

Scaling Solutions Wiki

The Layer 1 Ethereum blockchain faces scalability issues as the number of users grows, leading to slower transactions and higher costs. This necessitates scaling solutions to increase transaction speed and throughput without compromising decentralization or security, which are crucial for Ethereum's widespread adoption.

Off-chain scaling solutions are implemented separately from the main Ethereum network and do not require changes to the protocol. They include:

- Layer 2 solutions, such as optimistic rollups and zero-knowledge rollups, which derive their security from the main Ethereum network.
- Other off-chain solutions, such as sidechains, validiums, or plasma chains, which have separate security mechanisms and interact with the main network in various ways
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Rollups

Rollups are a layer-2 scaling solution for Ethereum, designed to enhance transaction throughput and efficiency. They work by "rolling up" multiple transactions into a single batch, processing them off the main blockchain (off-chain), and then submitting a summarized record to the main chain. This reduces the data and computational load on the primary blockchain, enabling faster and cheaper transactions.

There are two types of rollups, each with different security models:

- Optimistic rollups
- Optimistic Rollups operate under the assumption that transactions are valid, which is why they are called "optimistic." These frameworks offer scalability improvements of up to 10-100x compared to the main Ethereum chain. One key feature is the fraud-proof mechanism, which enables anyone to challenge the validity of a transaction within a specified period. If a challenge proves a transaction to be fraudulent, it is corrected, and penalties are imposed on the responsible party. Transactions that go unchallenged are accepted as valid, greatly enhancing Ethereum's scalability and operational efficiency.
- Zero Knowledge rollups
- To enhance Ethereum's throughput, zero-knowledge rollups execute transactions off-chain. A summary of these transactions, along with a cryptographic proof of correctness, is then posted to the Ethereum Mainnet. This cryptographic validity proof confirms that the state changes are a result of the processed transactions. By adopting this approach, the amount of data transmitted to the blockchain is significantly reduced. Additionally, transaction finality is instant as state updates are approved once the validity proofs are verified on L1.
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What is Rollup-as-a-Service?

Rollups-as-a-Service (RaaS) is a specialized service designed to simplify the creation and customization of Rollup chains or application-specific Rollups for web3 projects. RaaS providers offer an integrated stack that handles the complexities traditionally associated with launching Rollups using SDKs and frameworks. This service provides an abstraction layer, eliminating the need for intensive infrastructure management, operating nodes, or writing complex code.

With RaaS, developers can easily tailor aspects like data availability and fee payments to fit their application's needs. The service offers a user-friendly, dashboard-like platform with advanced tooling, allowing developers to deploy production-grade, custom Rollups quickly and without requiring extensive technical expertise in the Rollup stack, similar to how software-as-a-service products operate without the need for users to manage hardware or host services.

Validiums

Validium is a scaling solution that enhances the processing capacity of Ethereum by utilizing off-chain data availability and computation. It operates similarly to ZKRollups, using zero-knowledge proofs to validate off-chain transactions on Ethereum. Unlike ZK-rollups, Validium stores all transaction data off-chain, substantially reducing its on-chain data footprint. This off-chain data model not only boosts scalability (enabling around 2500 transactions per second or more) but also reduces transaction fees for users, as the cost of publishing call data is lower. Validiums focus on transaction privacy and scalability making them primarily beneficial for applications like high-frequency trading or blockchain gaming.

Data Availability

Data availability in blockchain refers to ensuring that the data needed to validate and verify new blocks is accessible to all network participants. This is crucial for maintaining the integrity and security of the blockchain. In traditional blockchains, such as Ethereum, full nodes download each block to verify its contents. However, this approach is challenging for scalability. Modular blockchains, like those using Layer 2 rollups, address this by processing transactions off the main chain and then posting summaries to the primary chain. The key challenge here is to guarantee that all necessary data to recreate the off-chain (Layer 2) state is available, without requiring primary layer (Layer 1) nodes to download and store extensive data. This ensures the security and efficacy of off-chain scaling solutions.

