MAgiCS '26 Workshop (affiliated with Eurocrypt 2026)

10 May 2026, Rome

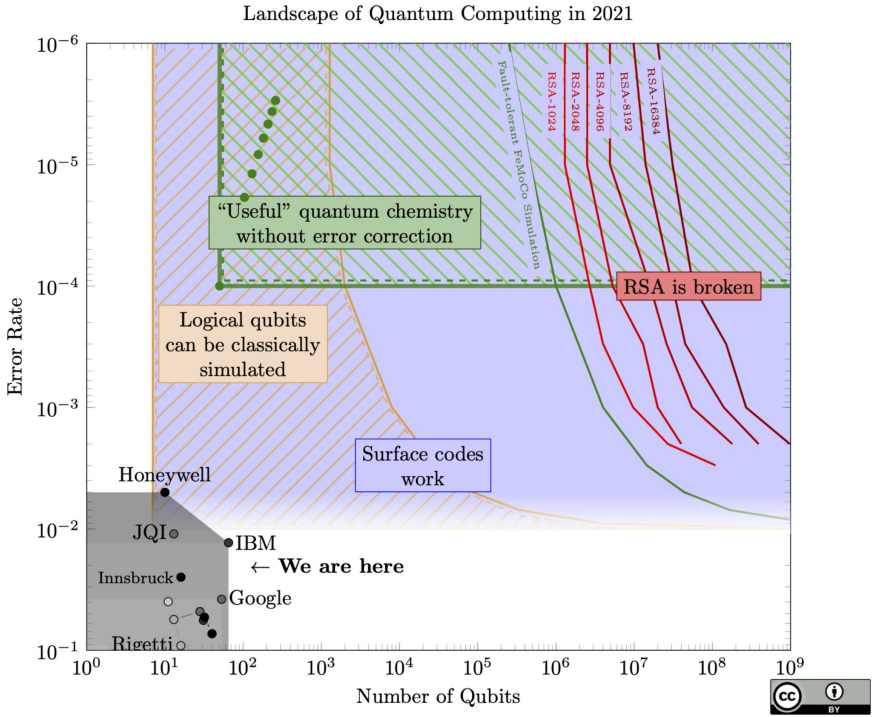
Post-Quantum Blockchains with Agility in Mind

Manuel B. Santos[1*], Danno Ferrin[2], Ron Kahat[2], Michael Lodder[2]

[1] Quantum, [2] Tectonic Labs

[*] Work done while at Tectonic Labs.

Motivation



By Samuel Jaques, https://sam-jaques.appspot.com/quantum_landscape

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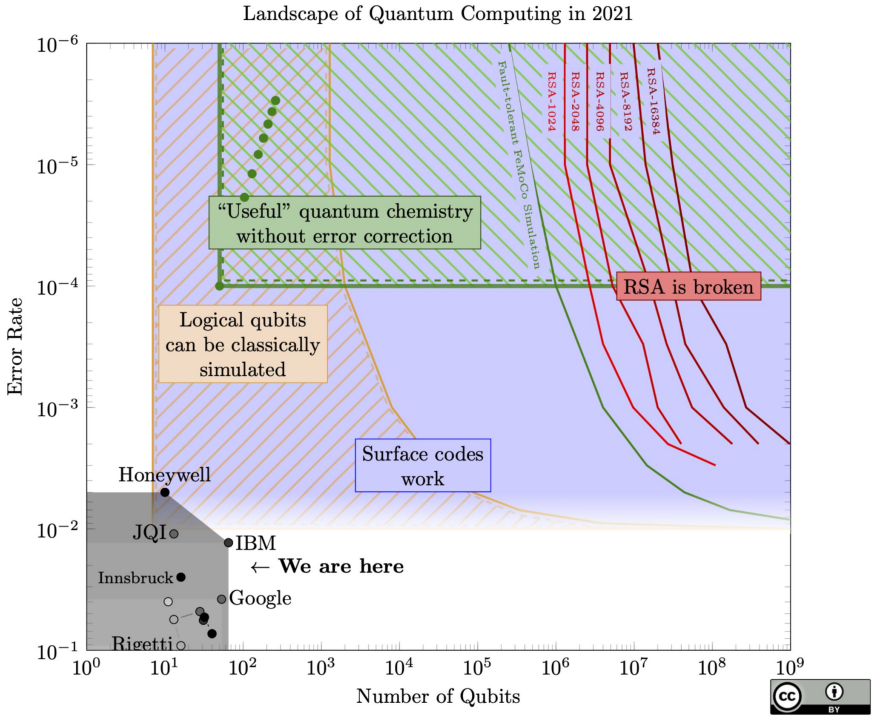
Quantum Error Correction



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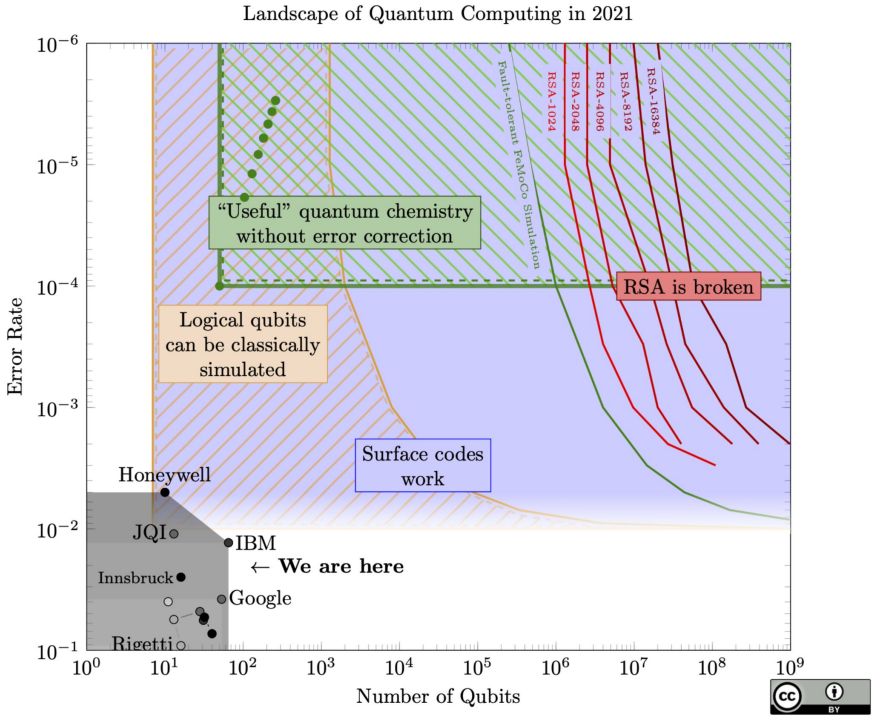
Fidelity of two qubit gate



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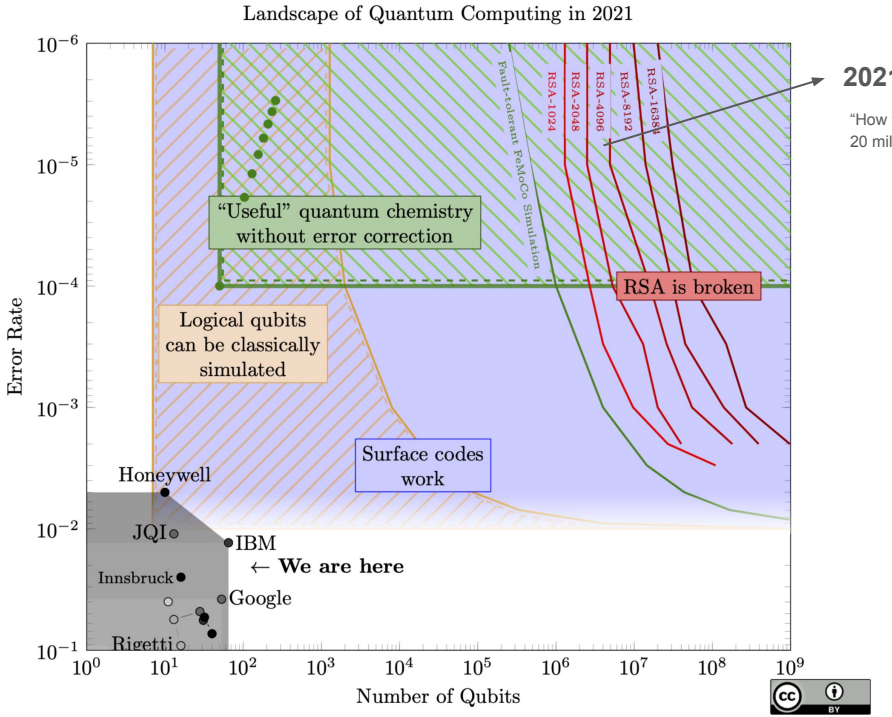

