CENG 3550 Decentralized Systems and Applications Lecture Slides

Section 1- Understanding Cryptography and Cryptocurrency

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MvRG - Metaverse Research Group

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29 Eylül 2024

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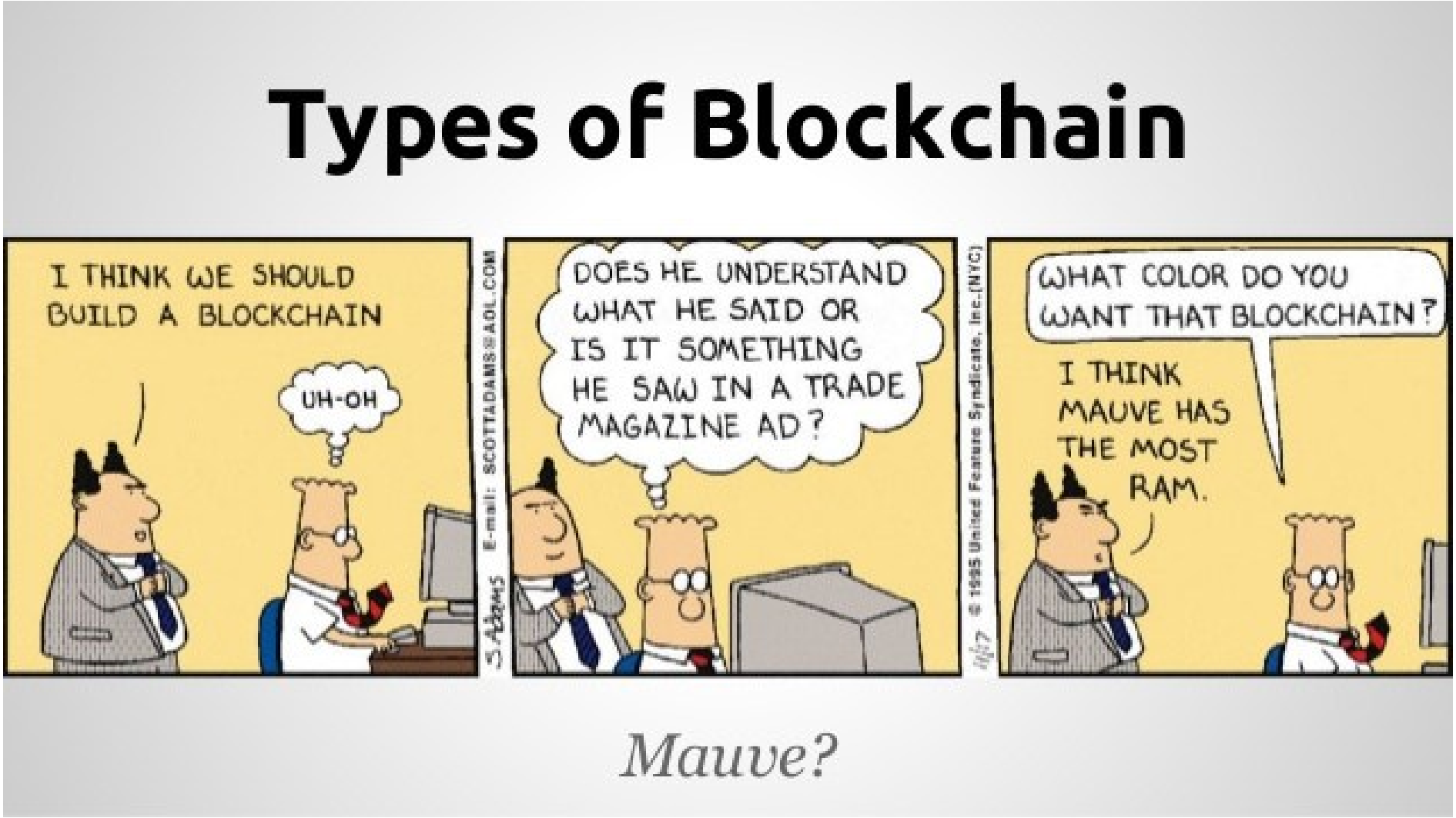
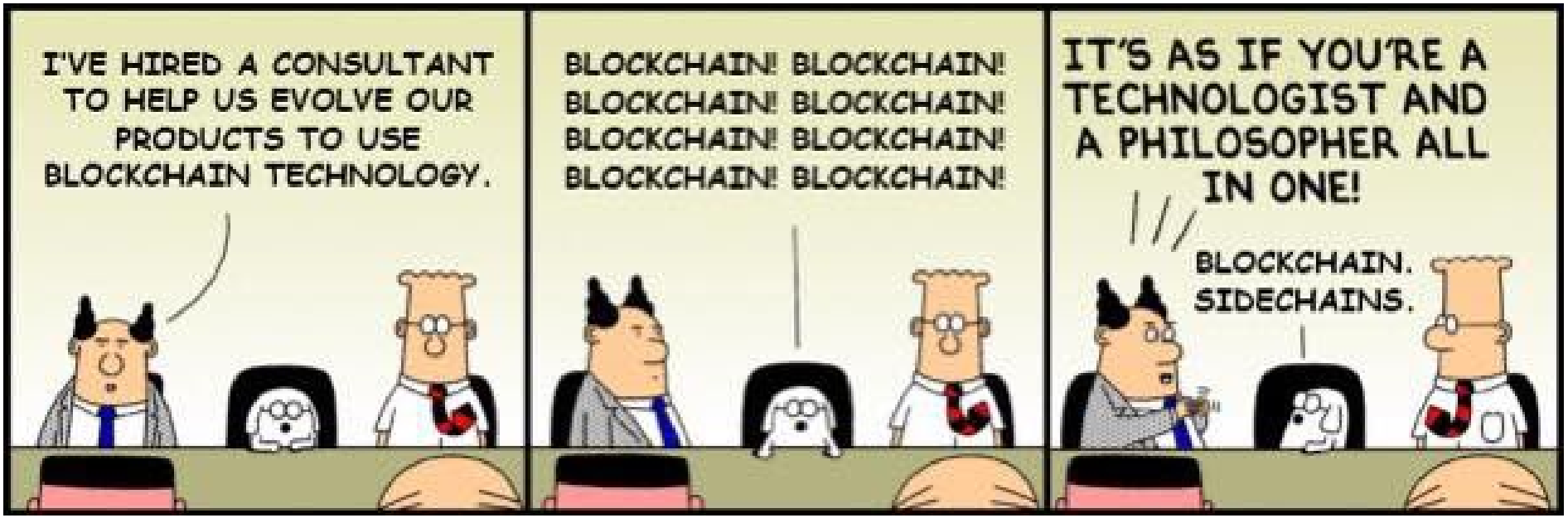
Introduction

We Should Build a Blockchain Project :)



and everywhere is full of blockchain experts :)



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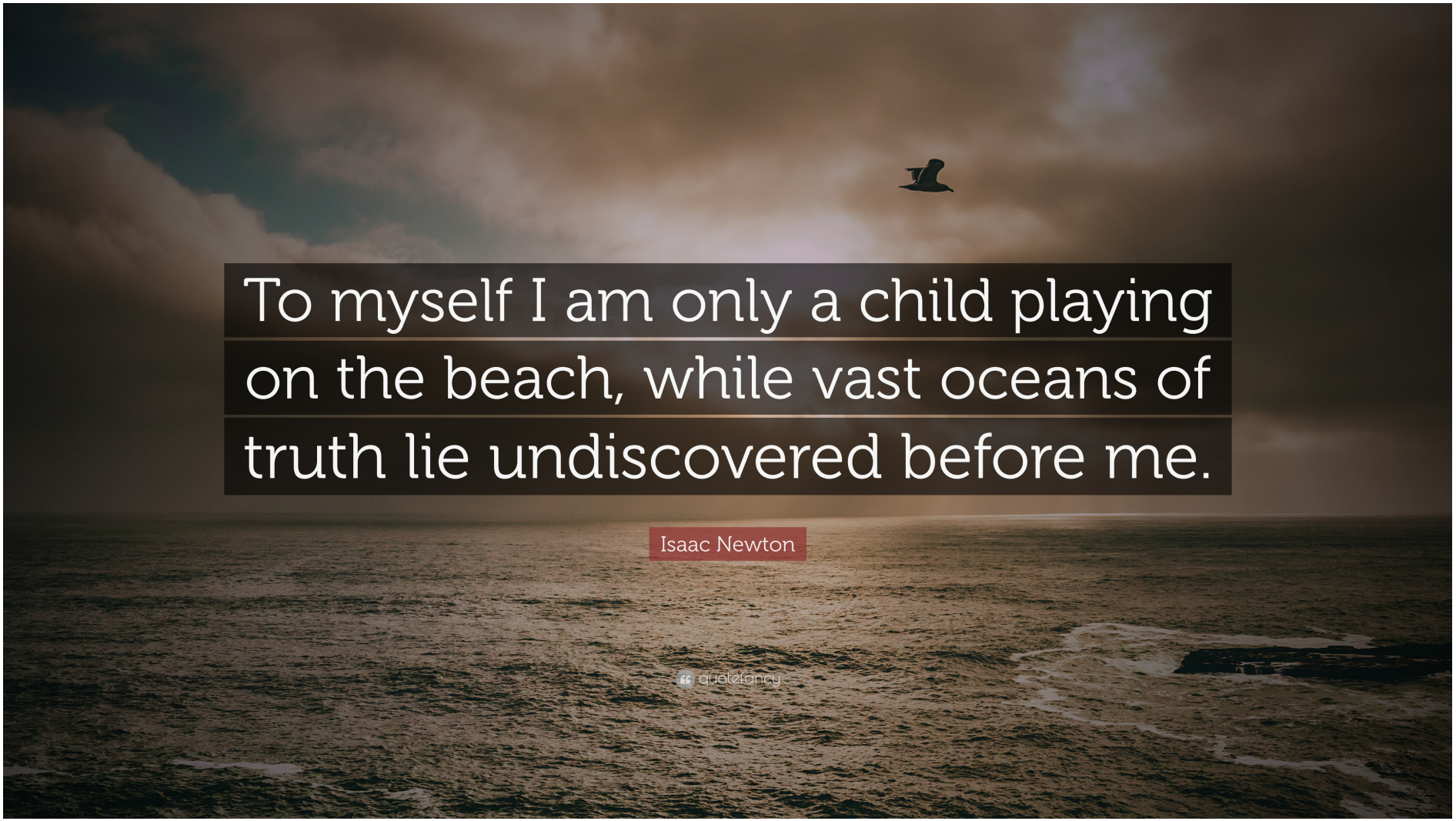

Dr. Enis Karaarslan

MSKÜ Cyber Security & AI Disciplines

- Academician and consultant
- My specialization: Cybersecurity, blockchain, data science
- Blockchain and Artificial Intelligence studies in various fields (health, national security, tourism)
- cybersecurity model,
- Effective use in terms of data science
- Testing
- Metaverse

Dr. Enis Karaarslan : enis.karaarslan@mu.edu.tr

MSKU Blockchain Research Group - http://wiki.netseclab.mu.edu.tr/index.php?title=MSKU_BcRG

MSKU Blockchain Research Group (MSKU BcRG)

- 20 Invited Speech, Panel, Seminar
- 10+ Education (Bosnia and Herzegovina, Ankara, Muğla, Eskişehir)
- 6 Live Stream (MSKU Blockchain presentations and chats)
- Blockchain Summer Internship (17 students, 12 experts)
- 1 Blockchain Research Network (DS4H - nodes in 4 different cities)
- 3 Tübitak/ITEA Project Consultancy
- 1 Patents
- 25 Papers (Articles, Conference Papers)
- 8 Book Chapter
- 2 MsC (Ceng 3550 - Decentralized Sys.& Appl.), 1 BsC course
- 19 Graduation Thesis (1 M.Sc., 8 Bachelor Thesis)
- 8 Awards (Teknofest - Tübitak 2242 Turkey 1st, 2nd, 3rd, 4th prizes)
- 1 Magazine Publication, 1 Interview, videos, presentations, drawings ... Turkish content ...

Blokzinciri yayını 2017 :)

Uluslararası Bilgi Güvenliği Mühendisliği Dergisi, Cilt:3, No:2, S:16-21, 2017
16

BLOKZİNCİRİ TABANLI SİBER GÜVENLİK SİSTEMLERİ

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ÖZET

Kripto paralar (cryptocurrency), eşler arası (Peer-to-Peer) mimaride birbirine bağlı madenci düğümü adı verilen bilgisayarlara ve blokzinciri yapısında tutulan kayıt sistemine dayanmaktadır. Bu sistemler sadece bir para birimi sağlamamakta, bu altyapılar üzerinde çeşitli 'merkezi olmayan' (decentralized), dağıtık (distributed) sistemler/yazılımlar tasarlanmaktadır. Bu çalışmada blokzinciri sisteminin nasıl çalıştığı, sağladığı veri bütünlüğü, kullanılabilirlik, mahremiyet gibi güvenlik servisleri ve hata toleransı incelenmektedir. Blokzinciri yapısının; nesnelerin interneti (Internet of Things), akıllı şehirler, kişisel verilerin korunması, bilgisayar ağları için kullanımı gibi siber güvenlik konularındaki çalışmalar ele alınmaktadır. Blokzinciri uygulamalarındaki temel sorunlara ve olası çözümler gözden geçirilmiştir. Bu tür çözümlerin ağ güvenliğinde kullanımına dair önerilere yer verilmiştir.

Anahtar Kelimeler: Blokzinciri, Siber Güvenlik, Kripto Para

Let's start ...

Starting with Cryptocurrencies...

Bitcoin: A Peer-to-Peer Electronic Cash System

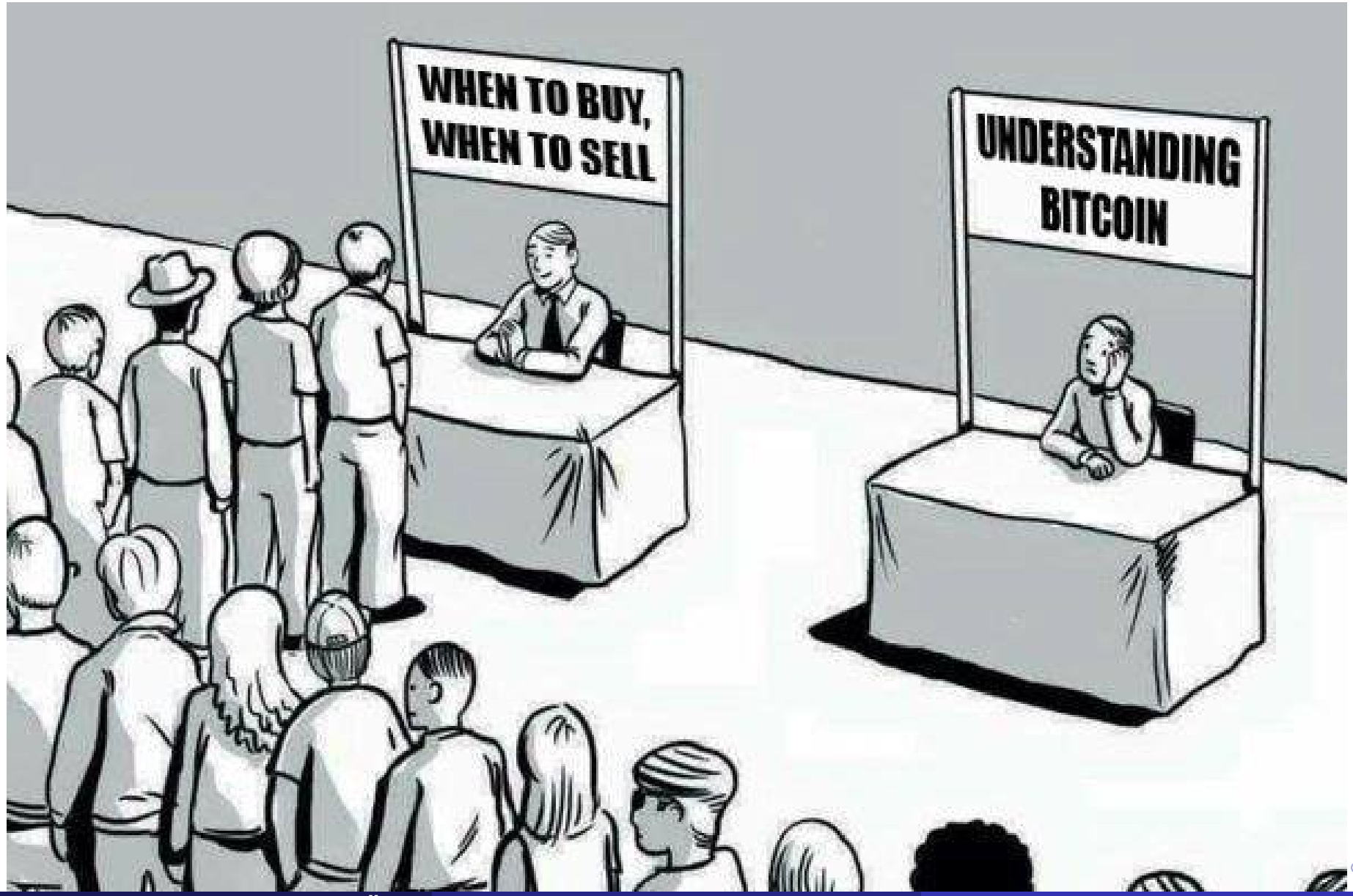
Satoshi Nakamoto
satoshin@gmx.com
www.bitcoin.org

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.

1. Introduction

Cryptocurrency

Humor



Decentralized systems

- Systems where intermediaries are removed (or intermediaries of which we are unaware)
- Freedom?
- Trust?

