SCET Blockchain Lab

Introduction to Blockchain tech & Use Cases

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2018

Alexander **Fred-Ojala**

- **Research Director**
  Data Lab, SCET, UC Berkeley
- **Co-creator of Data-X**
  UC Berkeley class: Applied Data Science w Venture Applications
- **Co-founder**
  UC Berkeley / SCET's Blockchain lab
- **Founding Team of 3 companies**
  InnoQuant (COO), Auranest (CMO),
  Wheely's (YCombinator alumni)
- **Degree in Mathematical Statistics**
  UC Berkeley & Lund University, Sweden

Co-founder Blockchain Lab





OUTLINE

1. **Quick Blockchain Overview**

   History and statistics

2. **Bitcoin**

   The First Blockchain application

3. **Ethereum & Smart Contracts**

   Decentralized Apps, Web3.0

4. **Blockchain Applications**

   Fintech, Healthcare, Government, Energy

First:
QUESTIONS TIME!

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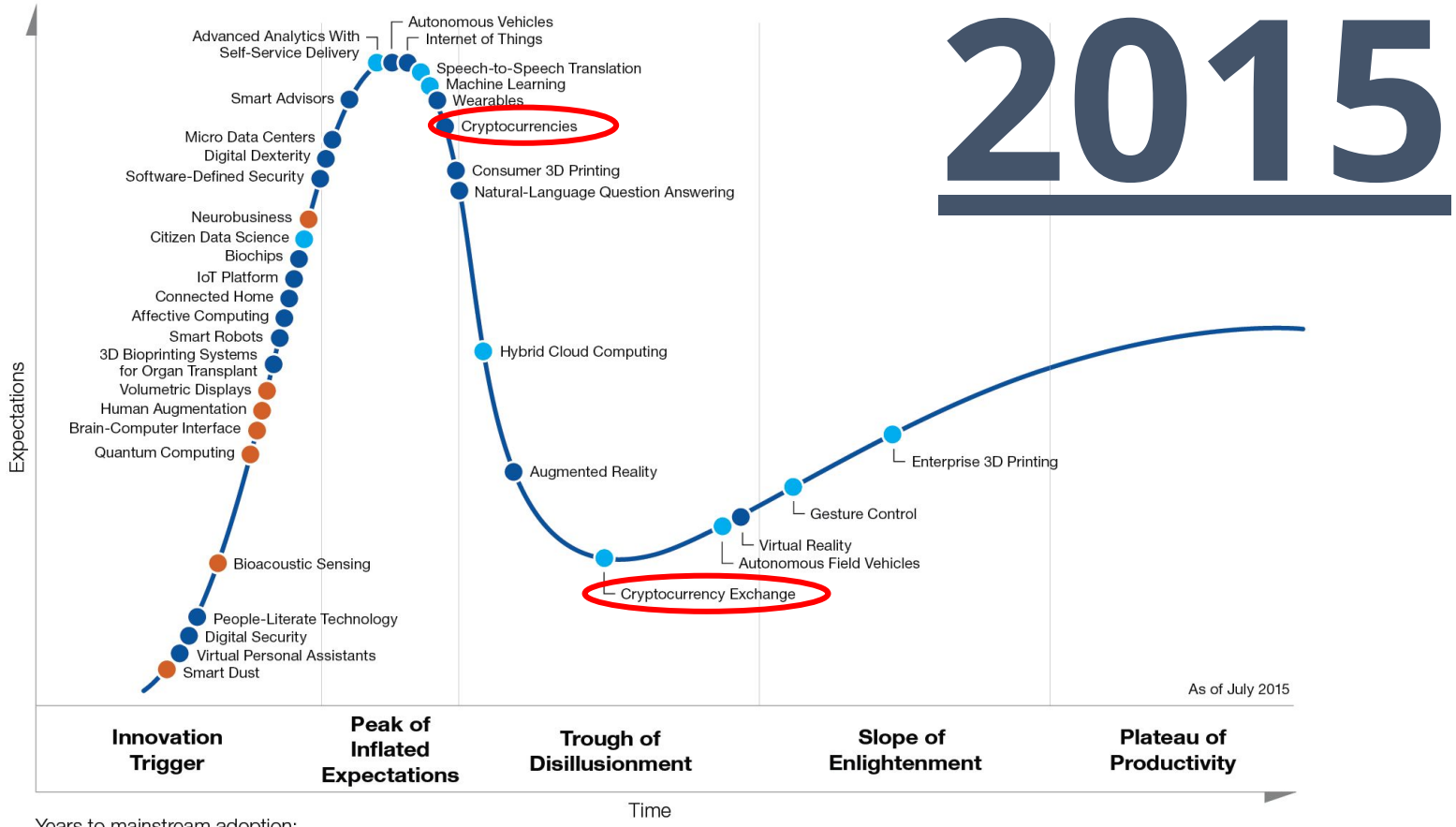
Blockchain Hype & History