2021: 20 million qubits

"How to factor 2048 bit RSA integers in 8 hours using 20 million noisy qubits", Gidney and Ekerå

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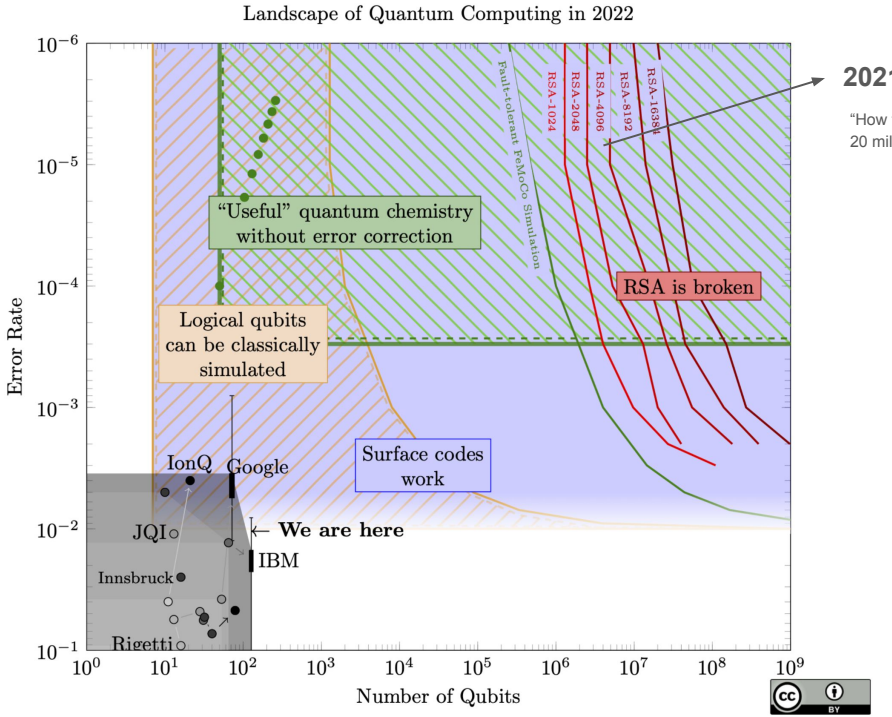

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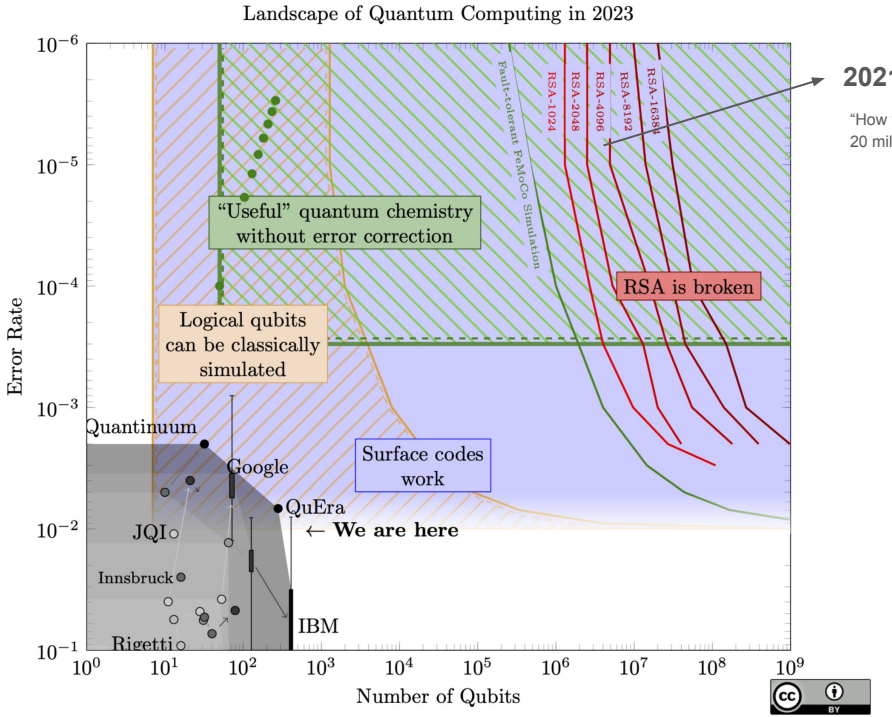

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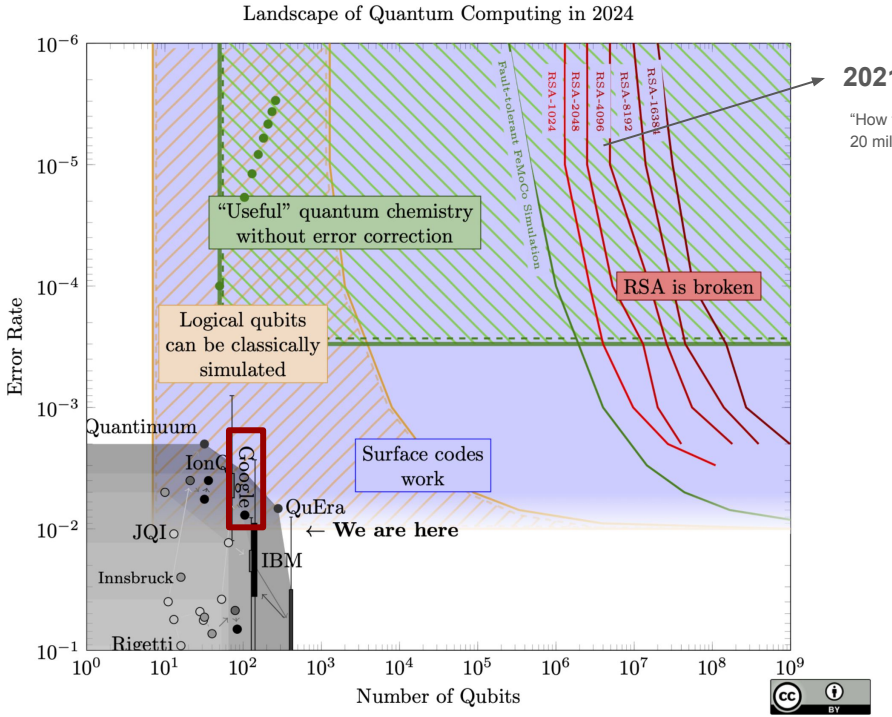

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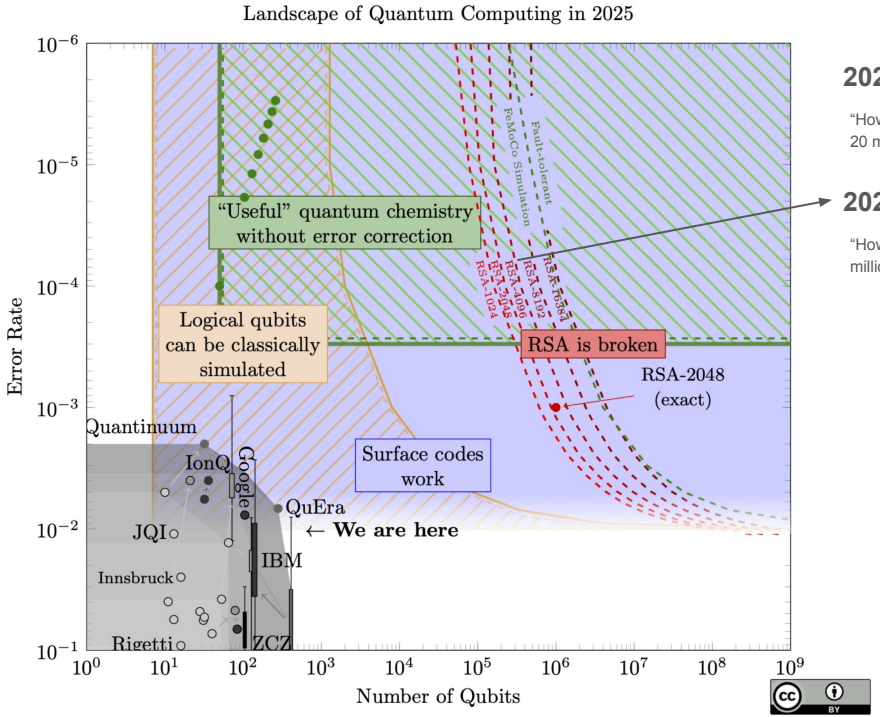

