Deutsche Bank
Research

Scalability of cryptocurrencies

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Why do I talk about scalability?
Definition of scalability?

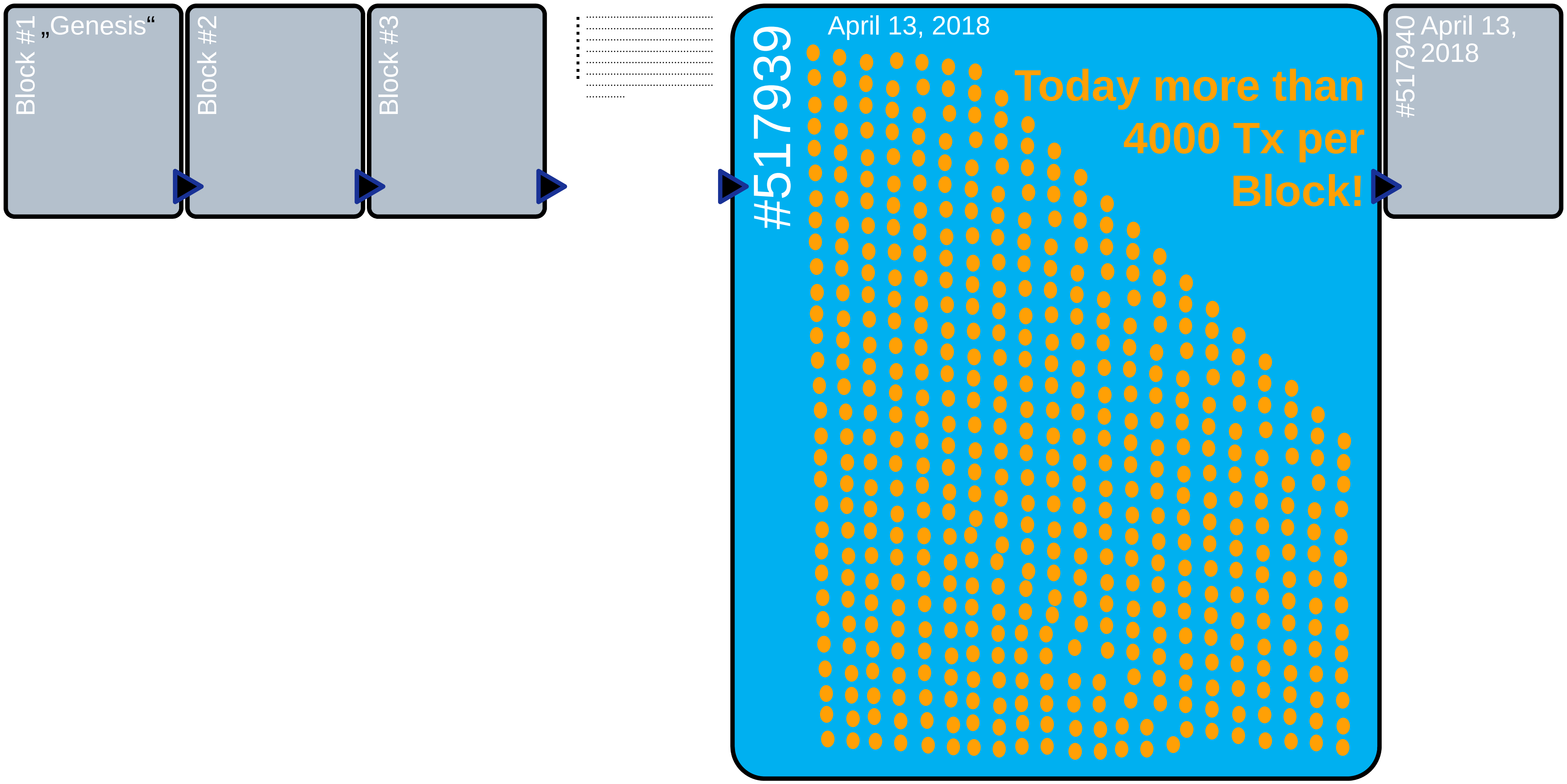
There are two future developments which could really challenge traditional industries and institutions?

- ❑ A completely decentralized crypto infrastructure
- ❑ Cryptocurrencies solve the scalability issue