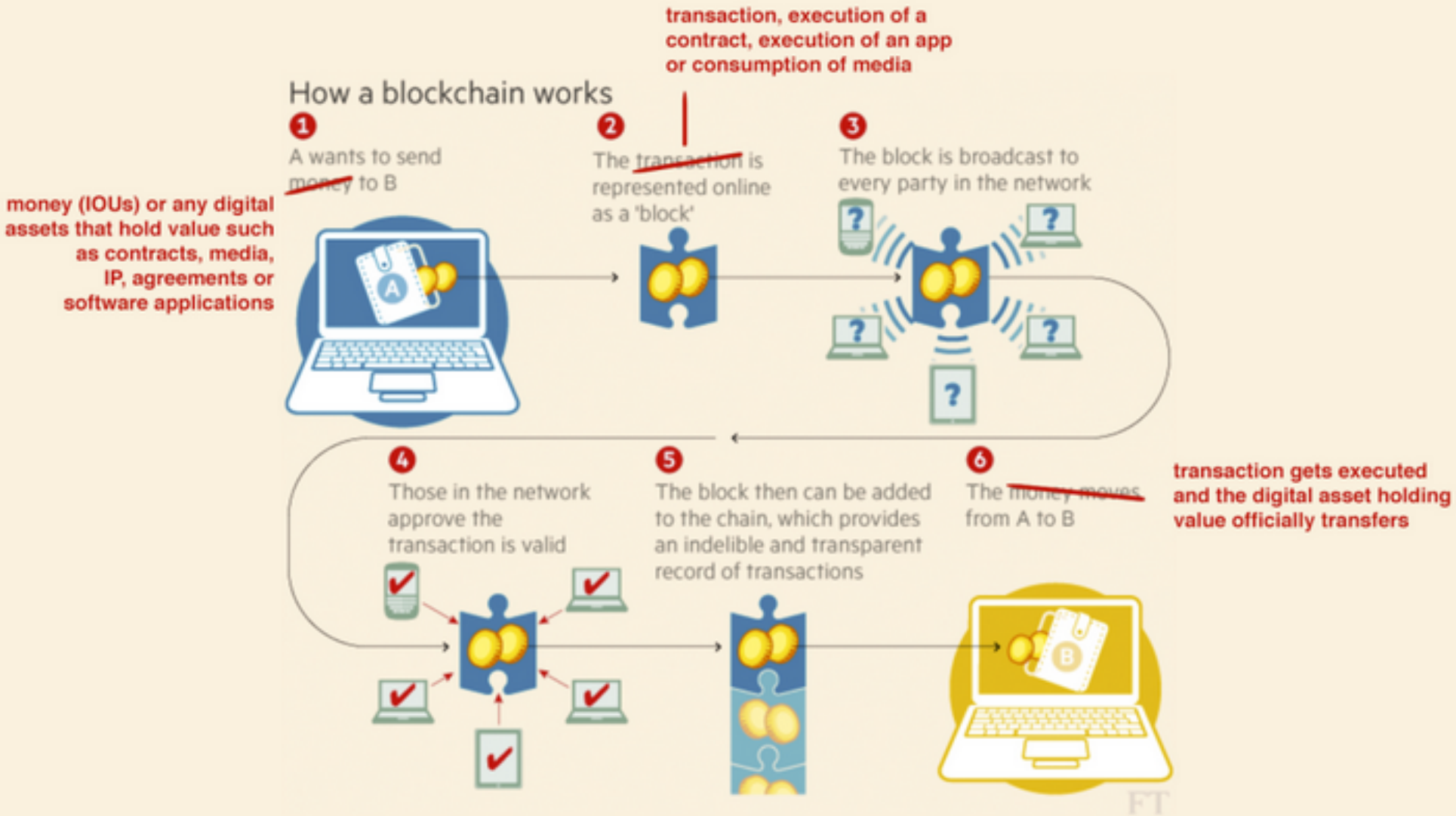
Or Totally Emotional

Intermediaries ...

What's different in Blockchain?

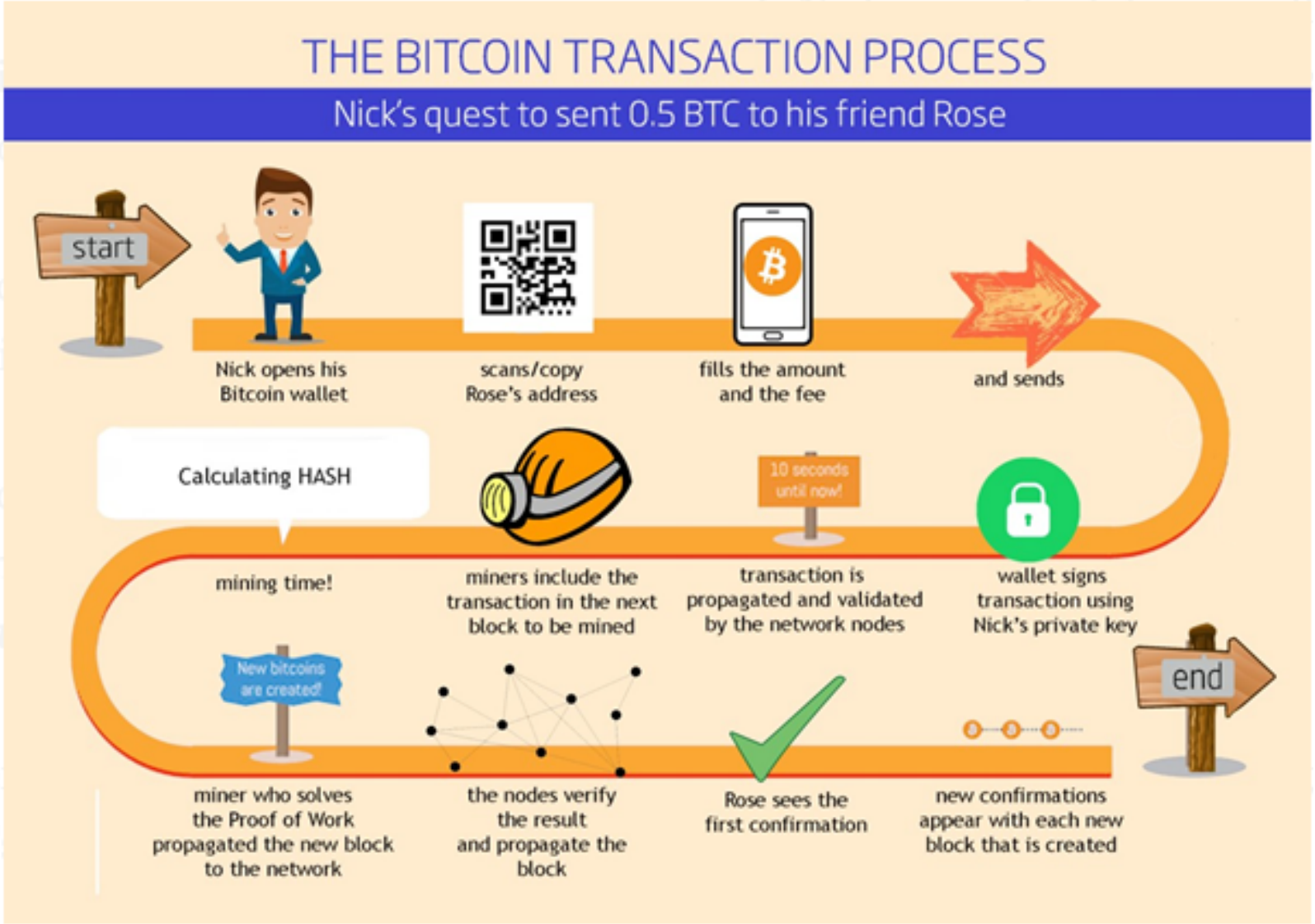
- No intermediary in transactions
- An autonomous (self-executing) system
- No system administrator (no root)
- Everything is recorded (immutable recording system)
- Developers who support the system (Community)
- Preferably open source and "free software"

Crypto Currencies - How Does Blockchain Work? [4]

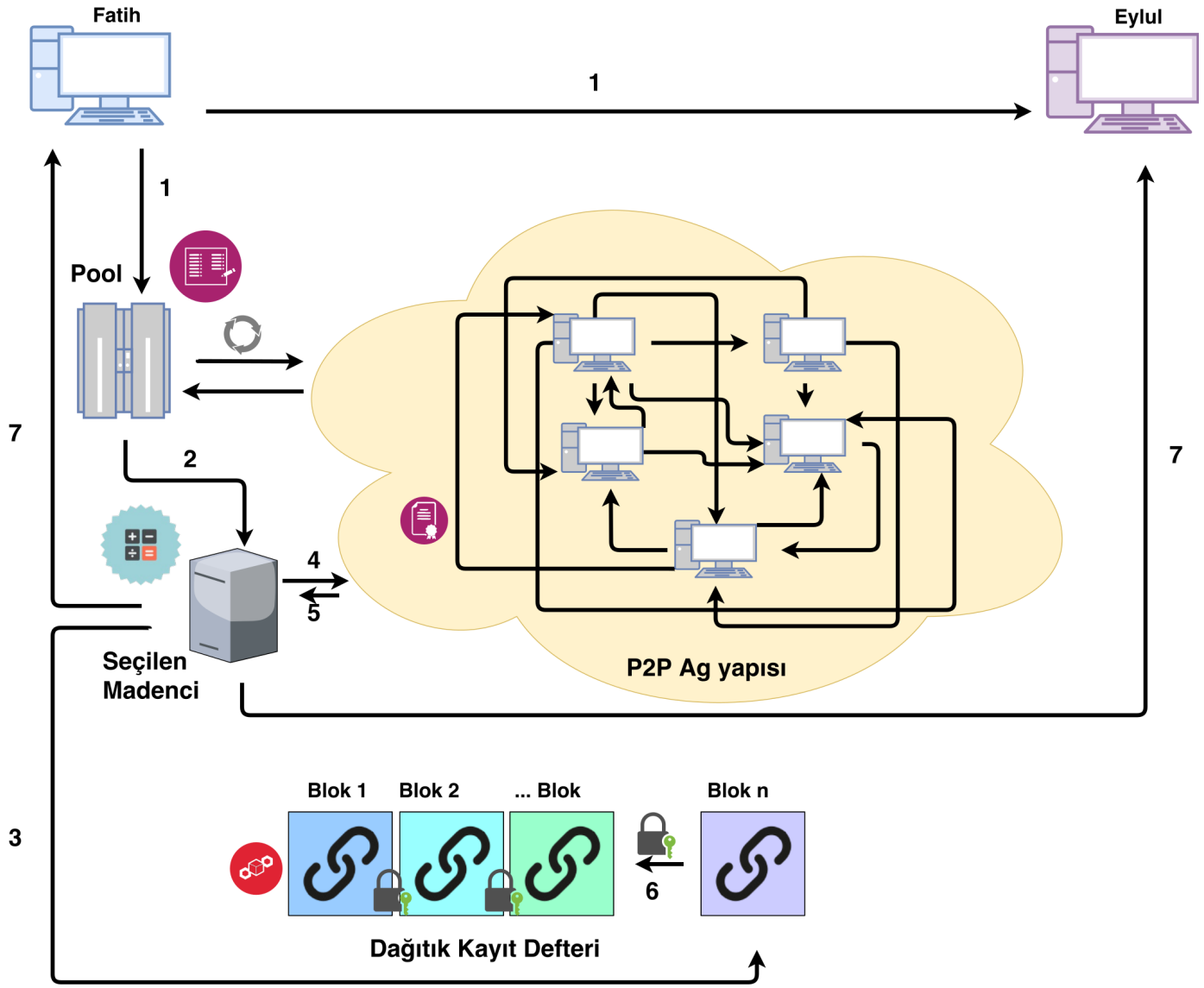


How Blockchain Works

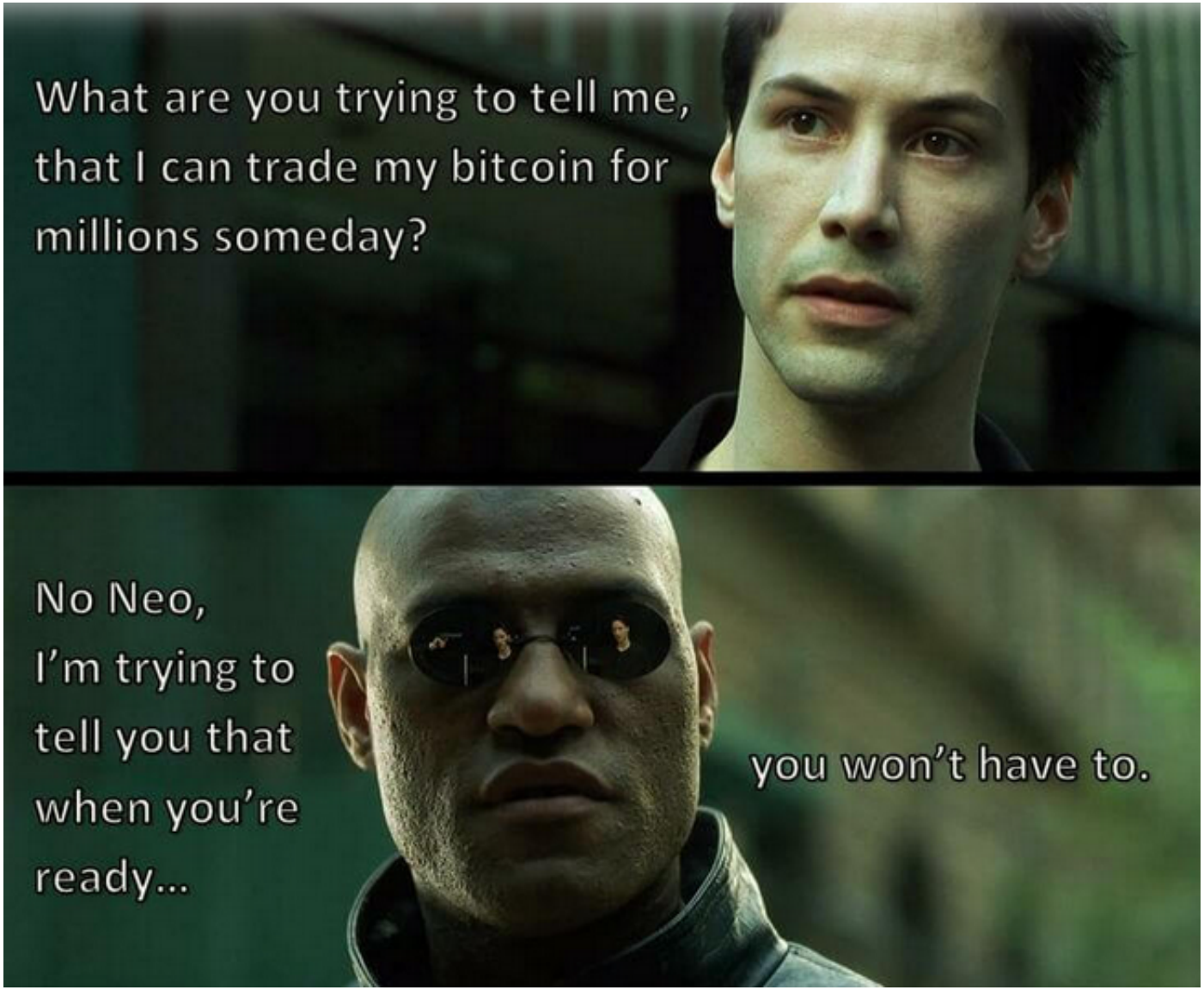
How Does It Work? (Satoshi Style (revised) :))



How Does It Work? (Pool added (revised) :))



Bitcoin :))


What are you trying to tell me, that I can trade my bitcoin for millions someday?
No Neo, I'm trying to tell you that when you're ready...
you won't have to.

Fundamentals

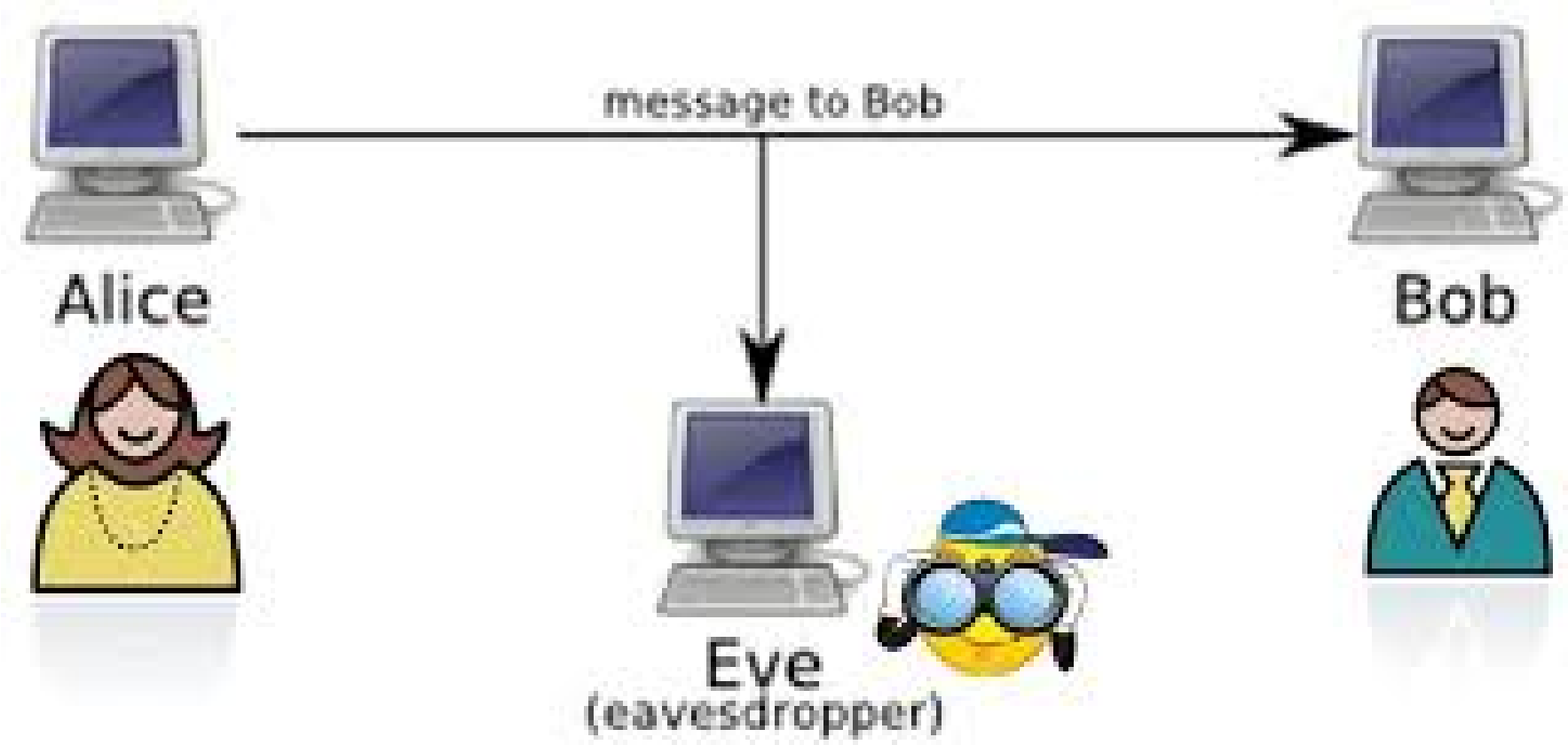
Introduction - Blockchain (cryptocurrency) Systems