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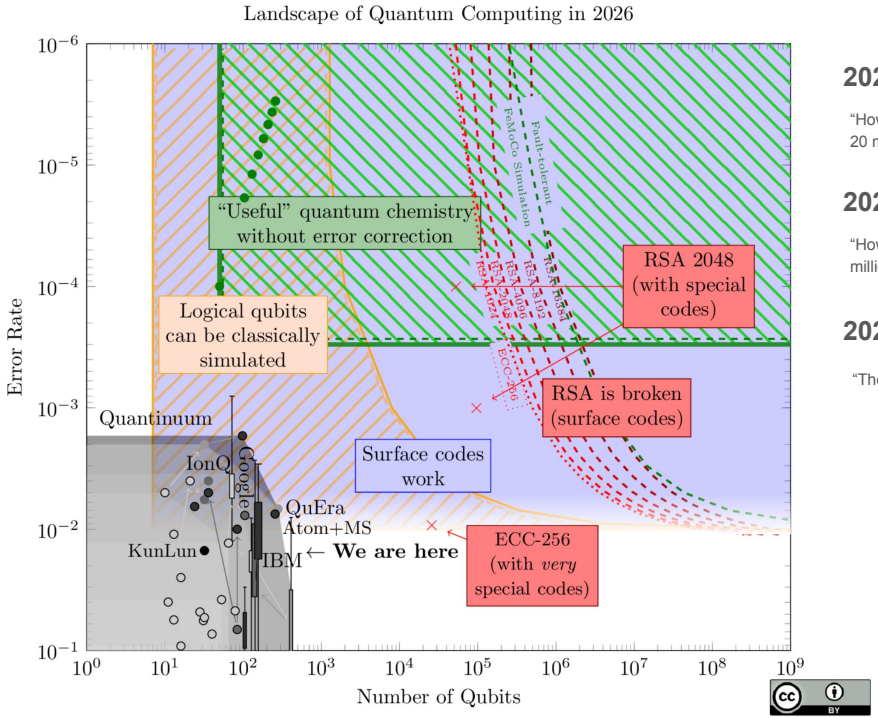

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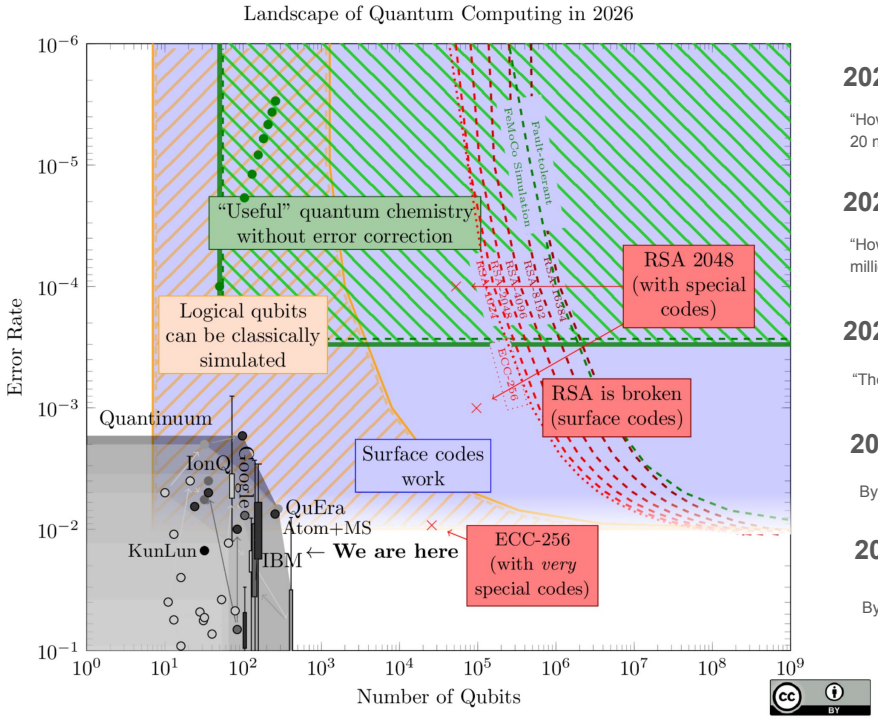

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By Oratomic

2026: 1 thousand qubits

By Google quantum AI, Berkeley, Ethereum Foundation, Stanford

Motivation

Challenges (NIST CSWP 39):

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Blockchains

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Blockchains

decentralization

long-term integrity

Overview

- Intro to EVM-based blockchains
- Flexibility framework
- CATX
- Experiments

EVM-based blockchains

World state: σ_t

Address	Balance
0x742d3	0.1 ETH
0x841a7	2.1 ETH

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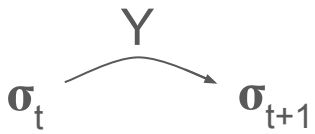

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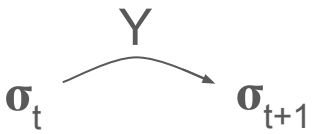


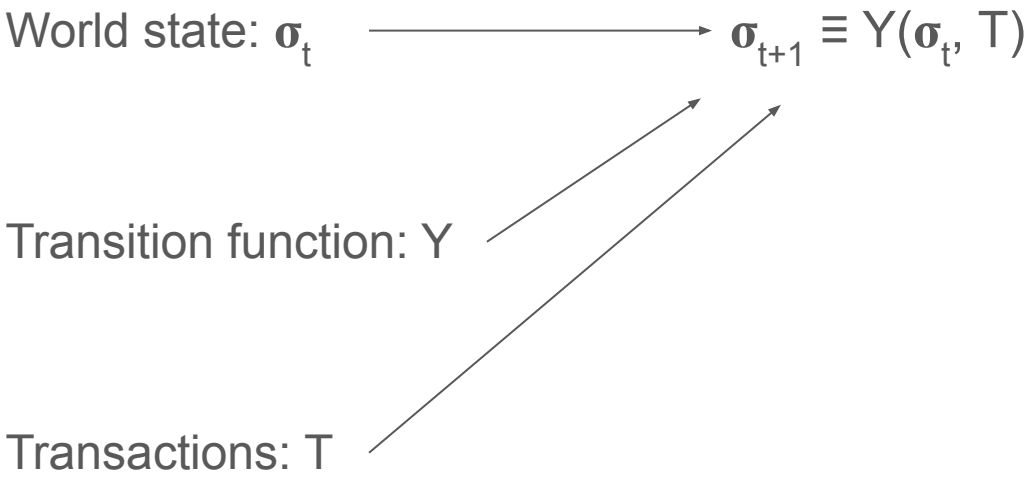
Transactions: T →

From: 0x742d3

To: 0x841a7

Amount: 0.01 ETH

EVM-based blockchains



EVM-based blockchains

Quantum vulnerable: ECDSA signature

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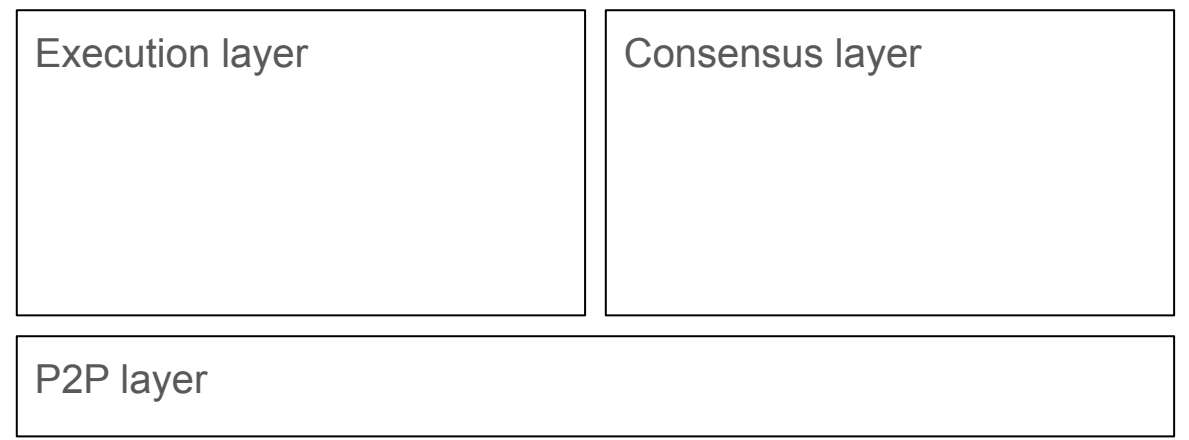

