Blockchain in the lens of BFT

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VMware Research

ATC 2018

“ Centralized services are a security hole ’’

Nick Szabo, 2001

cryptographer and legal scholar

inventor of “*smart contracts*”

Agenda

What ?

Why ?

How ?

Blockchain Technology: A 3-Layer View

Distributed Apps

Contracts / Transactions

Distributed Ledger Technology (DLT)

Unspent Transaction Outputs (UTXOs)

new minted coins C, D

transfers:

A	←	0.0 of coin A
B	←	1.0 of coin A

…

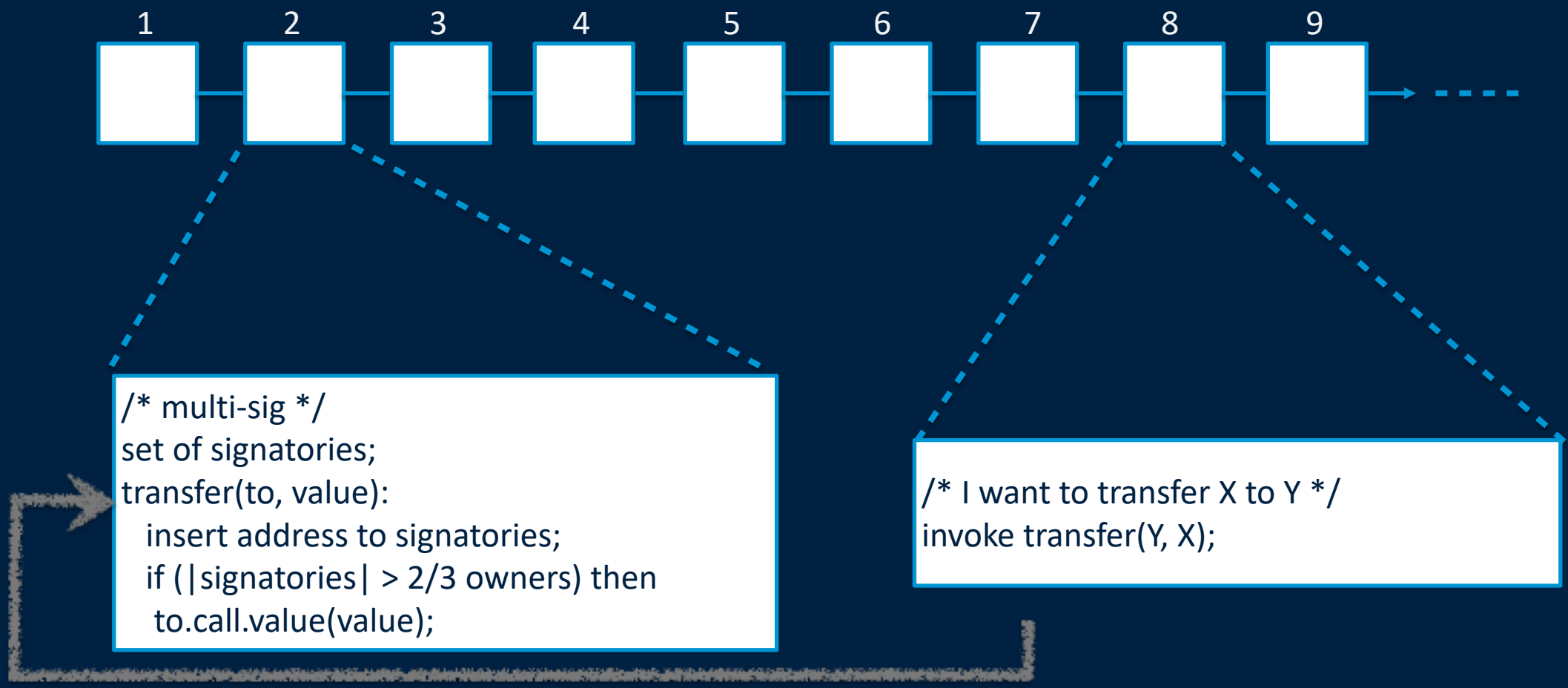
new minted coins E, F

transfers:

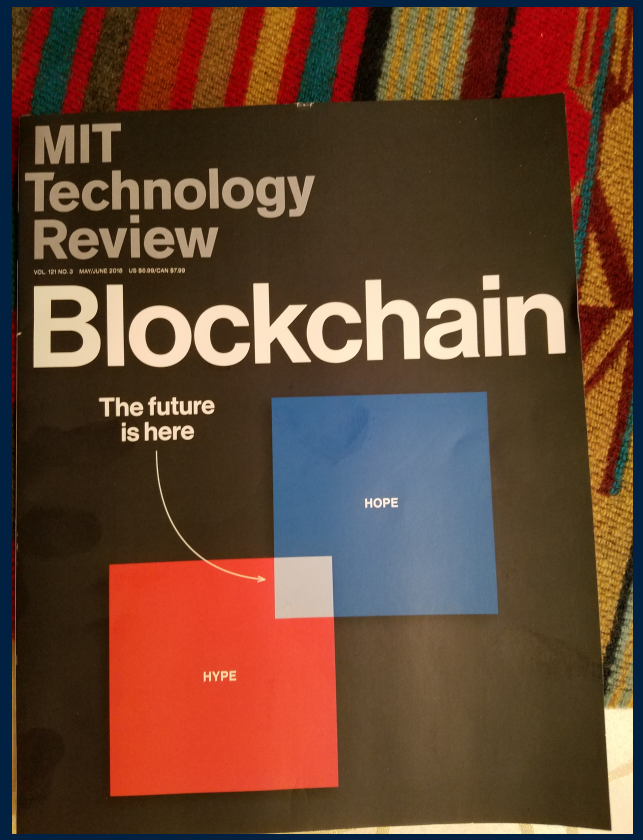
A	←	1.0 of coin A
X	←	.5 of coin C
C	←	.5 of coin C

…

Scripts (Smart Contracts)



Use-cases?



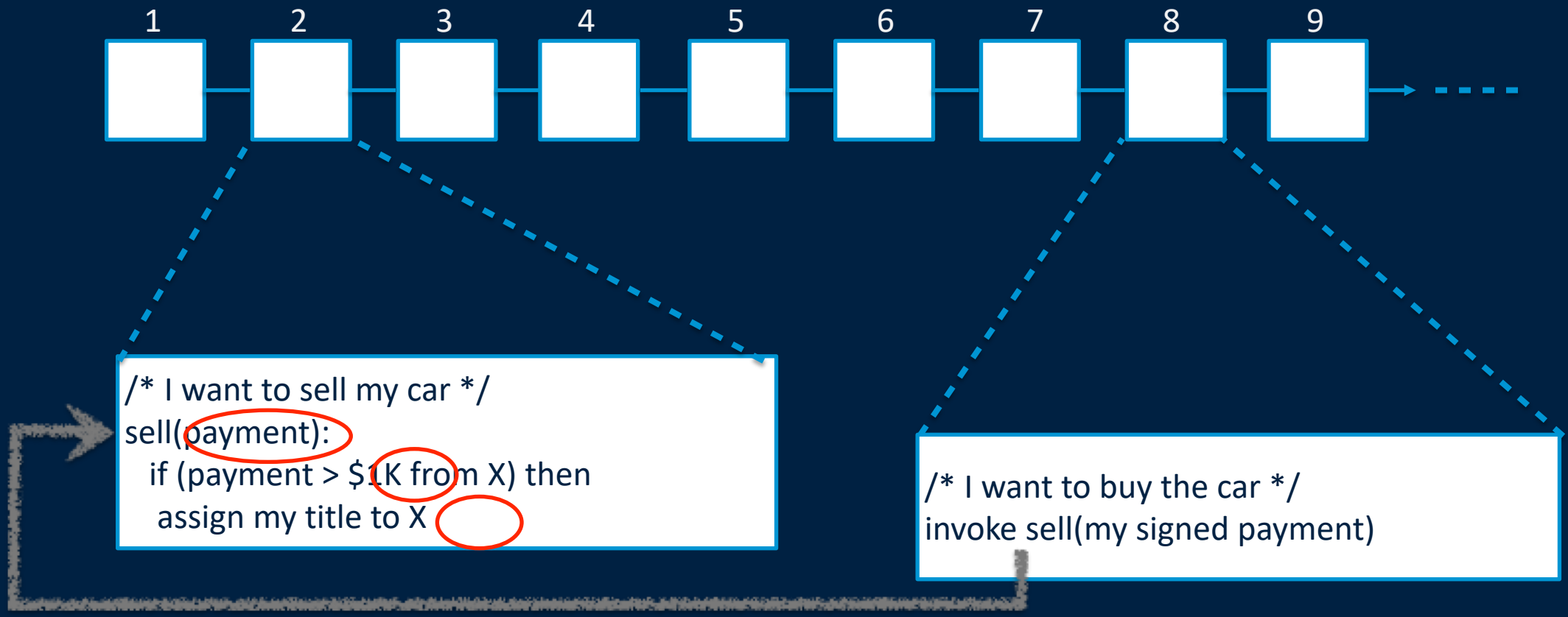
“ I need blockchain because my CxO says I do”

Use-cases?