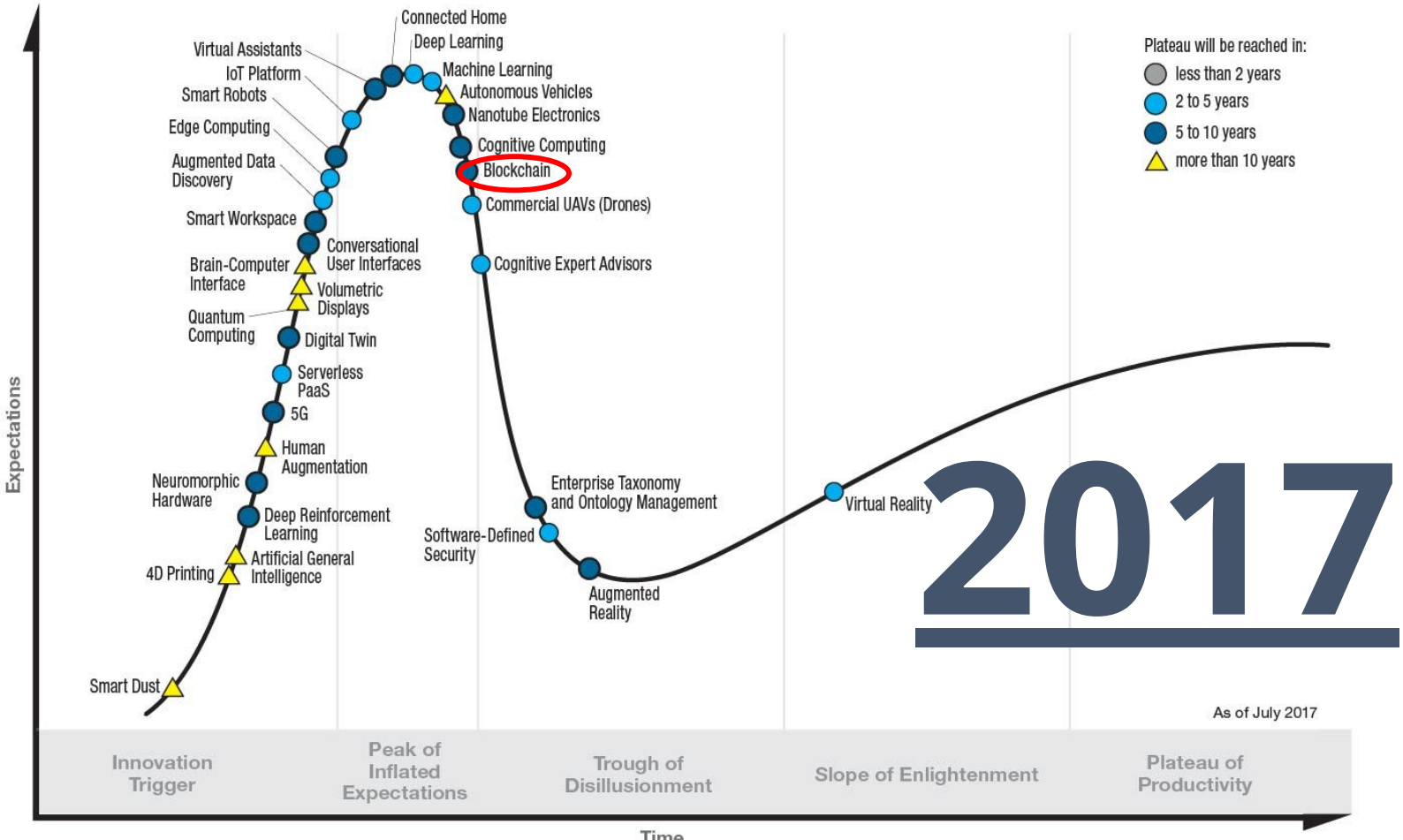
Emerging Technology Hype Cycle

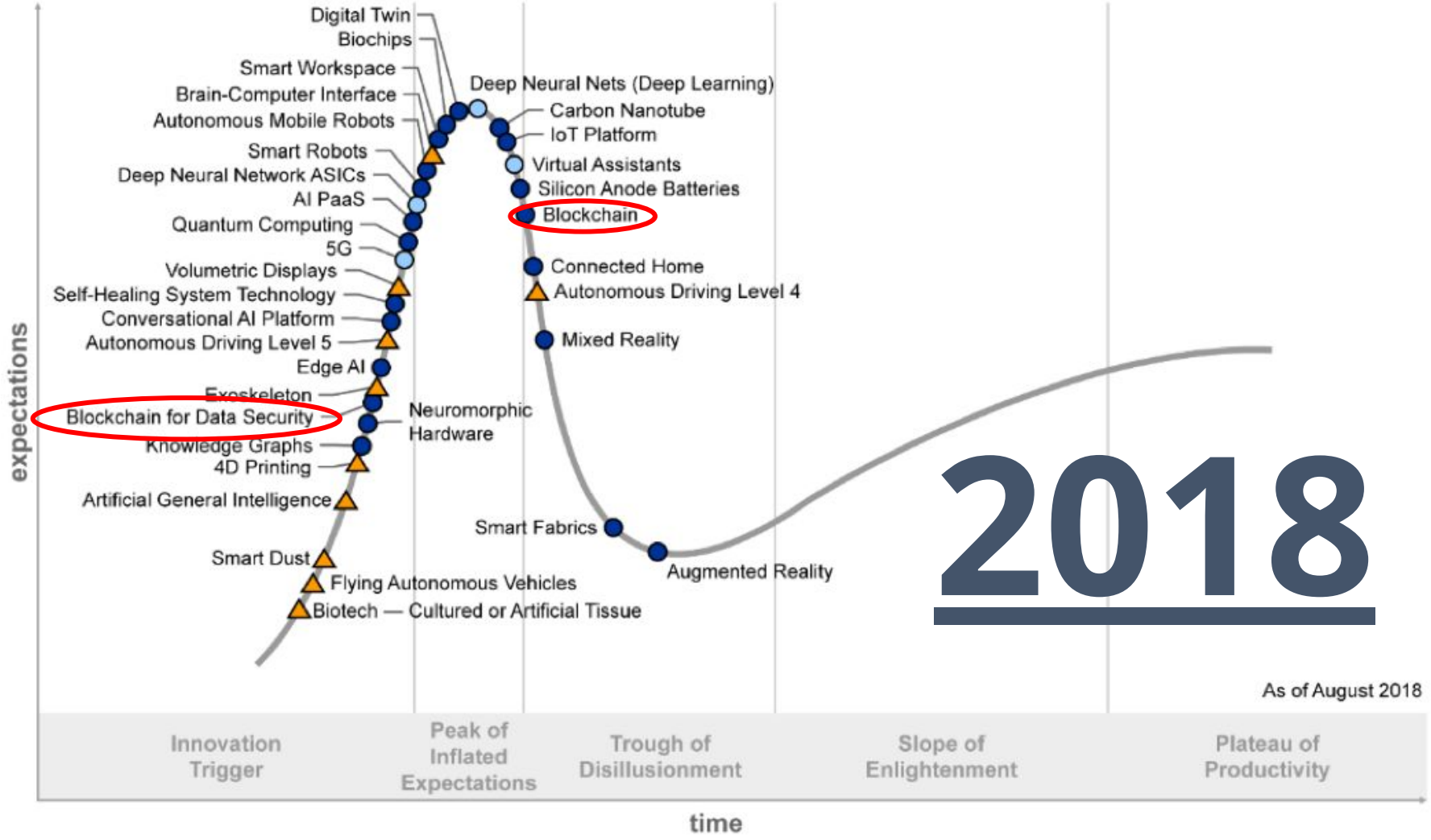


Gartner Hype Cycle for Emerging Technologies, 2016

2016

Gartner Hype Cycle for Emerging Technologies, 2017




Digital Twin
Biochips
Smart Workspace
Brain-Computer Interface
Autonomous Mobile Robots
Smart Robots
Deep Neural Network ASICs
AI PaaS
Quantum Computing
5G
Volumetric Displays
Self-Healing System Technology
Conversational AI Platform
Autonomous Driving Level 5
Edge AI
Exoskeleton
Blockchain for Data Security
Neuromorphic Hardware
Knowledge Graphs
4D Printing
Artificial General Intelligence
Smart Dust
Flying Autonomous Vehicles
Biotech — Cultured or Artificial Tissue
Deep Neural Nets (Deep Learning)
Carbon Nanotube
IoT Platform
Virtual Assistants
Silicon Anode Batteries
Blockchain
Connected Home
Autonomous Driving Level 4
Mixed Reality
Smart Fabrics
Augmented Reality
2018
As of August 2018
expectations
Innovation Trigger
Peak of Inflated Expectations
Trough of Disillusionment
Slope of Enlightenment
Plateau of Productivity
time

Blockchain **Hard numbers**

1. Global **Market Cap:** Blockchain tokens

$820Bn (Jan 2018)
0.9% of World GDP

3. **Price** Oct 30th 2018

$6300 / BTC
$200 / ETH

2. # of **Blockchain users**

~ 30 million users.

4. Blockchain **Disk Space**

Bitcoin: **184Gb**
Ethereum: **> 1Tb**

1. ttps://coinmarketcap.com/charts/
2. ttps://www.reddit.com/r/Ripple/comments/80hd4j/ripplexrp_price_and_the_total_number_of/t

3. https://coinmarketcap.com/
4. https://blockchain.info/charts/blocks-size (Bitcoin) https://etherscan.io/chart2/chaindatasizefast (Ethereum)

How Do Blockchains work

A Bitcoin case study

2008: Enter Bitcoin

First Blockchain Application

Digital money!

History of Bitcoin

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Bitcoin Whitepaper, **2008**

Satoshi Nakamoto releases Bitcoin in the wake of the financial crisis. Owns 1Mn BTC.

10k BTC for a Pizza, **2010**

First real-world transaction: $25, 2 pizzas in Jacksonville, Florida for 10,000 BTC. ¼ cent.

Largest bitcoin crash, **2013**

The bitcoin price fell 75% over the course of 24hrs in April 2013.

Mt Gox hack, **2014**

6% of all bitcoin ever created stolen from the largest exchange. $500Mn.

Bitcoin enters the mainstream, **'16-'18**

ICOs, blockchain technology, and the price of bitcoin are ever present in the news. The hype takes the price to ~$20k / BTC. Market correction in 2018.

FUTURE

Bitcoin (USD) Price

Closing Price OHLC

1h 12h 1d 1w 1m 3m 1y All

Jul 18, 2010 to Sep 5, 2018 Export

What is **Bitcoin**?

Digital, Decentralized & Trustless Currency

First widely adopted digital currency. Regulated by a community that anyone can join.

Financial Inclusion: Pseudonymous identities

Anyone can join w/o revealing identity. Transactions are public but identities are not linked to accounts / keys.

Public ledger with transactions

Full transaction history is public, anyone can audit.

Transfer Money Globally **P2P**

No need for trusted 3rd party or intermediary to validate transaction.

bitcoin / **Bitcoin**?!

- ***bitcoin*** *is the currency*

  (BTC = digital money)

- ***Bitcoin*** *is the technology / protocol*

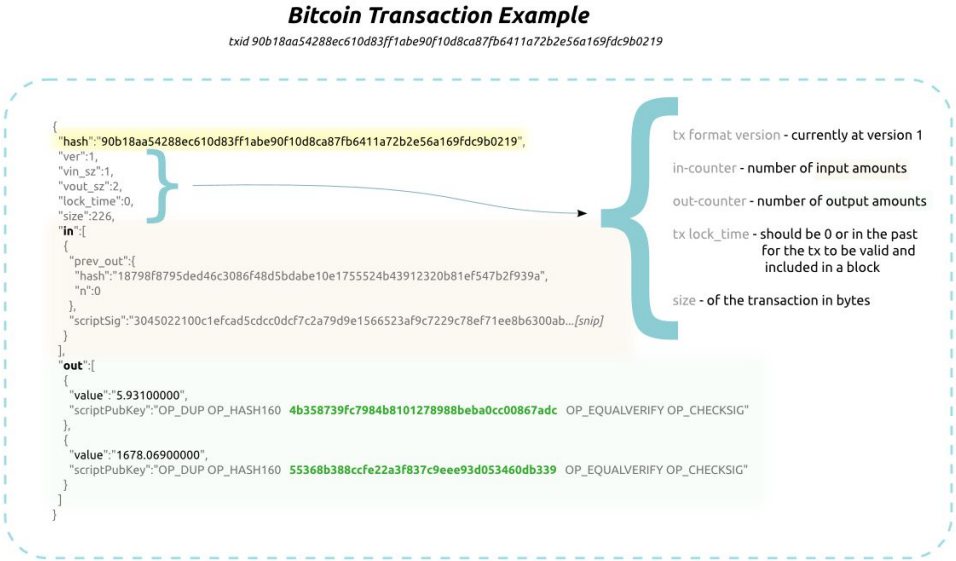
  (almost like the infrastructure for a bank)

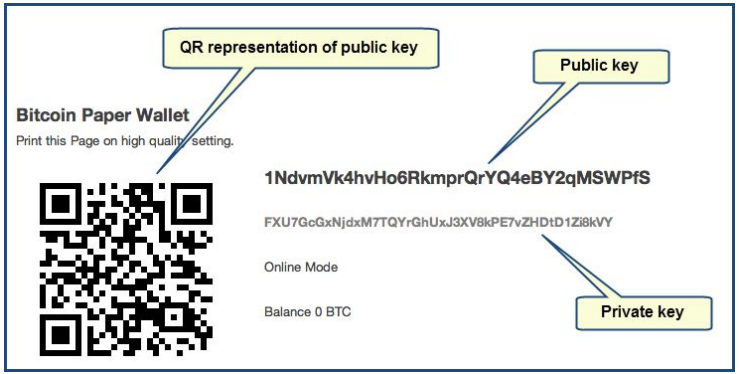
Bitcoin:
User Perspective

1. First system to enable **simple transactions** with a digital currency.
2. User's use a **wallet with Public and Private keys** to send and receive bitcoin.

Private key signs transactions

Public key verifies signature





Private / Public **Keys**

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Bitcoin Identity: *To send and receive bitcoins, unique private - public key pair.*

Private Key:

Secret. Like a password. Keep it safe. No recovery option.

- Generated from random processes
- Used to sign transactions and prove ownership.

```
5K8BwE76VsatQiRa5wJpGng7758FAz4vLkMxAry8QnyZTdQJxPn
```

Public Key:

External. Like a username. Generated deterministically from Private key.

- Private key will always generate same public key (ECSDA: Elliptic Curve Digital Signature Algorithm)
- Public address for receiving bitcoin.