Scalability has two dimensions

- ❑ Throughput of transactions
- ❑ Latency in the distributed network

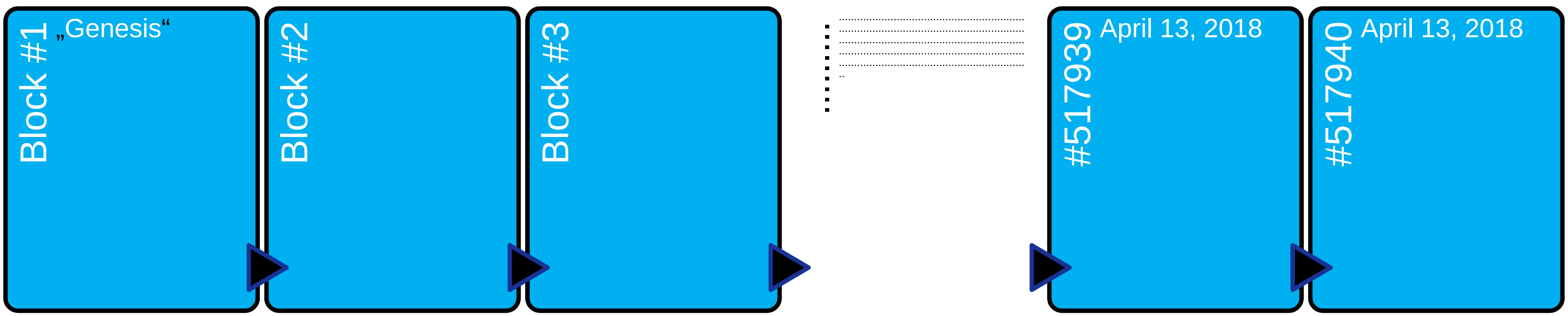
What does scalability of cryptocurrencies mean? Example: Bitcoin



- ❑ **Every 10 min (=600sec) a block is printed**
- ❑ **4200 TPBlock / 600 sec ~ 7 TPS**

TPBlock = Tx per block, TPS = Tx per second

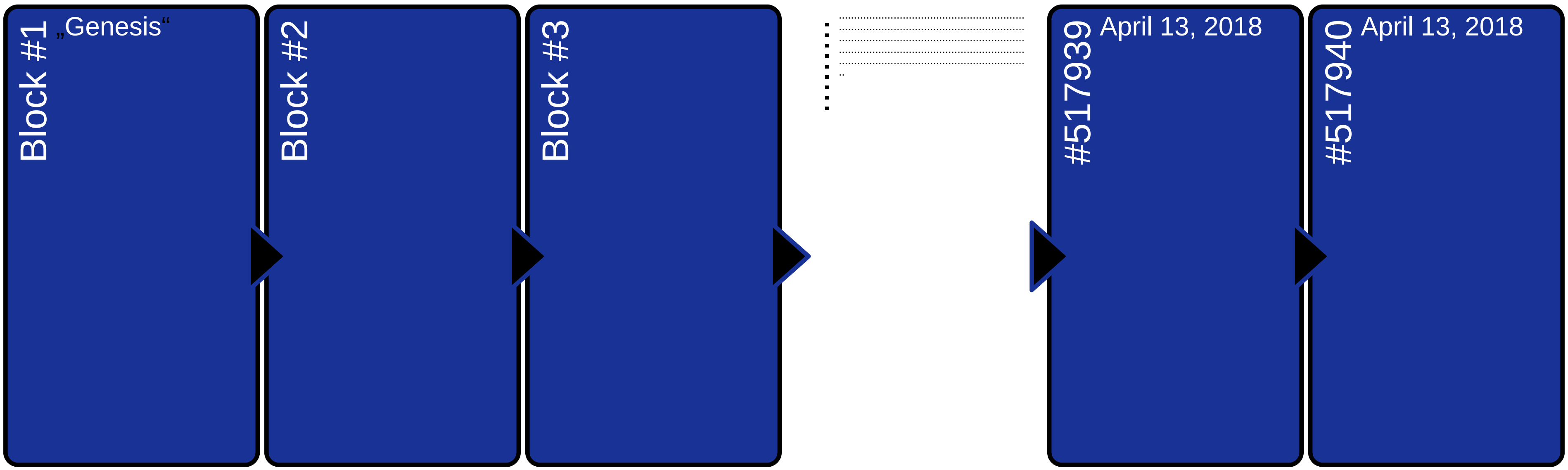
Scalability of cryptocurrencies:
How many transactions can Bitcoin (BTC) handle?



~ max. 7 TPS

Bitcoin does not scale!

Scalability of cryptocurrencies: Increase block size
Is Bitcoin Cash (BCH) different?



~ Max. 60 TPS

Moreover, larger blocks imply
Tradeoff between scalability
and de-/centrality

Bitcoin Cash does not scale!

Interim conclusion

Today, neither Bitcoin nor Bitcoin Cash nor any other decentraliced cryptocurrency scales.

Moreover, no. of Tx handled clearly below technological limits.

Centraliced/traditional payment systems are much more efficient

- ❑ VISA allows for several 1,000 TPS
- ❑ VISAs technological limit could be above 20,000 TPS

Will cryptocurrencies scale in the future?

Key debate in 2017

(1) Bitcoin scaling debate: Increase the blocksize

Will cryptocurrencies scale in the future?

(2) Lightning network

(3) From Blockchains to Blocktrees

Further proposals

- Switch of Ethereum from Proof of Work to Proof of Stake
- Other payment channel solutions in bitcoin
- Cardano approach „Connecting multiple blockchains“
- Byzcoin
- …..