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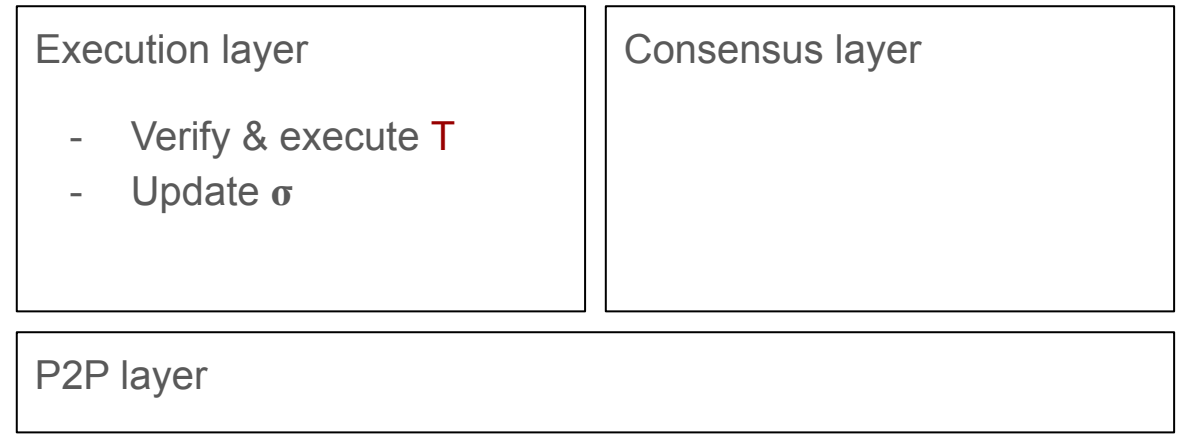

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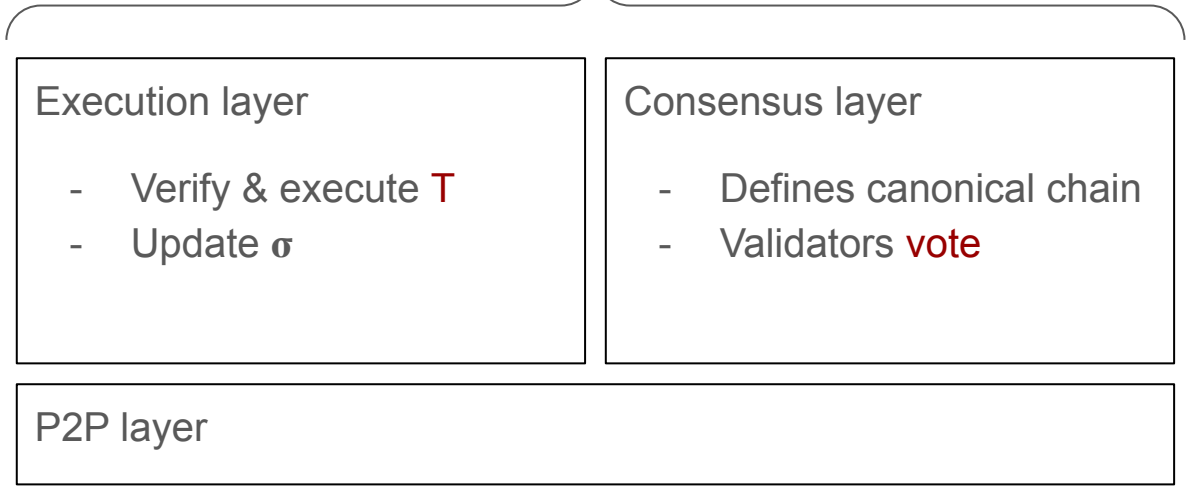
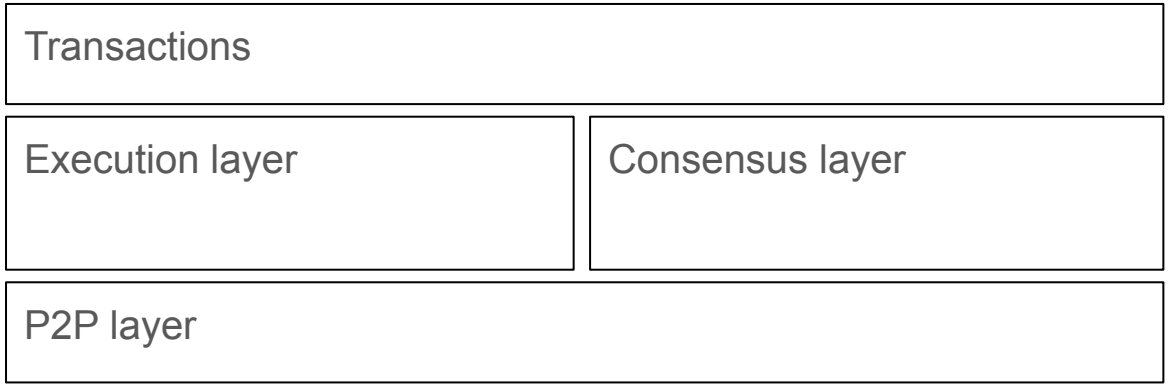
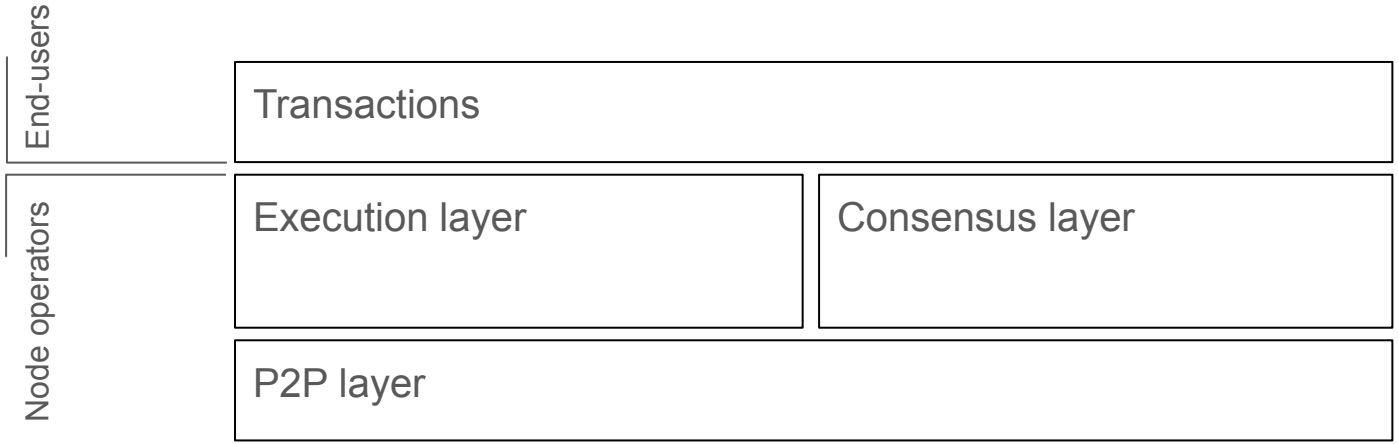


