RESEARCH REPORT

Modular Blockchains & EigenLayer

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KEY INSIGHTS

Key insights:

1. **The Emergence of Modular Blockchains:** Modular blockchains, focusing on specialised functions, offer improved scalability, flexibility, and interoperability compared to monolithic blockchains, signalling a trend towards more efficient and collaborative blockchain architectures.

2. **EigenLayer's Innovation in Ethereum's Security:** EigenLayer enhances Ethereum's security through ETH restaking, allowing applications to leverage Ethereum's security framework while earning rewards. It represents a shift towards decentralised security and network enhancement.

3. **Restaking's Role in Blockchain Security:** Restaking represents a new paradigm in blockchain security, promoting an ecosystem driven by innovation and growth, where ETH can be rehypothecated across various networks, enhancing innovation in application development and growth in validator engagement.

4. **Impact of Celestia and EigenDA:** Celestia and EigenDA are at the forefront of modular blockchain approaches, driving significant advancements in data availability (DA) and scalability for Layer 2 solutions, thereby contributing to the broader adoption and efficiency of blockchain technology.

INTRODUCTION

First, let's define two important terms. A '**Monolithic Blockchain**' is a type of blockchain architecture where all of its functionality is integrated into a single, unified layer. This traditional design offers simplicity and robust security, but can face scalability challenges due to the heavy processing load on the single chain. A '**Modular Blockchain**' is a type of blockchain architecture that separates its core functions, such as data availability and execution, into different layers or modules. This design aims to enhance scalability and efficiency by allowing each module to operate independently and specialise in its specific function.

The blockchain industry is witnessing a paradigm shift towards modular blockchains, largely influenced by protocols like EigenLayer and Celestia. This transition is driven by the need for enhanced scalability, flexibility, and interoperability within the blockchain ecosystem. Modular blockchains, by decoupling core blockchain functions, offer solutions tailored to specific needs. This shift is pivotal in addressing the limitations of traditional blockchain structures, paving the way for more efficient, secure, and user-friendly blockchain applications, and marking a significant evolution in the blockchain landscape.
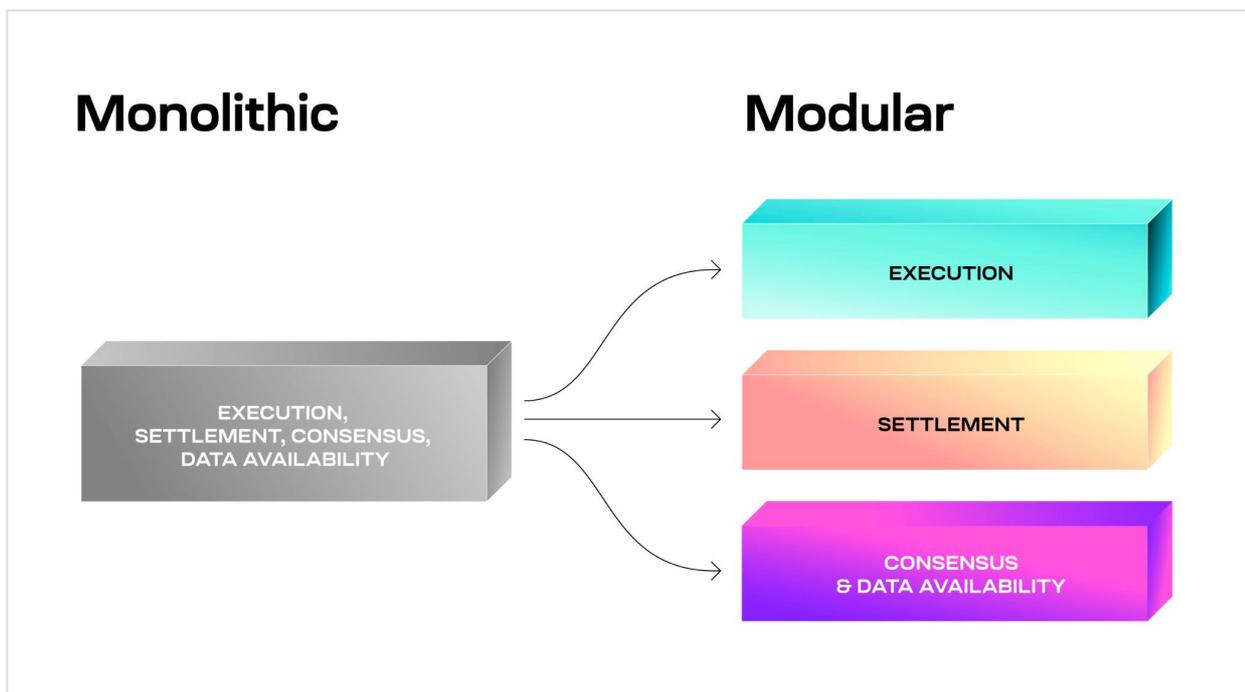
EigenLayer's innovative approach in re-staking ETH and extending cryptoeconomic security demonstrates a significant step forward in this architectural evolution, addressing core challenges faced by earlier blockchain models and setting new standards for efficiency in order to advance the existing Ethereum network.

1.0 MODULAR BLOCKCHAINS: AN EVOLUTION IN BLOCKCHAIN ARCHITECTURE

Overview

Modular blockchains are specialised blockchains focusing on the distinct layer functions of blockchains (execution, settlement, consensus, and data availability). This specialisation fosters scalability, flexibility and interoperability. These qualities are crucial for mass adoption of blockchain applications for end users as the blockchain space aims to solve the blockchain scalability trilemma.The blockchain trilemma refers to the idea that it's hard for blockchains to achieve optimal levels of the three properties of blockchains; decentralisation, security, and scalability.