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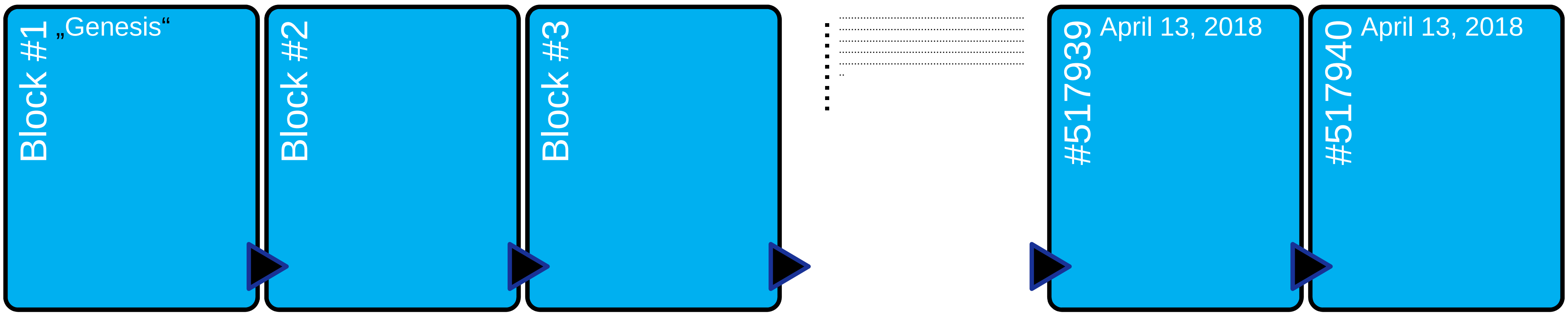
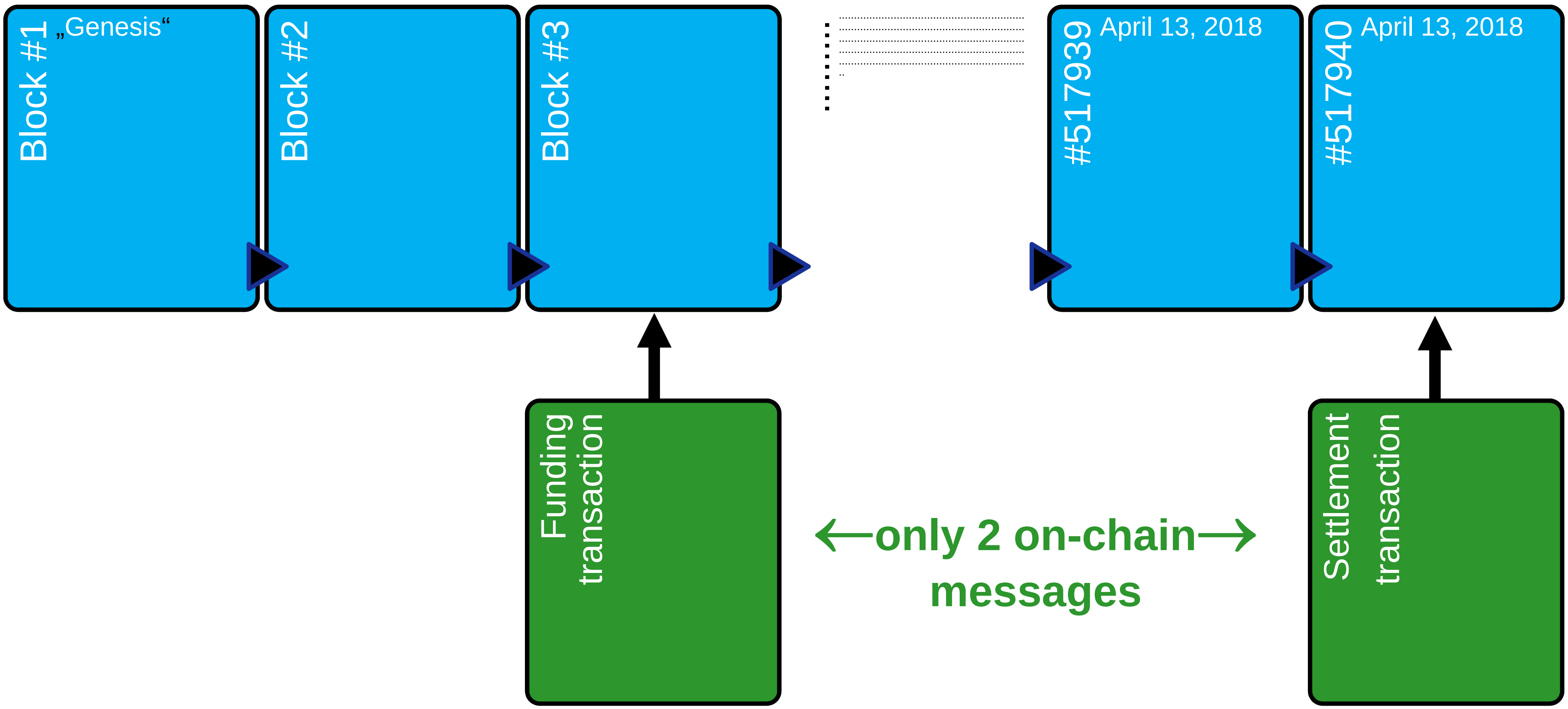
One proposed solution in the Bitcoin system to scale the number of Transactions: Lightning network



