

Course Outline – MSBD5017 (L1)

Introduction to Blockchain Technology

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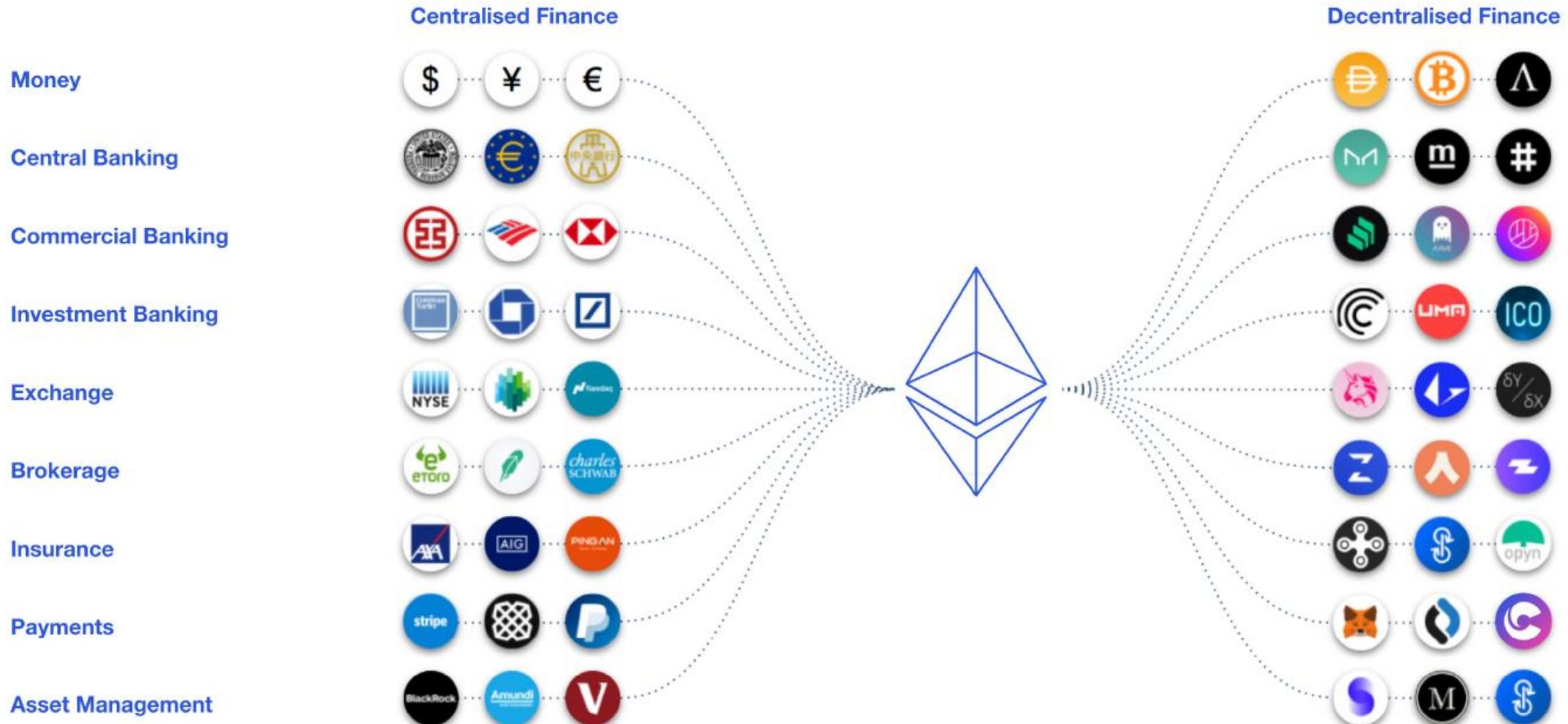
Poll Question

How would you invest in crypto currencies/assets today?

- Buy
- Transfer
- Business
- Earn/work
- Mine (hardware)
- Project
- Crowd funding
- ICO
- STO



Mapping traditional finance to decentralized finance



Course Background

□ Course instructor – Math/HKUST

□ About this course

- ❖ why a blockchain course
- ❖ what you expect from this course
- ❖ what I expect of you

□ Blockchain technologies

- ❖ not one technology, a spectrum of technologies
- ❖ not one domain, multiple, cross-domain
- ❖ constantly evolving
- ❖ why is it important connecting the dots
- ❖ technologies – enables business model vs in general technologies driven by biz
- ❖ more challenging, more demanding, more exciting, more rewarding
- ❖ course projects

Course Schedule & Evaluation - Logistics

Time – Friday 7:30-10:20pm, Zoom

- ❖ Feb: 5, 19, 26
- ❖ Mar: 5, 12, 19, 26
- ❖ Apr: 9, 16, 23, 30
- ❖ May: 7

Add/drop period: Feb 1 – Feb 17

Course Evaluation

- ❖ Class participation: 20%
- ❖ Homework: 30%
- ❖ Course Project: 50%

Distributed Ledger Technology & Blockchain

- ❑ DLT is a series of networks of databases that allow participants to create, disseminate and store information in an efficient and secure manner.
- ❑ These networks of databases can operate smoothly and securely without any central party that everyone trusts.
- ❑ This course will cover
 - ❖ Blockchain & Cryptocurrencies
 - ❖ Mining and eco-system
 - ❖ Consensus algorithms
 - ❖ Smart contracts
 - ❖ Economic, social, and computational models
 - ❖ Distributed intelligence
 - ❖ Scalability, security, and privacy
 - ❖ Applications in FinTech, IoT, smart city, 5G/edge computing

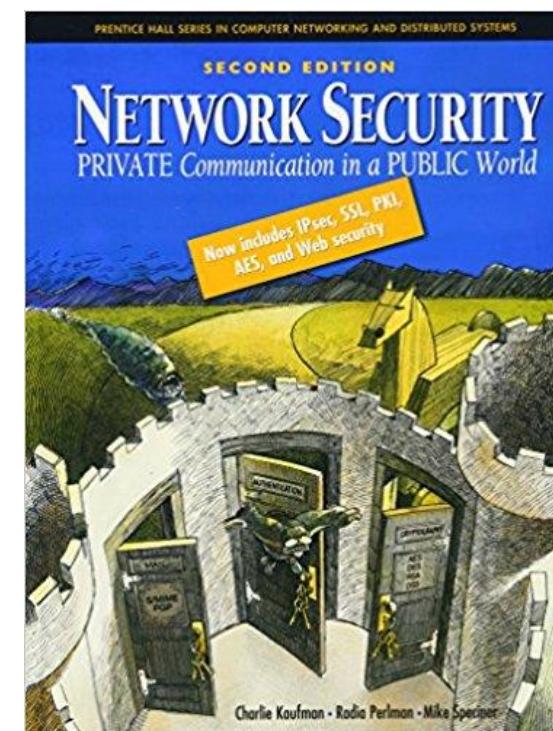
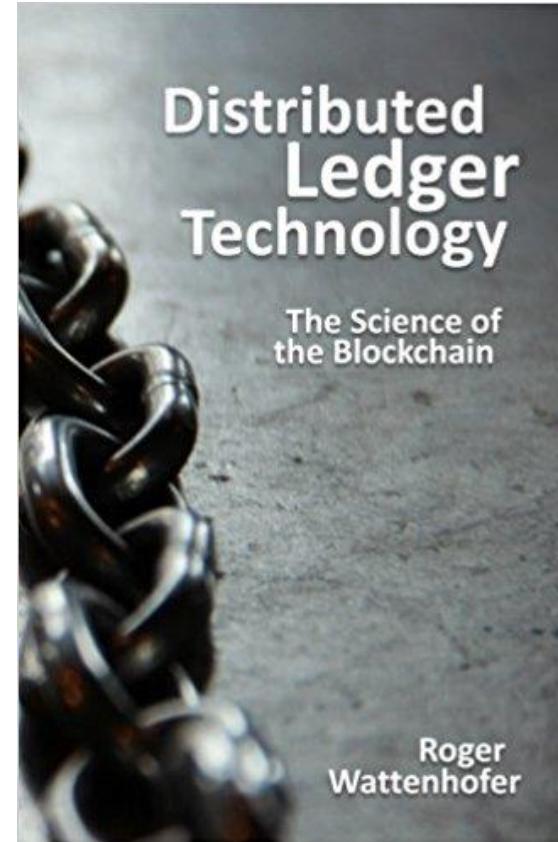
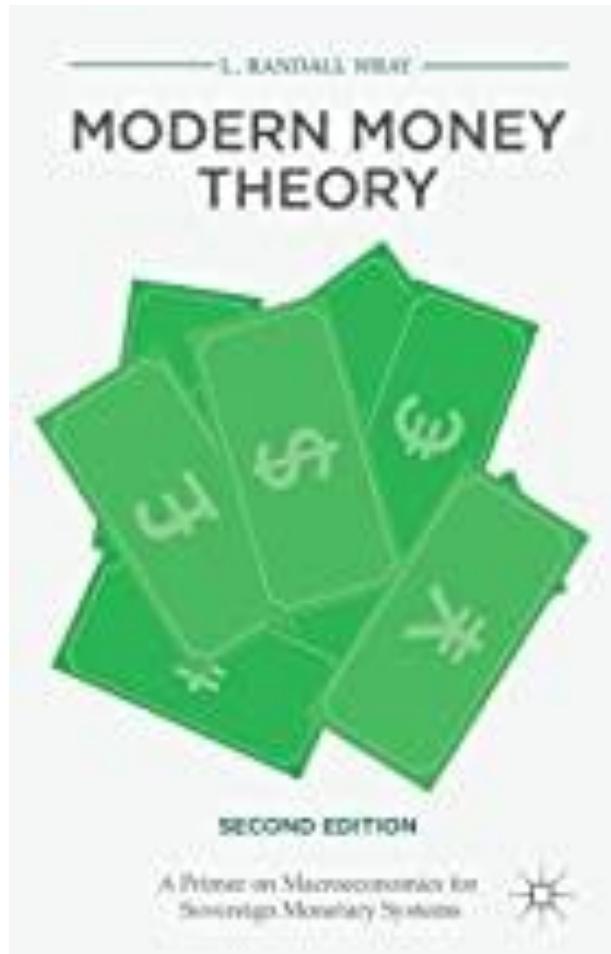
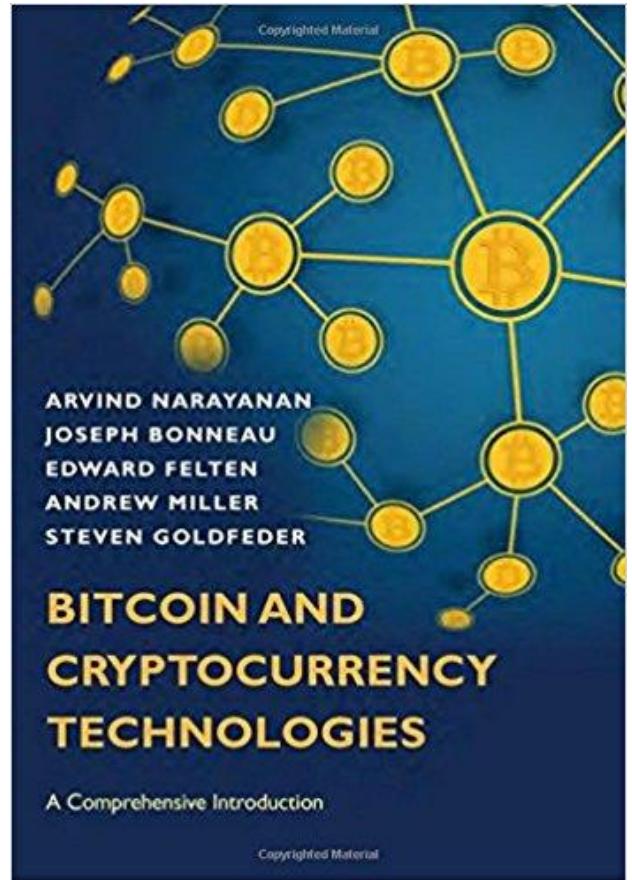
Course Information

Prerequisites:

- ❖ Discrete math (number theory)
- ❖ Data structure & algorithms
- ❖ Software programming

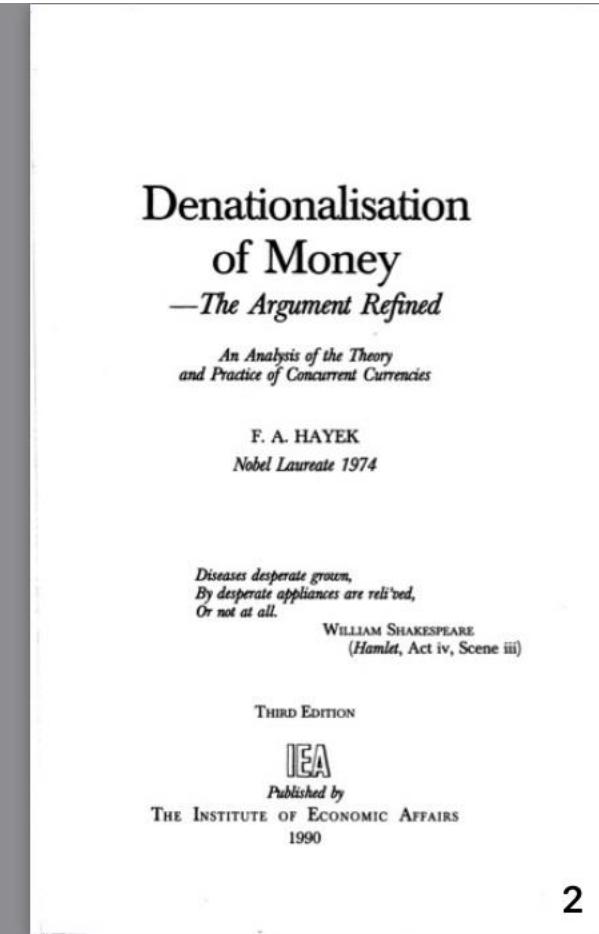
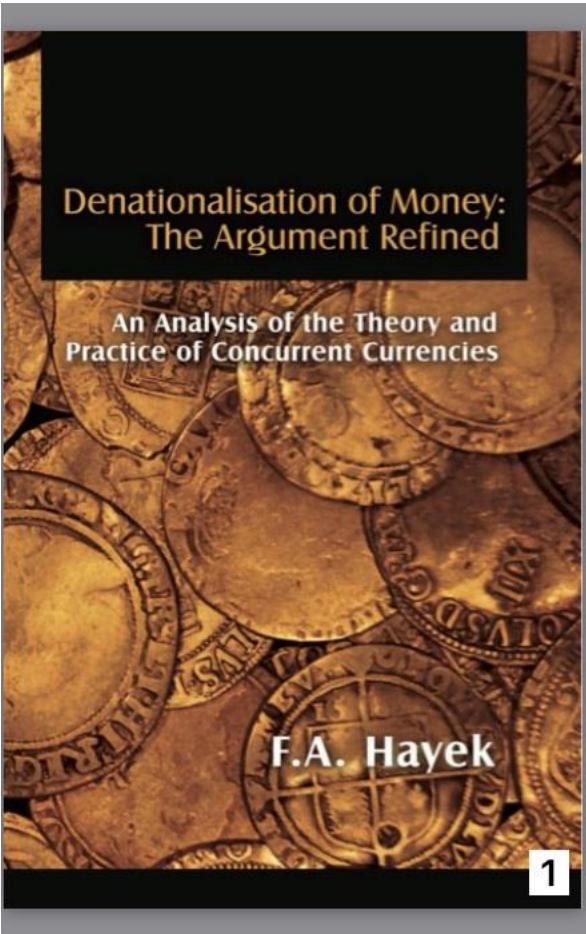
References:

- ❖ “Bitcoin and Cryptocurrency Technologies”, by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder
- ❖ “Denationalization of Money”, by F.A. Hayek
- ❖ “Modern Money Theory”, by L. Randall Wray
- ❖ “Distributed Ledger Technology: The Science of the Blockchain”, Roger Wattenhofer, 2nd edition, Inverted Forest Publishing, 2017
- ❖ “Network Security: Private Communication in a Public World”, 2nd edition, Charlie Kaufman, Radia Perlman, Mike Speciner, 2002

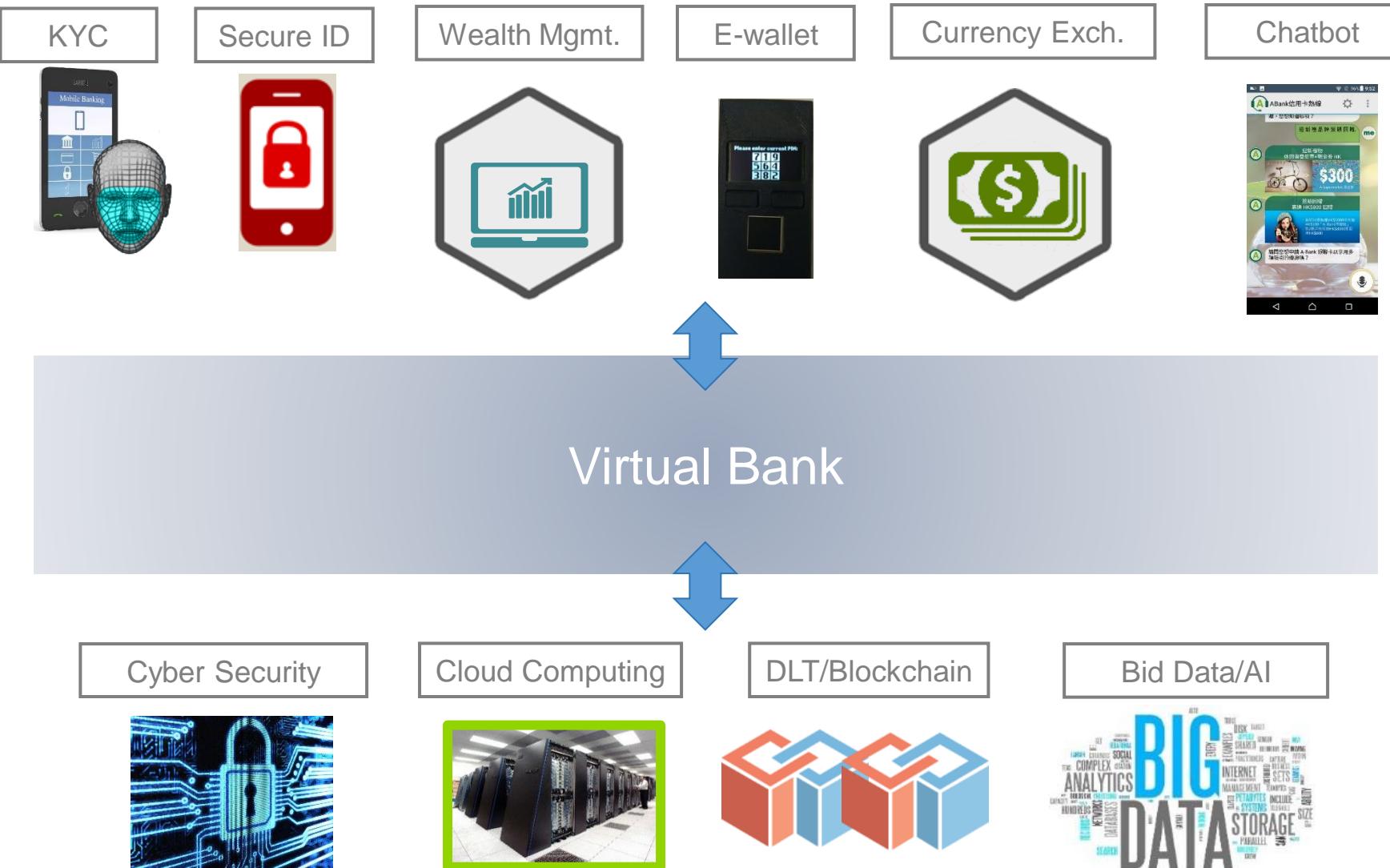


Denationalisation of Money

- ❑ Blockchain provides a solid technological foundation for Hayek's theory of "Denationalisation of Money"



