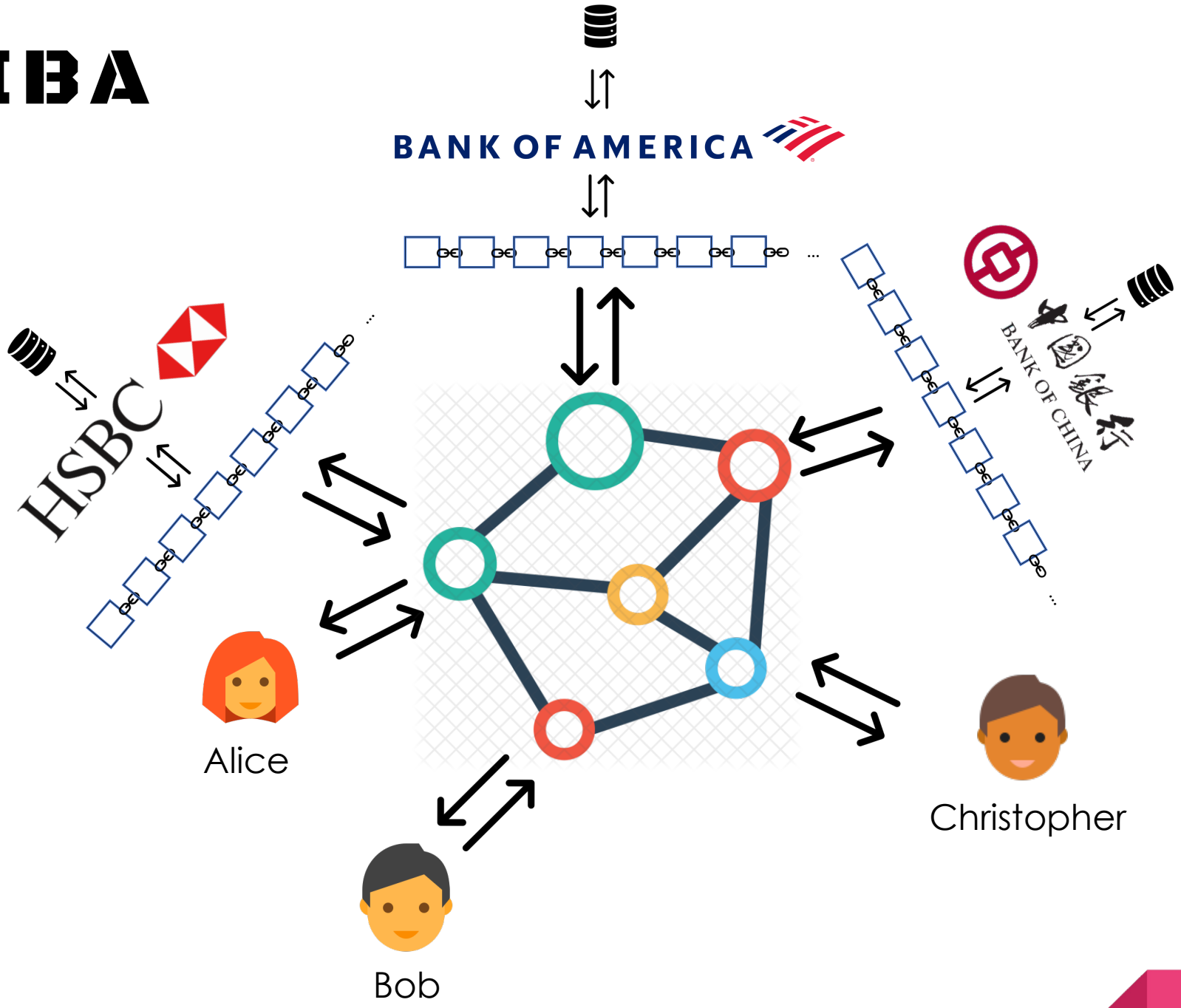

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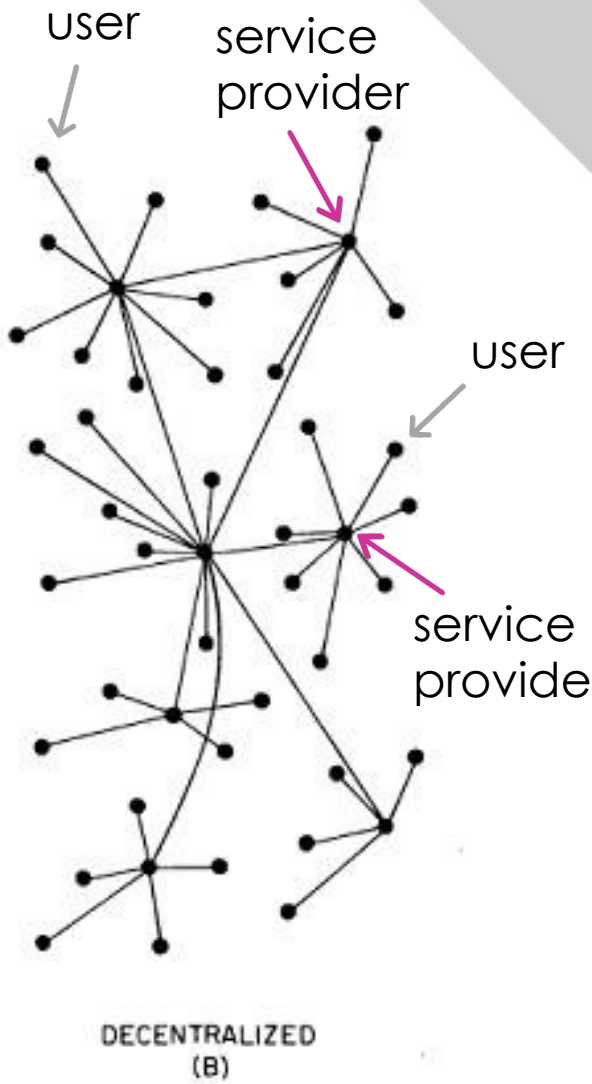
What's the solution?

An alternative future…?

- **Decentralized** means:
  - Standardized basic-level Protocol
    - Single source of reference & truth for all
  - Democratize control of data
  - Harder to maintain and update
  - Slower and less efficient
  - More work on some people
  - Multiple points of smaller failure
    - If one got cut, connect to another!
  - Bitcoin Payment System



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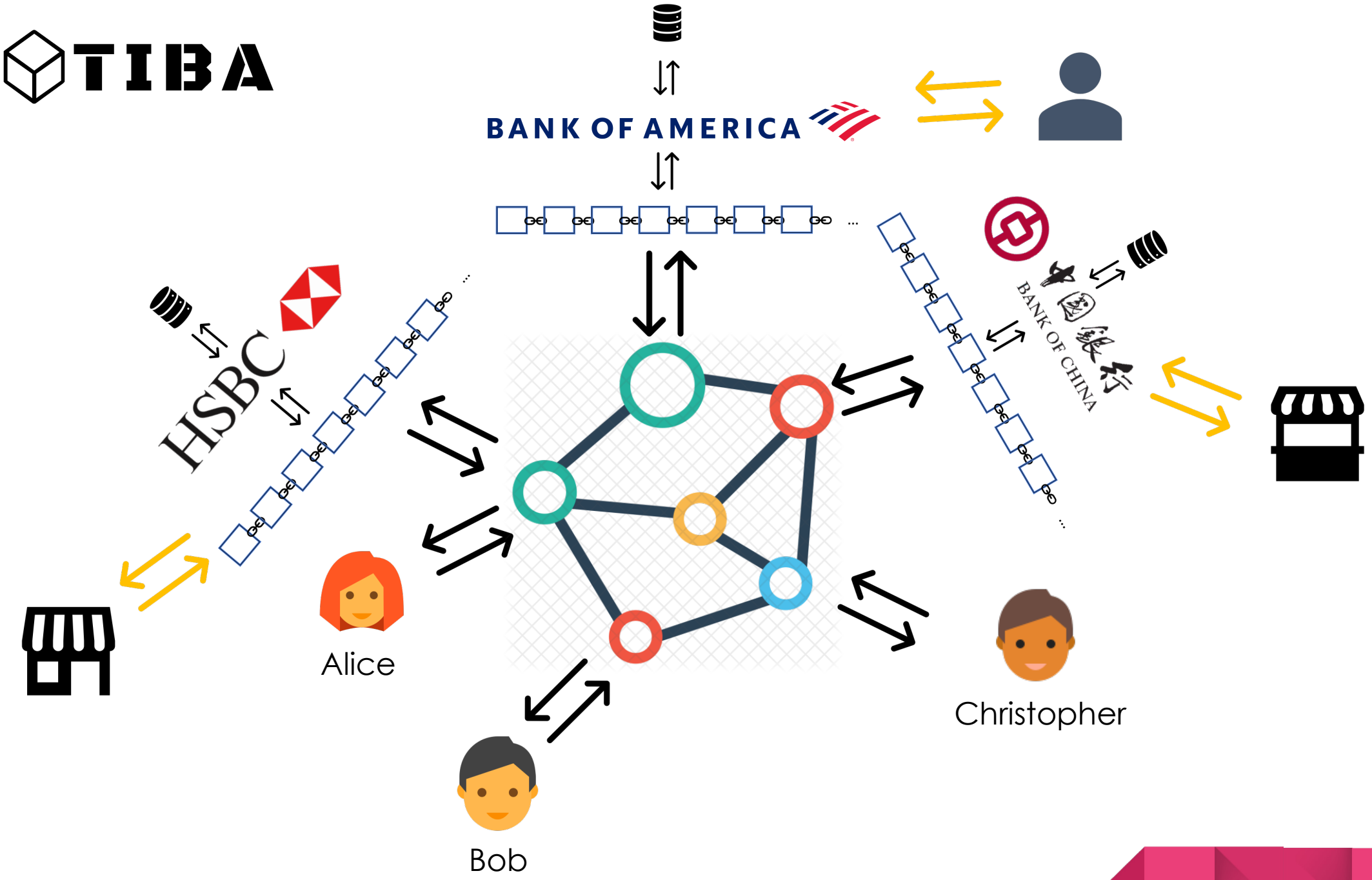

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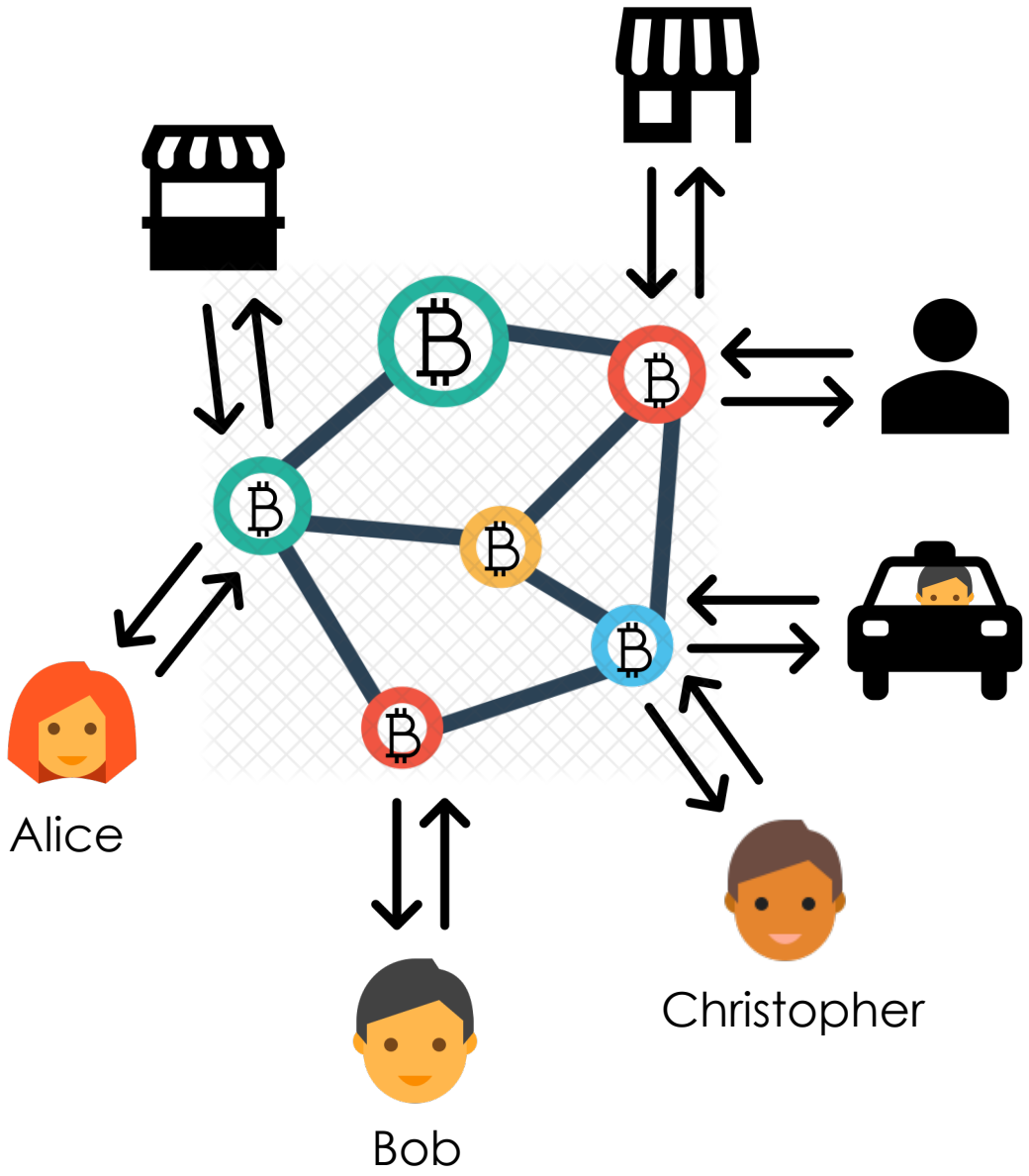