Theoretically, the Lightning Network allows for various number of Tx off-chain



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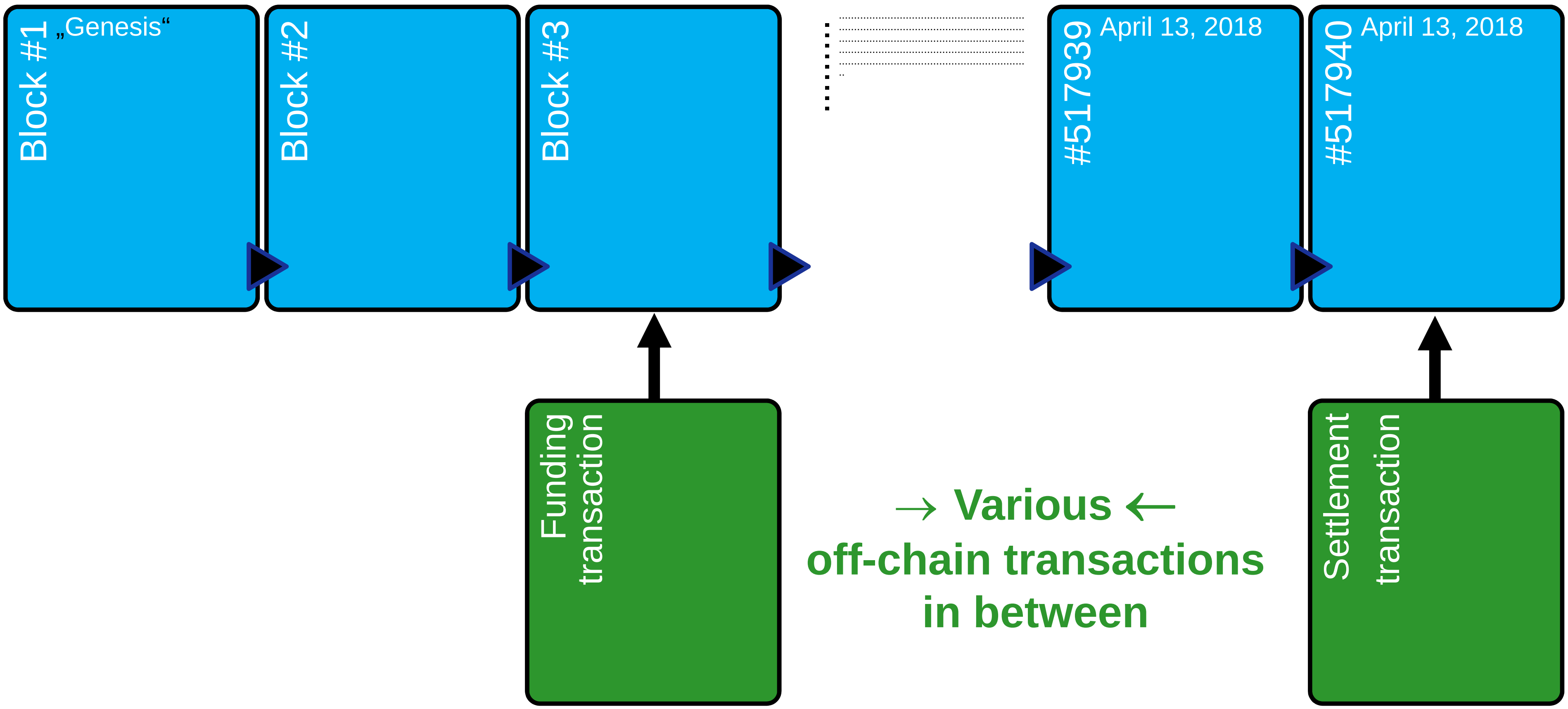


How does the Lightning Network work?

Setup a payment channel for Adam & Eve

1) Initial/funding transaction is visible for the Bitcoin nodes: Each person pays bitcoins into a “2x2 multi signature wallet” (= joint account)
2) Then Adam & Eve can perform many potential transactions off-chain, i.e. without announcing it to the Bitcoin network
3) If everyone cooperates transactions are settled on-chain.

Problems and solutions

How to avoid cheating? Simultaneous cross-swap of private keys & semi-signed transactions allows to punish cheaters

How to avoid non-responses? Transactions are automatically terminated in an expected future date → Timeouts

How does the Lightning Network work? Does it scale?

