Scaling distributed ledgers and privacy-preserving applications

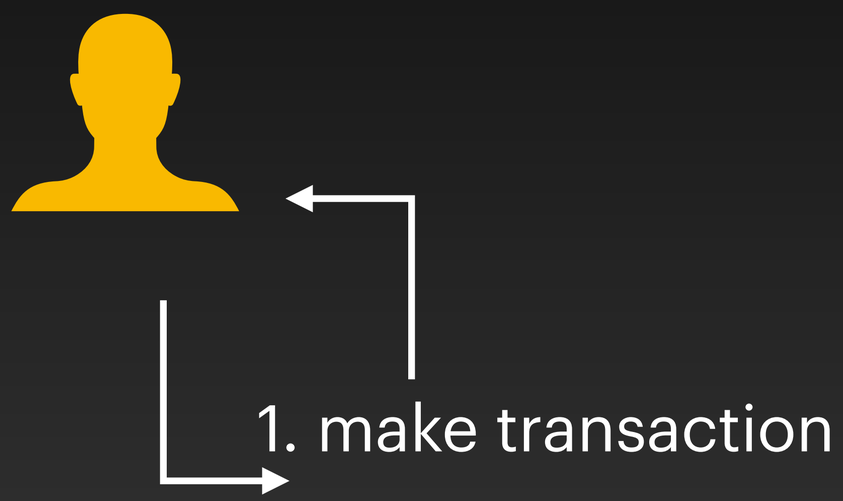
PhD Defense

Alberto Sonnino

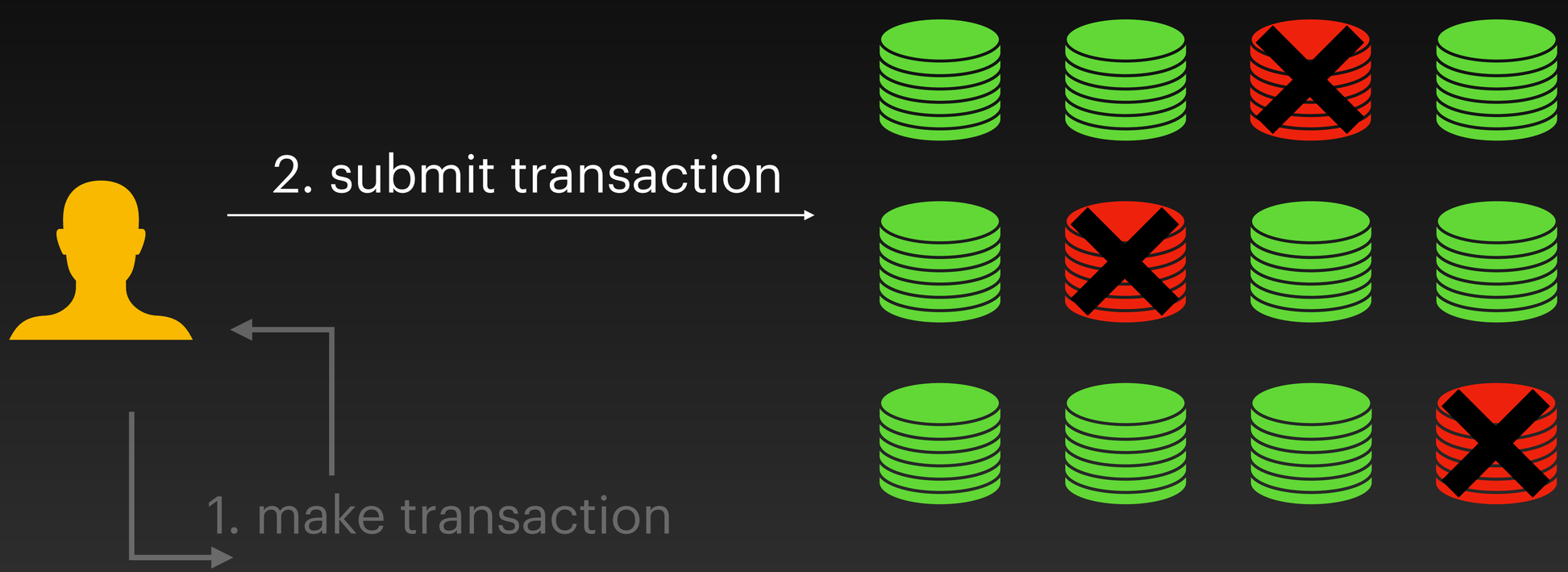
A set of nodes