Image: https://secure.bankofamerica.com/login/sign-in/signOnV2Screen.go; http://www.finncham.com.hk/membership/member-directory/17159/bank-of-china-hong-kong/; https://www.theclimategroup.org/partner/hsbc-holdings-plc;

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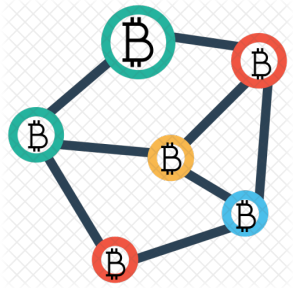
Taking to the extreme

A utopian future…?

- **Distributed** means:
  - Standardized all-level Protocol
    - Single source of reference & truth for all
  - Complete control of own data
  - Even harder to maintain and update
  - Slow and less efficient
  - More work on all people
  - Near impossible to hack
- Bitcoin Peer-to-Peer Network



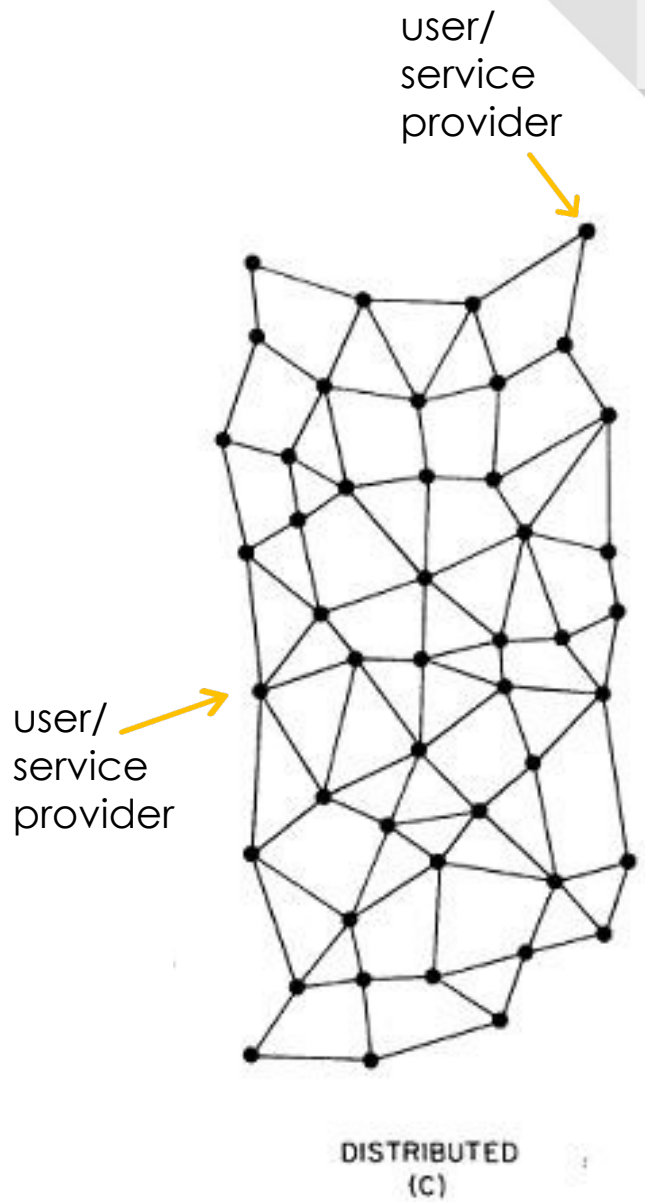


Image: https://medium.com/distributed-economy/what-is-the-difference-between-decentralized-and-distributed-systems-f4190a5c6462

Internet of Value

Blockchain Enabled Internet 2.0

- Internet 1.0 = Internet of Information
  - virtually free transfer of information
    - Email
    - Video
    - …
- Internet 2.0 = Internet of Value
  - Lower cost and secure transfer of value
    - Money
    - Asset
    - Identity
    - …
- Blockchain enables the peer-to-peer transfer of value

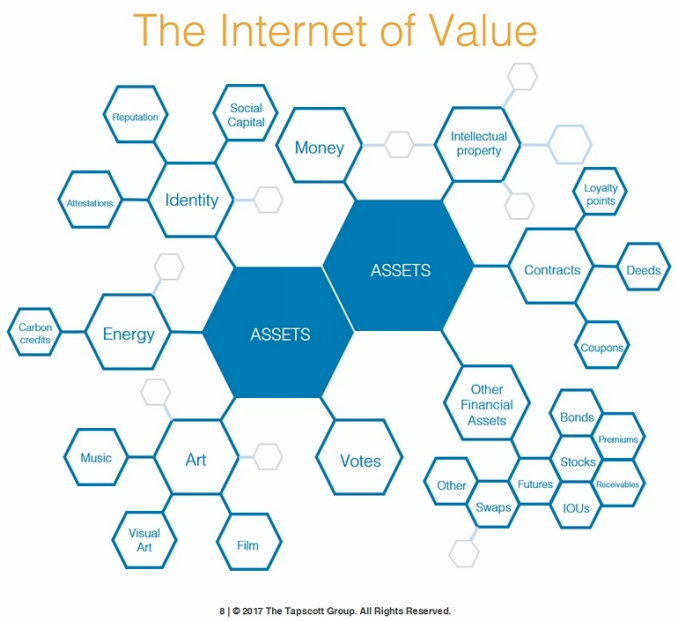


Image: https://www.altoros.com/blog/the-internet-of-value-8-top-sectors-being-transformed-by-blockchain/;

Figure 2. Moving toward the Internet of value

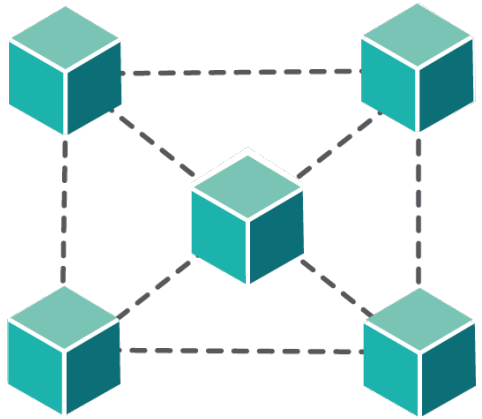
Web 1.0/ Web 2.0

Data is copied

VS.

Blockchain

Ownership is transferred



Types of data

- Texts
- Images
- Videos
- Music

Types of transactions

Intangible assets

- Currency
- Shares
- Copyrights
- Patents

Tangible assets

- Real estate
- Goods

Obligations

- Contracts
- Pledges

Source: Deloitte analysis.

Image: https://www2.deloitte.com/us/en/insights/industry/public-sector/understanding-basics-of-blockchain-in-government.html;

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Is Blockchain the Future?

- Bubble or Revolution?
  - Buzzword/over-hyped
  - Limited applications
  - Inefficient use of resources (energy consumption, duplicate data,…)
  - Scalability problem
  - Regulation
  - Trustless system
  - Decentralization
  - Immutability
  - Transparency
  - Anonymity
- **Learn & know for yourself!**

Source: https://steemit.com/blockchain/@beggars/the-blockchain-is-not-the-solution-to-every-problem

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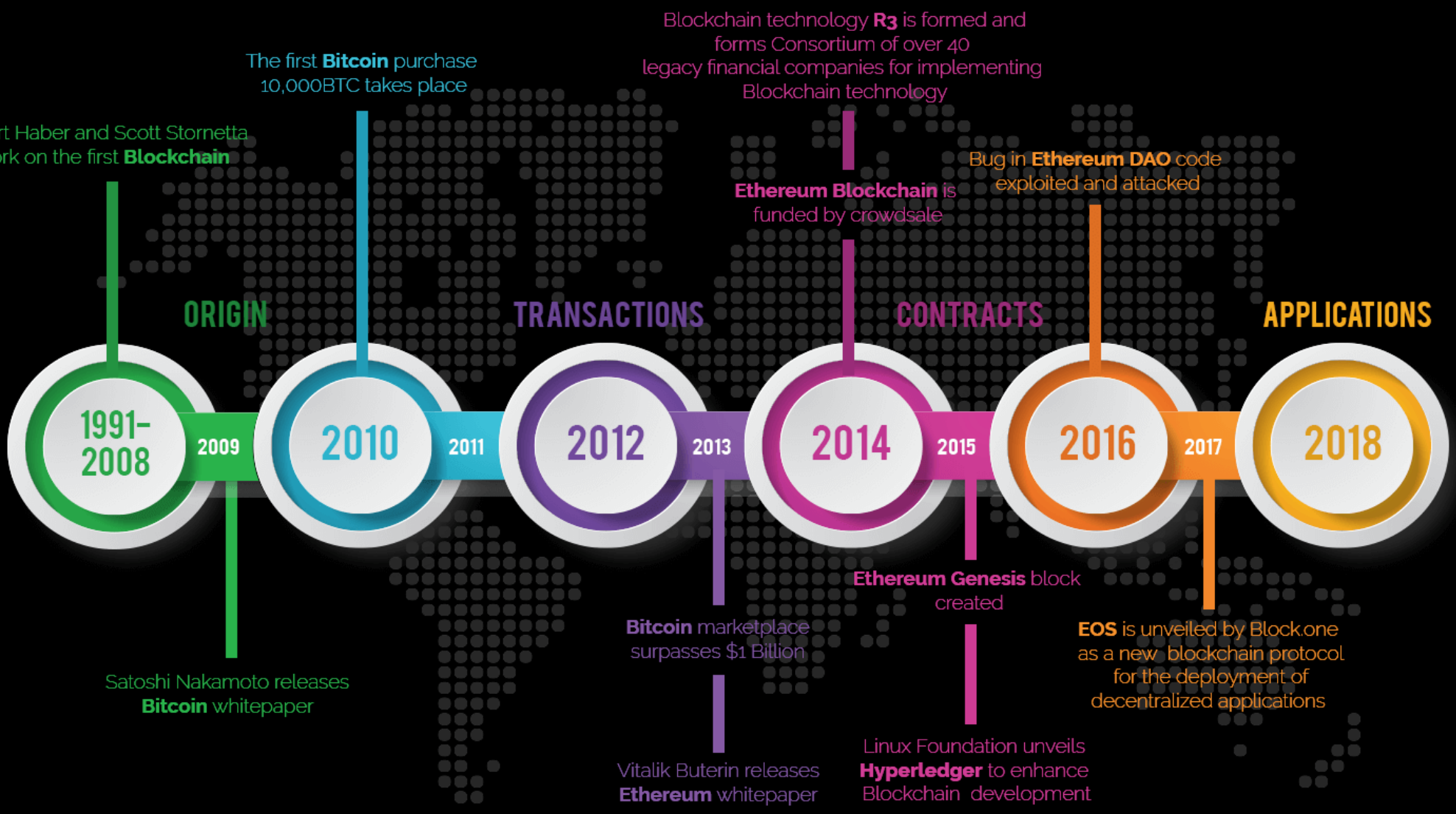
Blockchain History

101 Blockchains

THE HISTORY OF BLOCKCHAIN TECHNOLOGY



Created by 101blockchains.com

Blockchain History – Early Stage

- **1991**, cryptographer **Stuart Haber and W. Scott Stornetta** co-wrote a paper called "*How to Time-Stamp a Digital Document*", where they try to use a cryptographically secured chain of blocks to secure documents.
- **1992**, incorporate Merkle trees data structure
- **1995**, founded a company called Surety, the world's oldest running blockchain, uses the *New York Times* as timestamp!

