Blockchain: The Code Law

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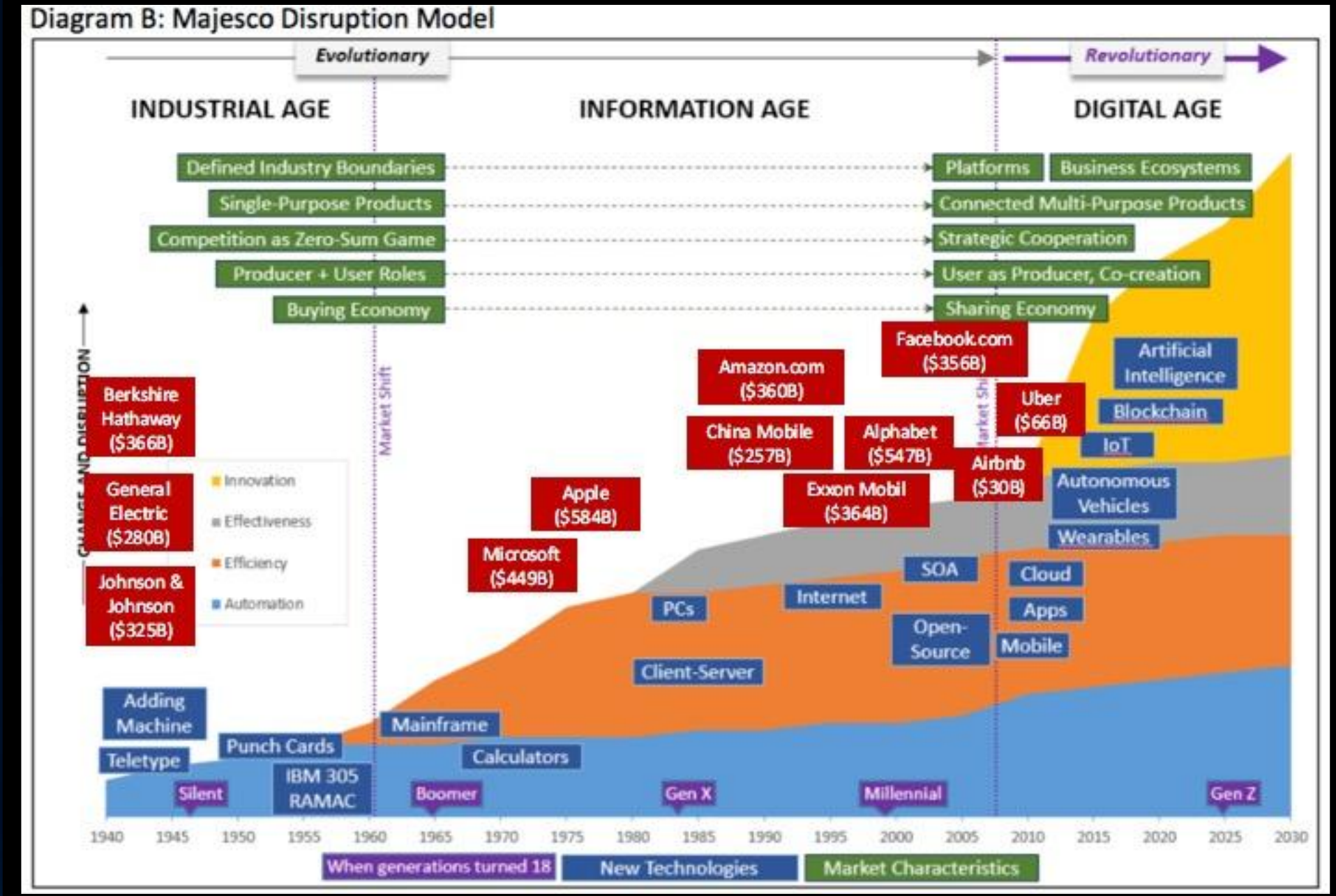
Agenda

1. Seminar opening
2. Introduction
   - Blockchain 101 – what is (a) blockchain
   - Blockchain data – what are blocks and how are they created
   - Blockchain network – some major differences between a blockchain and a traditional DB
   - Blockchain consensus – the process of confirming transactions

<short break>

3. Comparison
   - Core differences between the bitcoin & ethereum blockchain
4. Blockchain Applications
   - Use-cases and implementation scenarios
   - How to create your own blockchain instance
5. Q & A



Source: Majesco (NYSE MKT: MJCO), a global provider of core insurance software

What Is a Blockchain?

- A distributed database
- Maintains a growing list of ordered records - blocks.
    - Each block has a timestamp and a link to a previous block.
- Trustless but trustworthy system

Why the fuss?