- **Individual scalablility through direct connections:** Enables microtransactions, e.g. daily coffee, newspapers, video streaming, etc. between individuals and could also be used to pay for services per second or even sub-second periods.
- **Network scalability through indirect connections:** Permanent payment channels between important hubs, e.g. cryptoexchanges, could boost no. of Tx and could open up indirect off-chain channels which could scale.
- **Scalability across networks:** Implementing Lightning Network in Bitcoin offsprings, e.g. Litecoin, Bitcoin Cash, allows to transfer funds across blockchains.

However, problems and questions remain

- Nonsimultaneous cross-swap of keys & semi-signed Tx could be abused
- Indirect connections between networks have the potential for multiple failures $\Rightarrow$ multiple timeouts poise a risk of losing funds for a very long time span
- How to handle Tera/Peta/Etabyte of data if crypto scales?

Bottom-line: Lightning Network scales, at least to some extent.

Will cryptocurrencies scale in the future?

Key debate in 2017

(1) Bitcoin scaling debate: Increase the blocksize

Will cryptocurrencies scale in the future?

(2) Lightning network

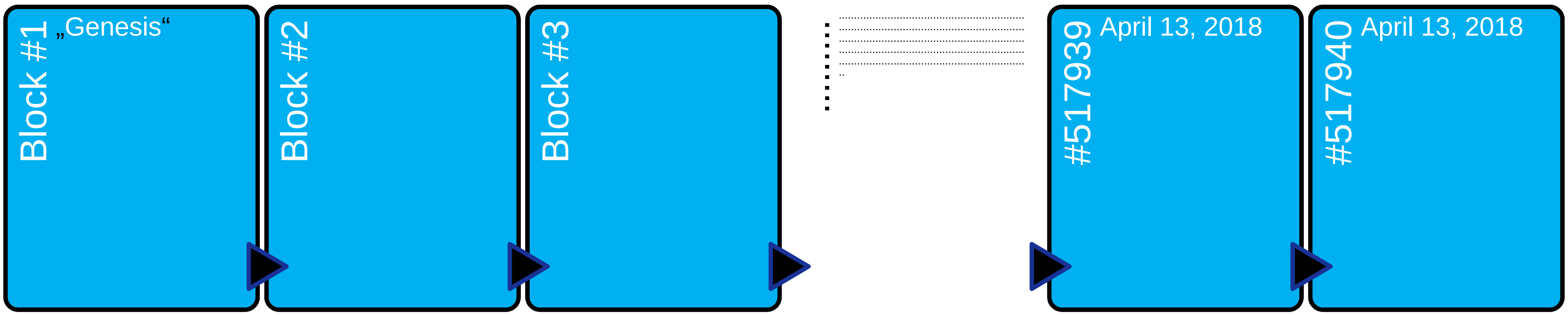
(3) From Blockchains to Blocktrees

Further proposals

- Switch of Ethereum from Proof of Work to Proof of Stake
- Other payment channel solutions in bitcoin
- Cardano approach „Connecting multiple blockchains“
- Byzcoin
- …..