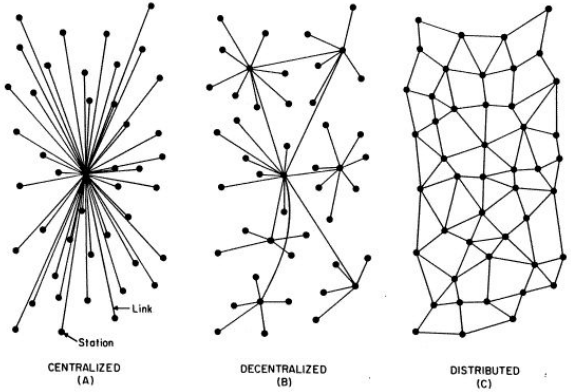
```
1M3RLrXve5wcT2ZcJu8WXoXjdh4WXcWQA9
```

Bitcoin: Network Perspective

- Users broadcast transactions to **decentralized P2P network of computer nodes** that validates payments and keeps track of transactions**.**

- Anyone can setup a node and join the Bitcoin network. Nodes exist globally. **No central point of failure**, gets around the honey pot problem.

- Nodes validating transactions are called **miners**. They group transactions into blocks, and link blocks in an immutable chain. This data structure is called a **Blockchain**.



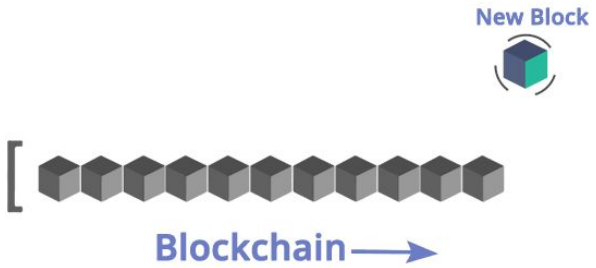
The Bitcoin Blockchain

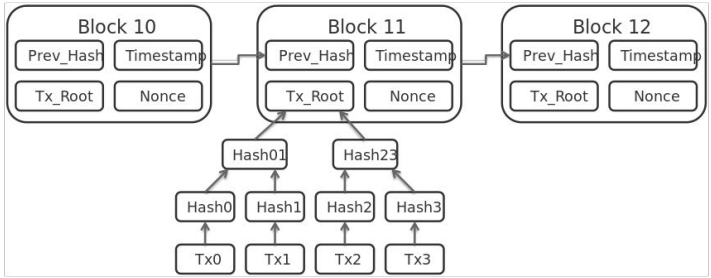
Shared Database: Tracks every transaction since the Genesis block

- **Ledger:** Like an append only spreadsheet.
- **Immutable: Cryptographically Secured** by including the hash of the previous block in the current block.
- **Transactions are grouped together in blocks.**

  A new block is added every 10 minutes.
- **Consensus protocol:** Majority decide valid chain.

  Tie voting power to resource. Proof of work.





Source: https://www.edureka.co/blog/blockchain-technology/

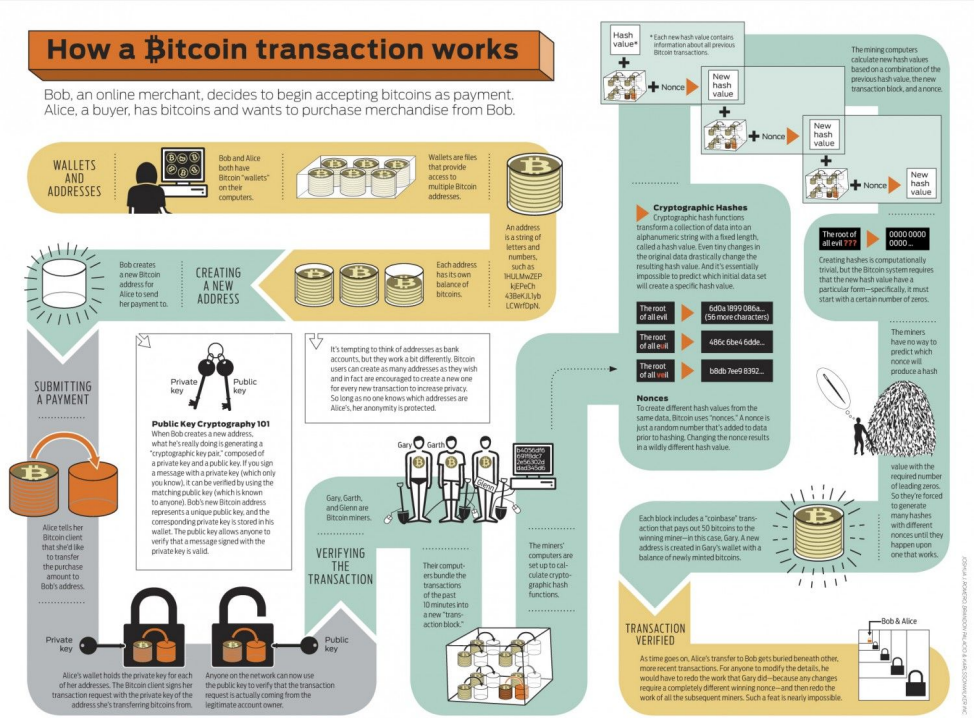
Bitcoin: Incentivizing Participation

Why do peers wanna join and set up mining rigs?

1. **Monetary incentive:** Every time a node validates a block of transactions they get a reward. Plus transaction fees.
2. Convenient way to **create and distribute new money.**

Source: https://www.cnbc.com/2018/01/12/what-it-looks-like-inside-an-actual-bitcoin-mining-operation.html

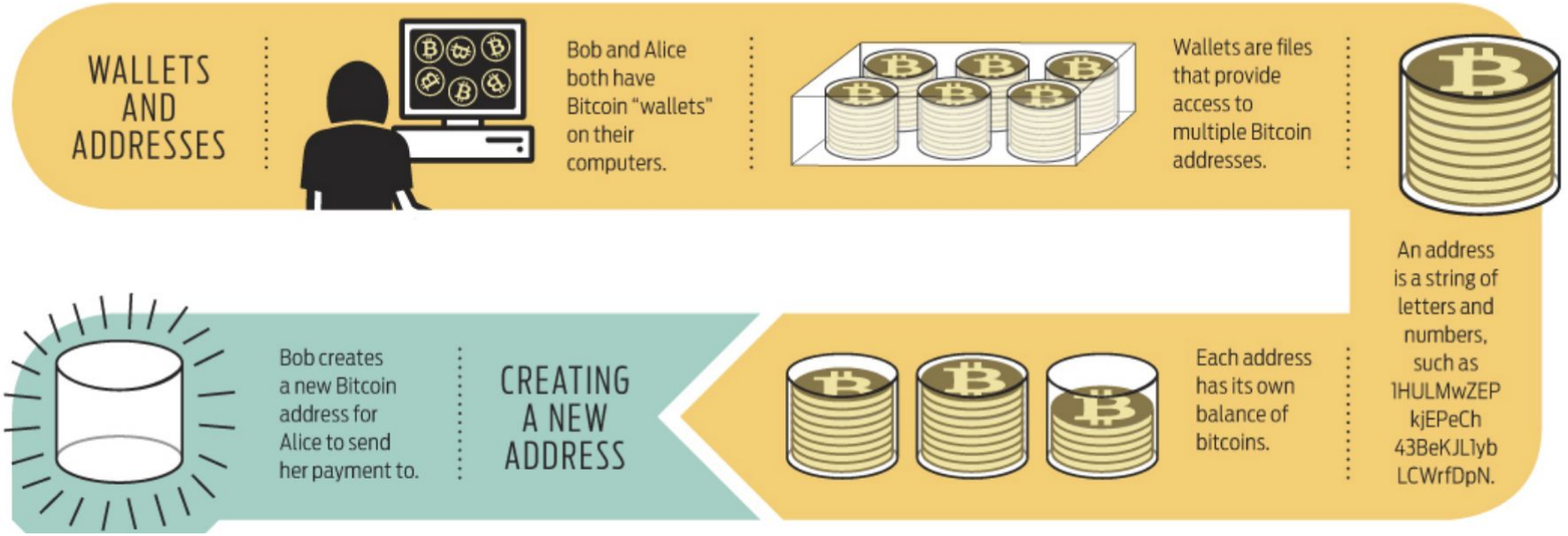
Bitcoin: System Overview



Source: IEEE Spectrum

Bitcoin: System Overview (1/4)

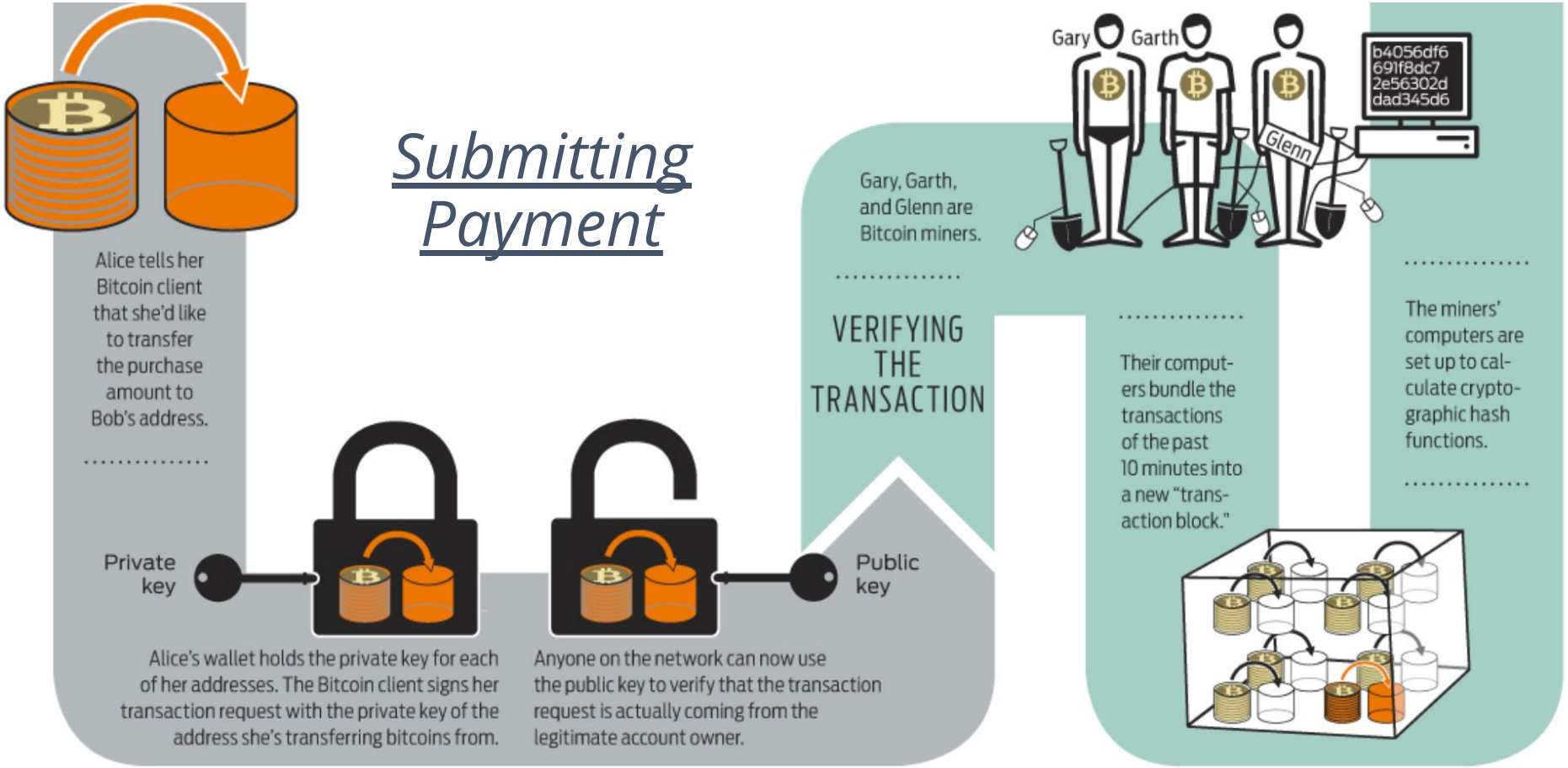
Bob, an online merchant, decides to begin accepting bitcoins as payment. Alice, a buyer, has bitcoins and wants to purchase merchandise from Bob.