- Eliminating the need for an intermediary of any sort
    - recording transactions, establishing identity and establishing contracts
- can be used to store any kind of digital information, including computer code. (not only bitcoins)

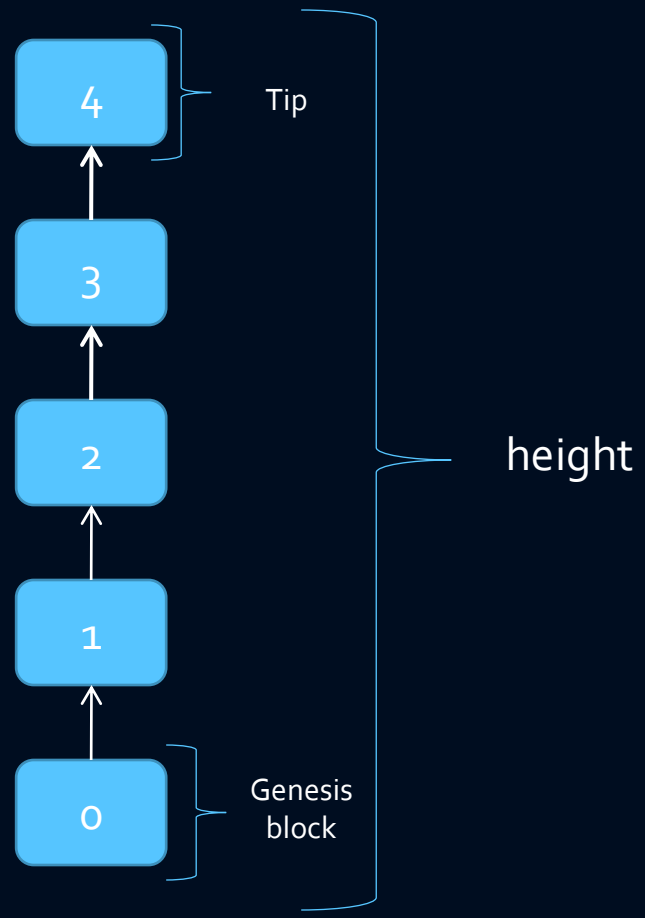
Most important features:

- no middleman required
- anonymous/private
- distributed
- cryptographically secure

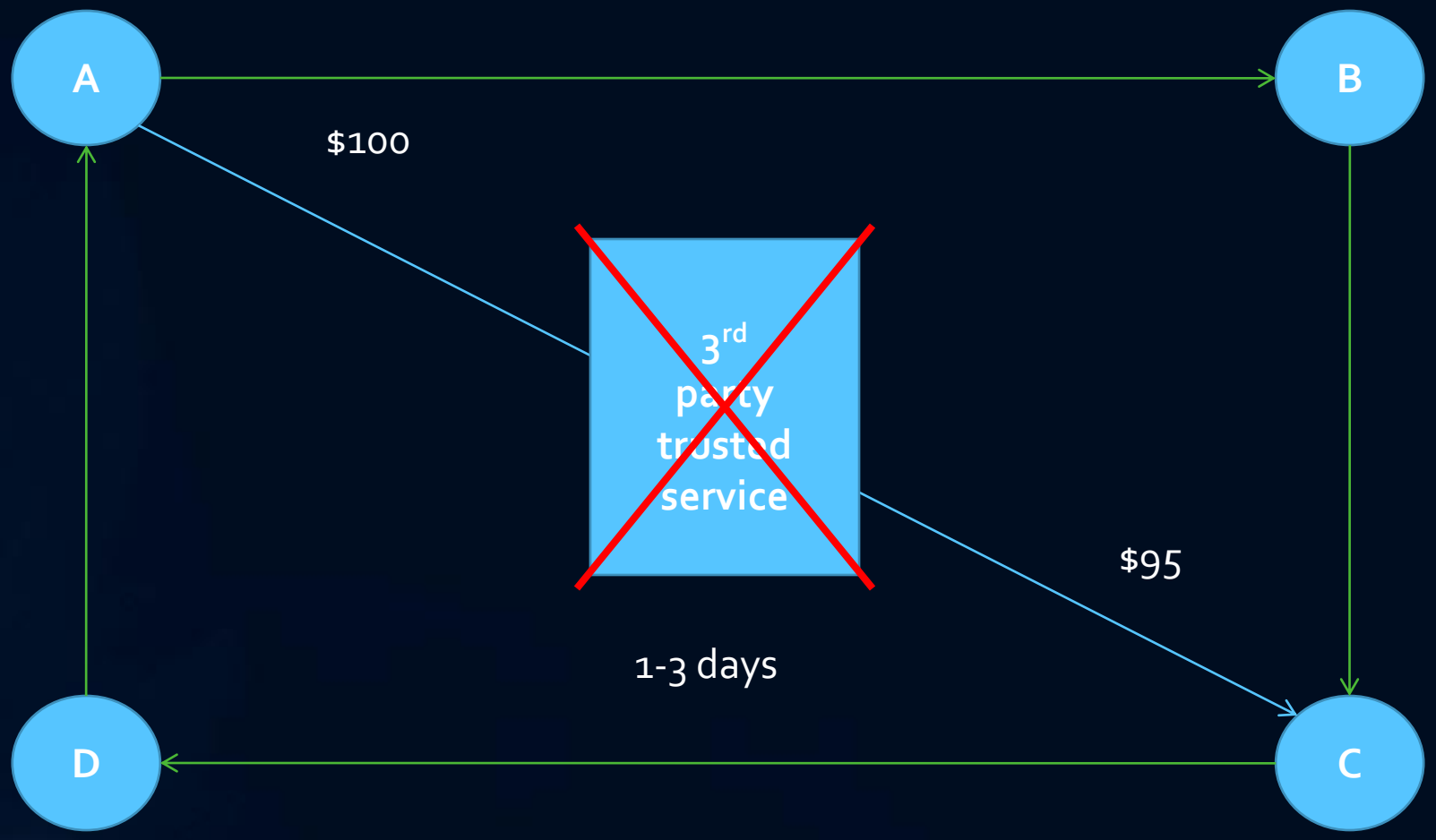
Let us get into the details:

