OST
Eastern Switzerland
University of Applied Sciences

Distributed Systems & Blockchain (DS1)

Bitcoin/Blockchain I

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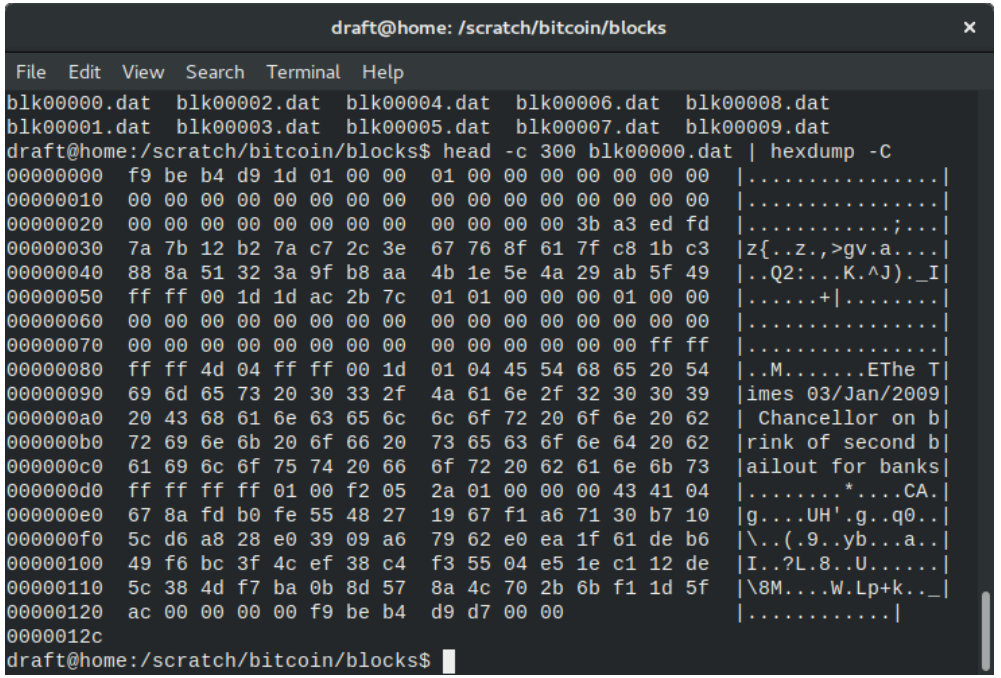
19 April 2021

Introduction

- Bitcoin is an experimental digital currency
  - Bitcoin is fully peer-2-peer (no central entity)
  - 1st Bitcoin issued on January 3, 2009
  - Smallest unit: 0.00000001 BTC (1 satoshi)
- Key characteristics
  - Maximum of ~21 million BTC
  - Every transaction broadcast to all peers
    - Every peers knows all transactions (~340 GByte as of today)
  - Validation by proof-of-work (partial hash collision)
    - Difficult to fake proof-of-work
    - No double-spending
- The initiator is unknown so far



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Who is Satoshi Nakamoto?

- The New Yorker believes that Satoshi Nakamoto was Michael Clear.
  - Analyzed texts from Nakamoto and searching for linguistic clues
  - 2nd possible candidate Vili Lehdonvirta
- Fast Company argues its either Neal King, Vladimir Oksman, or Charles Bry.
- Other names suggested: Martii Malmi (involved in Bitcoins since the beginning), Jed McCaleb (founder of Ripple), Donal O'Mahony, Michael Peirce, Hitesh Tewari (authors of Electronic Payment Systems for E-Commerce 2nd edition), Shinichi Mochizuki (Math Prof. Kyoto University), Hal Finney, Michael Weber, Wei Dai, Nick Szabo, Craig Wright (wired article),
- Dorian S Nakamoto (a guy with the same name)

- Satoshi is probably rich, first miner, may have ~1mio BTC
- Craig Wright, May 2016: «I'm Satoshi Nakamoto», fails to deliver proof

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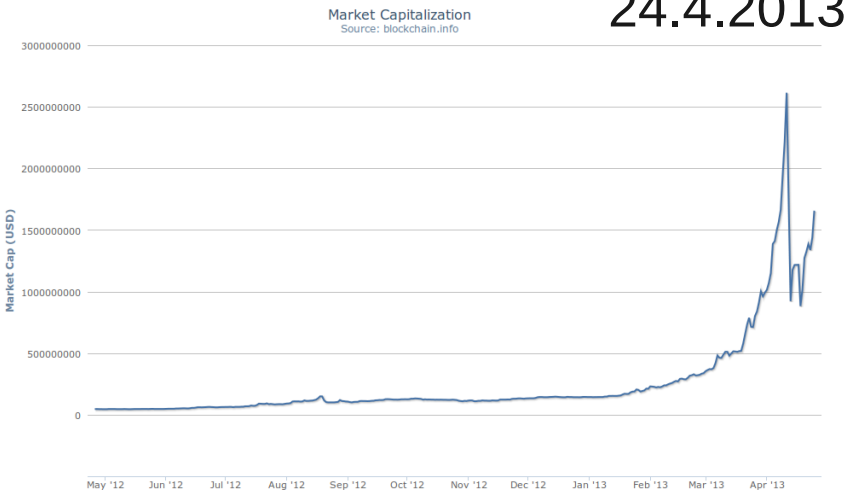
Bitcoin‘s Market Capitalization in USD

- Bitcoin boom, started in 2013 – current price

10.4.2013

24.4.2013



26.4.2014

22.4.2015

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Bitcoin‘s Price USD 2021

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The Rise and Fall of Bitcoin

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About Babbage

In this blog, our correspondents report on the inters… between science, technology, culture and policy. T… takes its name from Charles Babbage, a Victorian mathematician and engineer who designed a mec… computer.