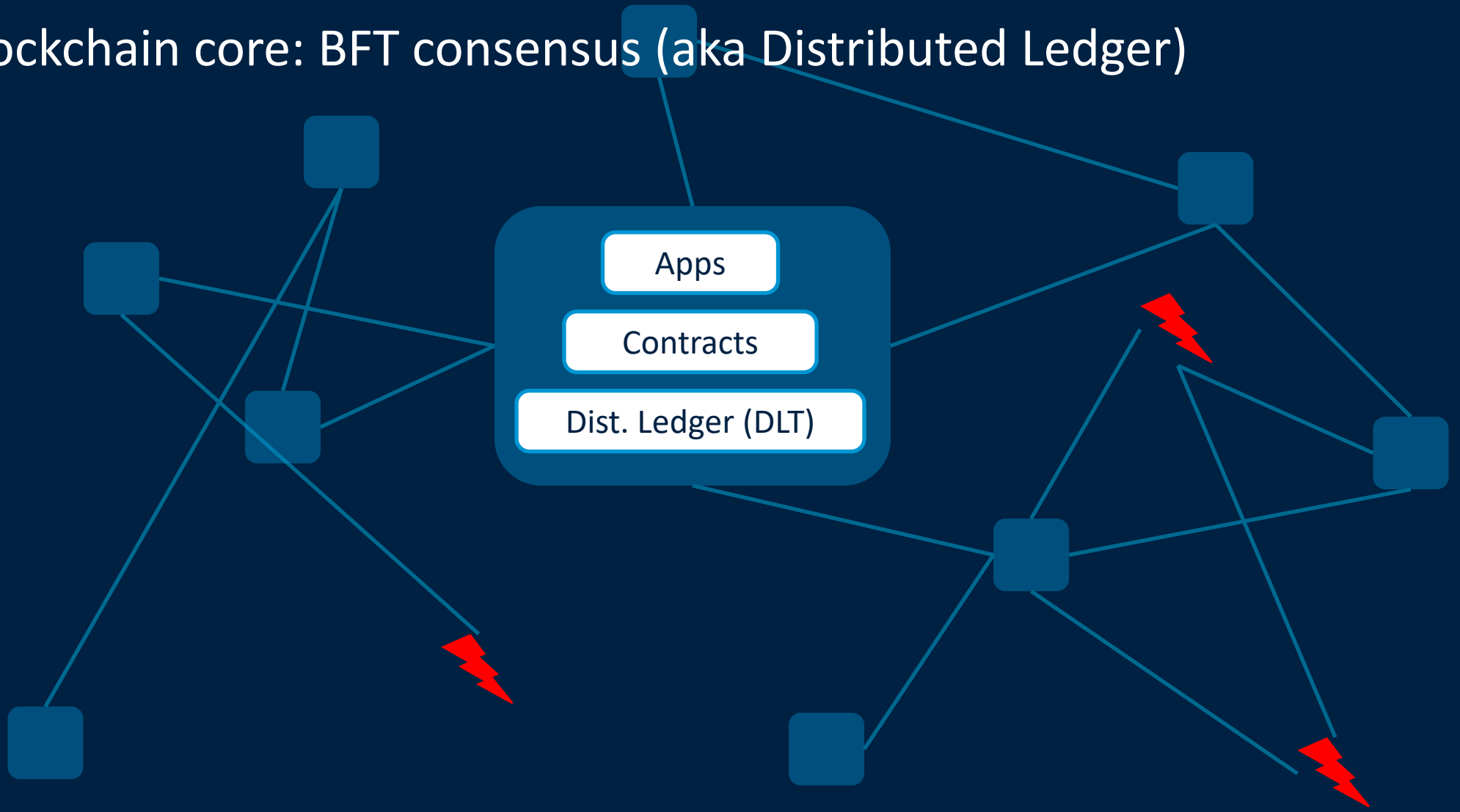
``Centralized Services are a Security Hole'', Nick Szabo, 2001

- crypto-currencies
  - "utility tokens"
  - multi-sig
- reliable, ordered broadcast channel
  - identity management
  - audit
  - provenance tracking
- a hash-chain
  - timestamp
  - immutable
- platform for privacy preserving information sharing and processing

Privacy Enhancements



Blockchain core: BFT consensus (aka Distributed Ledger)



“ Bitcoin is the first practical solution to a longstanding problem in computer science called the Byzantine Generals Problem “

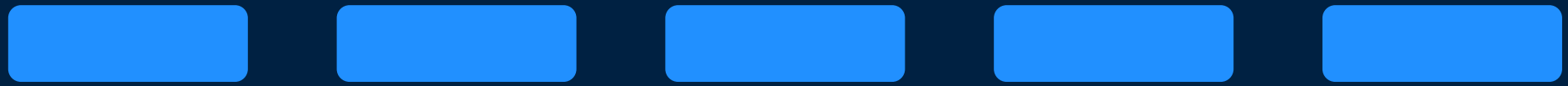
Marc Andreesen, NYTimes, 2014
inventor of Mosaic, VC, thought leader

Nakamoto Consensus [Santoshi Nakamoto 2008]

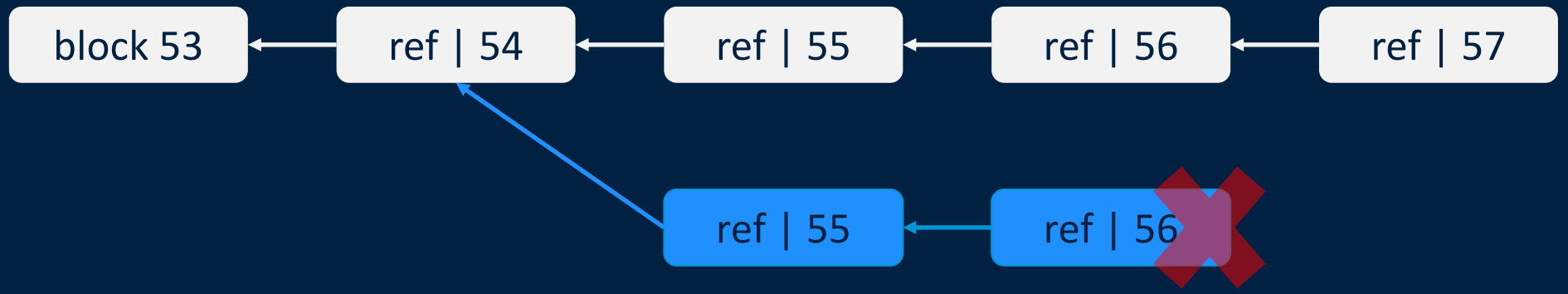
a triumph of math, algorithms and crypto

- Hash-chain
  [Haber and Stornetta 1991, *"How to Timestamp a Digital Document"*]

- Proof-of-Work (PoW)
  [Dwork and Naor 1992, *"Pricing via Processing or Combatting Junk Mail"]*



Nakamoto Consensus : Longest-Fork-Wins (LFW)



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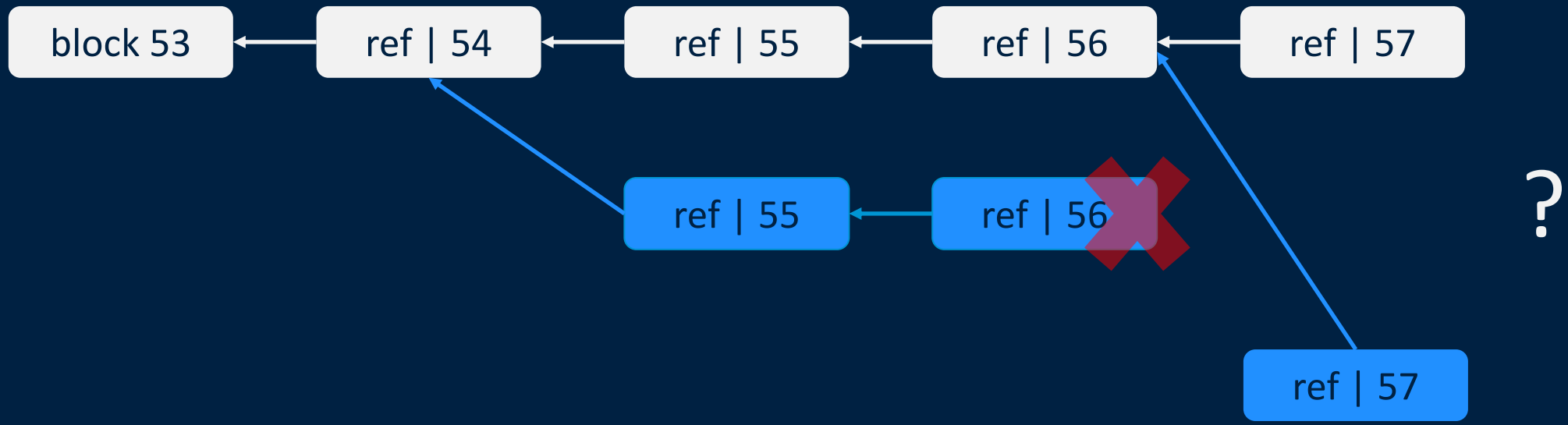
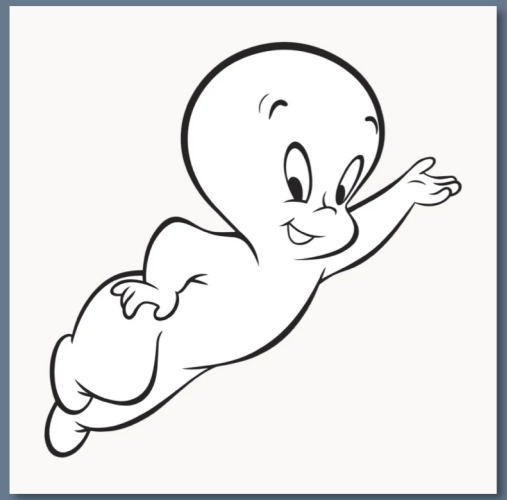


are we decentralized yet?