Reading: https://www.vice.com/en_us/article/j5nzx4/what-was-the-first-blockchain

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Blockchain History – Early Stage

NOTICES & LOST AND FOUND
(5100-5102)

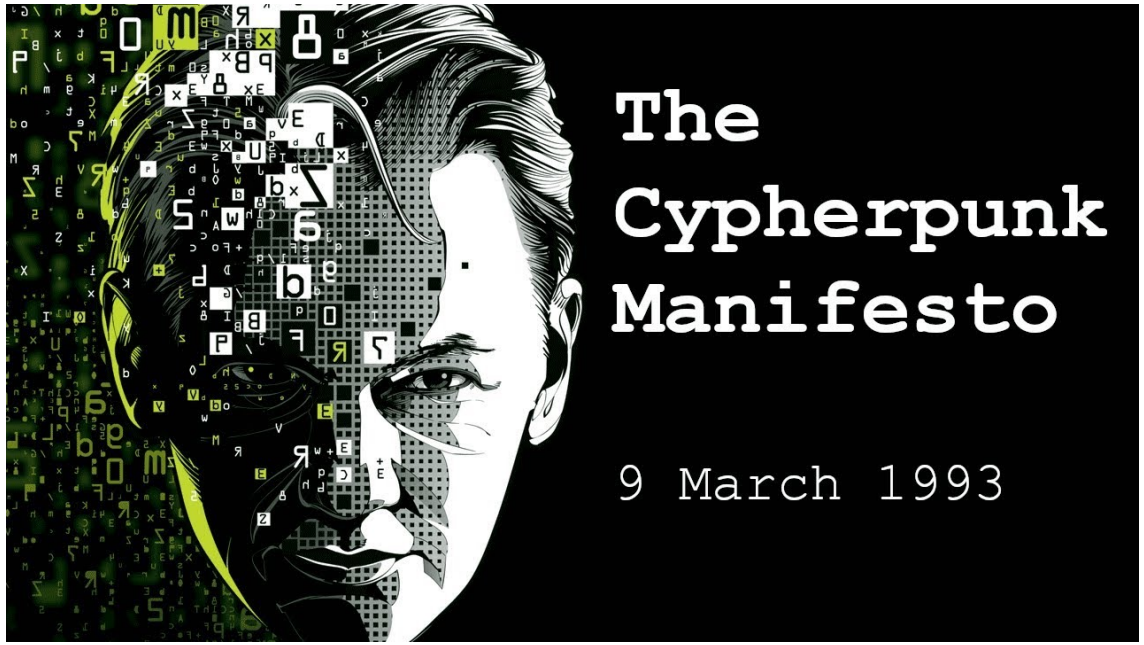
Universal Registry Entries:
Zone 2 -
dS8492cgVOFAoP9kvE1XzMOrQ
HgEwzkVbVafNvIkUz99qvq8/ME
p5v9EFSG8XxzMBaIGQQ==
Zone 3 -
JnFCg+HCmvhj8GmmUP7VZna71
NgZup/RfuKUQNzCHWXMuqLK
durxHQV5pSHLqBGPRIv+mg==
These base64-encoded values represent the combined fingerprints of all digital records notarized by Surety between 2009-06-03Z 2009-06-09Z.
www.surety.com 571-748-5800

Source: https://www.vice.com/en_us/article/j5nzx4/what-was-the-first-blockchain

Blockchain History – Cypherpunk

- **A Cypherpunk's Manifesto by Eric Hughes**

"Privacy is necessary for an open society in the electronic age. **Privacy is not secrecy**. A private matter is something one doesn't want the whole world to know, but a secret matter is something one doesn't want anybody to know. **Privacy is the power to selectively reveal oneself to the world.** … "



Img: https://www.youtube.com/watch?v=Fe6GJu2LMGU&app=desktop; source: https://www.activism.net/cypherpunk/manifesto.html;

Source: https://freedomnode.com/blog/66/21-wise-and-funny-bitcoin-quotes-by-satoshi-nakamoto

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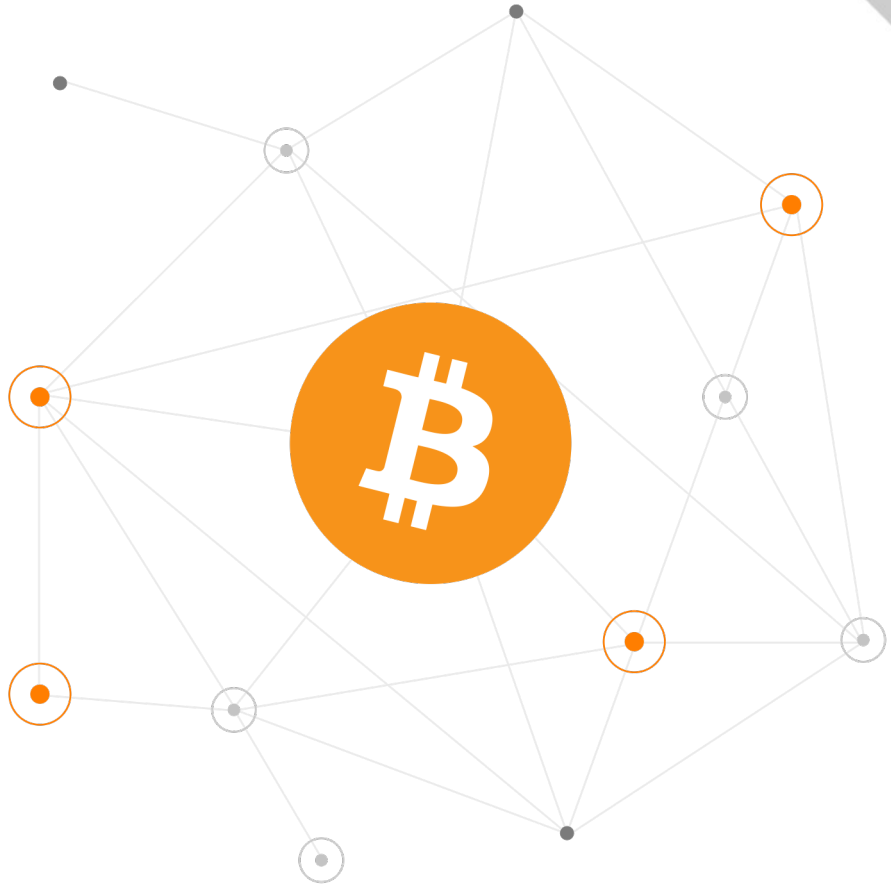
What is Bitcoin?

The First Peer-to-Peer Cryptocurrency

- Bitcoin = bit + coin
  = data + monetary value
- "Bitcoin(฿) is a cryptocurrency. It is a decentralized digital currency without a central bank or single administrator that can be sent from user to user on the peer-to-peer bitcoin network without the need for intermediaries. " - Wikipedia



Source: https://en.wikipedia.org/wiki/Bitcoin Img: https://bitcoin.org/en/;

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Blockchain History – Bitcoin

Just Another Email

Cryptography Mailing List

Bitcoin P2P e-cash paper

2008-10-31 18:10:00 UTC - Original Email - View in Thread

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

Source: https://satoshi.nakamotoinstitute.org/emails/

Blockchain History – Bitcoin

- **August 2008**, domain name bitcoin.org was registered
- **October 2008**, a paper titled "*Bitcoin: A Peer-to-Peer Electronic Cash System*" was published by the name **Satoshi Nakamoto**
- **January 2009**, Satoshi mined the genesis block of the bitcoin blockchain (block number 0), with a reward of 50 bitcoins

Bitcoin: A Peer-to-Peer Electronic Cash System

Satoshi Nakamoto
satoshin@gmx.com
www.bitcoin.org

Abstract. A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.

Source: Bitcoin white paper, https://bitcoin.org/bitcoin.pdf

Source: The Face Behind Bitcoin, Newsweek, https://www.newsweek.com/2014/03/14/face-behind-bitcoin-247957.html

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Bitcoin Creator

- **Satoshi Nakamoto**, a pseudonym!
- Several potential suspects:
  - Hal Finny (Bitcoin network's first transaction recipient)
  - NSA (US National Security Agency)
  - Dorian Nakamoto (a Japanese American computer engineer, whose birth name is Satoshi Nakamoto)
  - Craig Wright (self-claim to be Satoshi)
  - Nick Szabo (proposed the idea of smart contract)
  - …
- no one knows for sure and it'll likely remain this way

Reading: https://www.investopedia.com/tech/three-people-who-were-supposedly-bitcoin-founder-satoshi-nakamoto/
https://en.wikipedia.org/wiki/Satoshi_Nakamoto#Dorian_Nakamoto;

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Blockchain History – Bitcoin

- **January 2009**, first bitcoin transaction (Satoshi to **Hal Finney**)
- **May 2010**, $25 worth of pizza for 10,000 BTC, purchased by **Laszlo Hanyecz** (Bitcoin has real value!)

Source: https://amp.businessinsider.com/bitcoin-pizza-10000-100-million-2017-11

Blockchain History – Bitcoin

- **Oct 2, 2020**, 10,000 BTC = 105,431,000 USD

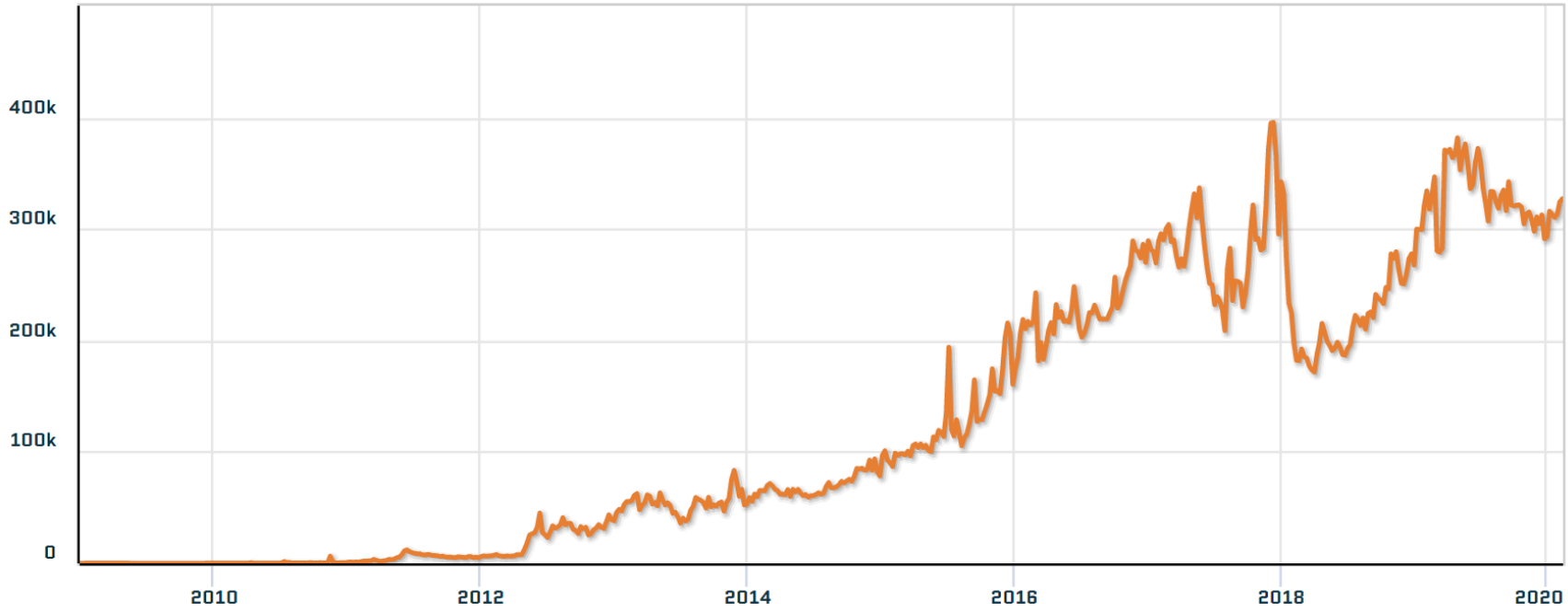
Source: https://coinivore.com/2018/05/22/happy-bitcoin-pizza-day-8-years-ago-today-someone-spent-82-million-on-two-pizzas/