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BITCOIN, DIE DEVISE IM WEB

07. Juni 2011 07:15; *Akt: 07.06.2011 09:11*

Der gefährliche Cyber-Dollar

von Gérard Moinat - Die Online-Währung Bitcoin wirft hohe Wellen. Es sei das «gefährlichste Open-Source-Projekt aller Zeiten» und «gefährde

Bitcoins in the News

As of 2021

- 15.04.2021, Handelsblatt
  «Coinbase-IPO beflügelt Bitcoin – Rekordmarke bleibt in Sicht»
- 17.04.2021, TagesAnzeiger
  «Geldblog: Immobilien, Aktien, BitcoinWie schütze ich mein Vermögen vor Inflation?»
- 13.04.2021, NZZ
  «Bitcoin: Die Kritik wächst, der Wert aber auch»
- 16.04.2021, 20min
  «Darum geht der Dogecoin durch die Decke»
- 16.04.2021, finews
  «Bitcoin: Exakt soviel gehört in ein ausgewogenes Portfolio»

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Bitcoin - Introduction

- Not relying on trust, but on strong cryptography
- Weak anonymity (pseudonimity)
  - All peers know all transactions
  - Clustering: e.g. if a transaction has multiple input addresses, assume those addresses belong to the same wallet. (example)
- Not controlled by a single entity
  - Development community, no central bank – forks – Bitcoin Cash, SV
- BIP: Bitcoin Improvement Proposals
- Bitcoins can be exchange for real currencies
  - Several companies allow to exchange BTC for Dollar, Euro, …
- US, CH considered Bitcoin friendly, China (energy), Turkey not that much

Bitcoin in Numbers / Fake Volume

- 1 BTC ≈ 56422 US$ (19.04.2021)
- Total of 18.6 Million BTC mined
  - Market capitalization of 1.1 Trillion US$
  - Volume fake? E.g., CoinBene, RightBTC
- Spread, e.g. ETH
- High spread, should be around 0.01USD

9	Bitfinex	ETH/USD	$2,405.70	$22,429,625	$8,879,712	$149,025,250	0.47%	High	645	Recently
10	Bitstamp	ETH/USD	$2,409.14	$2,117,937	$2,415,352	$120,185,425	0.38%	High	396	Recently
11	Binance	ETH/EUR	$2,423.08	$731,224	$1,017,017	$114,211,638	0.36%	High	727	Recently

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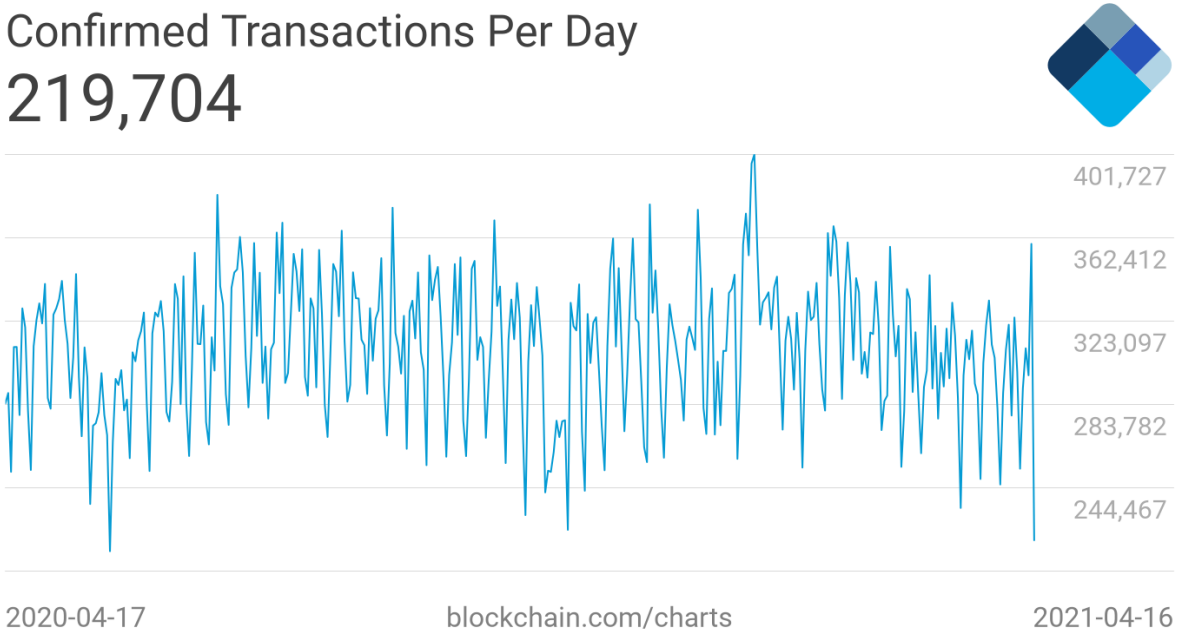
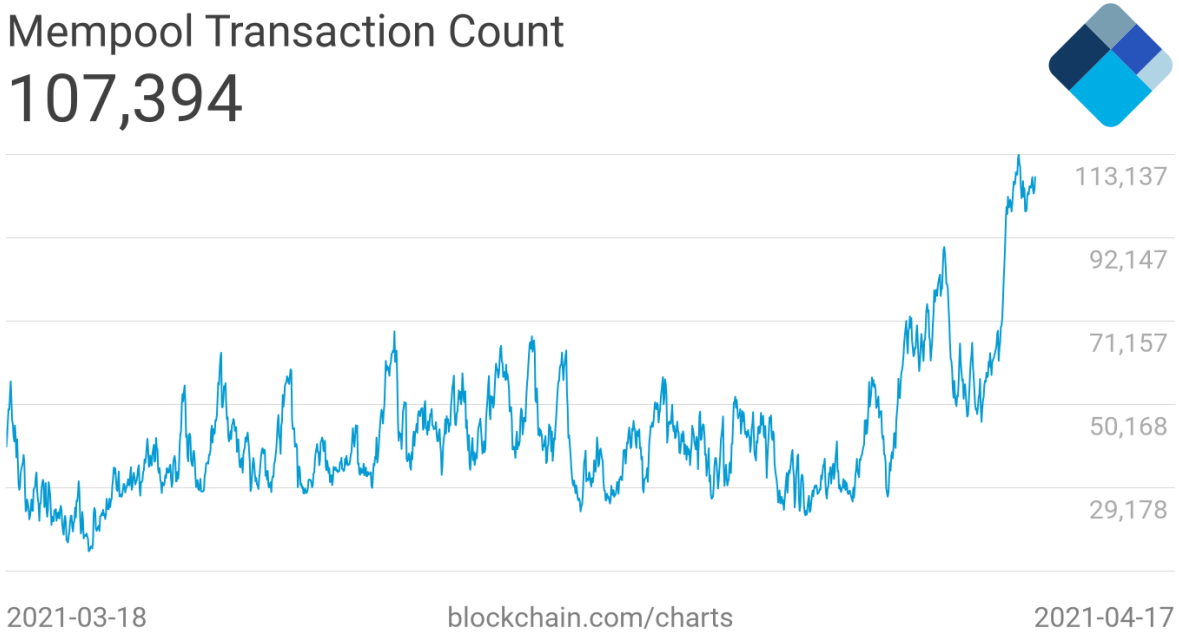
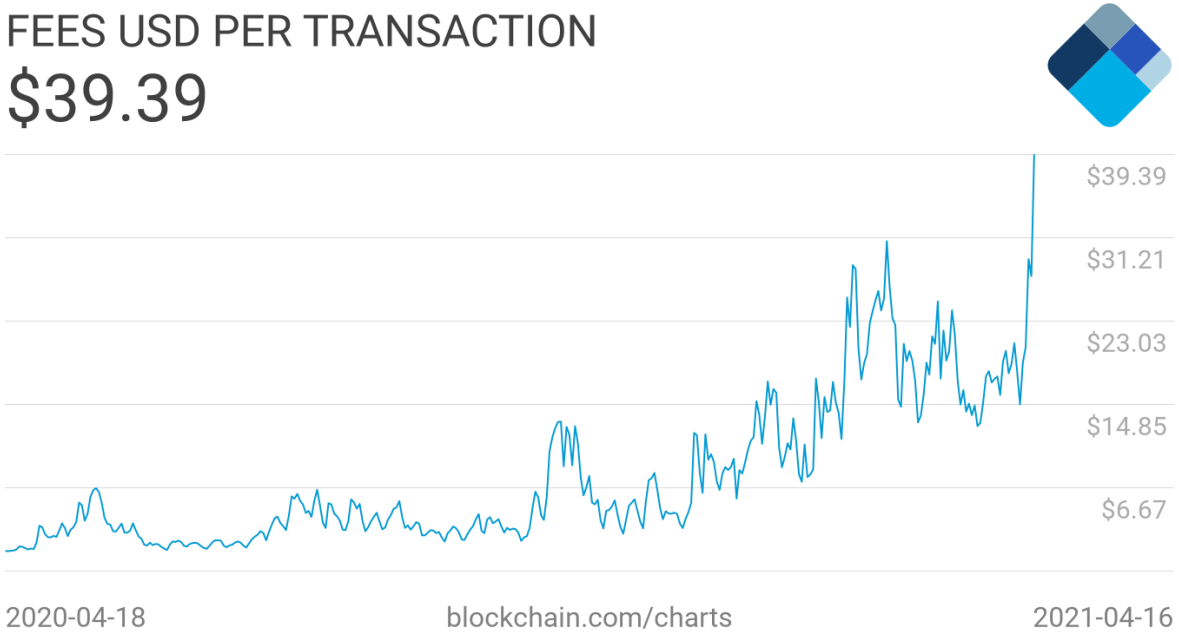
Bitcoin Transactions