Source: IEEE Spectrum

Source: IEEE Spectrum

Bitcoin: System Overview (2/4)



Bitcoin: System Overview (3/4)

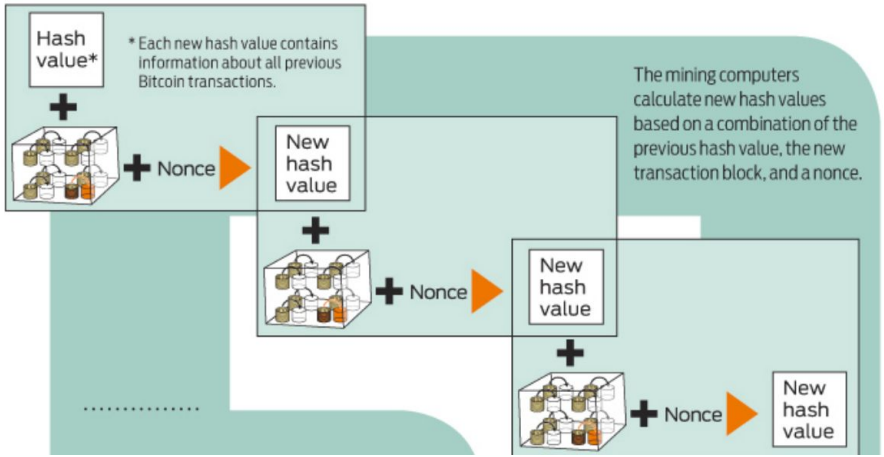
Cryptographic Hashes

Cryptographic hash functions transform a collection of data into an alphanumeric string with a fixed length, called a hash value. Even tiny changes in the original data drastically change the resulting hash value. And it's essentially impossible to predict which initial data set will create a specific hash value.

The root of all evil	6d0a 1899 086a... (56 more characters)
The root of all evil	486c 6be4 6dde...
The root of all veil	b8db 7ee9 8392...

Nonces

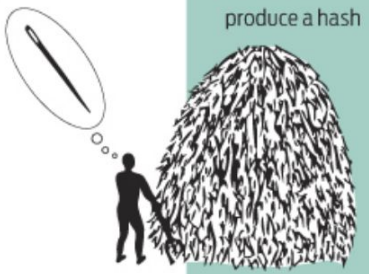
To create different hash values from the same data, Bitcoin uses "nonces." A nonce is just a random number that's added to data prior to hashing. Changing the nonce results in a wildly different hash value.



The root of all evil ??? ▶ 0000 0000 0000 ...

Creating hashes is computationally trivial, but the Bitcoin system requires that the new hash value have a particular form—specifically, it must start with a certain number of zeros.

The miners have no way to predict which nonce will produce a hash value with the required number of leading zeros. So they're forced to generate many hashes with different nonces until they happen upon one that works.



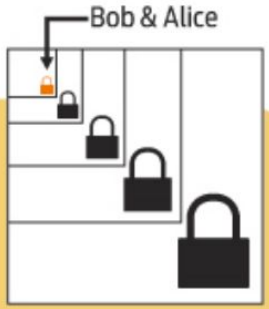
Source: IEEE Spectrum

Bitcoin: System Overview (4/4)

Each block includes a "coinbase" transaction that pays out 50 bitcoins to the winning miner—in this case, Gary. A new address is created in Gary's wallet with a balance of newly minted bitcoins.

TRANSACTION VERIFIED

As time goes on, Alice's transfer to Bob gets buried beneath other, more recent transactions. For anyone to modify the details, he would have to redo the work that Gary did—because any changes require a completely different winning nonce—and then redo the work of all the subsequent miners. Such a feat is nearly impossible.



Source: IEEE Spectrum

User owned and managed

Digital, Network Money!

(Wow, we pay thousand of dollars to claim hashes on a ledger!)

Around 2013:

How to improve Bitcoin?

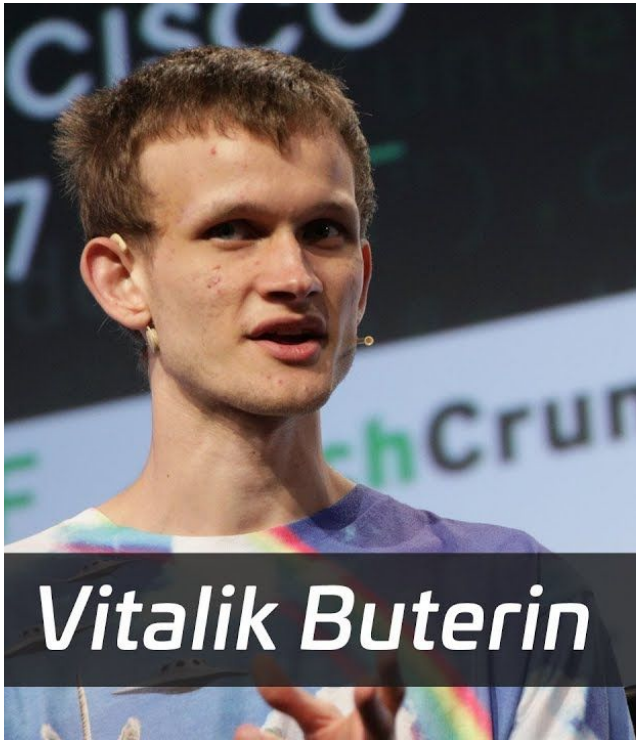
Smart Contracts

- **“Standard” Contract definition:**
  - Agreement with another party.
  - Some entity (courts, banks, escrow agents) enforces the agreement and the terms so that they are not violated.
- **Smart Contract** (Nick Szabo, 1996):
  - Define terms of agreement in programmatic code.
  - Code that facilitates, verifies, and enforces execution of the digital contract.
  - Code becomes law!

Satoshi Nakamoto

Vitalik Buterin

VS.




ethereum
HOMESTEAD RELEASE
BLOCKCHAIN APP PLATFORM

Enter Ethereum

- **Blockchain Smart Contract Platform:**
  - **Total network has a state**
  - Transactions and smart contract executions change state.
- **Distributed World Computer (EVM)**
  - Turing Complete (allowing loops)
- **Native Asset: Ether (ETH)**

ethereum

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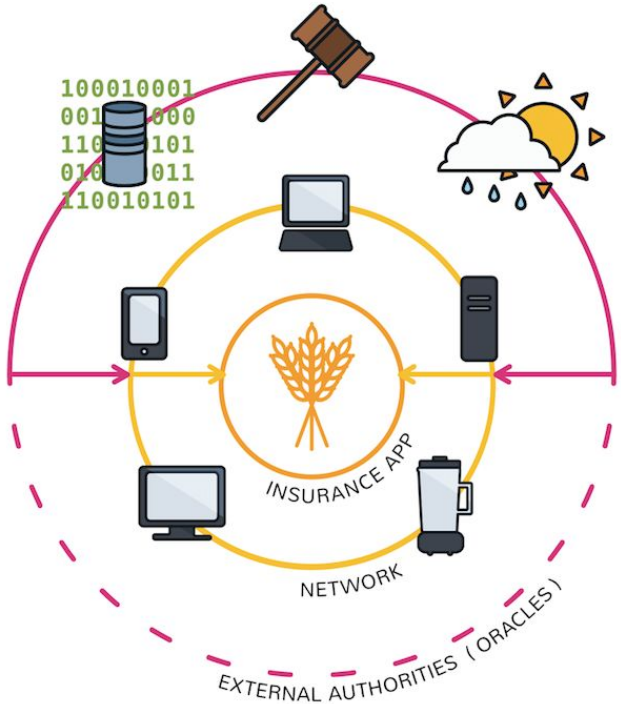
Ethereum Smart Contracts

Computer protocol to digitally verify and enforce a contract without 3rd parties.

- Stored as code on the Blockchain. Evaluated by all nodes.
- Transparent, distributed, decentralized, deterministic agreement.

Decentralized Application (dApps)

- **dApps:** “Normal” applications that use smart contracts (smart contracts can also call other smart contracts)
- Sometimes has a **token that is native** to the application.
- Can be based on their own Blockchain or existing one.