- Energy cost / waste
- High latency to “finality”
- Limited throughput
- Forking attacks
- Concentration of power
  - http://arewedecentralizedyet.com :
    - # entities controlling > 50%
      BITCOIN: 3 Ethereum: 3 Ripple: 1 Stellar: 1 …

Revisiting BFT



Hybrid Blockchain

- Combination
- Example: Ethereum Casper

Consortium Blockchain

- Known group of participants
- Example: Banking

Public Blockchain

- Permissionless: Anyone can join
- Example: Bitcoin


HOORAY
I'M RELEVANT
memegenerator.net

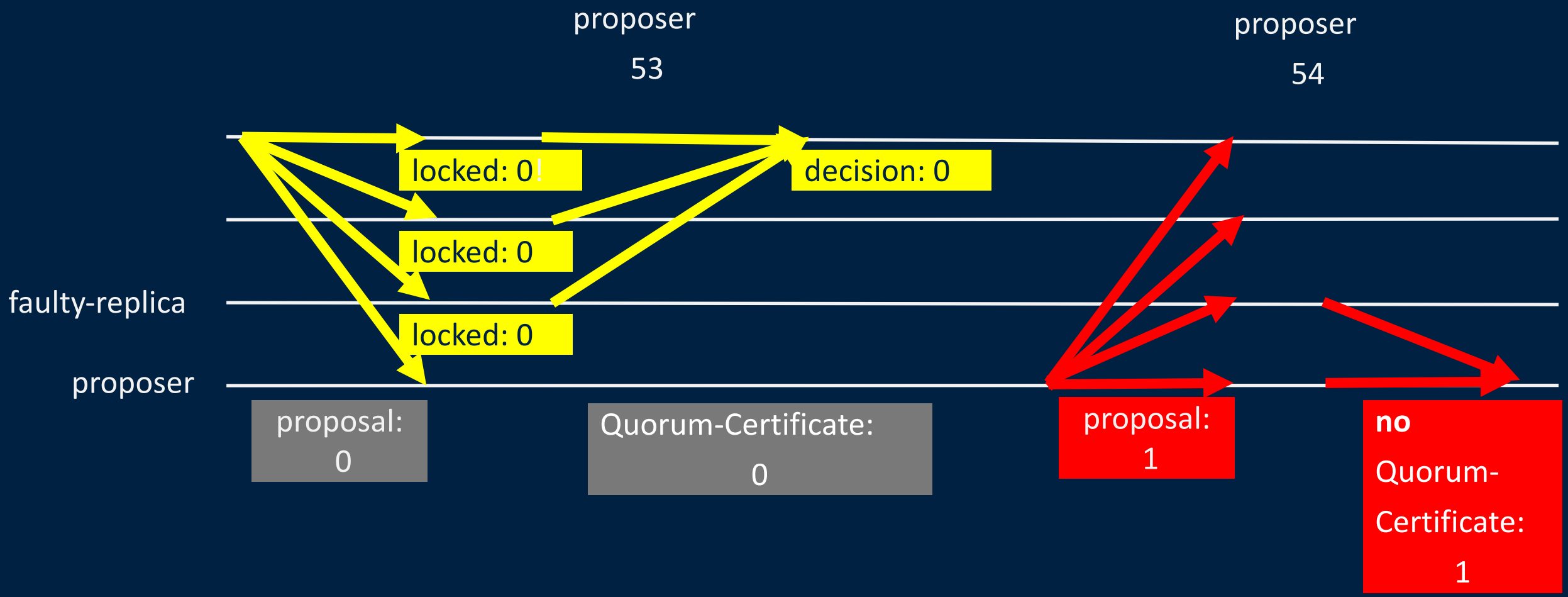
BFT in the lens of Blockchains
and
Blockchains in the lens of BFT

BFT Consensus

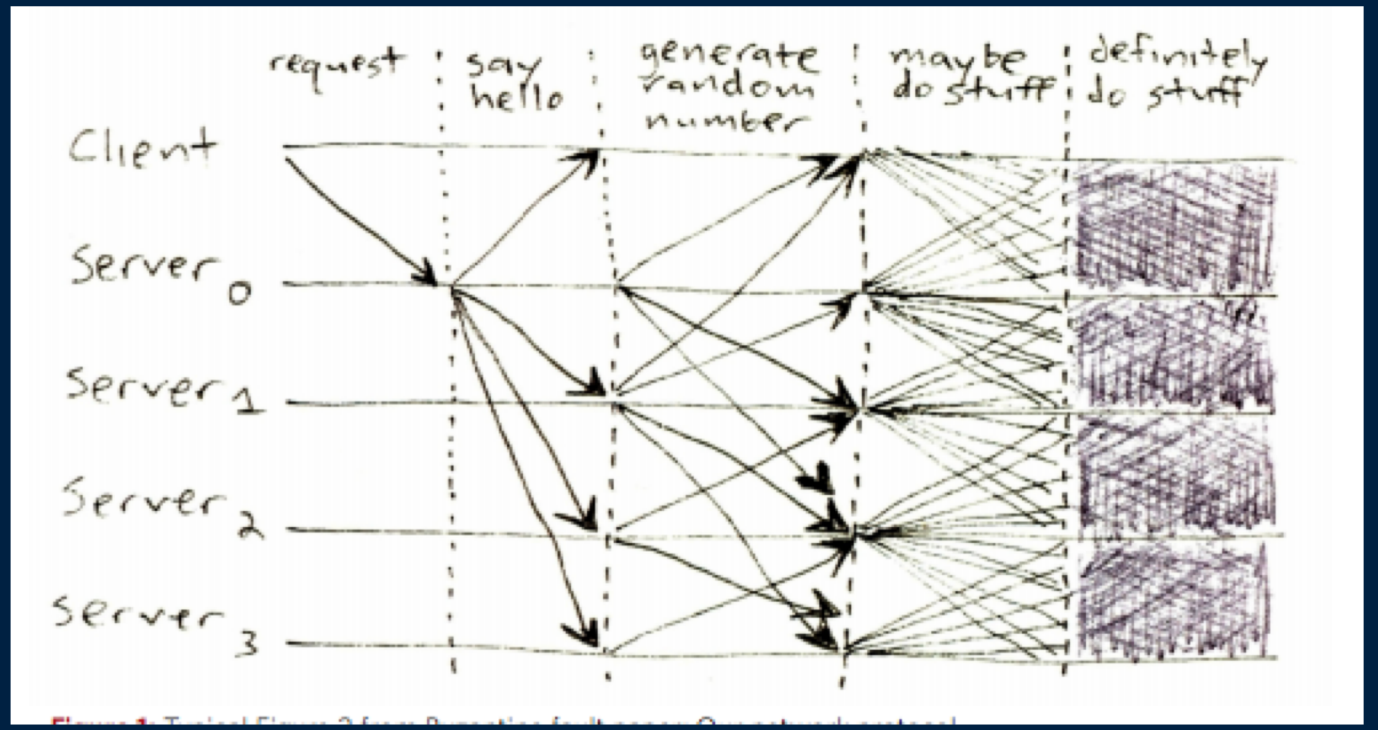
- $n=3f+1$
- authenticated communication channels
- agreement, eventual termination, validity
- partial synchrony
  - eventually known bound Δ
  - safety maintained against asynchrony
  - liveness during synchronous periods

DLS [Dwork Lynch Stockmeyer, 1988]