- 450,000 transactions per day (highest)
  - ~2-5 transactions per second
- 150,000 BTC traded per day
- Transaction fees per day ~ 140 BTC

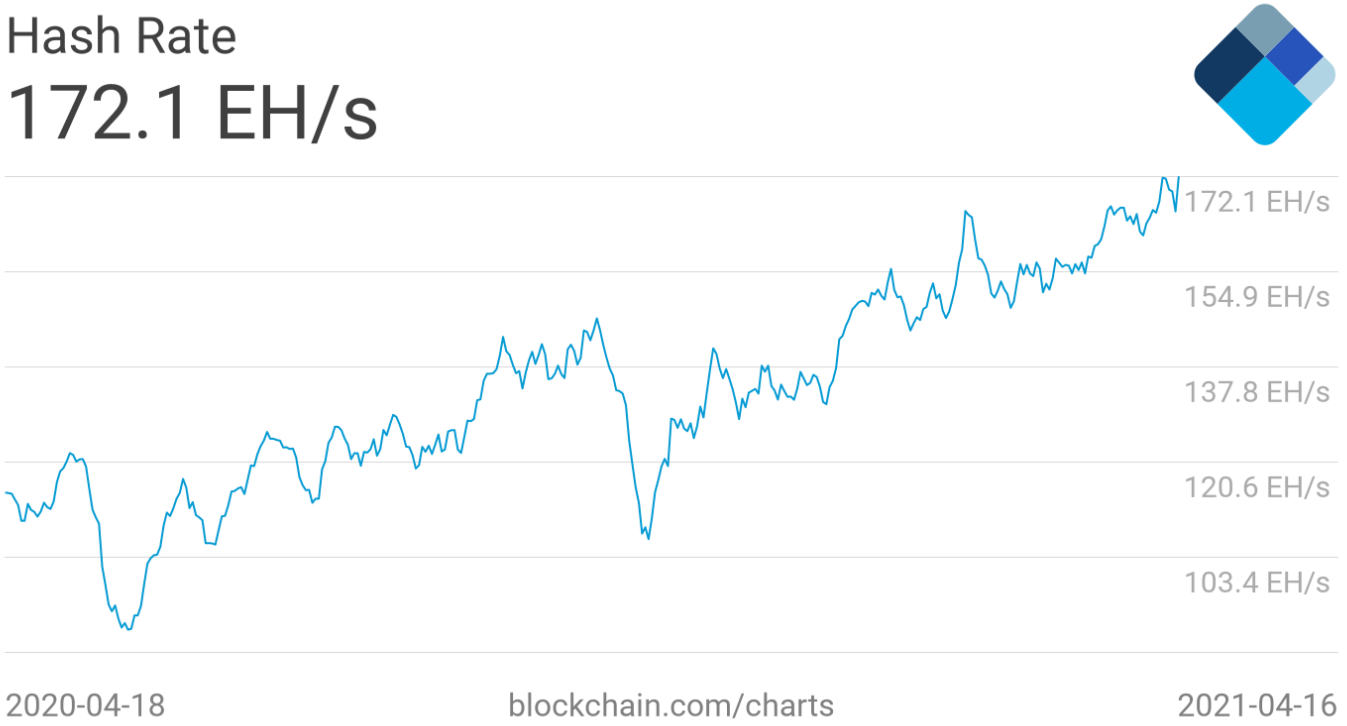


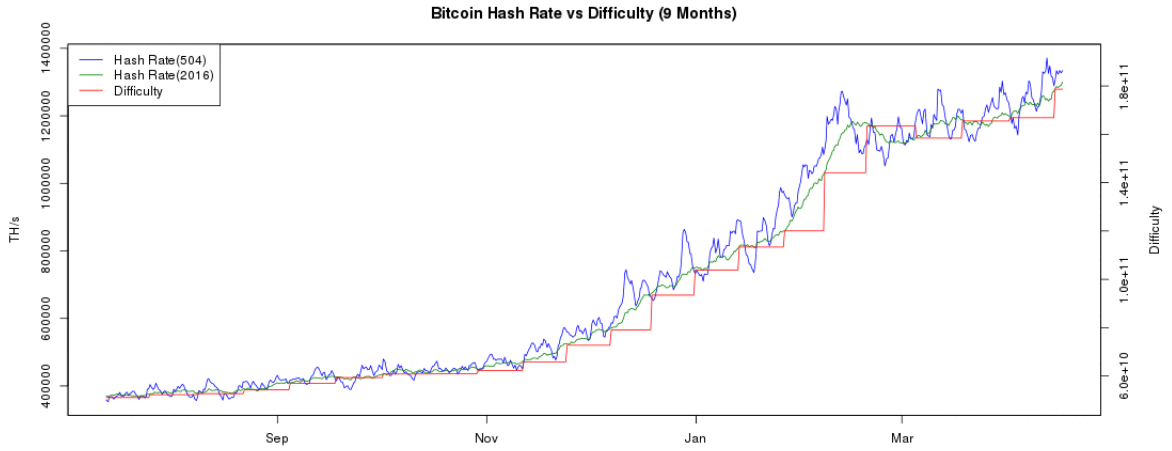




Bitcoin Numbers

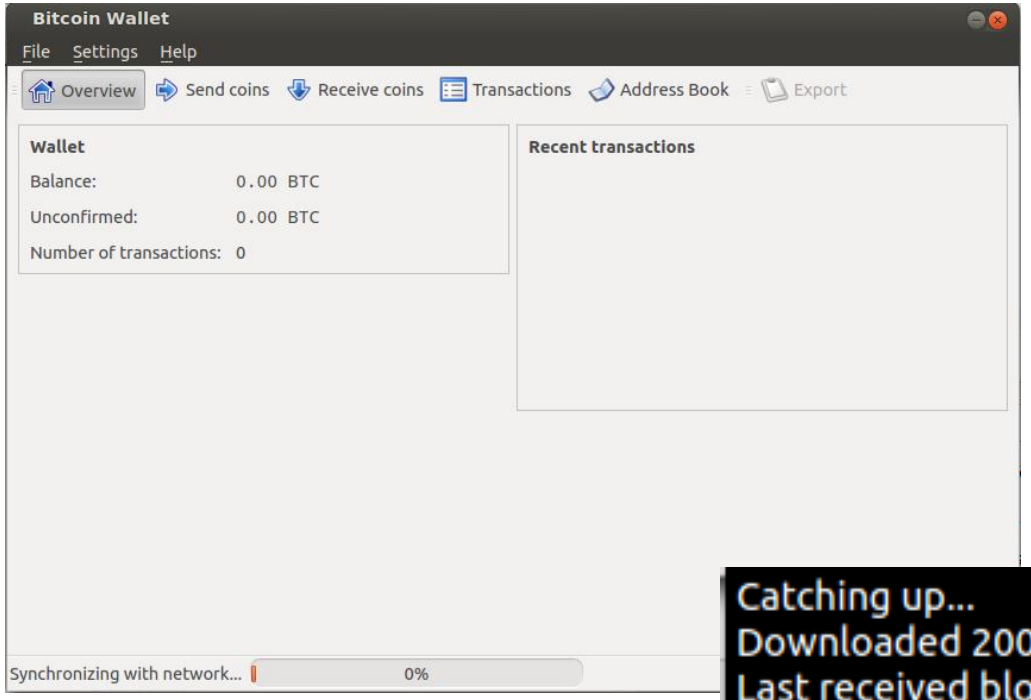
- Network Hashrate
  - ~2.1 YottaFLOPS in 2021
  - ~1.4 YottaFLOPS in 2020
  - ~635 ZettaFLOPS in 2019
  - ~4 ZettaFLOPS in 2015
  - ~714 ExaFLOPS in 2014
  - ~900 PetaFLOPS in 2013
  - ~155 PetaFLOPS in 2012
- Adjust time: ~14 days
- Fastest supercomputer (top500.org) Summit
  148 PetaFLOPS (max), all
  500 ~6 ExaFLOPS
- Fugaku with 442 PetaFLOPS
  - exascale-level processing