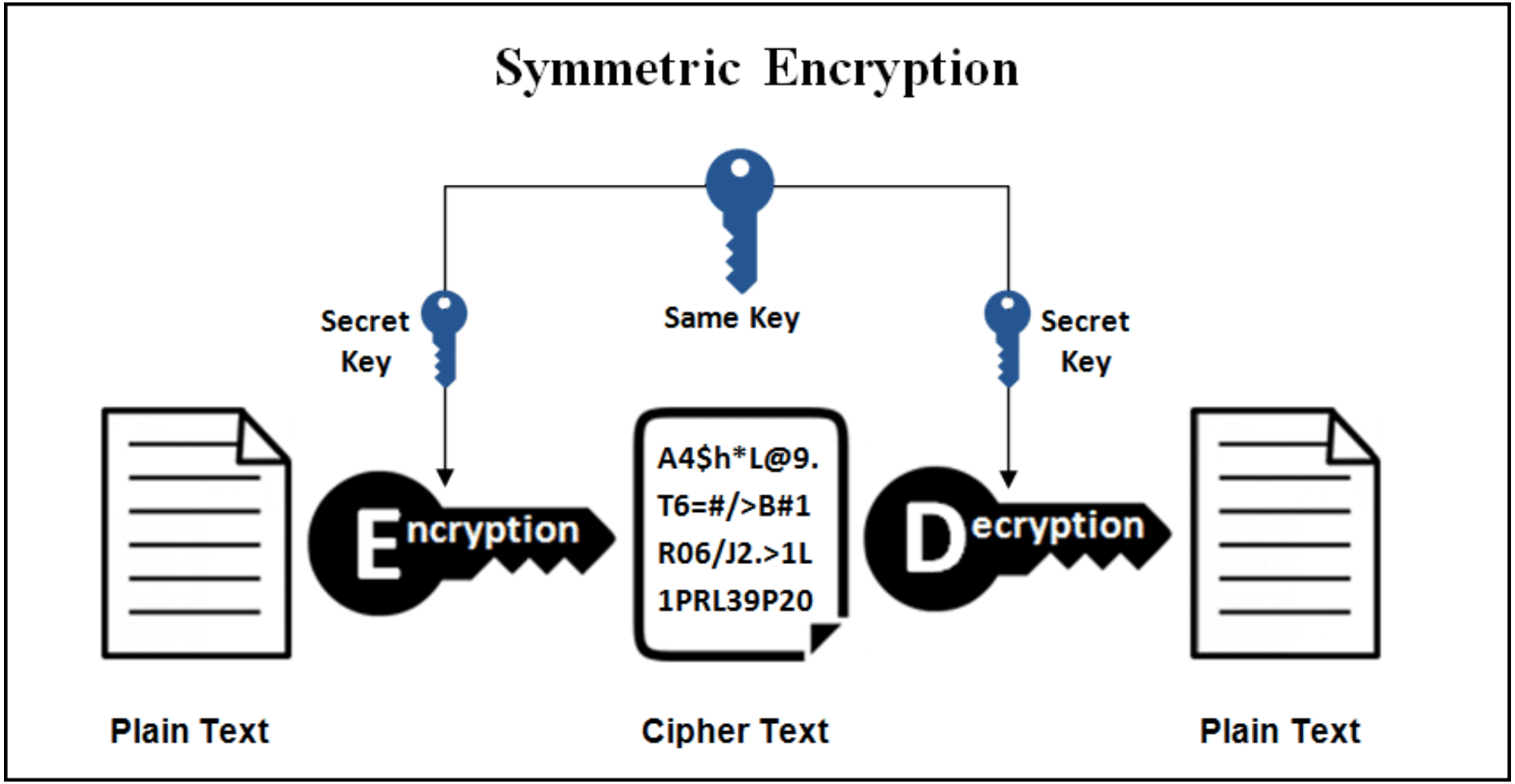
Cryptocurrencies keep the transactions made in the blockchain structure on computers connected to each other with the P2P protocol.

The blockchain technology that Bitcoin introduced to us; the basic concepts and cryptocurrencies will be discussed in this section.

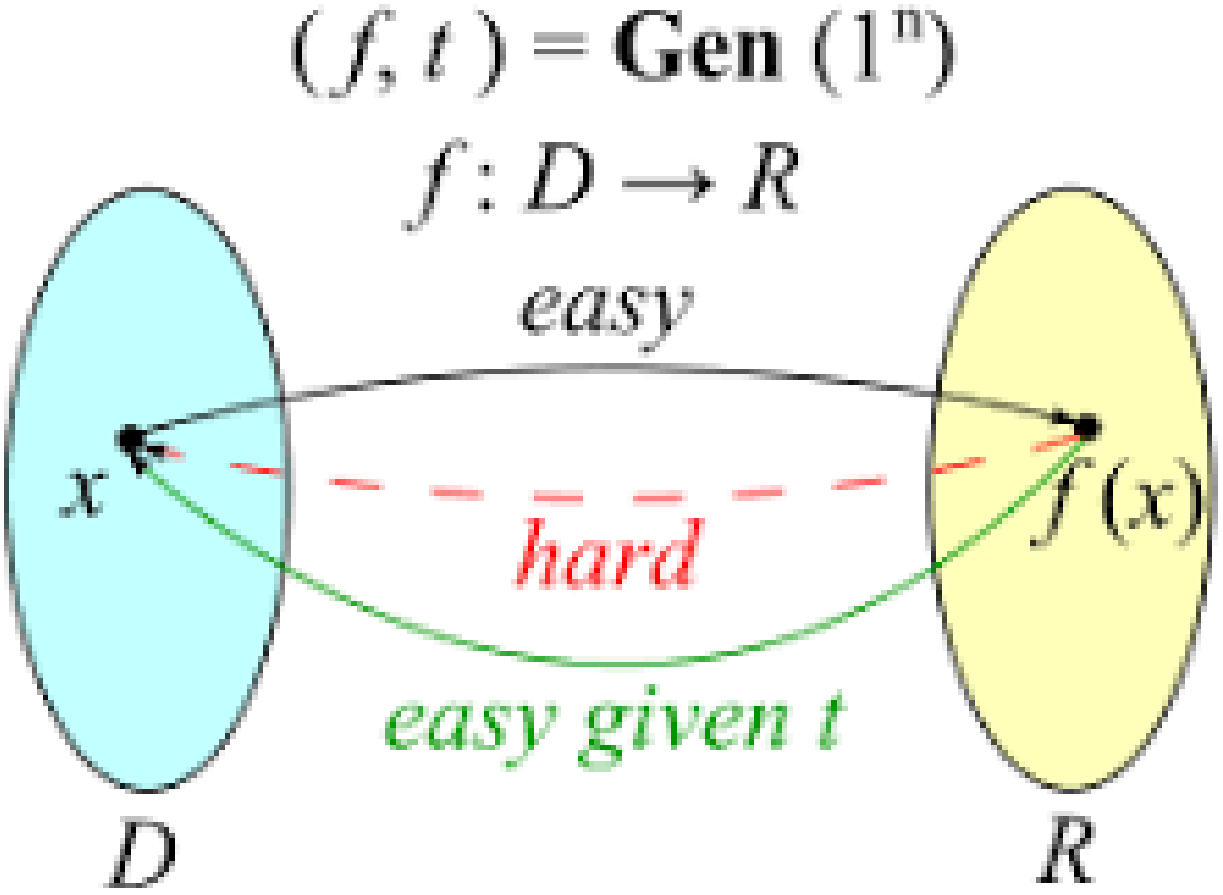
Cryptography

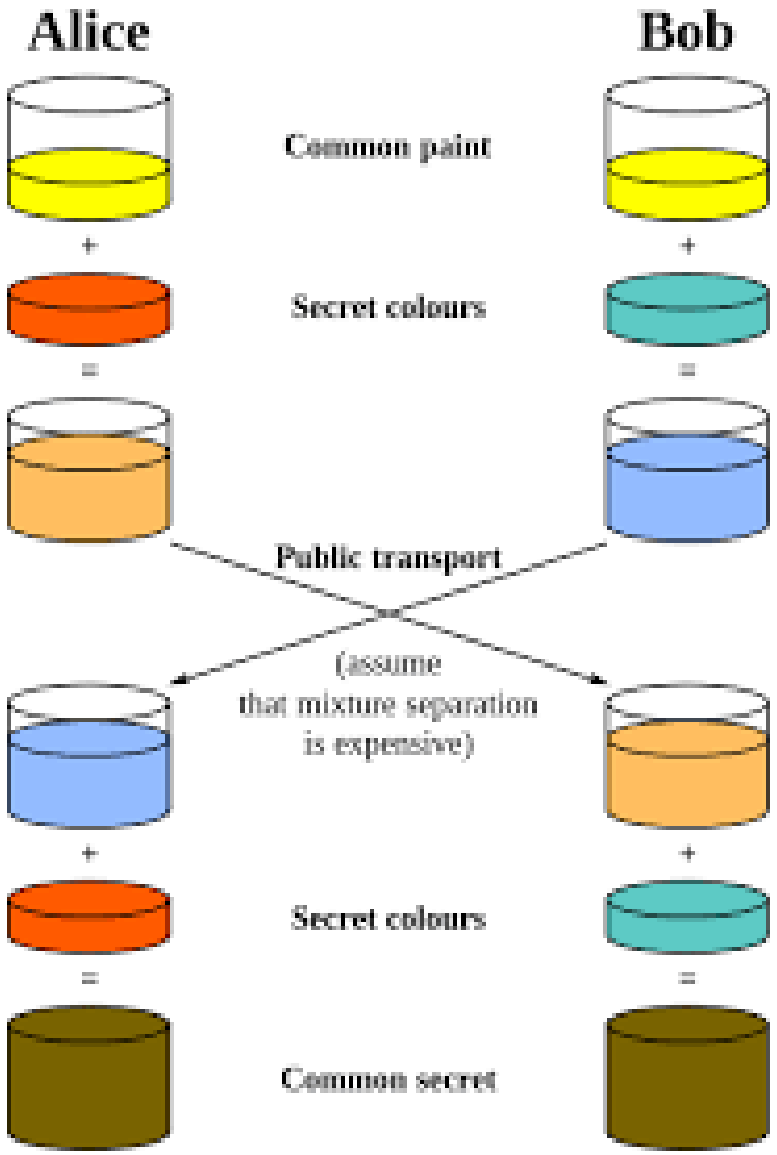
Secure Communication Issue

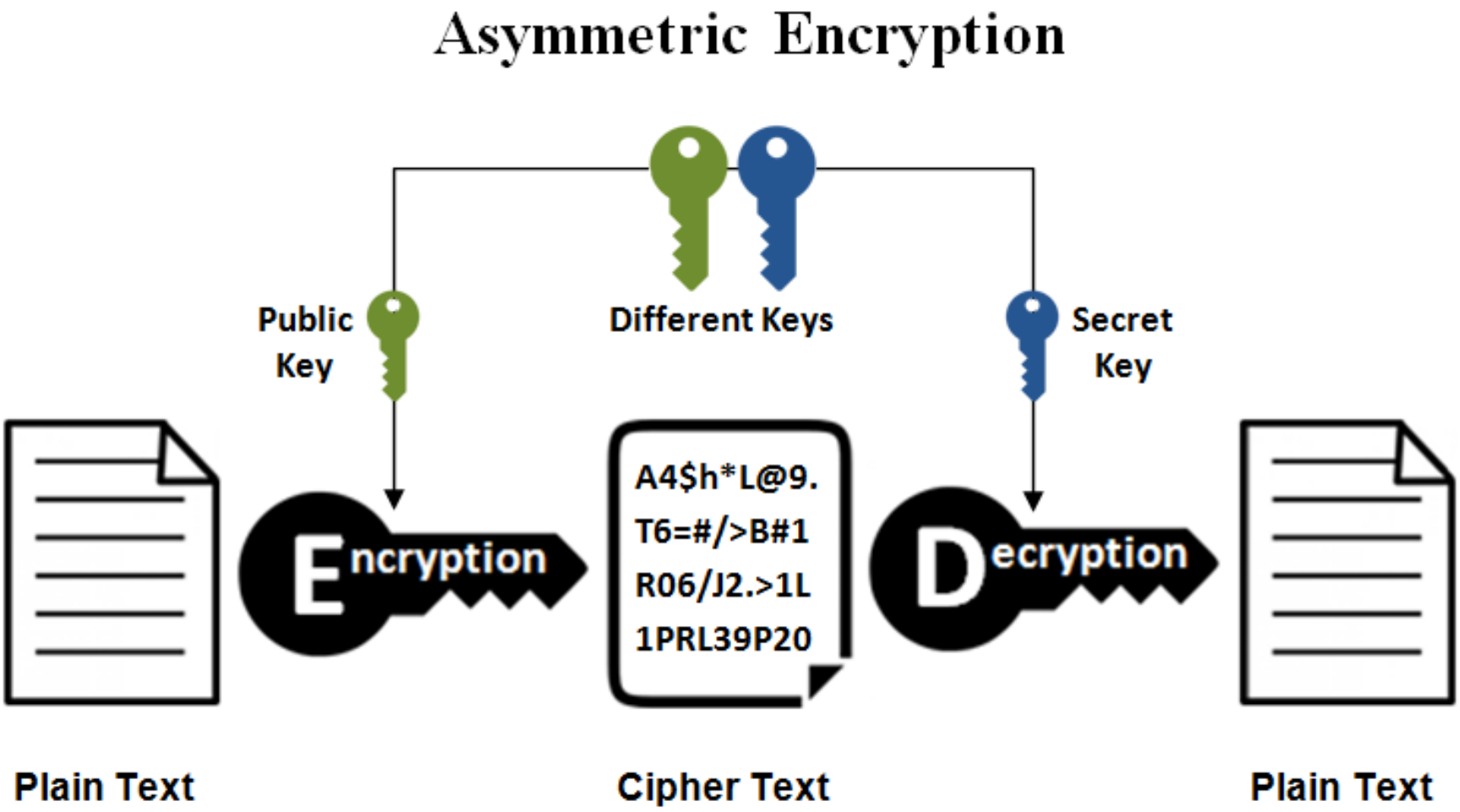



Symmetric Encryption
Secret Key
Same Key
Secret Key
Encryption
A4$h*L@9.
T6=#/>B#1
R06/J2.>1L
1PRL39P20
Decryption
Plain Text
Cipher Text
Plain Text

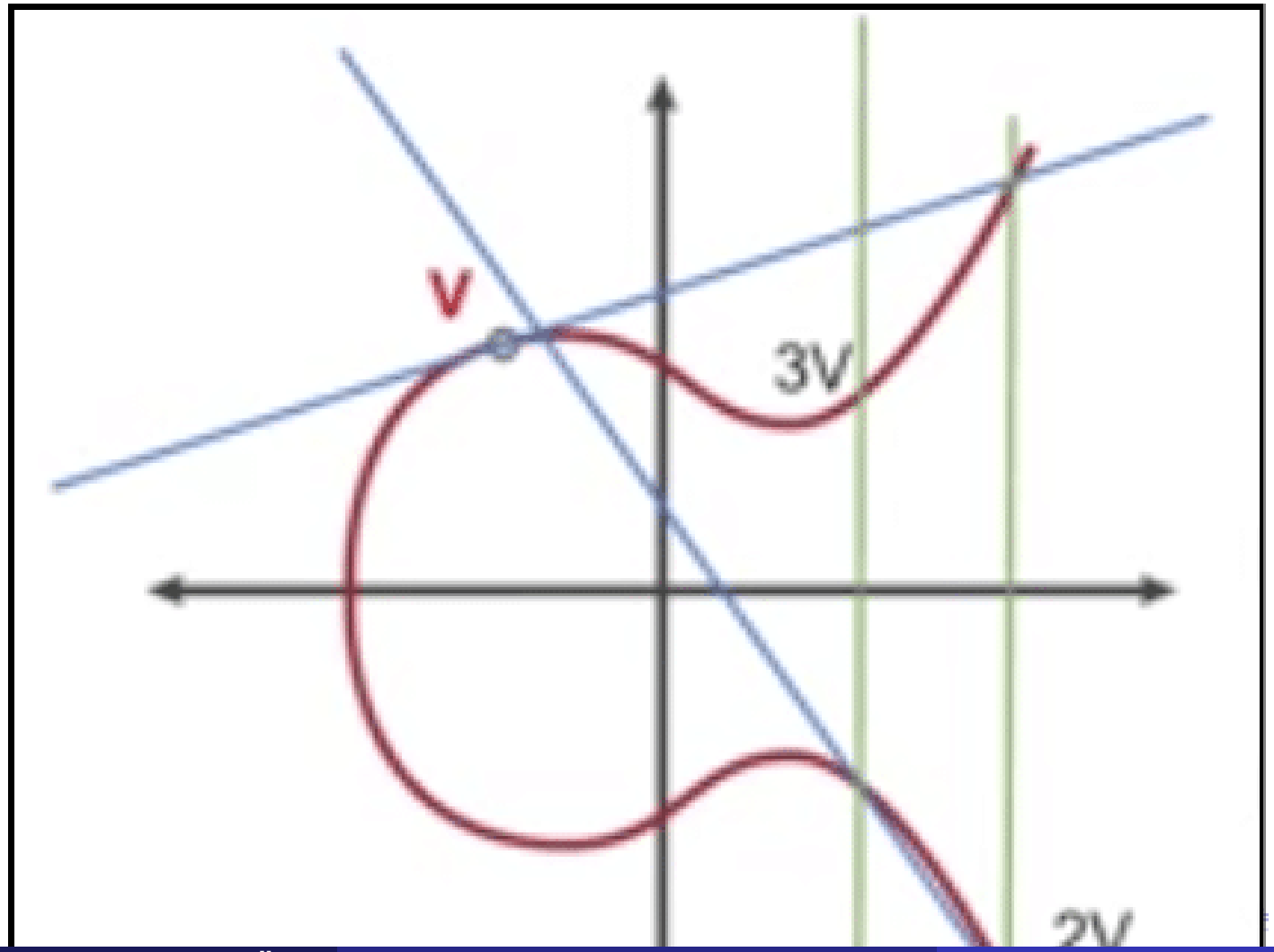
How will the key be safely delivered to the other party?
Key Distribution Problem


$(f, t) = \mathbf{Gen}(1^n)$
$f : D \rightarrow R$
easy
x
hard
$f(x)$
easy given t
D
R


Alice
Bob
Common paint
+
Secret colours
=
Public transport
(assume
that mixture separation
is expensive)
+
Secret colours
=
Common secret

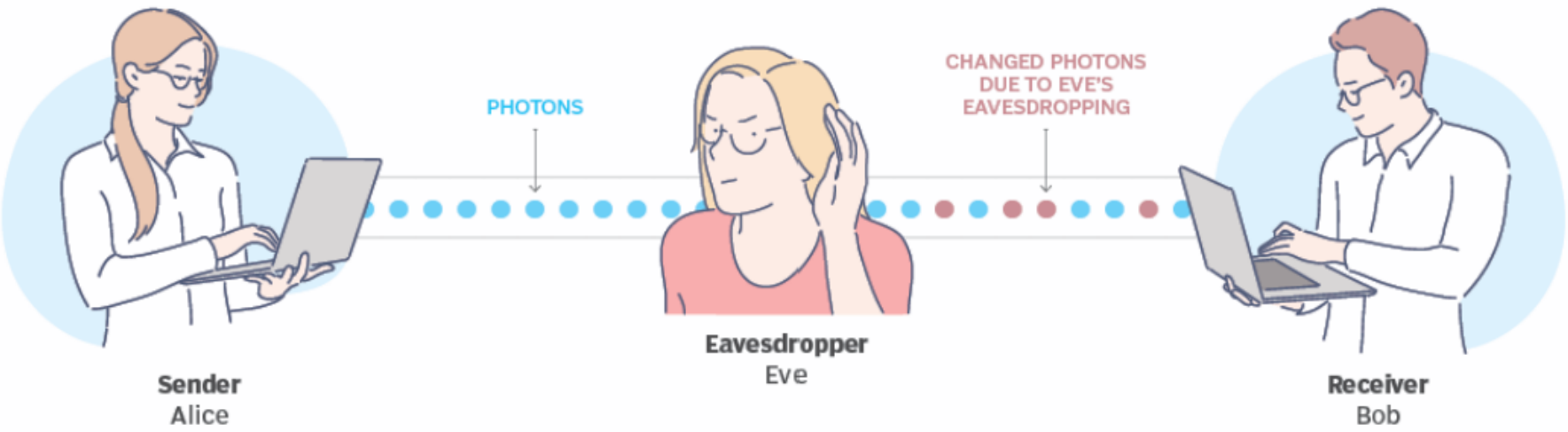

Asymmetric Encryption
Public Key
Different Keys
Secret Key
Encryption
A4$h*L@9.
T6=#/>B#1
R06/J2.>1L
1PRL39P20
Decryption
Plain Text
Cipher Text
Plain Text