FinTech Solutions for Virtual Bank

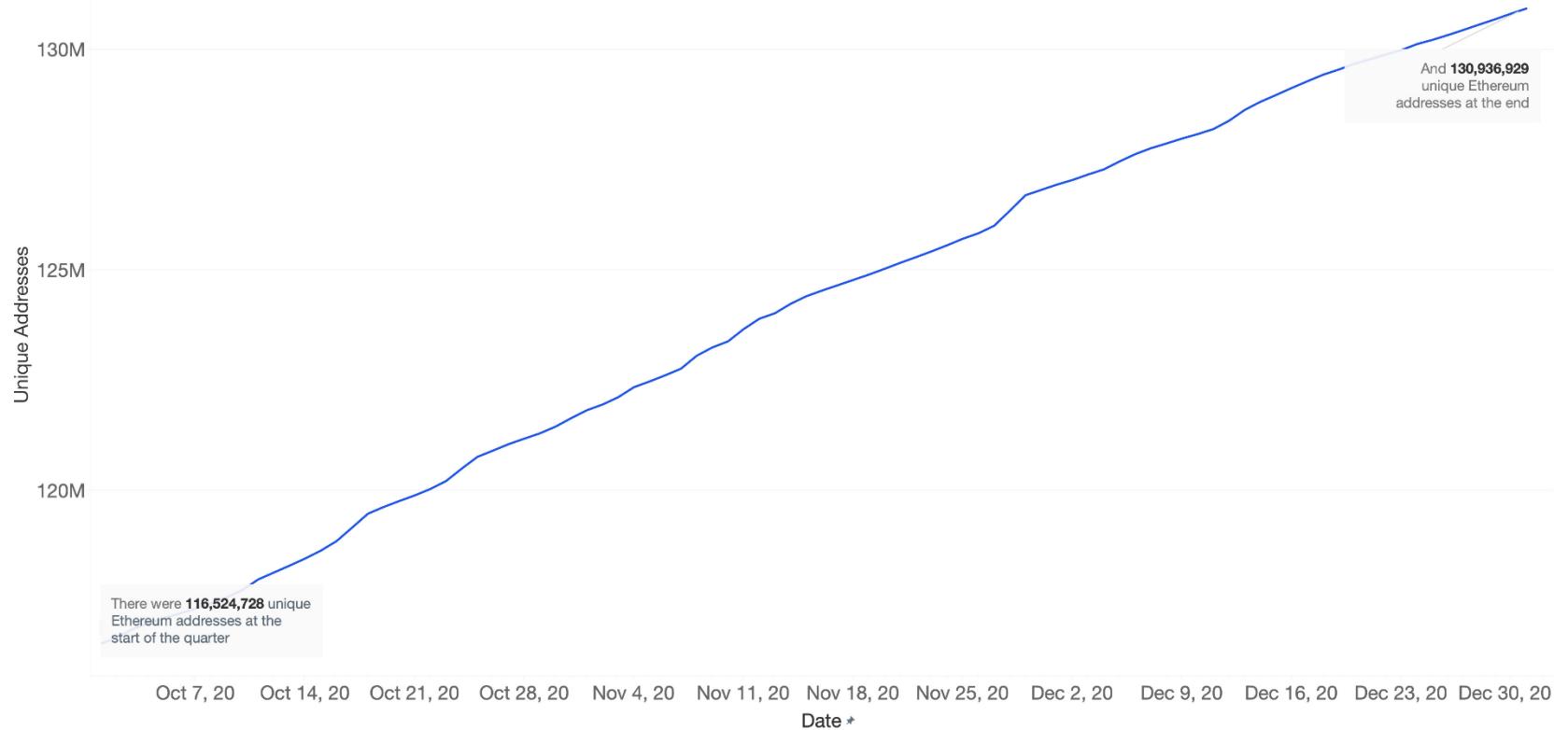




- Crypto trust**
- Crypto bank**
- STO (Securitized Token Offering)**
- AMM (Automatic Market Maker) & DEX (De-centralized Exchange)**
- Stable coins**
- Middleware for asset on-chain - synthetic assets by collaterals, Oracles**
- Digital Identity & Data privacy**
- Non Fungible tokens, crypto collectables**
- Public chain infrastructure, Eth2.0, Polkadot**
- Blockchain distributed storage, web 3.0**

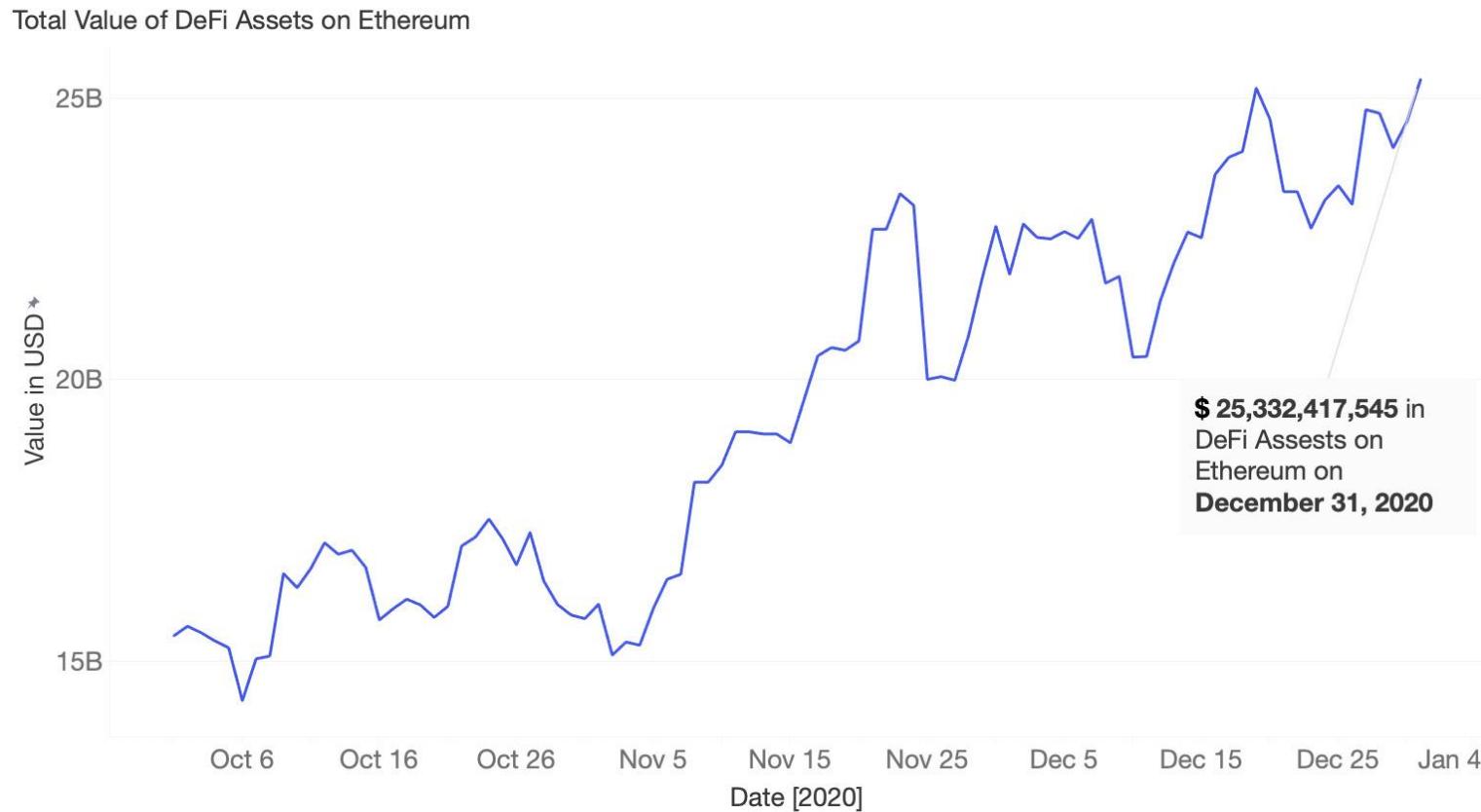
On Average, 100k new addresses were created daily in Q4 2020

Growth of Unique Ethereum Addresses in Quarter 4 2020



- Financial activities through trading, borrowing, lending, options, and derivatives
- Protocols and applications built on different assumptions of trust deliver powerful new patterns of creating and distributing value for communities
- Coming to consensus without trusted intermediaries, like escrow accounts, banks, or lawyers - social contract

Total value of DeFi assets on Ethereum exceeds \$20 billion



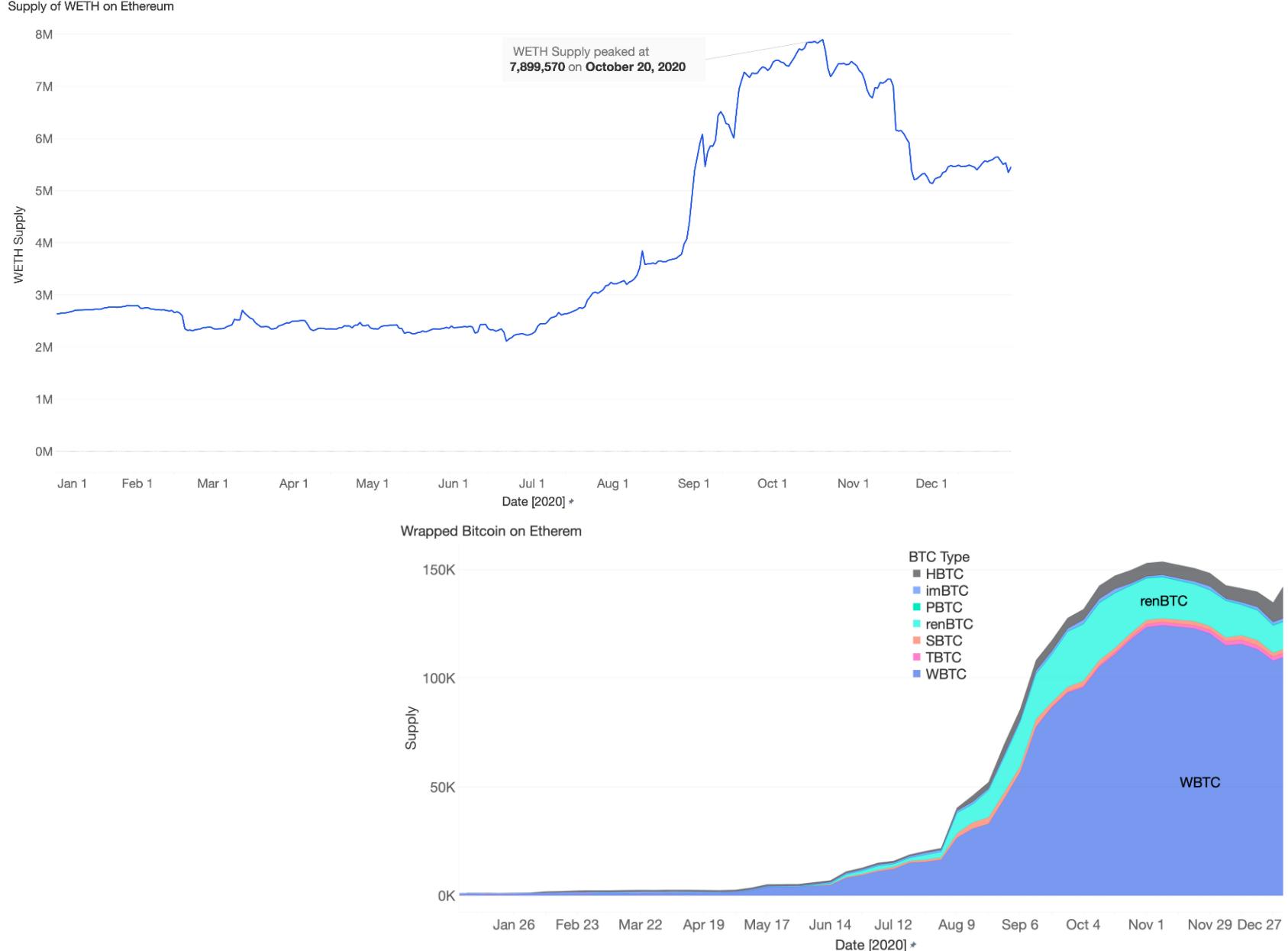
- Composability - easier to build new products and services on Ethereum
- DeFi can leverage any combination of open source protocols without needing permission
- ERC-20 standard makes stablecoins, governance tokens, and derivatives
- Standards ensure smart contracts remain composable, and other types of assets represented on Ethereum
- automated finance: value accrues to those involved

Increasingly, users of protocols are realizing the upside of fees



- Fees go to the team that built the applications, and
- Users of these applications that provide liquidity for trading pairs on decentralized exchanges (DEXes) or collateral for loans

Wrapped Tokens - Access to DeFi Liquidity

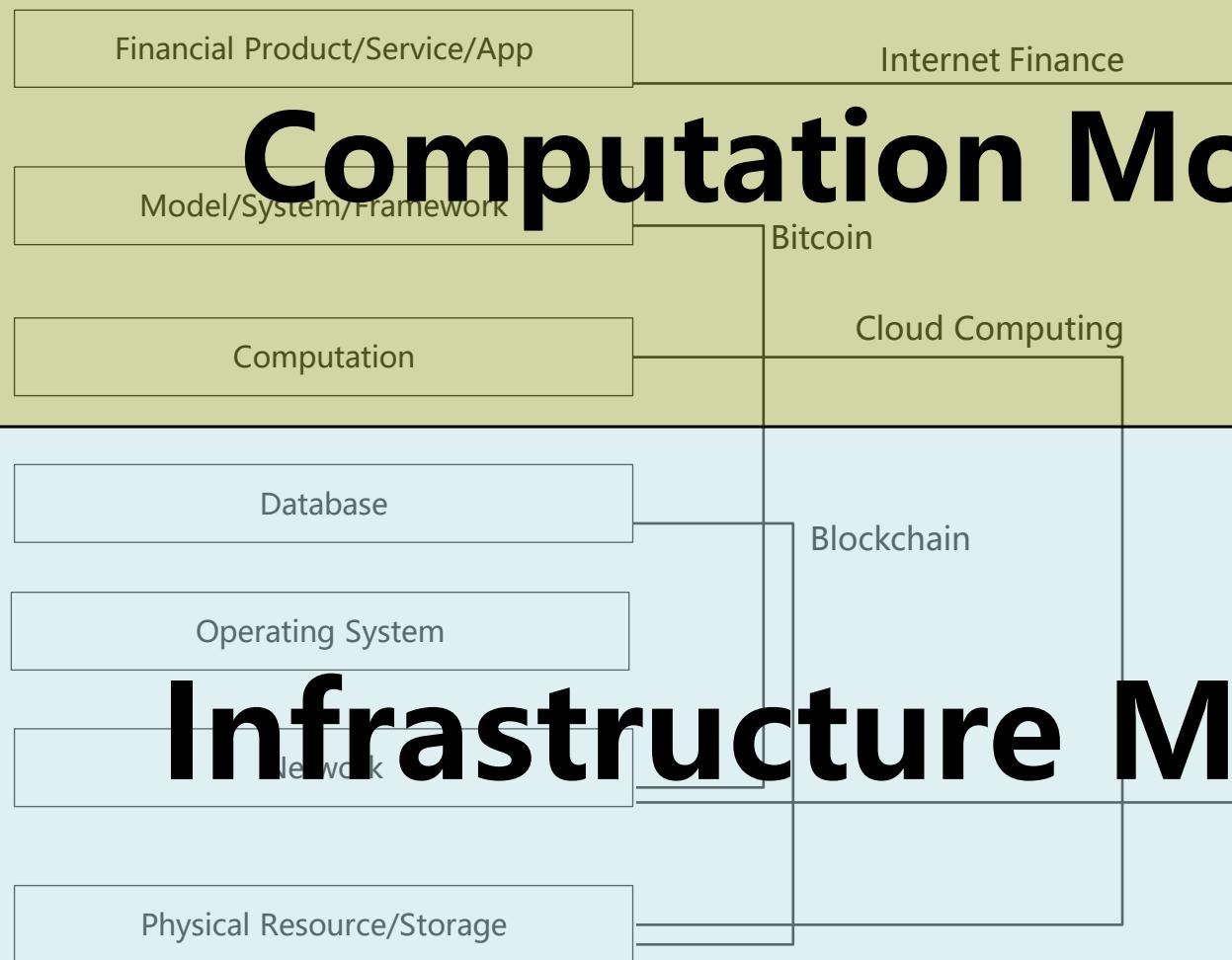


- Wrapping tokens on Ethereum is to transform an existing crypto asset into an ERC-20 token
- Lock the original token in a smart contract, then mints an equivalent amount of wrapped tokens
- From wrapped Bitcoin and Filecoin, to institutional funds and professional traders interacting seeking alpha on DeFi protocols, new inflows of value tokenized on Ethereum

INSTITUTIONS & PROFESSIONAL TRADERS ACCESS DEFI

- ❑ Interest rates on trading pairs or lending protocols with 5-12% APY compared to US treasuries at 0.92% yield
- ❑ More funds channeled into De-Fi, the more that risk and assets diversity is distributed - increased liquidity, narrowing of spreads, better risk profiling and insurance coverage - important benefits of institutional participation
 - ❖ Q4 2020, PayPal offering crypto custody and trading
 - ❖ Mass Mutual adding Bitcoin to balance sheet - institutional interest in alternative assets
- ❑ Lacking robust reporting for accounting, tax, and P&L purposes – need operational, security, and reporting features for a professional De-Fi trading desk
- ❑ From CeFi to DeFi: can an asset be both permissionless, but still have some controls necessary for legal jurisdictions?
 - ❖ ERC-1400, hybrid Ethereum token designed for traditional financial assets: both a nonfungible token (like an ERC-721) and a fungible token (like ERC-20).
 - ❖ With ERC-20 standard, compatible with existing tools and platforms.
 - ❖ With ERC-721, more controls and can comply with requirements for asset issuers

Traditional IT vs FinTech



Financial Technologies? (FinTech)

redefine the boundary between quantitative finance and information/communication technology