Flexibility framework



Flexibility framework | Coordination



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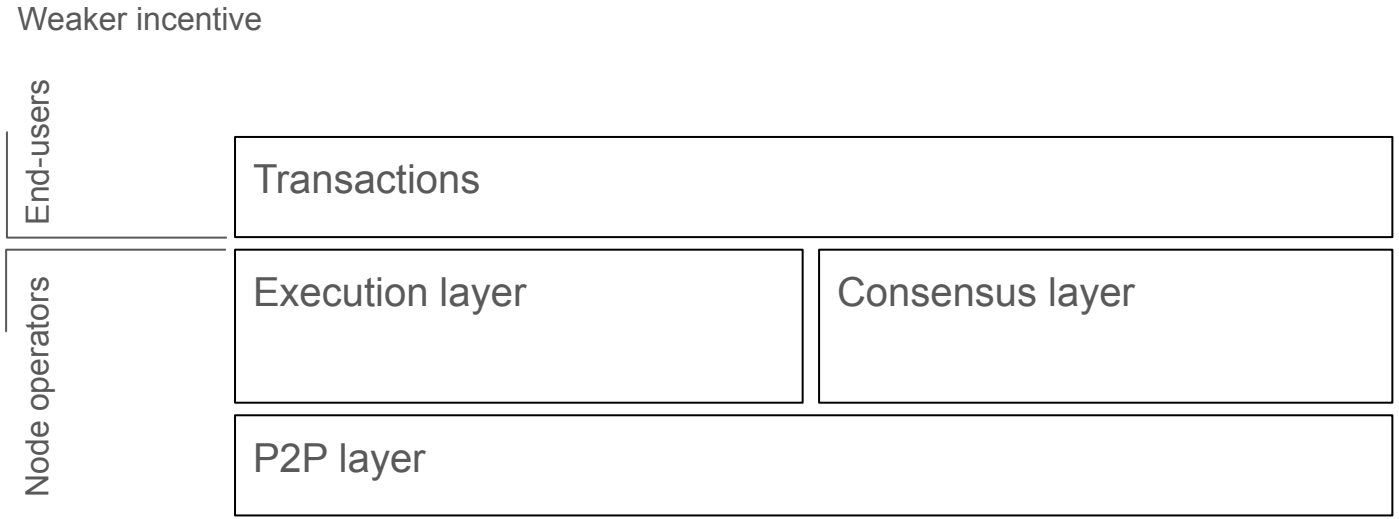
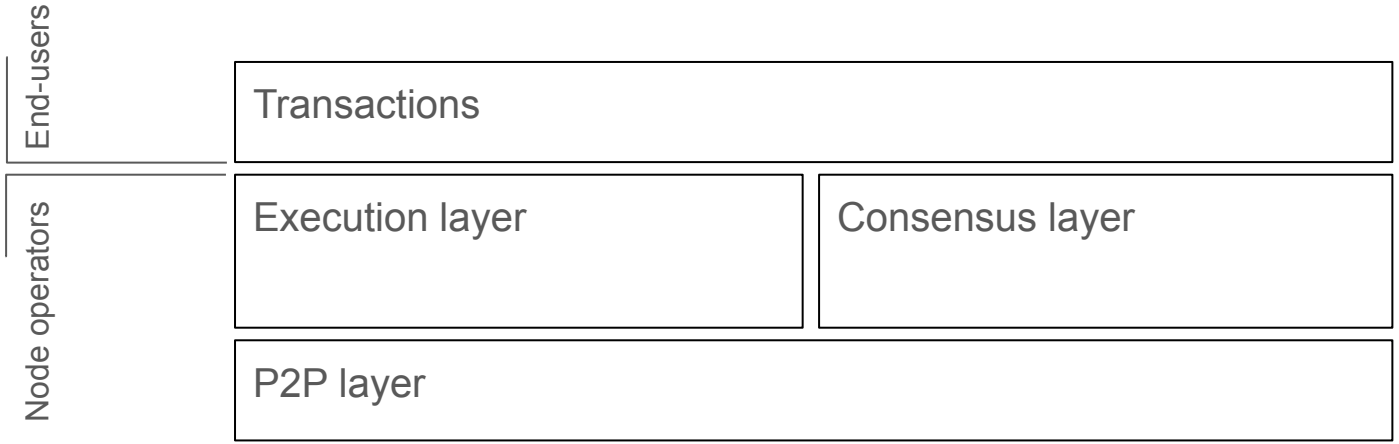


Flexibility framework | Coordination

Weaker incentive



Stronger incentive

HSM

Flexibility framework | Types

- Singular

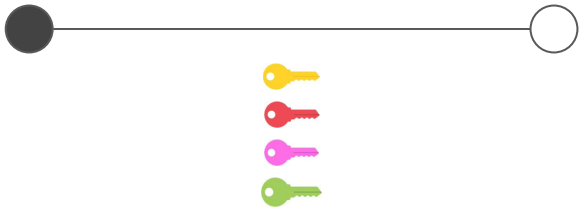
Legend:

: cryptographic scheme

Flexibility framework | Types

- Singular

- Selected



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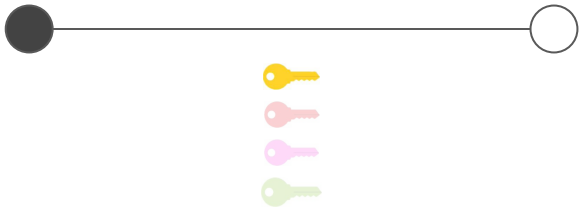

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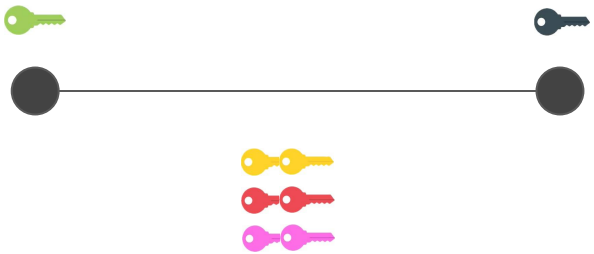

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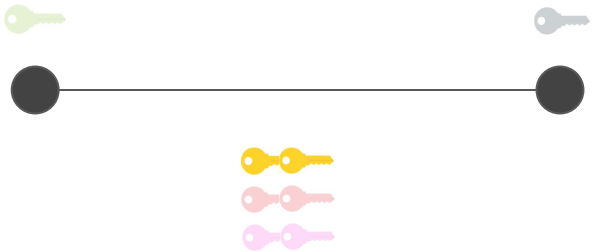

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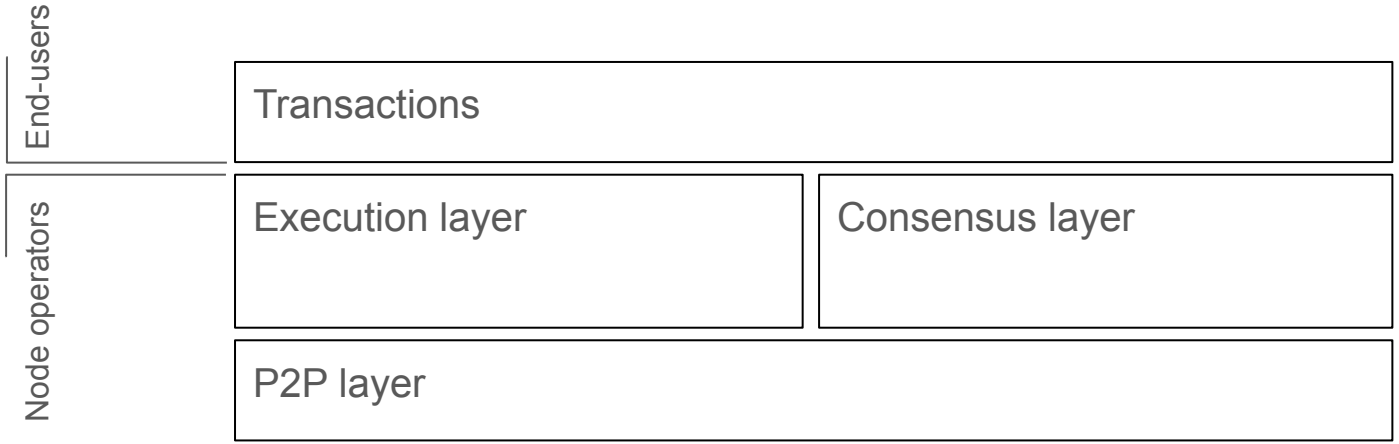