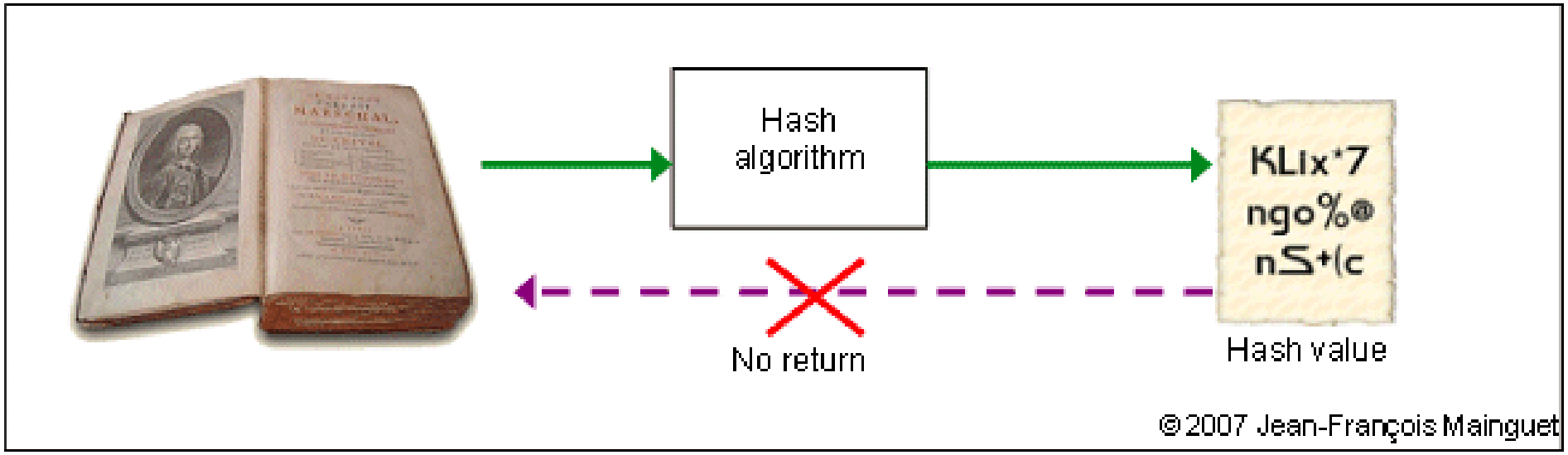
Bitcoin and Ethereum use Elliptic Curve Digital Signature Algorithm (ECDSA) with 256-bit keys

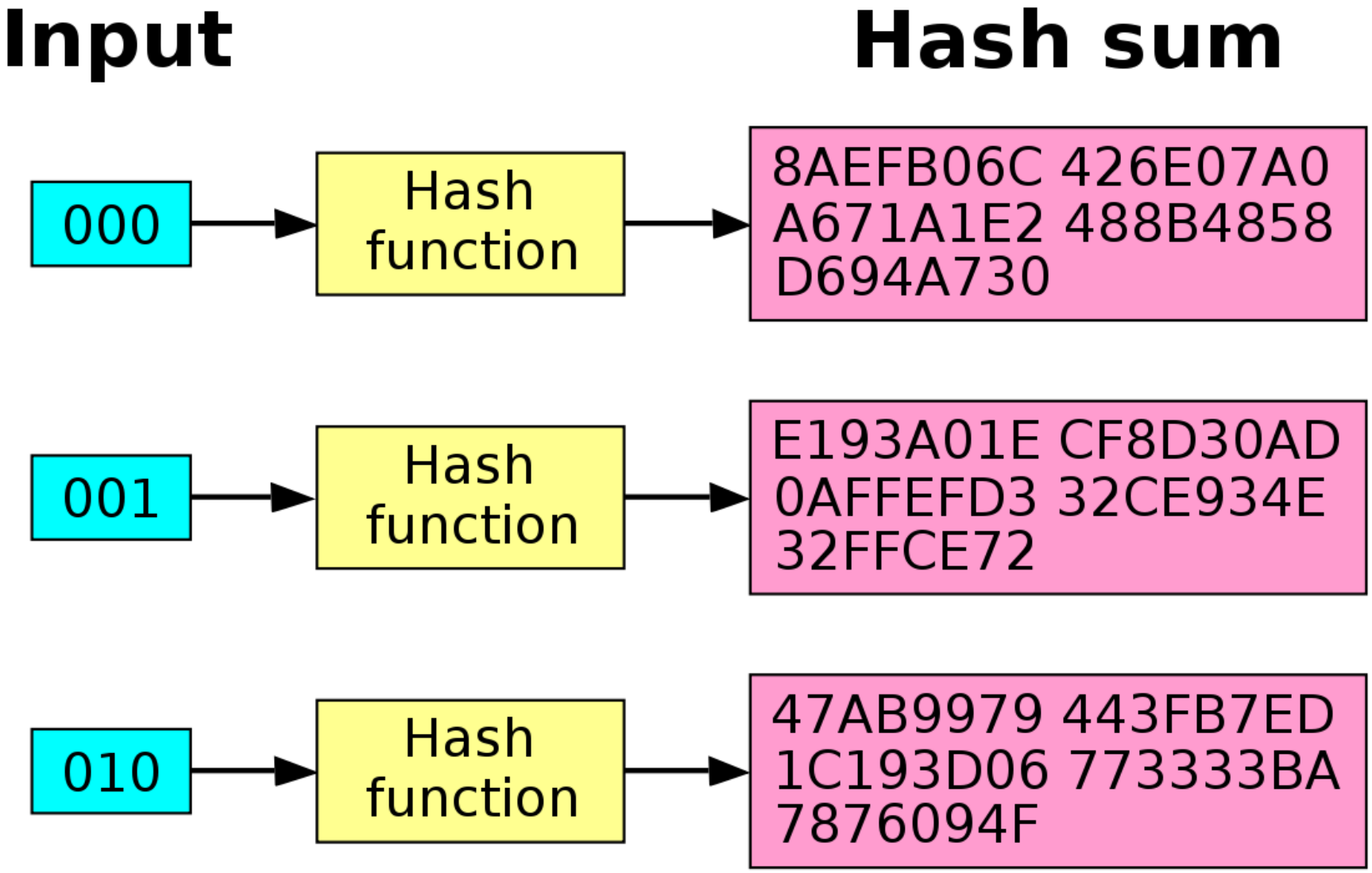


- EEC is much more efficient than RSA. It provides the same level of security as RSA with a smaller (large) key
  - 256-bit key EEC -> 3072-bit key RSA
  - 384-bit key EEC -> 7680-bit key RSA
- NSA recommends 384-bit EEC encryption for highly confidential documents. (Needs an update regularly!)
- However, NSA is transitioning to post-quantum cryptography due to the potential threat posed by quantum computer

- International bodies are developing quantum-resistant algorithms.
- Blockchain platforms are actively researching quantum-resistant algorithms to ensure security post-quantum.
  - Forking and Upgrading: Cryptocurrencies may implement hard forks to transition to quantum-safe algorithms once standardized.
  - Hybrid cryptography: Using both classical and quantum-resistant methods during the transition.

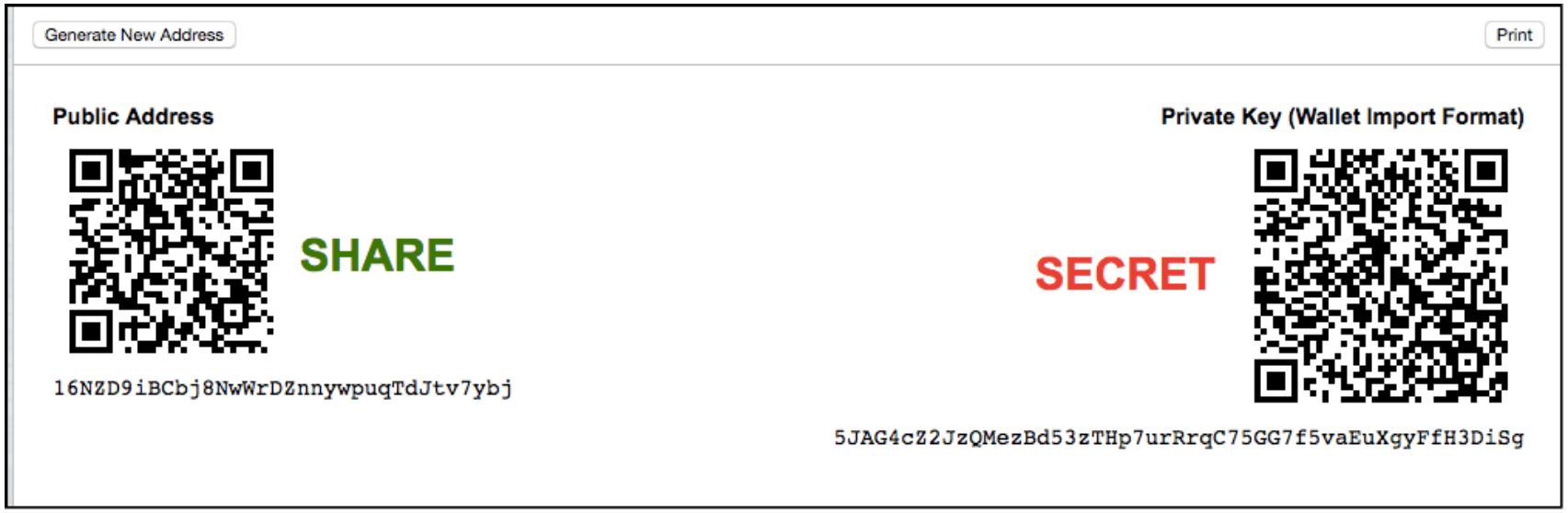



Hash
algorithm
No return
Hash value
©2007 Jean-François Mainguet


Input
Hash sum
000
Hash function
8AEFB06C 426E07A0 A671A1E2 488B4858 D694A730
001
Hash function
E193A01E CF8D30AD 0AFFEFD3 32CE934E 32FFCE72
010
Hash function
47AB9979 443FB7ED 1C193D06 773333BA 7876094F

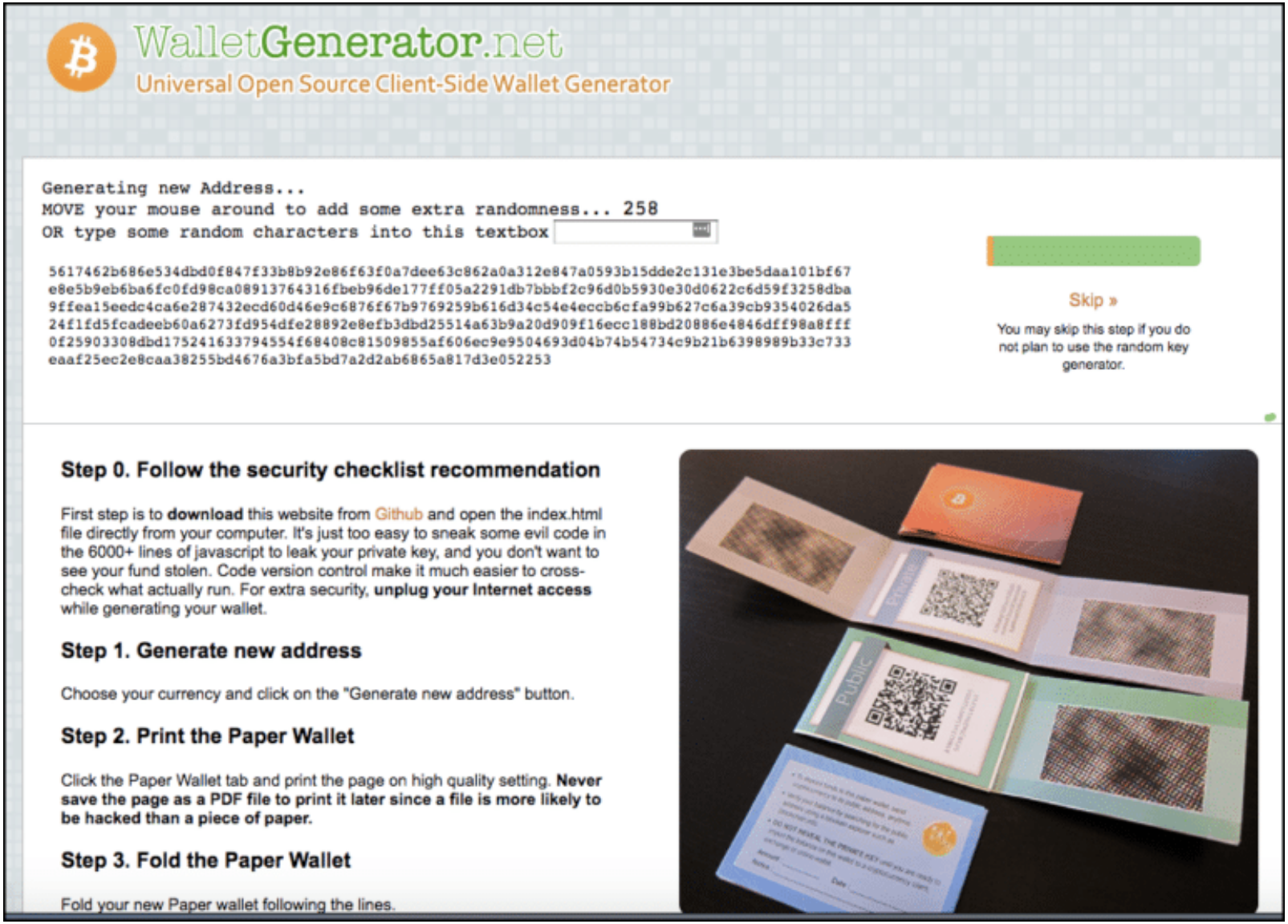
WIF format

Public key is generated from private key



Cryptography

Cryptocurrency - Bitcoin Wallet - 265 bit private key

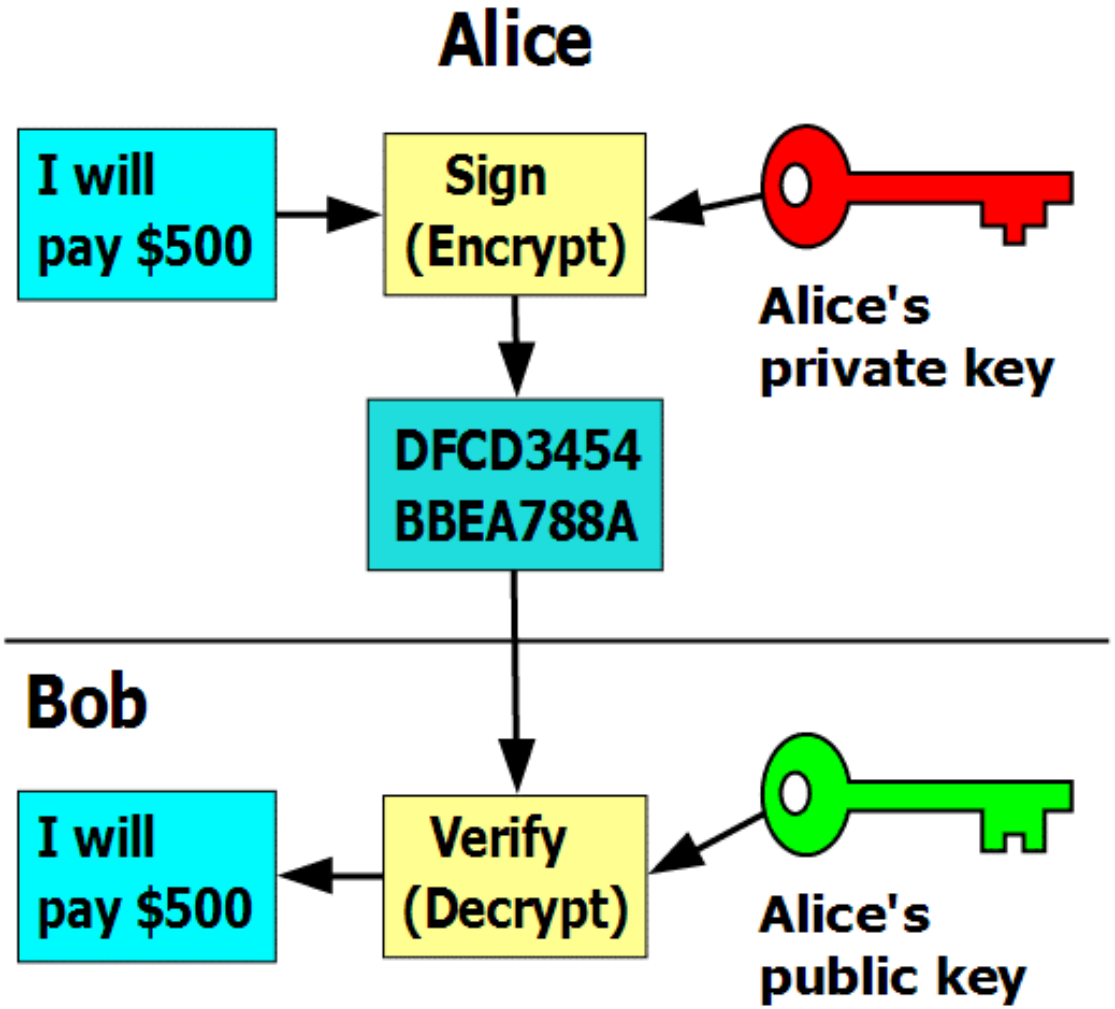


- Hash fn SHA 256 (private key) - > first value
- Hash fn RIPE MD 160 (initial value) -> Part A
- Hash fn SHA 256 (Part A) -> second value
- Hash fn SHA 256 (second value) -> C, First 7 bits (C) -> Part B
- Public key = Part A + Part B

With current mathematical methods and processing capabilities, it is estimated that deriving a private key from a public key would take an incredibly long time—on the order of 40 octillion years (40,000,000,000,000,000,000,000,000,000 years) assuming:

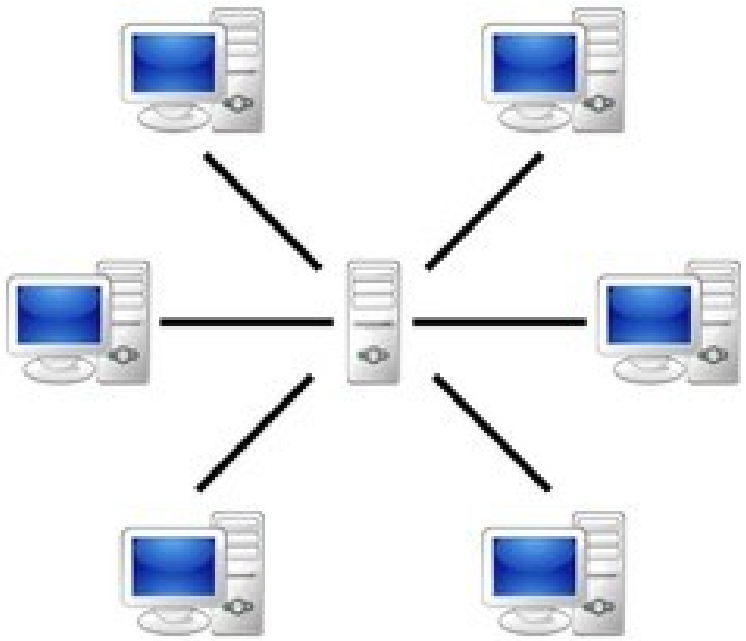
- ecp256k1 curve - 256-bit keys
- Computational power such as a modern supercomputer.