Landmark in asynchronous BFT agreement solutions



No Liveness

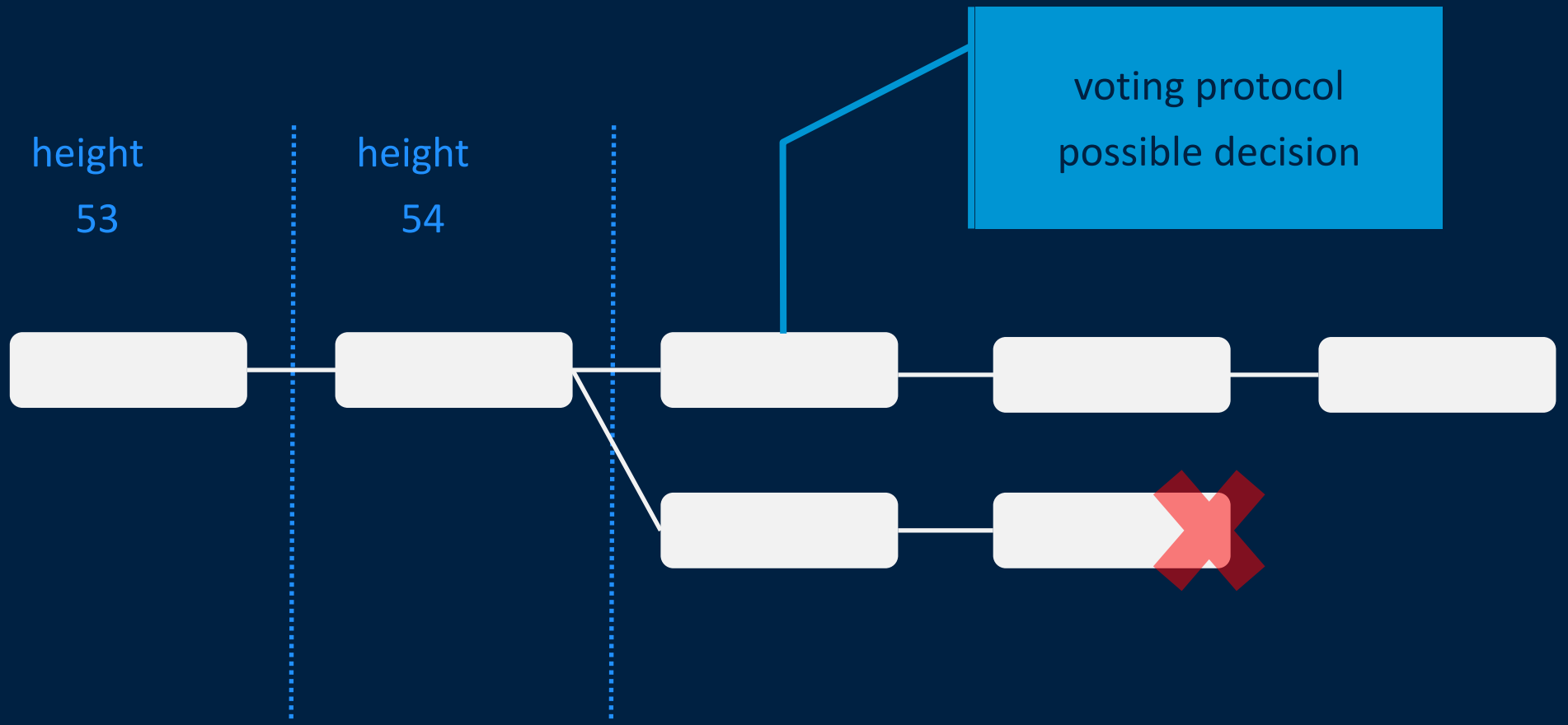


"*The Saddest Moment*" [Mickens 2013]

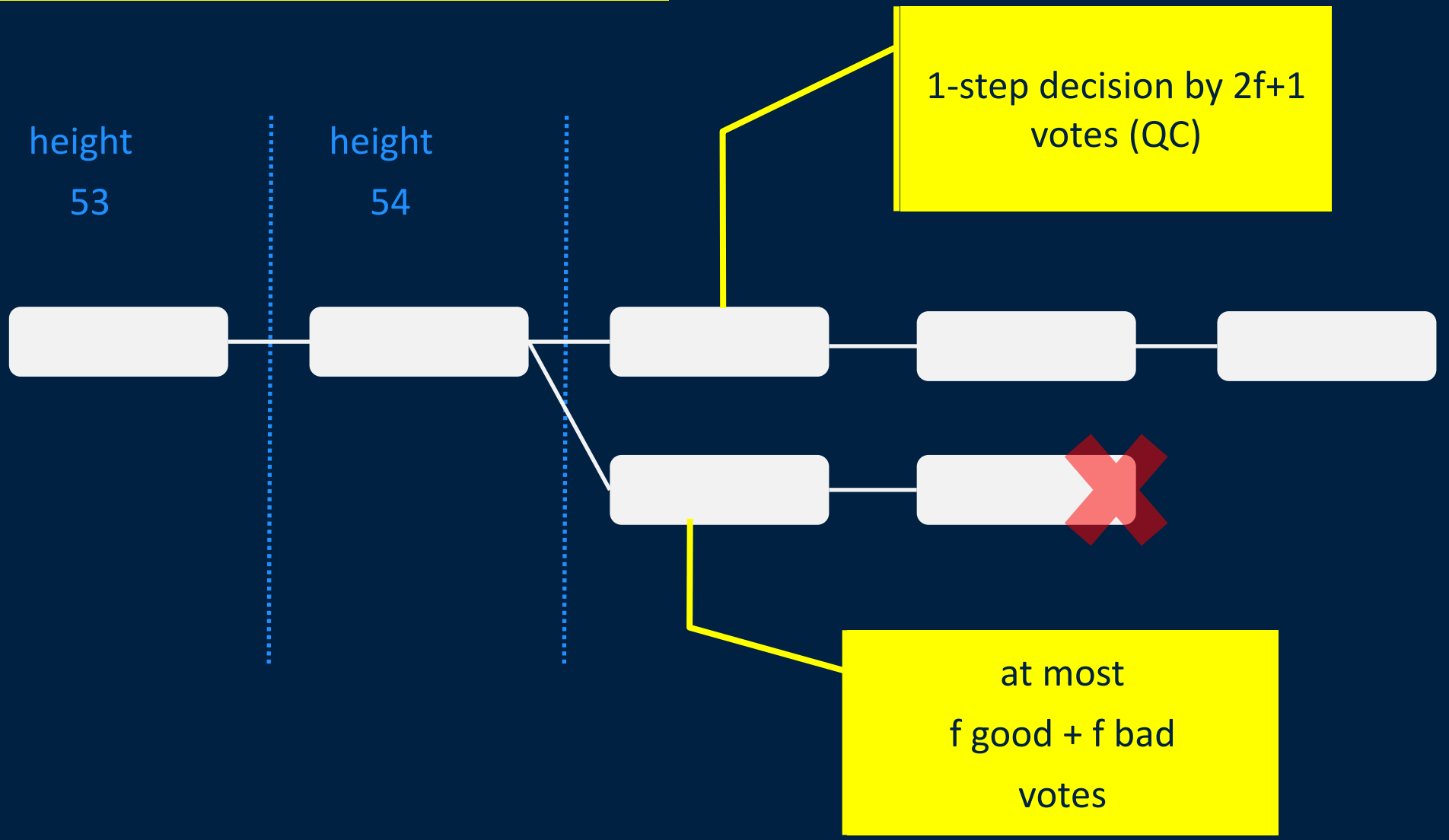
BFT in the Lens of Blockchains

- Tendermint [Buchman, 2016, ``*BFT in the Age of Blockchains*'']
- Casper [Buterin and Griffith 2017, ``*Casper the Friendly Finality Gadget*'']
- Hot-Stuff [AGM 2018, ``*Hot-Stuff the Linear One-Message BFT Devil*'']