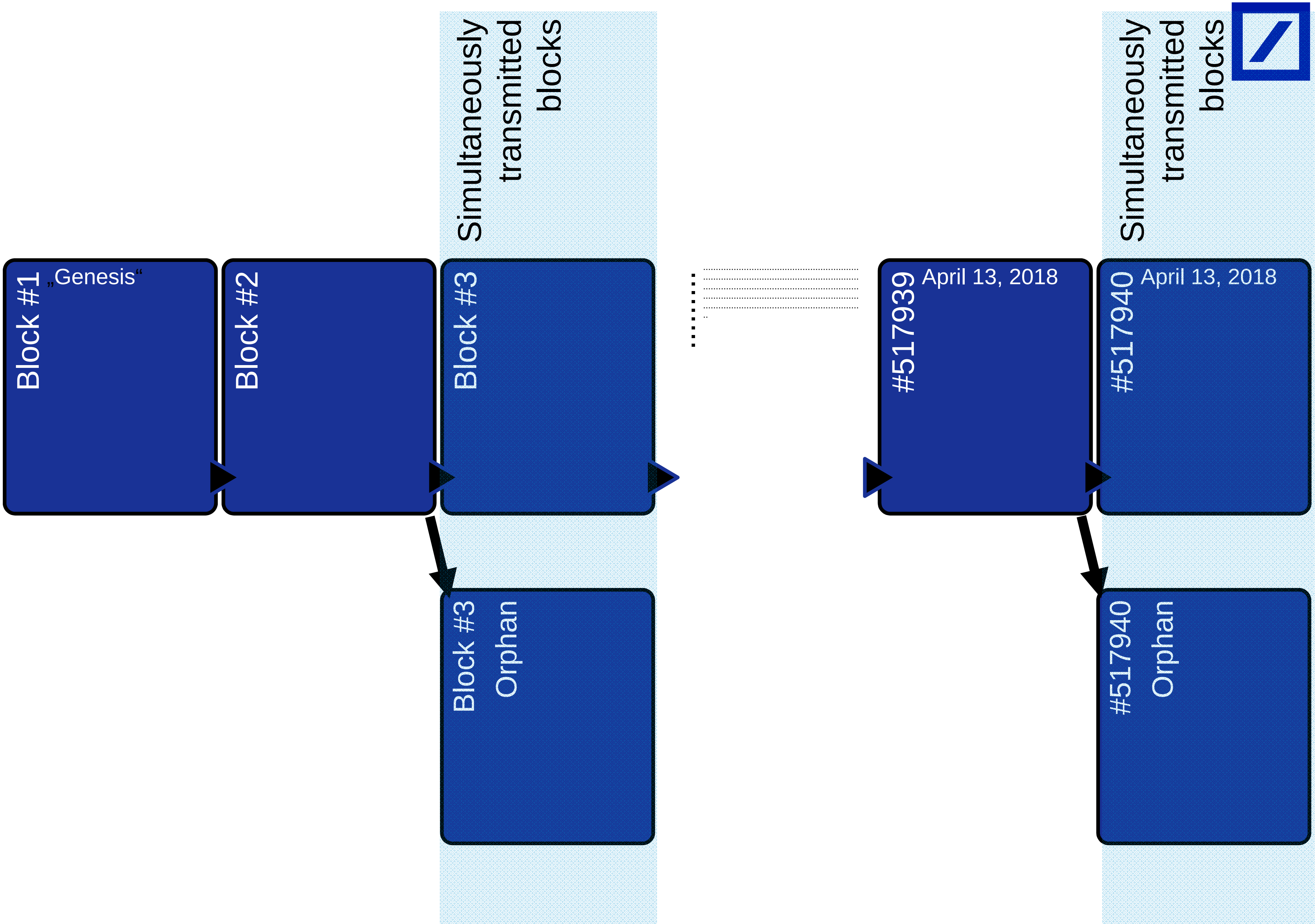
One proposed solution to scale the number of Tx for any blockchain based crypto system: Blocktrees

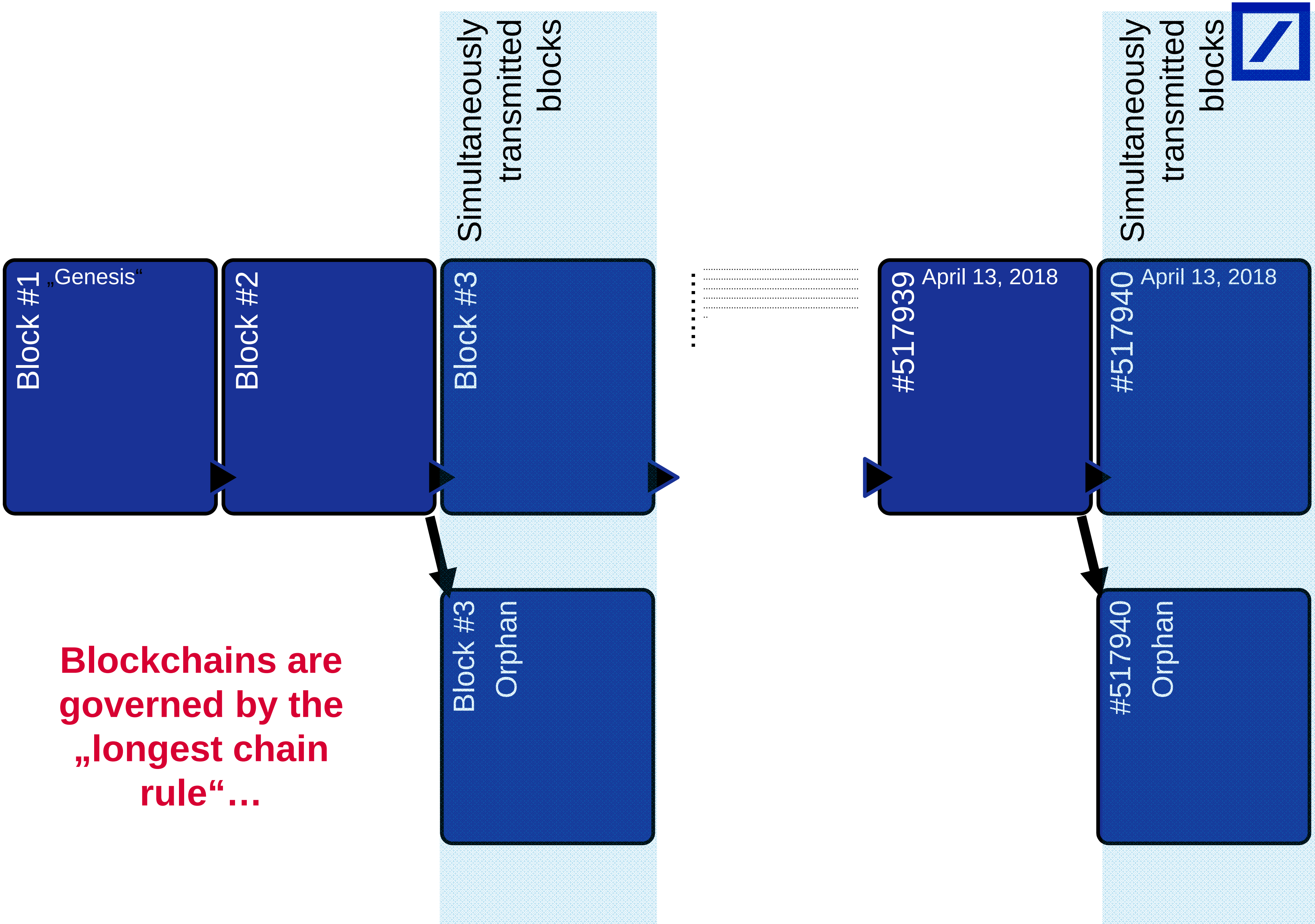
Technical term for Blocktrees = Directed acyclic graphs (DAG)