Blockchain History – Bitcoin

- Oct 2, 2020, 17:04 US ET
1 BTC = 10,541.29 USD

Source: Coinbase, https://www.coinbase.com/price/bitcoin

Blockchain History – Bitcoin



- Number of Bitcoin transactions over the years

Source: https://www.quandl.com/data/BCHAIN/NTRAN-Bitcoin-Number-of-Transactions

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Blockchain History – Bitcoin

Mt.Gox – the Centralized Exchange for Decentralized Bitcoin

- **July 2010**, **Mt. Gox** was launched by **Jed McCaleb**, the biggest online Bitcoin exchange platform
- **June 2011**, suffered a significant security breach which allow the hacker to change the Bitcoin pricing to a single cent
- **End of 2013**, handled over **70%** of all Bitcoin (BTC) transactions worldwide

Source: https://en.wikipedia.org/wiki/Mt._Gox
Reading: https://www.coindesk.com/2-billion-lost-in-mt-gox-bitcoin-hack-can-be-recovered-lawyer-claims

Blockchain History – Bitcoin

Mt.Gox

- **February 2014**, **Mt. Gox** was hacked and filed for bankruptcy
- **Mt. Gox** lost about 850,000 bitcoins, (750,000 belonged to its customers) valued more than $450 million, at the time and $8.5 billion today

Source: https://en.wikipedia.org/wiki/Mt._Gox; https://www.theverge.com/2014/2/19/5425220/protest-at-mt-gox-bitcoin-exchange-in-tokyo
Reading: https://www.coindesk.com/2-billion-lost-in-mt-gox-bitcoin-hack-can-be-recovered-lawyer-claims
https://www.ledger.com/hack-flasback-the-mt-gox-hack-the-most-iconic-exchange-hack/

Blockchain History – Bitcoin

Mt.Gox

- 200,000 bitcoins were eventually recovered, the remaining 650,000 (3.7% of Bitcoin's circulating supply) have never been recovered
- The victims of the **Mt.Gox** hack have not seen a Satoshi of their Bitcoins returned to this day
- The Bitcoin price **drop to nearly 50%** of its value prior to the hack. It took till the end of 2016 to return to the same value

Source: https://www.ledger.com/hack-flasback-the-mt-gox-hack-the-most-iconic-exchange-hack/
Reading: https://www.coindesk.com/2-billion-lost-in-mt-gox-bitcoin-hack-can-be-recovered-lawyer-claims

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Blockchain History – Bitcoin

Silk Road – Bitcoin's Anonymity is Perfect for Illegal Activities

- **February 2011**, **Ross Ulbricht** used **Tor**(anonymous communication) and **Bitcoin**(anonymous transaction) to create an online black market for drugs
- http://tydgccykixpbu6uz.onion
- February 2012, **Ross Ulbricht** called himself Dread Pirate Roberts

Source: https://www.zdnet.com/article/after-silk-road-seizure-fbi-bitcoin-wallet-identified-and-pranked/
Reading: https://news.law.fordham.edu/jcfl/2018/02/21/silk-road-the-dark-side-of-cryptocurrency/

Source: for full picture go to https://www.businessinsider.com/silk-road-history-2013-10/, http://www.drugabuse.com/featured/silk-road

Blockchain History – Bitcoin

Silk Road – the Downfall

- **October 2013**, FBI arrested Ross Ulbricht and shut down the website
- **May 2015**, Ross sentenced To double life imprisonment without the possibility of parole
- **October 2015**, two agents involved with the case charged with corruption
- **Silk Road 2.0** shut down by FBI and Europol on 6 November 2014
- **Silk Road 3.0** went offline in 2017 due to loss of funds

Source: https://en.wikipedia.org/wiki/Silk_Road_(marketplace)#Book_club; https://www.ranker.com/list/silk-road-dark-web-timeline/quinn-armstrong

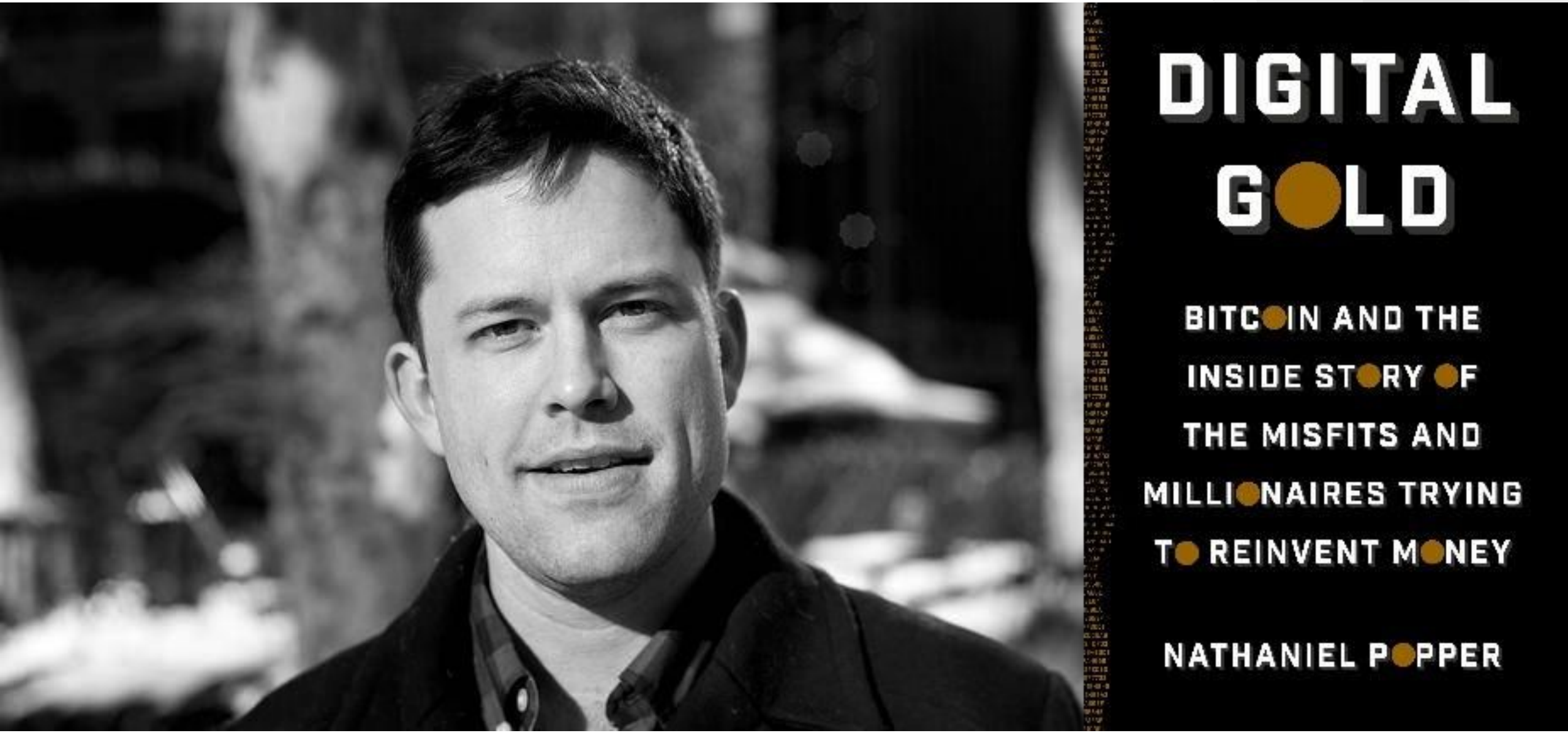
WIRED The Untold Story of Silk Road, Part 1

SUBSCRIBE

Reading: https://www.wired.com/2015/04/silk-road-1/

More on Silk Road

- Forbes, 2019, *"Best Stories Of The Decade: 'Meet The Dread Pirate Roberts, The Man Behind Booming Black Market Drug Website Silk Road'"*,
- Newsweek, 2015, *"The Rise and Fall of Silk Road, the Dark Web's Amazon"*,



Source: https://www.forbes.com/sites/laurashin/2015/05/19/what-bitcoins-history-means-for-its-future-qa-with-nathaniel-popper-author-of-digital-gold/#4d050c1f3916

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Blockchain History – Ethereum

What is Ethereum?

- **Ethereum** is a public blockchain-based distributed computing platform featuring **smart contract**
  - Ethereum VM, decentralized *Turing-complete* virtual machine for executing scripts
  - "ether", cryptocurrency token
  - "gas", a priced resource for computation

ethereum

Source: https://en.bitcoinwiki.org/wiki/Ethereum; https://en.wikipedia.org/wiki/Ethereum;

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Blockchain History – Ethereum

Ethereum: the World Computer

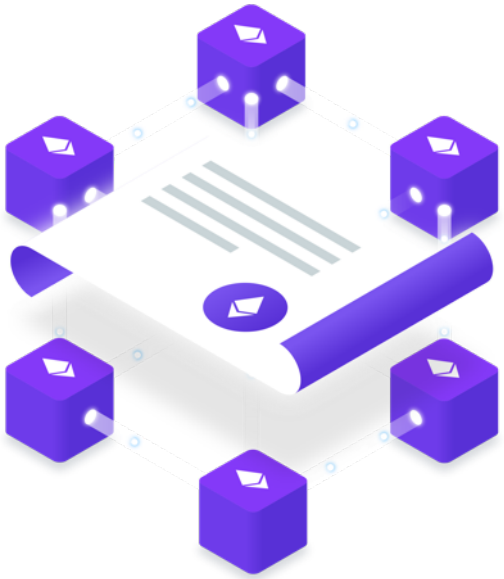
ethereum

Source: https://www.youtube.com/watch?v=j23HnORQXvs

Blockchain History – Ethereum

Smart Contract

- A **smart contract** is a self-executing contract with the terms of the agreement between buyer and seller being directly written into lines of code
- The code is stored on and exist across a distributed, decentralized blockchain network
- first proposed in 1994 by **Nick Szabo** (invented “Bit Gold" in 1998)



Source: https://www.investopedia.com/terms/s/smart-contracts.asp
https://www.pulsehyip.com/smart-contracts-development; https://www.originprotocol.com/en/product

Blockchain History – Ethereum

Ethereum History – The Beginning

- **November 2013**, **Vitalik Buterin** published the Ethereum whitepaper
- **June 2014**, Ethereum foundation founded
- **July & August 2014**, Ethereum crowdsale, future users and investors allowed to purchase Ether in exchange for Bitcoin, 11.9 million Ethereum tokens were sold (about 13% of the circulating supply), raising about 18.4 million USD

Source:
https://www.coinmama.com/guide/history-of-ethereum ;
https://www.cnbc.com/2018/02/19/ethereum-creator-vitalik-buterin-warns-about-cryptocurrency-investment.html

Blockchain History – Ethereum

Ethereum History

- **July 2015**, Ethereum blockchain launched
- **May 2016**, Value of Ethereum tokens worth more than $1 billion
- **July 2016**, the Dao hack

Source: Blockchain@Berkeley Fundamental Decal Fall 2018 Lecture 2: https://blockchain.berkeley.edu/courses/fall-2018-fundamentals-decal/; https://www.coinmama.com/guide/history-of-Ethereum; https://www.preethikasireddy.com/post/how-does-ethereum-work-anyway

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Blockchain History – Ethereum

The Dao Hack

- **Dao**(Decentralized autonomous organization)
  - a complicated smart contract that allows any app idea to be voted on by token holders
  - **"The DAO"** was a specific DAO created on the Ethereum blockchain, raised over 150 million USD with crowdsale
  - **June 2016**, an unknown attacker exploited the vulnerability and withdrew 50 million USD in Ether from the smart contract (roughly 15% of all Ether at the time)