(Future) Quantum computers and new techniques will (probably) shorten this period, for now it is enough for today. However, "Post quantum" cyptography will be required then.

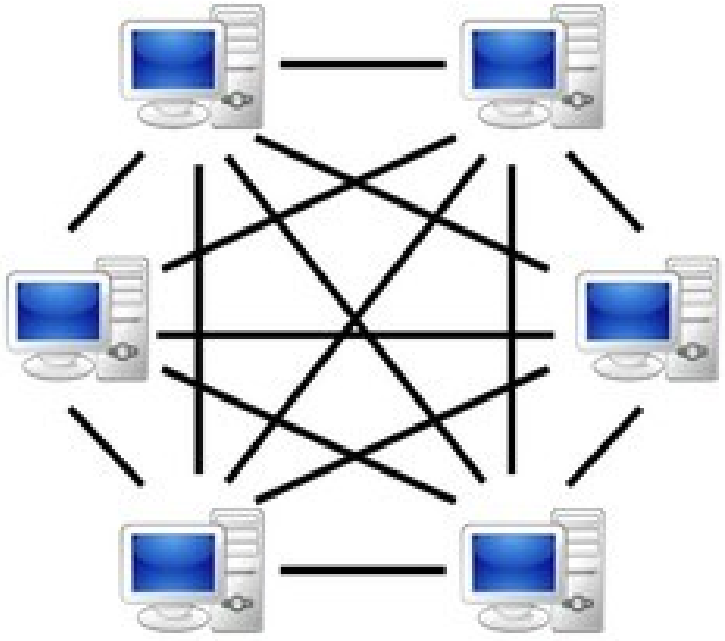

Alice
I will pay $500
Sign (Encrypt)
Alice's private key
DFCD3454 BBEA788A
Bob
I will pay $500
Verify (Decrypt)
Alice's public key

- When connecting Blocks in Blockchain
- Coin mining - creating money (is there really such a process? No.)
  - Not valid for all Cryptocurrency (such as Tokens)
  - Limited and limited number (These can also be changed with forks)

P2P



Server-based



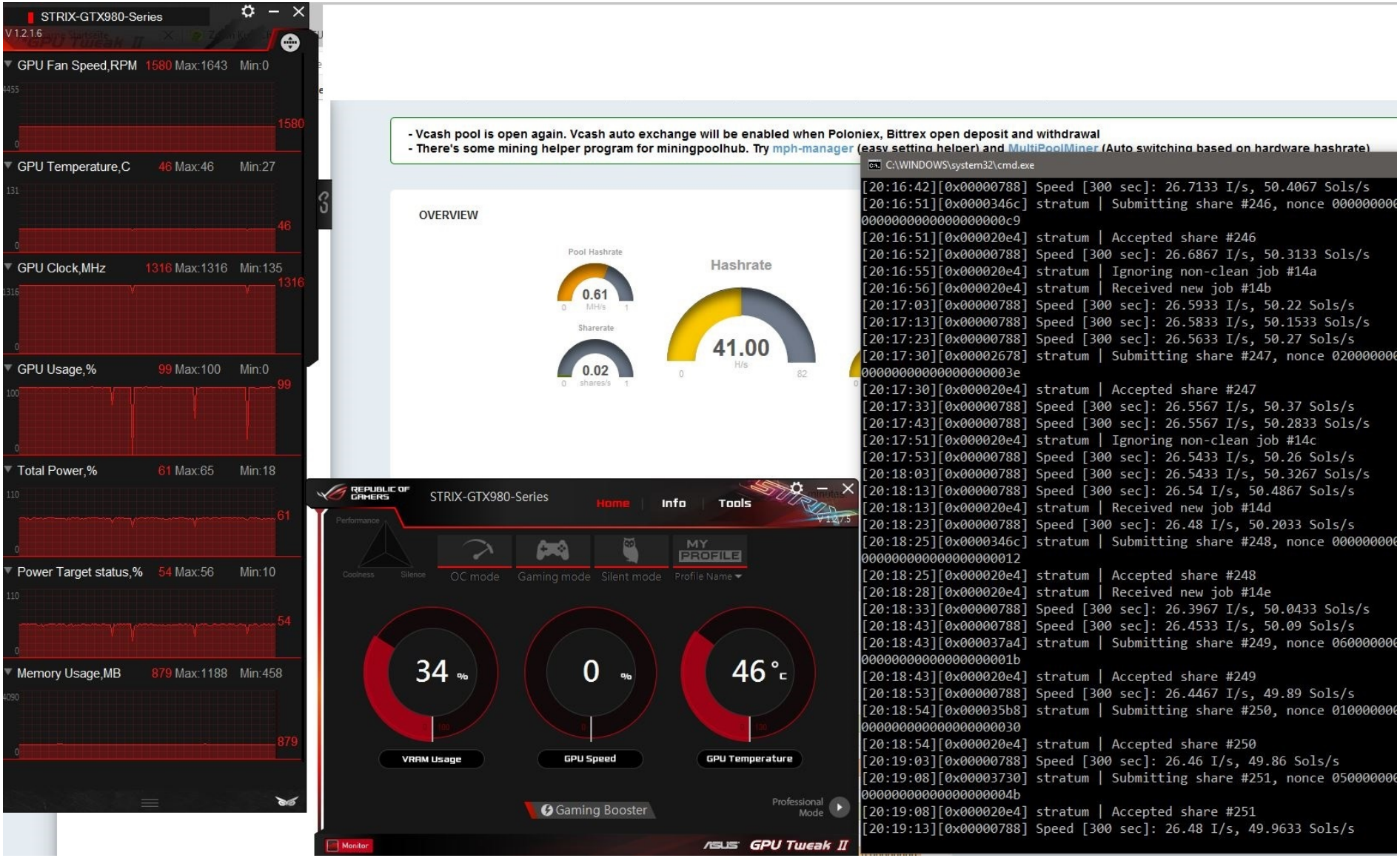
P2P-network

Cryptocurrency Mining Eco System

Miner Node - Machines

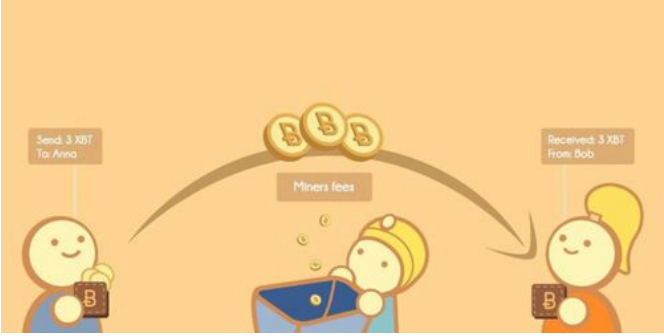
Mining RIG - GPU

Mining Power - GPU H/s



Cryptocurrency Mining

- Share from the money that was put into circulation with the block writing award
- Share from transaction fees



Cryptocurrency

Humor

Mining RIG - GPU

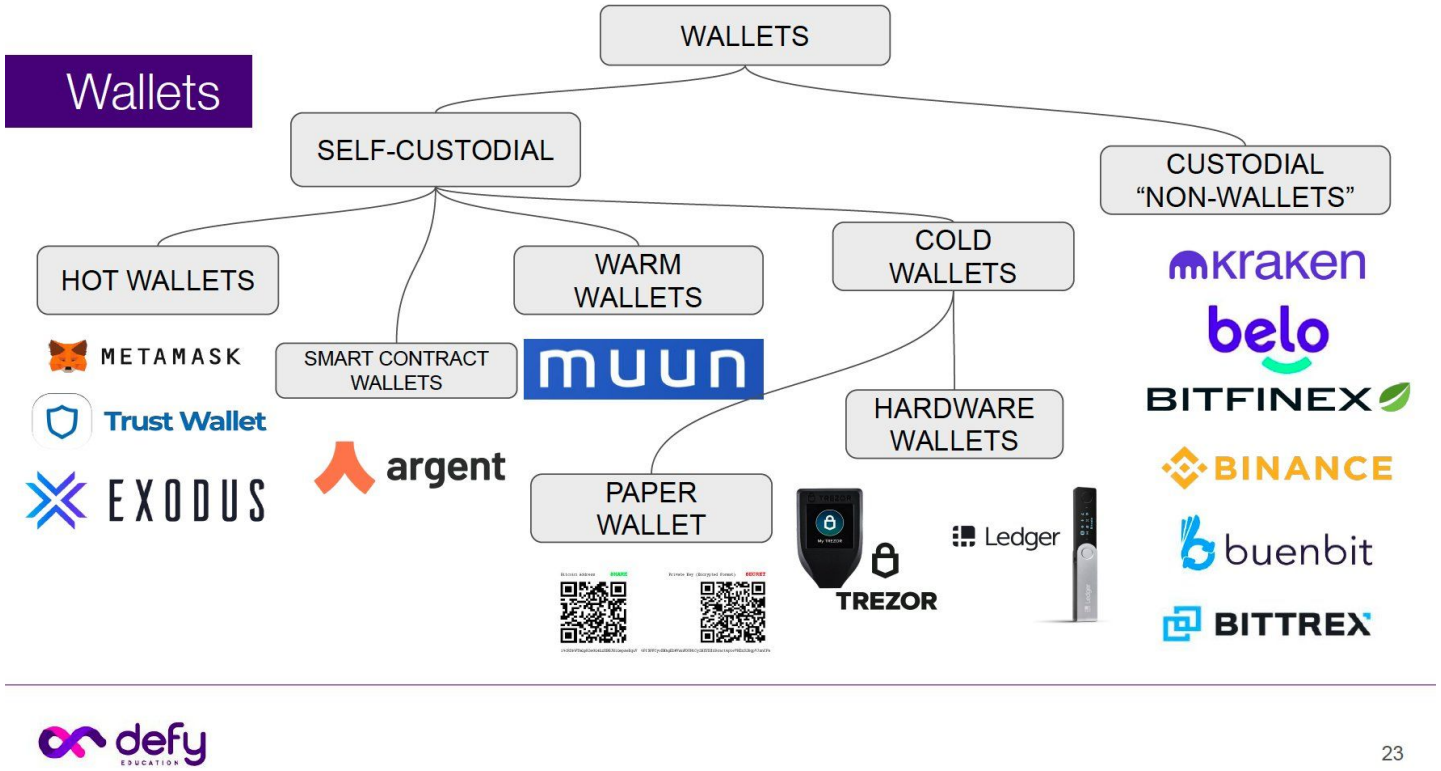
Who made the most money during the California gold mine rush?

Cryptocurrency

Cryptocurrency

Wallet

Wallets ...


Wallets
WALLETS
SELF-CUSTODIAL
CUSTODIAL "NON-WALLETS"
HOT WALLETS
SMART CONTRACT WALLETS
WARM WALLETS
COLD WALLETS
HARDWARE WALLETS
PAPER WALLET
METAMASK
Trust Wallet
EXODUS
argent
muun
TREZOR
Ledger
kraken
belo
BITFINEX
BINANCE
buenbit
BITTREX
defy EDUCATION
23

Cryptocurrency - physical(?) wallet

Cryptocurrency - Hardware wallet

Cryptocurrency

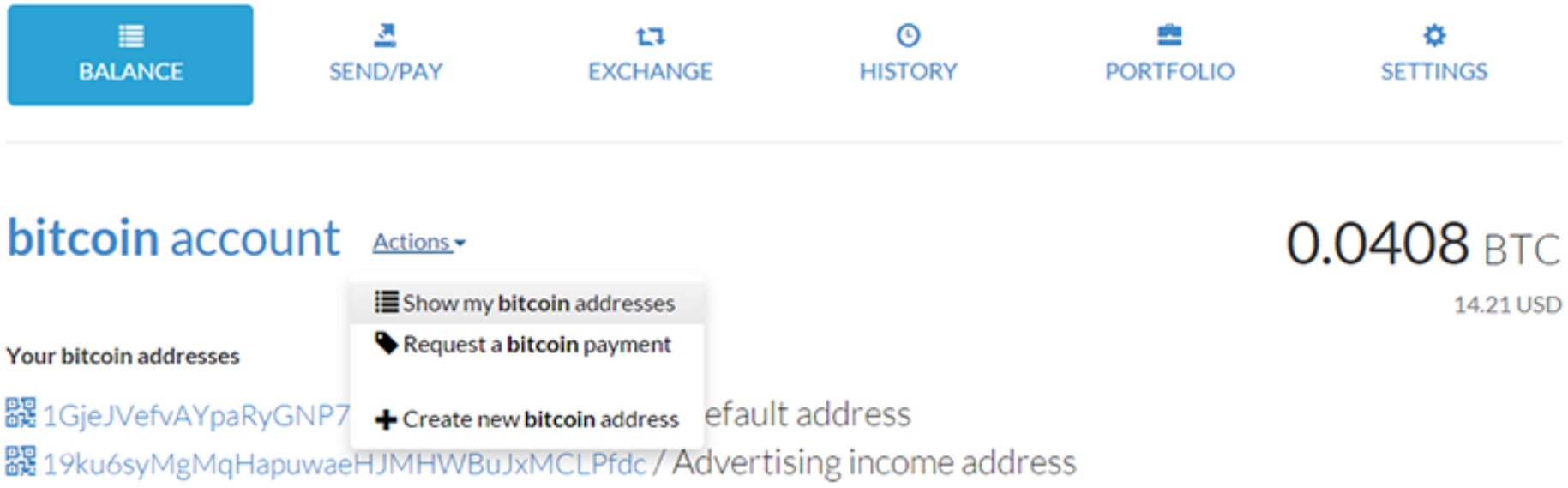
Humor

Cryptocurrency
Bitcoin(BTC)

- Bitcoin (BTC),
- using P2P protocol
- decentralized
- Digital (crypto) money
- active since 2009
- Not managed by any financial institution(?)

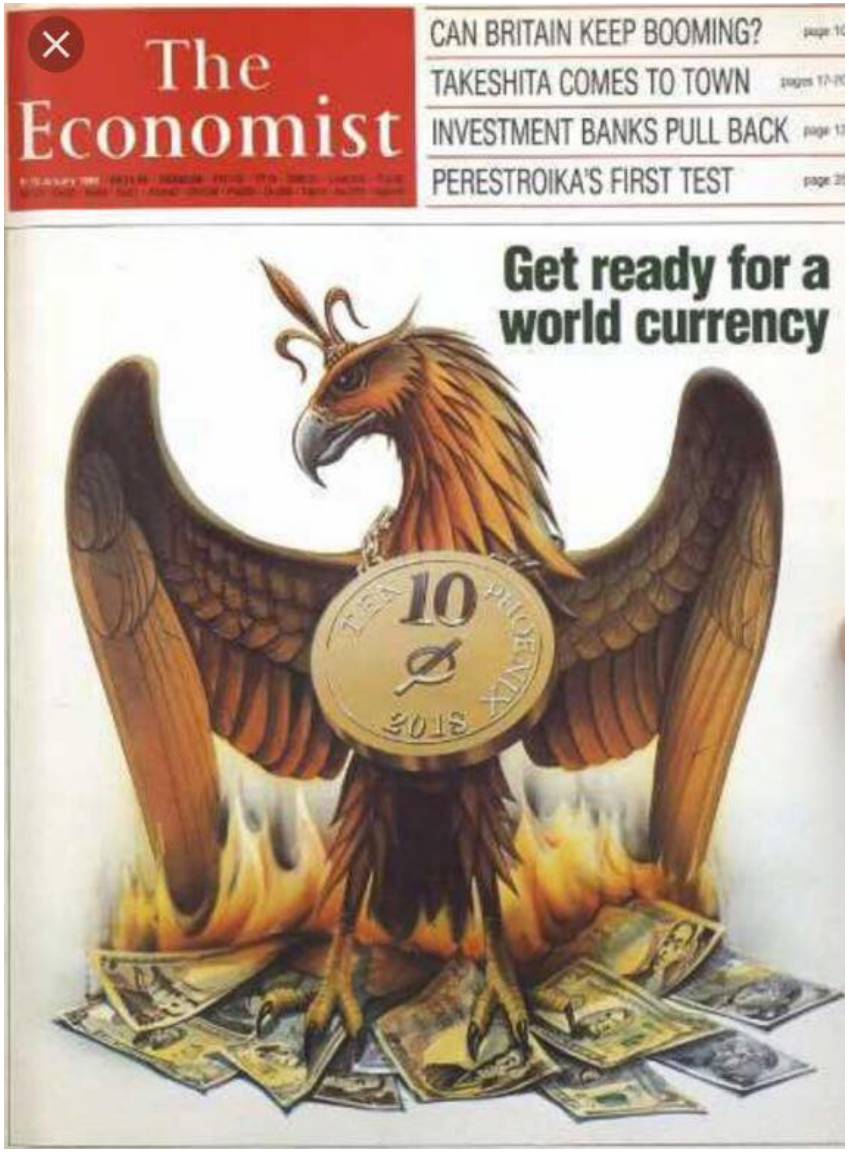
Cryptocurrency

Account



Cryptocurrency

Bitcoin - The Economist - 1988 - Conspiracy theory?