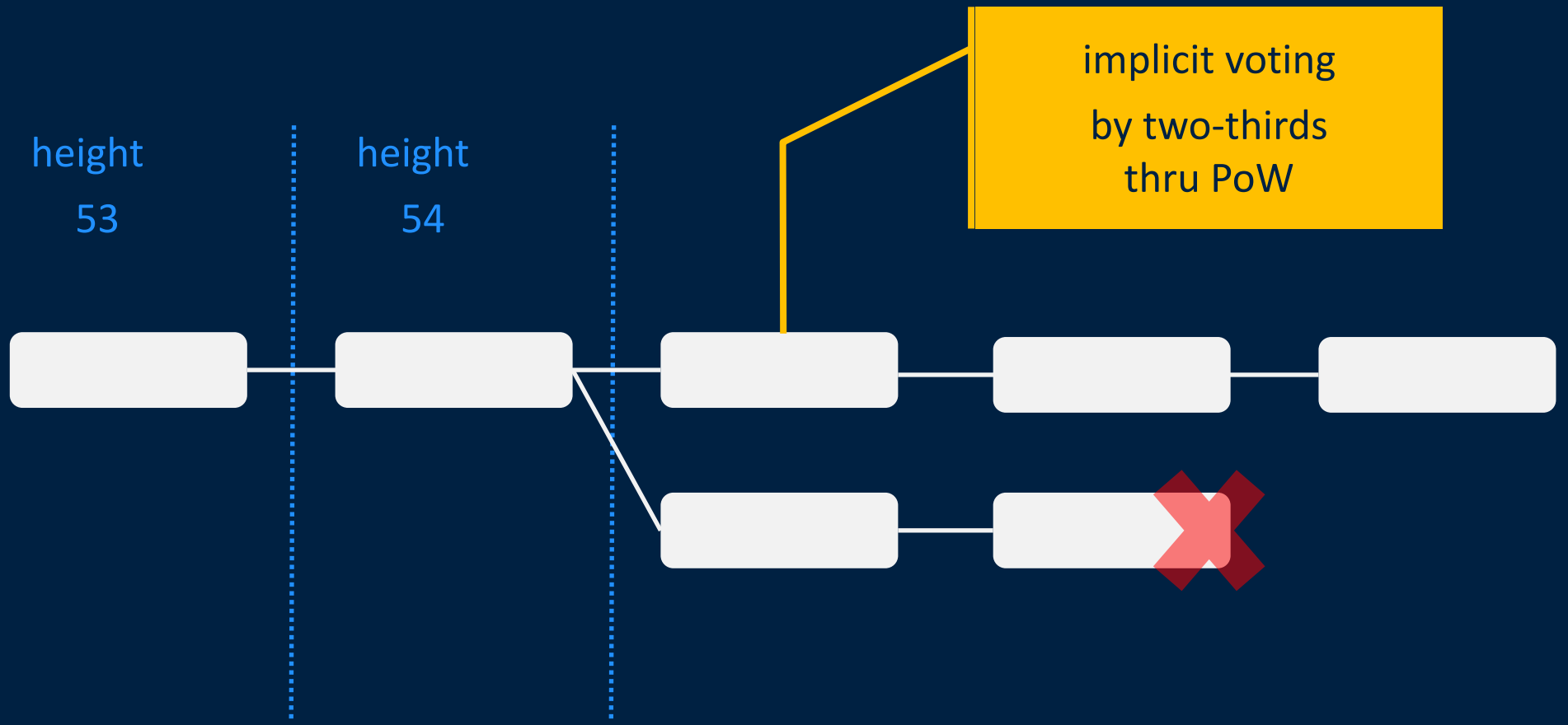
BFT in the lens of Blockchains



DLS in the lens of Blockchains



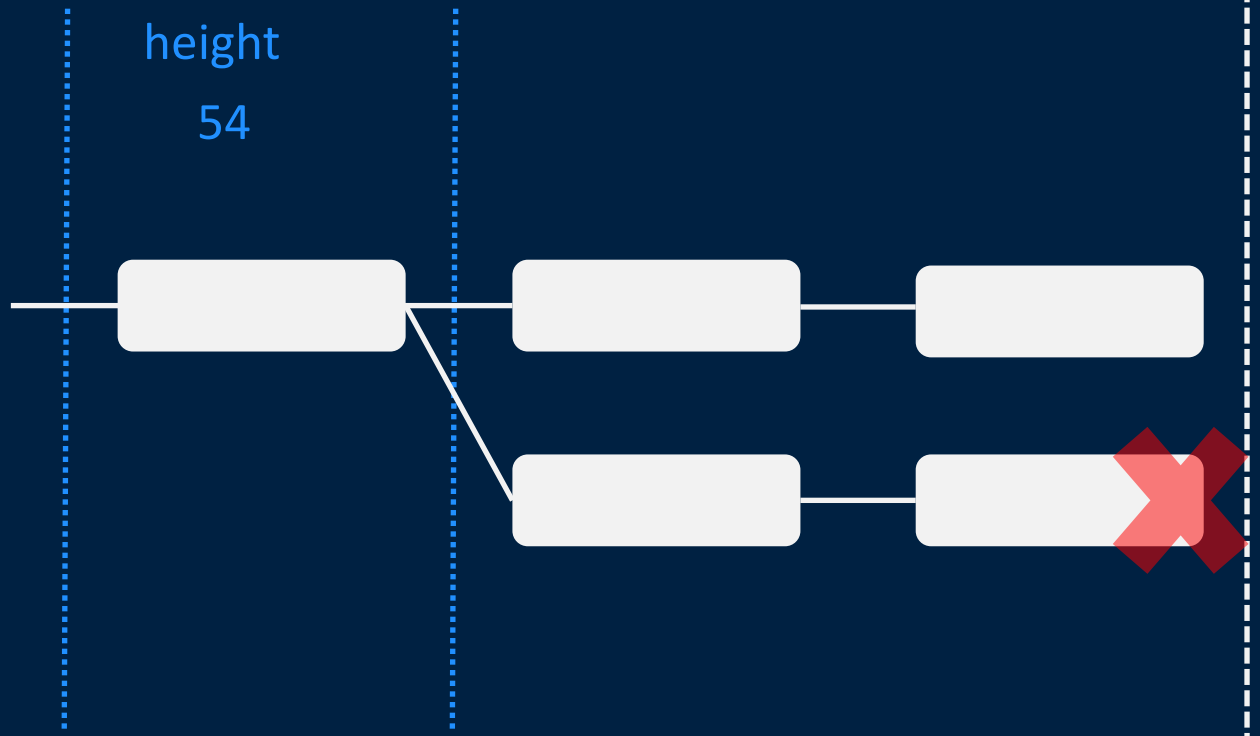
Blockchains in the lens of BFT