Initial Coin Offering

ICO

- Introduction of a new Altcoin / Cryptocurrency / Token
- **Incentivizes a community to buy into the idea**
  -> Scale factors and network effects.

Over 4000 cryptocurrencies exist, most use ERC20 standard*.

List of inactive coins: deadcoins.com

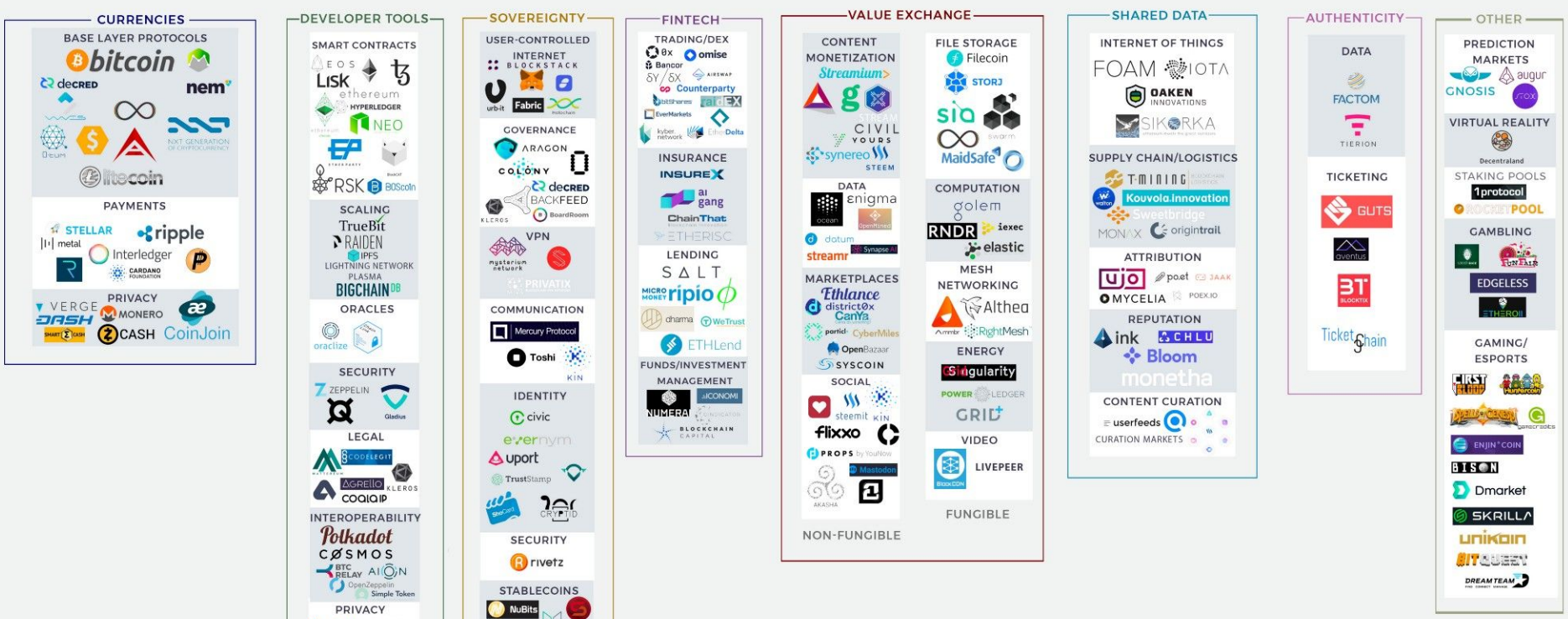
** coinranking.com (April 2018)*

Ethereum: Powering Web 3.0

Web 3.0

- Distributed file storage
- 24 hour stock markets
- Decentralized exchanges
- Unique and scarce items (CryptoKitties)
- Digitize assets
- Store sensitive data and records
- Smart grid solutions for energy
- Supply chain management
- Medical records
- Track provenance of goods
- Remittances
- Prediction markets
- Open source incentives (Gitcoin)
- Federated Learning / Homomorphic enc.
- Content creation automatic compensation
- Get paid to reply to emails (Earn.com)
- Self sovereign identities

Overview: Exciting & Promising Blockchain Projects



Source: Josh Nussbaum, https://medium.com/@josh_nussbaum/blockchain-project-ecosystem-8940ababaf27

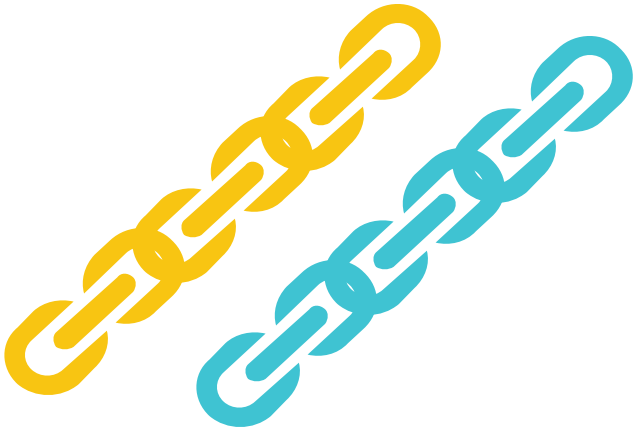
Public vs Permissioned Blockchains

A Blockchain can either be open for everyone **(public)** or it can be restricted to a specific group of participants **(private)**. Blockchains are valuable if there aren't innate trust among participants

Public Blockchains

Trustless, anyone can join, truly decentralized

- **Bitcoin, Ethereum, EOS, IOTA, NEO**



Permissioned Blockchains

Restricted

- **Hyperledger, Ripple, Quorum**

Blockchain

Examples of Industry Use Cases

FinTech

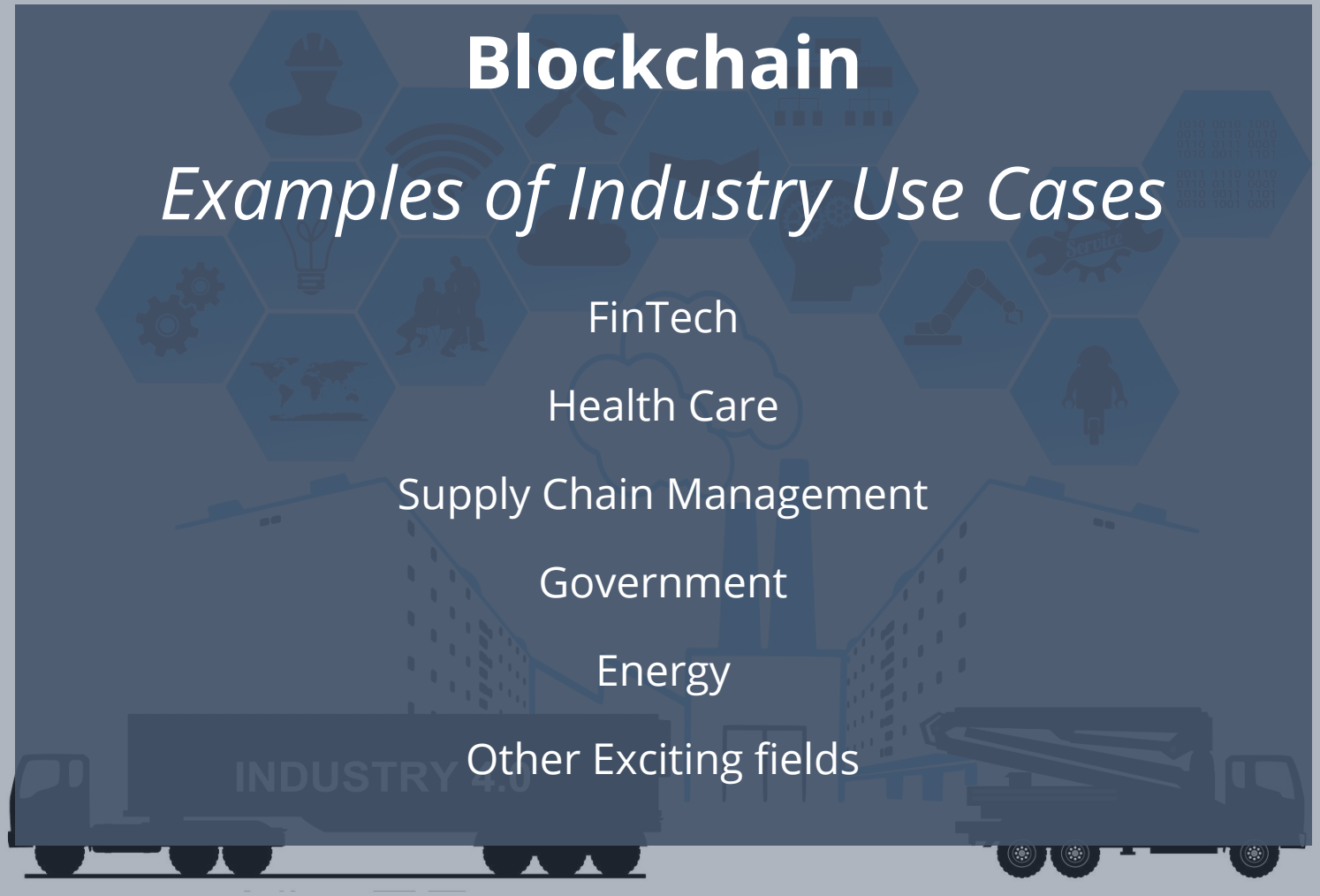
Health Care

Supply Chain Management

Government

Energy

Other Exciting fields



Blockchain Use Cases: **Fintech**

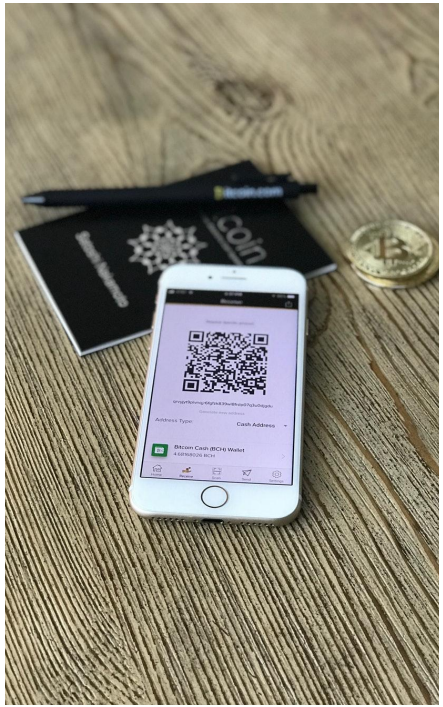
P2P Global Payments, P2P Loans and Financial Inclusion

- **Bank the 2Bn unbanked** and 4Bn under-banked
- **Improve remittances and prevent corruption for humanitarian aid**
- **Automatic P2P exchange** of assets, stocks, bonds or securities. 24hr stock exchanges.
- **P2P Loans**

Blockchain Use Cases: **Fintech pt. 2**

Financial instruments and services

- Improved and simplified **KYC process**
- **Private Blockchain Consortiums** (R3, Corda, Quorum) to reduce settlement times and paper trails
- **Corporate cross border payments** with instant settlements.