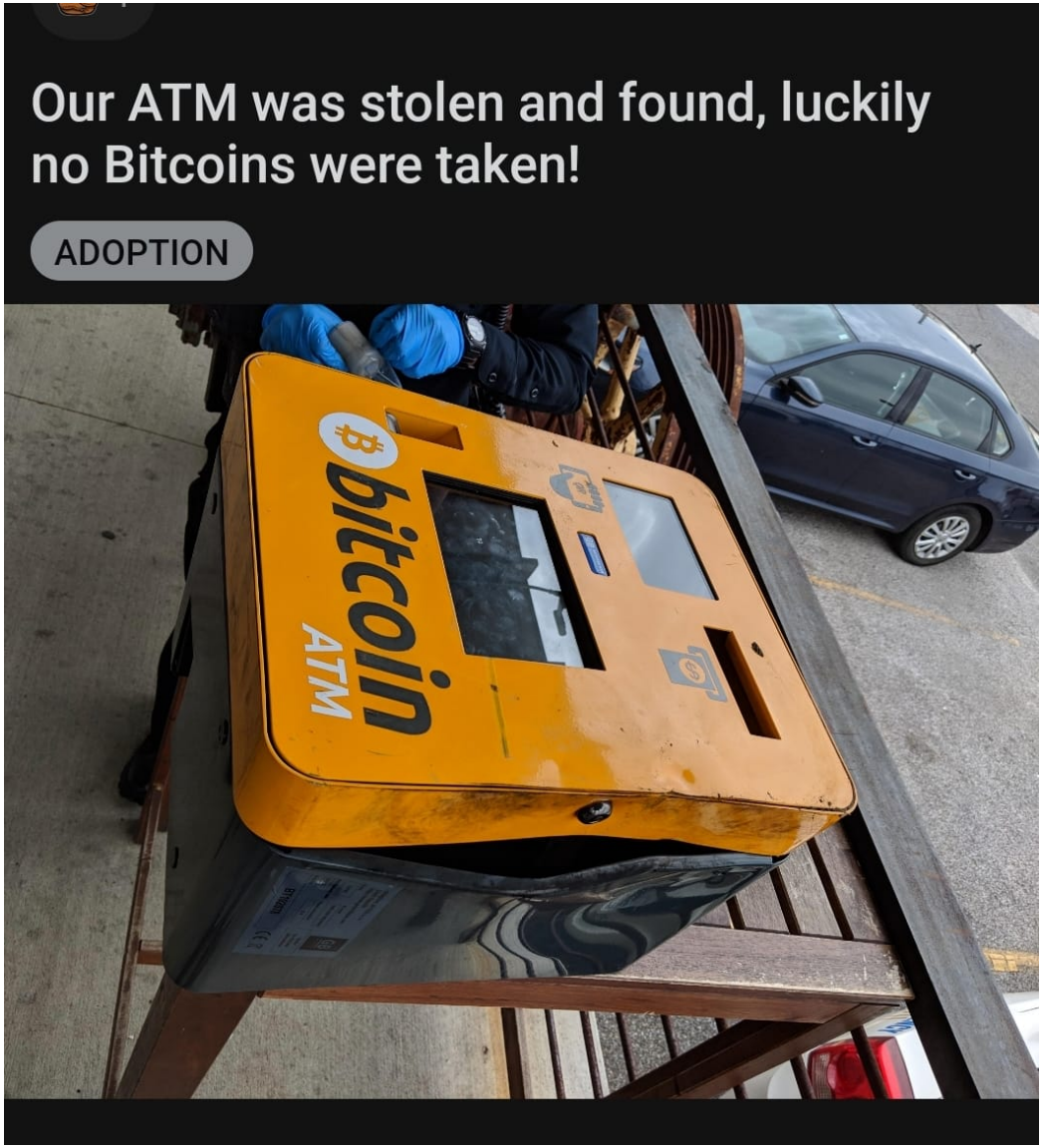


Cryptocurrency

Who uses it

Cryptocurrency

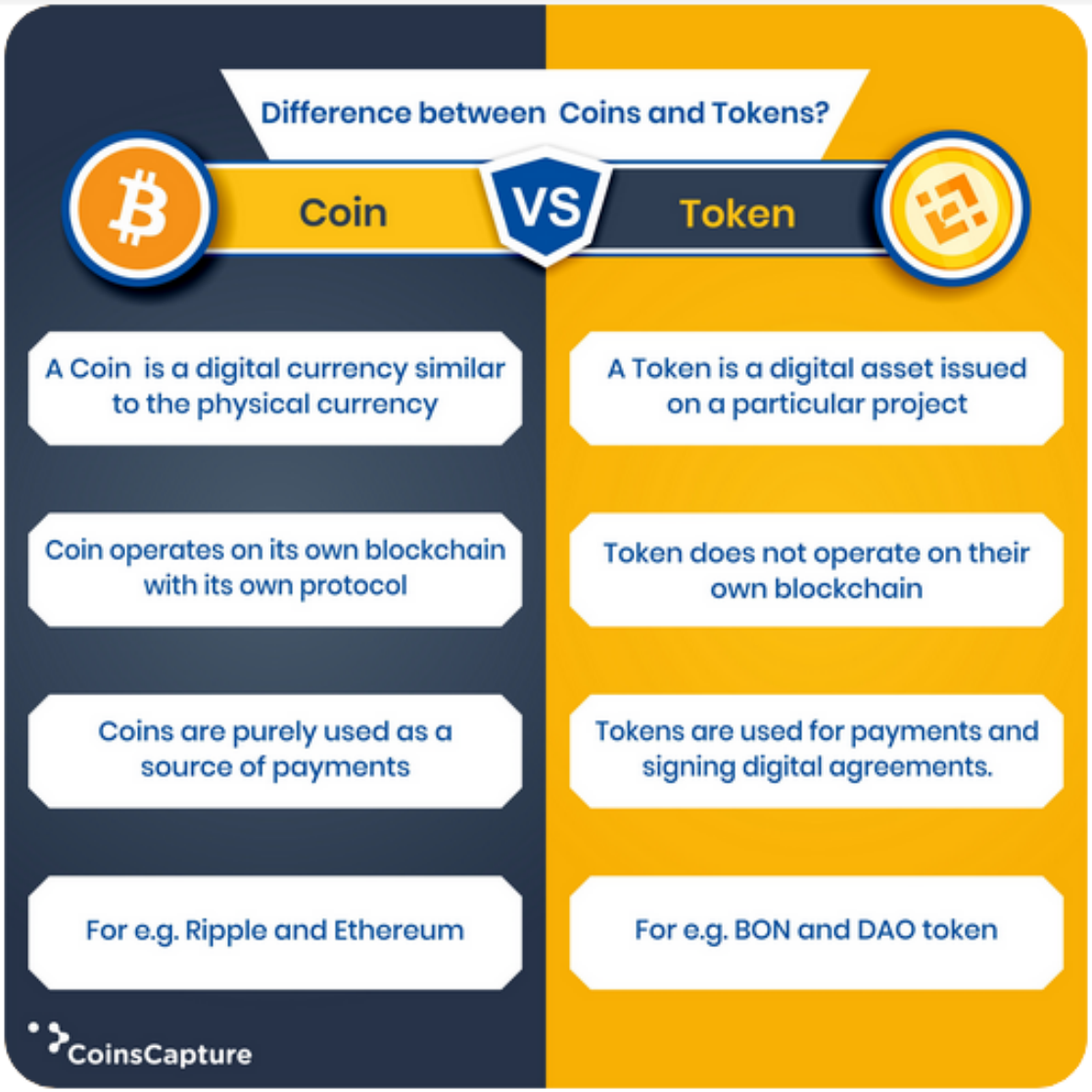
Bitcoin ATM



- Alternative coin (altcoin)
  - Similar to Bitcoin in the way they work (mostly but not always)
  - Need for miner machines (not always for "tokens")
  - Promises a Technology (should but not always as "meme" coins)

Cryptocurrency

Coin versus Token



Cryptocurrency

Coin versus Token

CRYPTOCURRENCY

COINS

LAYER 1 TECH

01 Unit Of Accounting

02 Medium Of Exchange

03 Store of Value

04 Built INTO the Blockchain

05 Technologically: you are the sole owner of the asset. Your private keys are directed at the asset/storage and you directly own the asset

CRYPTOCURRENCY

TOKENS

LAYER 2 TECH

01 Unit Of Accounting

02 Medium Of Exchange

03 Store of Value

04 Built ON TOP of a Blockchain

05 Technologically: you are given the allowance to spend the asset that you receive, thereby the token is forever owned by the contract creator

Ethereum - It allows running various applications (decentralized app - dapp) on its infrastructures with smart contract. It is possible to develop smart contracts on **Ethereum Virtual Machine** with high-level languages such as **Solidity**.

Cryptocurrency

Ethereum - Vitalik

Cryptocurrency

Ethereum - Vitalik Quote

Whereas most technologies tend to automate workers on the periphery doing menial tasks, blockchains automate away the center. Instead of putting the taxi driver out of a job, blockchain puts Uber out of a job and lets the taxi drivers work with the customer directly.

Vitalik Buterin

Cryptocurrency

Ethereum - Vitalik Quote

"A smart contract is a mechanism involving digital assets and two or more parties, where some or all of the parties put assets in, and assets are automatically redistributed among those parties according to a formula based on certain data that is not known at the time the contract is initiated."

Vitalik Buterin
Co-Founder And Inventor Of Ethereum

A Next-Generation Smart Contract and Decentralized Application Platform

Satoshi Nakamoto's development of Bitcoin in 2009 has often been hailed as a radical development in money and currency, being the first example of a digital asset which simultaneously has no backing or "intrinsic value ↗ " and no centralized issuer or controller. However, another, arguably more important, part of the Bitcoin experiment is the underlying blockchain technology as a tool of distributed consensus, and attention is rapidly starting to shift to this other aspect of Bitcoin. Commonly cited alternative applications of blockchain technology include using on-blockchain digital assets to represent custom currencies and financial instruments ("colored coins" ↗), the ownership of an underlying physical device ("smart property" ↗), non-fungible assets such as domain names ("Namecoin" ↗), as well as more complex applications involving having digital assets being directly controlled by a piece of code implementing arbitrary rules ("smart contracts" ↗) or even blockchain-based "decentralized autonomous organizations ↗ " (DAOs). What Ethereum intends to provide is a blockchain with a built-in fully fledged Turing-complete programming language that can be used to create "contracts" that can be used to encode arbitrary state transition functions, allowing users to create any of the systems described above, as well as many others that we have not yet imagined, simply by writing up the logic in a few lines of code.

How many Bitcoin nodes?

Cryptocurrency

Bitcoin nodes(reachable)

https://bitnodes.io

REACHABLE BITCOIN NODES

Updated: Sun Sep 29 15:30:39 2024 +03

18822 NODES CHARTS

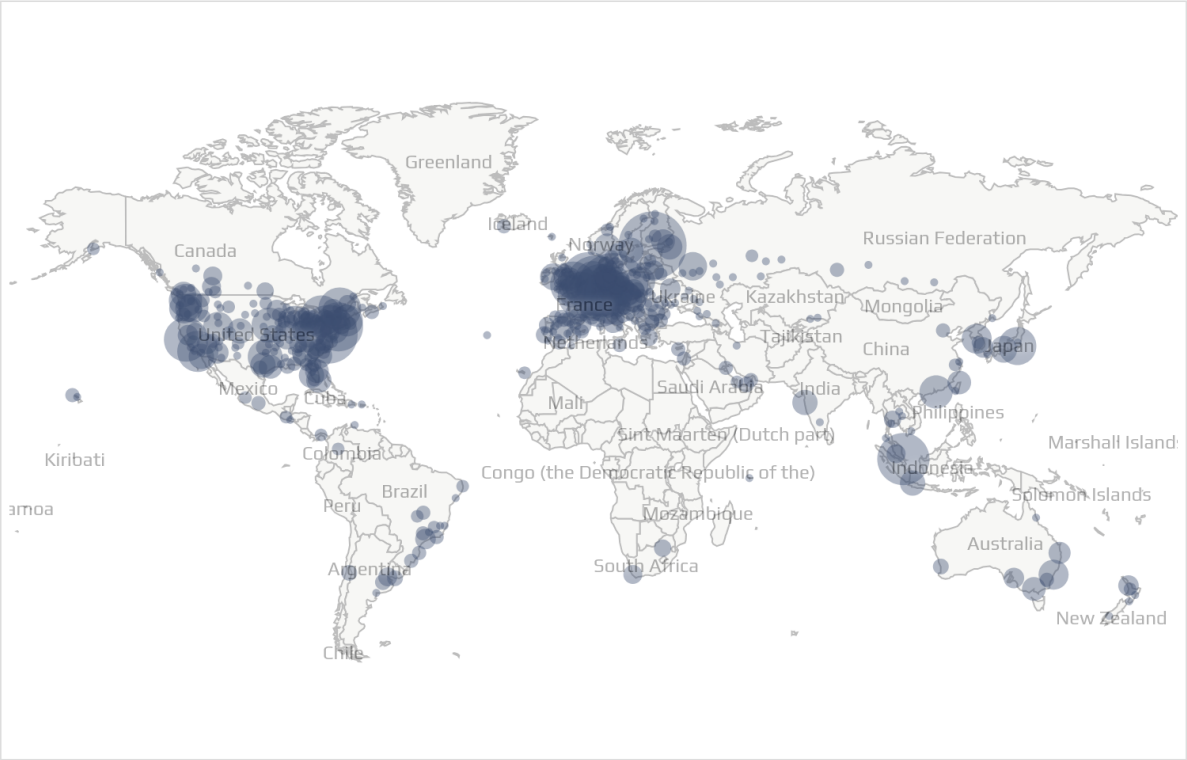
IPv4: -3.1% / IPv6: -5.6% / .onion: +10.7%

Top 10 countries with their respective number of reachable nodes are as follows.

RANK	COUNTRY	NODES
1	n/a	11981 (63.65%)
2	United States	1918 (10.19%)
3	Germany	1355 (7.20%)
4	Finland	402 (2.14%)
5	France	372 (1.98%)
6	Netherlands	338 (1.80%)
7	Canada	278 (1.48%)
8	United Kingdom	206 (1.09%)
9	Switzerland	184 (0.98%)
10	Singapore	158 (0.84%)

All (90) »

NOTE / The data above includes reachable nodes only. View global nodes here »

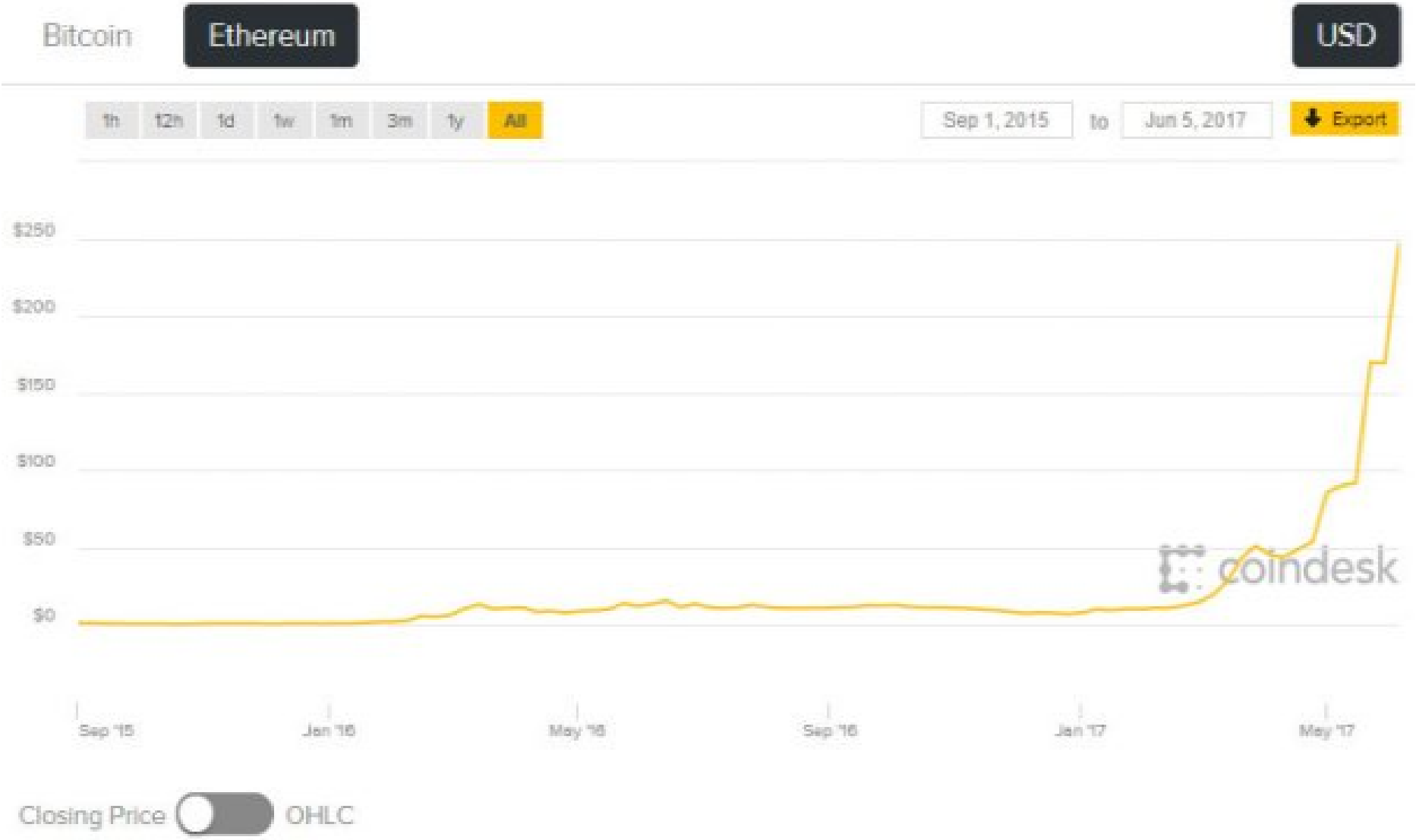


Map shows concentration of reachable Bitcoin nodes found in countries around the world. LIVE MAP

- PoW: requires miners to solve complex mathematical problems, consuming significant energy
- POS Eliminates the need for energy-intensive mining.
  - POS: Validators are chosen to create blocks based on the amount of ETH they stake (hold as collateral).
  - Expected to reduce Ethereum's energy consumption by 99.95%.

