Zero-Knowledge for Privacy, Succinct for Rollups

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SENDA - Security of Networks and Distributed Applications

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Plan de Recuperación, Transformación y Resiliencia
España | digital 2026
incibe_ INSTITUTO NACIONAL DE CIBERSEGURIDAD

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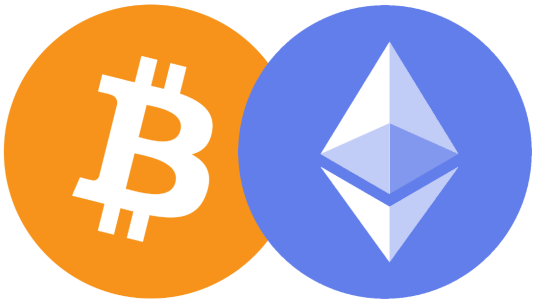
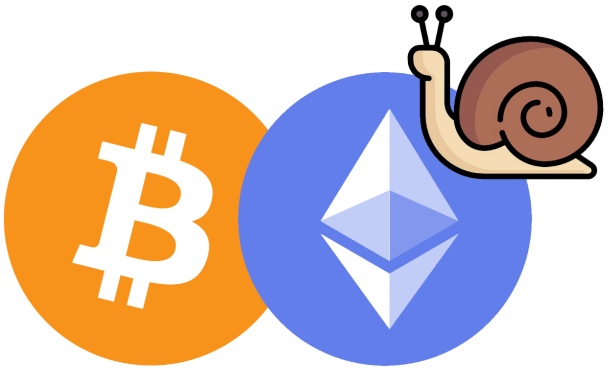
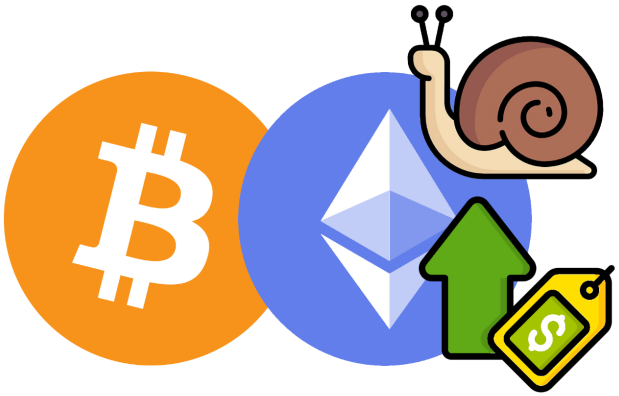
Bitcoin and Ethereum do not scale



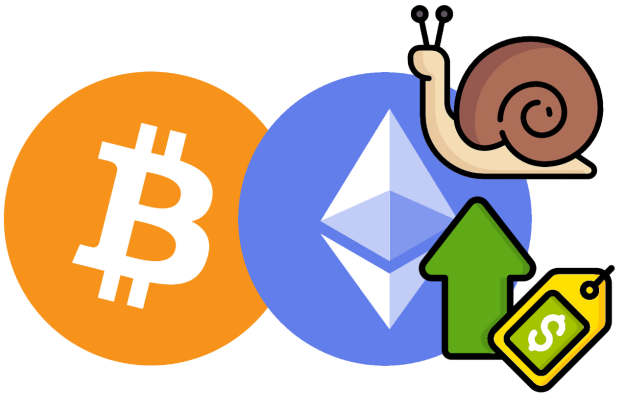
Slow

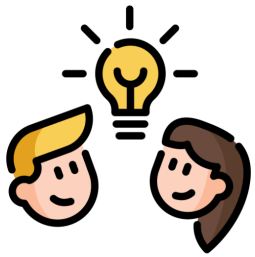


Expensive

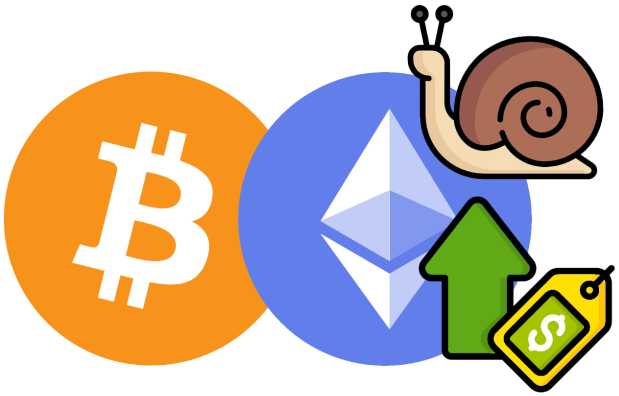


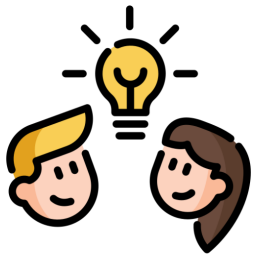
But people have ideas... Layer 2!