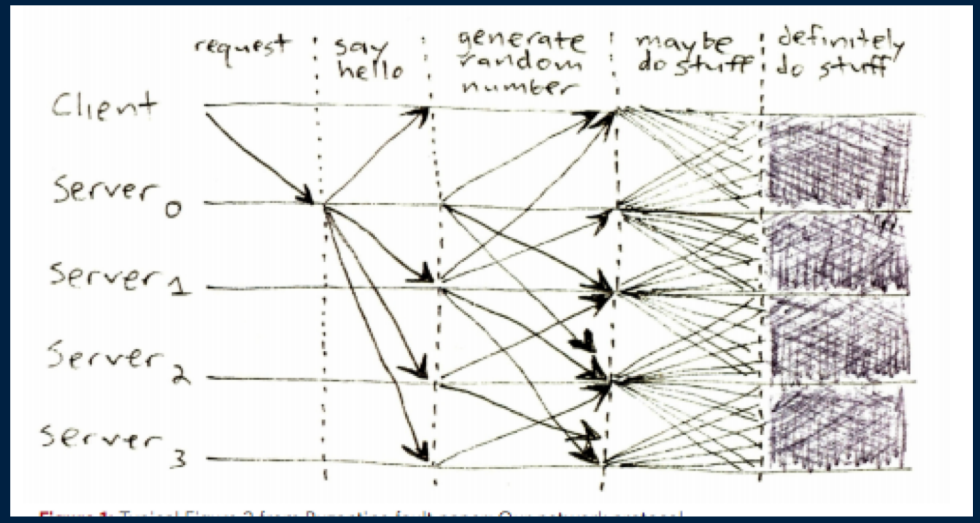
after

height

54



before



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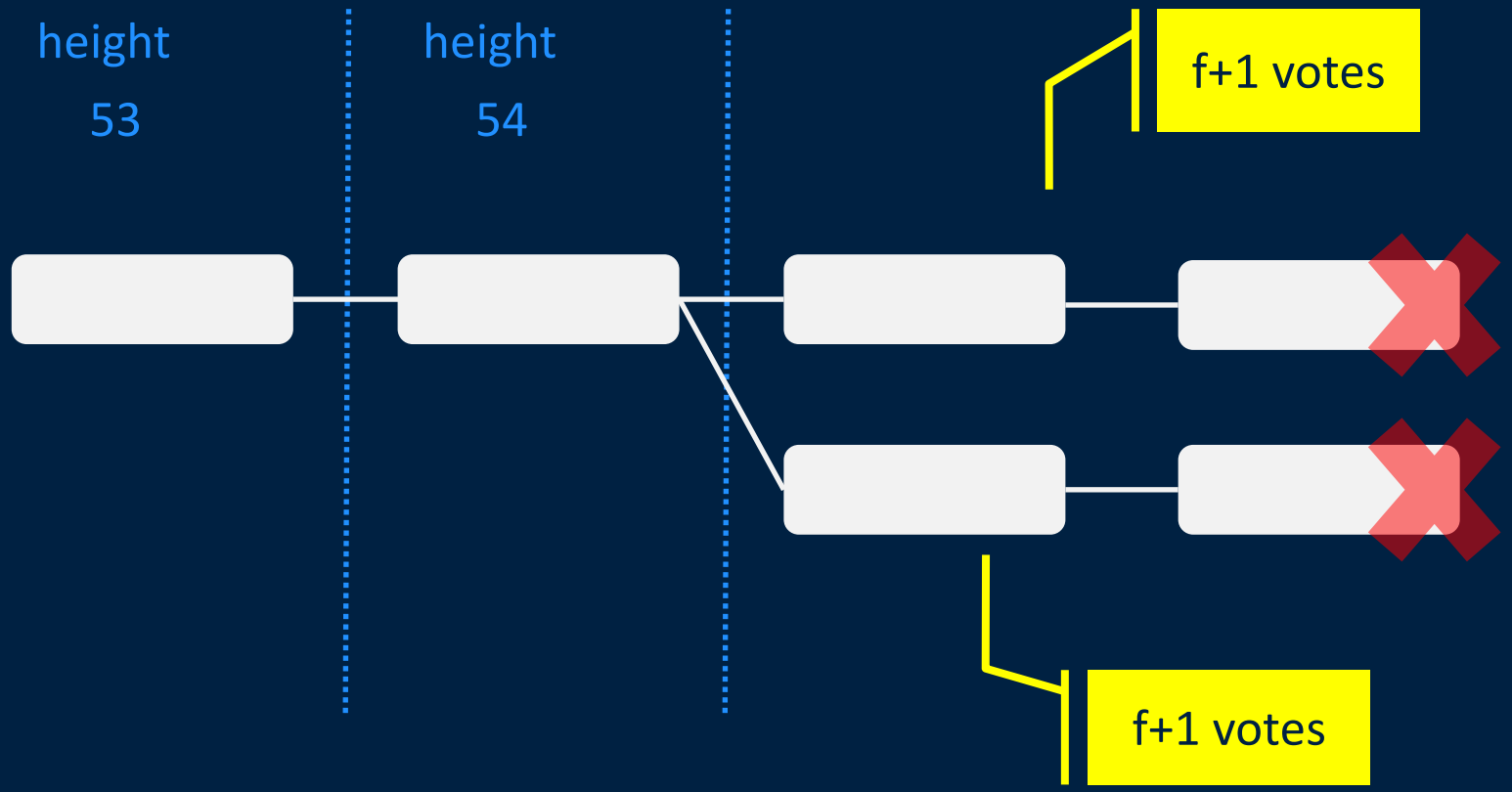
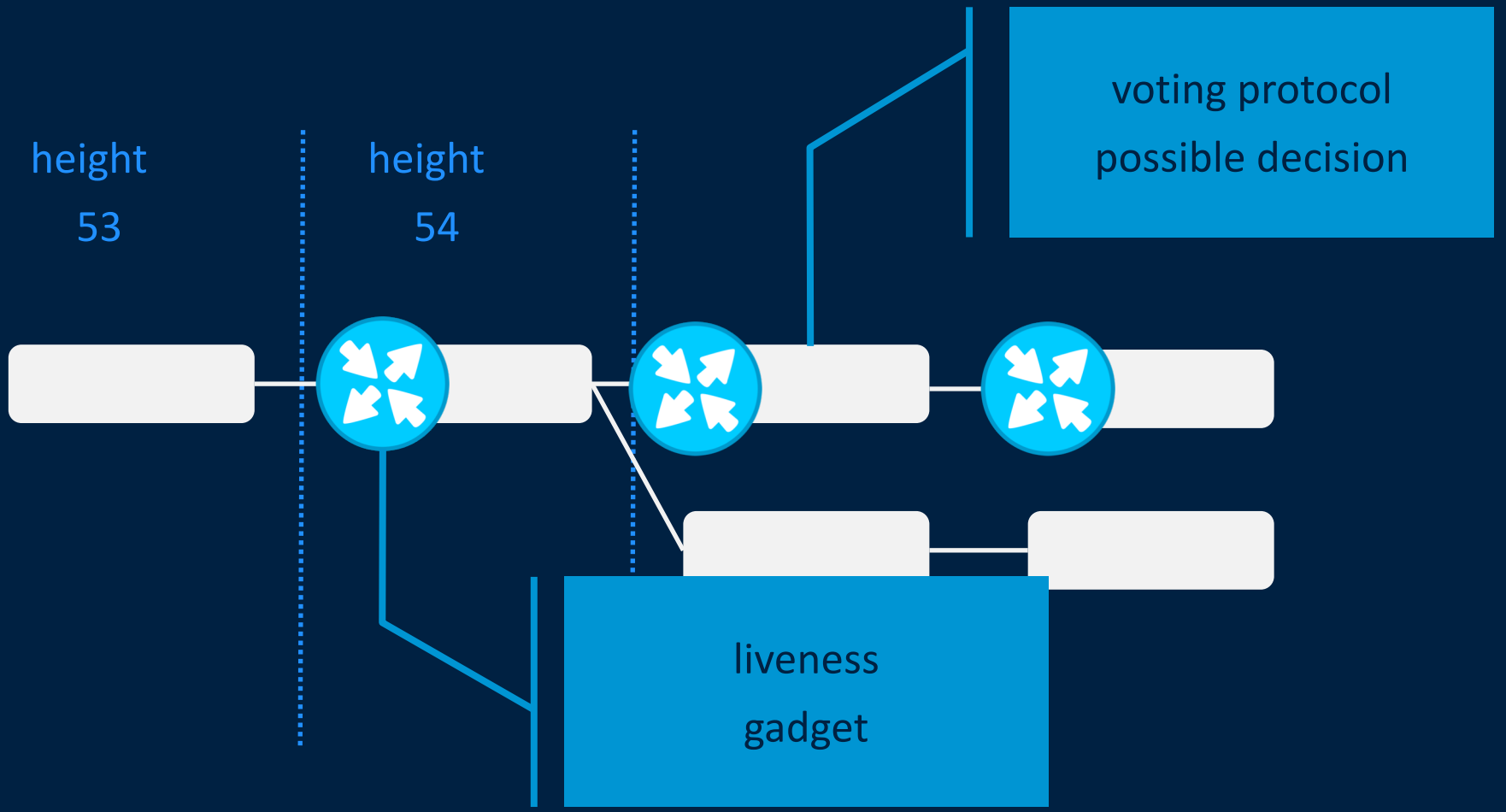