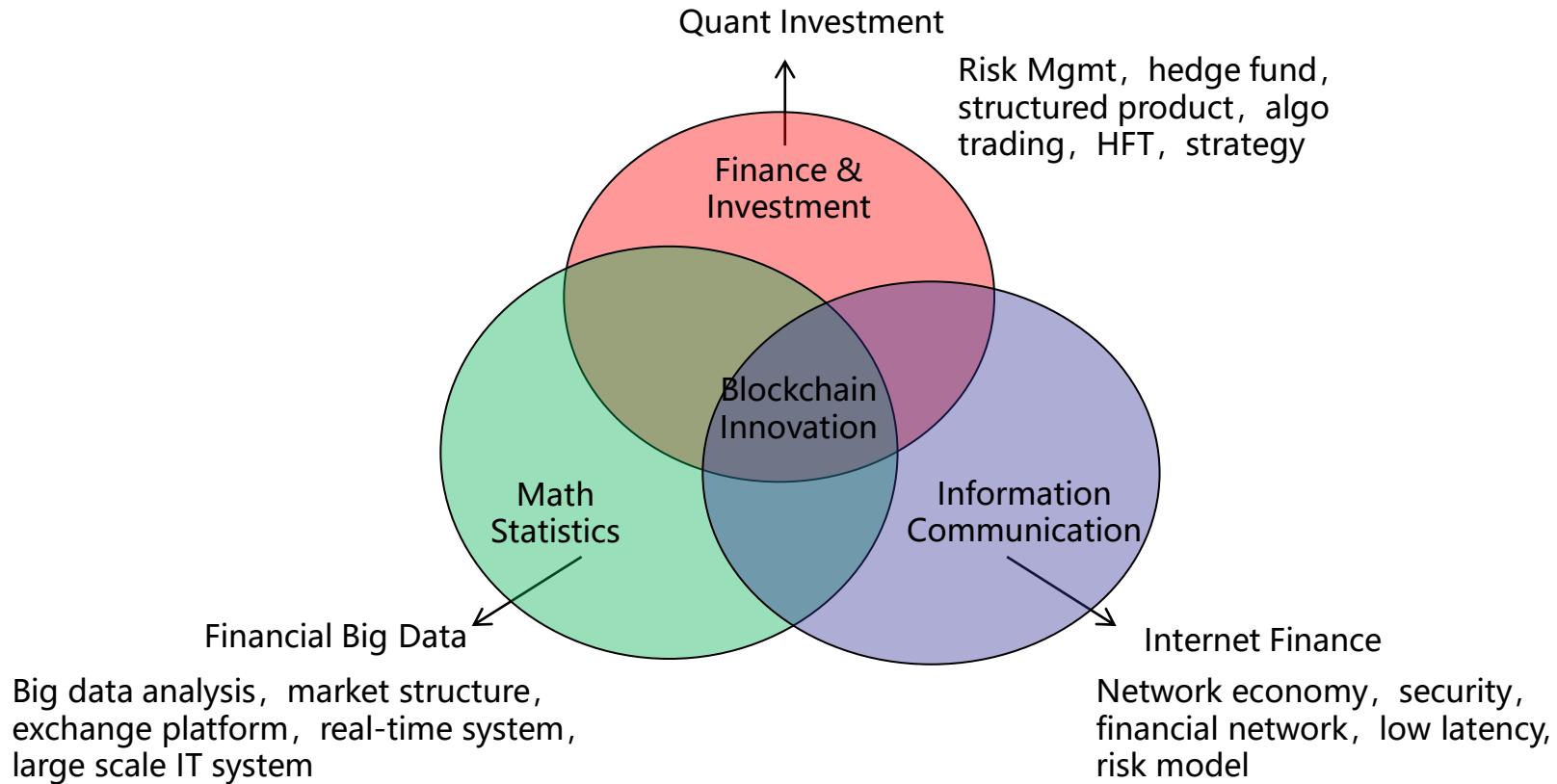
Cross-layer innovation

Traditional IT used in Finance

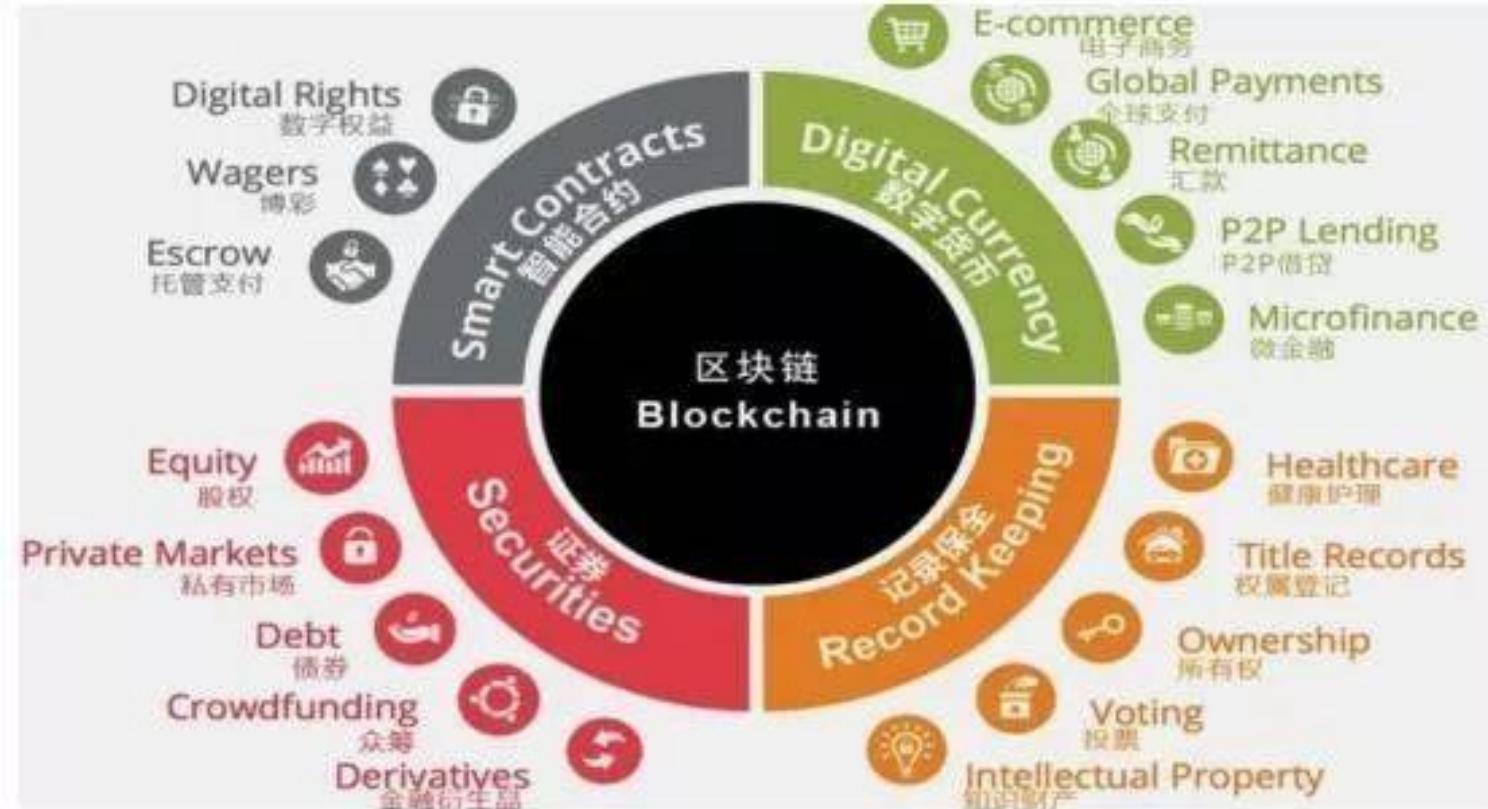
IT serves the financial industry

Strict boundary between layers

Blockchain Innovation – Inter-disciplinary Innovation



Generations of Blockchains

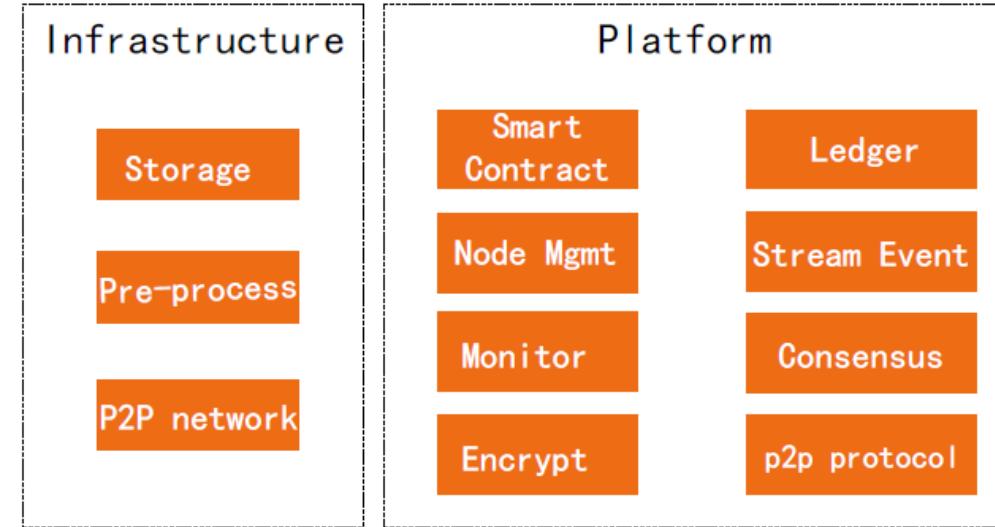


- **Blockchain 1.0: programmable money – carrier currency -> Ledger Record**
 - ❖ Ledger record is both the means and ends (method and purpose)
- **Blockchain 2.0: programmable finance – smart contract (code execute contracts for people)**
 - ❖ Value Record, shares/debts/rights registration, transfer, securities/contracts/betting exchange
- **Blockchain 3.0: programmable society**
 - ❖ Value Internet – info/data with value, can record rights, quantify, and store
 - ❖ Record everything valuable – code represents logical things – most of society (minus moods, sensation etc.)

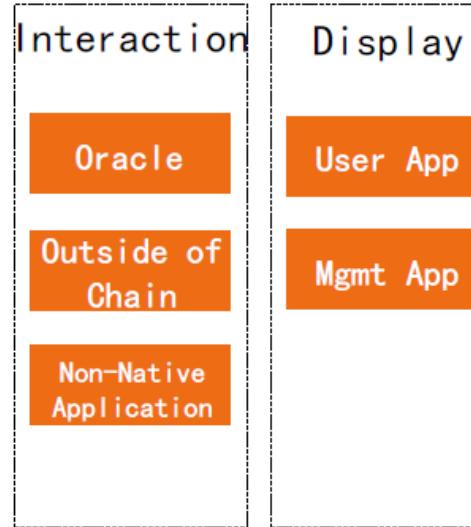
Blockchain Industry Chain



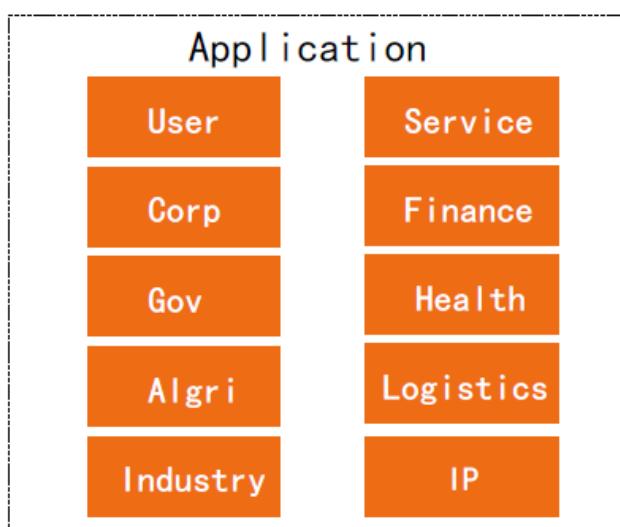
Down stream



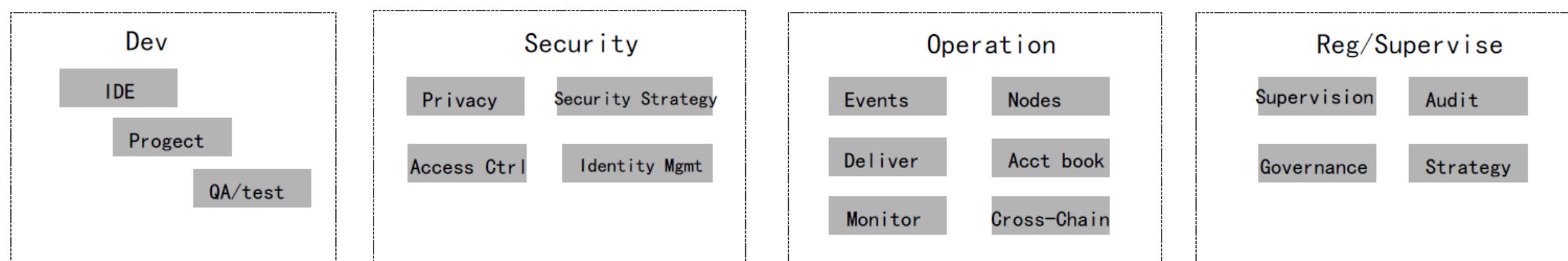
Mid Stream



Up Stream

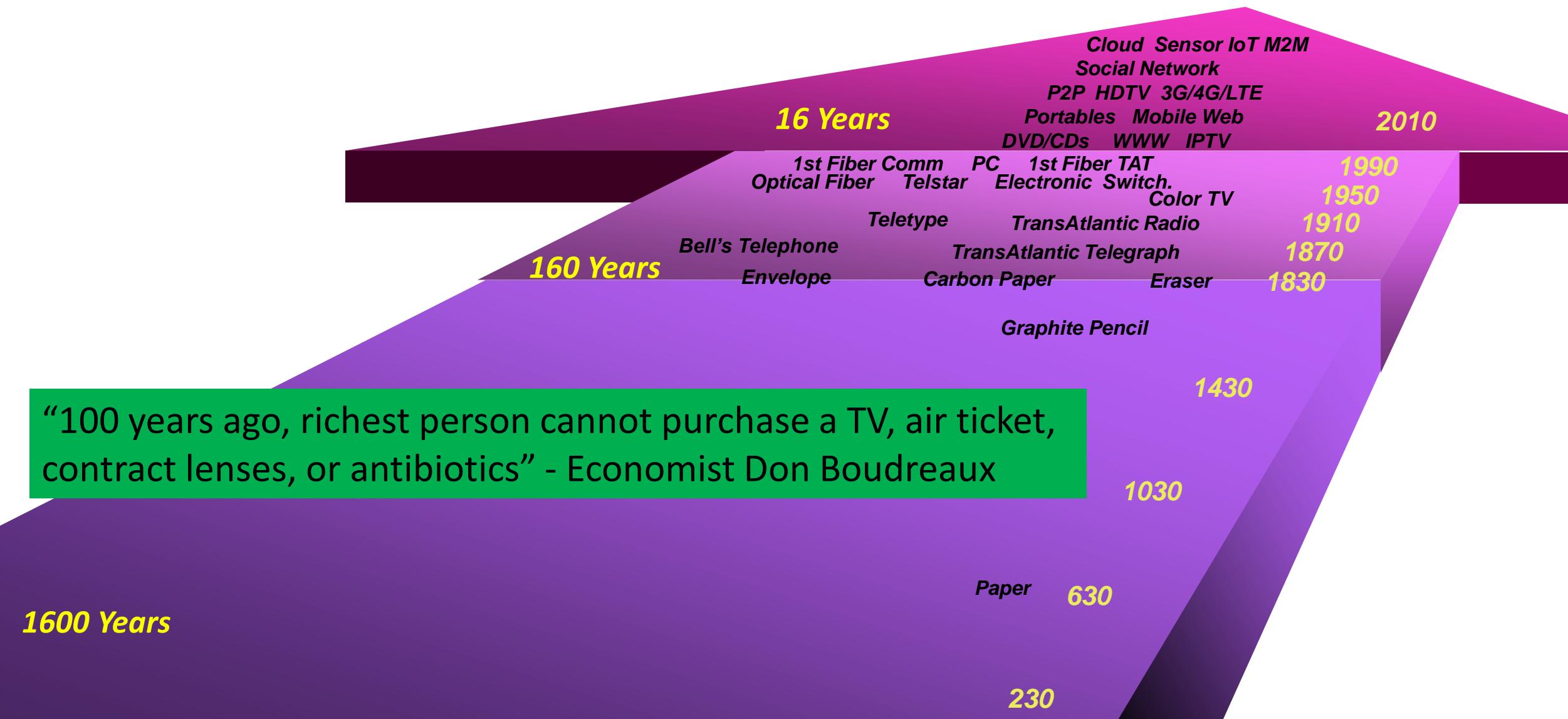


Services



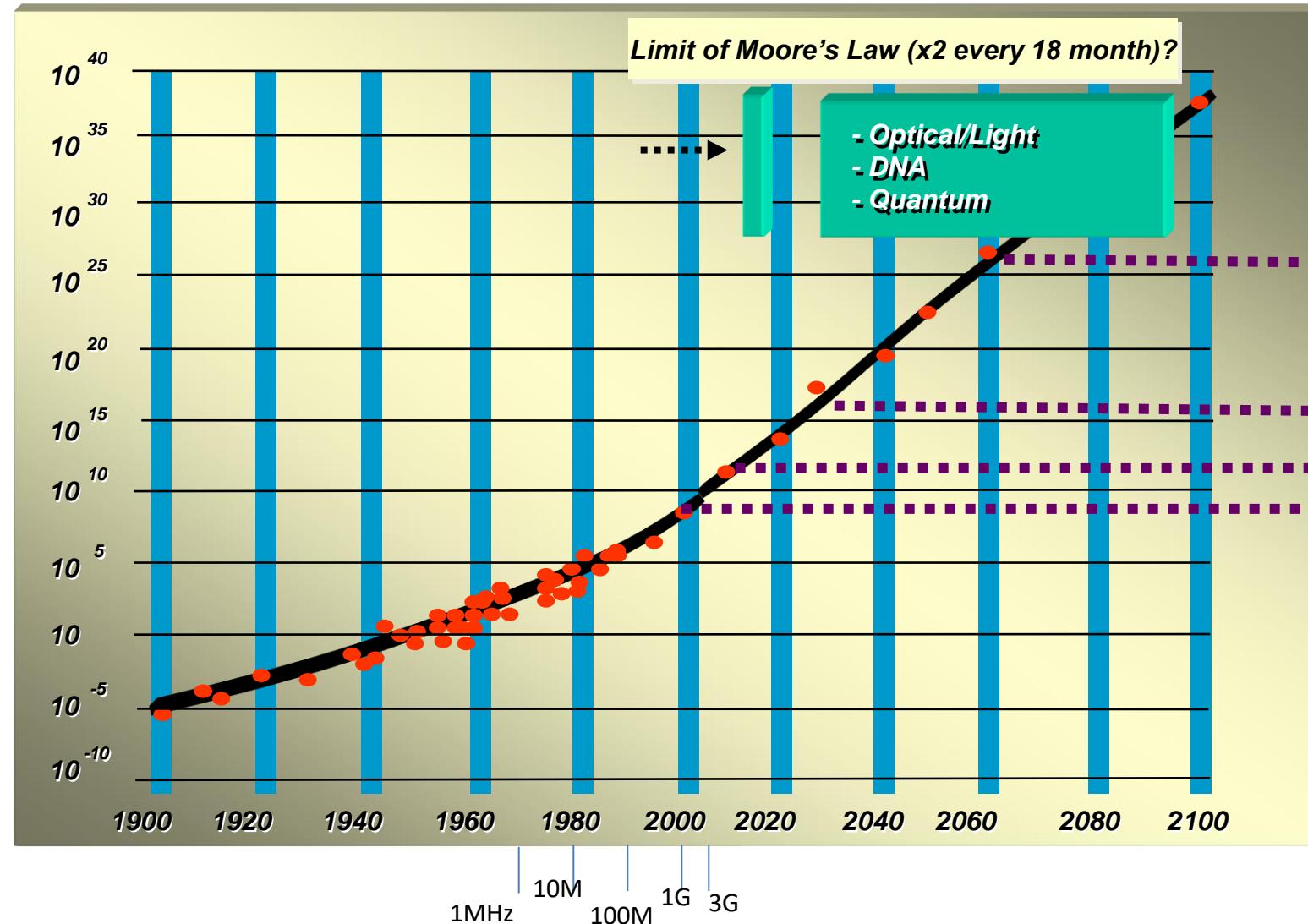
Information & Communication Technology (ICT)

5G / AI / Blockchain – Machines start to take over



\$1,000 Computation Power

(# Calculations per Second)



Brains of All Humans



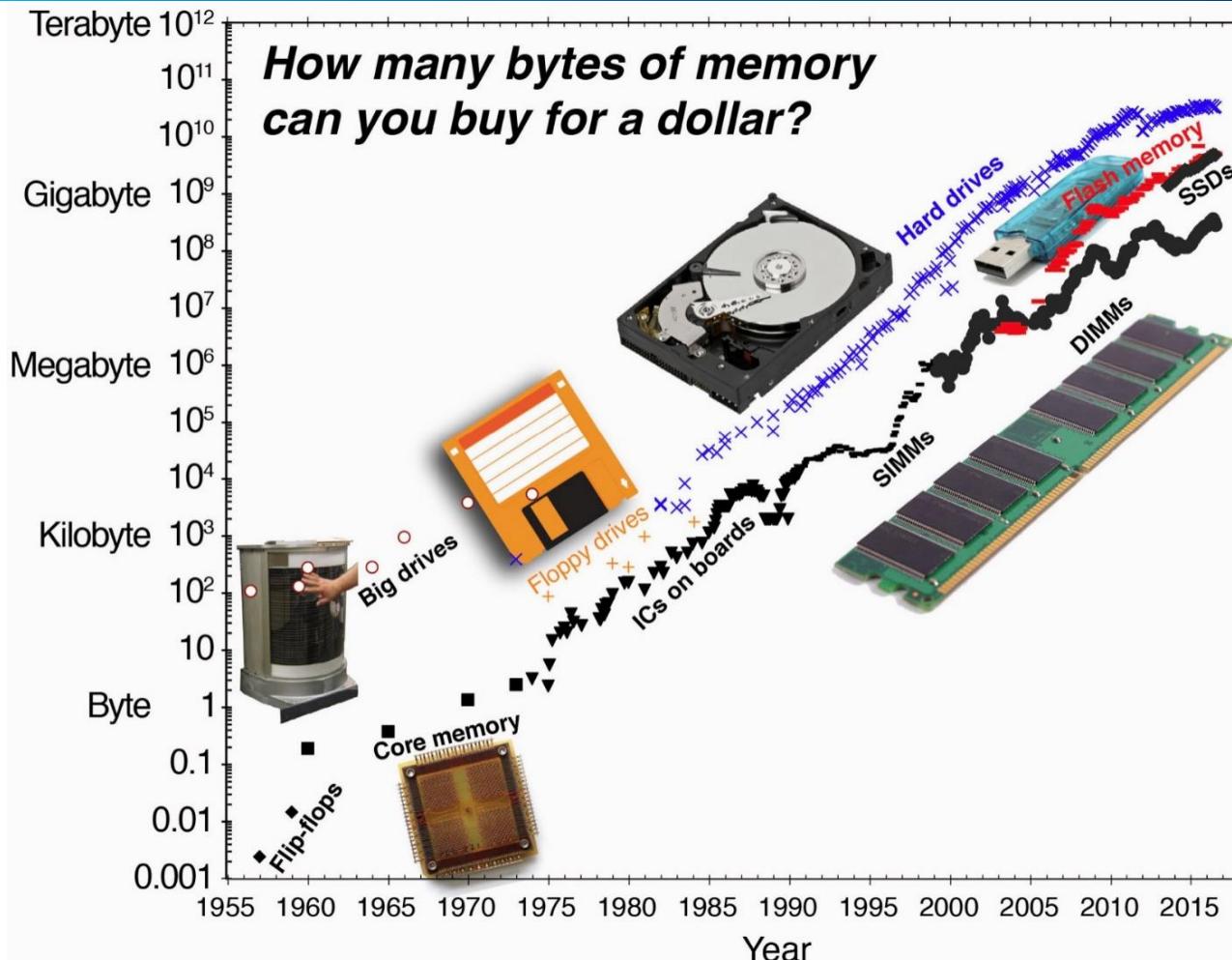
One Human Brain



One Insect Brain

One Mouse Brain

Computer and Human Memory Devices



Computer memory has gotten twice as cheap roughly every couple of years



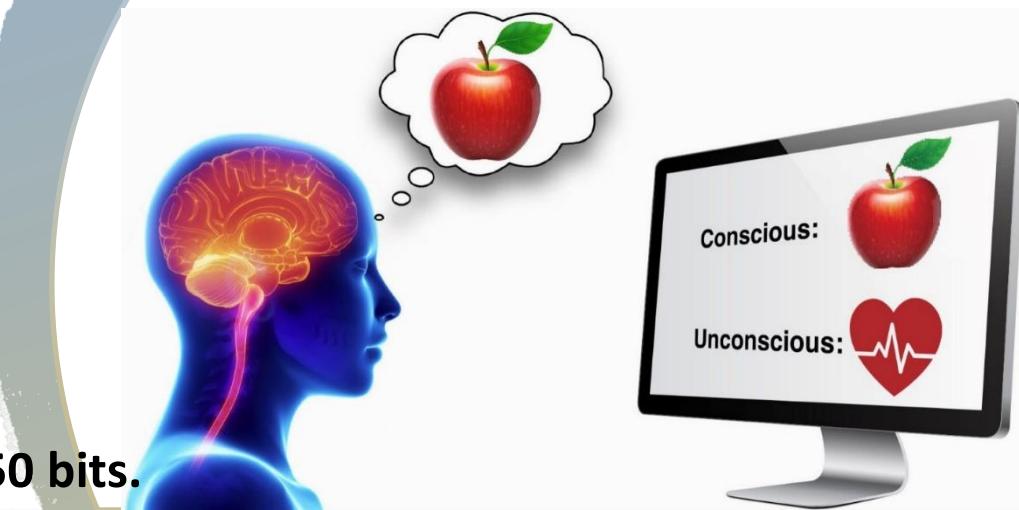
How about memory devices of humans?

- DNA can store about 1.6G
- Brains stores 10G electrically (which of 100B neurons are firing at any one time) and 100T chemically/biologically (how strongly different neurons are linked by synapses)

I cannot imagine a consistent theory of everything that ignores consciousness.