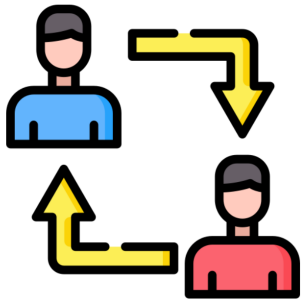




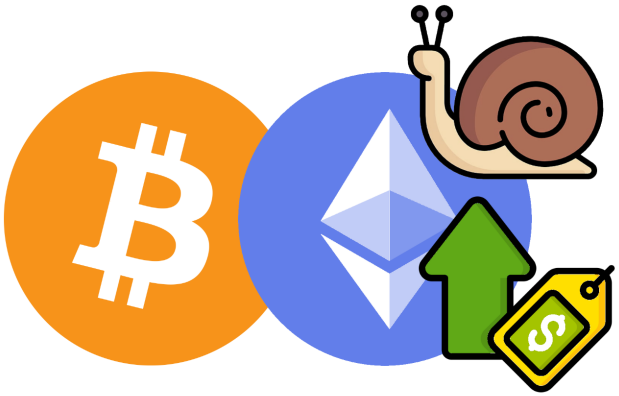
Payment Channel Networks

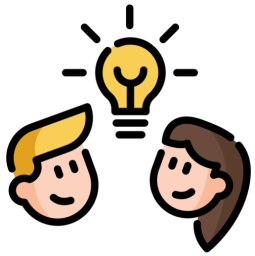


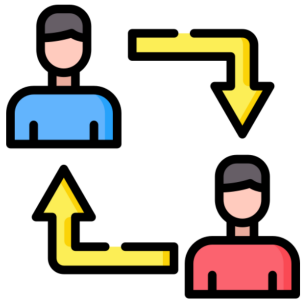


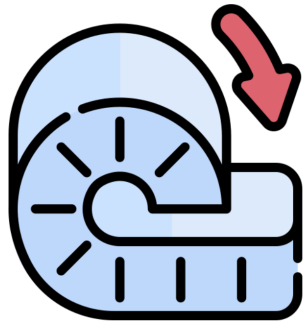


Rollups

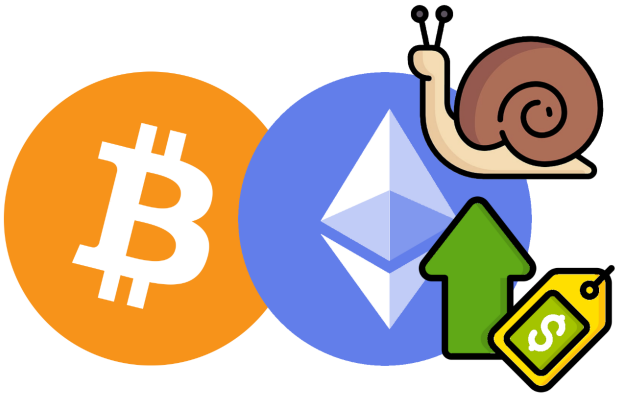


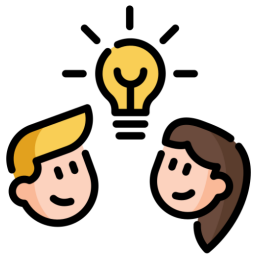


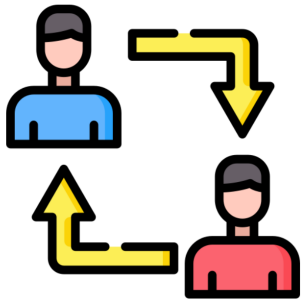


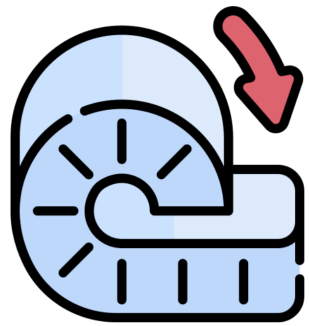


Bridges to enable interoperability

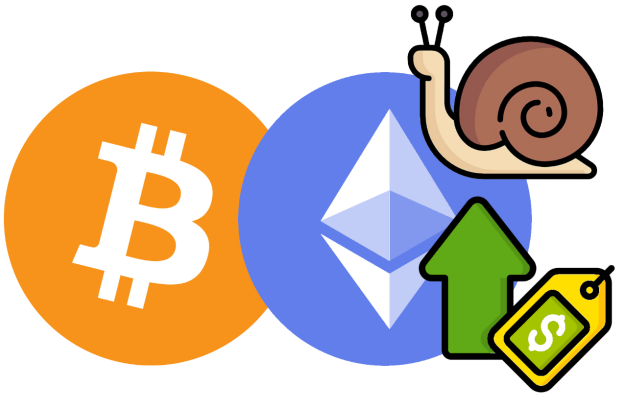


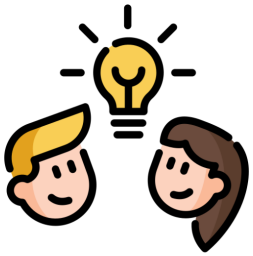


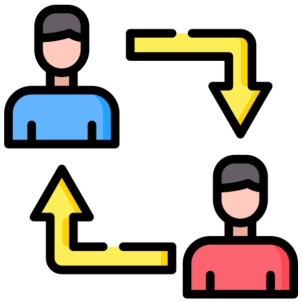


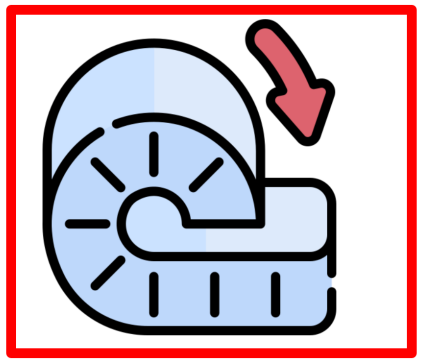


We are interested on rollups









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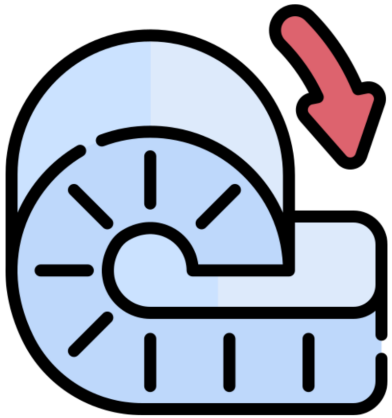
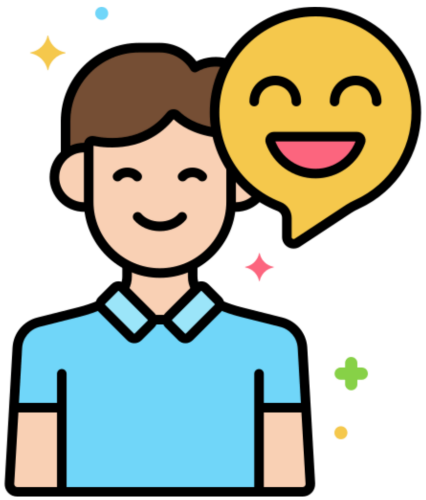
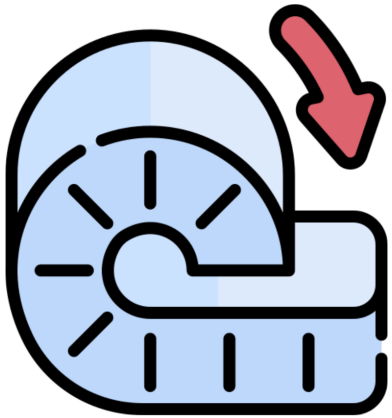
Rollups