- back-linked structure of ordered data
- often visualized as vertical stack with each block on top of the other (remember this please)
- Some terms:
  - blockchain height
  - blockchain tip
  - genesis block

- Each block is identified by a hash (SHA256 - bitcoin)
- Each block references a previous one – the parent
- Each block contains its parent hash in its header
- **The sequence of hashes linking each block to its parent creates a chain going back all the way to the first block ever created, known as the *genesis block*.**
- When the parent is modified in any way, its hash changes.
- **This change affects the child block and all subsequent blocks**
  - *Think of a big pot filled with soil – the surface is soft, but the deeper you go, the more stable it gets*



An Example

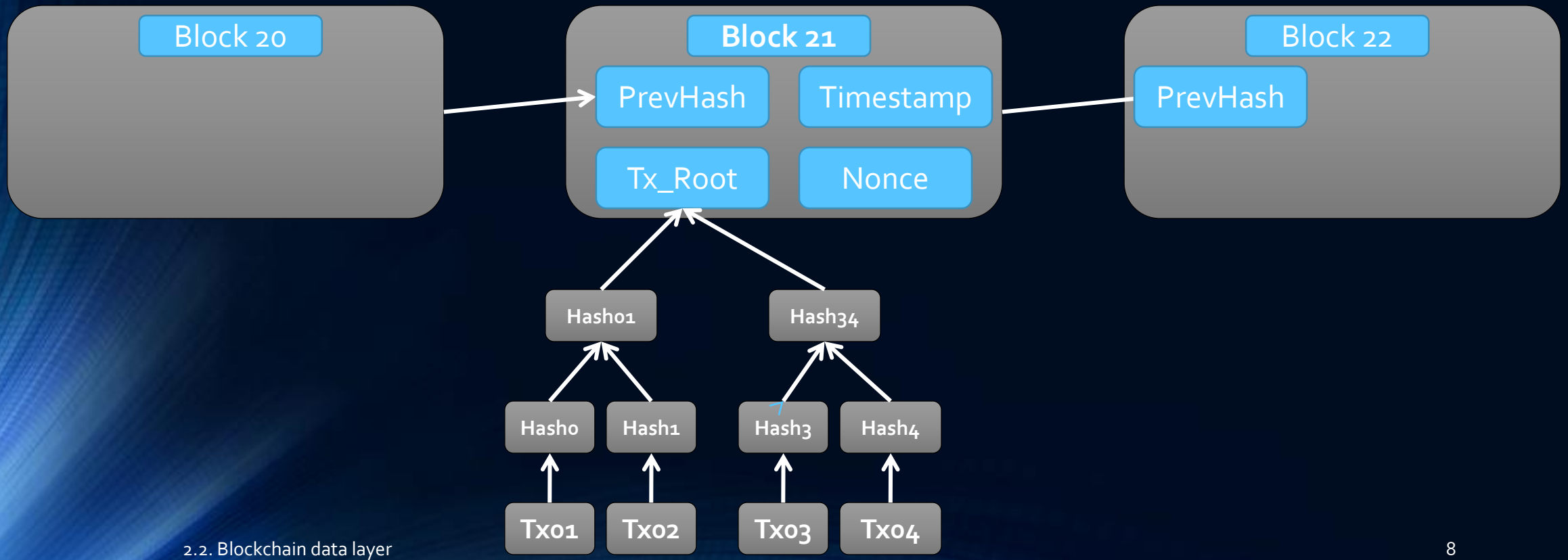


Digital ledger = blockchain

- Think also of pages in a book
- Blockchains by definition are linear and grow in chronological order
- Blockchains are P2P networks, with each peer holding a copy of the ledger (contrast to client-server)

Data Layer

- Data is stored in blocks
- Blocks are chained together via a hash
- Hash = a program that processes data(transactions) and outputs a piece of data. This process is also called mapping.
- Nonce – makes it impossible to duplicate block. In essence it is a random number.