… Some of which are bad

Blockchains

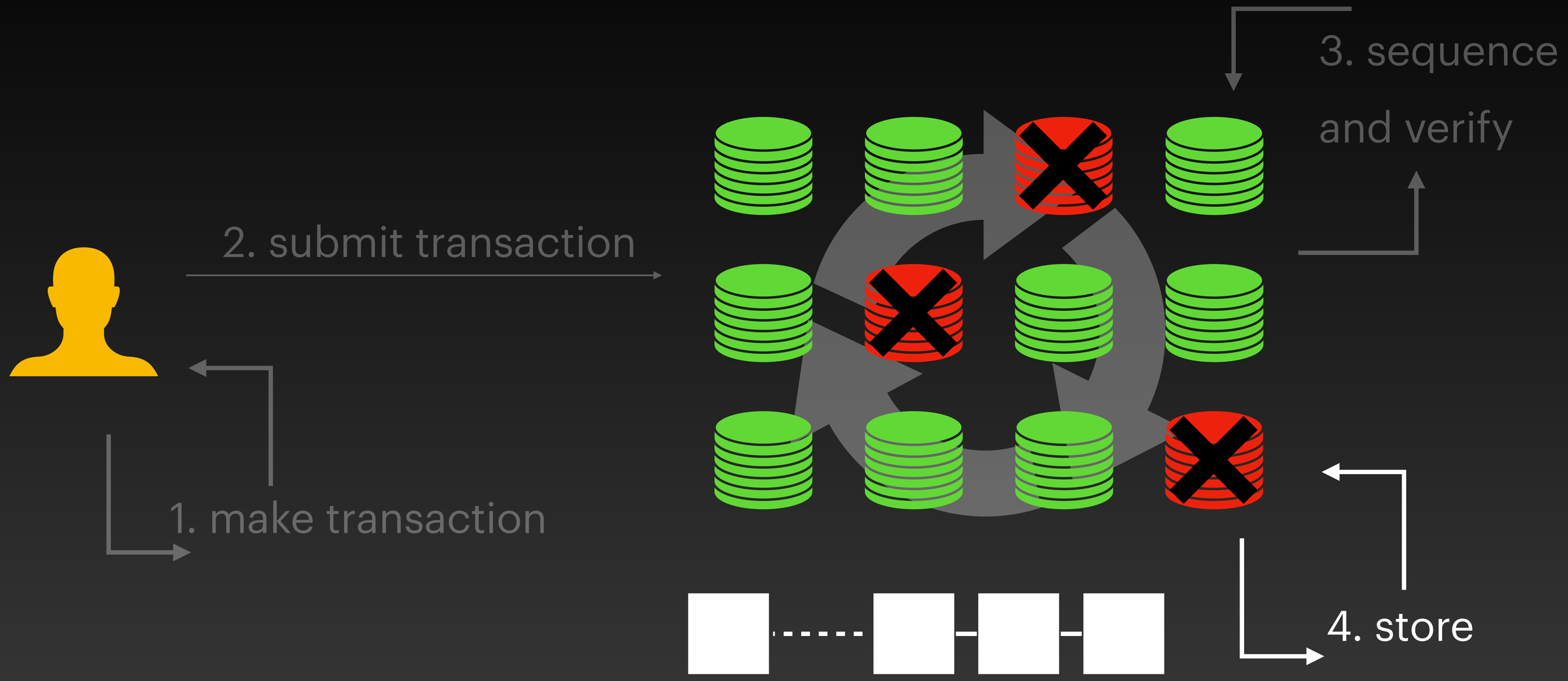


Blockchains



Blockchains

Blockchains



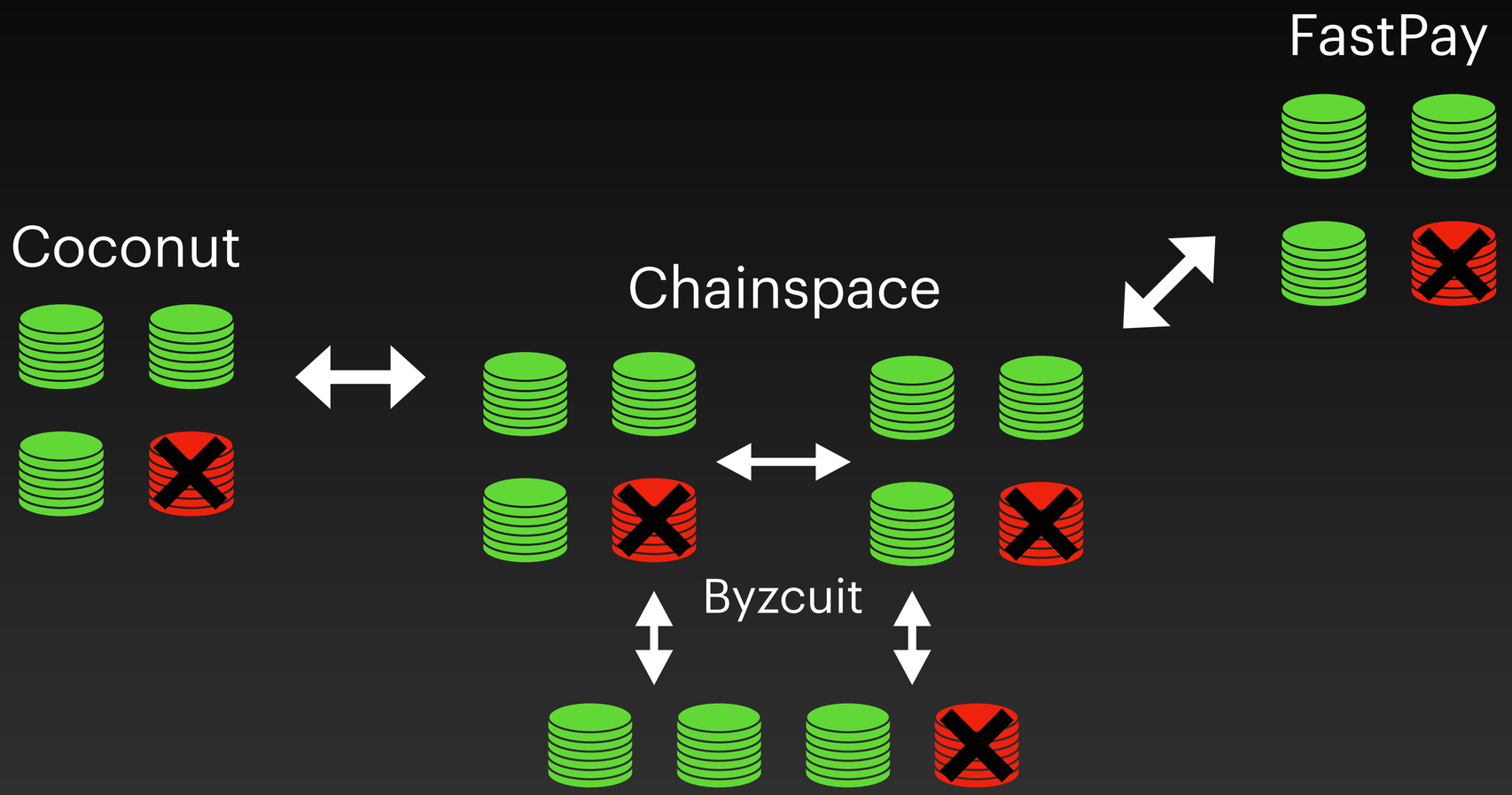
Low throughput

High latency