Source: https://www.coinmama.com/guide/history-of-ethereum

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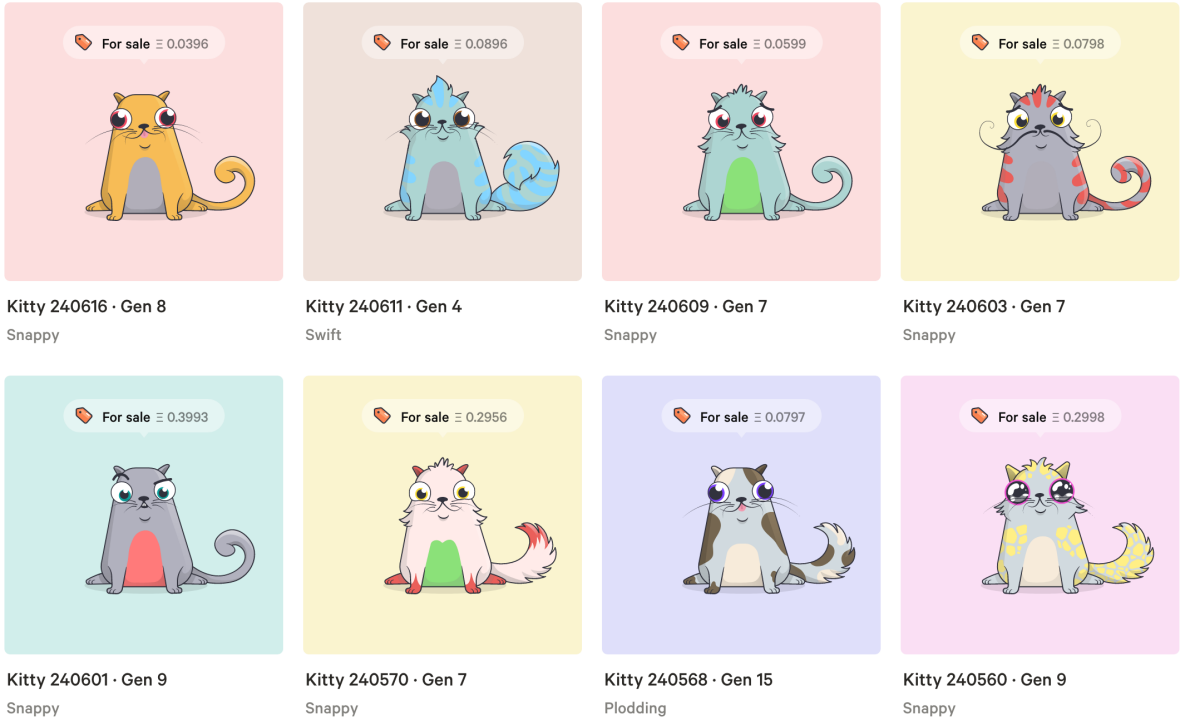
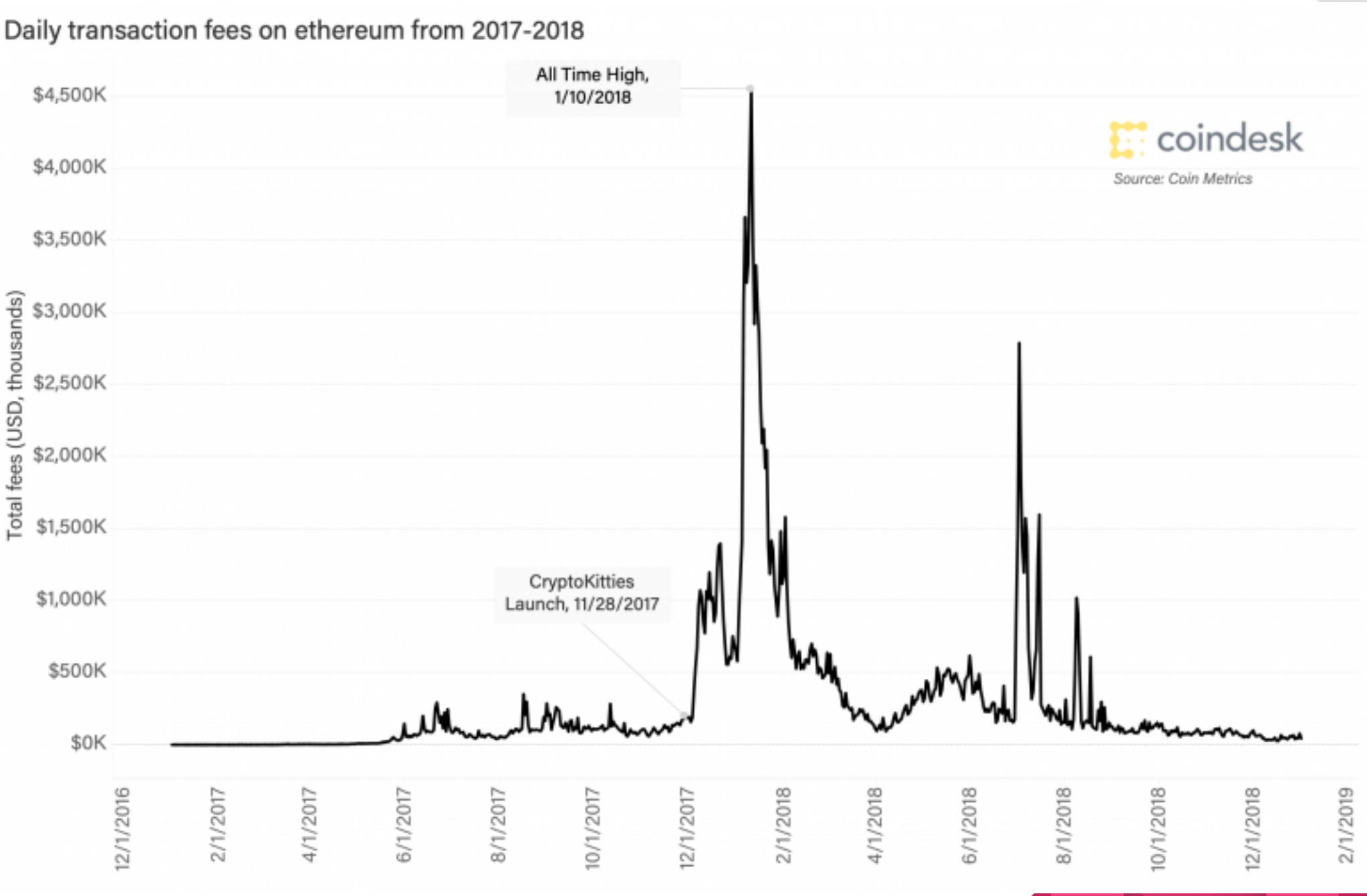
Blockchain History – Ethereum

CryptoKitties

- **CryptoKitties**
  - https://www.cryptokitties.co/
  - A blockchain application built on Ethereum
  - Launched November 28, 2017
  - “CryptoKitties is a game centered around breedable, collectible, and oh-so-adorable creatures we call CryptoKitties! Each cat is one-of-a-kind and 100% owned by you; it cannot be replicated, taken away, or destroyed.”



Img: https://medium.com/@gmcmullen/do-you-really-own-your-cryptokitties-d2731d3491a9;

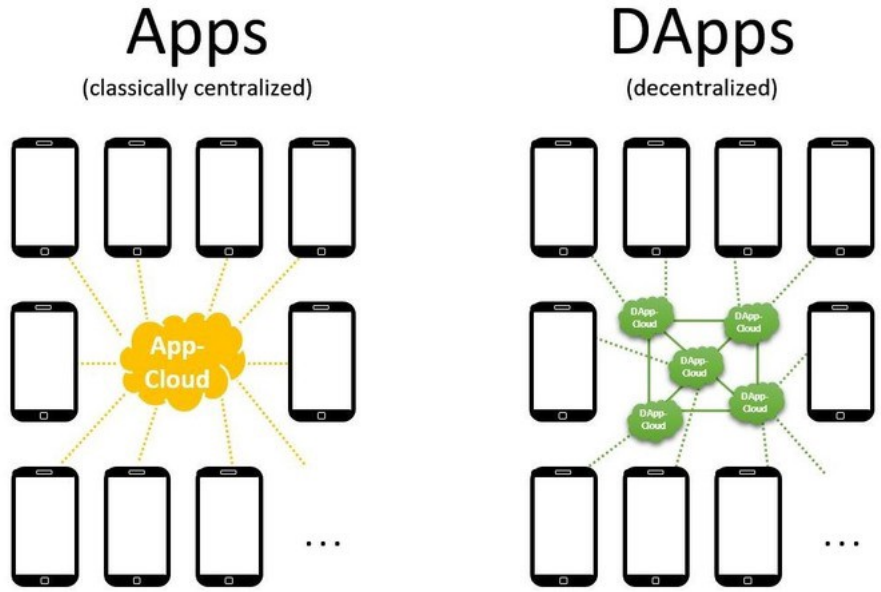


Img: https://www.coindesk.com/ethereum-history-in-5-charts;

Blockchain History – Ethereum

DApps

- **Dapps (Decentralized Applications)**
  - Ethereum becomes the go-to platform for creating dapps



Img: https://medium.com/dexon/002-dapp-do-we-really-need-it-programmer-explain-ca4d45912074;

Blockchain History – Ethereum

- Oct 2, 2020, 17:06 US ET

1 ETH = 346.30 USD

Source: https://www.coinbase.com/price/ethereum

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Blockchain History

Bitcoin vs. Ethereum

	bitcoin	ethereum
concept	digital money	smart contracts
transaction	send from alice to bob	send from alice to bob if.. • date = jan 1, 2018 • bob's balance < 10 eth
market cap (as of feb 2017)	~$18 billion	~$1 billion
founder	satoshi nakamoto (unknown)	vitalik buterin and team
release date	jan 2009	july 2015

Source: https://blog.coinbase.com/a-beginners-guide-to-ethereum-46dd486ceecf

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What is Blockchain?

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Blockchain Definition

Blockchain = Block + Chain

"Blockchain is a data structure that's secure (tamper-resistant) by the nature of cryptography and a decentralized database by giving a network of users each a copy of the data and the possible ability to modify those data and a trustless system/distributed network by allowing users to constantly check on one another to reach a single consensus."

- Samuel Tang

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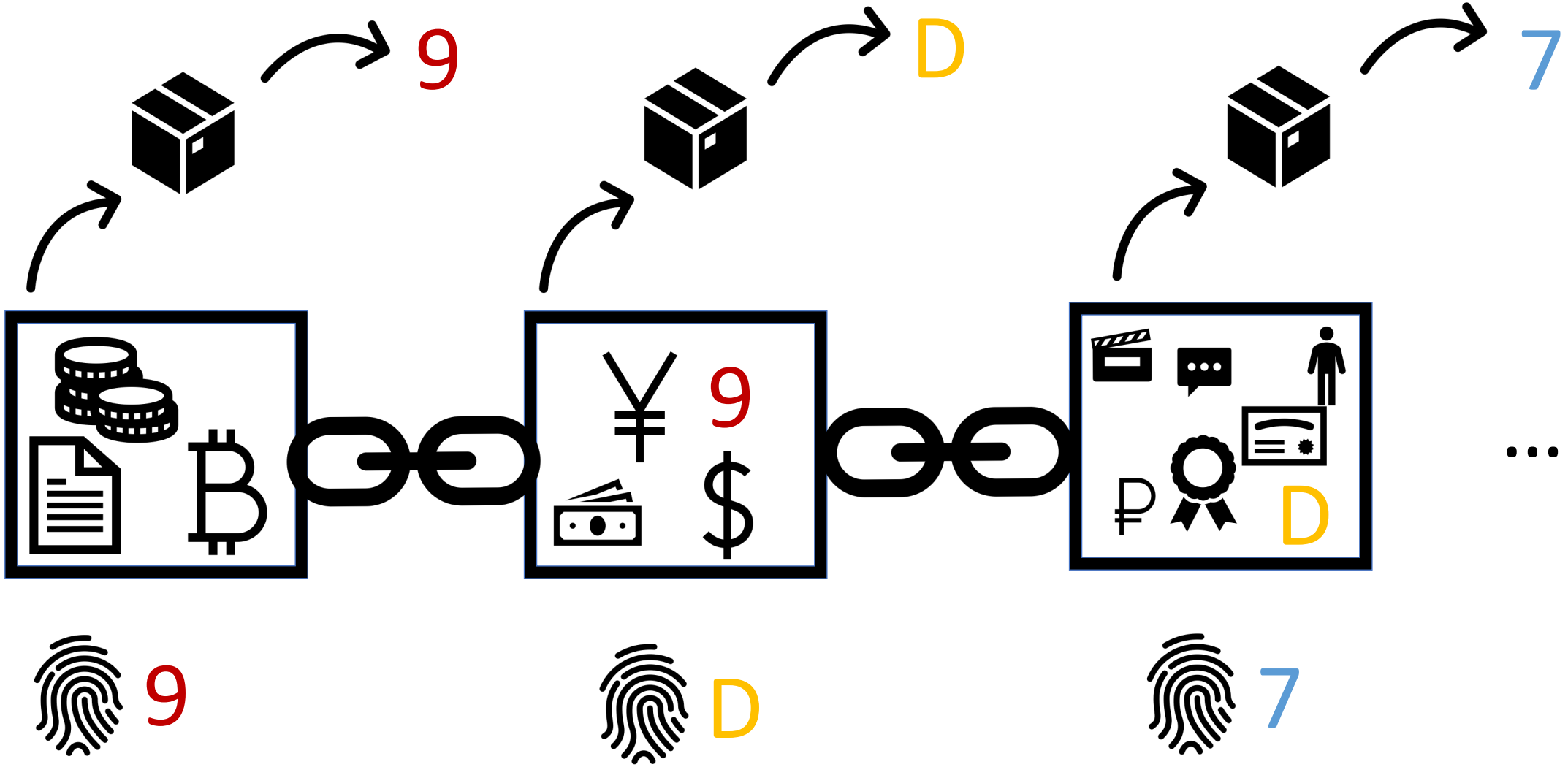