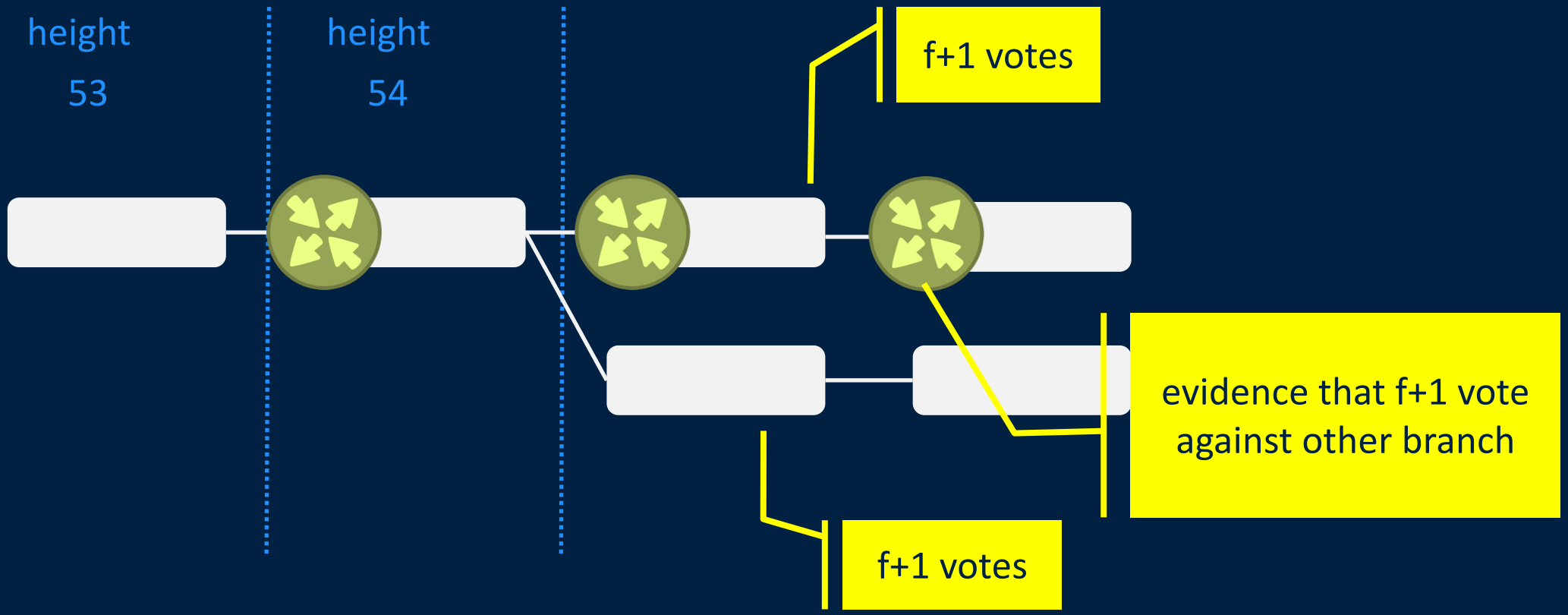
BFT in the lens of Blockchains



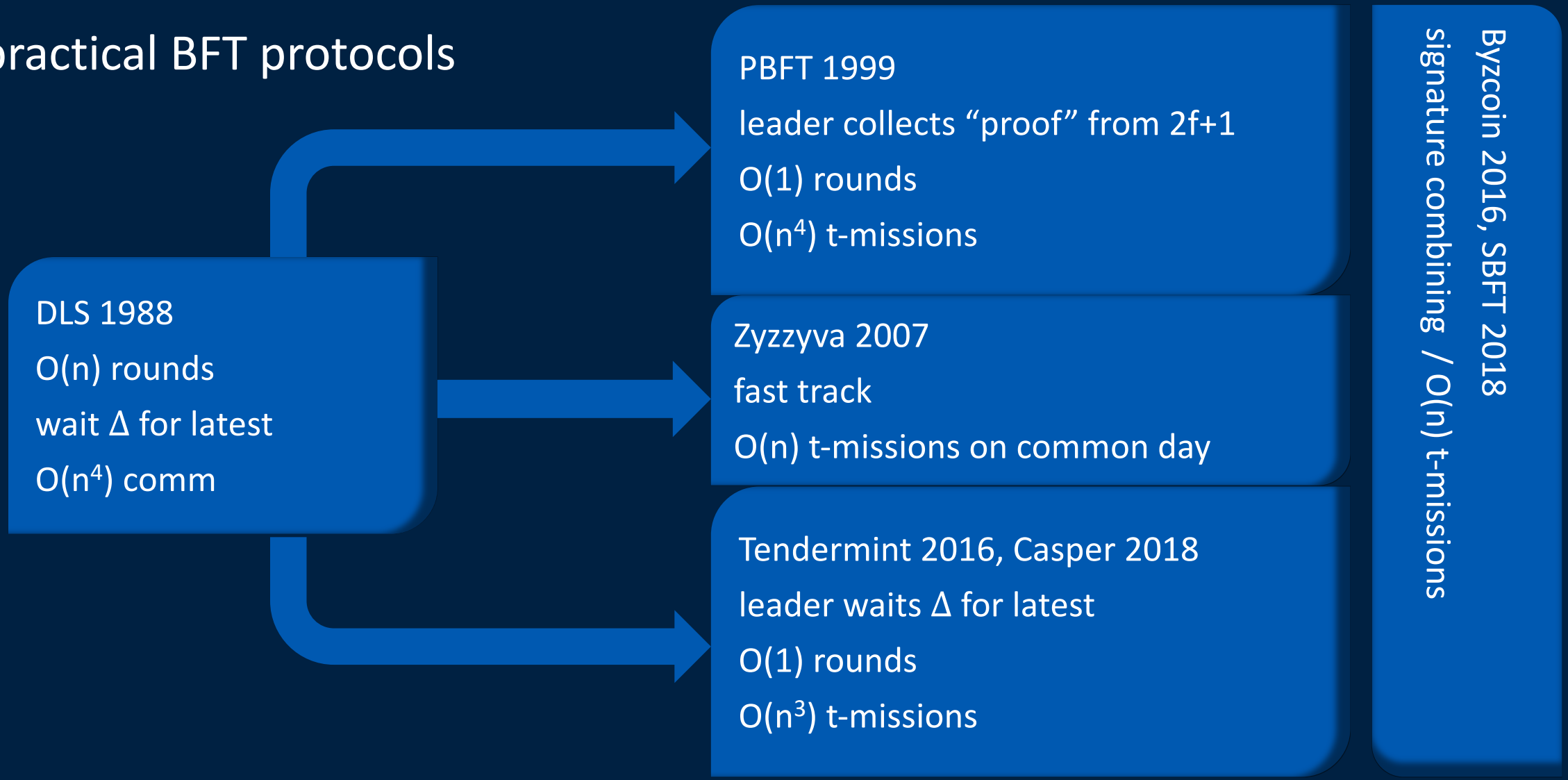
Liveness Gadgets

- when can you guarantee progress?
  - proposer extends a safe branch
  - no correct replica locked on a different branch
  - synchronous communication with proposer

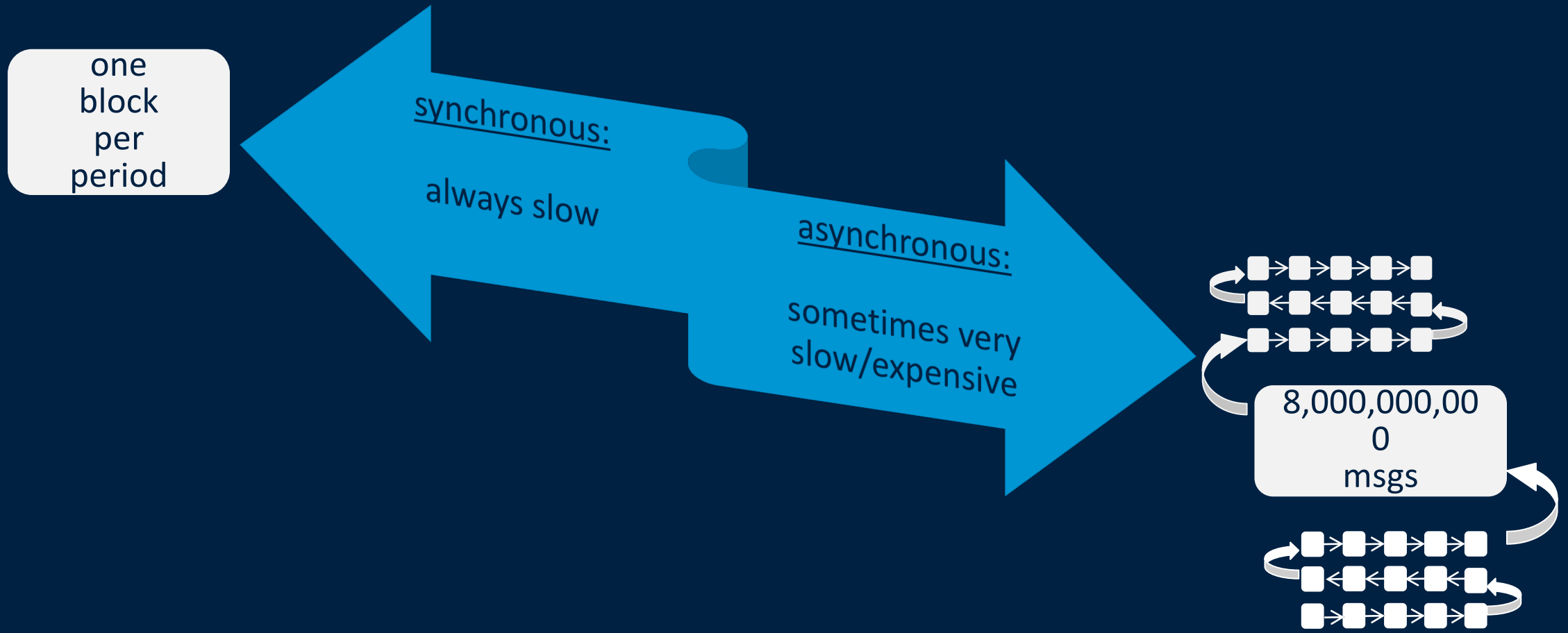
DLS in the lens of Blockchains



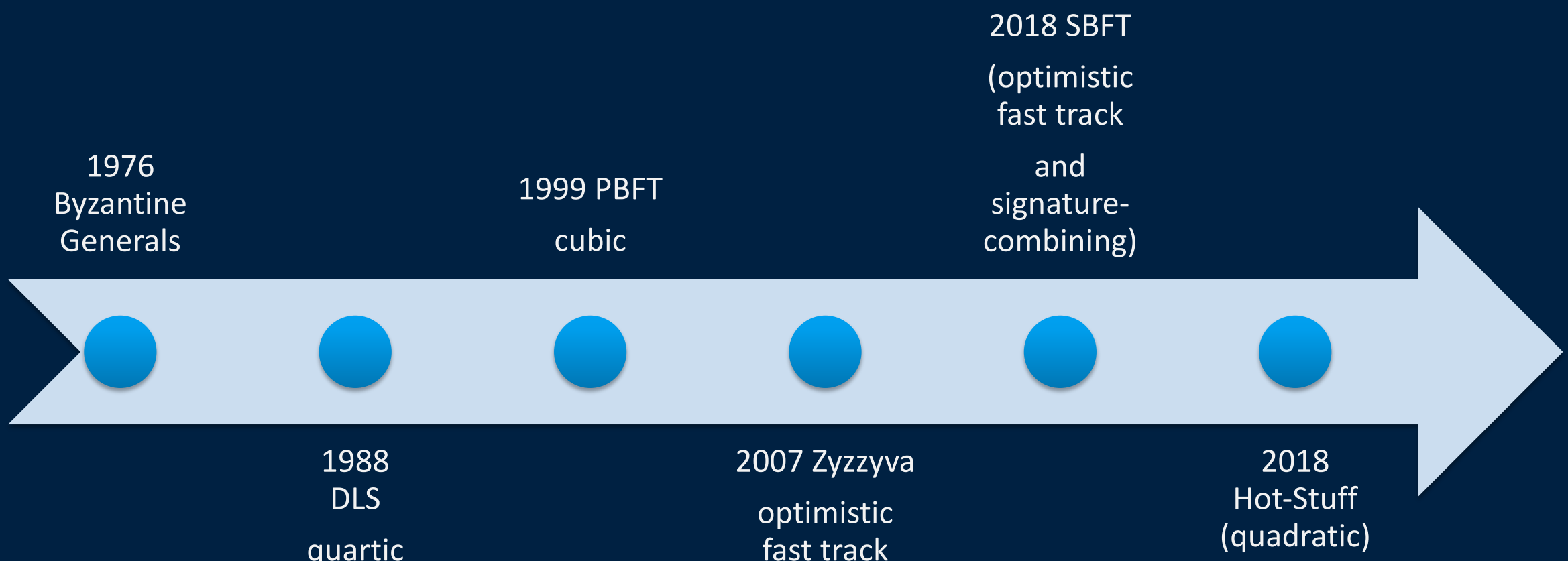
practical BFT protocols



Current conundrum



Are we decentralized yet?