Andrei Linde, 2002

**Consciousness =
Subjective Experience**

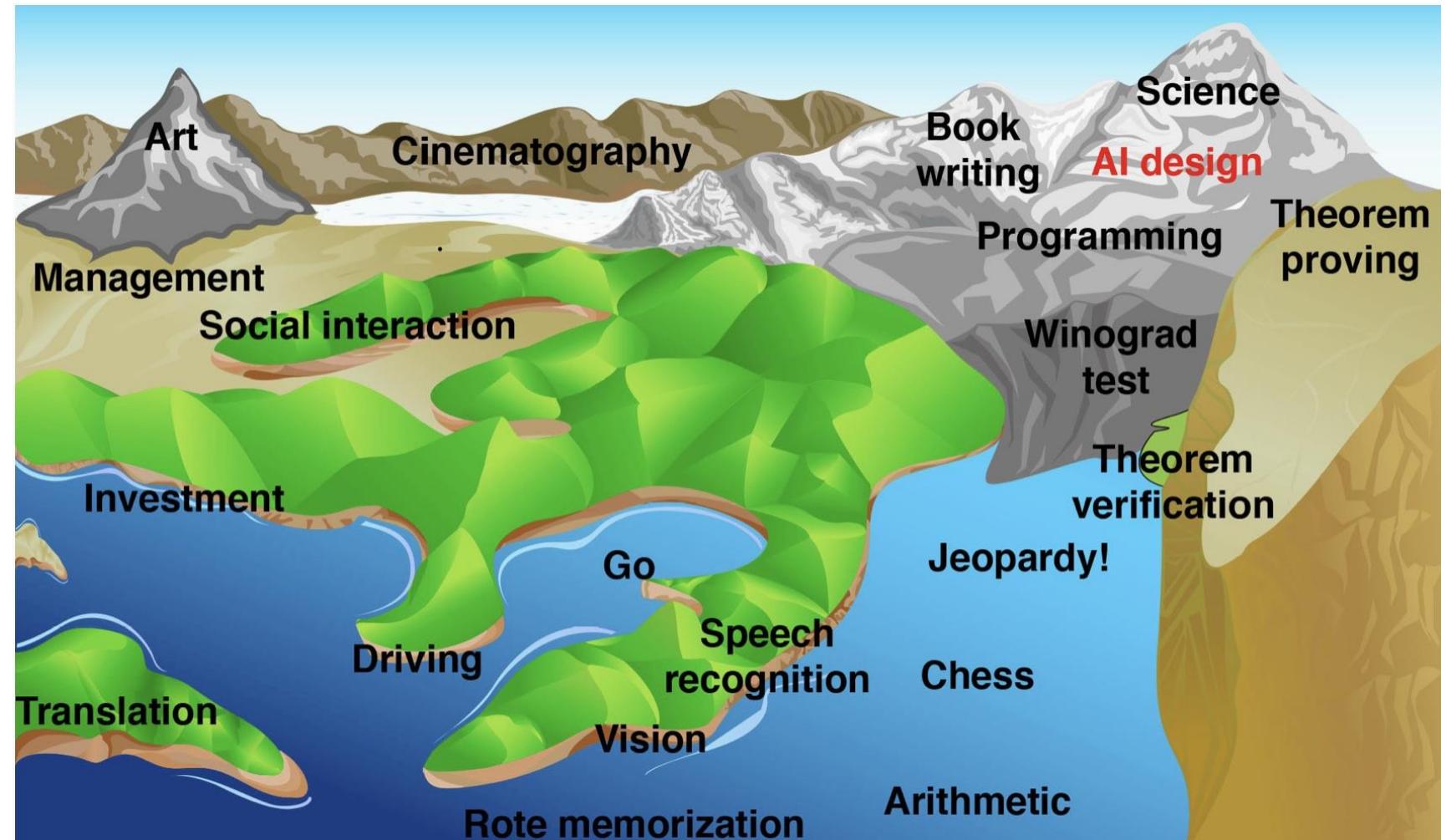


10^7 bits info enters our brain each sec, we are aware of only 10 to 50 bits.

Hans Moravec's Landscape of Human Competence

Elevation represents difficulty for computers, and the rising sea level represents what computers can do.

AI not completely lacks goals, breadth, intuition, creativity or language — central traits for human. AI will have a dramatic impact on how we view ourselves, what we can do when complemented by AI, and what jobs left for us.



IN 60 SECONDS..

1 NEW
DEFINITION
IS ADDED ON
UPDAN

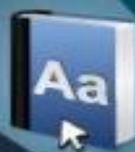
1,600+
READS ON
Scribd.

13,000+ HOURS
MUSIC
STREAMING ON
PANDORA

12,000+
NEW ADS
POSTED ON
craigslist

370,000+ MINUTES
VOICE CALLS ON
skype

98,000+
TWEETS



320+
NEW
TWITTER
ACCOUNTS

100+
NEW
LINKED IN
ACCOUNTS



1 NEW
ARTICLE IS
PUBLISHED



6,600+
NEW
PICTURES ARE
UPLOADED ON
flickr



50+
WORDPRESS
DOWNLOADS



125+
PLUGIN
DOWNLOADS

695,000+
FACEBOOK
STATUS UPDATES



79,364
WALL
POSTS

510,040
COMMENTS



13,000+
iPhone
APPLICATIONS
DOWNLOADED

100+
ANSWERS.COM
40+
YAHOO! ANSWERS

600+
NEW
VIDEOS

QUESTIONS
ASKED ON THE
INTERNET...

25+ HOURS
TOTAL
DURATION



70+
DOMAINS
REGISTERED

1,500+
BLOG
POSTS

60+
NEW
BLOGS

168 MILLION
EMAILS
ARE SENT



Google

Google Search

1,700+
Firefox
DOWNLOADS





Opportunities when data connected

- rich data + smart analytics = **contextual data** reflecting events in wider environment
- device data - how it performs, where to extend value
- user data – how/when/why actions - reshape what we know, prioritize how we decide
- **outcome economy**: purchase by the hour, e.g. airlines own planes -> lease planes -> lease engines
- synthetic perspectives w/ peripheral input from peers (not server) - new channels for delivering value
- decentralization of value creation/exchange: mimic the infrastructure that enables it

Personal + Collective Data Provide Better Experiences

- Companies: better & low-priced services from user data
- Users: increasing usage time
- Regulators: user data is used properly

2.2B
Facebooks

200MM
Pinterests

170MM
Spotifys

125MM
Netflixes

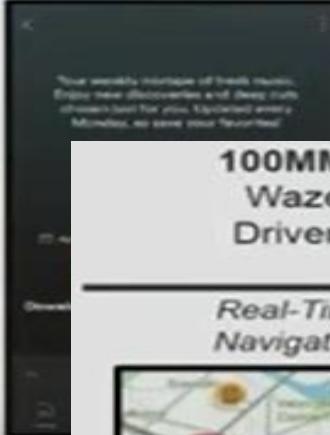
Newsfeed



Discovery



Music

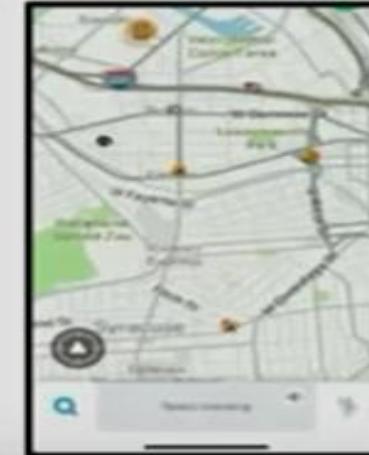


Video



100MM+
Waze
Drivers

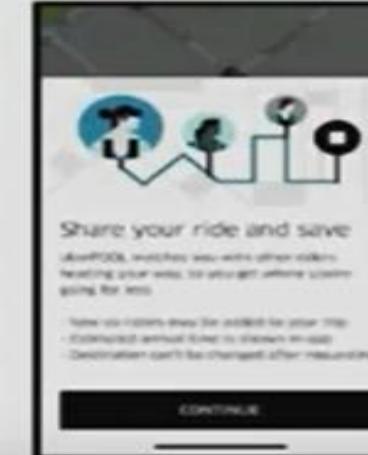
Real-Time
Navigation



20%

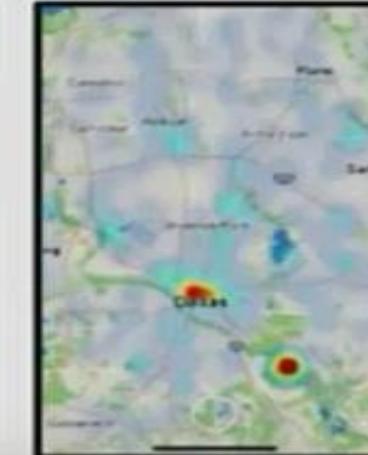
UberPOOL Share of All
Rides, Where Available*

Real-Time
Transportation



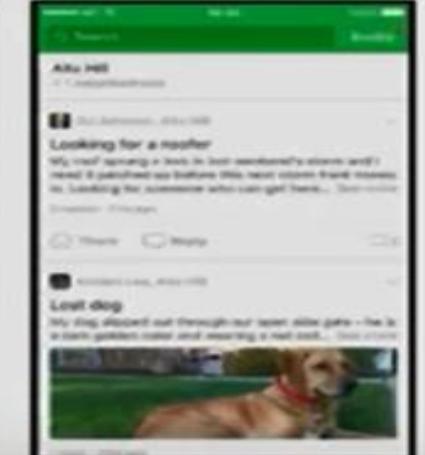
100MM+
Snap Map
MAUs

Real-Time
Social Stories



17MM**
Nextdoor
Recommendations

Often Real-Time
Local News



Do we understand data?

Do numbers have intrinsic value?

What is number?

- 5430096148141338410444291311
- 7364096122801338410406731311
- 84104101321041019711411632104971153210511611532114
101971151111011532119104105991043211410197115111103210711011111911532
1101111610410511010332111102
- 324892
- 10687873516724500307654093085300013526854881095934835963916860316778321
6179413
- 98764321234212121212121212121211111111111229

What is number?

- 草在结它的种子
- 风在摇它的叶子 - 顾城 (telegraph code)
- The heart has its reasons which reason knows nothing of - Blaise Pascal (ASCII code)
- 100 HKD series number
- Hash value of a picture of fish (SHA256)
- A prime number

What is Number

- **Encryption Key**
- **Digital currency**
- **Bank**
- **Content (text, music, photo, movie)**
- **Software (app, office, game)**
- **Network (router, switch, exchange, cloud)**
- **Organization/Market/Economy/Society**
- **What is Smart Data?**

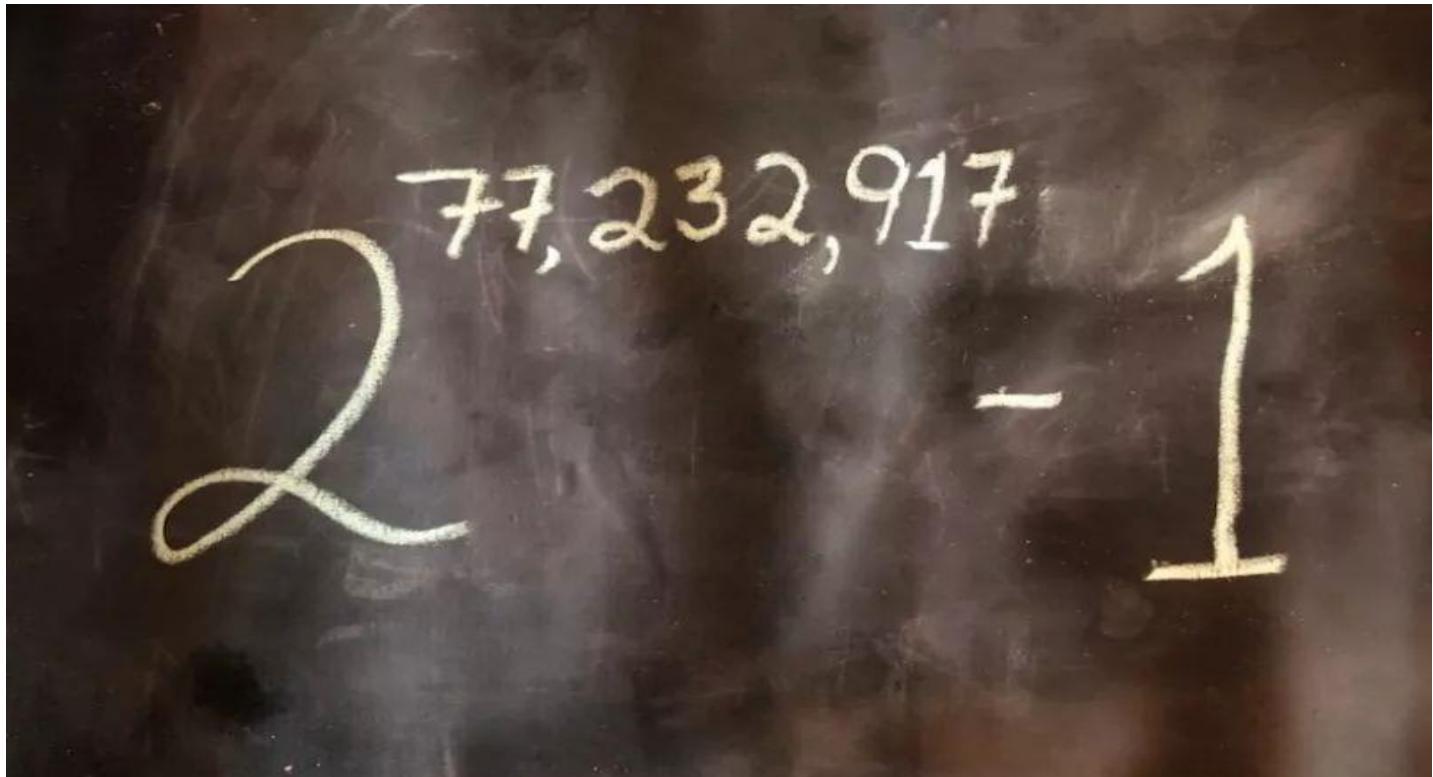
Prime Number

- Used to be considered “least useful math branch”
- Ancient Greek method: e.g. 18
 - 2, 4, 6, 8, 10, 12, 14, 16, 18
 - 3, 6, 9, 12, 15, 18
 - . . .
 - 3, 5, 7, 11, 13, 17
- Number theory & cryptography foundation for IT security
- Hunt for prime numbers: commerce, banking, email

$$n = p \times q$$

- n public, p,q private – is “n” a prime number?
- Greek method is effective, but not efficient

Largest Prime Number



The image shows a chalkboard with the mathematical expression $2^{77,232,917} - 1$ written in white chalk. The number 77,232,917 is written above the base 2 and below the exponentiation symbol. The chalkboard has a dark, textured background.

Fill 9000 pages

Total number of atoms in the whole observable universe is less than 100 digits

Public Key Cryptography

- In 1970s the Public Key Cryptography emerged
- Each user has two mutually inverse keys
- The encryption key is published
- The decryption key is kept secret
- Anybody can send a message to Bob, only Bob can read it



Cryptocurrency – High Level View

□ Who are you?

=> Identity / Wallet

□ What have you?

- ❖ Earned
- ❖ Exchange
- ❖ Given by someone

□ What's on the record?

- ❖ Who writes what on the ledger?

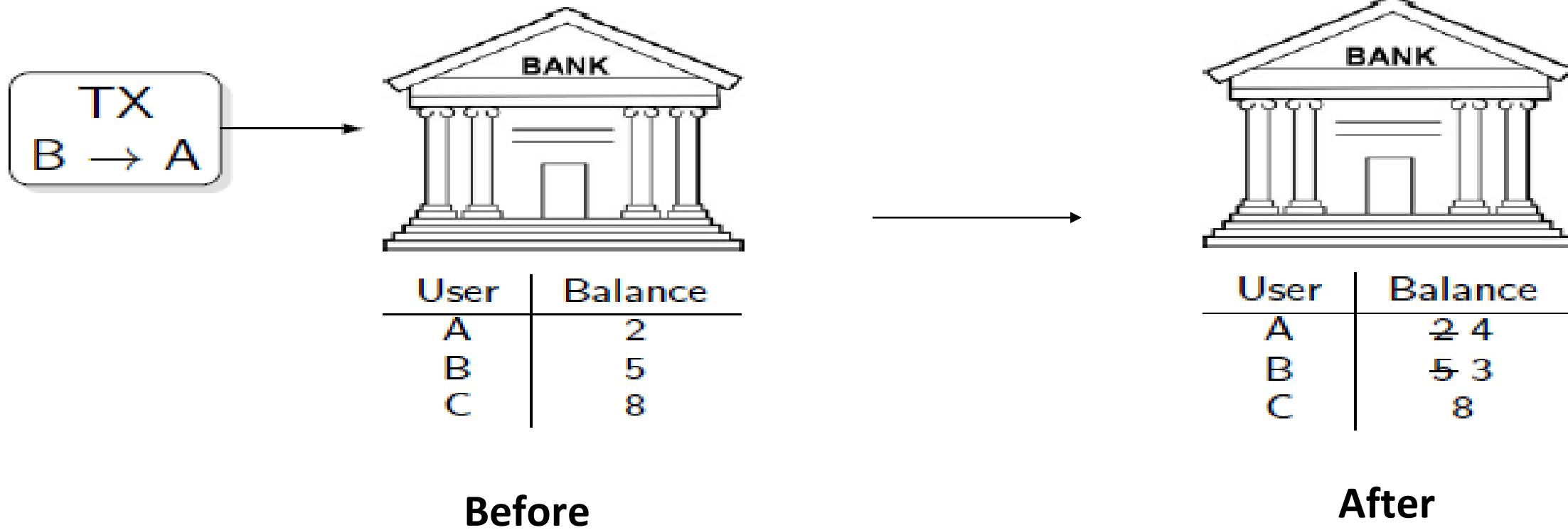
Encryption is to protect digital asset, and tamper-proof;

Just like email & password



The Bank of Bitcoin

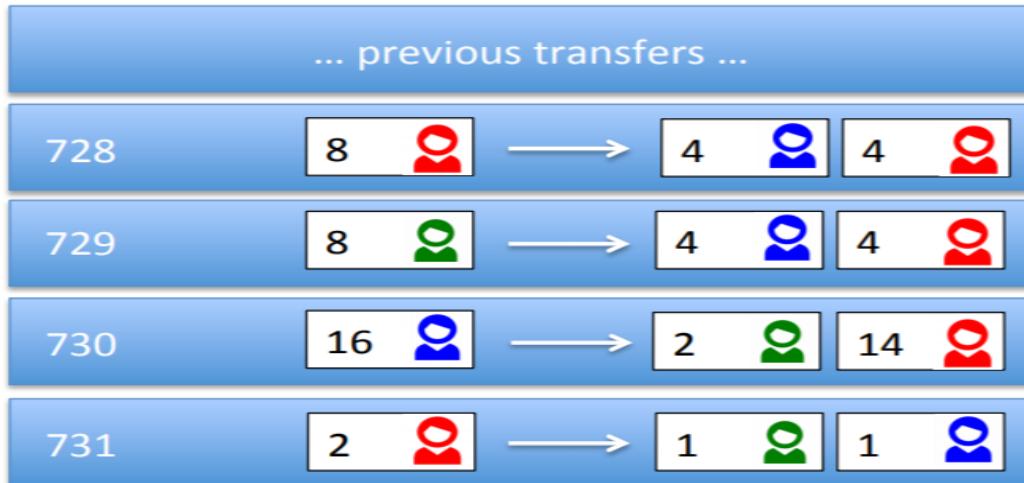
Customer B transfers 2 BTC to A



Wallet interface

Cryptocurrency – Ledger of Financial Transfer

Assume all previous transfers leave a balance of 8 for each person



transaction	amounts	RED
		8
728	-8+4	4
729	+4	8
730	+14	22
731	-2	20



transaction	amounts	BLUE
		8
728	+4	12
729	+4	16
730	-16	0
731	+1	1



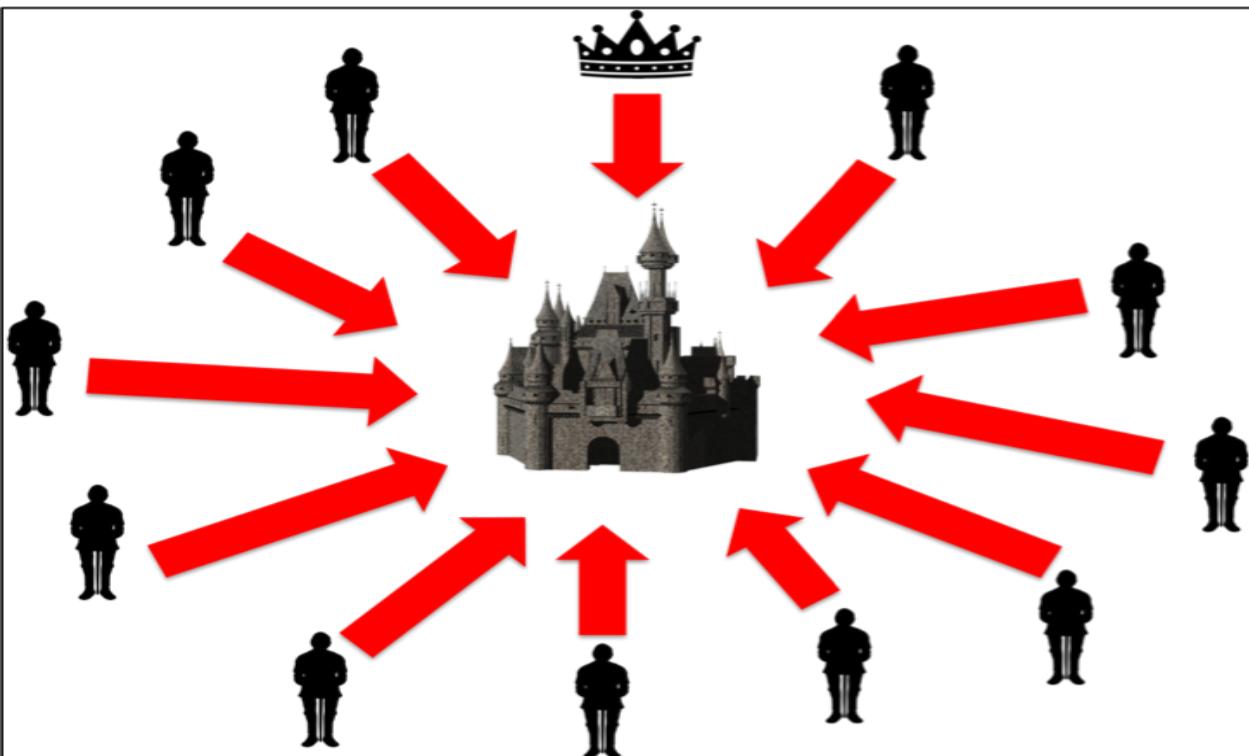
transaction	amounts	GREEN
		8
728	0	8
729	-8	0
730	+2	2
731	+1	3

Bitcoin – decentralized, public ledger of Transactions

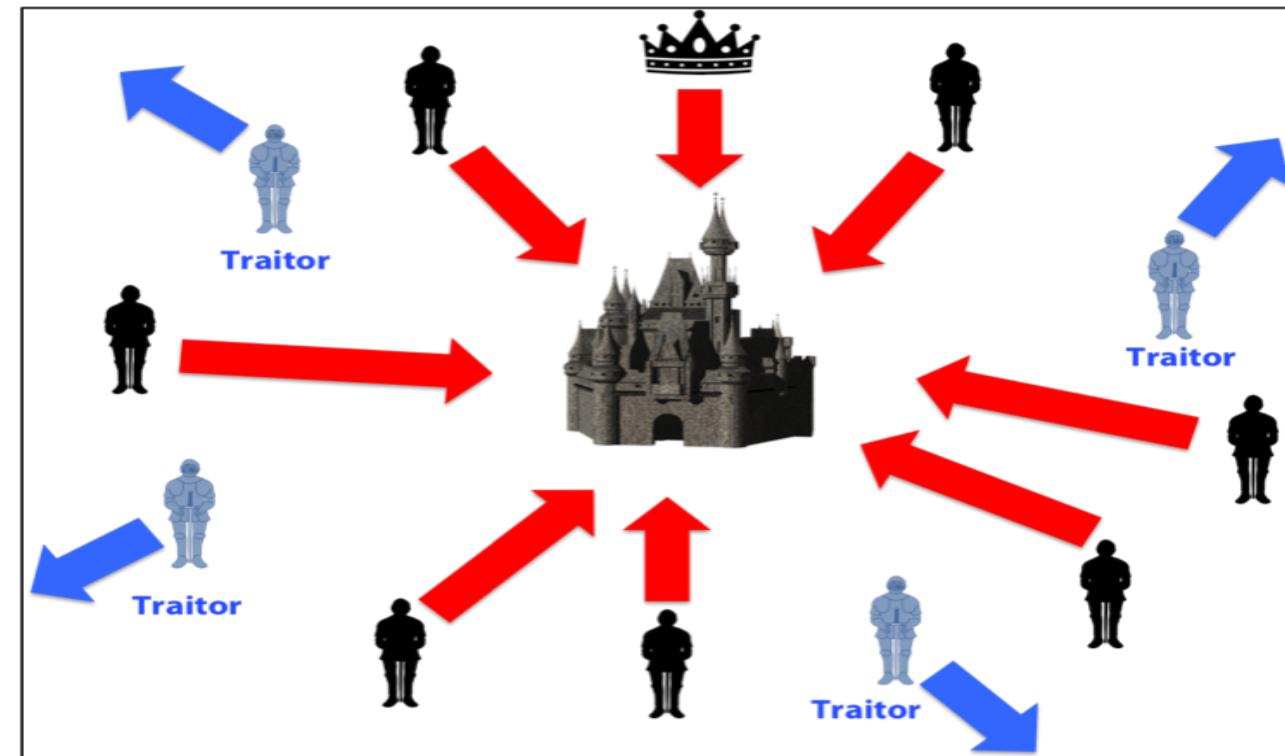


Whose record is THE correct one?