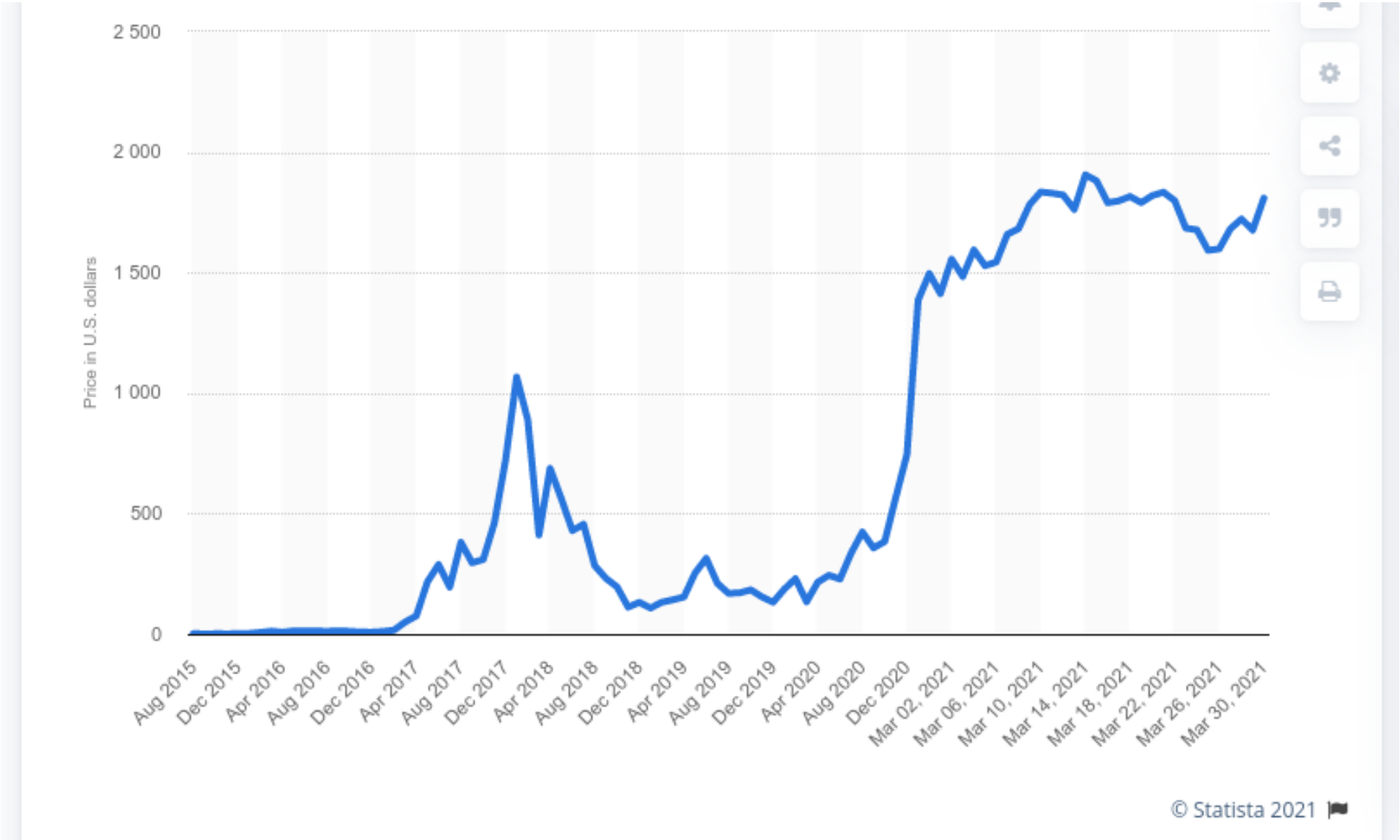
Cryptocurrency

Economy - Value (where I started tracking)



Cryptocurrency

Economy - Value - Meme Coins

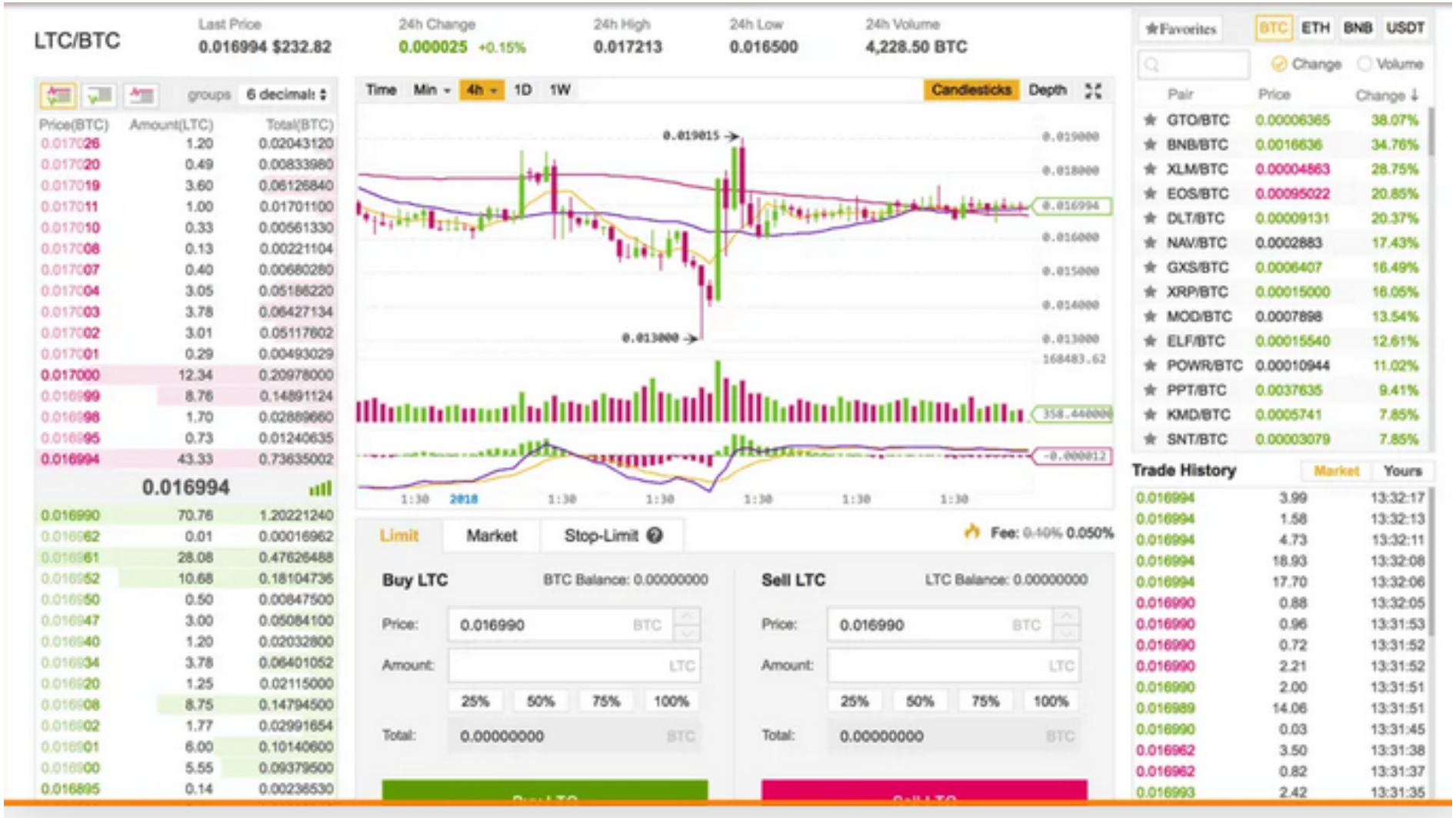


Cryptocurrency

Economy - Value

Cryptocurrency

Exchange



Cryptocurrency

Humor

Staking

WHAT IS STAKING?

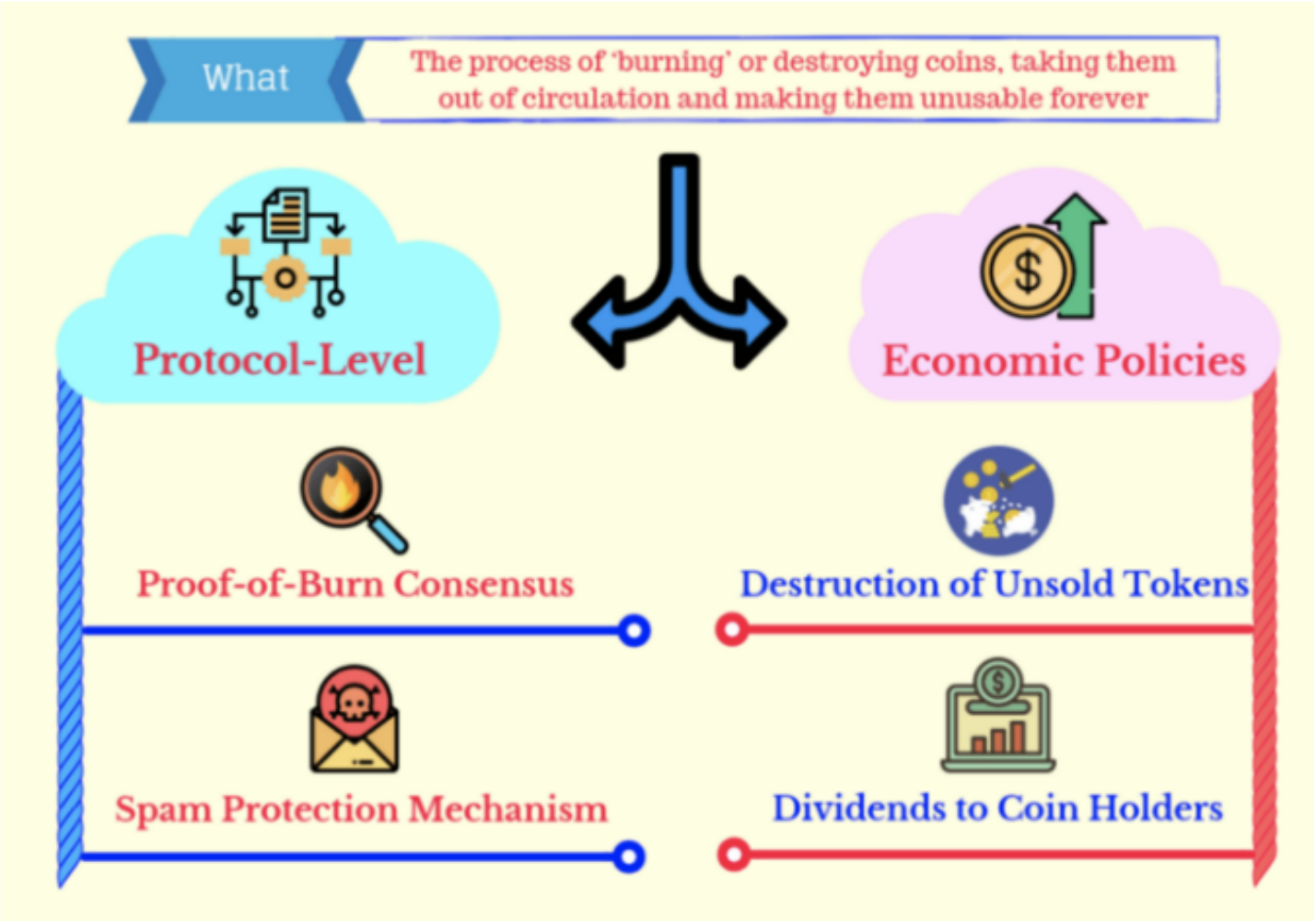
Staking means participants hold their cryptocurrency funds in a wallet and thus support the blockchain's functionality. Stakeholders lock their tokens in their wallets. In return, they are rewarded by the network.

Participants become an important part of the network's security infrastructure, acting as validators.

Staking income is offered in the form of interest paid to the holder.

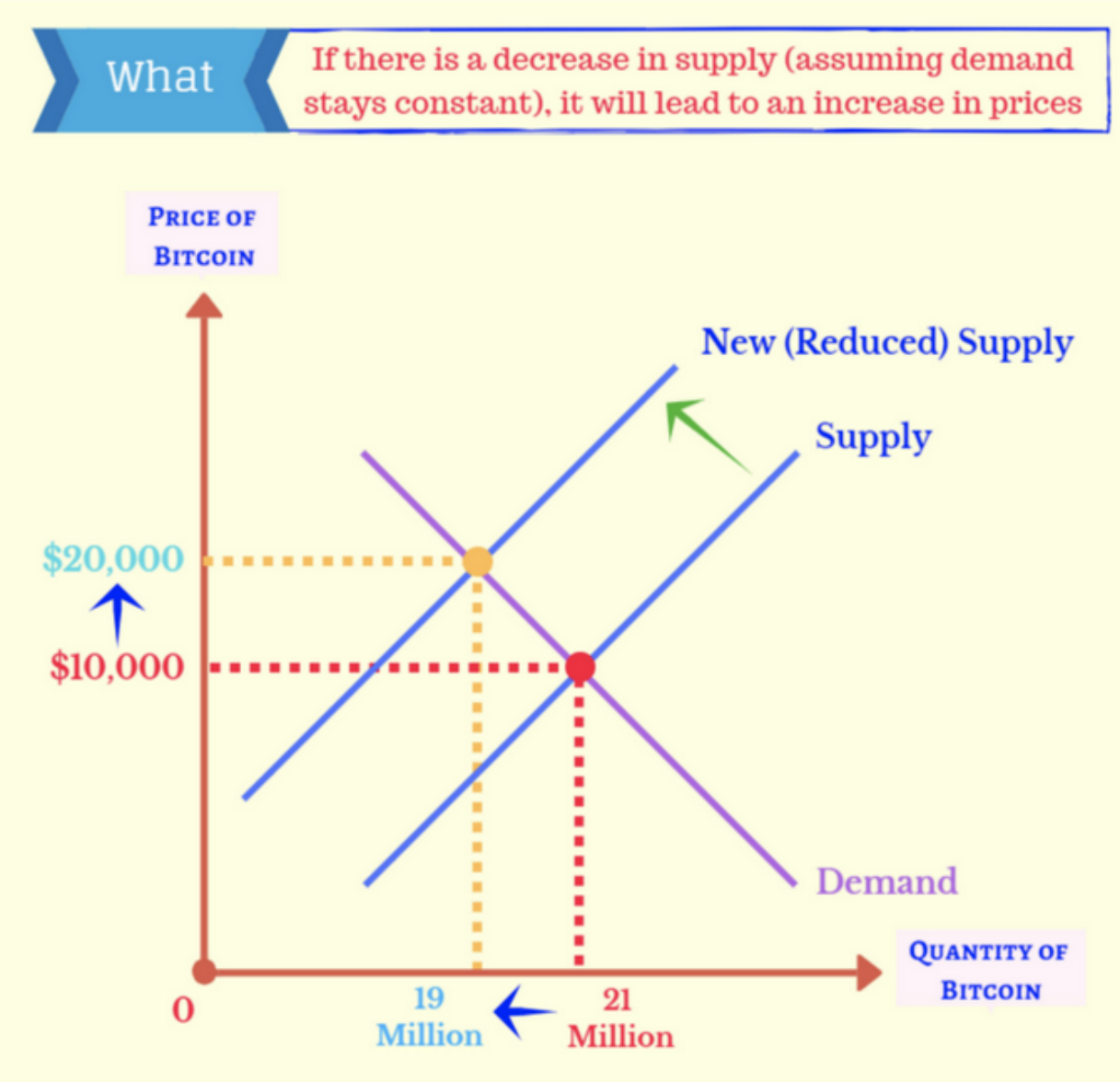
Coin burning[3]

Categories



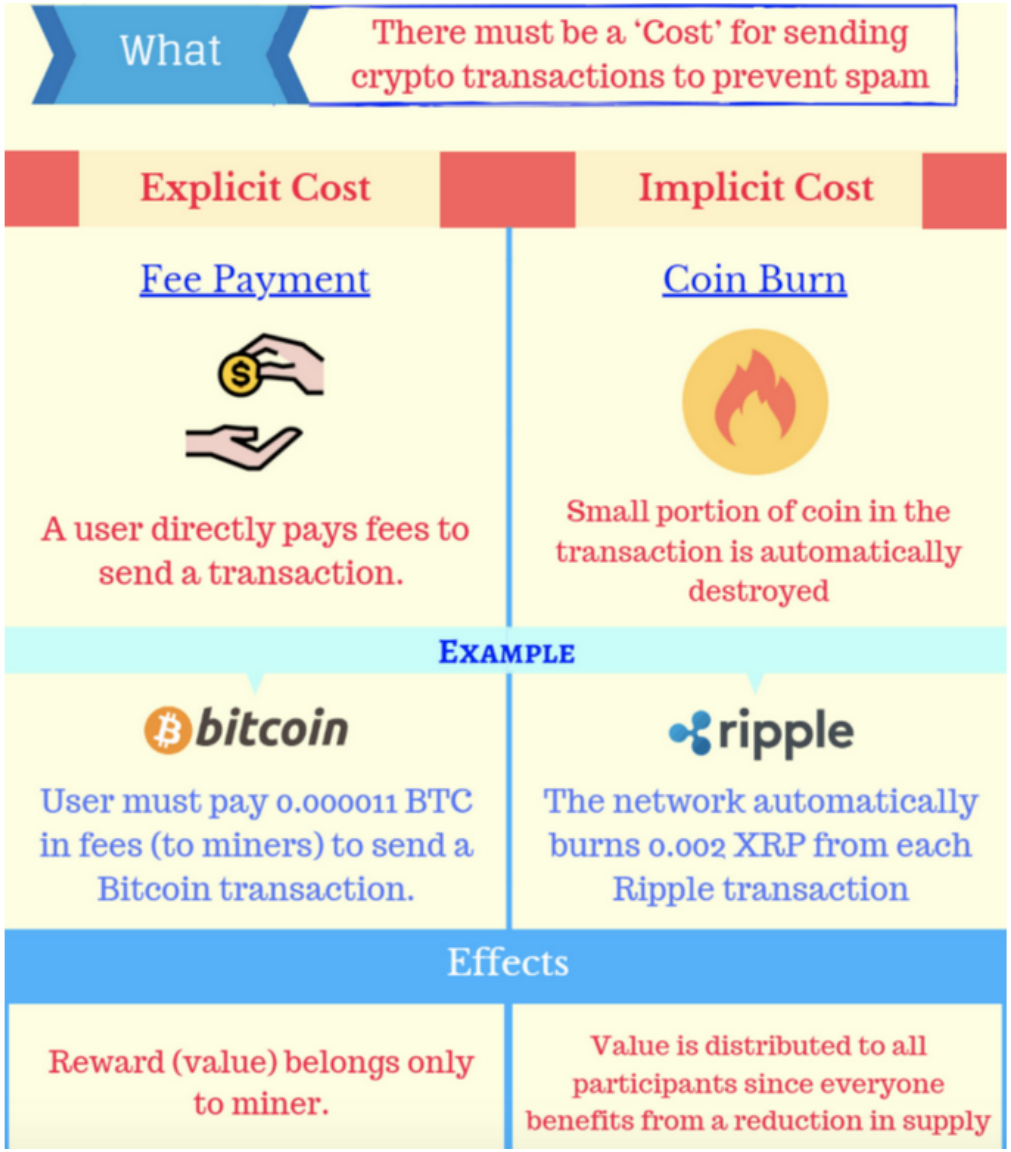
Coin burning to[3]