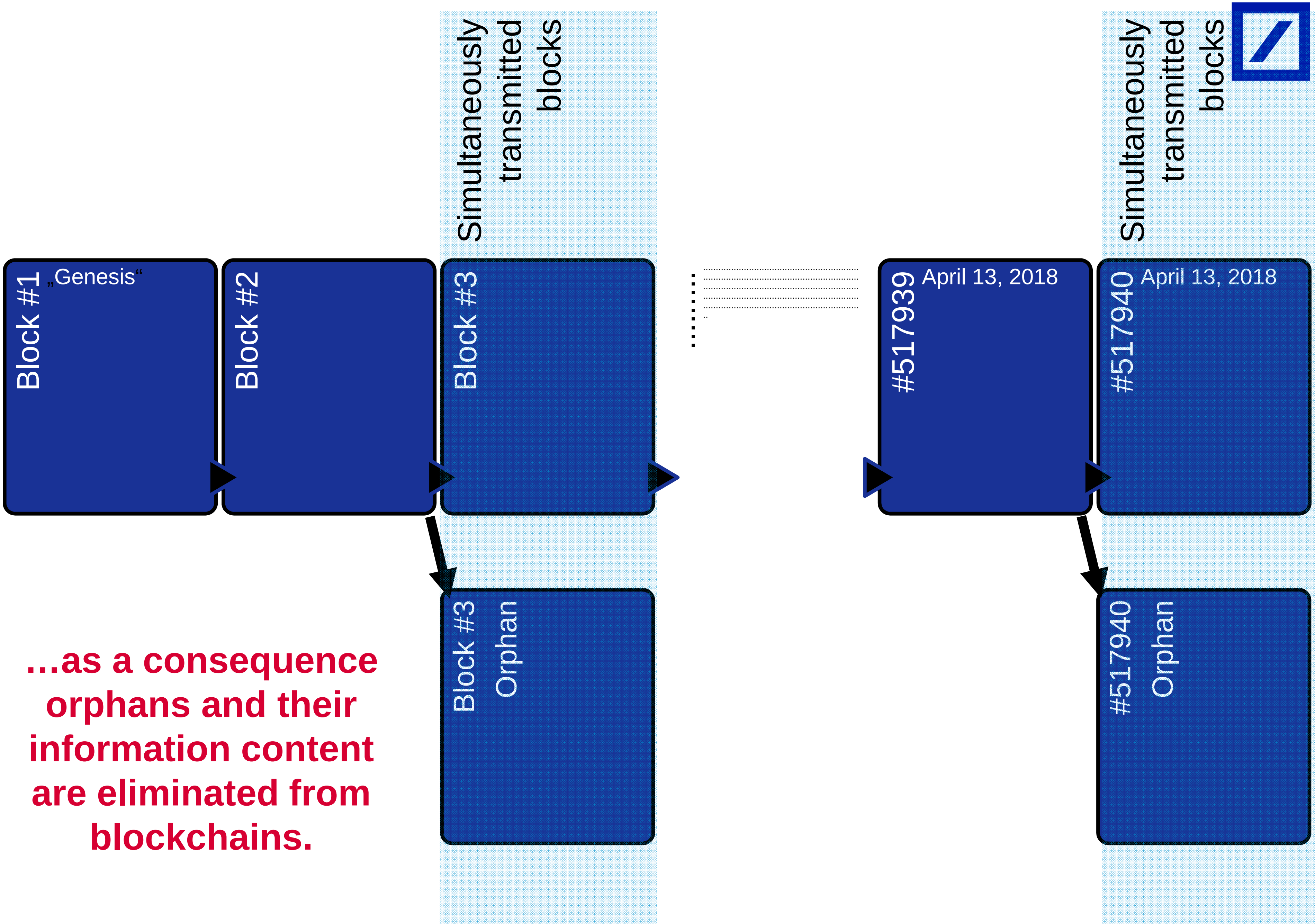
Yonatan Sompolinsky, Yoad Lewenberg & Aviv Zohar
"SPECTRE: Serialization of Proof-of-work Events: Confirming Transactions via Recursive Elections"