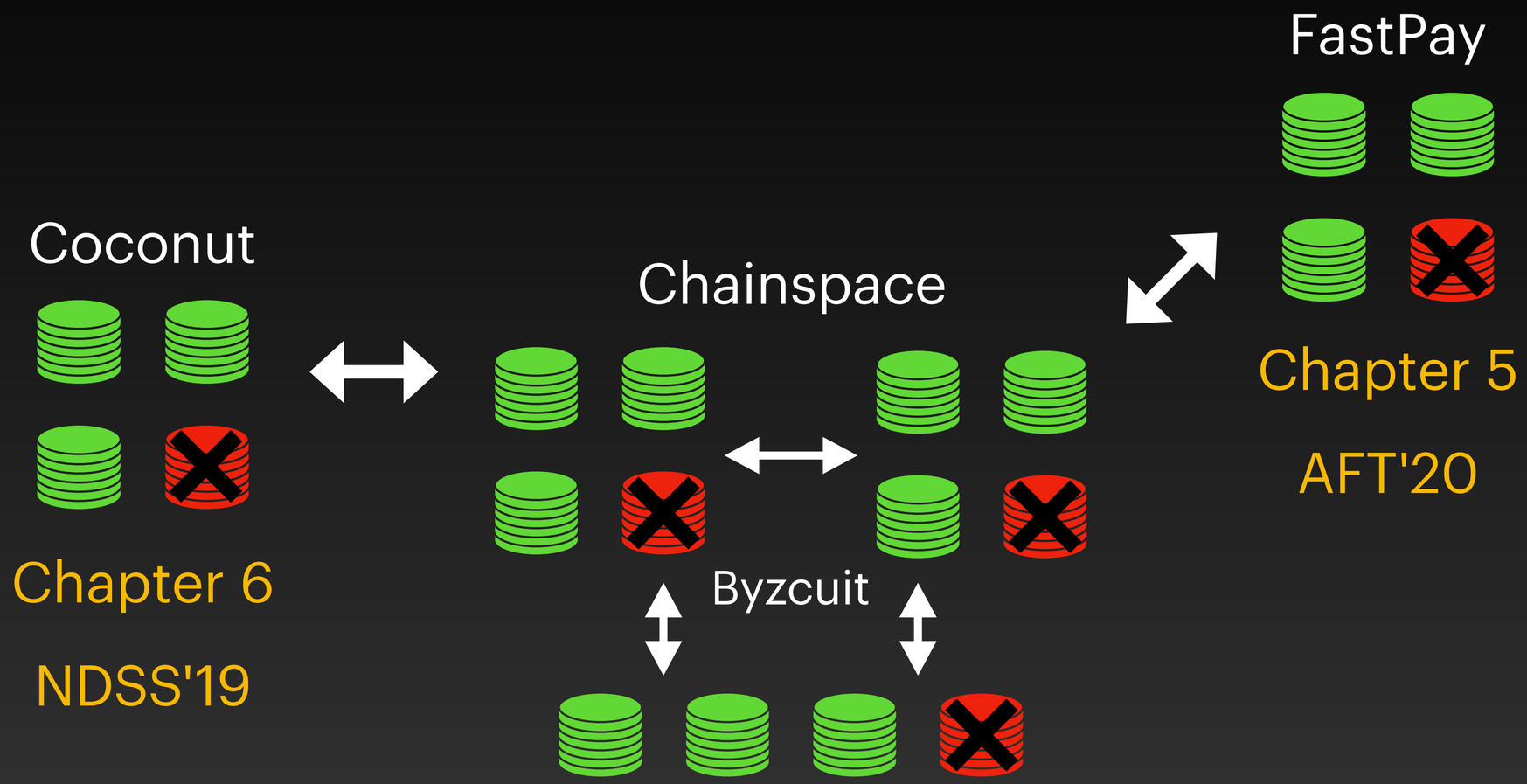
Slow finality

Poor privacy

Overview



Overview


FastPay
Coconut
Chainspace
Chapter 5
AFT'20
Chapter 6
NDSS'19
Byzcuit
Chapter 3 & 4
NDSS'18 & EuroS&P'20