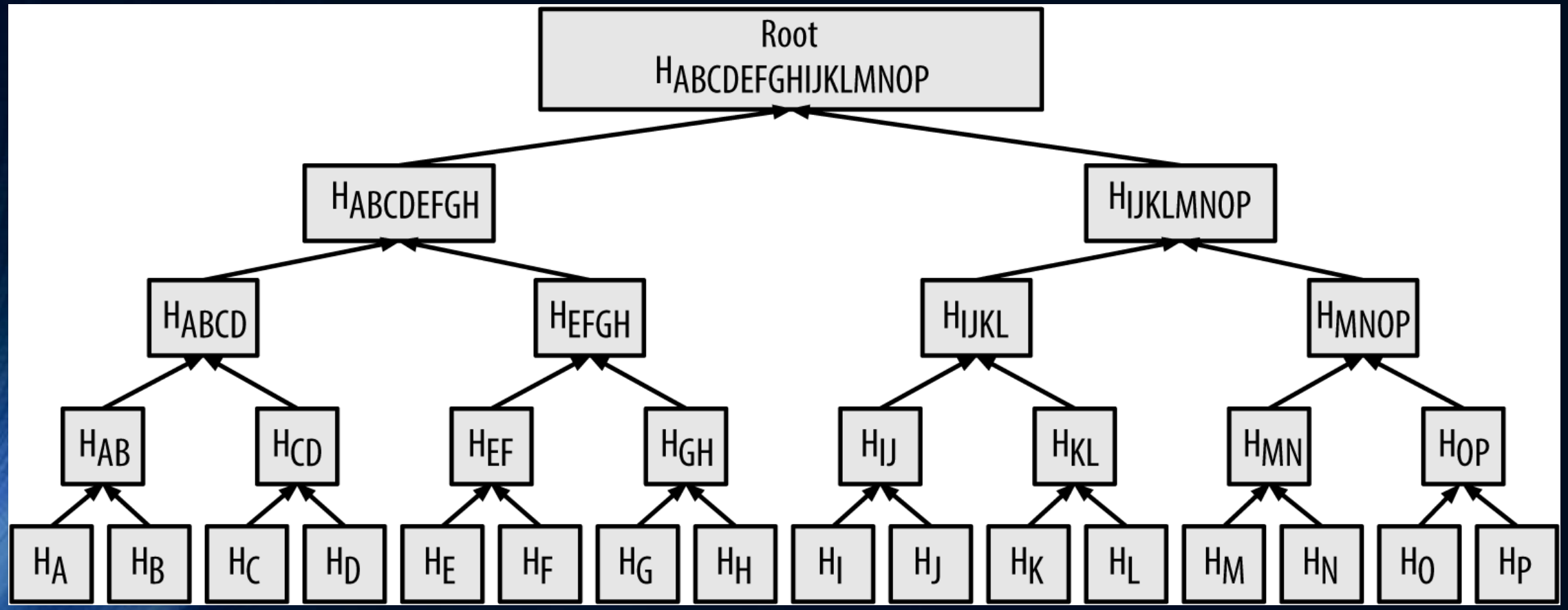


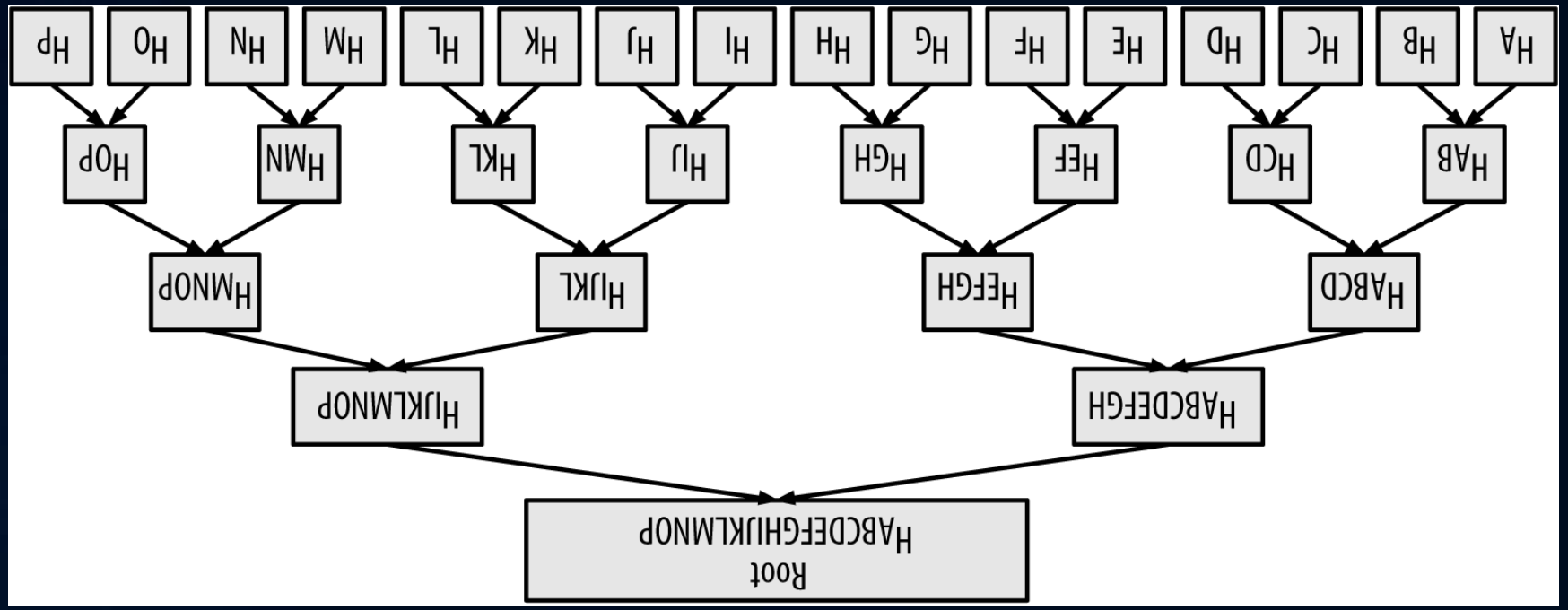
Briefly About Hashing

- Hashing:
  - taking data of random size and mapping it to data of fixed size
- Hash
  - The output of the hashing functions
- One-way hashing function
  - Easy to check if true BUT impossible to recreate the input data
- Hashing ≠ encrypting
  - Encryption supposes someone will decrypt something, with hashing you can only check values