Byzantine Fault Tolerant Problem

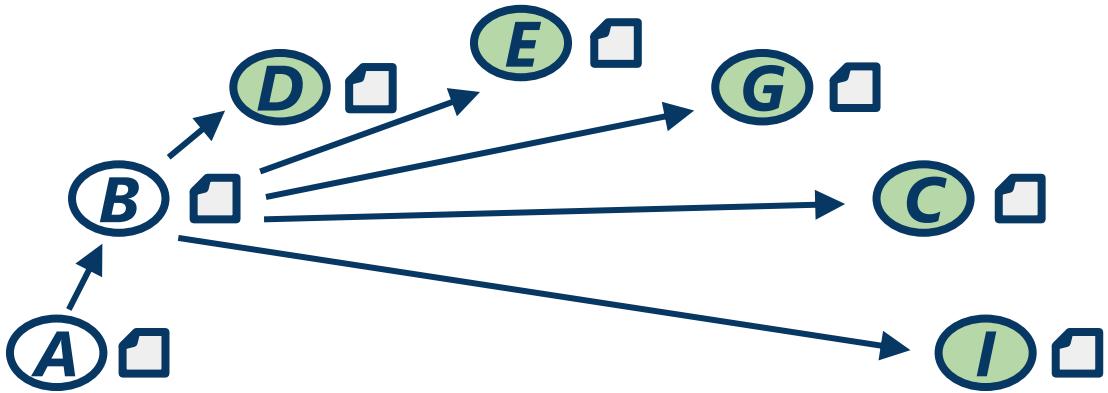
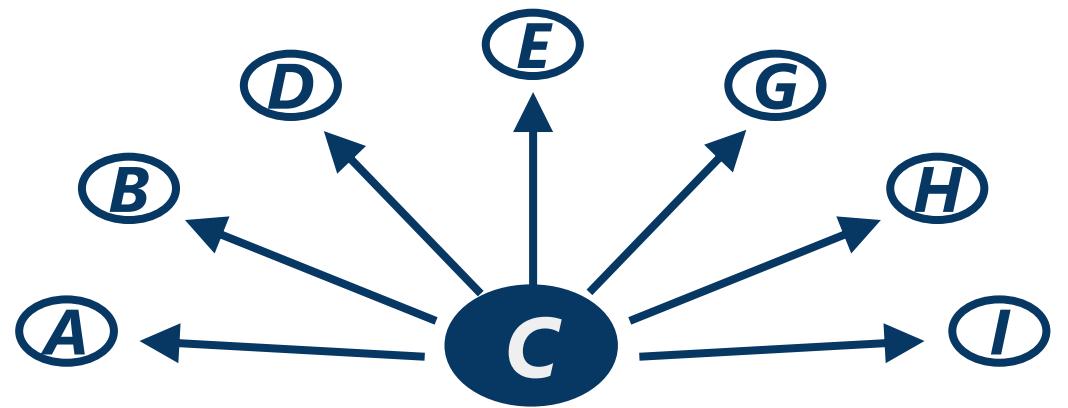


Coordinated Attack Leading to Victory



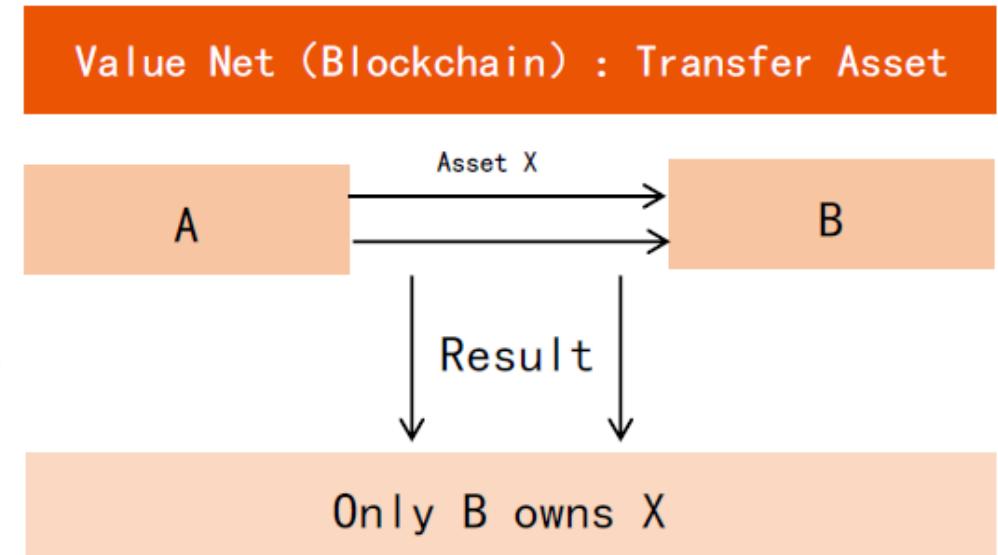
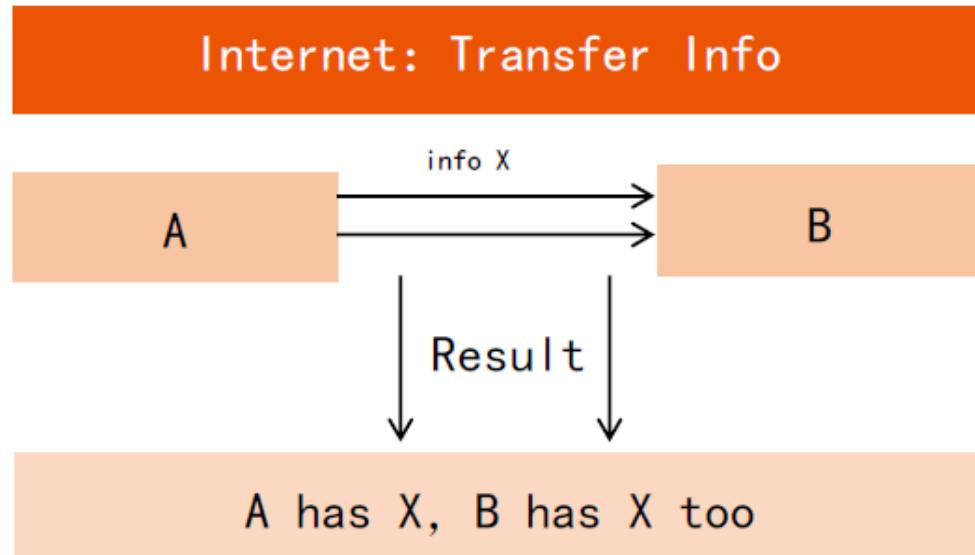
Uncoordinated Attack Leading to Defeat

Central v.s. Distributed System

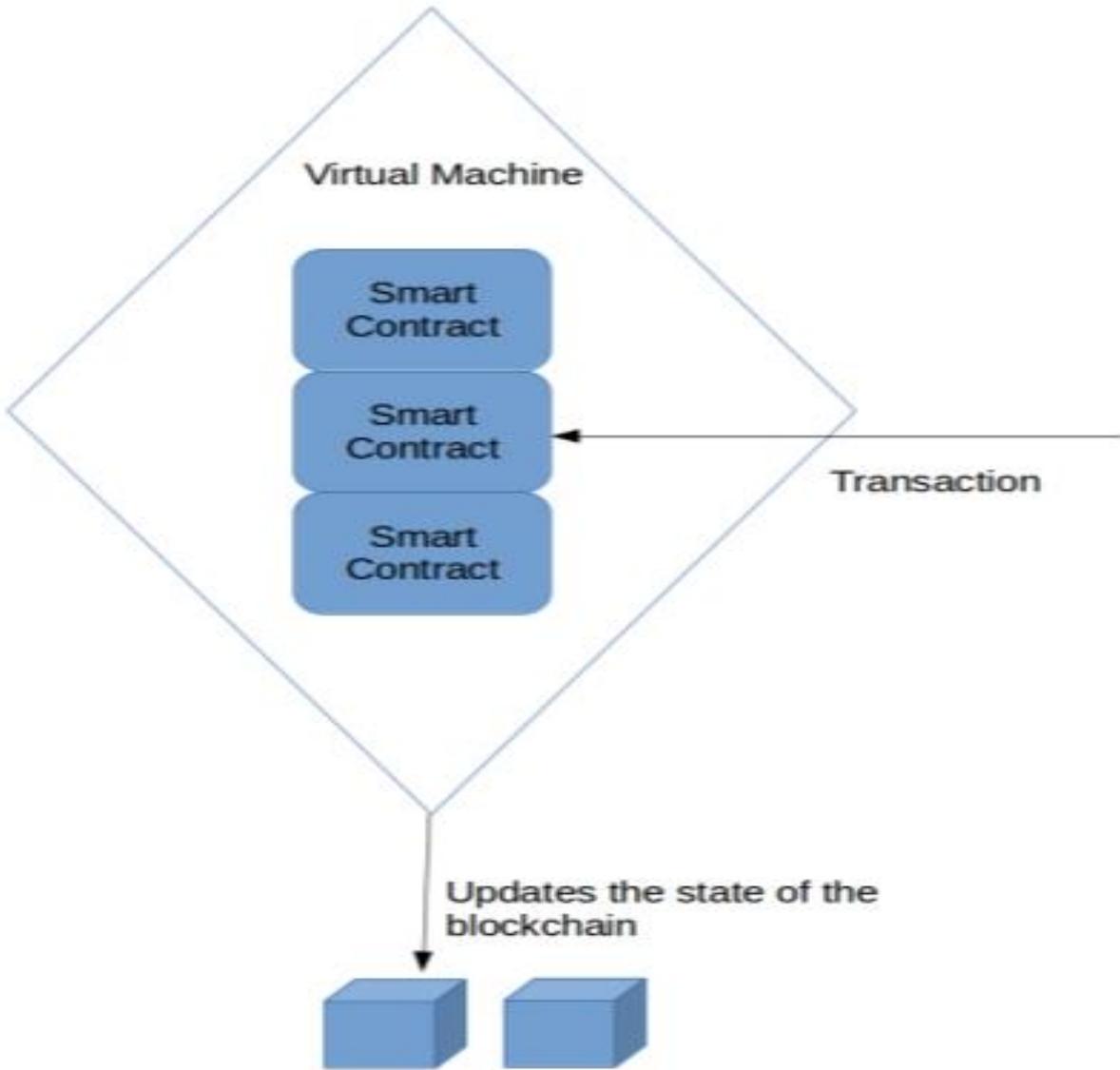


You are doing a good job. Here is your 10 BTC.

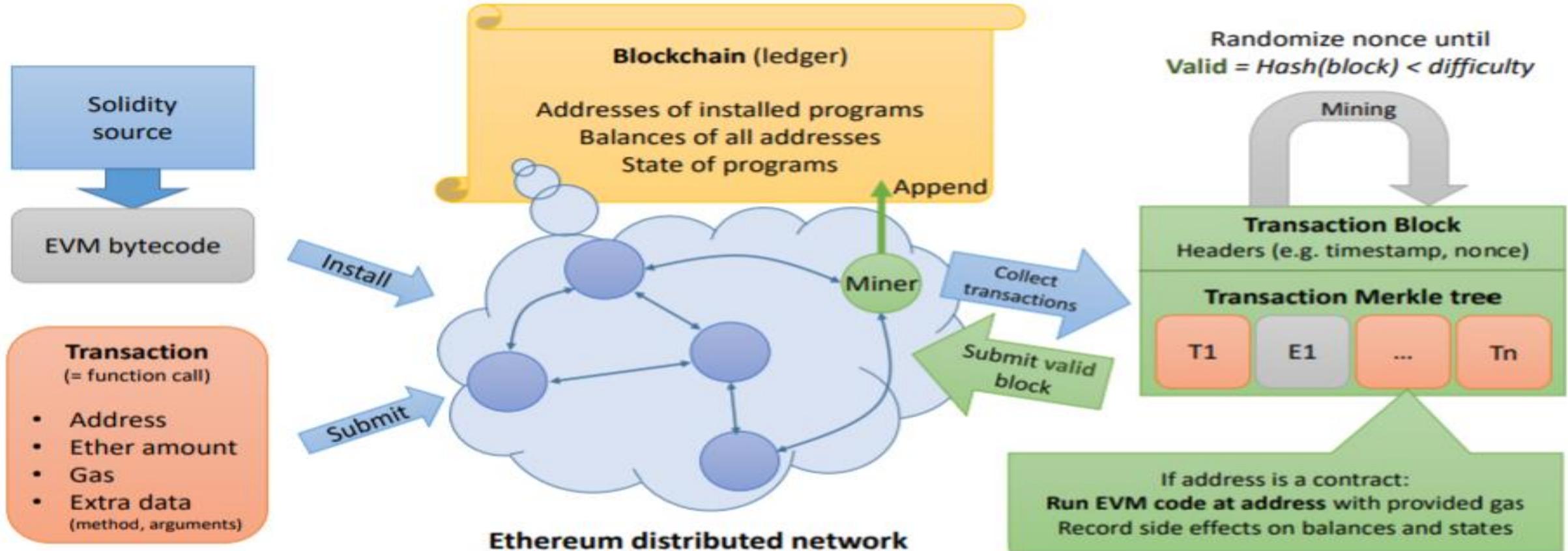
From Information Transfer to Value Transfer



Ethereum Node



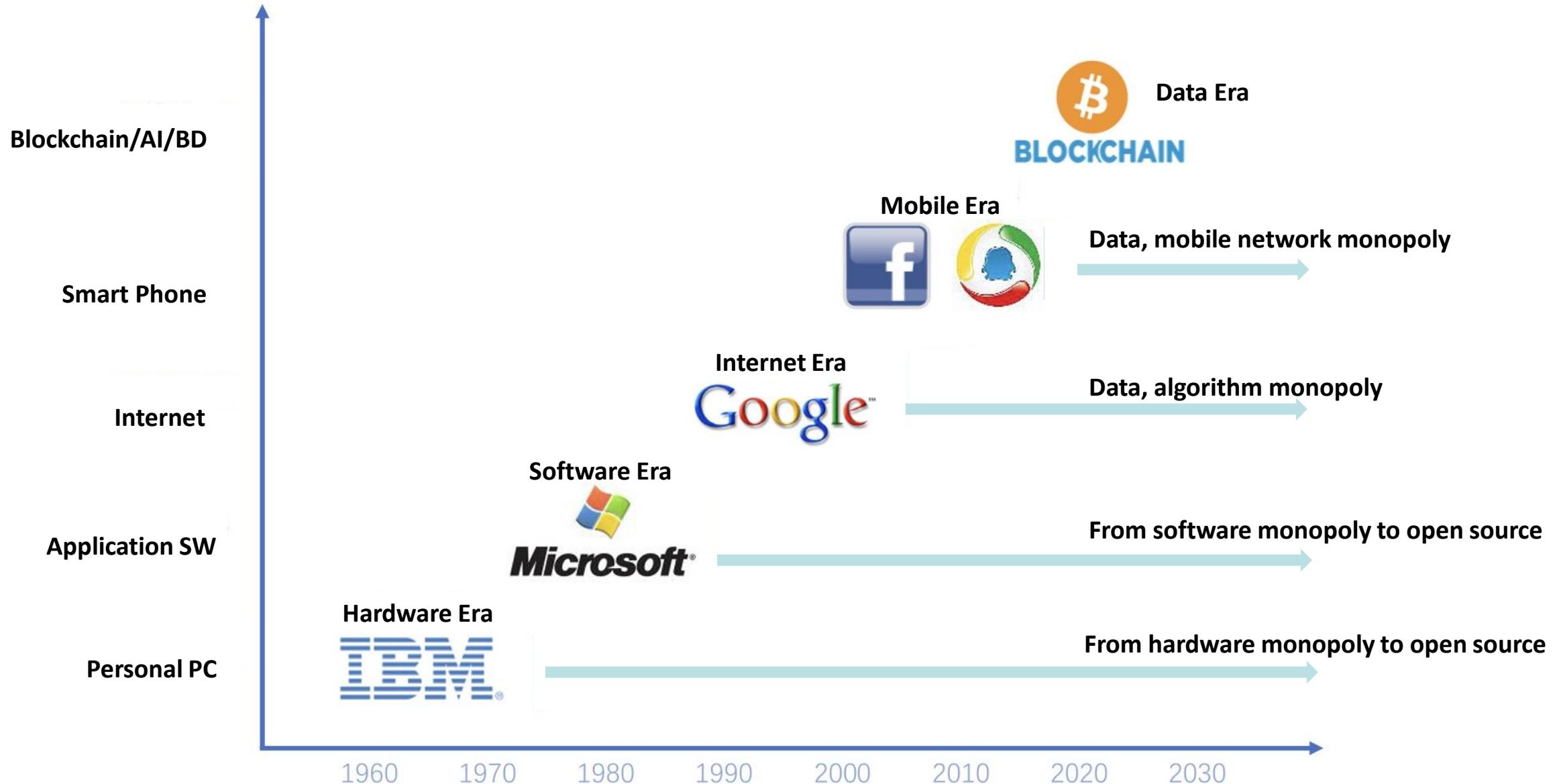
Ethereum Network – World Wide Computing



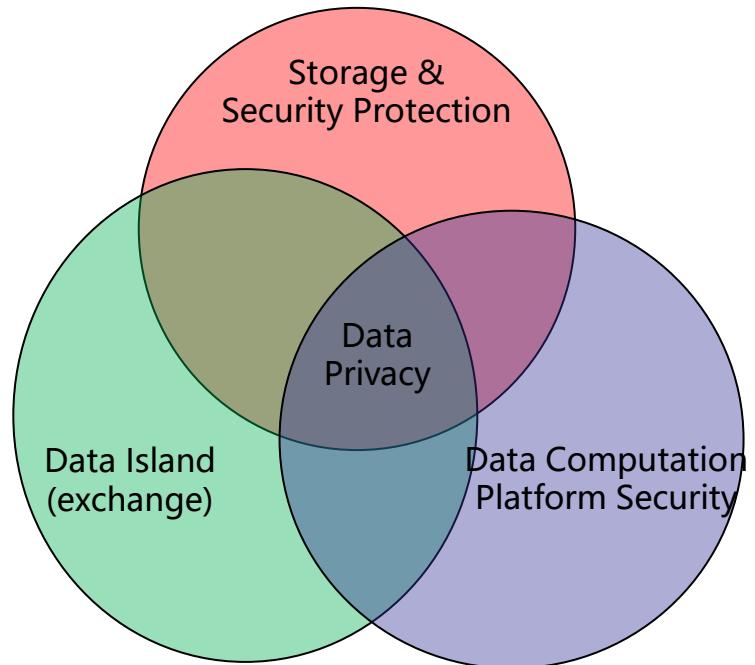
World Wide Web: provide information

World Wide Computing: de-centralized economy

Blockchain – Break the Data & Internet Value Monopoly



Data Privacy & Security



Privacy Security
Desensitization, anonymous

Data Security
Classes, Isolation
Encryption, trace/tracking

Platform/Operation Security
Transport, Storage, Computation
Admin/operation, infrastructure