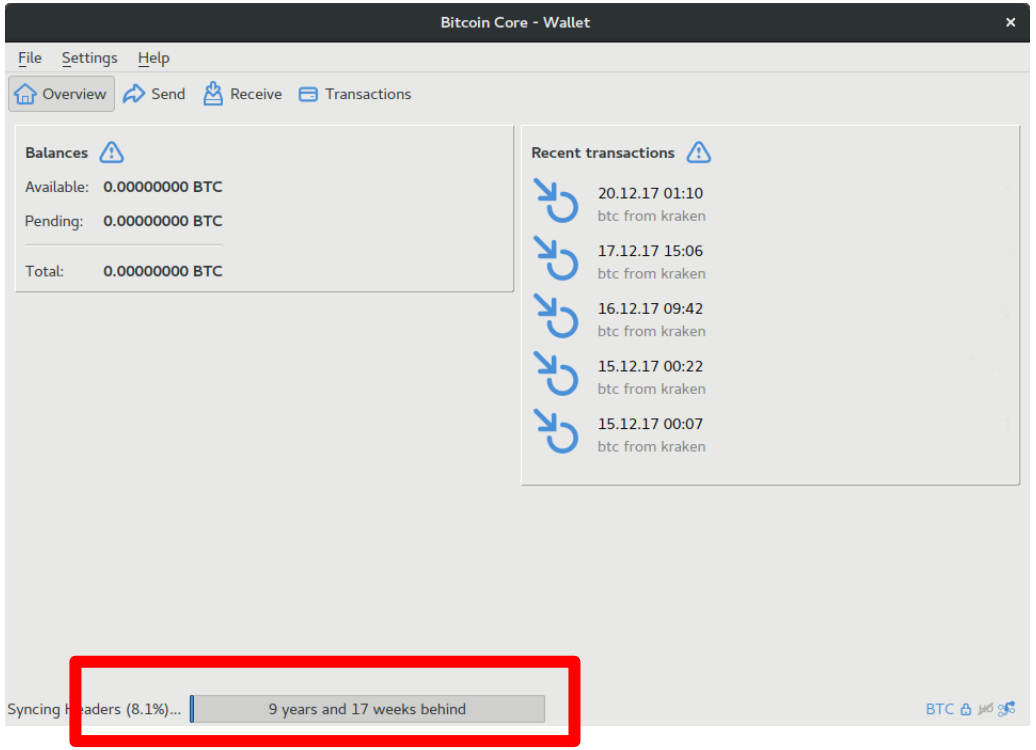




Bitcoin Example

- Bitcoin is also the name of the software
  - 2012: ~2 hours and 1.8G less disk space later…
  - 2013: 8G disk space
  - 2014: 19G disk space
  - 2015: 36G disk space, 2016: 71G, 2019: 220 GB





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Bitcoin Example

- Not easy to buy BTC…
  - Especially with credit cards / paypal / okpay

- Decided to transfer via bank
  - SWIFT (financial messaging network) fee 25CHF, send 20USD
  - Exchange rate 0.94000 → fee of 1,000 Yen → ~7.2USD

- Spend 43.80 CHF for ~1.42 lousy BTC (2012) on Mt.Gox

- Now, transfer with bitstamp, kraken: register, proof of residency, SEPA bank transfer → easier

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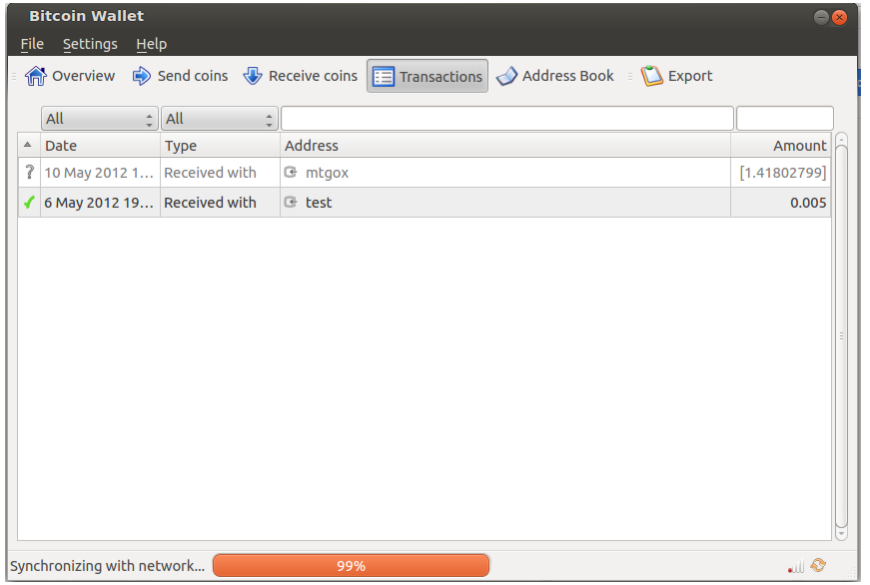
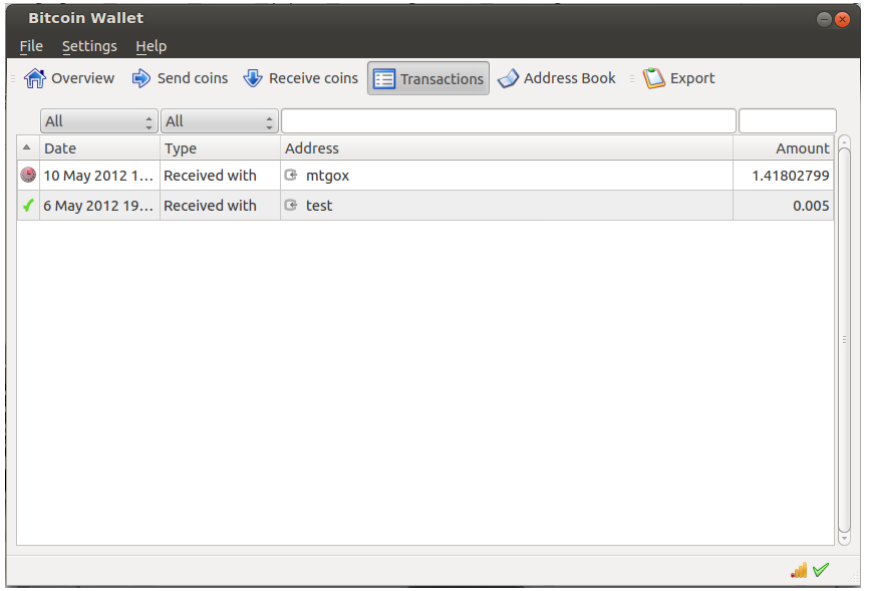
Bitcoin Client

- 2012: Not easy to buy BTC… (credit cards / paypal)
- 2016: more market places
  - http://coinbase.com, http://bitstamp.net, https://www.kraken.com/
  - Not operating: http://mtgox.com, http://bitcoin-24.com, http://bitfloor.com, http://bitcoin-central.net
- 2021: it's getting better
  - SBB
  - Exchanges: KYC, delays
- Good idea: don't leave coins in an online wallet





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Mechanism

- A wallet has public-private keys (wallet.dat)
  - Public key, ECDSA 256 bit → Bitcoin address (can receive bitcoins)
  - Simple address ~ base58(RIPEM160(Sha256(ecdsa public key)))
    - E.g. 1GCeaKuhDYnNLNR6LGmBtKhPqEJD4KeEtF
  - Private key used for signing transactions

- Transaction
  - Peer A wants to send BTC to peer B → creates transaction message
  - Transaction contains input / output
    - where the BTC came from and where it goes
  - Peer A broadcasts the transaction to all the peers in the network
  - Transaction stored in blocks → block is created / verified ~10min