Chainspace & Byzcuit

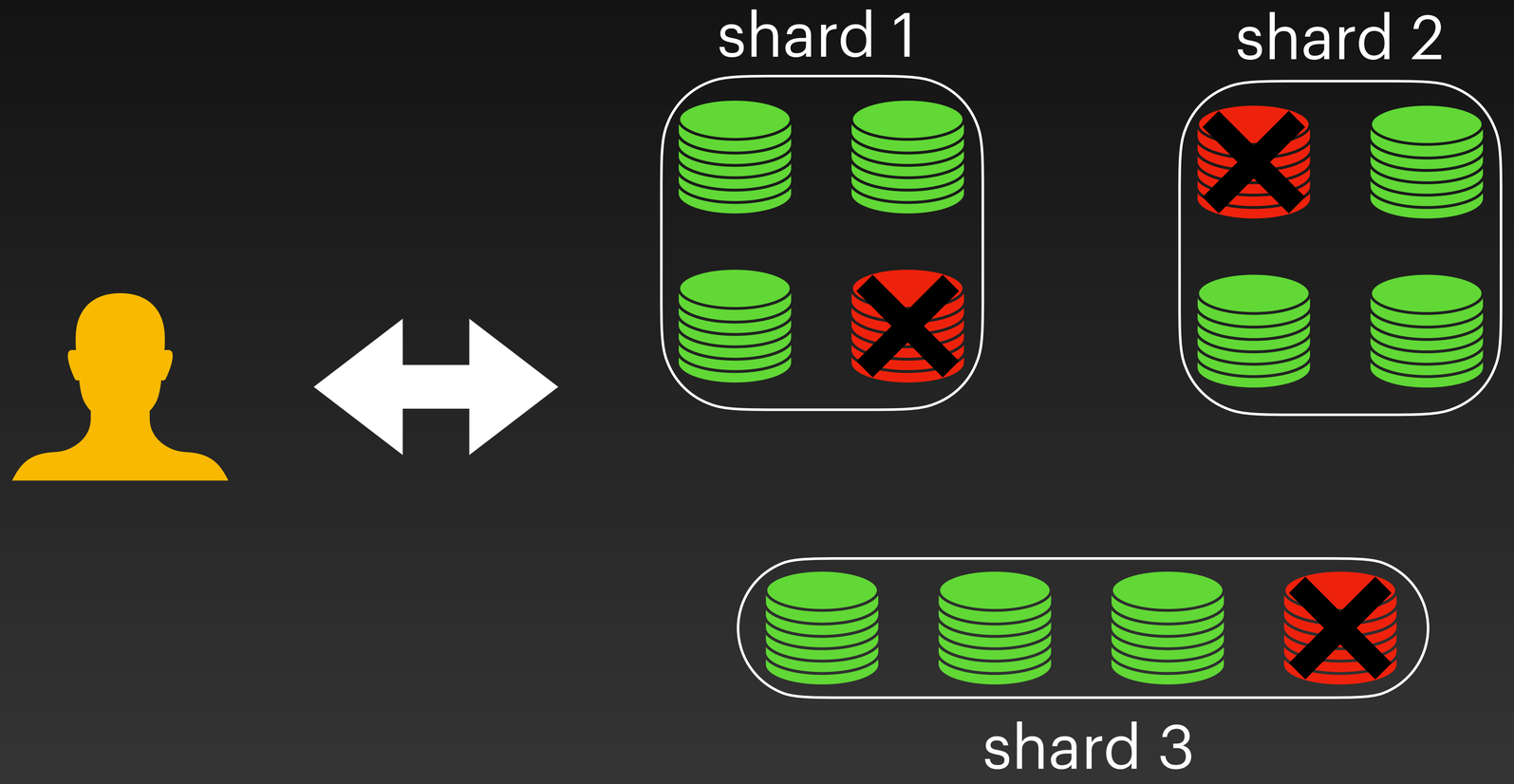
A scalable backbone with integrated privacy support