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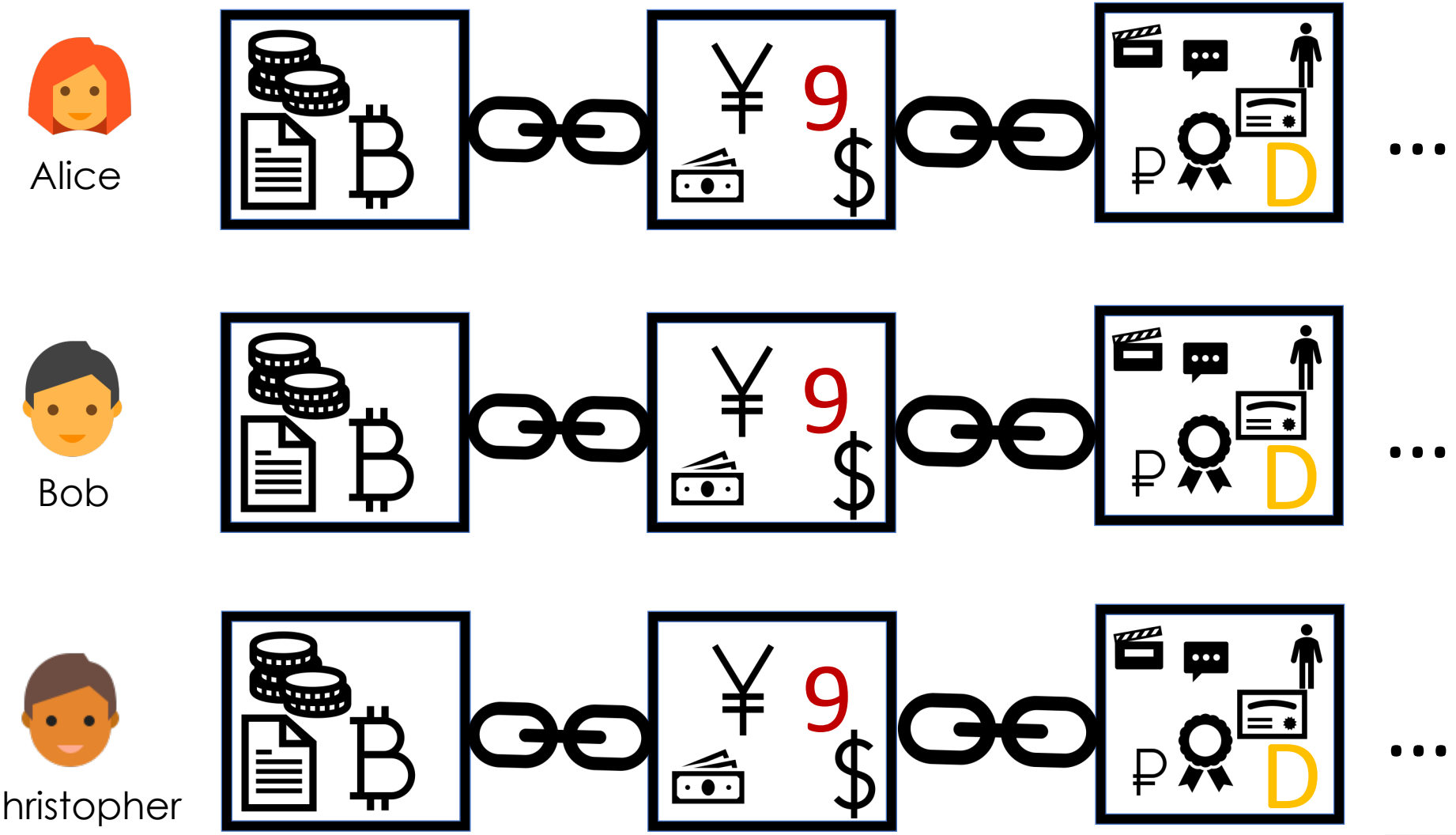
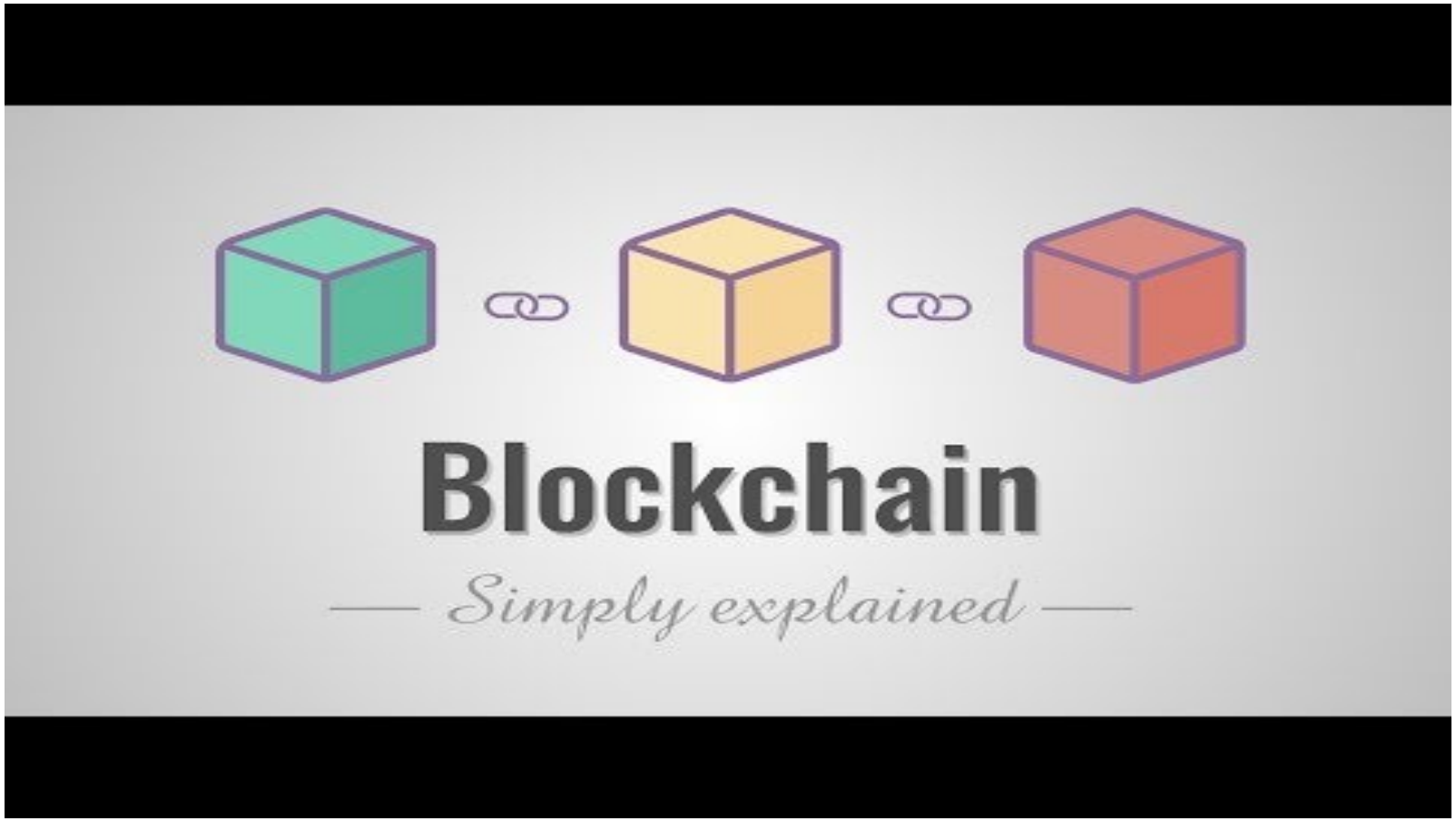


Blockchain Definition

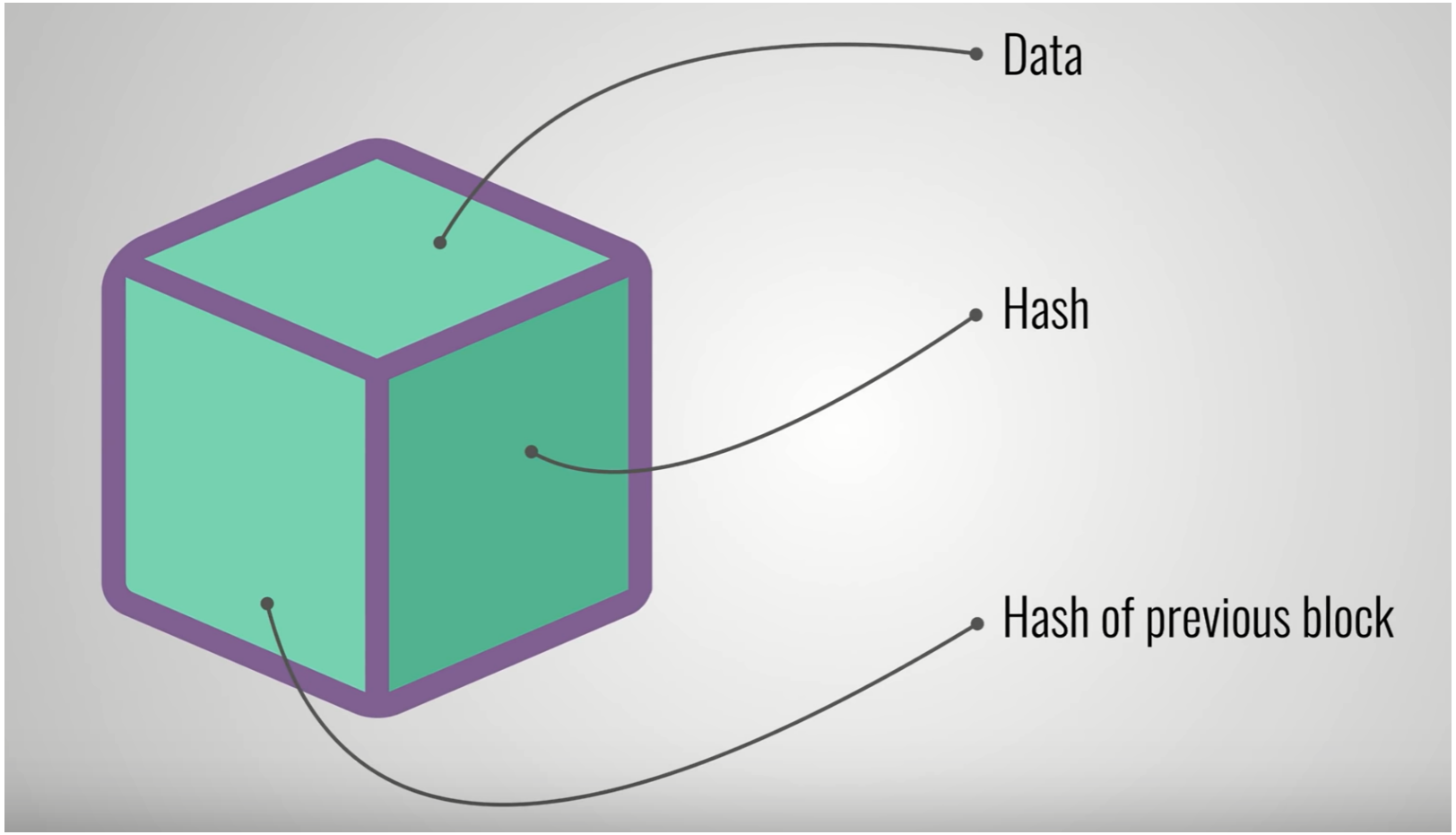


By:

Simply Explained - Savjee
158K subscribers

Source: Simply Explained – Savjee, Youtube
https://www.youtube.com/watch?v=SSo_EIwHSd4

Blockchain Definition Data Storage



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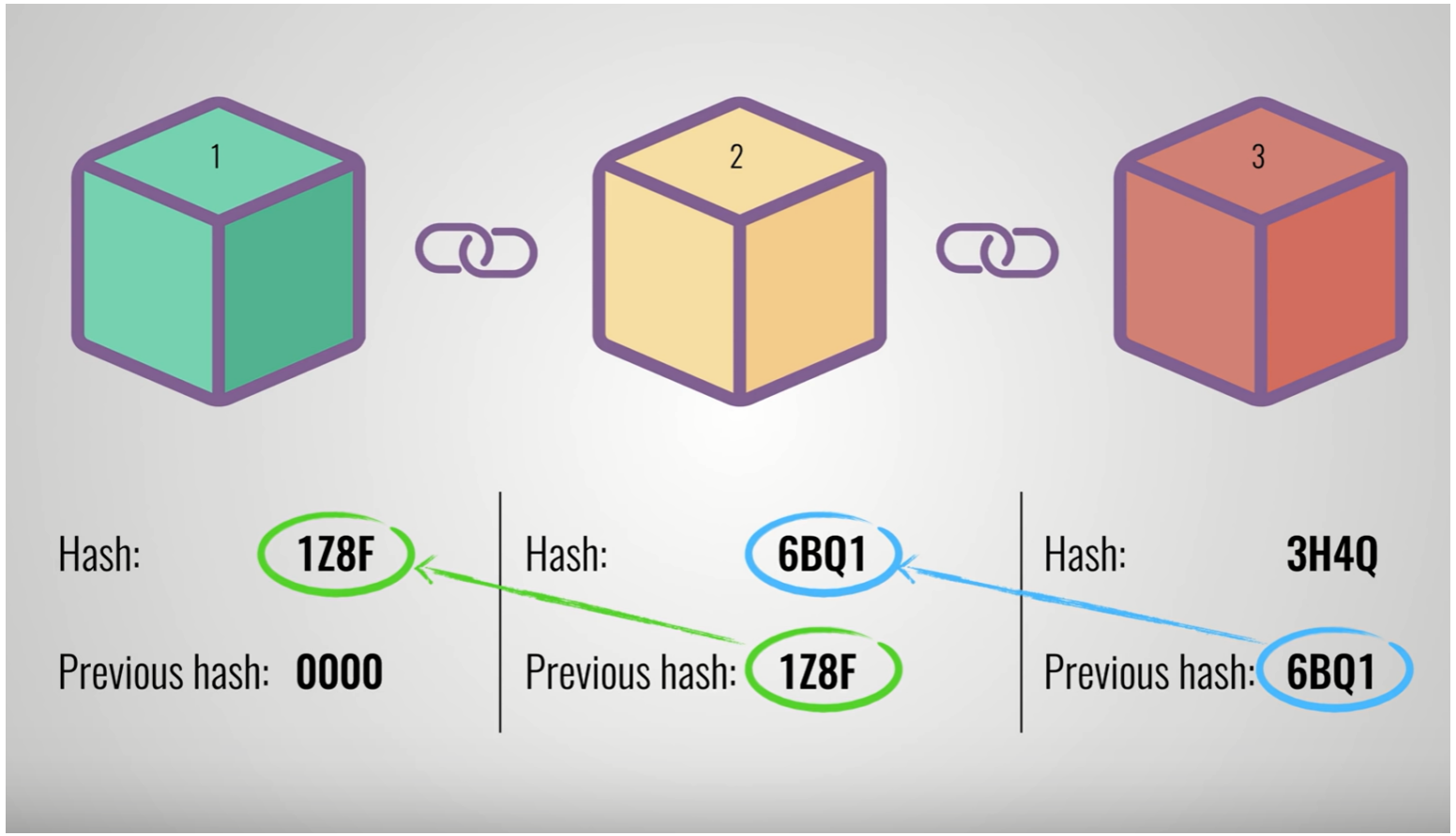
Source: Simply Explained – Savjee, Youtube, https://www.youtube.com/watch?v=SSo_EIwHSd4

Blockchain Definition Chain of Blocks



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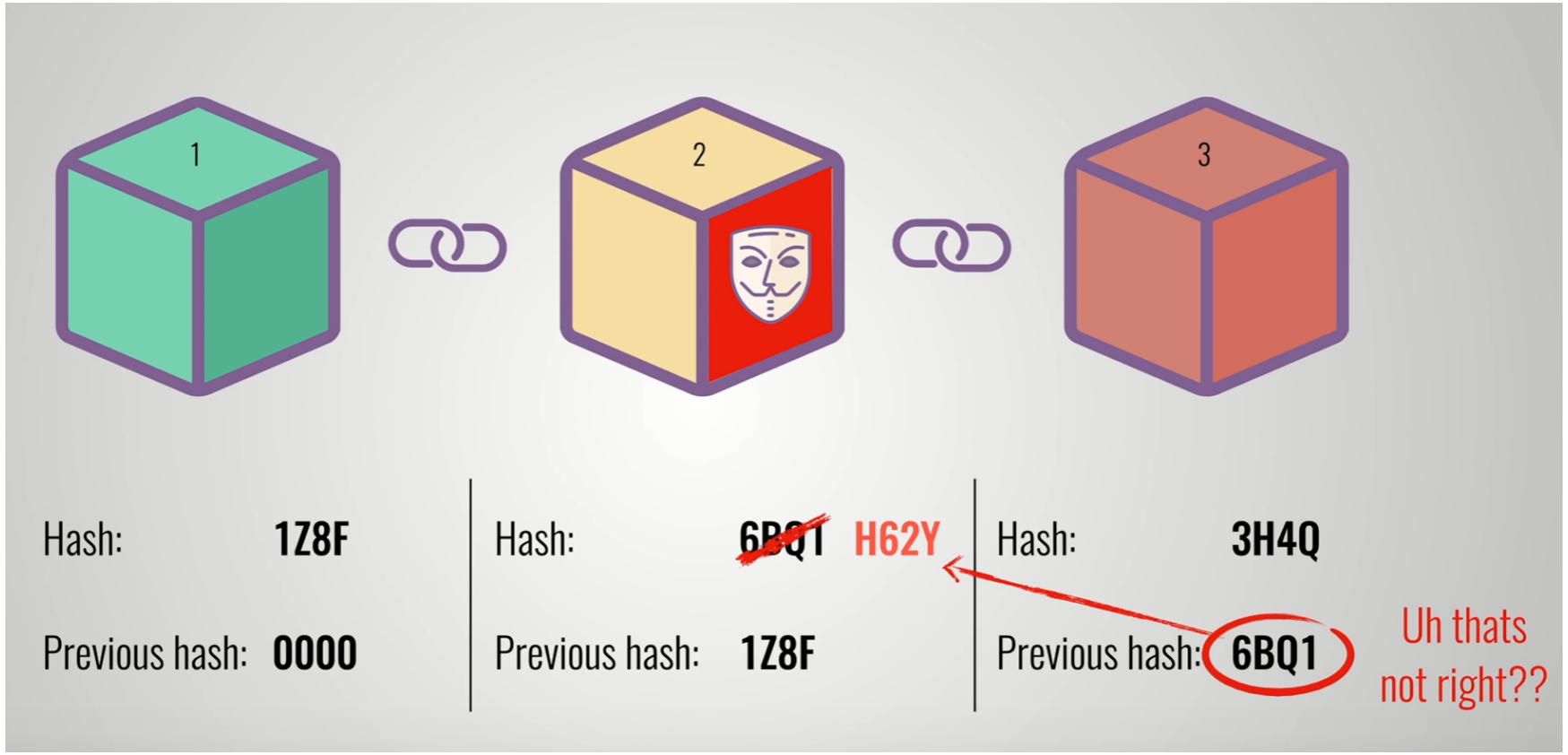
Blockchain Definition Tamper-Resistant



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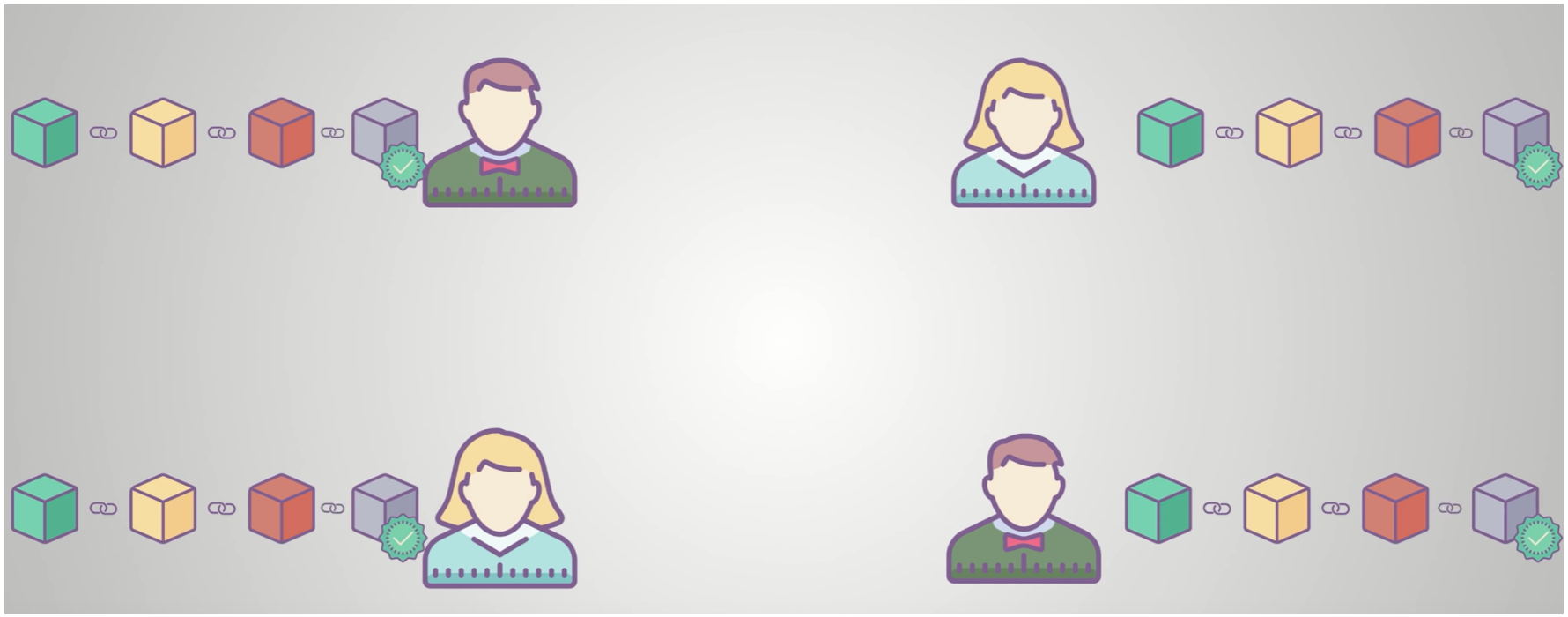
Source: Simply Explained – Savjee, Youtube, https://www.youtube.com/watch?v=SSo_EIwHSd4