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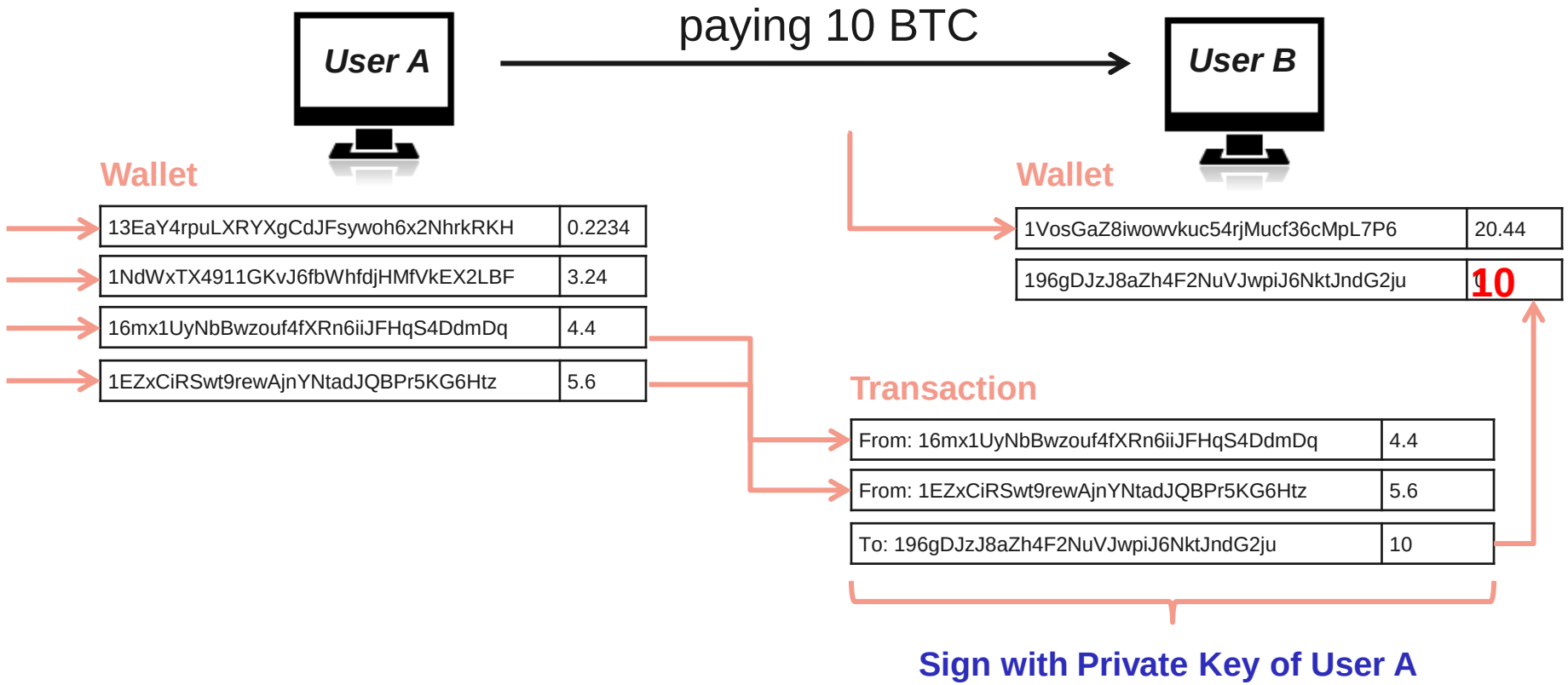
Key Bitcoin Operations

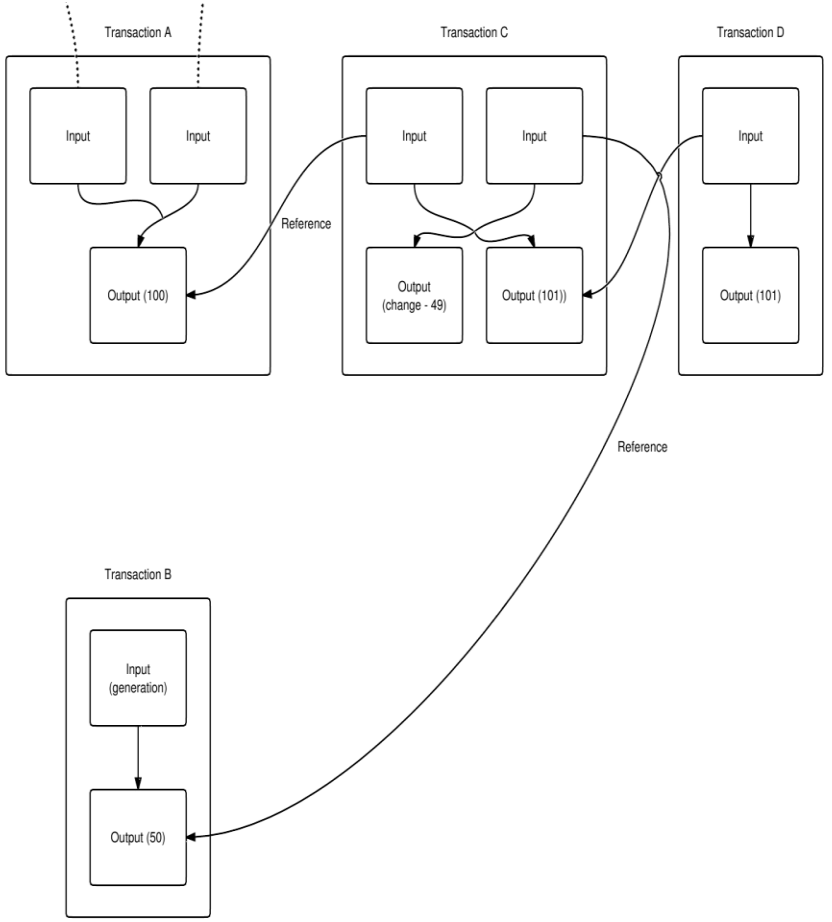
- Private key authorizes the transaction (“access“)
  - If keys are stolen, thief may use “your” coins
  - If keys are lost, coins are lost
  - In UTXO (unspent transaction output) systems, complete output is spent



Mechanism

- Avoiding double spending
  - Transactions in blocks are confirmed.
  - guessing value that results in zero bits (000000000000001805ff174586 b6acf100f733aaf634e92f9580b4fac9272ed97)
  - Chained proofs of work
- Generation of coins
  - Mining / creating blocks → Miner get currently 6.25 BTC per creation
    - adjustable difficulty 6 blocks / h
    - Sometime in 2024 reward will be 3.125, now (6.25)