Block Data Structure

- Merkle tree = binary hash tree
- has the ability to make a large piece of data very small, allowing quick access (reference) and provability
- "I had certain data, the hash is the proof"




Root
HABCDEFGHIJKLMNOP
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HIJKLMNOP
HABCD
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Network Layer

- by definition blockchains are ***decentralized*** and ***distributed***
  - i.e. a list of transactions is replicated across a number of computers, rather than being stored on a central server.

- If a certain blockchain does not posses this attributes it is:
  - Either a centralized/private blockchain
  - Or a database incorrectly termed as a "blockchain"

- Full nodes vs Miners in a network
  - Simplified Payment Verification (SPV)

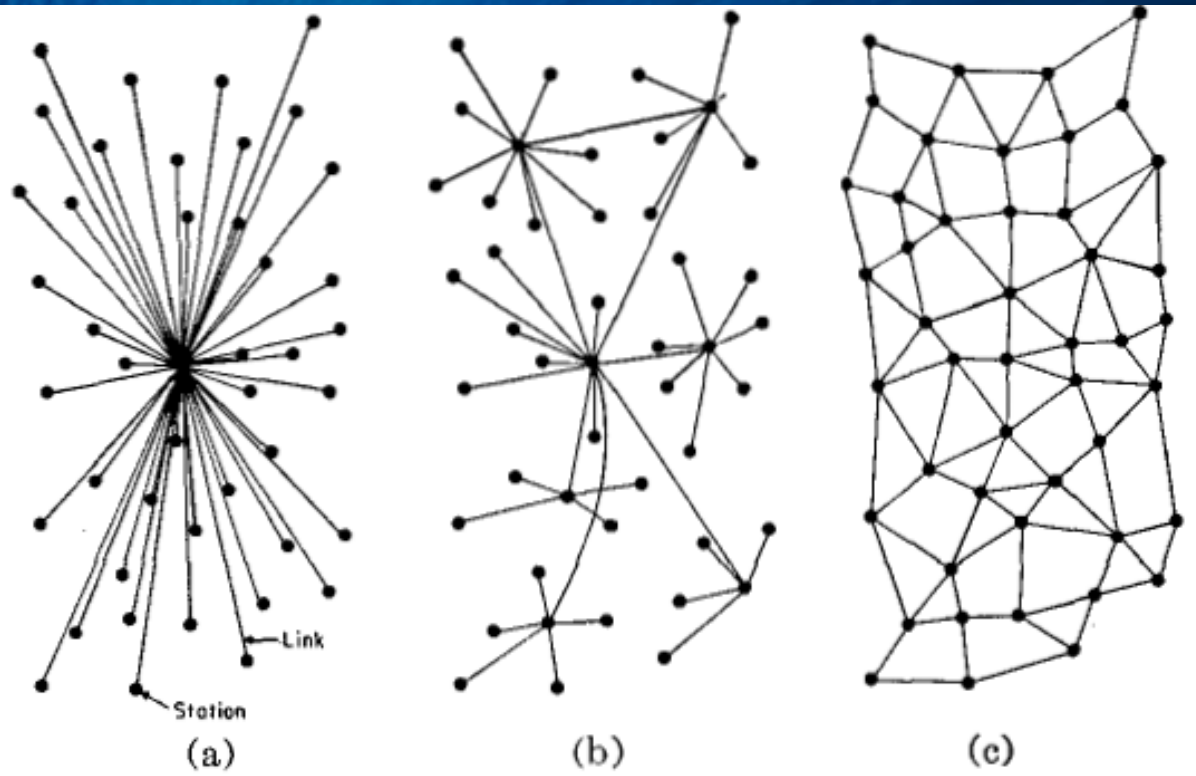
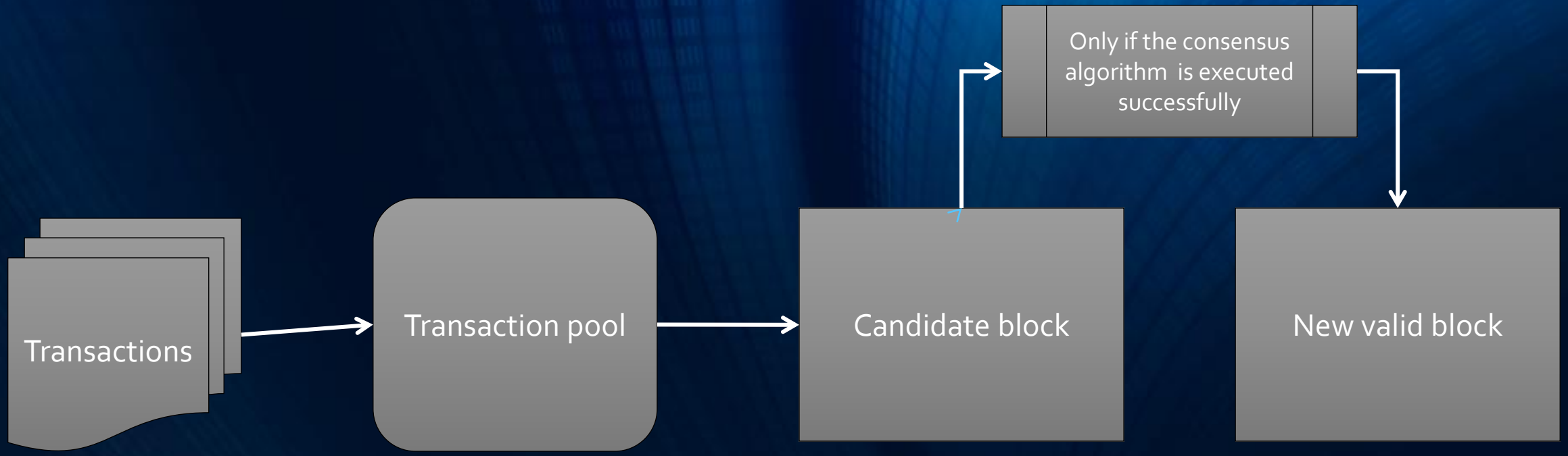