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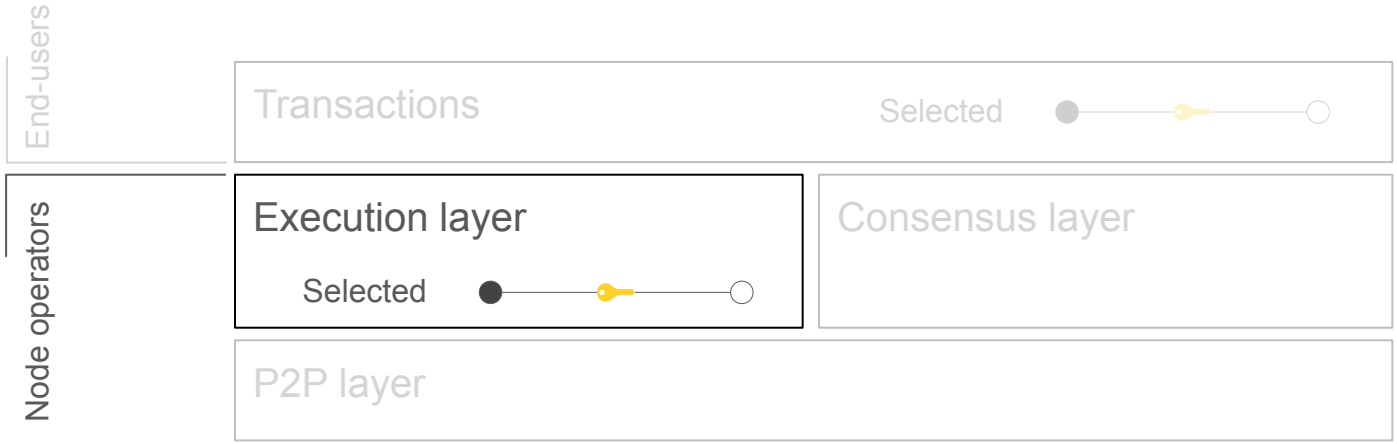

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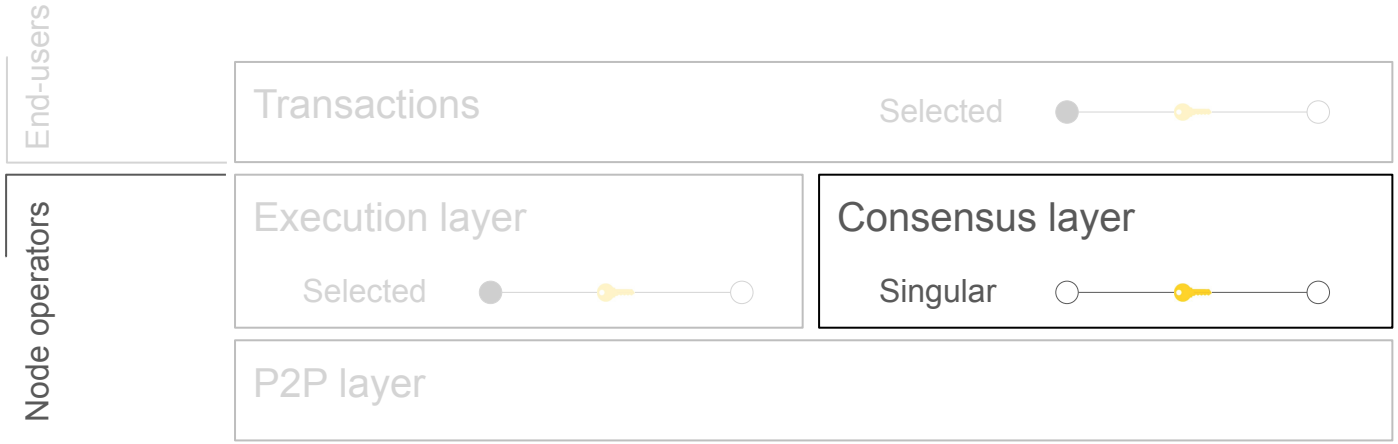

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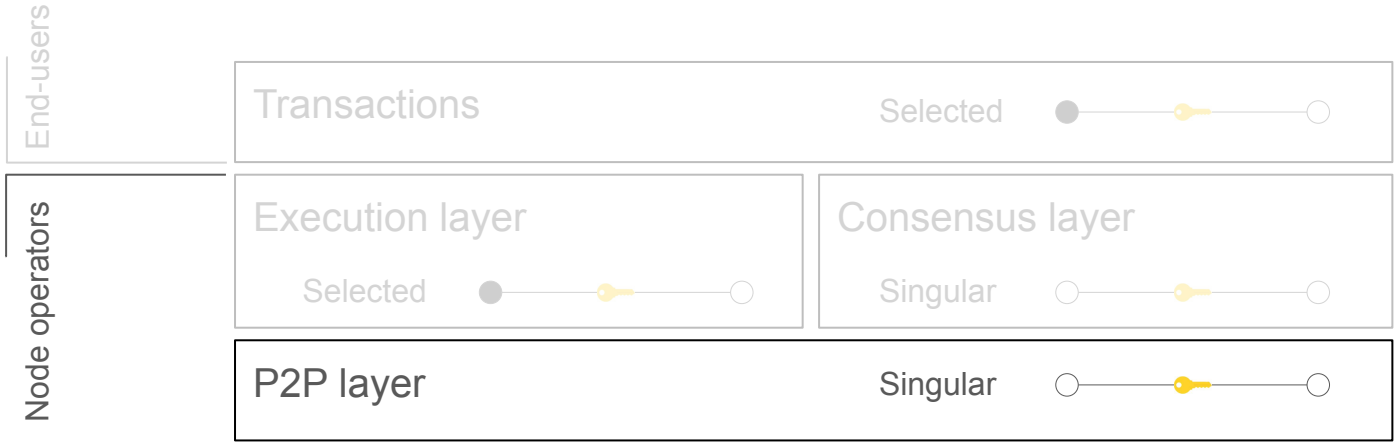

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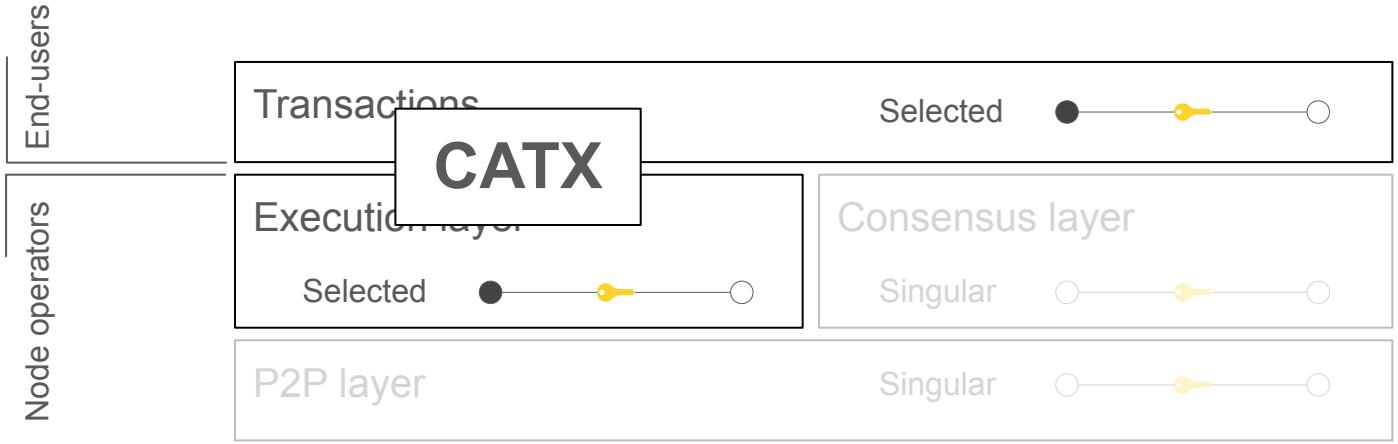