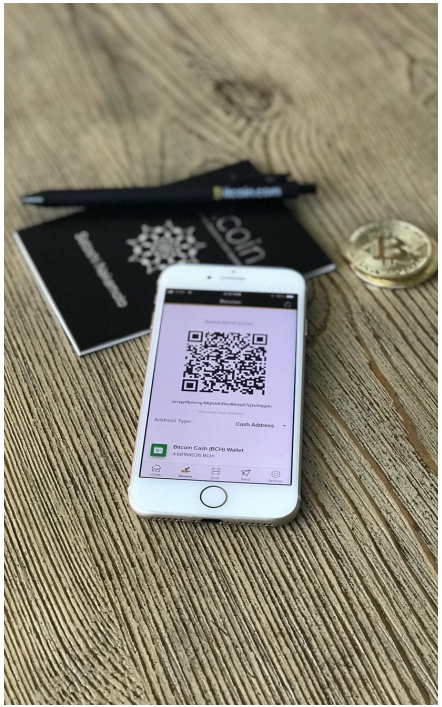


Blockchain Use Cases: **STO**

Security Token Offering / Asset Tokenization

- Typically represents an ownership stake in traditional assets such as real estate, equity, bonds, and VC funds.
- Actors in stock trading: Brokers, Transfer Agents, Registrars, Clearing Firms, Custodians etc. If that same share was tokenized, the only entity you'd have to trust is the issuer.
- Tokenization makes issuance and trading of assets more efficient by cutting out third parties.
- Less administrative fees, faster time of issuance, global market and most importantly opens the availability of capital for issuers.
- Can also tokenize physical, otherwise illiquid assets (real estate, art, gold and diamonds,
- Automatically pay out revenue in the form of rent or dividends or similar
- Legal frameworks need to be in place (how to handle the liquidification of an asset).

"The future of real estate investing is one that provides global exposure, transparency, public access and liquidity, all of which are elements that can be delivered through blockchain technology."



Blockchain Use Cases: **Health Care**

Safe and Shared Health Records

- **Store and share medical history and health records.** Pilot in Estonia running today!
- **Aggregate sensitive medical data** in secure repositories. Empower researchers to extract insights.
- **Patient owned and controlled data**

Blockchain Use Cases: **Supply Chain**

Track Goods w/ IOT, Limit Paperwork, Improved Security

- **Track goods, from origin to destination.** Limit documentation**.** Simplify ownership transfer and automatic payments.
- **Food safety:** Let growers, consumers etc. gain permissioned access to food information. Trace back source of bad food in the supply chain.
- **Track Pharmaceuticals:** Preserve drug integrity from production facility to consumer. Track serial numbers, limit spread of fake drugs.

Blockchain Use Cases: **Government**

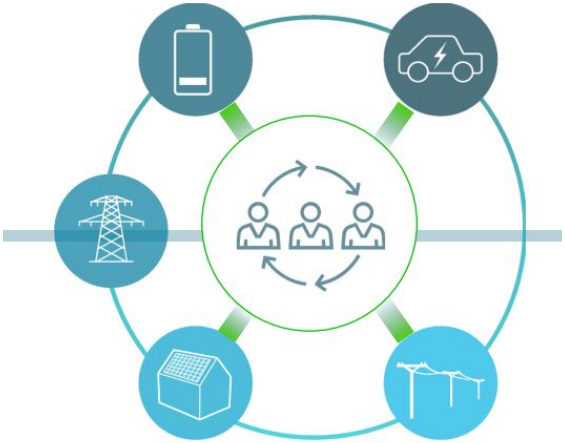
Open Government, Power to the People, Less Corruption

- **Individually Controlled Identities:** Estonia has launched Blockchain based citizenship.
- **Blockchain-based voting.** Sierra Leone, blockchain based election. Diminish the likelihood of electoral fraud.
- **Land records and titles:** Ukraine
- **Trace political spending, campaign contributions**

Blockchain Use Cases: **Energy**

Microgrids, Energy Certificates, Renewables

- **Microgrids:** Automatic transactions between producers and consumers. Powerpeers in Netherlands and Exergy in Brooklyn.
- **Track clean energy:** See if it's generated by fossil fuels, solar energy or wind. **Organize the messy market of traded energy certificates**.



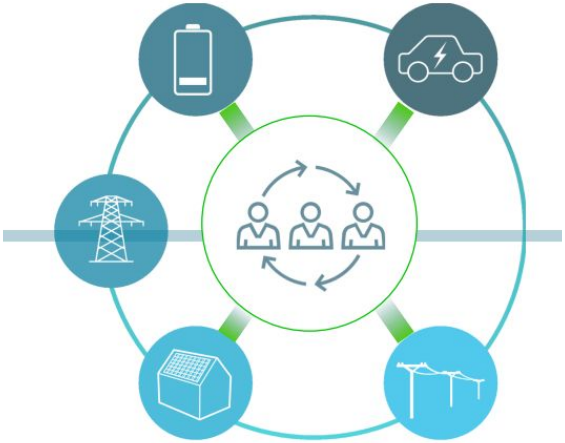
The New Energy Economy

Source: https://www.eniday.com/en/technology_en/blockchains-energy-market/

Blockchain Use Cases: **Data Security**

Security of Computations, User owned Data

- **Blockchains coupled with Secure Enclaves:** Secure cloud computing (don't share business secrets with Google etc)
- **Store data in encrypted shared:** Dropbox for **Organize the messy market of traded energy certificates**.

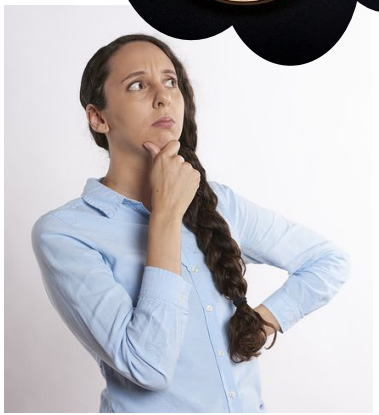


The New Energy Economy

Source: https://www.eniday.com/en/technology_en/blockchains-energy-market/

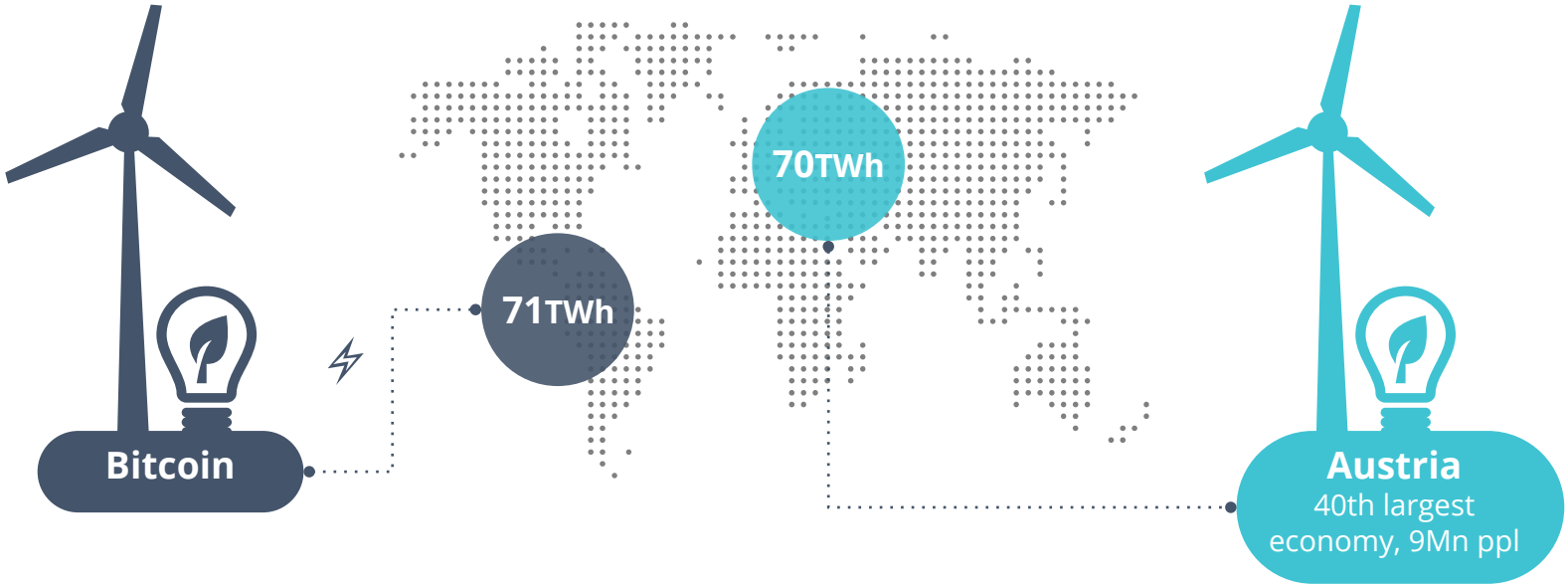
Beyond the Hype: Rational perspective

- **Maturity:** Right now the technology and fundamental protocols still need to be refined before global adoption.
- **Speculation:** The field is very hyped right now and beware of frauds, scams. Always do thorough due diligence.
- **Policy & Regulation:** Many policy frameworks have to be created and implemented before wide scale adoption can become a reality.