See also daglabs.com


Simultaneously transmitted blocks
Block #1
„Genesis“
Block #2
Block #3
Block #3
Orphan
#517939
April 13, 2018
#517940
April 13, 2018
#517940
Orphan
Simultaneously transmitted blocks

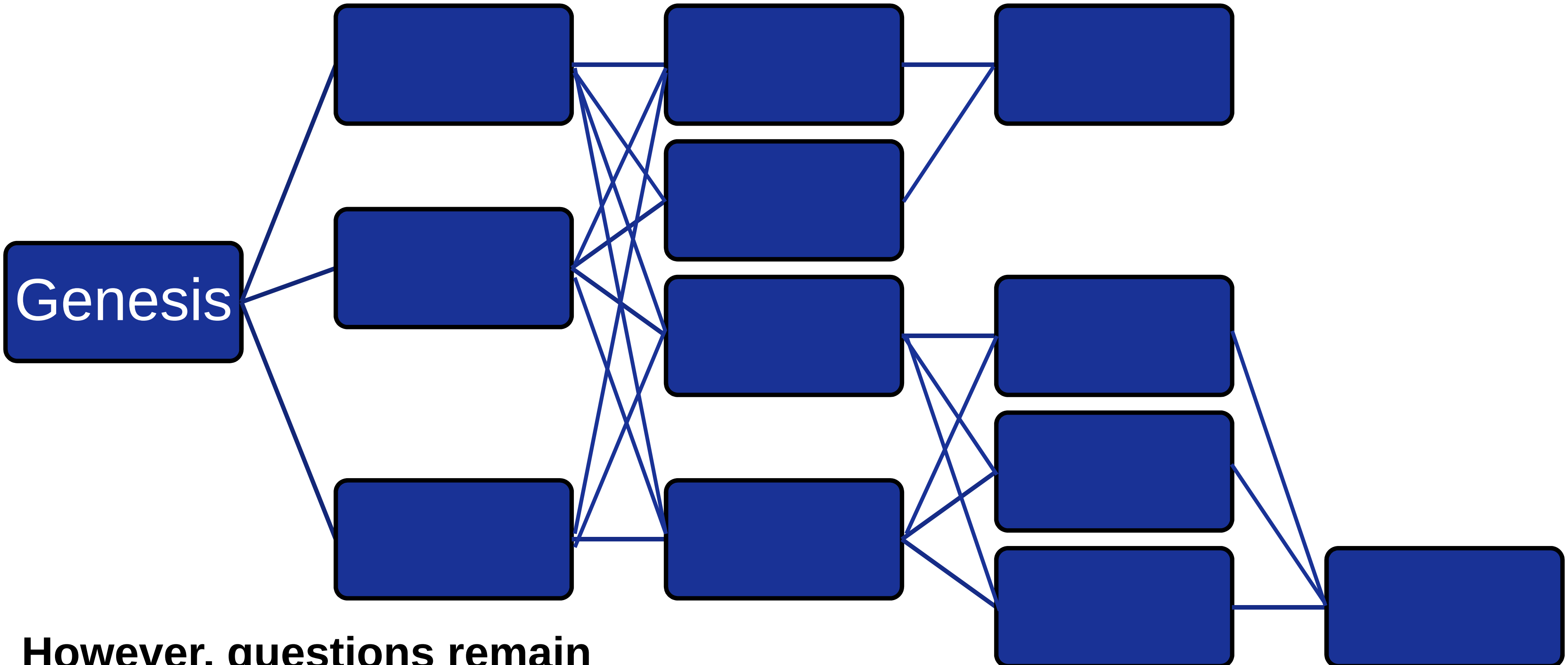


Blockchains are governed by the „longest chain rule“…



…as a consequence orphans and their information content are eliminated from blockchains.

Goal of SPECTRE: 1 m blocks per day (BTC 144) **ZenCash & IOHK** already work **on implementation**.



However, questions remain

- How to handle Tera/Peta/Eta/…byte of data if crypto scales?
- What are the pitfalls in implementing the game-theoretical approach?
- Would SPECTRE result in a less decentralized network node?

Bottom-line on scalability

- ❑ Many projects are in the offing
- ❑ Scalability seems only a matter of time.
  - ❑ Lightning Network and
  - ❑ Blocktrees/DAGs
  - ❑ plus many further proposals

- ❑ However, problems remain. It seems likely that cryptocurrencies scale gradually over the coming years.

  ⇒ very similar to the development of the internet

- ❑ Key problems of scalability are

…adoptability of cryptocurrencies. Many users do not understand either the traditional/centralized nor the new/decentralized payment systems.

…regulatory uncertainty.

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