Chainspace

State sharding

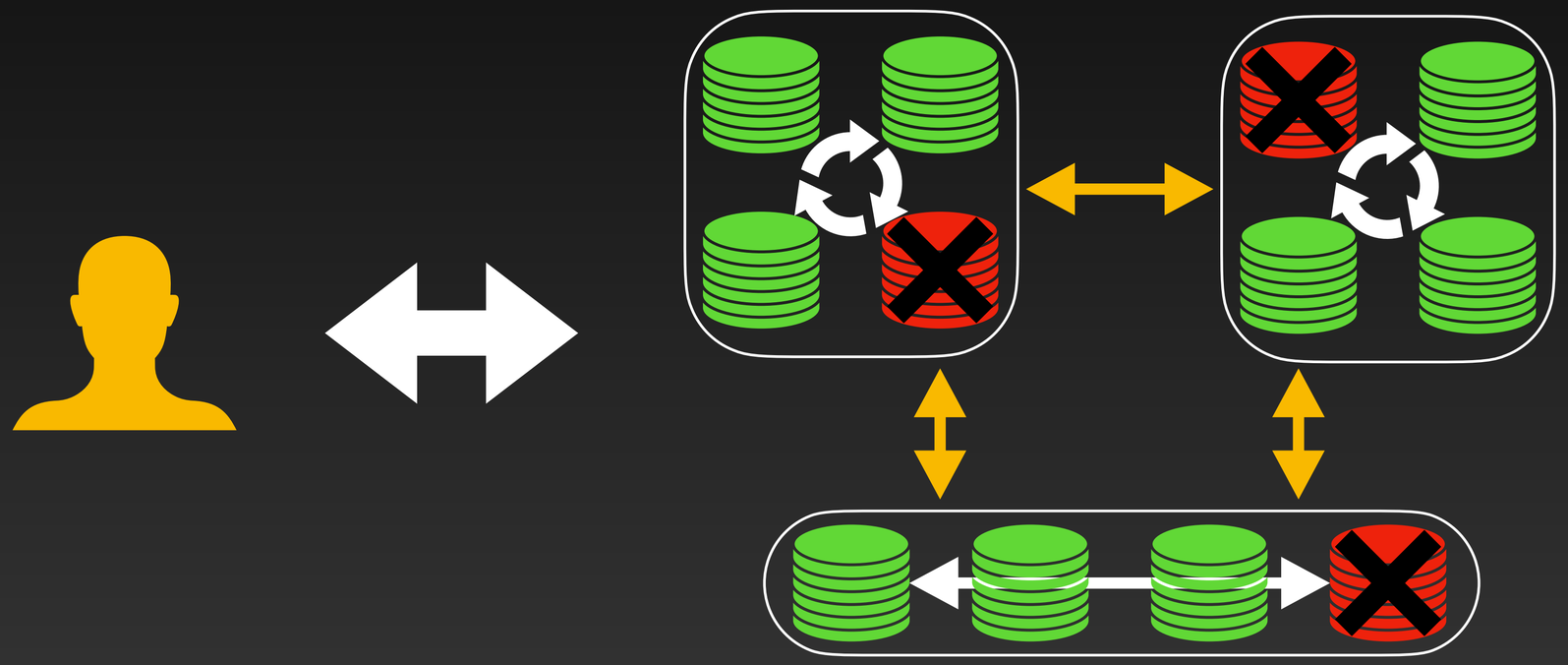
Chainspace

State sharding



Byzcuit

Cross-shard consensus protocol



Privacy by Design

procedure

checker

Privacy by Design

procedure

(make zk-proof)

checker

(verify zk-proof)

High throughput

Low latency

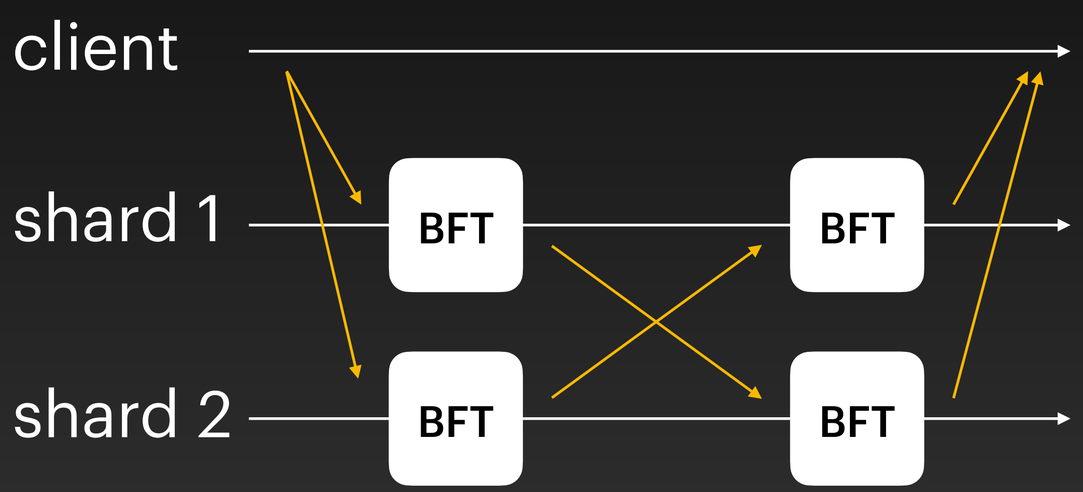
Fast finality

Good privacy

FastPay

A low-latency payment system

What we have so far



Total Latency:

slowest shard during phase 1

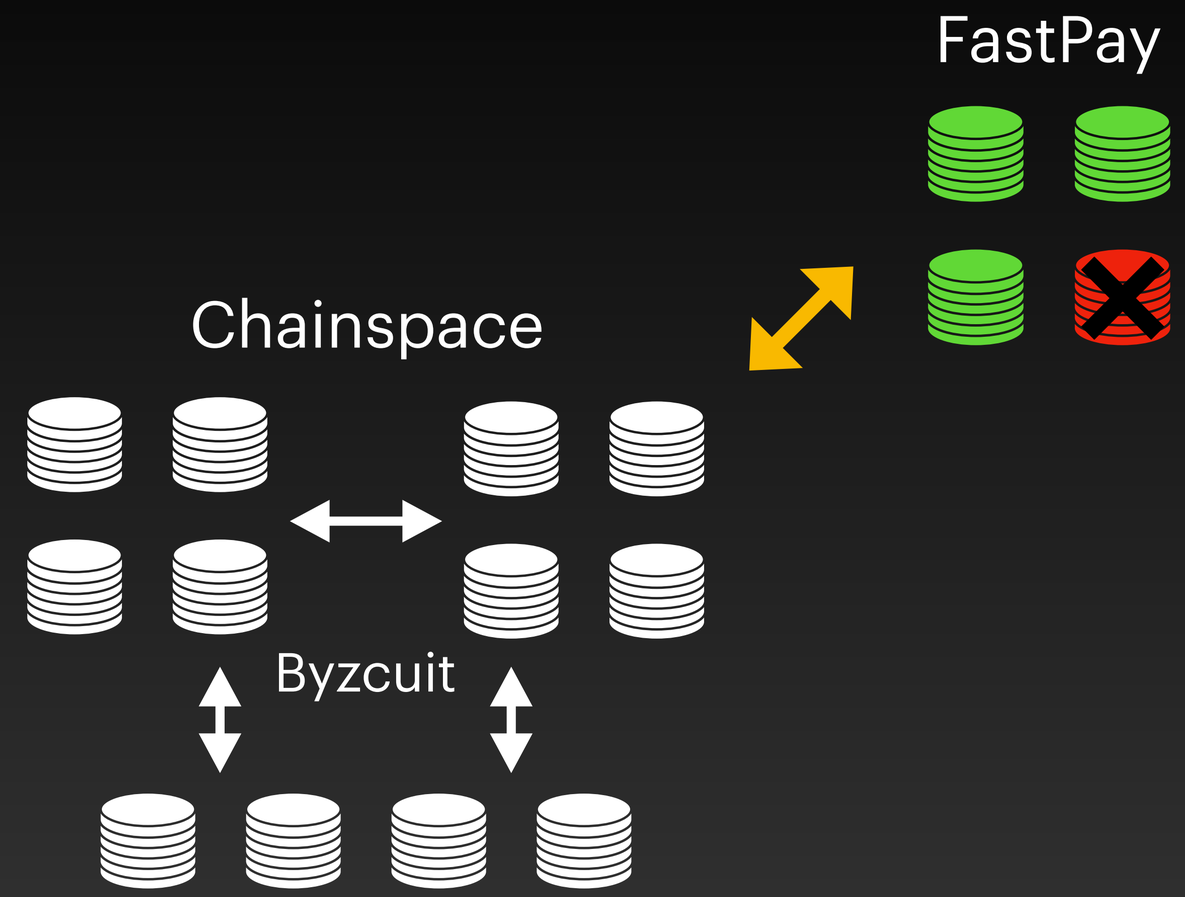
+

slowest shard during phase 2

+

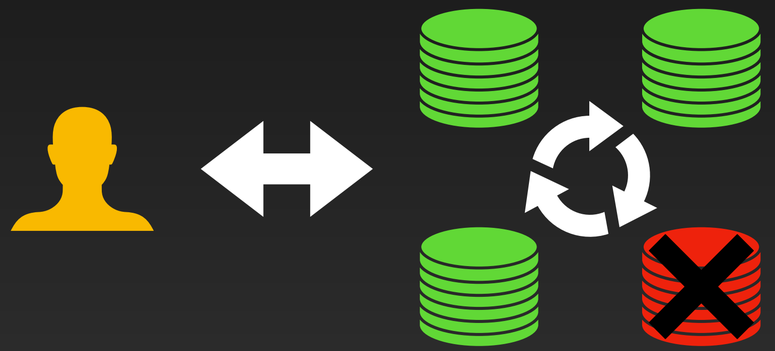
all communications

Overview



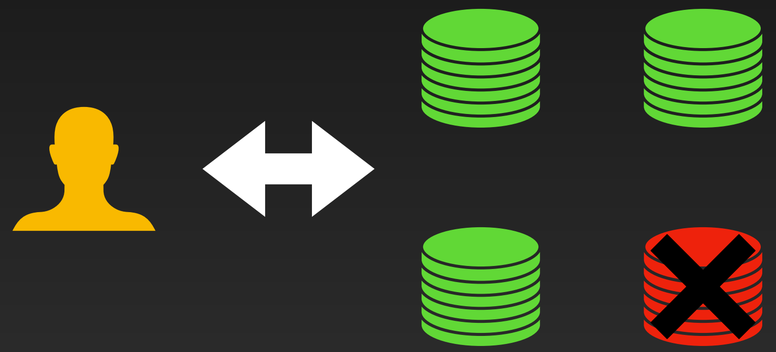
Difference with blockchains

Blockchains