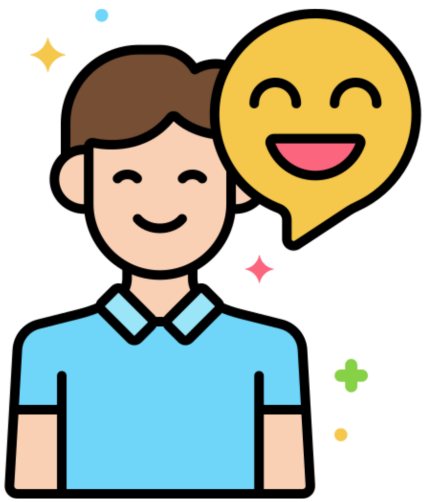


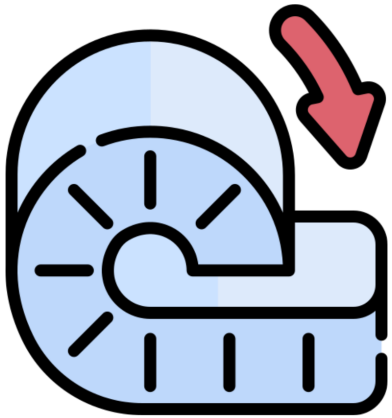
Optimistic Rollups

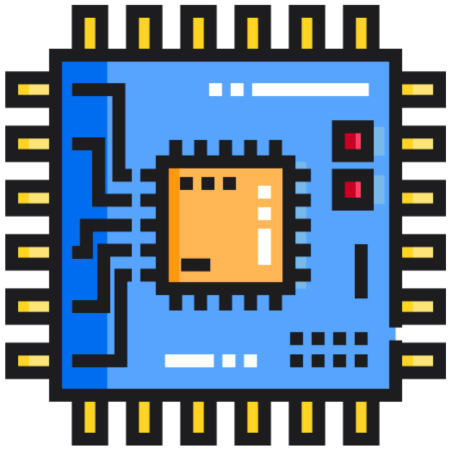




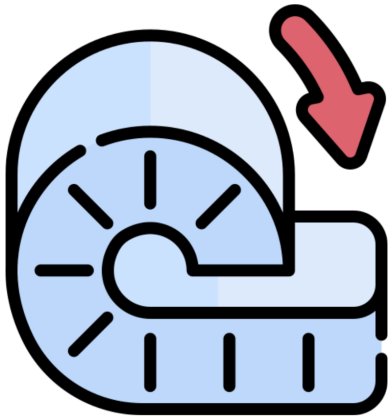
Zero-Knowledge Rollups