Increase Value of Coins

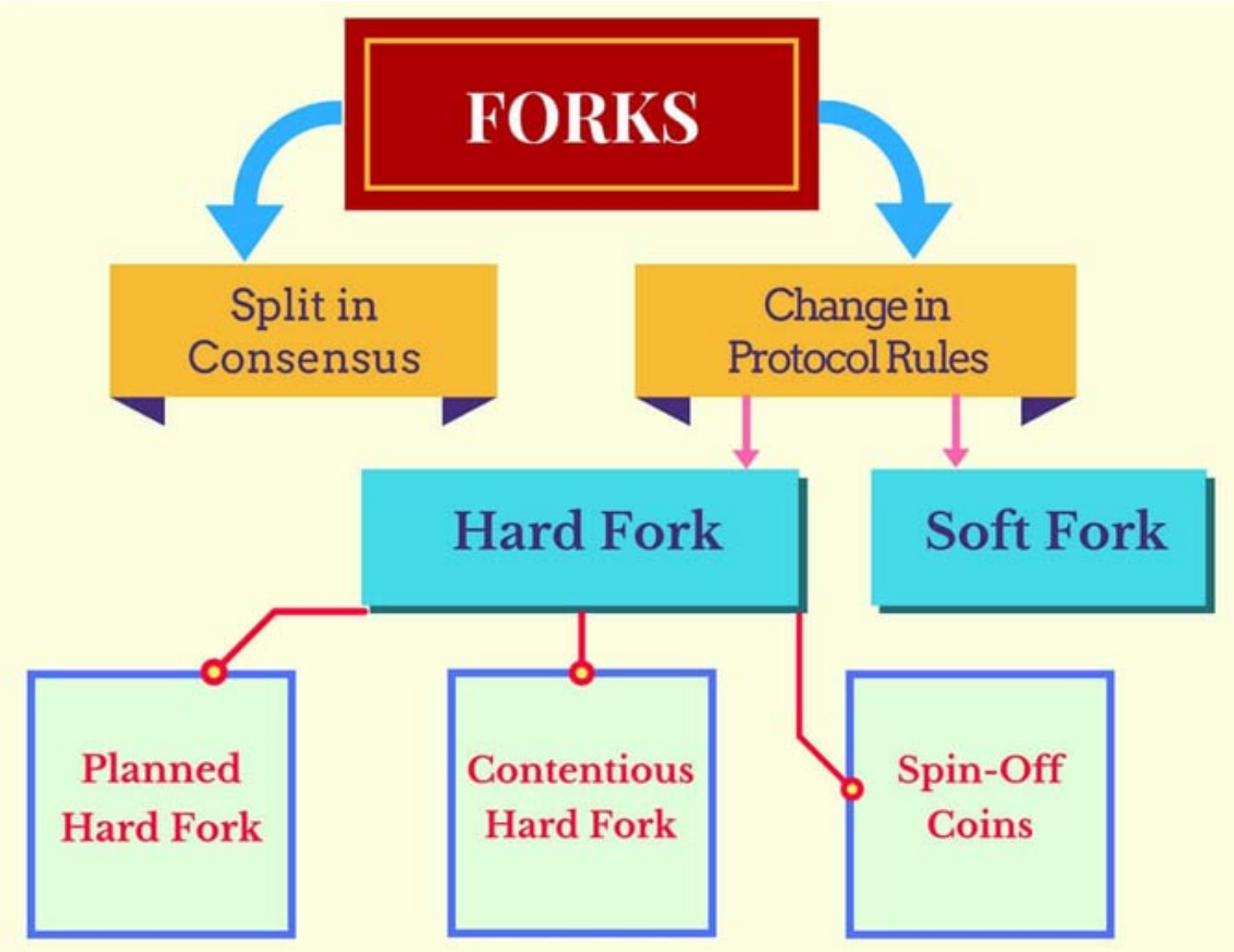


Coin burning to [3]

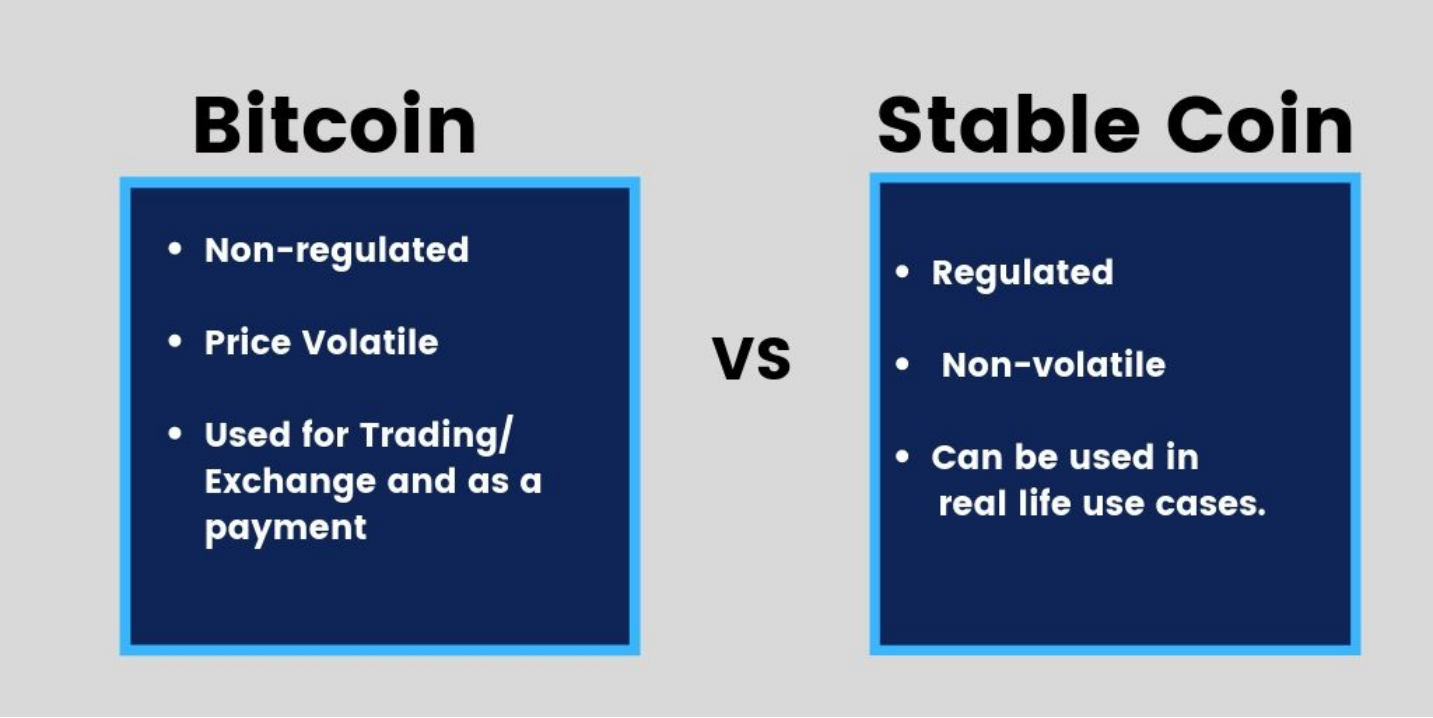
Protection Against Spam



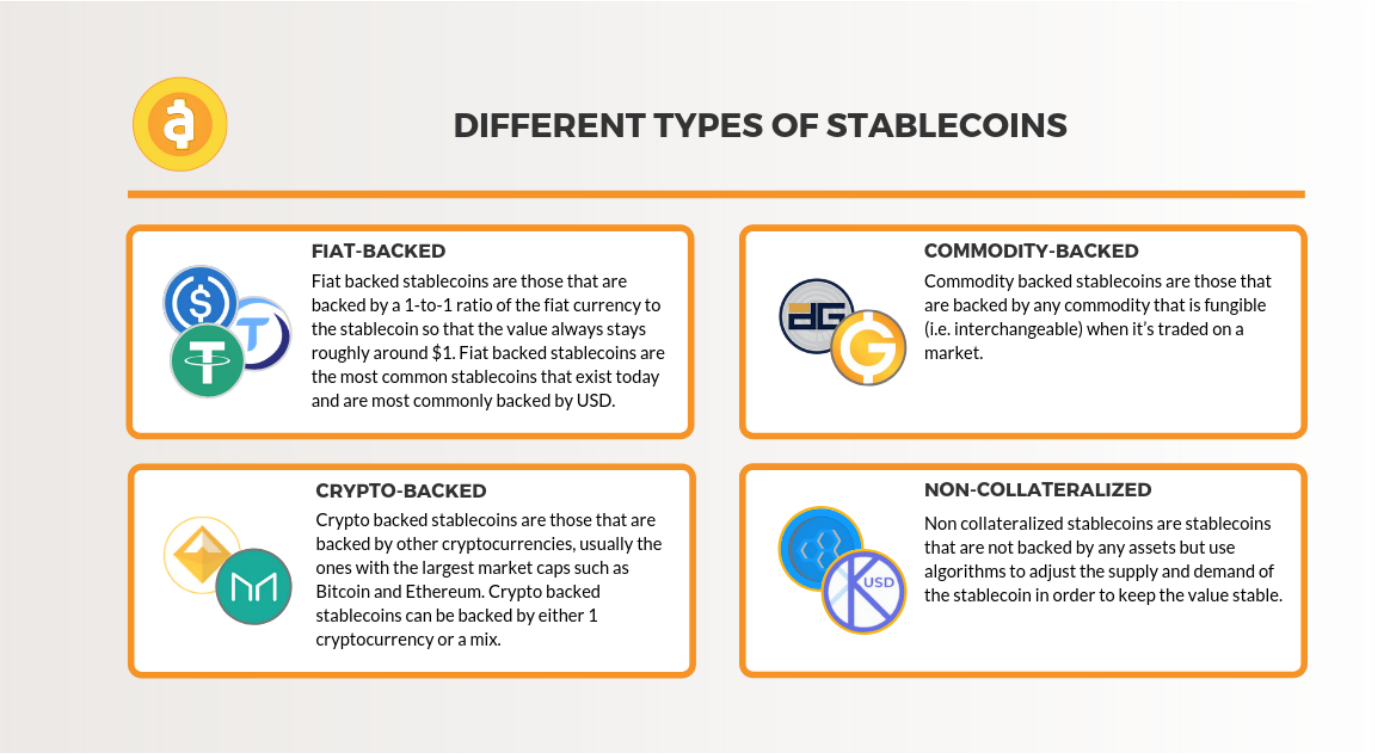
Forks[5]


FORKS
Split in Consensus
Change in Protocol Rules
Hard Fork
Soft Fork
Planned Hard Fork
Contentious Hard Fork
Spin-Off Coins

Stable Coins



Stable Coins



Stable Coins

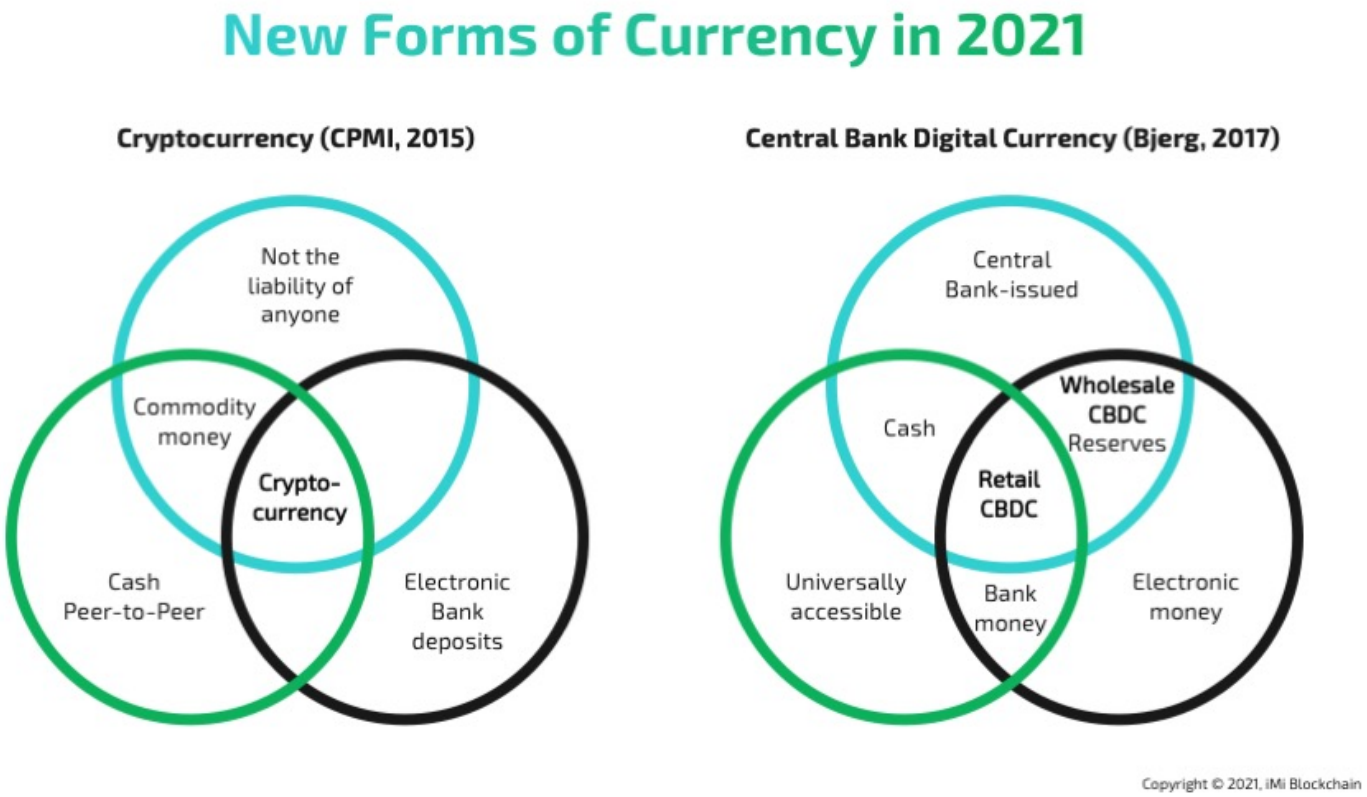
Types	issue company	issue time	asset-backed by	Issue principle	supervision mechanism
USDT	Tether	Februray 2015	USD	Bitcoin blockchain	Every USDT token issued, they will be backed by a US Dollars in their reserve account. But didn't provide any official documentation or audits.
TUSD	TrustToken	March 2015	USD	Ethereum blockchain	Collateralized, legally protected, and transparently verified by third party Accounting Firm (Cohen & Co)
USDC	Coinbase and Circle	May 2018	USD	Ethereum blockchain	Collateralized by a corresponding USD held in accounts subject to regular public reporting of reserves.
PAX	Paxos	September 2018	USD	Ethereum blockchain	Subject to US government supervision, and audited by Withum. A monthly report on mortgage assets is provided, and PAX also discloses its smart contracts.
EUSD	Epay	January 2019	USD	Ethereum blockchain	Regularly publish third-party audit reports to verify the transparency and legality of it.
DAI	MakerDAO	December 2017	Ether	Ethereum blockchain	Economic incentives ensure that the value is maintained.

Stable Coins

Stablecoins

	USDT	TUSD	USDC	PAX	GUSD	DAI
Company	Tether	Trust Token	Circle	Paxos Trust	Gemini	Maker
Maket Cap	1.9B	215.3M	226.9M	152.4M	103.8M	57.4M
Volume	6B	82.9M	52.2M	85.8M	38.3M	5.1M
Pairs	400	115	64	59	49	46
Rank	No.8	No.28	No.26	No.35	No.47	No.67

Made by JOYSO


New Forms of Currency in 2021
Cryptocurrency (CPMI, 2015)
Not the liability of anyone
Commodity money
Crypto-currency
Cash Peer-to-Peer
Electronic Bank deposits
Central Bank Digital Currency (Bjerg, 2017)
Central Bank-issued
Cash
Wholesale CBDC Reserves
Retail CBDC
Universally accessible
Bank money
Electronic money
Copyright © 2021, iMi Blockchain

Cryptocurrency

Humor - for the many things that we can't cover now

- A financial system built on blockchain technology that removes traditional intermediaries (banks, brokers).
- Allows users to access financial services directly through smart contracts
- Key Use Cases in DeFi
  - Lending/Borrowing (Aave, Compound)
  - Liquidity Pools (Uniswap, SushiSwap)
  - Decentralized Exchanges (DEXs) (Uniswap, PancakeSwap)
- A paradigm shift in finance, empowering users with new financial tools
- Be aware of security risks and carefully assess the platforms used

- Financial Privacy: Protects users from surveillance by governments, corporations, or hackers.
- Use Cases: Ideal for those needing enhanced privacy, such as journalists, activists, or individuals in oppressive regimes.
- Debates and Risks:
  - Regulatory Scrutiny: Privacy coins face higher regulation due to their potential use in illegal activities.
  - Exchanges: Some exchanges delist privacy coins due to compliance concerns.
- Monero (Ring Signatures, Stealth Addresses) and Zcash (zk-SNARKs) offer two different approaches to privacy, both important for protecting financial data in an increasingly transparent world.


Turkcell LTE
23:20
Tweet
Alphan Manas
@alphanmanas
Emniyet çoğunlukla suça dahil olan silah, mühimmat, uyuşturucu vs'yi yakaldıktan sonra dizerek sergiliyor. Bu kez konu 'Siber Suç' olunca ilginç olmuş.
Translate from Turkish
SİBER SUÇ. MÜC. ŞUBE MÜDÜRLÜĞÜ

- Regulatory frameworks aim to address the risks associated with cryptocurrencies; fraud, money laundering, market manipulation.
- The landscape of regulation is rapidly evolving as governments and institutions seek to balance innovation with consumer protection.
  - America:
    - Securities Act of 1933 determines if cryptocurrencies are classified as securities.
    - FINCEN Regulations: Cryptocurrency exchanges must comply with anti-money laundering (AML) laws.
  - European Union: Markets in Crypto-Assets (MiCA) regulation to create a comprehensive framework for cryptocurrencies across EU.
  - China: Strict Regulations, banning all trading and Initial Coin Offerings (ICOs) since 2021.

- Government Has interest in regulating cryptocurrencies but has not yet to implement comprehensive legislation.
  - 2020 Presidential Annual Program - "kripto varlık"
  - Bans on Payments: In 2021, the Central Bank prohibited the use of cryptocurrencies for payments, citing risks.
  - New taxes?: The Ministry of Treasury and Finance is working on a framework that may include taxation and AML measures.
  - SWIFT Alternatives (SFPS?)
  - Municipalities
  - civil society ?

Cryptocurrency

The agenda can surprise at any time


I HAVE NO IDEA
WHAT I'M DOING
ME 24 HOURS AGO
ME TODAY

Metaverse Loading ...

Conclusion

Cryptocurrency will be in our lives much more intensely in the future, but first of all,

- should not be seen as just an easy way to make money (Remember every boost is temporary if you can "live without it"...)
- should have more applications - use in our life...
- It should not conflict with the (Decentralized) Philosophy
  - Countries
  - Companies (Facebook etc.)

Conclusion (ctd.)

- Technology should be studied
  - should become easier to use
  - Needs to be faster, scalable
  - Systems that consume less energy should be developed
  - Must offer different "decentralized" services

Conclusion (ctd.)

- Price fluctuations should become more stable
  - Not based on a technological development that will enable its valuation
  - Speculation and manipulations (with the so-called comments of social media phenomena...)
  - So-called sponsorships
  - Pump groups ...
- Legal arrangements should be made

Conclusion (ctd.)

- Should be cleaned of system abusers...
  - Which have no technology behind it
  - Promises high profits and ends the project after raising the money
- In particular, DeFi (decentralized finance); environments should be created where technology can be studied academically.

End of Section One - Waiting for Your Questions...

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MSKU Blockchain Research Group
http://wiki.netseclab.mu.edu.tr/index.php?title=MSKU_Blockchain_Research_Gr

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