Scalability Issue: **Energy Consumption**

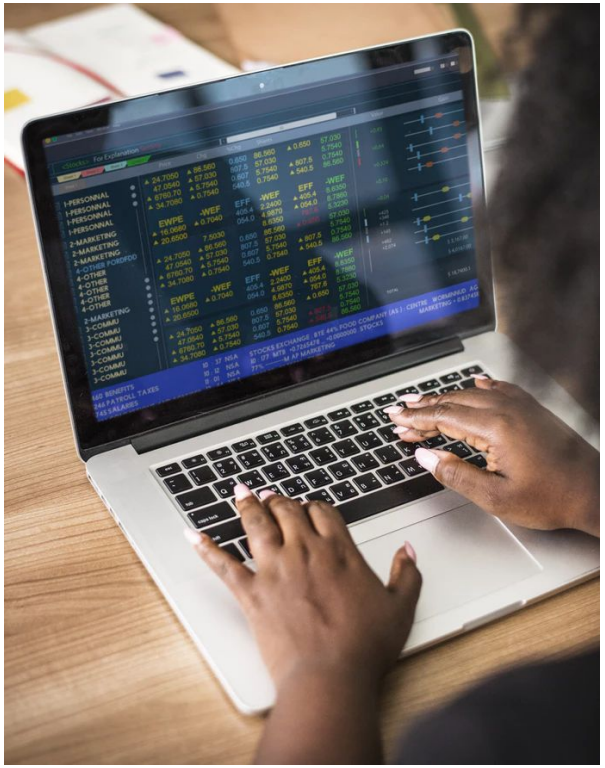
Bitcoin, Ethereum and many other Blockchain Technologies currently utilize Proof of Work as their consensus algorithm. Scalability problem and waste of resources. It is estimated that



Source: https://digiconomist.net/bitcoin-energy-consumption

Scalability Issue: **Transactions**

- **Bitcoin:** 7 tx / second
- **Ethereum:** 25 tx / second
- **Stellar (??):** 1,000 tx / second
- **Ripple:** 1,500 tx / second
- **Visa:** 24,000 tx / second



Positive Global Outcomes & Opportunities

- **User Owned Data**
- **Financial inclusion**
- **Sharing Economy:** True decentralized services, cut costs of platform owners.
- **Increased transparency,**
- **Open-source, free technology, empowering everyone**

Thanks!

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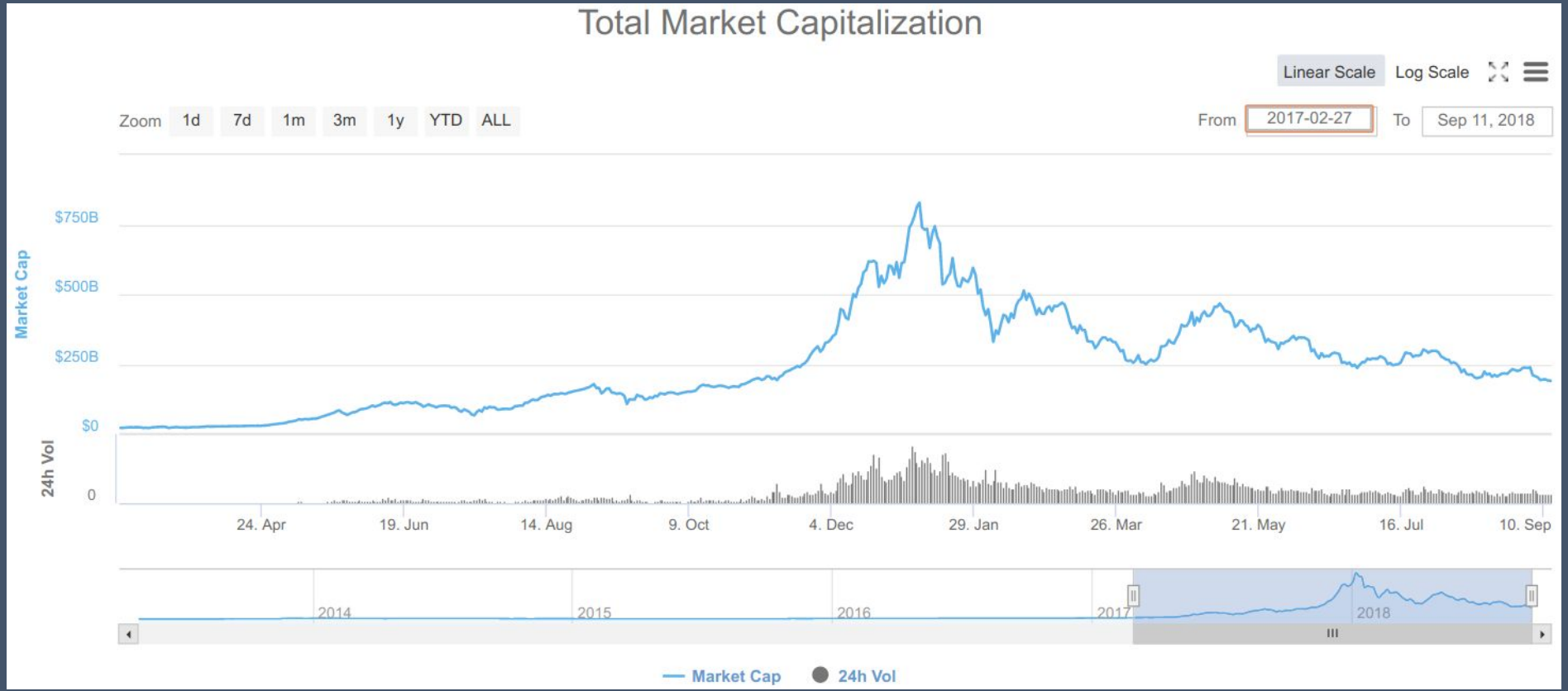
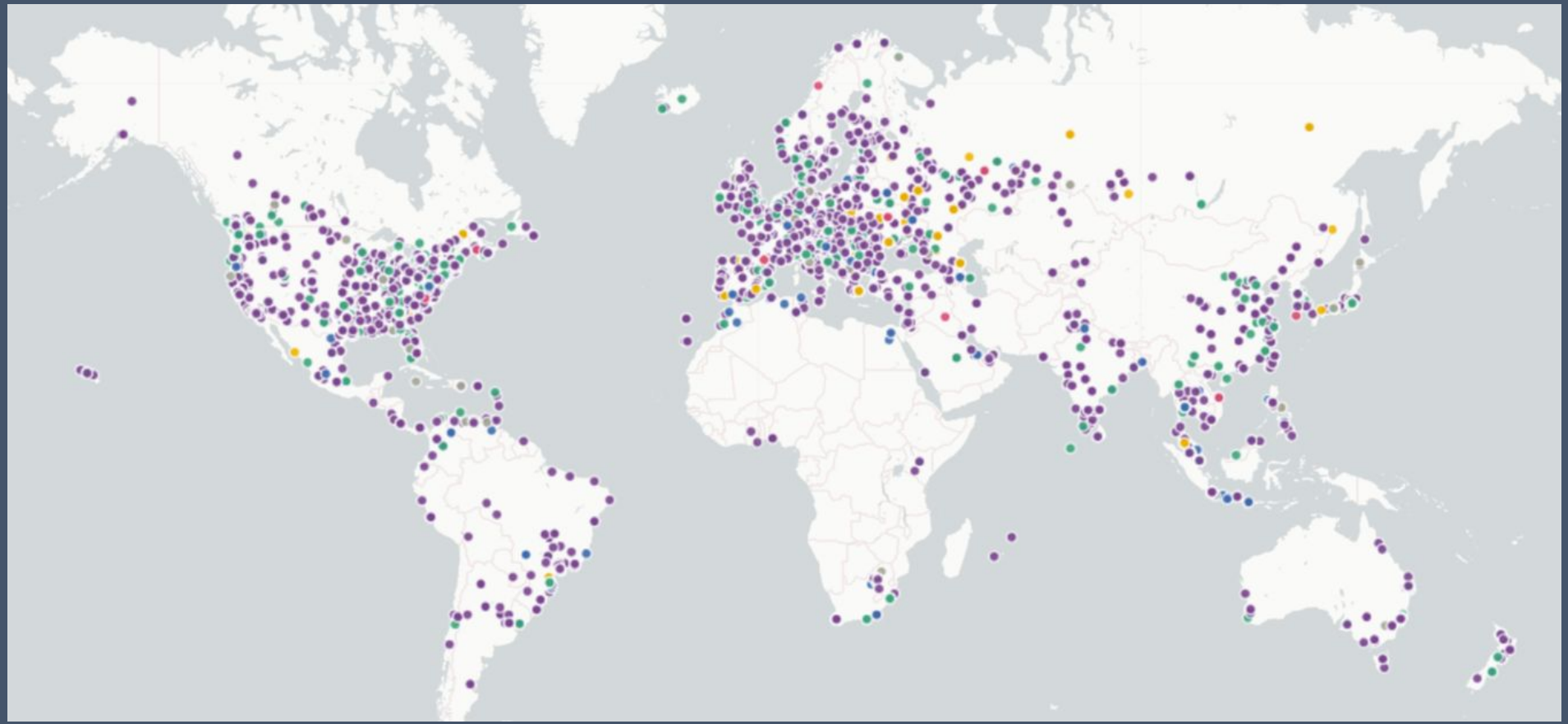
Market Cap for all cryptocurrencies

Peak: $820Bn (today $190Bn)