Byzantine Consensus

FastPay



Byzantine Consistent Broadcast

High throughput

Low latency

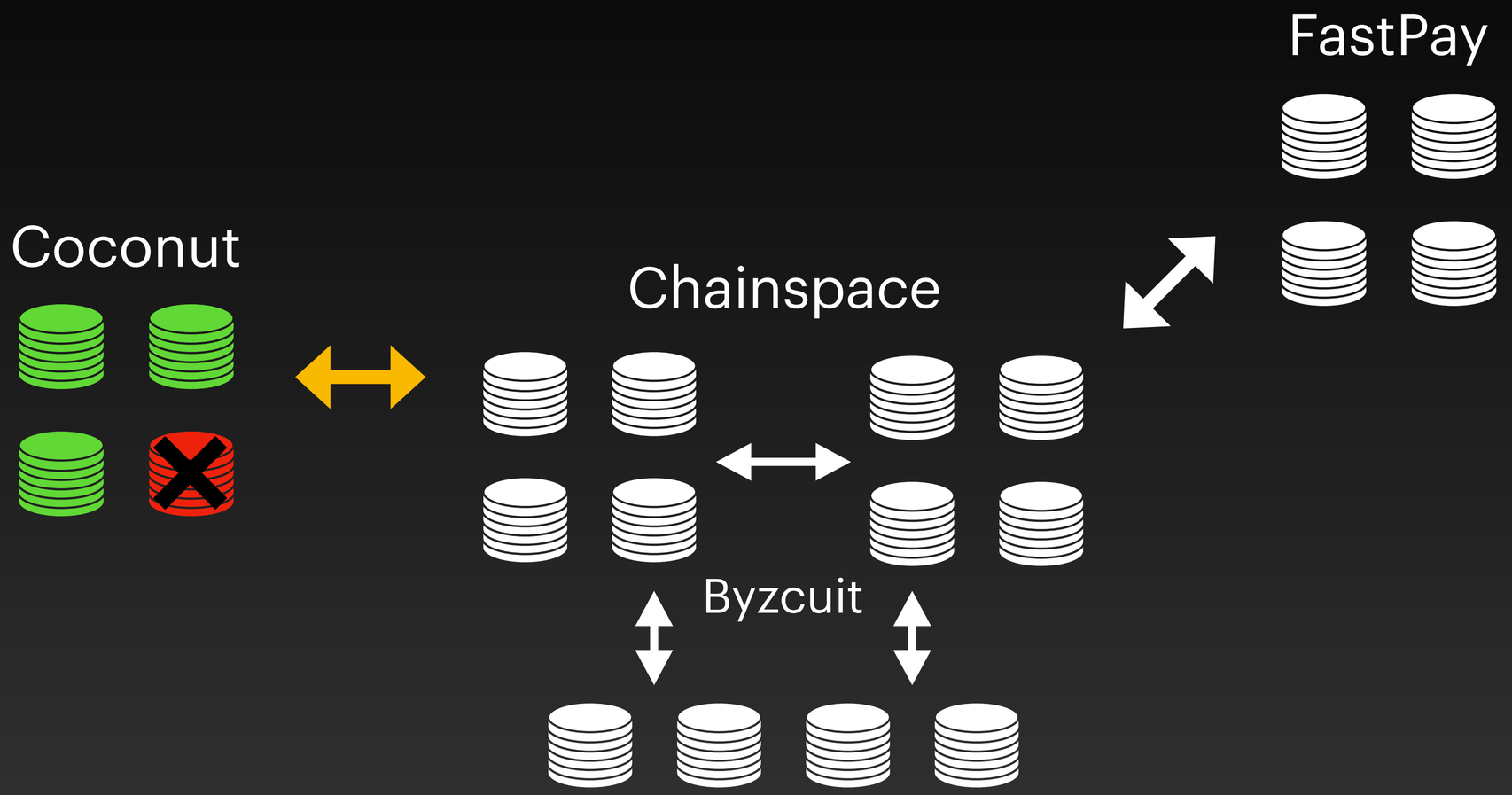
Fast finality

Good privacy

Coconut

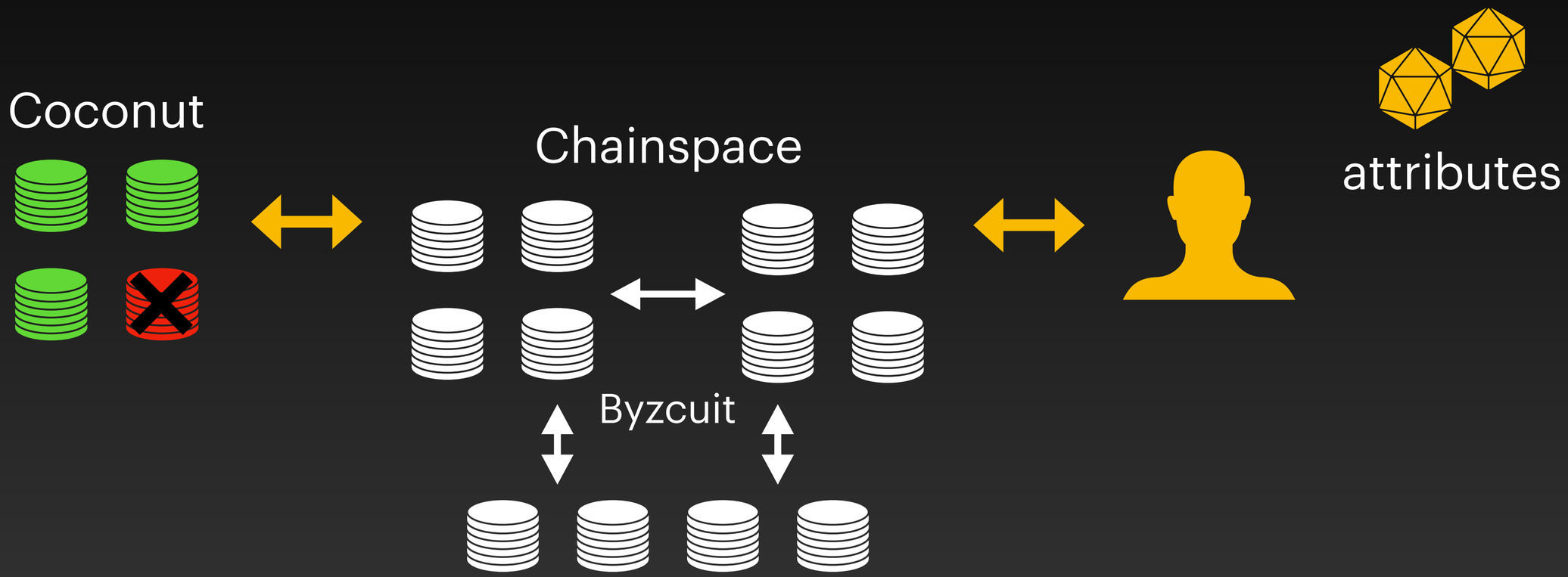
Privacy-preserving credentials for smart contract applications