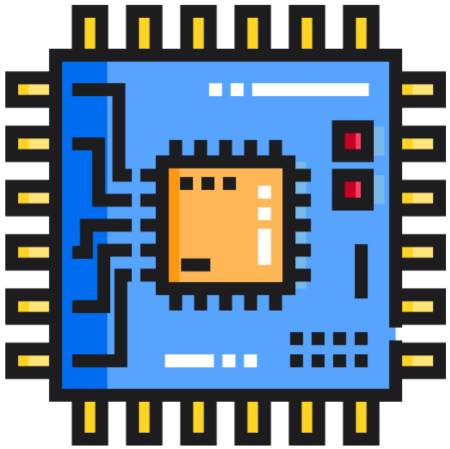




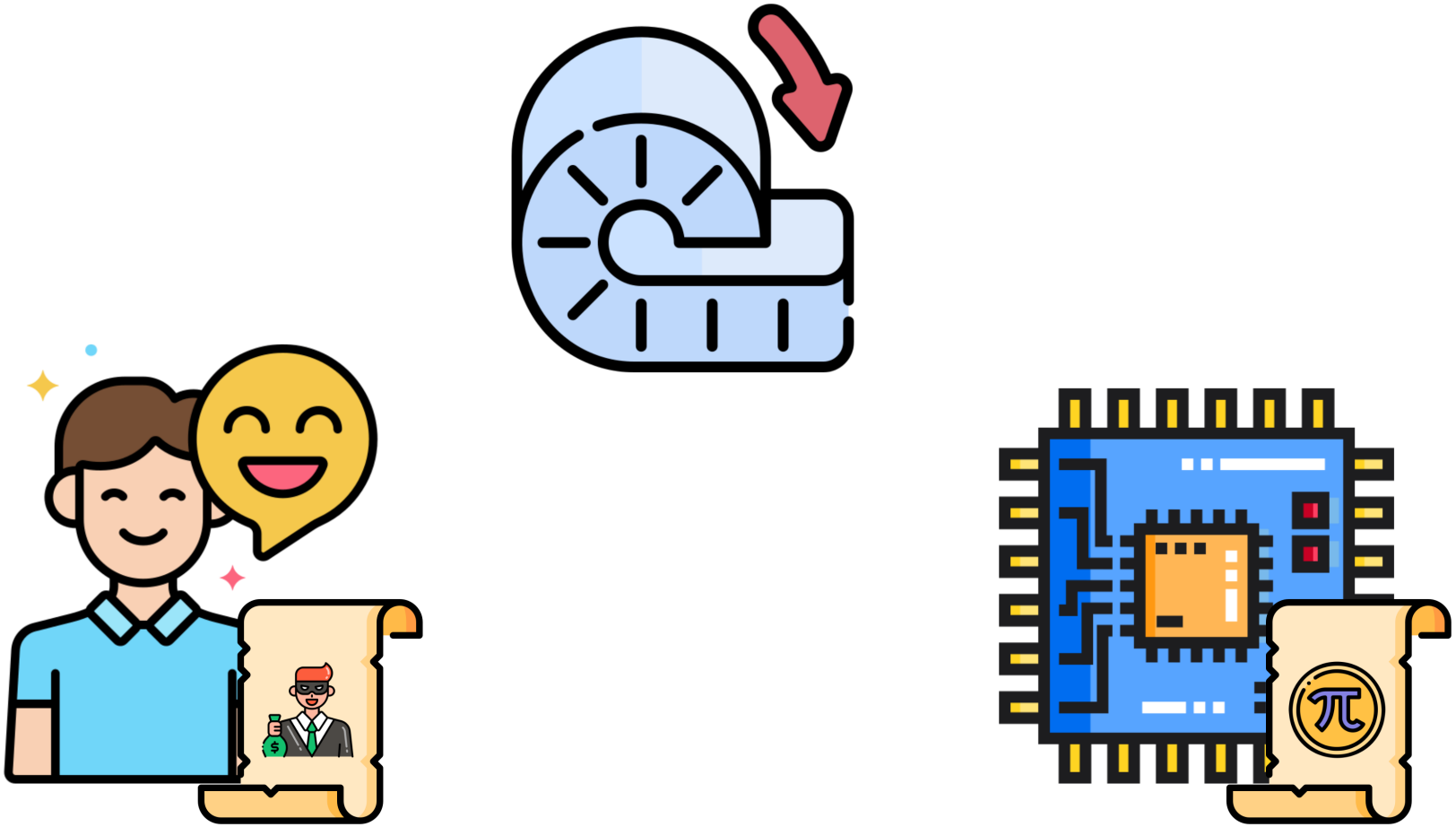


Optimistic Rollups - Fraud Proofs

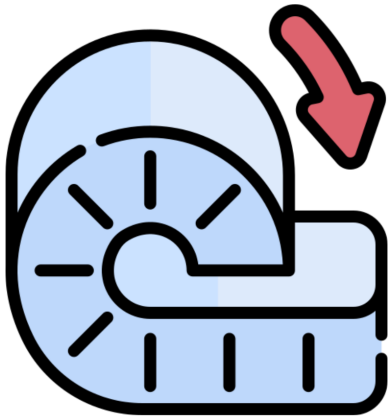


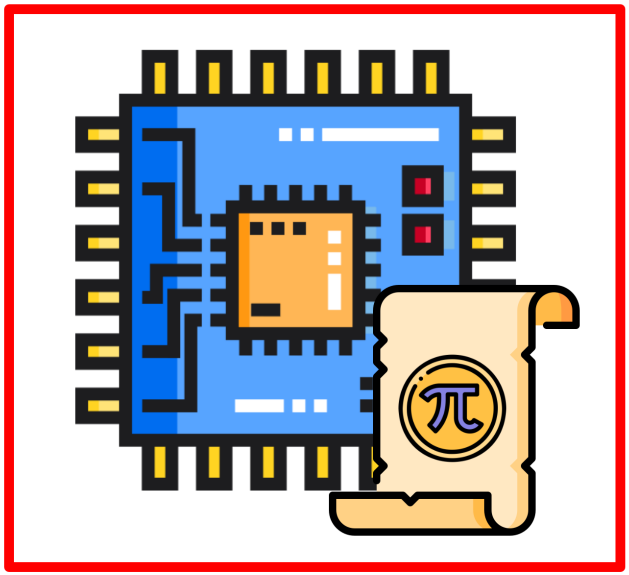


Zero-Knowledge Rollups - Validity Proofs