Data Privacy & Security

Content Privacy

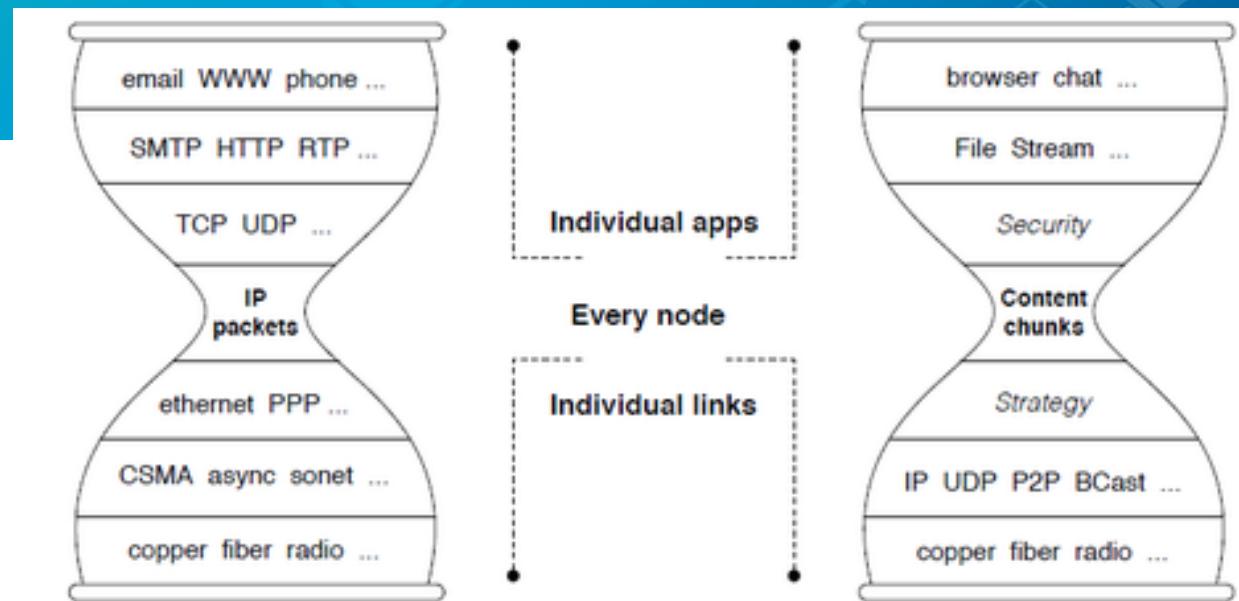
- Homomorphic encryption
- Secure MPC

Exchange Privacy

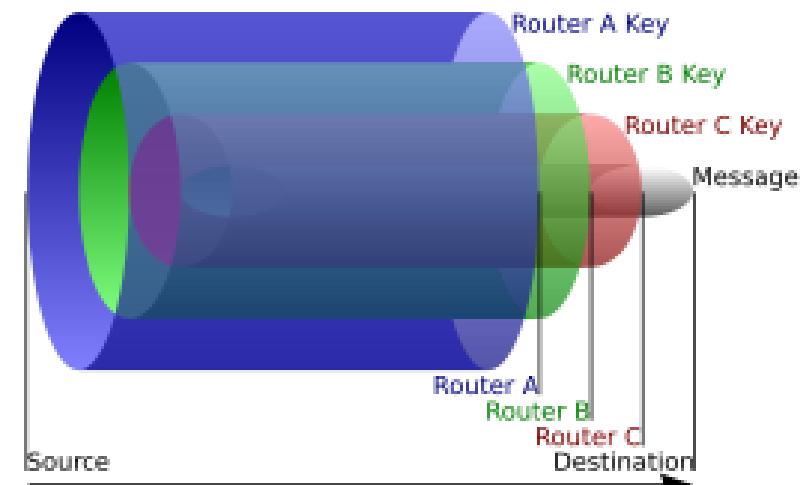
- Coin Mixing
- Ring signature
- Zero Knowledge Proof (ZKP)

Network Privacy

- Tor, Onion Network
- Garlic, Invisible Internet (I2P)
- Named Data Network (NDN)

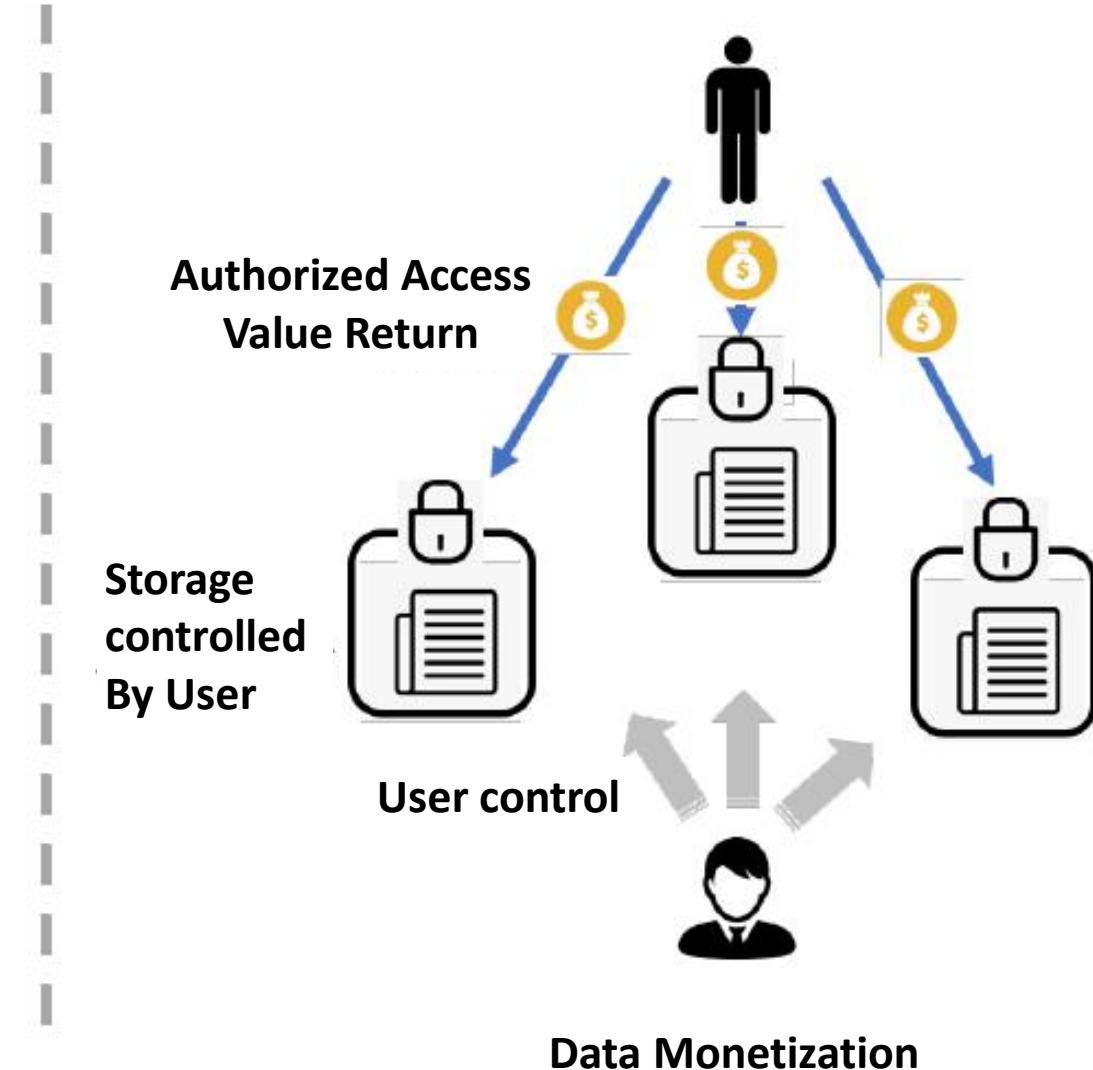
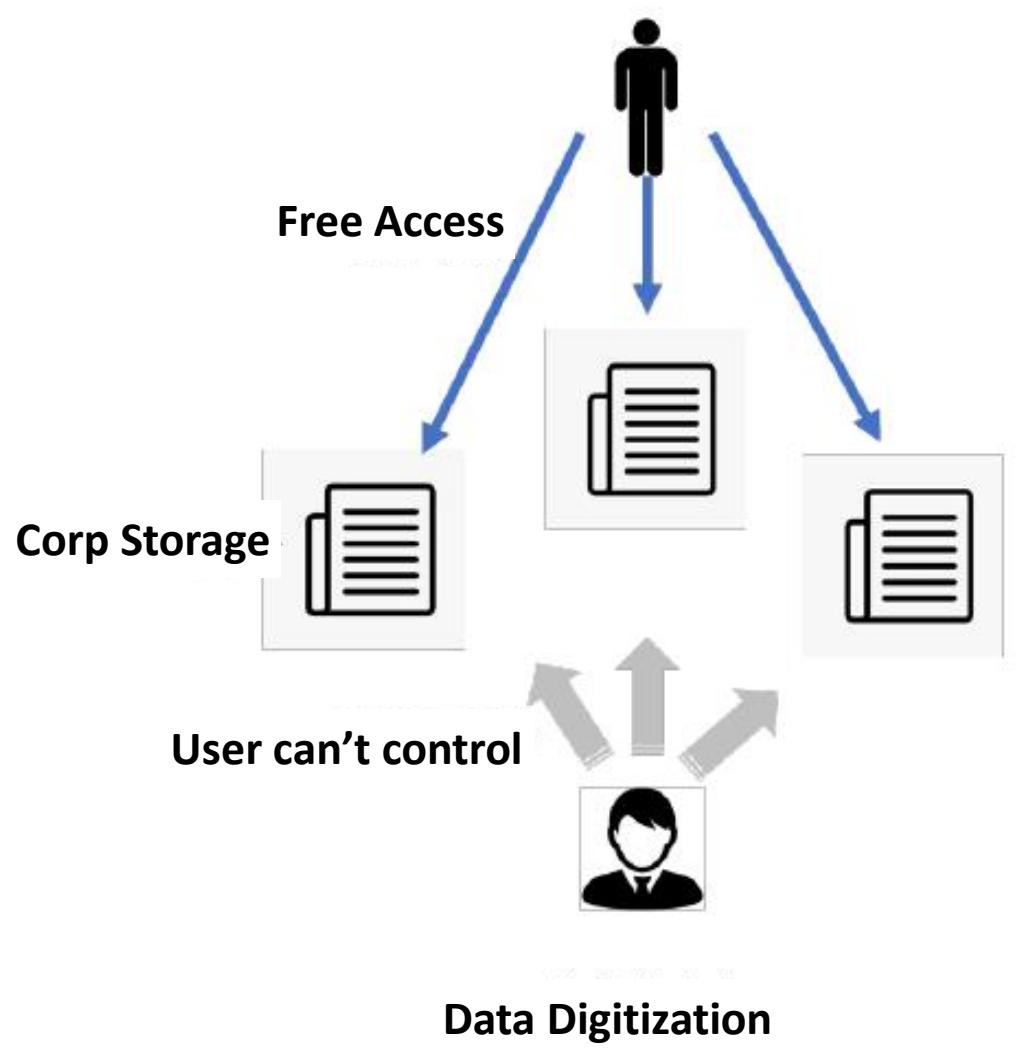


NDN named content chunks, in contrast to the IP packets

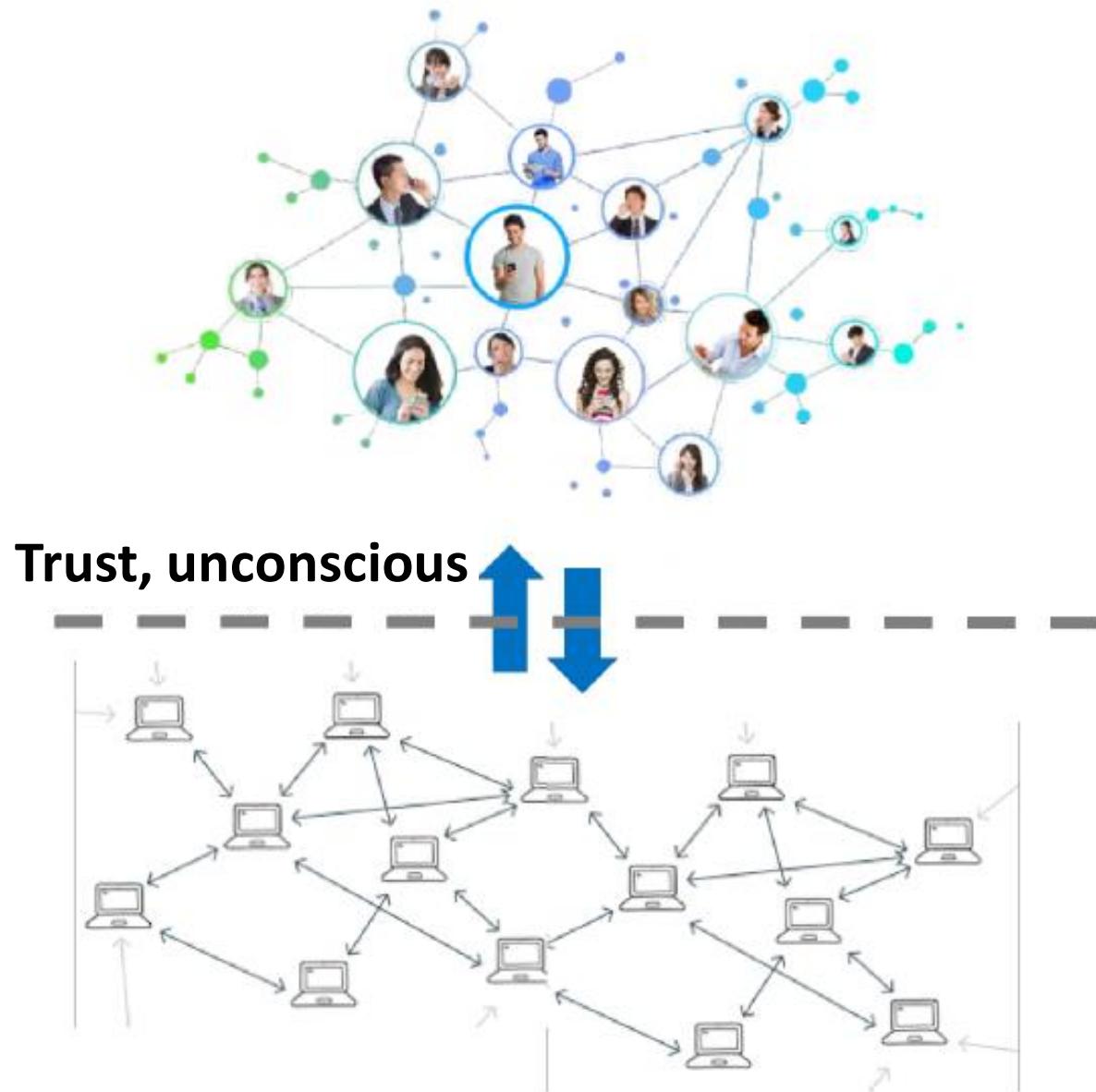


Router A sends it to Router B, which decrypts another layer to learn its next destination.

Data Digitization & Monetization



De-centralized Technology & De-finance (De-Fi)

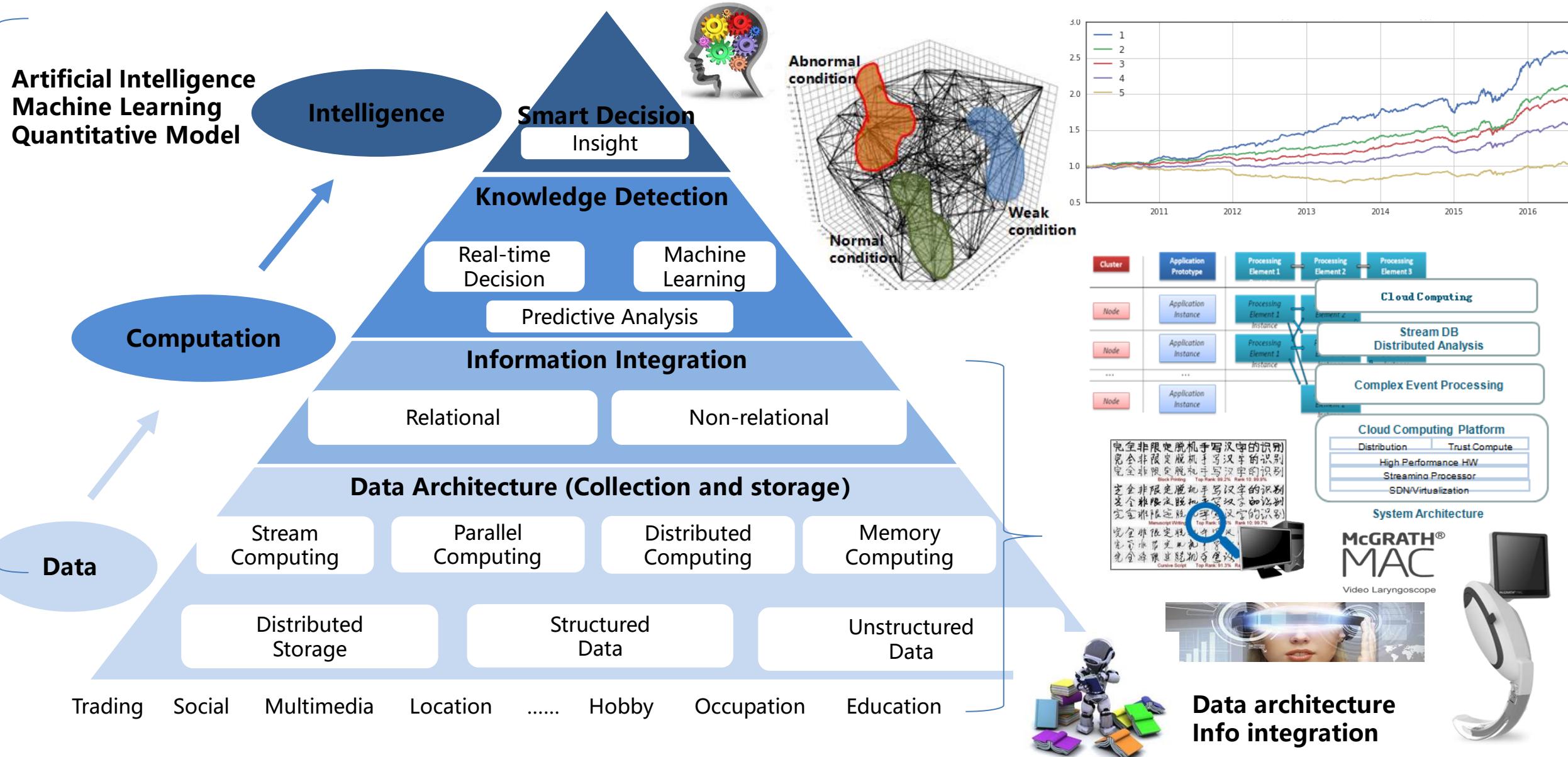


User behavior:

Disperse, volume, frequent, small



Data -> Computation -> Intelligence



AI & Big Data

- **Theoretic foundations on Intelligence**

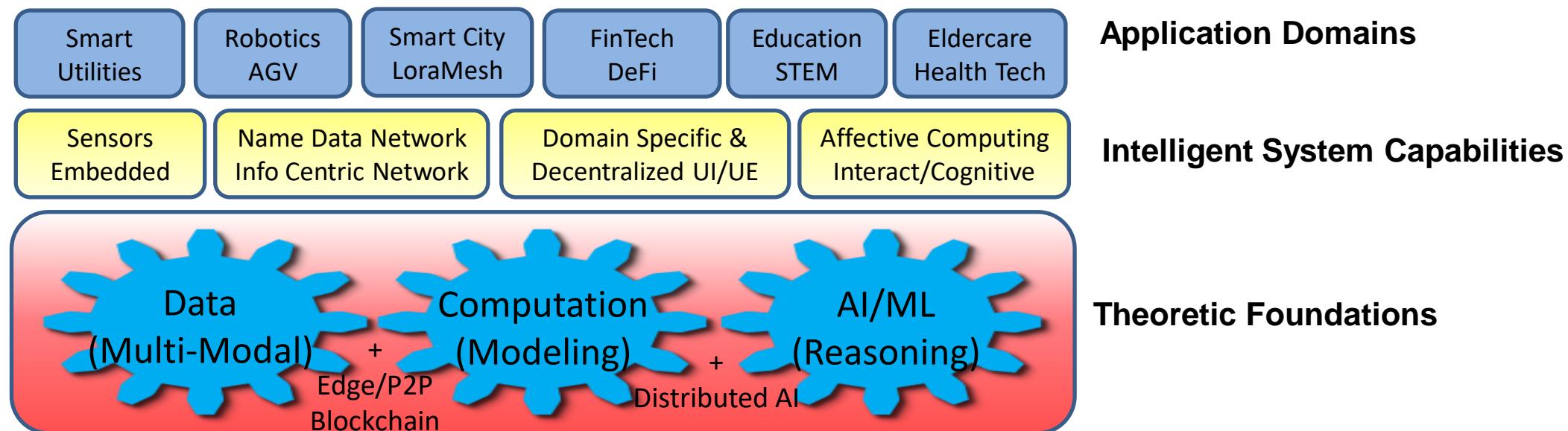
- Distributed, cognitive, actionable, explainable (human centric), trustworthy - De-centralized AI, swarm intelligence, Quantum AI, Natural Language Understanding, joint symbolic/numeric computation, compressive sensing, neuron computation, etc.