Blockchain Definition Distributed/Decentralized



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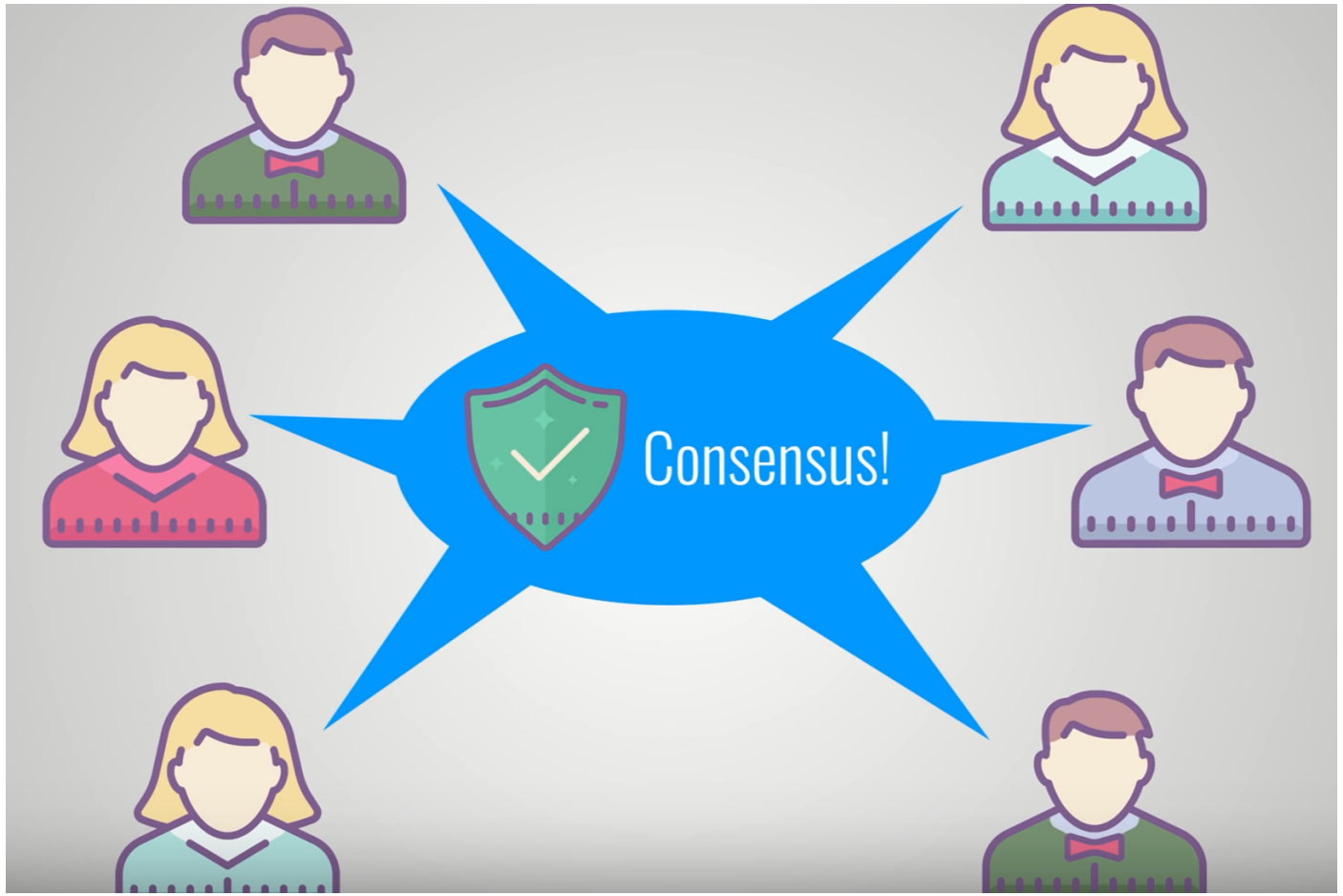
Source: Simply Explained – Savjee, Youtube, https://www.youtube.com/watch?v=SSo_EIwHSd4

Blockchain Definition Consensus



By:

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Source: Simply Explained – Savjee, Youtube, https://www.youtube.com/watch?v=SSo_EIwHSd4

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Blockchain Definition

Core Idea:
Blockchain == an immutable ledger of data without relying on a central authority

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Still, many questions remain:

- What are those magical boxes? 
- How do we reach consensus on the state of the blockchain?
  - which block to keep, which to discard?
- Who would want to store the entire blockchain?
  - Who gets to make new blocks?
  - Who verifies the correctness of the data?
- What data to put inside a block?
  - Transparent while private?
- What applications?

Blockchain Definition

Additional Material:

- Blockchain Explained, Investopedia,
- Understand the Blockchain in Two Minutes, YouTube,
- ‘Blockchain’ is Meaningless, The Verge,
- A simple explanation of how blockchain works, Medium,
- What is blockchain technology?, IBM

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Blockchain Applications

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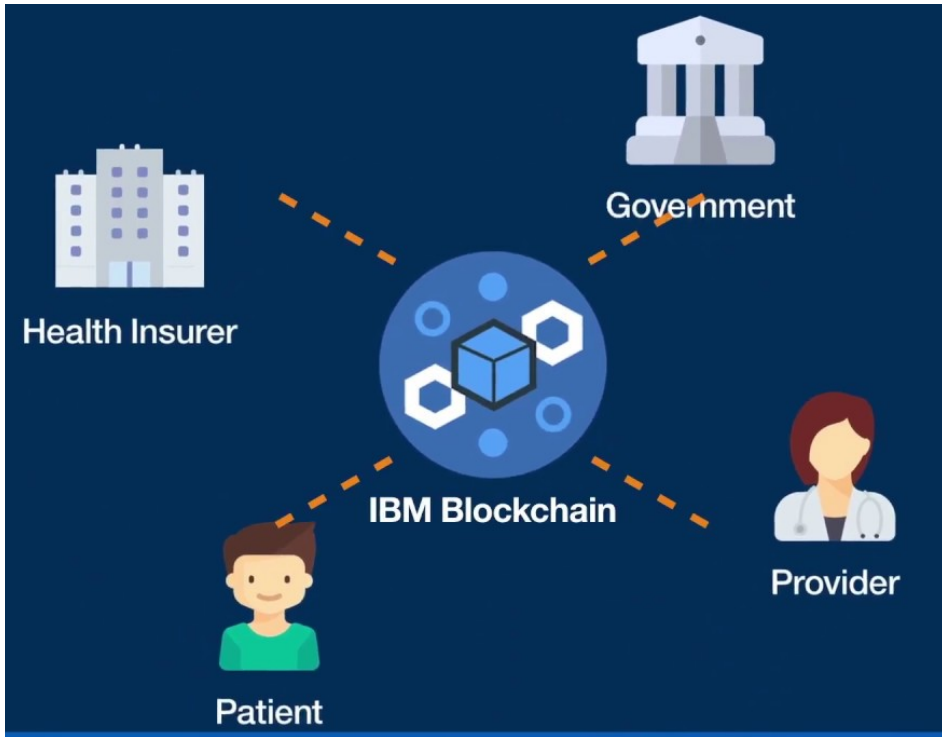
Blockchain Applications

Potential Applications

- **Cryptocurrency**
  - Bitcoin
  - Ethereum
  - …
- **Healthcare**
  - patients assign access rules for their medical data
  - same record for all parties
- **Government**
  - secure online voting system



Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6517629/

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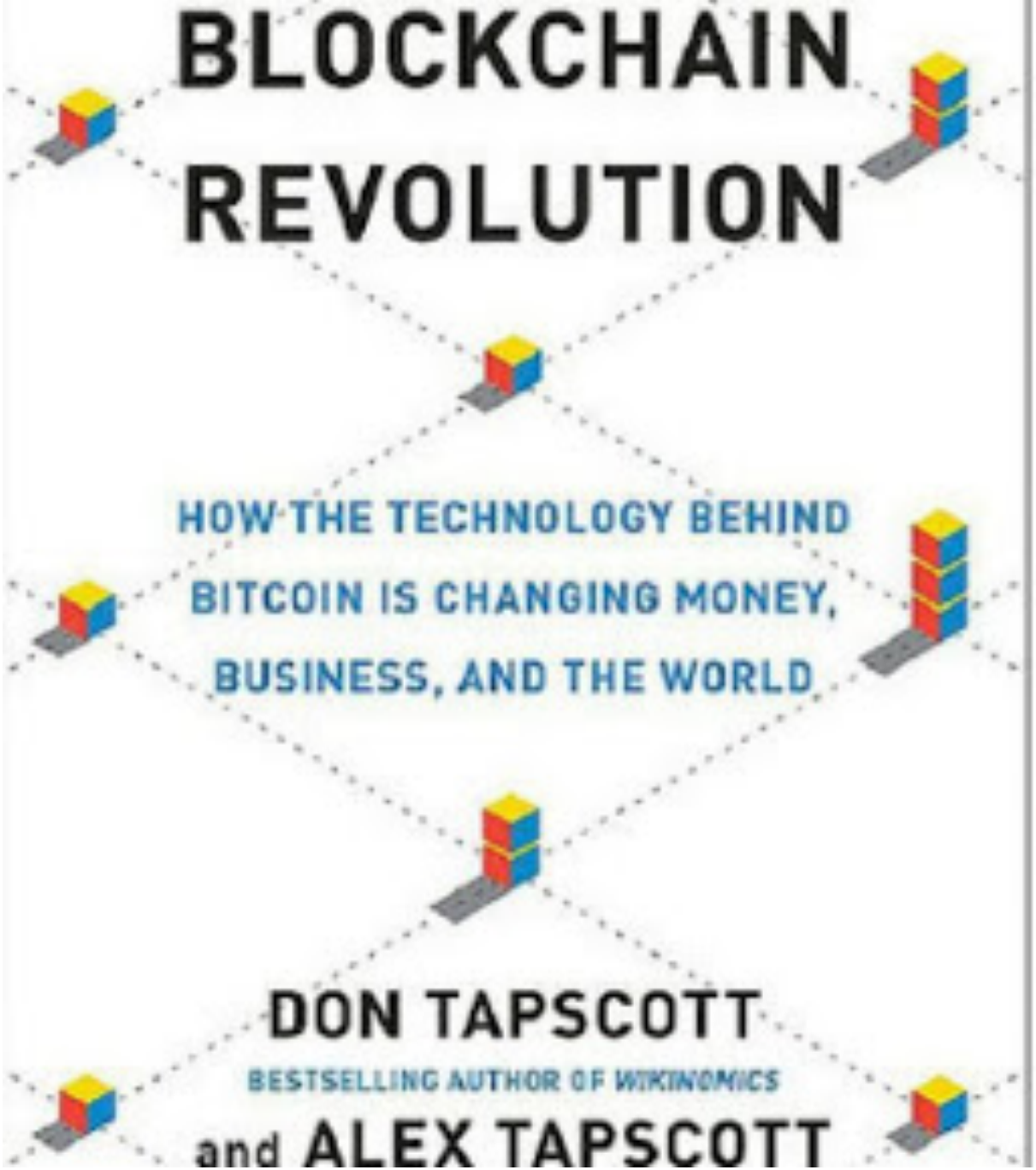
Blockchain Applications

Potential Applications

- **Music**
  - musicians to receive equitable royalty payments
- **Insurance**
  - improved transparency
- **Digital identification**
  - more secure management & storage of digital identities with tamper-proof infrastructure
- **Supply chain**
  - IBM Food Trust – used by Walmart to trace lettuce
- and many more…

Source: https://builtin.com/blockchain/blockchain-music-innovation-examples
https://consensys.net/blockchain-use-cases/digital-identity/



Source: http://www.alextapscott.com/in-the-press/blockchain-revolution-excerpt-don-alex-tapscotts-upcoming-book/

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Homework Assignments

- Vinay Gupta - the Promise of the Blockchain
- How does a blockchain work - Simply Explained
- Blockchain Expert Explains One Concept in 5 Levels of Difficulty | WIRED
- [optional]You Might Have Missed it, but Blockchain is Now Mainstream
- [optional] How the blockchain is changing money and business | Don Tapscott
- [optional] What the heck is Blockchain?

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Questions?

TIBA

Introduction
to
Blockchain
by
Samuel Tang

Thank you for listening!
See you next week!

TIBA

Discussion

1. Introduce yourself
2. Why do you want to learn blockchain?
3. What are some applications of blockchain that you're excited about?