Fig. 1—(a) Centralized. (b) Decentralized. (c) Distributed networks.

Blockchain consensus

- How do blockchain nodes agree which transactions are valid and hence be included in the blockchain?
- The block is the final result of performing ***distributed*** consensus
- Consensus protocols – PoW / PoS. Consensus protocols make the blockchain what it is: store data in an ***open*** but ***immutable*** way



Consensus Protocols

- The consensus protocol does two things:
  - ensures that the **next** block in a blockchain is the one and **only version of the truth**
  - keeps **powerful** adversaries from derailing the system and successfully forking the chain
- **Currently, in Bitcoin, the SHA256 hashing must produce a sequence starting with 18 zeros. The number of zeros is set by the difficulty.**
- **What are the chances to have a hash starting with 0? And 2^n - for every subsequent zero**

Other Protocols:

- **Proof of stake**
  - a 'validator' invests in the coins of the system
  - validators (also called stakeholders, because they hold a stake in the system) are paid strictly in transaction fees.
  - require much less computational power and potentially eliminates the 51% problem
  - other issue: validators with nothing to lose can behave badly, e.g. double sign

- **Proof of activity**
  - a hybrid between PoW and PoS
  - the final block hash will require a signage

- **Proof of burn**
  - By committing your coins to never-never land, you earn a lifetime privilege to mine on the system based on a random selection process.

Consensus Protocols - 2

• Proof of capacity

• you 'pay' with hard drive space. The more hard drive space you have, the better your chance of mining the next block and earning the block reward.
• The more plots you have, the better your chance of finding the next block in the chain.

• Proof of elapsed time (by Intel)

• This system works similarly to proof of work, but consumes far less electricity.
• Instead of having participants solve a cryptographic puzzle, the algorithm uses a trusted execution environment (TEE) – such as Software Guard Extensions (SGX) – to ensure blocks get produced in a random lottery fashion, but without the required work.
• SGX protects selected code and data from disclosure or modification.
• Intel's approach is based on a guaranteed wait time provided through the TEE.
• **the protocol requires investing trust in a third party (Intel). Could be suitable for private blockchains.**

Proof of Service (PoSe)

• not a consensus protocol
• Refers to tier 2 of a crypto ecosystem but works hand in hand with tier 1

Bitcoin & Ethereum blockchain

How do they stack up against each other?

Criteria	Blockhain	
	Bitcoin	Ethereum
Open-Source	Yes	Yes
Currency	bitcoin	ether
Block time	10 minutes	14.5 seconds
Block size	1 MB	No direct limit
Consensus protocol	PoW	PoW + PoS
Protocol function	SHA-256	Ethash
Network	Bitcoin network protocol	ĐΞVp2p
Scripting language	None (Bitcoin Scripting Language)	Solidity (JS+C# libraries)
Storage	Transactions	Transactions + code
Data Structure	Binary hash tree	Modified Radix tree

Bitcoin & Ethereum blockchain - Currency

- Initial distribution: mining vs ICO
- Total supply: 21m vs constant annual rate = 0.3 x ICO
- Ethereum's founders studied Bitcoin economics for a while before coming up with Ethereum

Bitcoin & Ethereum blockchain - Blocks

- Bitcoin: 10 minute blocks, the blockchain can process 3 - 7 transactions per second
- Ethereum: 14.5 sec blocks, the blockchain can process 25 transactions per second
- Compare to Visa's scale

Bitcoin & Ethereum blockchain
- Consensus protocol and function

- Bitcoin: PoW blockchain, hashing SHA-256
- Ethereum: PoW - > PoS blockchain , Ethash-ing:
    - finding a nonce input to the algorithm so that the result is below a certain threshold
    - the consensus function is ASIC resistant