- **Application-driven Big Data automation**

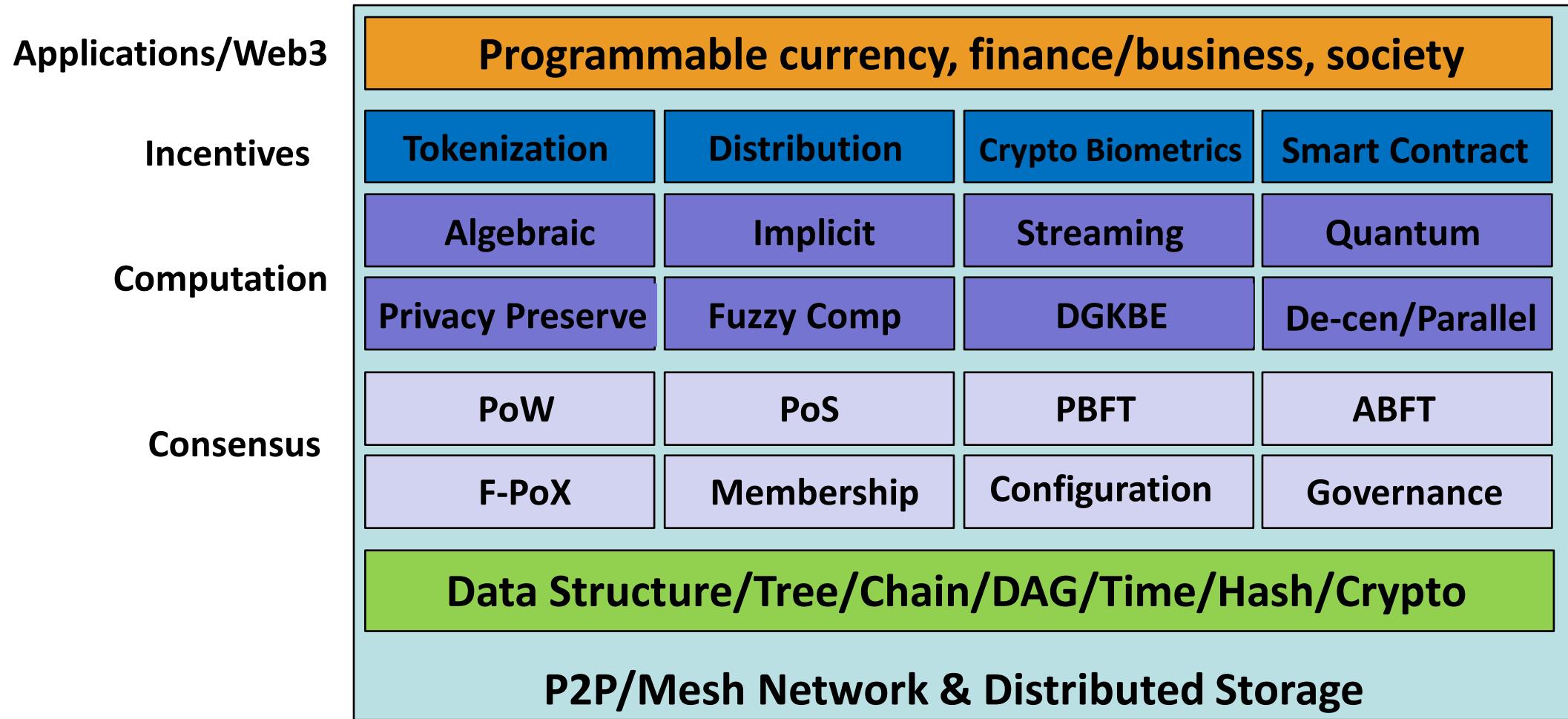
- Edge, p2p/m2m, IoT - sensor/mesh/Lora, Name Data Network/Info Centric Network, domain specific languages (DSL), blockchain OS, integrated AI/robotics, AGV, AI chips/RISC-V, 3C etc.

- **Meaningful interaction & self-aware learning**

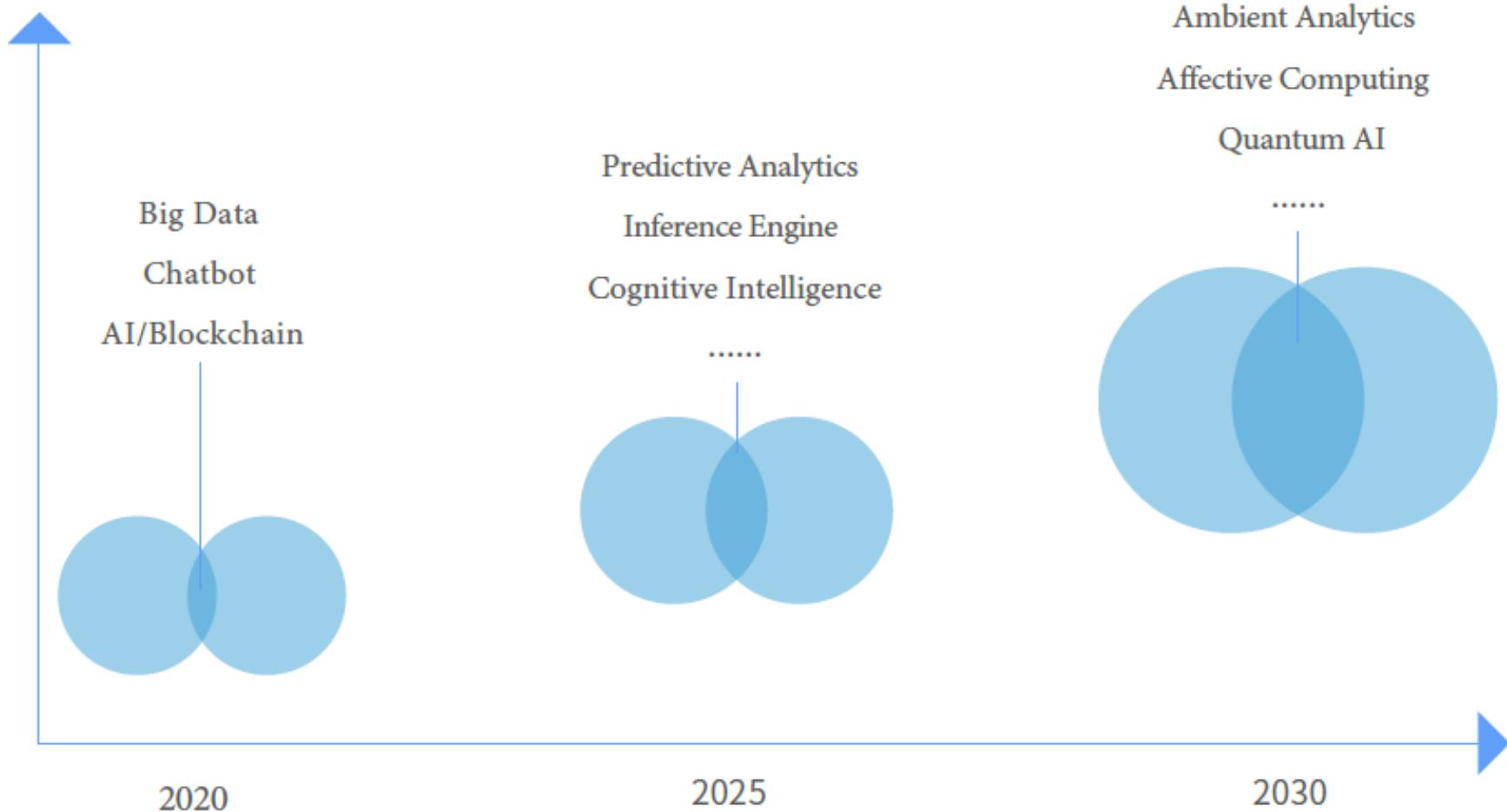
- Full contexts of AI – contextualized, multi-channel, trust and responsibility, ethics & safety - integrated design, affective computing, cognitive architecture, decentralized UI/UE, brain-computer interface etc.



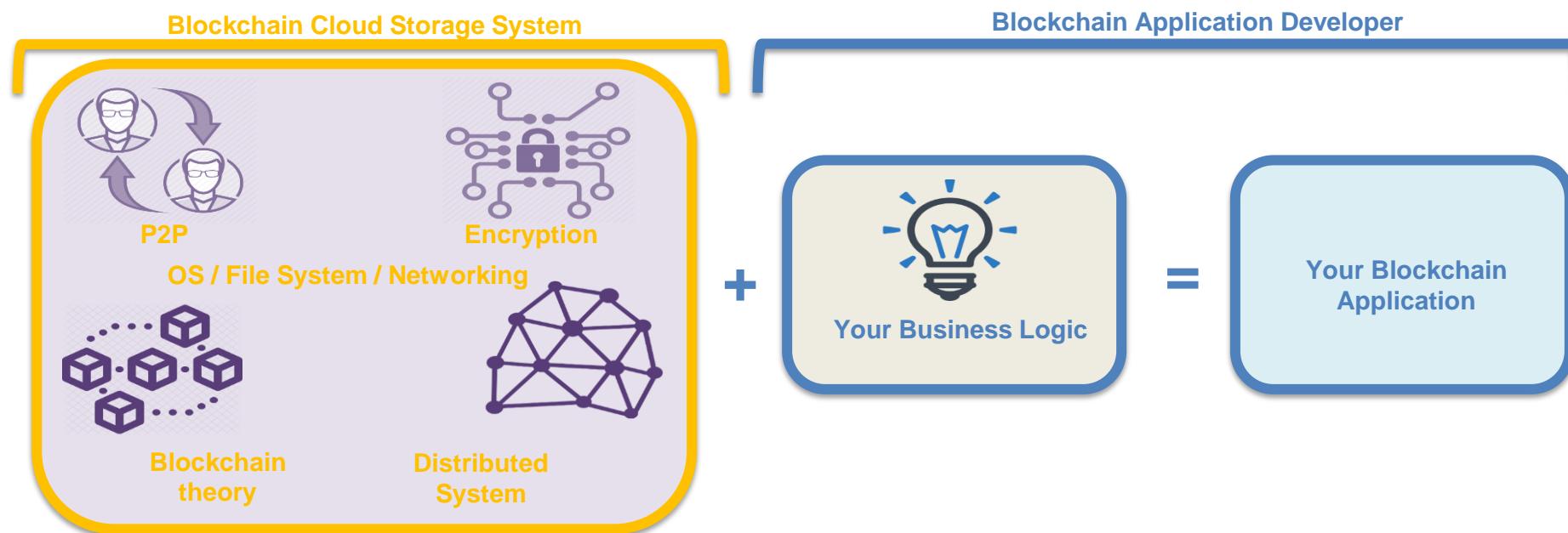
Blockchain & Distributed AI (BDAI) Architecture



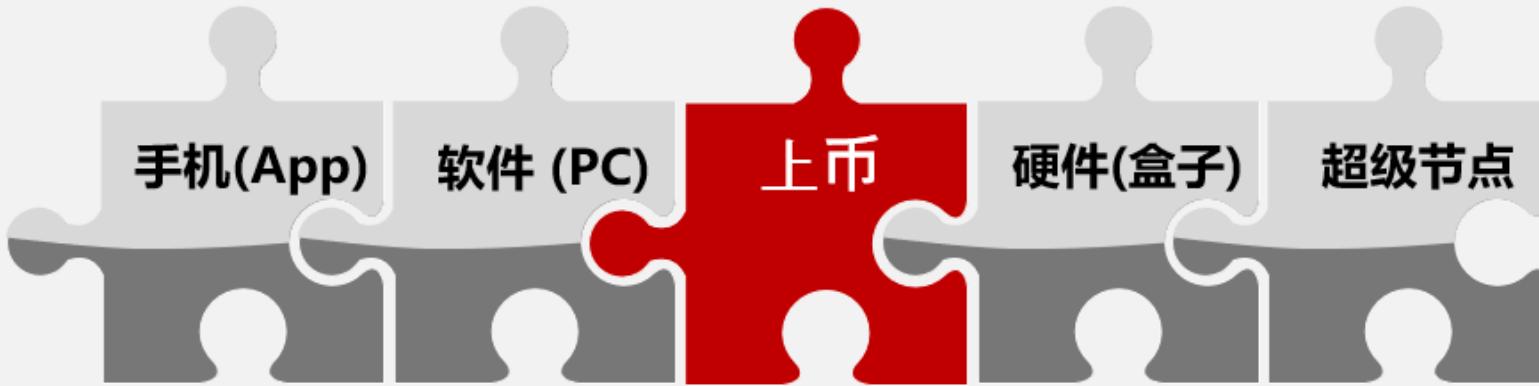
Blockchain & Technology Trends



To Develop blockchain applications



dApp Platform and Tools



左侧菜单栏

Home
Account
Earn
Team
Devices
Setting
TurboFil

期初余额即用户的可提取余额截止昨日收益计算结束的账户余额。这个值是不会改变的，直到今日收益结束，更新为最新余额。

4:21 PM 4:21 PM

100% 100%

23/25 23/25

0.5TFC/hr 0.5TFC/hr

150.12918 TFC 150.13002 TFC

团队状况
观察团队活跃度情况
挖矿速度
当前挖矿速度，点击进入增速方式页面：Earn页面
点亮按钮，一键挖矿
用户点击这个按钮即可开始挖矿，对于普通用户来说，他们只需要点击这个按钮，就能激活挖矿功能，并且观察到自己的账户持续增值。
质押利息
用户于明年1月1日可提取出的累积利息。这个利息与账户相关，提前支取账户余额会使得利息归零。利息根据账户余额计算，实时变化

Opening Balance Staking Interest

MainPage

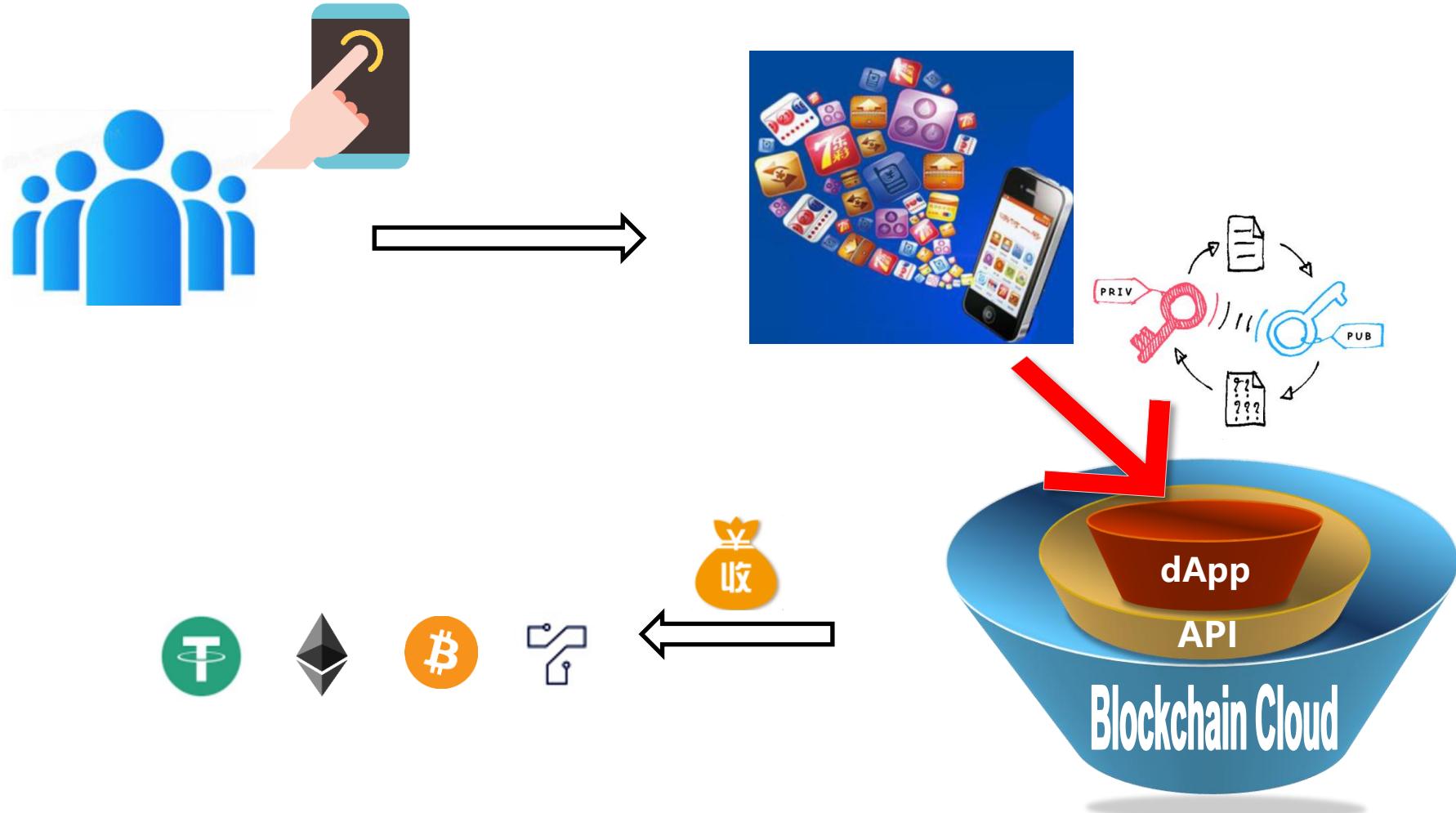


TFS/TFC
支持平台

BOS Version	Support OS
x86_32b	Ubuntu 14.04.4/16.04.4 LTS
x86_64b	Ubuntu 14.04.4/16.04.4/18.04.4/20.04.4 LTS, CentOS 7.x
x86_64b-alpine	Linux 5.4.12-1-its #2-Alpine SMP
arm32-pi3-raspbian	Linux raspberrypi 4.19.118-v7+ #1245 SMP
arm32-pi4-raspbian	Linux raspberrypi 4.19.118-v7+ #1311 SMP
arm32-wjx	Smart Water Concentrator
arm32-ztf	Engineering Machinery provided by ZTF
arm64-pi4-kali	Linux kali 4.19.66-Re4son-v8+ #1 SMP
win	Windows 95, 98, NT, 2000, XP, 7, 8, 10 and etc, both x86_32b and x86_64b version
mac	Mac OS X 10.0-7, OS X 10.8-11, macOS 10.12-15
unix	unix/Linux, such as Arch, Debian/Ubuntu, Fedora, Gentoo, RHEL/CentOS, SUSE and etc
android	Android 4.0 - 11
ios	iOS 5.1.1 - 12.4.7 · iPhone, iPad, iPod touch

ubuntu CentOS
Raspbian KALI
Windows xp Windows
Mac OS debian fedora
iOS

Mobile Clicks = Mining Cryptos

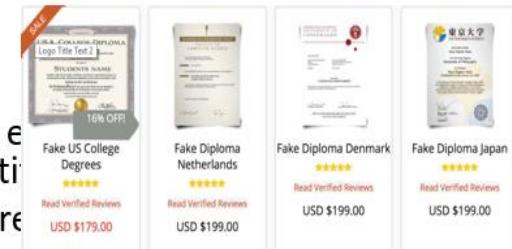


Historical Projects

Beautiful Life Virtual World



Certificate Blockchain



Buy Rust Alpha

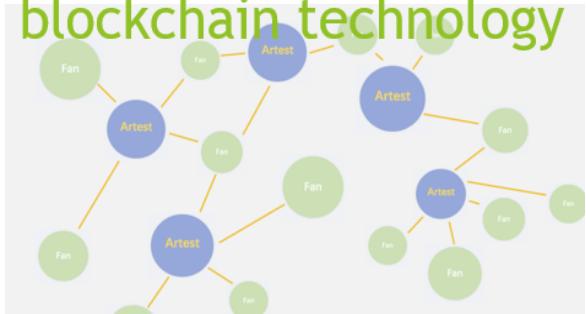
Two screenshots of the Steam store page for "Rust Alpha". The top one shows the standard listing with a price of \$19.99 and an "Add to Cart" button. The bottom one shows a "Four Pack" listing where four copies of the game are bundled together for \$59.99.

BrickChain

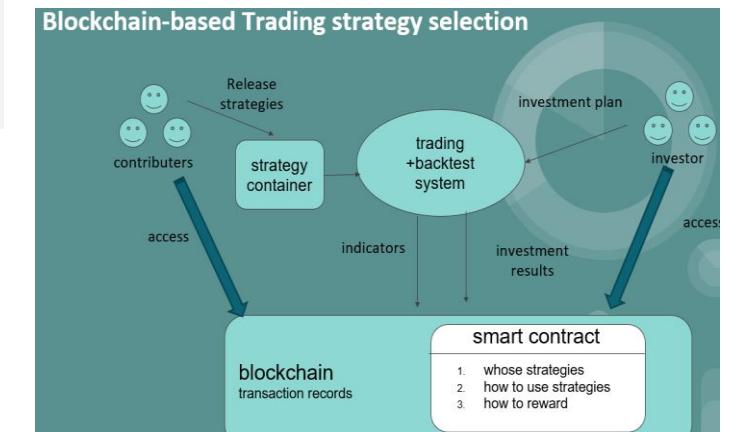
Real Property Tokenization



Online music platform blockchain technology



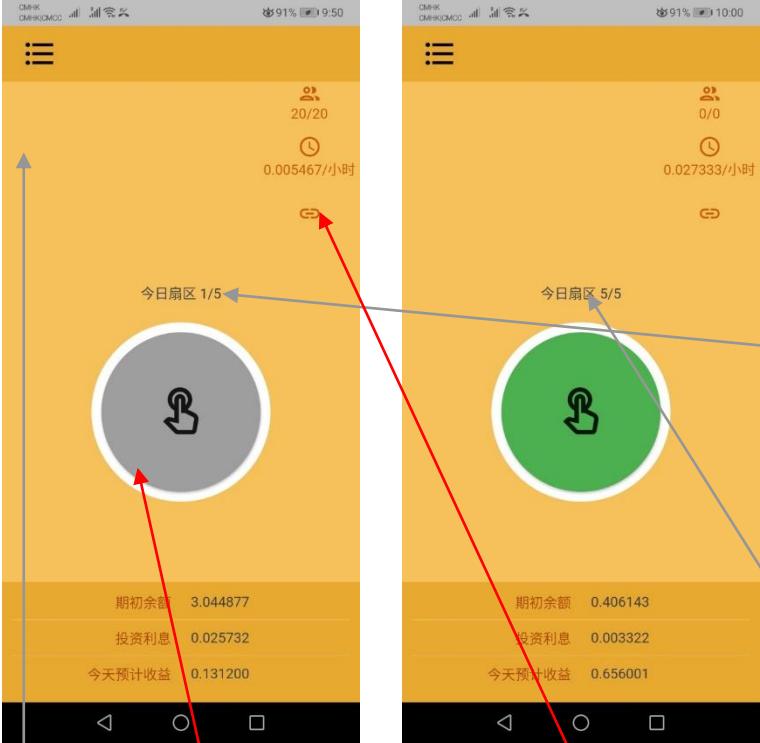
TRACKING AND VERIFICATION OF COMMODITIES



Thoughts Sharing

Course Project

- Non-fungible token**
- DID (de-centralized ID) / DDNS**
- Blockchain games**
- Virtual assistant / cocoPDA**
- Video sharing**
- SaaS**
- Asset tracking**
- De-fi**
- Quant investments**
- Super Star ranking**
- ...
- Your own idea (before end of Feb)**



今天还有4次机会（共5次）
You have 4 more chances to contribute (total 5 times today)

谢谢您！今天5次贡献已完成。
Thank you! You have already contributed 5 times today.