Zero-Knowledge Rollups





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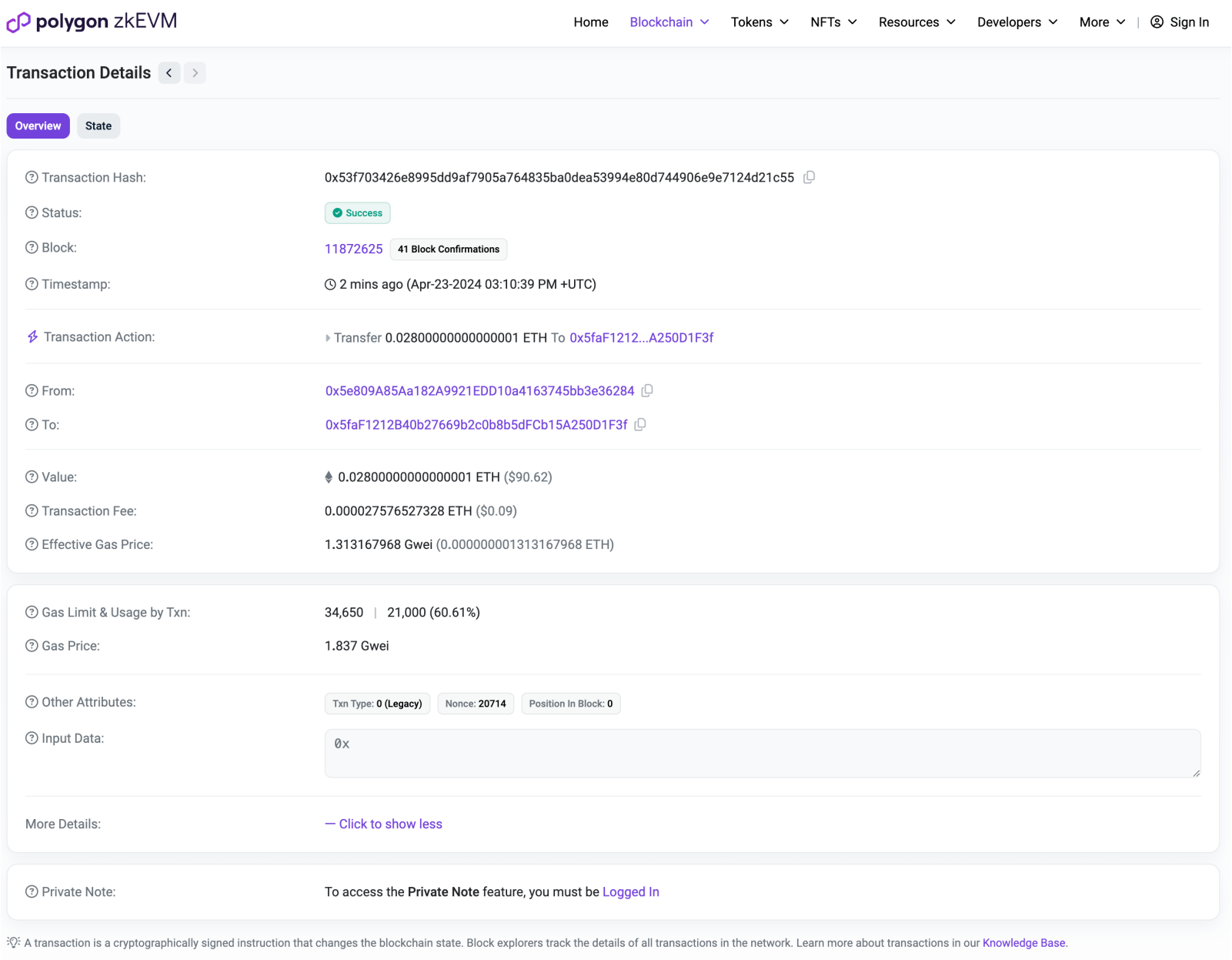
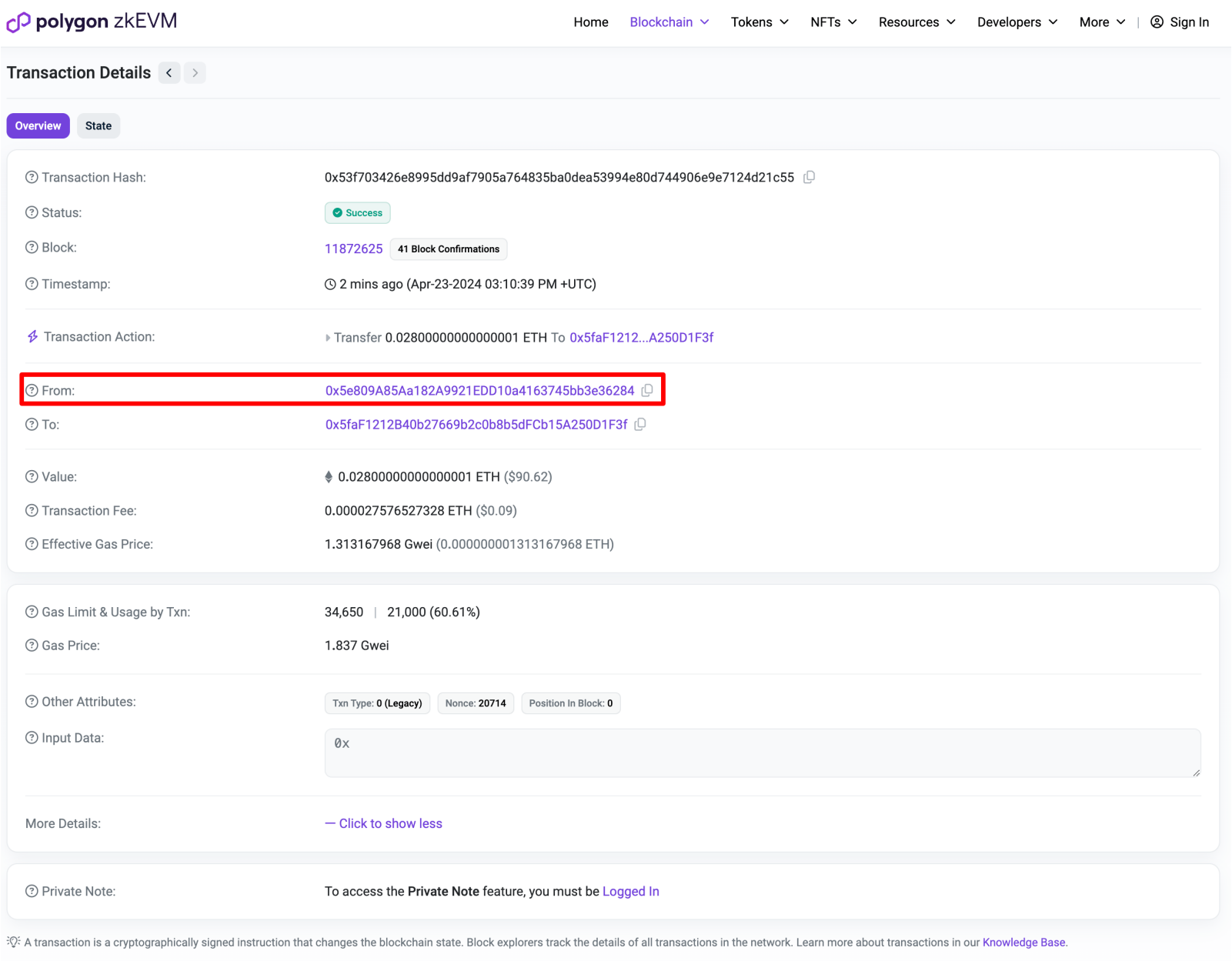
Exploring a zkRollup...



Exploring a zkRollup...