Overview



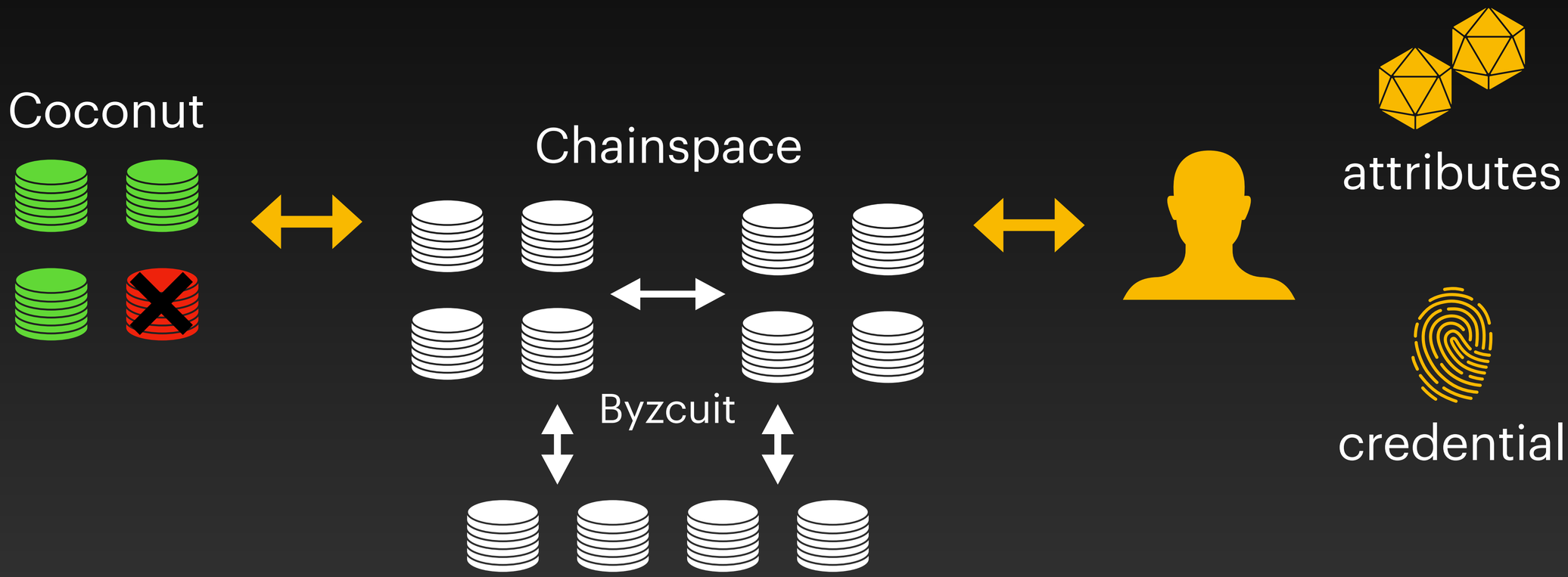
Coconut

Anonymous credentials in a blockchain setting



Coconut

Anonymous credentials in a blockchain setting



High throughput

Low latency

Fast finality

Good privacy

15. Fraud Proofs: Maximising Light Client Security and Scaling Blockchains with Dishonest Majorities

Mustafa Al-Bassam, **Alberto Sonnino**, Vitalik Buterin, Ismail Khoffi, Financial Cryptography and Data Security (FC), 2021

14. EL PASSO: Privacy-preserving, Asynchronous Single Sign-On

Zhiyi Zhang, Michał Król, **Alberto Sonnino**, Lixia Zhang, Etienne Rivière, International Symposium on Privacy Enhancing Technologies (PETs), 2021

13. Twins: White-Glove Approach for BFT Testing

Shehar Bano, **Alberto Sonnino**, Andrey Chursin, Dmitri Perelman, Zekun Li, Avery Ching, Dahlia Malkhi, ArXiv Preprint, 2020

12. FastPay: High-Performance Byzantine Fault Tolerant Settlement

Mathieu Baudet, George Danezis, **Alberto Sonnino**, ACM Conference on Advances in Financial Technologies (AFT), 2020

11. Replay Attacks and Defenses against Cross-shard Consensus in Sharded Distributed Ledgers

Alberto Sonnino, Shehar Bano, Mustafa Al-Bassam, George Danezis, IEEE European Symposium on Security and Privacy (EuroS&P), 2020

10. PASTRAMI: Privacy-preserving, Auditable, Scalable & Trust-worthy Auctions for Multiple Items.

Michał Król, **Alberto Sonnino**, Argyrios G. Tasiopoulos, Ioannis Psaras, Etienne Rivière ACM/IFIP Middleware, 2020

9. Location, location, location: Revisiting Modeling and Exploitation for Location-based Side Channel Leakages

Christos Andrikos, Lejla Batina, Lukasz Chmielewski, Liran Lerman, Vasilios Mavroudis, Kostas Papagiannopoulos, Guilherme Perin, Giorgos Rassias, **Alberto Sonnino**, Asiacrypt, 2019

8 FMPC: Secure Multiparty Computation from Fourier Series and Parseval's Identity

Alberto Sonnino, ArXiv Preprint, 2019

7. AStERISK: Auction-based Shared Economy ResolutIon System for blocKchain

Alberto Sonnino, Michał Król, Argyrios Tasiopoulos, Ioannis Psaras, Workshop on Decentralized IoT Systems and Security (DISS), 2019

6. SybilQuorum: Open Distributed Ledgers Through Trust Networks

Alberto Sonnino, George Danezis, ArXiv Preprint, 2019

5. Proof-of-Prestige: A Useful Work Reward System for Unverifiable Tasks

Michał Król, **Alberto Sonnino**, Mustafa Al-Bassam, Argyrios Tasiopoulos, Ioannis Psaras, IEEE International Conference on Blockchain and Cryptocurrency (ICBC), 2019

4. Coconut: Threshold Issuance Selective Disclosure Credentials with Applications to Distributed Ledgers

Alberto Sonnino, Mustafa Al-Bassam, Shehar Bano, Sarah Meiklejohn, George Danezis, Proceedings of the Network and Distributed System Security Symposium (NDSS), 2019

3. SoK: Consensus in the Age of Blockchains

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2. Airtnt: Fair Exchange Payment for Outsourced Secure Enclave Computations

Mustafa Al-Bassam, **Alberto Sonnino**, Michał Król, Ioannis Psaras, ArXiv preprint, 2018

1. Chainspace: A Sharded Smart Contracts Platform

Mustafa Al-Bassam, **Alberto Sonnino**, Shehar Bano, Dave Hrycyszyn, George Danezis, Proceedings of the Network and Distributed System Security Symposium (NDSS), 2018