Bitcoin & Ethereum blockchain - Network

- Bitcoin: the Bitcoin Network Protocol, all communications over TCP
- Ethereum: ĐΞVp2p -
    - geared towards building a robust transport
    - well-formed network
    - software interface in order to provide infrastructure which meets the requirements of distributed or decentralized applications such as Ethereum

Bitcoin & Ethereum blockchain - Scripting Language

- Bitcoin: Script
  - Scripting provides the flexibility to change the parameters of what's needed to spend transferred Bitcoins. For example, the scripting system could be used to require two private keys, or a combination of several, or even no keys at all.
  - slightly lower level than C

- Ethereum: Solidity
  - similar to JavaScript, high-level language
  - with Solidity you can create and implement your own “smart contracts” that exist on the Ethereum Blockchain

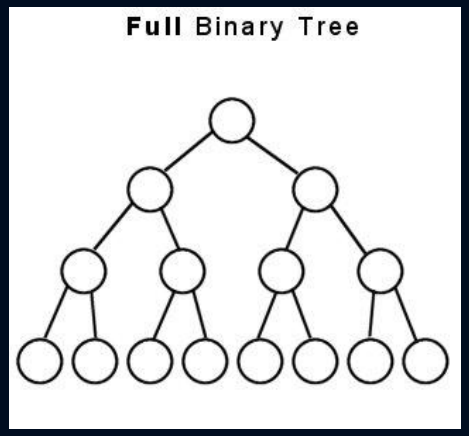
Bitcoin & Ethereum blockchain - Storage

- Bitcoin:
  - transactions
  - some conditions about those transactions

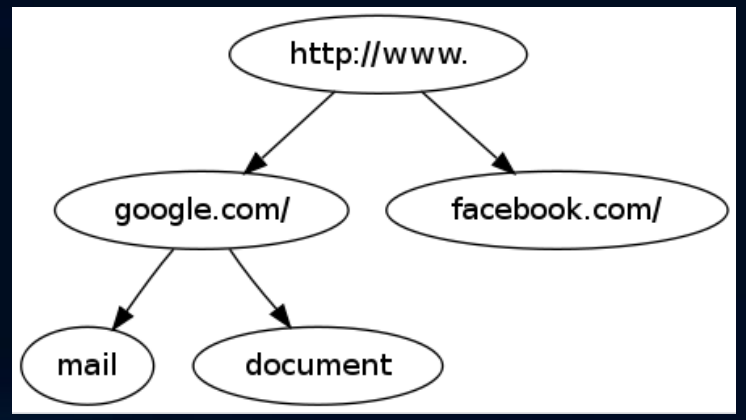
- Ethereum:
  - transactions
  - "smart contracts" – the code that is stored and executed in the blockchain
  - smart contracts essentially make possible blocks on the blockchain to store much more that sending and receiving sums
  - the smart contract contain **state** and **functions, i.e. business logic**
  - can be audited at any time, just like checking if a transaction exists on the blockchain
  - all nodes on the network have a copy
  - smart contracts are executed by the EVM

Bitcoin & Ethereum blockchain - Data Structure

- Bitcoin:



- Ethereum:

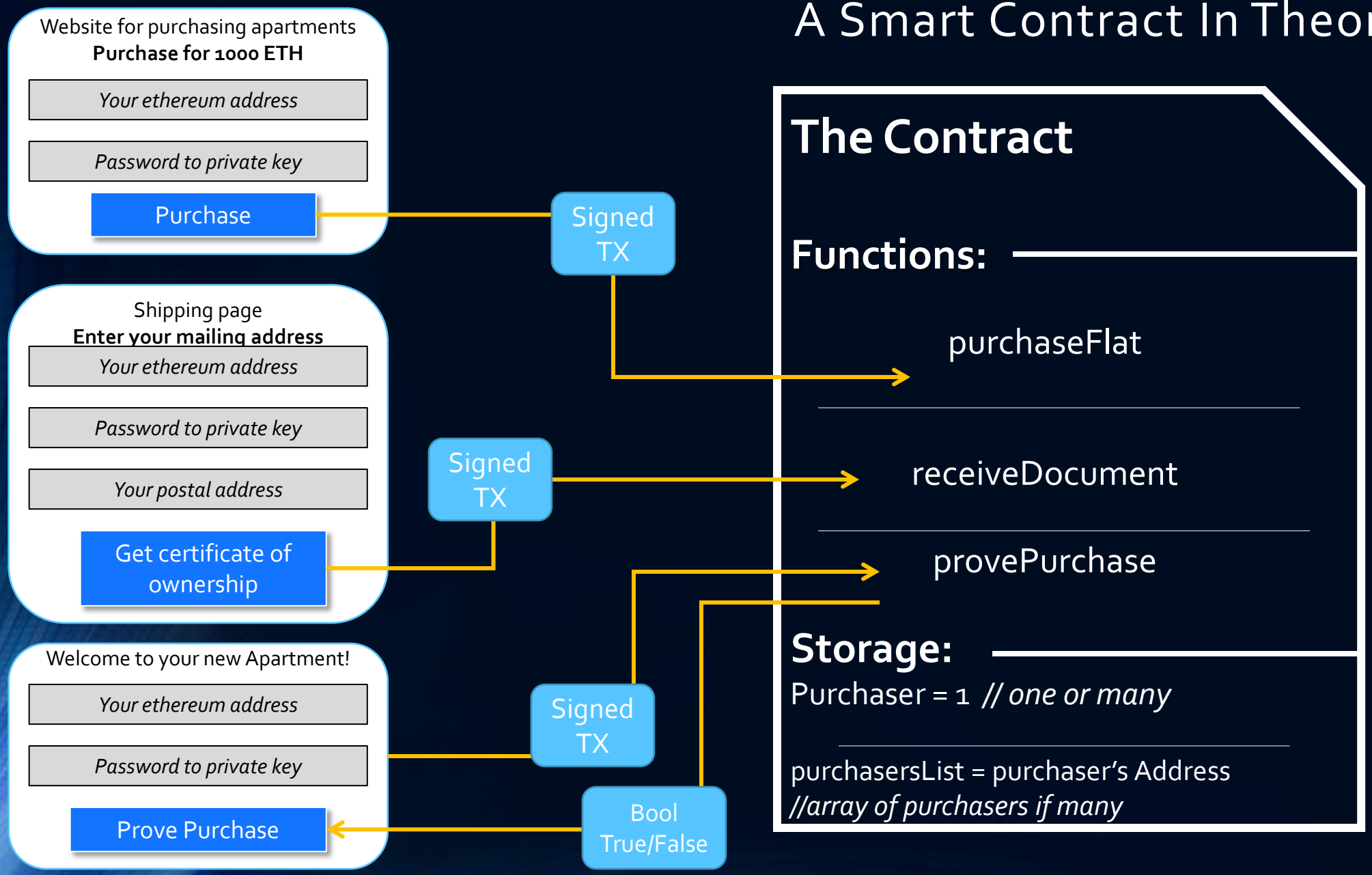


In very, very, very layman's terms -

Ethereum block data structure allows for:

- Much more checks of transactions and states
- Much better light client functioning (remember SPV's?)

A Smart Contract In Theoretical Action



Smart Contracts Essentials

- smart contracts are computer protocols
- they are based on contractual law
- smart contracts **execute the terms of the contract**
- Everything that:
    - can be coded
    - quantified or qualified in one way or another
    - is subject to an agreement

And most importantly, smart contracts are on-the-chain, thus

- everyone can look them up
- they are immutable
- cost some money to be executed, i.e. to call a function in a smart contract

Smart Contracts Essentials - 2

- Contracts are immutable, irrevocable, incorruptible APIs.
- Disclaimer: Solidity does provide a private selfdestruct method.
- Contracts on the public network have 100% uptime.
- Writing to the blockchain will cost you Ether (via gas).
- Writes will take ~15 seconds to be confirmed.
- Reads are free and instantaneous.
- Transactions only begin through external action.

Blockchain Types

Type	Permissioned	Decentralized	Trustless
Public	No	Yes	Yes
Hybrid	Yes	Partially	No
Private i.e. Database	Yes	No	No

- **Public blockchains**
  - no central authority, anyone can read, write and verify(participate in consensus) transactions
- **Hybrid blockchains**
  - no central authority, only selected participants can **write or verify transactions**. Read access can be public or not.
- **Private blockchains**
  - write permissions are centralized to one person/node or group. Read access could be granted to outside people

Blockchain Types By Industry

So a blockchain type would largely depend on the industry in point:

1. FinTech
    - Private blockchains
        - PWC
        - Quorum by JP Morgan
        - KPMG & Microsoft Azure

2. Non-financial
    - Private & public blockchains
        - Maersk & IBM

Blockchain Use cases

Financial	Corporate	Government	Cross-industry	Hospitality
International Payments	Supply chain management	Record management	Accounting	AirBnB
Capital Markets	Healthcare	Identity management	Shareholder's voting	Turo
Trade Finance	Real estate	Voting	Record management	Hotels
Regulatory Compliance & Audit	Media	Taxes	Cyber security	
KYC & anti-money laundering	Energy		Big data	
Insurance			Data storage	
P2P transactions			IoT	

Create Your Own Blockchain Instance

1. **BaaS by Azure**
   - a single-click, cloud-based blockchain developer environment
   - Learn, play & fail fast
   - Create your own private and hybrid blockchains

2. **Rubix by Delloite**
   - Architecture designed to support fully functional private networks

3. **IBM blockchain on Bluemix**
   - Distinguished for its pluggable architecture
   - Writing smart contracts with popular languages

4. **Others**
   - Multichain – target experimenting with blockchain for financial institutions
   - Walletbuilders.com – all in one , Bitcoin-based solution
   - OpenChain – a transaction chain, offering real-time confirmations

What About Adoption?

In terms if technology adoption and maturity:

- Feasible adoption can begin after the technology has matured to a level that can be easily supported
- There is a great chance that developing countries will be “adoption engines”
- Current stage: end of the beginning

If you can have a currency without a government body, then you might also be able to have a system fulfilling government functions, without a government.

Thank you for taking the time & interest!