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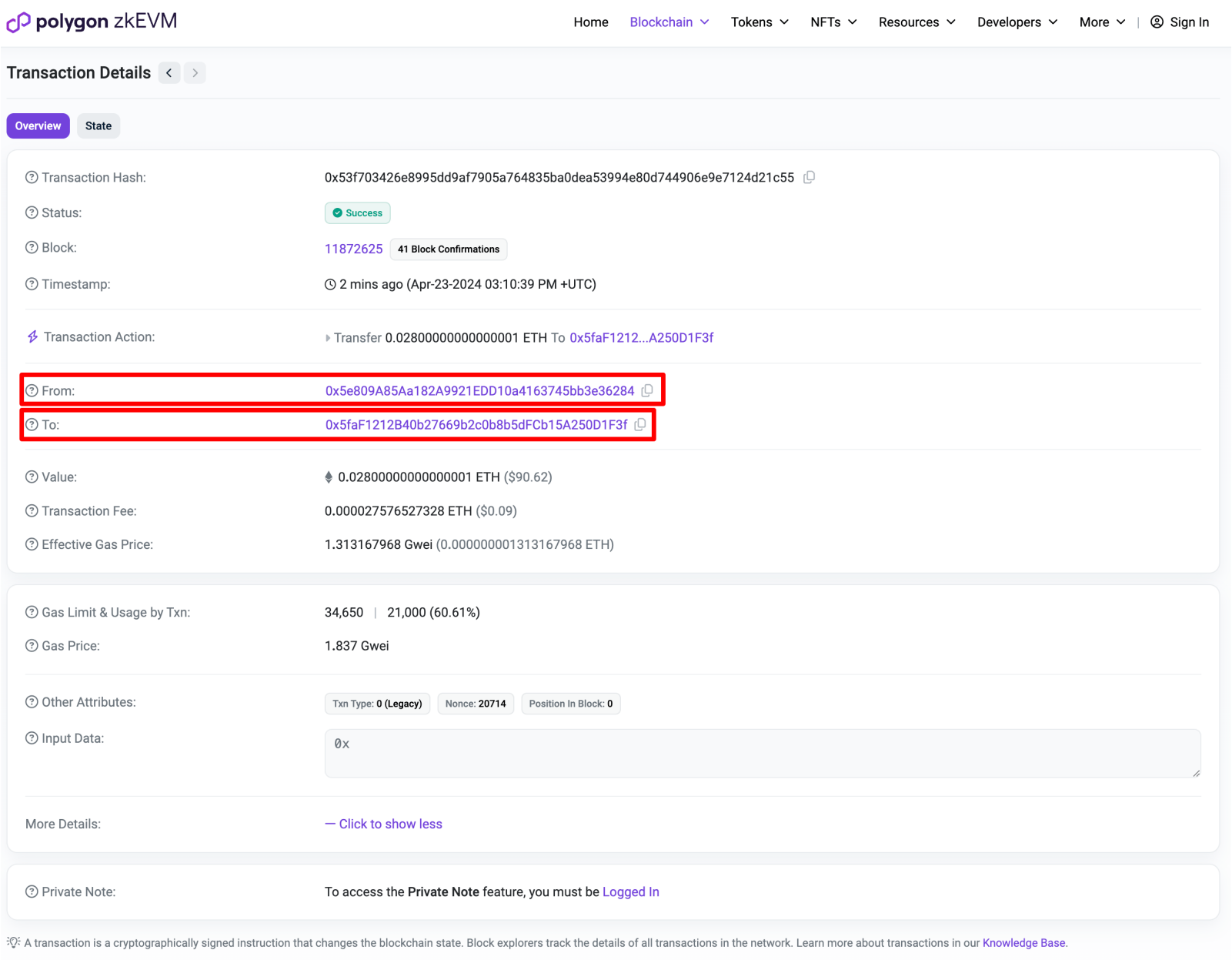

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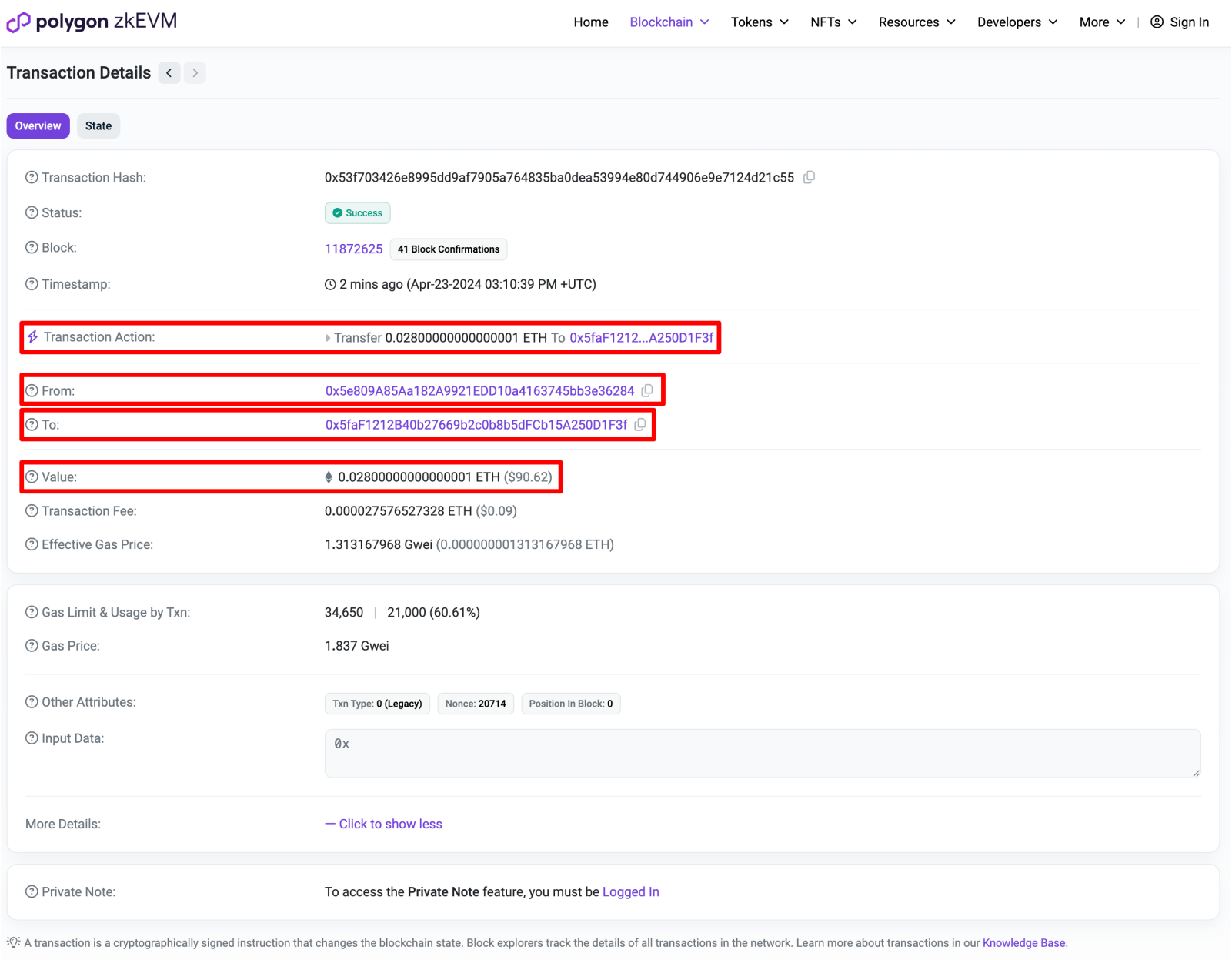