Abstract

In this note, we observe a safety violation in Zyzzyva [7, 9, 8] and a liveness violation in FaB [14, 15]. To demonstrate these issues, we require relatively simple scenarios, involving only four replicas, and one or two view changes. In all of them, the problem is manifested already in the first log slot.

Revisiting Fast Practical Byzantine Fault Tolerance

Ittai Abraham, Guy Gueta, Dahlia Malkhi
VMware Research

with:
Lorenzo Alvisi (Cornell),
Rama Kotla (Amazon),
Jean-Philippe Martin (Verily)

December 6, 2017

Abstract

In this note, we observe a safety violation in Zyzzyva [7, 9, 8] and a liveness violation in FaB [14, 15]. To demonstrate these issues, we require relatively simple scenarios, involving only four replicas, and one or two view changes. In all of them, the problem is manifested already in the first log slot.

message pattern, but votes for a *nil* block.

Tendermint as originally described by Buchman [13] suffers from a livelock bug, pertaining to locking and unlocking votes by validators in the protocol. However, the protocol contains additional mechanisms not described in the cited report that prevent the livelock from occurring [14]. While it appears to be sound, the Tendermint protocol and its implementation are still subject to a thorough, peer-reviewed correctness analysis.

Blockchain Consensus Protocols in the Wild

Christian Cachin Marko Vukolić
IBM Research - Zurich

faults have received gaining confidence in the resilience of a consensus protocols exposed to faults and adversarial nodes. We advocate to follow the established practice in cryptography and computer security, relying on public reviews, detailed models, and formal proofs; the designers of several practical systems appear to be unaware of this. Moreover, we review the consensus proto-

A Byzantine Fault-Tolerant Ordering Service for the Hyperledger Fabric Blockchain Platform

João Sousa *Alysson Bessani*
LaSIGE, Faculdade de Cincias, Universidade de Lisboa
Marko Vukolić
IBM Research Zurich

Abstract

Hyperledger Fabric (HLF) is a flexible permissioned blockchain platform designed for business applications beyond the basic digital coin addressed by Bitcoin and other existing networks. A key property of HLF is its extensibility, and in particular the support for multiple ordering services for building the blockchain. Nonetheless, the version 1.0 was launched in early 2017 without an implementation of a Byzantine fault-tolerant (BFT) ordering service. To overcome this limitation, we designed,

chaincode) and pluggable services [26]. The support for pluggable components, gives the HLF an unprecedented level of extensibility, and in particular the support for multiple ordering services for writing transactions on the blockchain. Despite of that, the version 1.0 (launched in early 2017) comes without any Byzantine fault-tolerant (BFT) ordering service, supporting only crash tolerance

Quorum

Quorum is an Ethereum-based distributed ledger protocol with transaction/contract privacy and new consensus mechanisms.

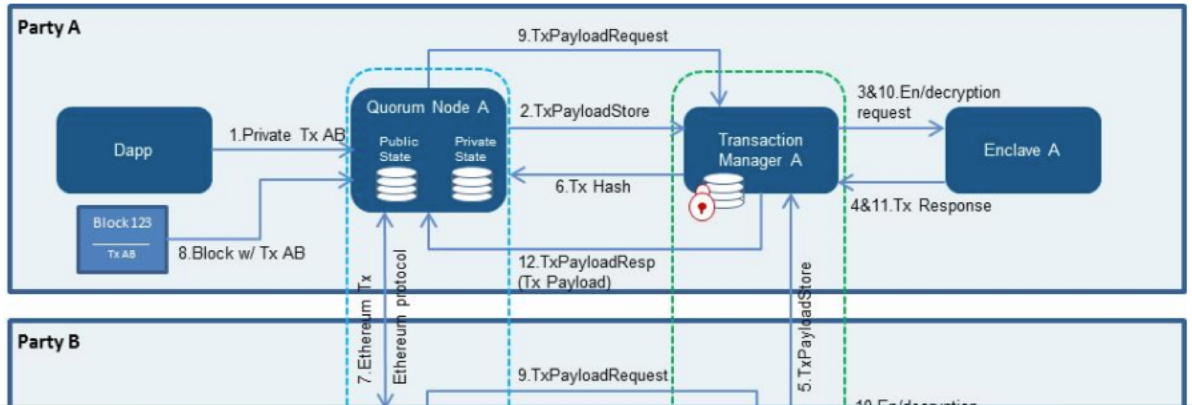
Quorum is a fork of go-ethereum and is updated in line with go-ethereum releases.

Key enhancements over go-ethereum:

- **Privacy** - Quorum supports private transactions and private contracts through public/private state separation and utilising Constellation, a peer-to-peer encrypted message exchange for directed transfer of private data to network participants
- **Alternative Consensus Mechanisms** - with no need for POW/POS in a permissioned network, Quorum instead offers multiple consensus mechanisms that are more appropriate for consortium chains:
  - **Raft-based Consensus** - a consensus model for faster blocktimes, transaction finality, and on-demand block creation
  - **Istanbul BFT** - a PBFT-inspired consensus algorithm with transaction finality, by AMIS.
- **Peer Permissioning** - node/peer permissioning using smart contracts, ensuring only known parties can join the network
- **Higher Performance** - Quorum offers significantly higher performance than public geth

Note: The QuorumChain consensus algorithm is not yet supported by this release.

Architecture



SBFT

200 WAN nodes, 2 months of Ethereum contracts

Tput:170/sec

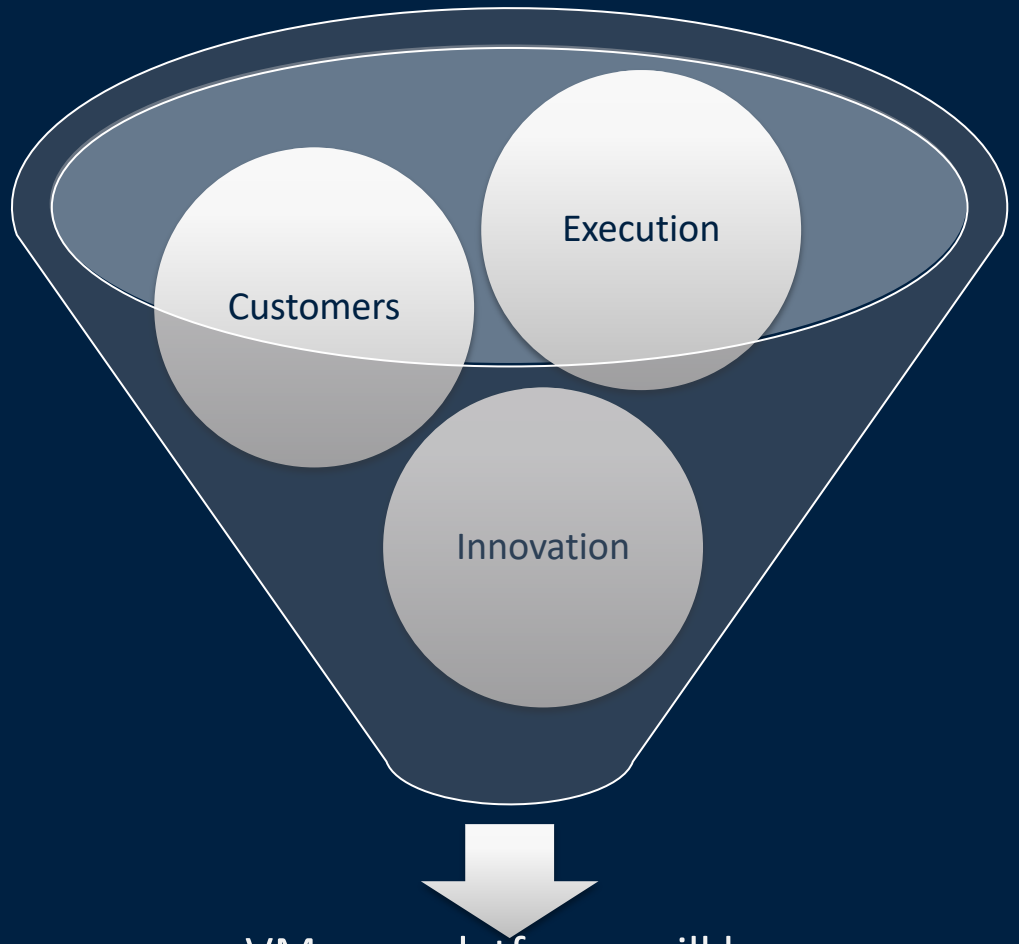
30x ETH

Latency: 600 ms

24x ETH

1000x XBT

VMware Blockchain



VMware platforms will be

The best place to run blockchain software

Thank You