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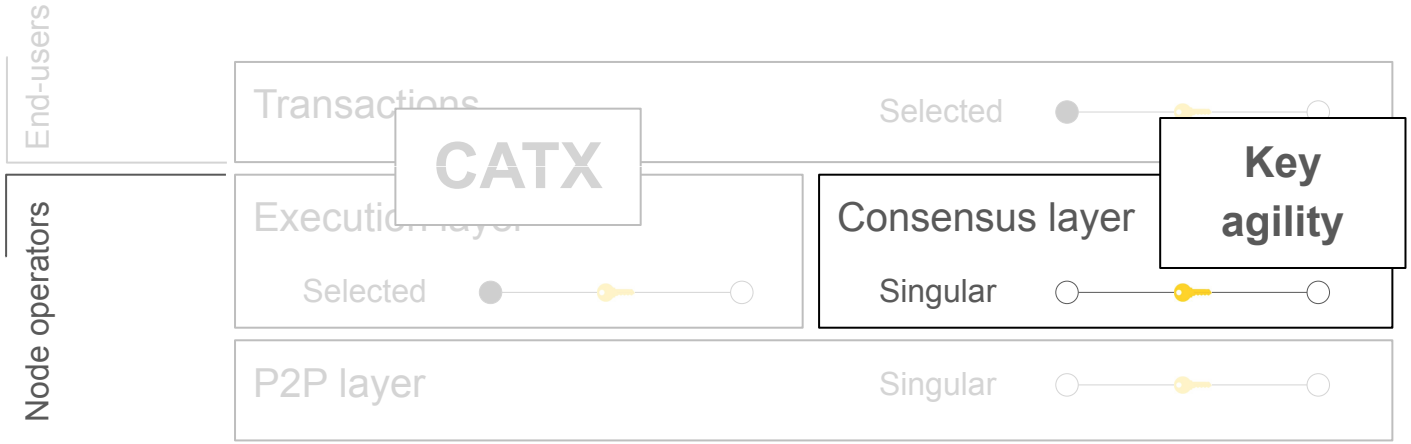

Cryptographically agile transactions (CATX)

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Legacy typed-transaction:

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$$\mathrm{Tx} = \texttt{0x02} \,\|\, \mathrm{RLP}\left(\begin{array}{c}\texttt{chainId}, \texttt{nonce}, \texttt{maxTip}, \texttt{maxFee}, \texttt{gasLimit}, \\ \texttt{destination}, \texttt{amount}, \texttt{data}, \texttt{accessList}, \texttt{v}, \texttt{r}, \texttt{s}\end{array}\right)$$

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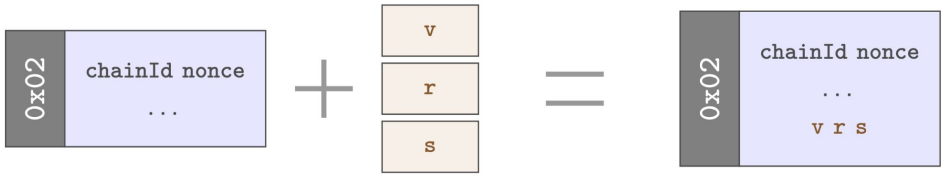

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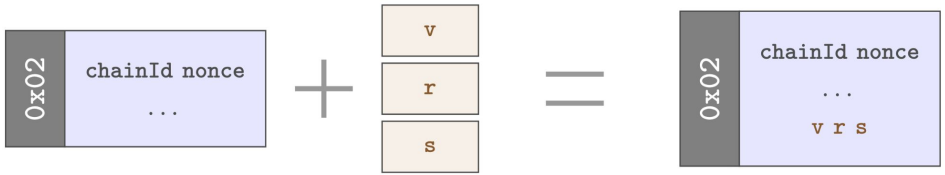

Limitations:

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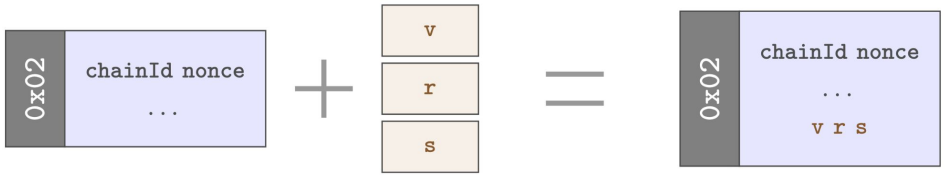

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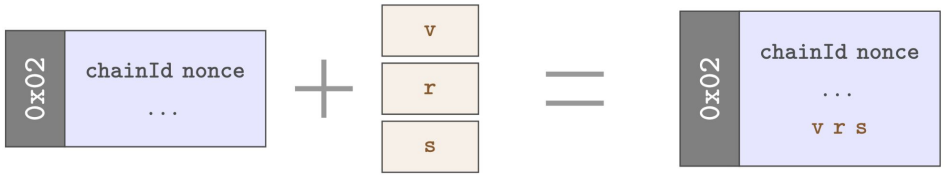

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❌ Modularity

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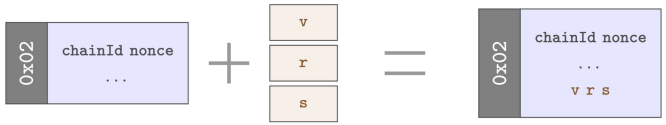

CATX design:

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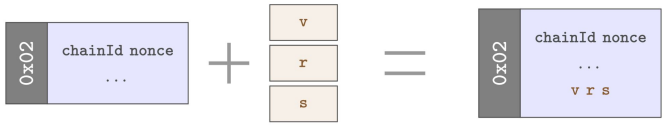

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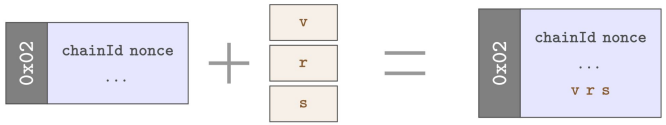

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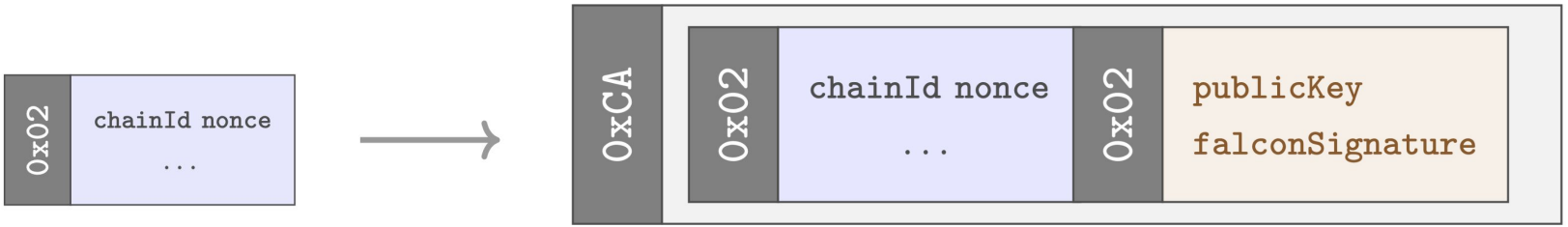

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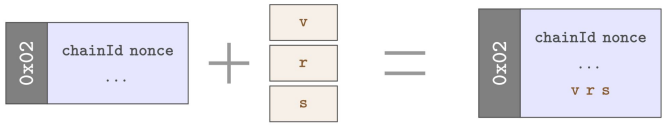

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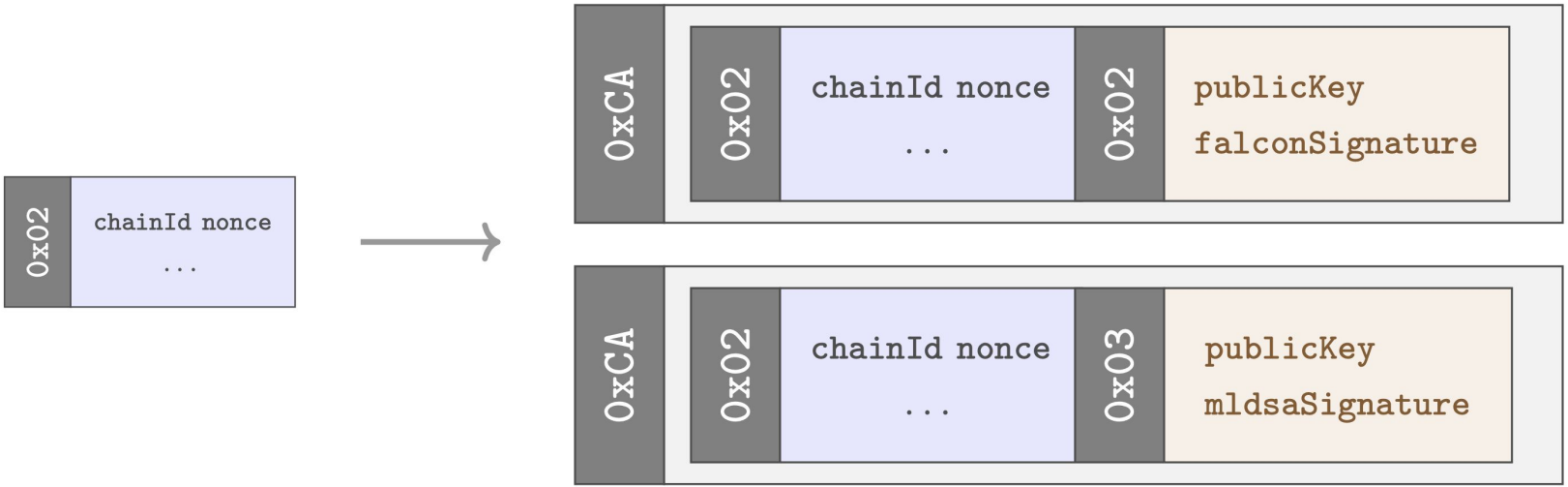