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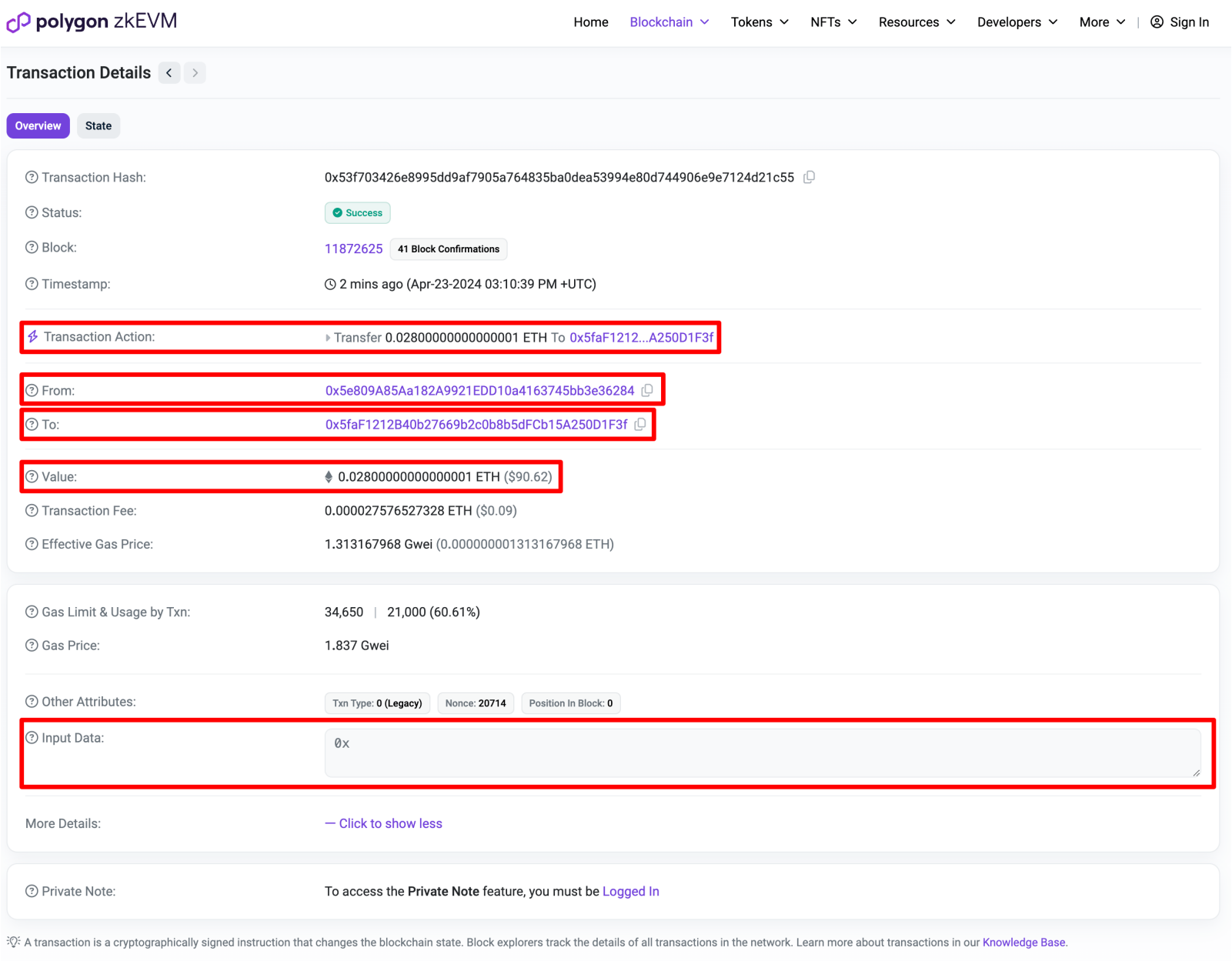

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SNARKs

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- S Succinct

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S Succinct: “means that the Proof is short.”

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SNARKs

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Renaming zkRollups

sucRollup Succinct Rollup?

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sucRollup Succinct Rollup?

ivcRollup IncrementallyVerifiableComputation Rollup?

Renaming zkRollups

sucRollup Succinct Rollup?

ivcRollup IncrementallyVerifiableComputation Rollup?

Or... Rollup + Privacy

Renaming zkRollups

sucRollup Succinct Rollup?