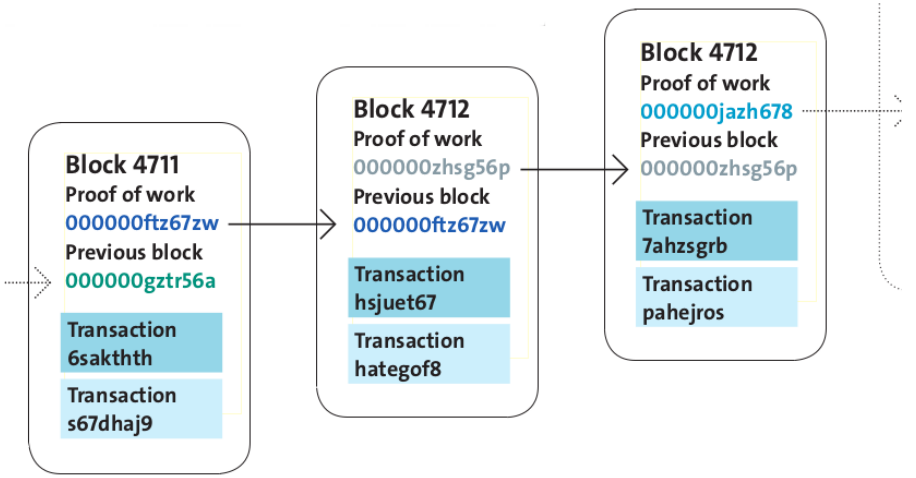
- Transactions have one or more inputs
  - A sends 100 BTC to C, C generates 50 BTC. C sends 101 BTC to D, and send himself some change. D sends the 101 BTC to someone



https://en.bitcoin.it/wiki/Transaction

Blockchain

- Transactions are collected in blocks
  - New block created approximately every 10 min
- Blocks contain solved crypto puzzles
  - In the form of partial hash collisions (SHA256)
- A block has a pointer to previous block → **Blockchain**
- Creation of blocks is called mining (reward)
  - Miners use highly specialized hardware!



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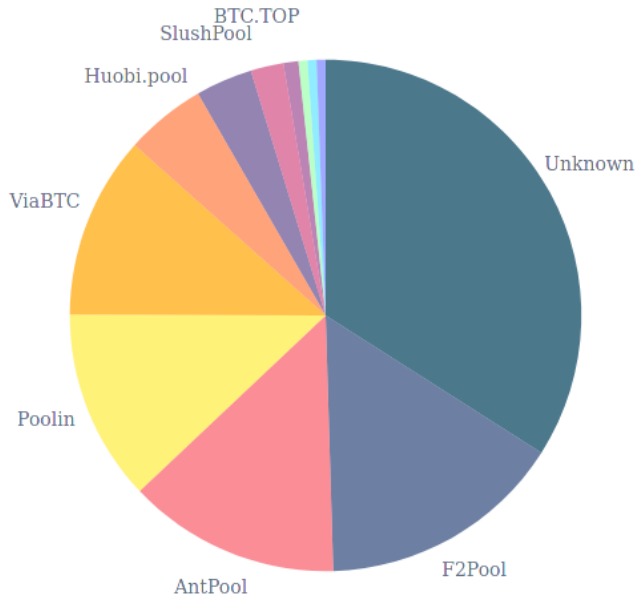
Mechanism - Mining

- Couple of big miners
  - Miners specialized, AMD GPUs, FPGA, ASIC (application-specific integrated circuit) [1][2][3]



http://blockchain.info/pools

- Mining = creating valid blocks
- Blocks are linked to previous blocks
  - Longest block survive (most difficult)
- Different level of confirmations
  - 3-6 block conf. is considered secure
- Dangerous if someone has more than 50% computing power
  - Can exclude and modify the ordering of transactions

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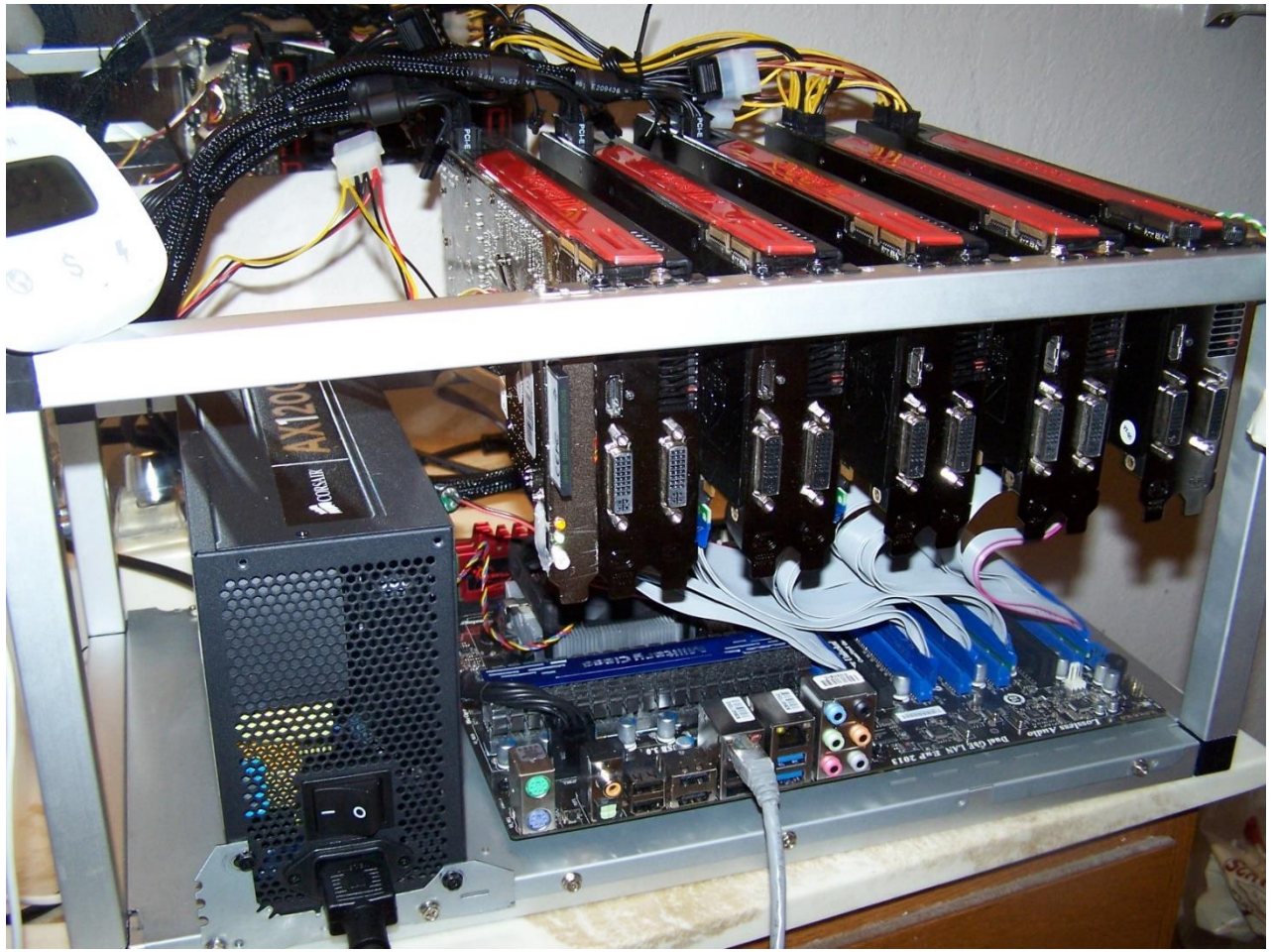
Mining Evolution – CPU