飞享
Turbo Share

飞赞
Turbo Like

超飞是一个共享社区，通过共享您的资源（如电脑存储，生活照片，为人点赞等）来共建超飞美好社区。贡献越多，您将收获越多超飞奖励。现在就和超飞一起点击飞享和飞赞吧！

TurboFil is a sharing community by contributing your idle resource such as disk space to share life's precious moments with photos and likes. The more you contribute, the more TFC you earn. Start clicking to share now!



3D-Silicon Brain versus Mammalian Brain

Matches linear energy scaling with neurons

Suzana Herculano-Houzel

Aa
文字
贴纸
特效
滤镜
自动字幕
画质增强

Video Sharing with tokens

可加配乐

文字

贴纸

特效

滤镜

自动字幕

画质增强

其他创意

-GAN

-推荐

-给视频自动生成故事

-合成音乐

-text to speech

日常 · 1天可见

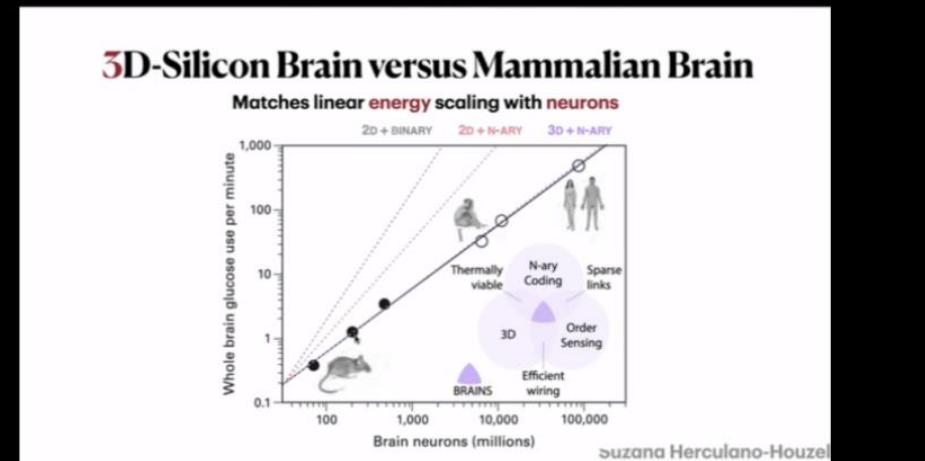
下一步

注：红色必须，黑色选择，蓝色新创意

61



腾讯投票



短视频偏好选择



如果短视频只有三个效果可以选择 你会选择那几个[多选]

文字输入 ✓

6票 17.6%

音乐添加

6票 17.6%

特效 (例如美图秀秀) ✓

5票 14.7%

滤镜 ✓

5票 14.7%

自动字幕生成

5票 14.7%

画质增强

3票 8.8%

表情贴纸

1票 2.9%

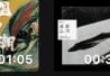
一键美颜

3票 8.8%

投票截至: 2021-12-22 13:25

显示详情

推荐 收藏

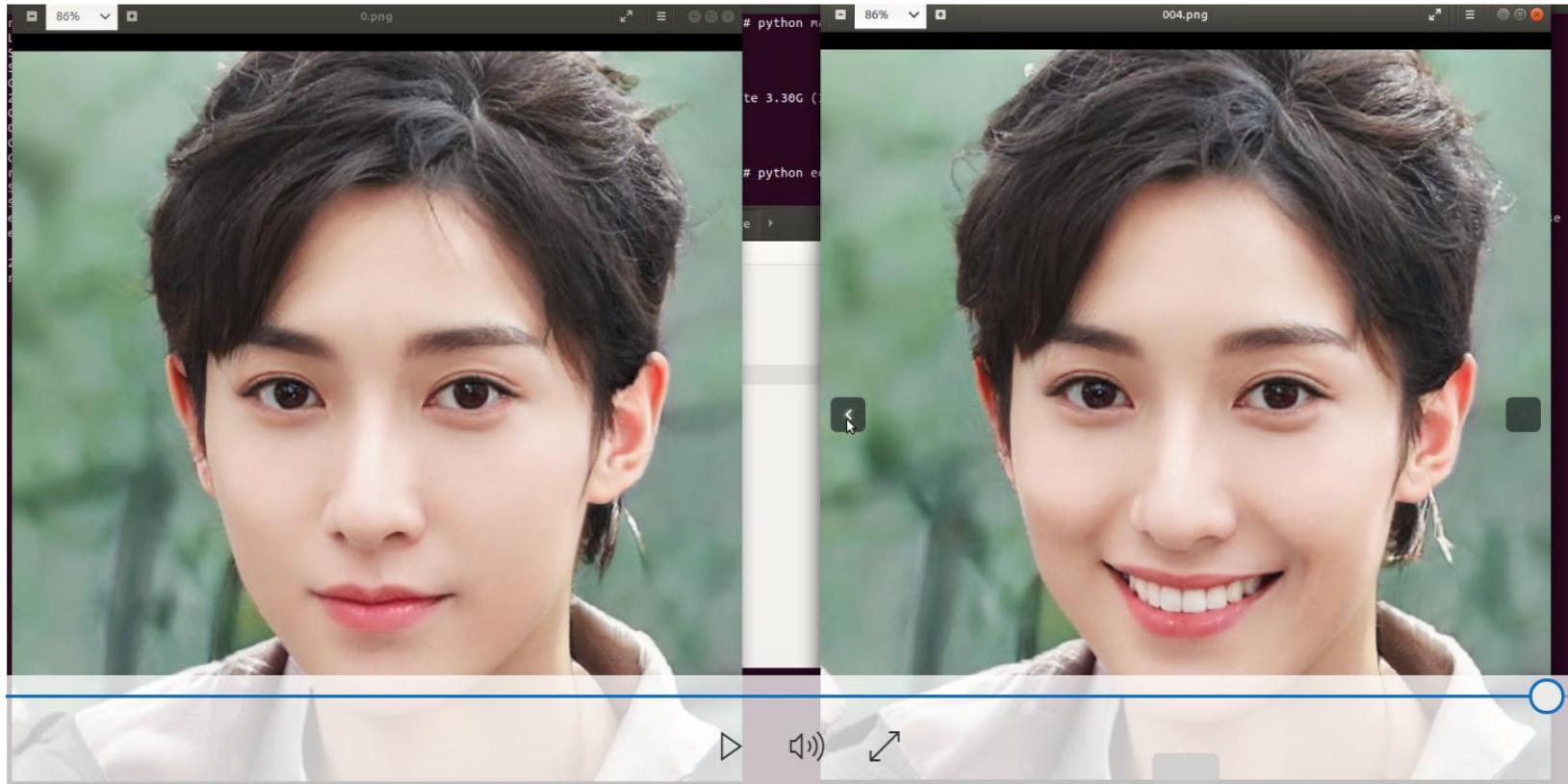


更多音乐 猪猪侠 (P) 魂！！ Home 布谷鸟 谁家姑娘 桃花朵朵开 哟哟唱的歌 小阿枫-桃 好花红 居心叵测 《赤诚年少》

配乐

音量

Synthetic Media



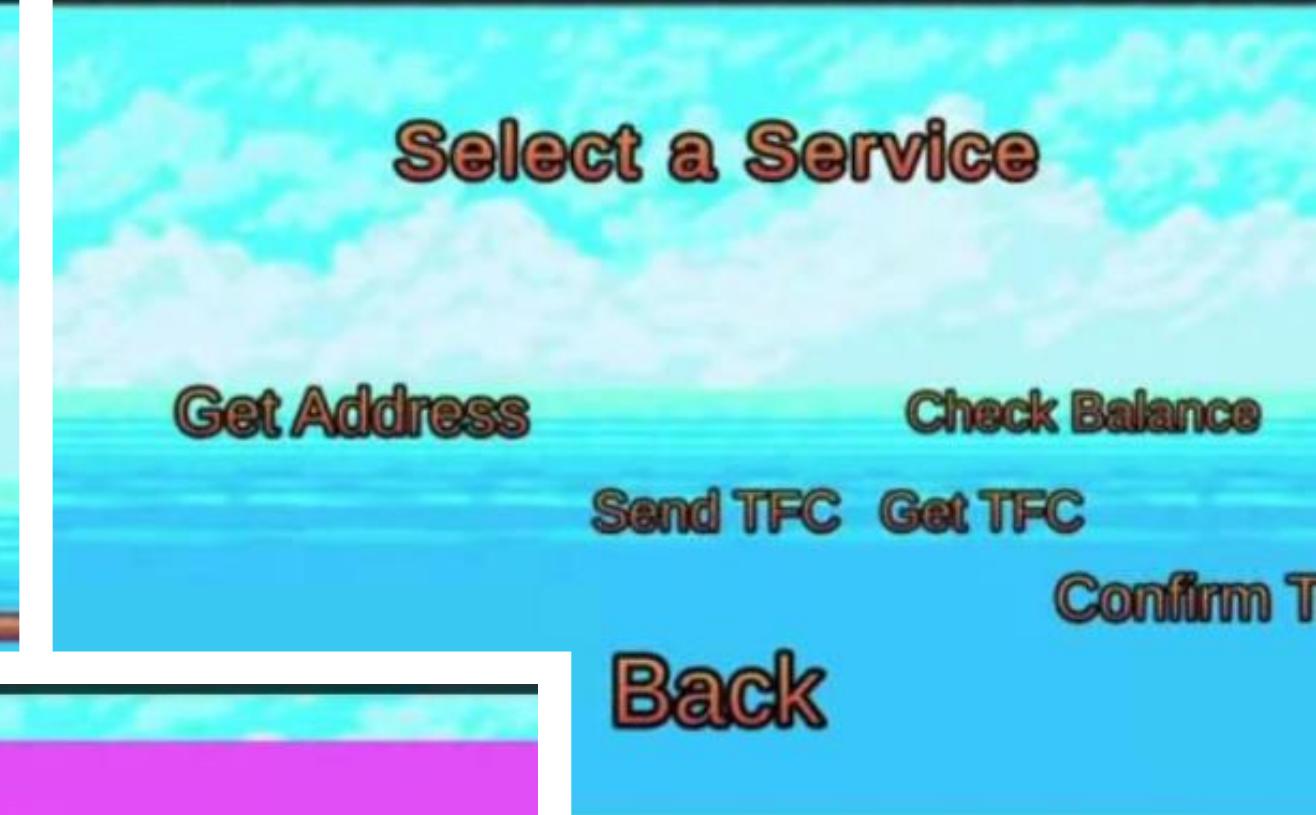
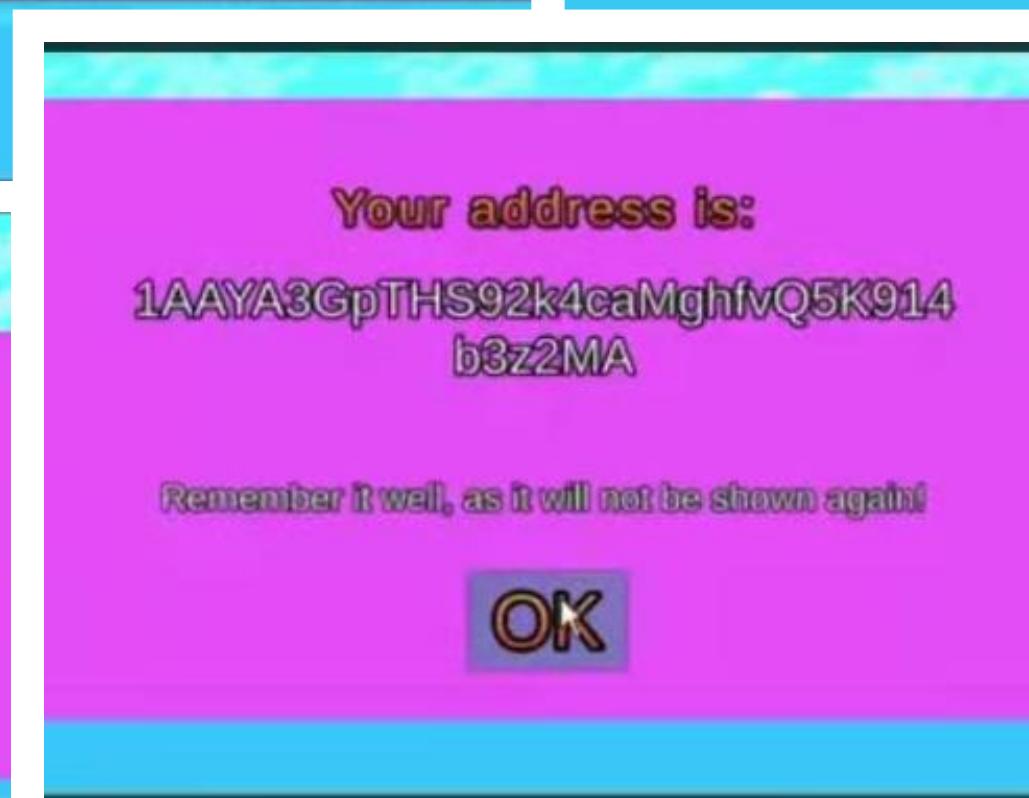
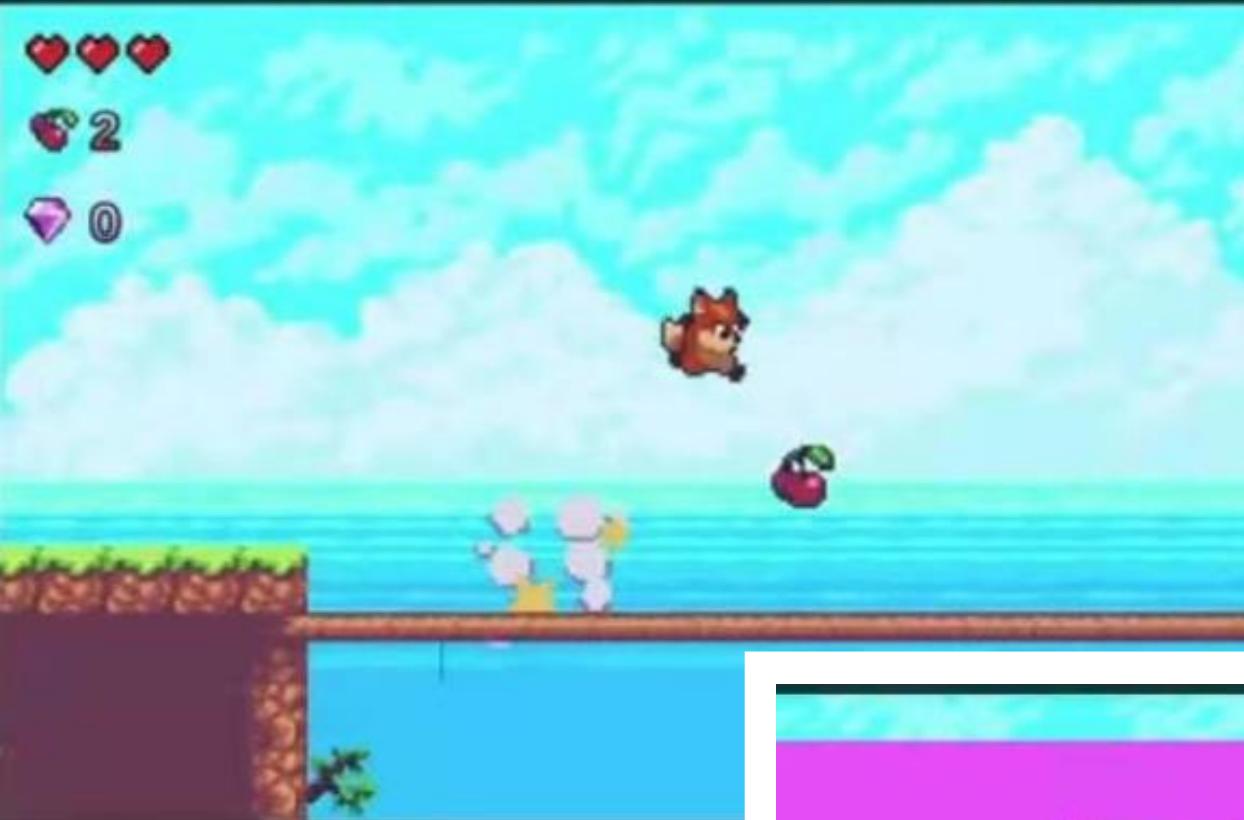
中国网红 (定制版)



/images/chinese_wanghong.jpg

Sample examples







5G: 高带宽通道

Wifi 6: 家庭WiFi信号覆盖

HDMI: 电视信号、爱奇艺、腾讯视频

网络和看电视成了人们生活的必需:

- 1、微信
- 2、腾讯视频
- 3、淘宝
- 4、京东
- 5、天猫
- 6、电影
- 7、电视

.....



提供家庭宽带
WiFi

提供央视信号、
爱奇艺、腾讯视
频等

- 1、免安装、插电即用
- 2、提供1g/s的速率，不
会为上网课卡顿发愁
- 3、丰富的内容，大片、
娱乐等节目应有尽有
- 4、送5G终端，提升品牌
形象

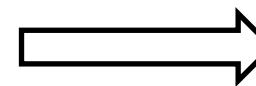
聚源社区电商 Community e-Commerce

**目标：50P
会员：1万个**

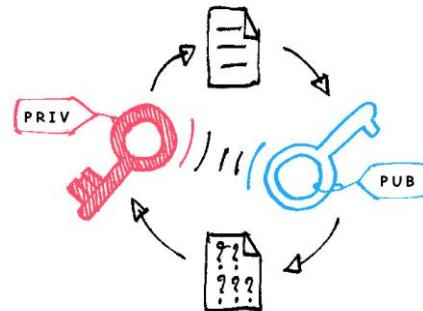
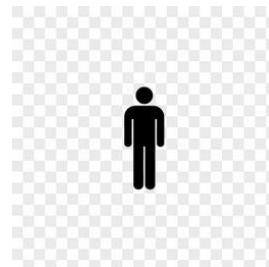


Vendor Machine – Loyalty Points

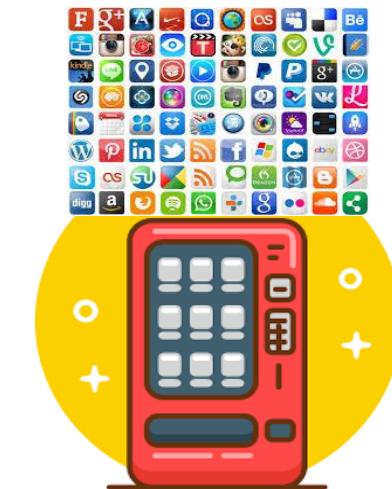
- 去中心化的技术
- 提供类交易所的功能
- 接入并整合其他应用
- 生态扩展，线下线上闭环



- 积分流通的公平公正
- 积分兑换的公平公正
- 积分定价的市场化
- 生态系统积分通兑
- TFC零售



TFC/积分



Brazilian Soccer Club – NFT Tokens

PROFITABILITY

MANAGEMENT OF ADVERTISERS
AND AUDIENCE ACTIVATION



CLUBS
REVENUE

NEOSPORTS
REVENUE



MINIMUM
GUARANTEED
FOLLOWED BY A
PRO-RATA DIVISION
ACCORDING TO THE
USED DATA OF
EACH TEAM



LALABELA ALLIANCE

拉拉贝拉音乐集团

Producer Profile 制作人简介



“Commissioner”
Gordon Williams
戈登·威廉姆斯

拉拉贝拉创始人，制作人，录音师，混音师

因为他参与了音乐界很多大量且不同风格的制作，
所以被称为是一位“多面”的艺术家。

戈登从业至今，
荣获了7个格莱美奖、众多金奖以及白金唱片奖。

Jerry Duplessis “Wonda”
杰瑞·杜普莱西斯
作曲家、唱片制作人
Fugees乐队吉他手

荣获了4个格莱美奖

代表作品及荣誉

Destiny's Child (真命天女) 1997年<No No No>
Whitney Houston (惠特妮·休斯顿) 1998年<My Love Is Your Love>
Santana (桑塔纳乐队) 2000年<Maria Maria>
Shakira (夏奇拉) 2006年 <Hips Don't Lie>

其他合作艺人：
[Jennifer Hudson](#)、[Akon](#)、[Keri Hilson](#)、[Ne-Yo](#)、[DJ Khaled](#)、[Justin Bieber](#)等（此排名不分先后顺序）



Will.i.am
威廉姆·亚当斯
歌手、演员、制作人
Black Eyed Peas创始人

第51届格莱美最佳城市音乐／另类歌手奖

代表作品及荣誉

Black Eyed Peas (黑眼豆豆) 2003年<Where Is The Love?>
2004年<Let's Get It Started>
2005年<My Humps>
2009年<Boom Boom Pow>
<I Gotta Feeling>

其他合作艺人：
[Michael Jackson](#)、[Britney Spears](#)、[David Guetta](#)、[Justin Timberlake](#)、
[Snoop Dogg](#)、[Usher](#)等（此排名不分先后顺序）