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Or... Rollup + Privacy

zkzkRollup Zero-Knowledge(Zero-Knowledge Rollup)?

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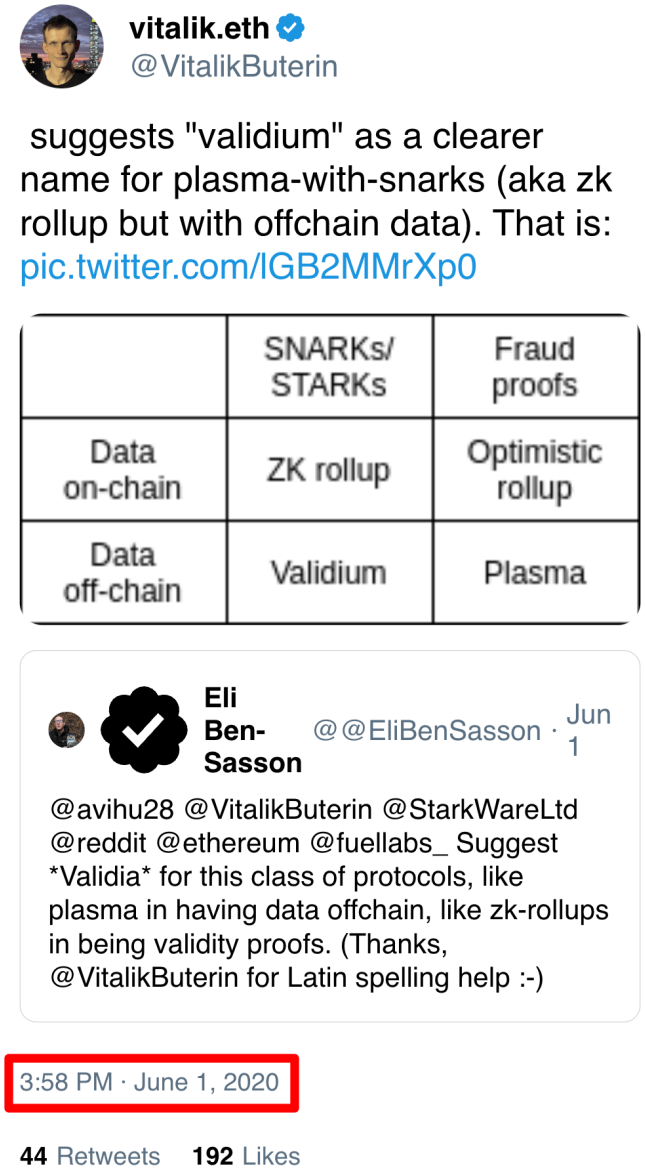
Original classification



vitalik.eth ✓
@VitalikButerin

suggests "validium" as a clearer name for plasma-with-snarks (aka zk rollup but with offchain data). That is: pic.twitter.com/lGB2MMrXp0

	SNARKs/ STARKs	Fraud proofs
Data on-chain	ZK rollup	Optimistic rollup
Data off-chain	Validium	Plasma

Eli Ben-Sasson @@EliBenSasson · Jun 1

@avihu28 @VitalikButerin @StarkWareLtd @reddit @ethereum @fuellabs_ Suggest *Validia* for this class of protocols, like plasma in having data offchain, like zk-rollups in being validity proofs. (Thanks, @VitalikButerin for Latin spelling help :-)

3:58 PM · June 1, 2020

44 Retweets **192** Likes

New classification

cal (zk/acc)
@calummoore

sorry, but this is what the table should actually be
pic.twitter.com/w7Q64RQG40

	SNARKs/ STARKs	Fraud proofs
Data **Public**	~~ZK-rollup~~ **succinct rollup**	Optimistic rollup
Data **Private**	~~Validium~~ **zk-rollup**	~~Plasma~~ **impossible**

vitalik.eth @@VitalikButerin · Jun 1

@EliBenSasson suggests "validium" as a clearer name for plasma-with-snarks (aka zk rollup but with offchain data). That is:
pic.twitter.com/lGB2MMrXp0
x.com/EliBenSasson/s…

7:00 PM · April 18, 2024

1 Retweet **6** Likes

Table of Contents

SNARKs

S **Succinct**

N Non-interactive

AR ARguments

K of Knowledge

(zk)SNARKs

(zk) Zero-Knowledge $\Rightarrow$ as *a* way to enable Privacy

S **Succinct**

N Non-interactive

AR ARguments

K of Knowledge

Adding Privacy to Rollups

From Satybaldy et al. (2020)

Adding Privacy to Rollups

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- Zero-Knowledge Proofs (zkSNARK or zkSTARK)

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- Zero-Knowledge Proofs (zkSNARK or zkSTARK)
- Secure Multi-party Computation

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- Zero-Knowledge Proofs (zkSNARK or zkSTARK)
- Secure Multi-party Computation
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Adding Privacy to Rollups

From Satybaldy et al. (2020)

- Zero-Knowledge Proofs (zkSNARK or zkSTARK)
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From Satybaldy et al. (2020)

- Zero-Knowledge Proofs (zkSNARK or zkSTARK)
- Secure Multi-party Computation
- Homomorphic Encryption
- Commitment Schemes
- Mixing
- Ring Signatures

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- Homomorphic Encryption
- Commitment Schemes
- Mixing
- Ring Signatures
- Differential Privacy

Adding Privacy to Rollups

From Satybaldy et al. (2020)

- **Zero-Knowledge Proofs (zkSNARK or zkSTARK)**
- Secure Multi-party Computation
- **Homomorphic Encryption**
- **Commitment Schemes**
- Mixing
- Ring Signatures
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Conclusions

- Next steps for zkRollups (after decentralisation)

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- Currently some projects aiming to do that
  - Aztec: "Privacy-first L2 on Ethereum"
  - Payy (but UTXO-based...)

Thank you for your attention!

@0xAdriaTorralba

0xAdriaTorralba

atorralbaag@uoc.edu

QR Code to my research