Source: https://99bitcoins.com/20-insane-bitcoin-mining-rigs/

Mining Evolution – GPU



https://bitcointalk.org/index.php?topic=7216.560

Mining Evolution – FPGA

http://www.openmobilefree.net/?p=1308

Mining Evolution – ASIC Farms

- Big mining facilities
  - https://www.youtube.com/watch?v=K8kua5B5K3I
    https://www.youtube.com/watch?v=-z4qbkQ3cK8,
    https://www.youtube.com/watch?v=XWPifXIWPwE,
    https://www.youtube.com/watch?v=OLddN0y2cS8 ,
    https://www.youtube.com/watch?v=4ekOcDG2D8E ,
    https://www.youtube.com/watch?v=-AJhJKSx_70
    https://www.youtube.com/watch?v=f0HC1Udk6-E

Source: https://www.datacenterdynamics.com/en/news/knc-miner-to-build-second-facility-in-the-node-pole/

Mining: Evolution ASIC

- Scenario: old ASIC miner
  - Example: Avalon Batch #2
  - 70GHash/s
- Generated ~0.005CHF per day in 2020
- Generates ~0.02CHF per day in 2021
- Uses 700W
  - 0.6KWh with 0.08 / 0.04CHF
  - Cost per day 2.59 CHF
    (Hochtarif, Mo-Sa 06:00-22:00)
  - Cost per day 1.30 CHF
    (Niedertarif, rest)

Many Coins – Similar Mechanism

- All electronic backed by scarce resource - avoid: double spending
  - Bitcoin: SHA256 partial hash collision: time, ASIC, electricity
  - Ethereum: variant of Dagger-Hashimoto, time, GPU, memory, electricity, miner store dataset: 1GB, verification only needs 16MB
  - Ethereum: Opcodes in Bitcoin, smart contracts in Ethereum
  - Litecoin: scrypt partial hash collision: time, GPU, memory, electricity
  - Ripple XRP: Unique node list (trusted validators, 1000): web of trust
  - Tezos, next Ethereum: proof of stake:
    - Holding/staking 1% will generate e.g., 1% of coins
    - Energy efficient / proof of stake
  - Cardano/EOS/…many more

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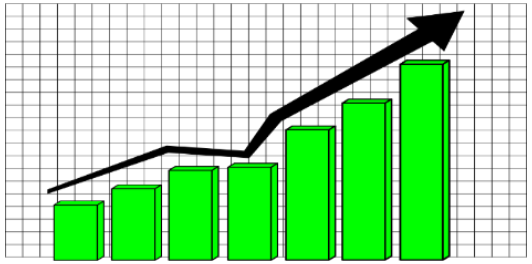
Discussion (1)

- Advantages
  - Low (fixed) tx fees
    - ~102 satoshi per byte / 14USD
  - Scalable
    - Hardware/storage gets faster



  - Anonymity
    - No privacy concerns/ datamining difficult

- Disadvantages
  - Power consumption
    - ~ as much as Netherlands
  - Not scalable
    - Bitcoin with 5 tps vs. VISA 57,000 tps (23.12)
      [tps: transactions per sec]

  - Anonymity
    - Can be used for illegal activities

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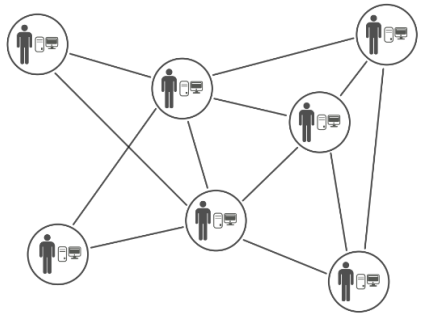
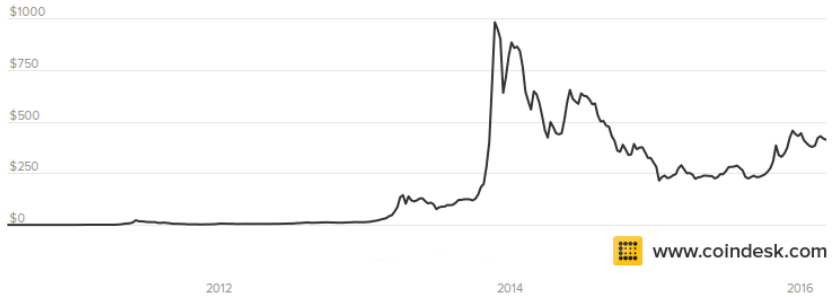
Discussion (2)

- Advantages
  - No major “crashes”
    - Mt.Gox was exchange site!
  - Decentralized
    - Open protocol
    - Forks



  - Many other blockchain use cases
    - Smart contracts

- Disadvantages



  - Central elemements
    - Core developers