Experiments

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Main question:

TPS: Tx/s

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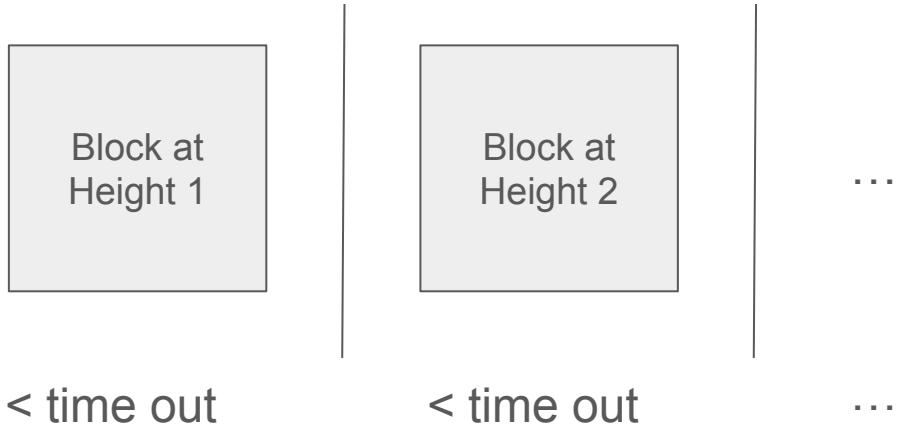
Tendermint consensus:



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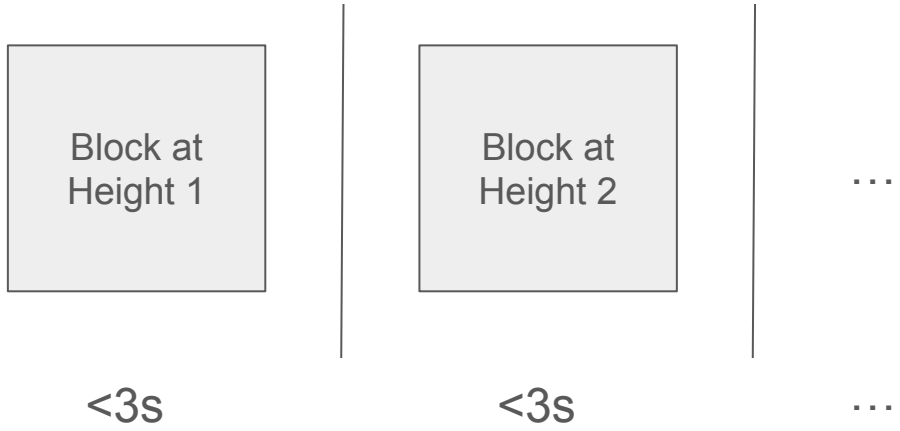

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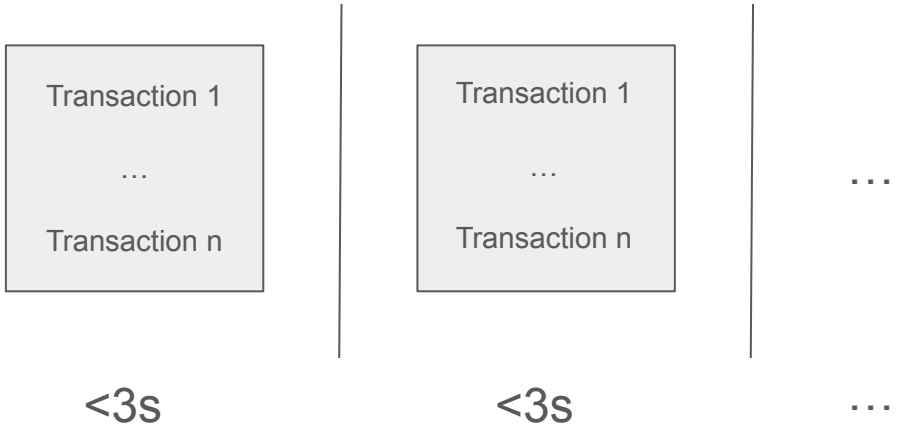

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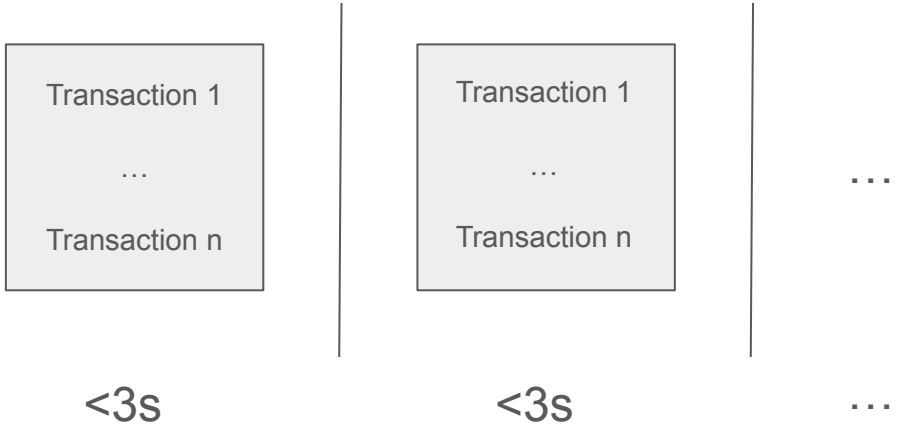
1 block proposer:

- Gather Tx
- Verifies Tx
- Proposes block

Attestors check



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Attestors check

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Attestors check

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- Gas

Experiments

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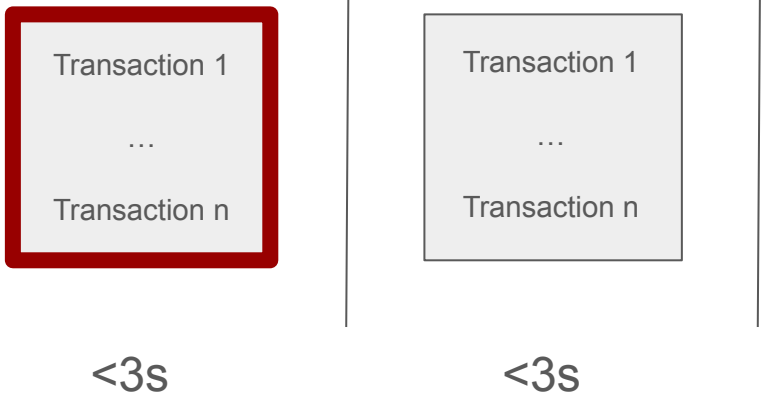

Constraints:

- CPU & disk i/o
- Gas
- Block size

Experiments

Type	Peak TPS	Sustained TPS	Gas%	Size%	Bottleneck
Legacy	4,021	3,963	19%	1%	CPU
ECDSA	4,032	3,964	22%	2%	CPU
Falcon-512	3,730	1,625	78%	72%	Mixed
ML-DSA-44	2,210	3,794	46%	**100%**	**Block size**

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ECDSA: limited by round timeout

Falcon + ML-DSA: limited by block size

MAgiCS '26 Workshop (affiliated with Eurocrypt 2026)

10 May 2026, Rome

Thank you

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