Coinmarketcap.com

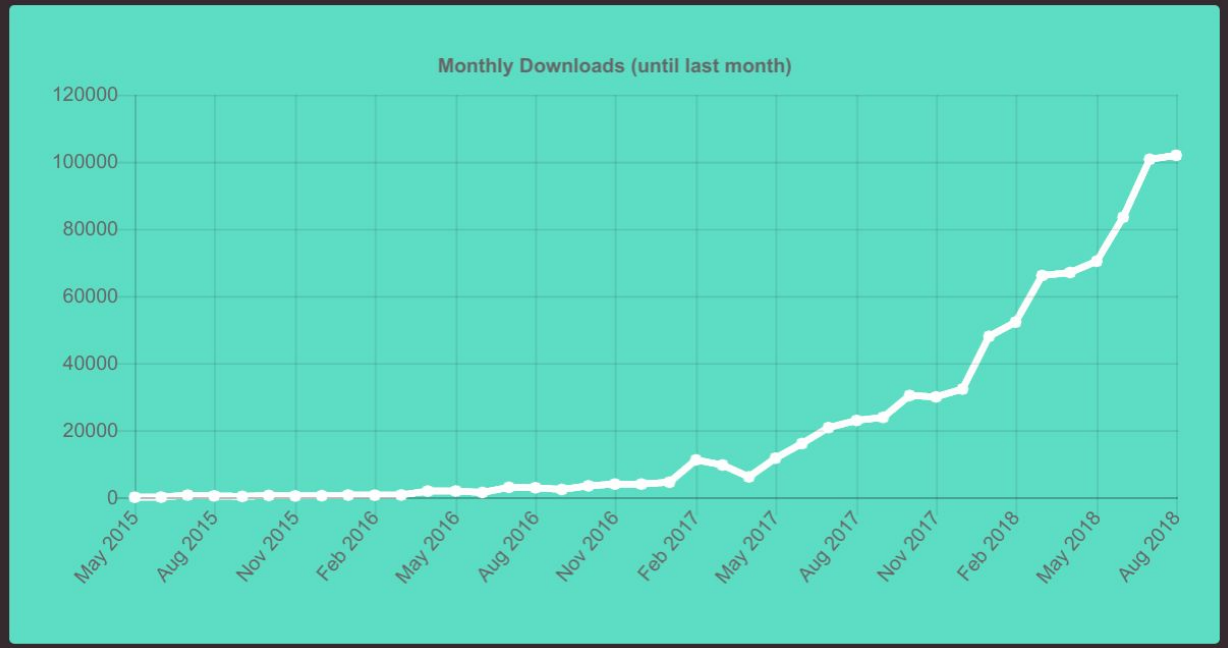


World map of Ethereum nodes according to
https://team.carto.com/viz/e70677d5-1111-40a8-9e19-f27da227a55c/public_map

Downloads

Over the lifetime of each product in the Truffle Suite, from inception to now.

TRUFFLE



Downloads of Blockchain Development Kit

Lifetime Downloads

869,911

Last Three Months

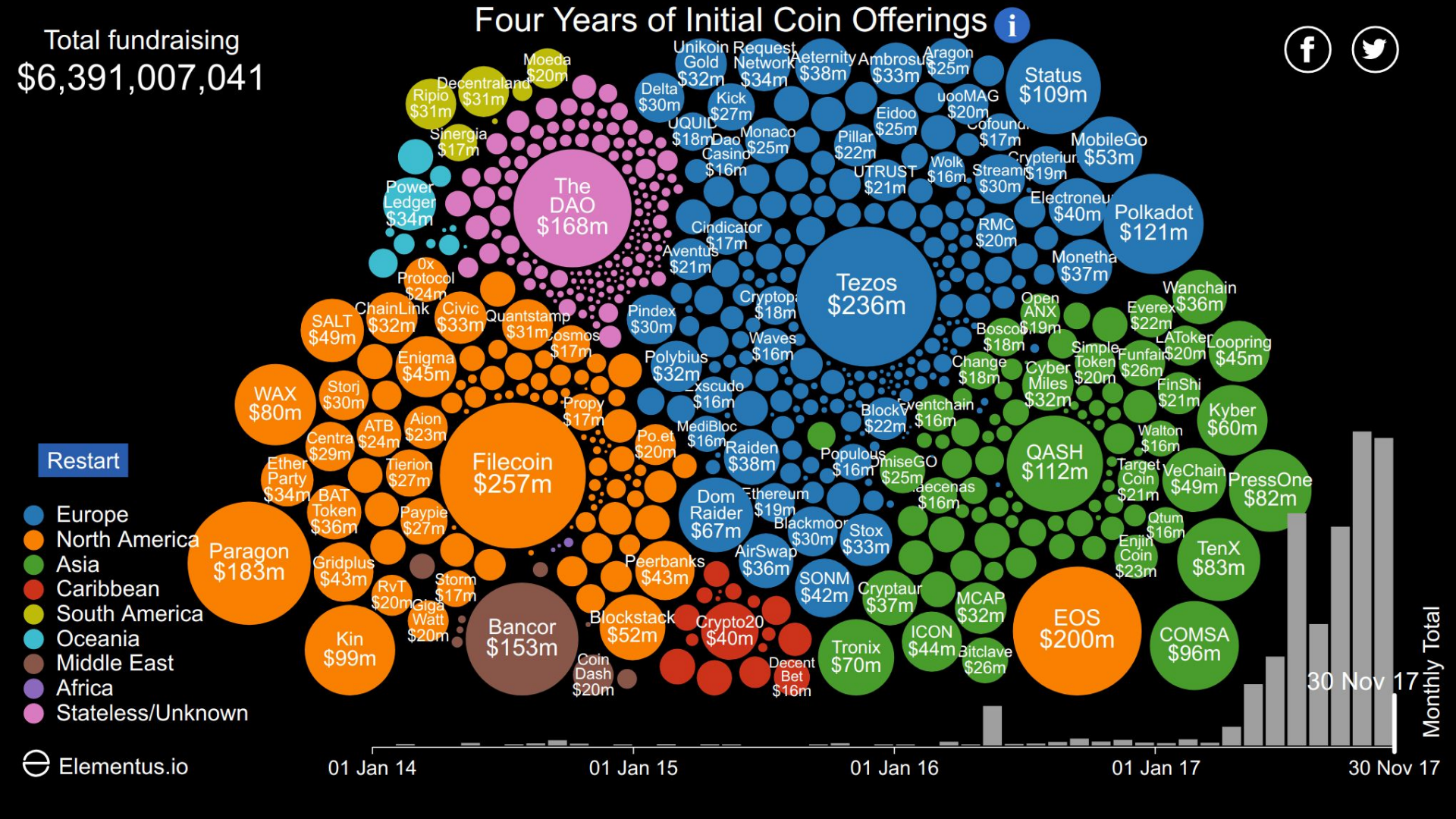
UP 40%

* excludes current month

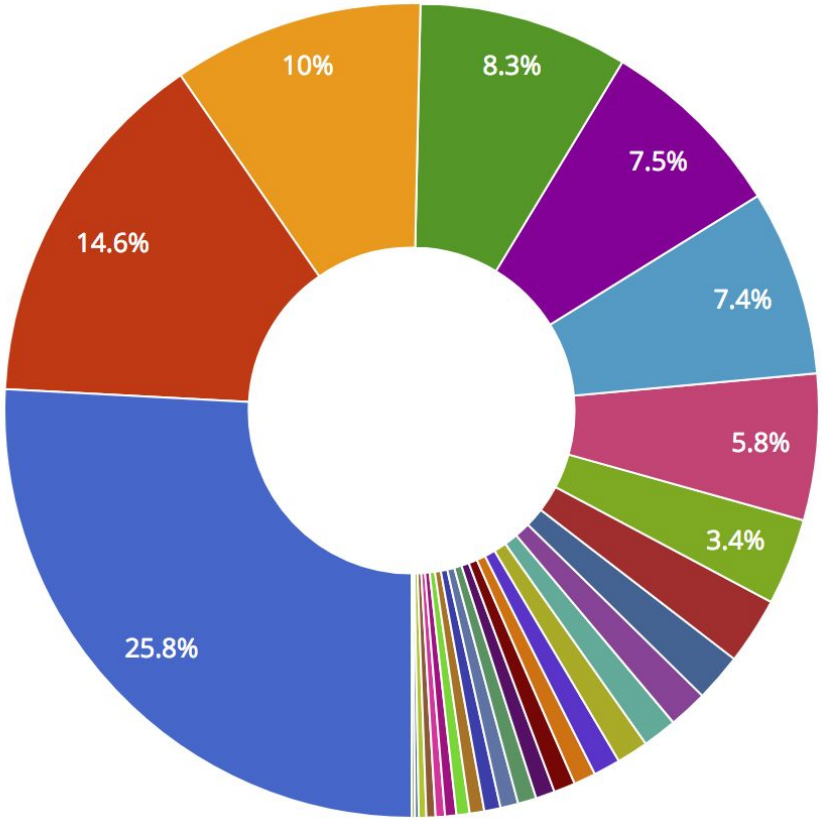
https://truffleframework.com/dashboard &
https://medium.com/loom-network/ethereum-will-be-the-backbone-of-the-new-internet-88718e08124f

Four Years of Initial Coin Offerings

Total fundraising
$6,391,007,041



Industry agnostic - ICOs by category in 2017



- Infrastructure 25.8% ($1,002,499,502)
- Finance 14.6% ($564,621,336)
- Trading & Investing 10.0% ($386,323,075.47)
- Communications 8.3% ($322,565,362)
- Payments 7.5% ($291,219,999)
- Data Storage 7.4% ($286,222,856)
- Drugs & Healthcare 5.8% ($225,326,054)
- Gaming & VR 3.4% ($133,418,167)
- Gambling & Betting 2.7% ($102,976,302.6)
- Commerce & Advertising 1.9% ($73,776,158)
- Data Analytics 1.5% ($60,000,000)
- Machine Learning & AI 1.4% ($52,658,661)
- Social Network 1.3% ($48,557,371)
- Privacy & Security 1.1% ($41,491,443)
- Art & Music 0.9% ($33,912,088)
- Identity & Reputation 0.9% ($33,000,000)
- Legal 0.8% ($29,368,234)
- Energy & Utilities 0.7% ($28,434,178)

1/2

Source: CoinSchedule.com