Source: Celestia

Traction & Growth

The Ethereum network is increasingly transitioning to a modular framework in order to reap the benefits of performance, scalability, and long-term sustainability through sharding. This is seen in the growth of rollups on the Ethereum network with networks like Optimism and Arbitrum drawing in significant Total Value Locked (TVL). Support for these Layer 2s can be seen by the Ethereum Foundation's efforts, specifically in Ethereum's move to push Proto-Danksharding through EIP-4844, essentially lowering fees for Layer 2s significantly.

The future evolution of this move to rollups is a move to modular rollups where efficient data availability chains (such as EigenDA) are utilised instead of Ethereum's expensive mainnet DA. We expect to see significant growth in modular solutions in the future; teams will utilise highly efficient solutions from various different modular chains in order to meet specific demands.

Comparison with Monolithic Blockchains

Modular blockchains, in contrast to the more resource-intensive and rigid monolithic blockchains, offer greater economic efficiency, higher throughput, enhanced security, and flexible dApp control.

This approach fosters a collaborative approach, as seen in Eclipse L2 - an Ethereum Layer 2 solution, integrating Celestia's data availability, Solana's Virtual Machine execution, and Ethereum's validation and settlement. Such innovations pave the way for interoperable blockchain layers, raising key questions about the dominant token for collateral and the protocol that will unify these services for developers and users.

How The Modular Stack Works

Source: Celestia

Execution: The execution layer's primary job is defining smart contracts and transactions, and then deploying. The execution layer is where a rollup will sit atop and where user-facing applications exist. The execution layer will publish batches of transactions to the settlement layer and pay a fee in its native token.

Settlement: The settlement layer is the functional hub for execution layers to verify proofs, resolve fraud disputes, and bridge between other execution layers. The settlement layer provides finality and provides data from the execution layer to the data availability layer for it to be verified via consensus.

Data Availability: The data availability layer in a modular blockchain stack is responsible for storing transaction data for record keeping. This is required so nodes can access data to verify transactions on chain and achieve consensus.

Consensus: In the consensus layer, blocks are validated using Proof of Stake by submitting values to a network of validator nodes, which then reach consensus on the appending of new blocks to the chain.

2.0 EIGENLAYER: ENHANCING ETHEREUM'S CRYPTOECONOMIC SECURITY

What is EigenLayer?

EigenLayer is a groundbreaking protocol developed atop the Ethereum network that introduces the novel concept of ETH restaking. This protocol enables the extension of cryptoeconomic security to a variety of applications on the Ethereum network.

By restaking ETH or its liquid staking tokens (LSTs), users can leverage Ethereum's existing security framework to validate new applications, and earn additional rewards through a market-driven fee mechanism. EigenLayer's first product to utilise restaked ETH is their modular data availability chain, 'EigenDA'.
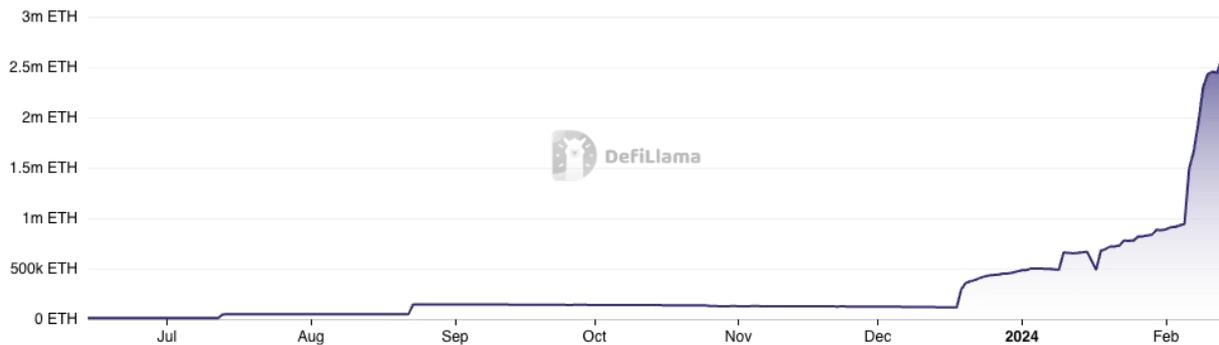
Foundational Background

Founded in 2021 by CEO Sreeram Kannan, a former professor and head of the University of Washington's blockchain lab, EigenLayer has found great success in 2024.

EigenLayer's founding team is composed primarily of researchers and engineers from the UW Blockchain Lab where they worked alongside Kannan in order to publish a strong history of well-regarded academic publications regarding blockchain architecture. Their academic expertise in blockchain technology has been a cornerstone in the technical development of EigenLayer.

Traction and Ecosystem Growth

As of the latest data, EigenLayer has an incredible total value locked (TVL) of 2.43 million ETH, equivalent to approximately US$6.47 billion. The testnet ecosystem currently consists of 45 different node operators, 8 rollup infrastructure providers using EigenDA, and 13 Actively Validated Services.This traction showcases a robust and expanding network and is impressive when considering EigenLayer has yet to launch its inhouse AVS, EigenDA, on Mainnet.

Source: DefiLlama

Actively Validated Services (AVSs): An AVS is defined as any system requiring its own distributed validation semantics for verification, notably including sidechains and data availability layers. In plain terms, any protocol that requires its own trust network. AVSs will be key in the development of the EigenLayer ecosystem.
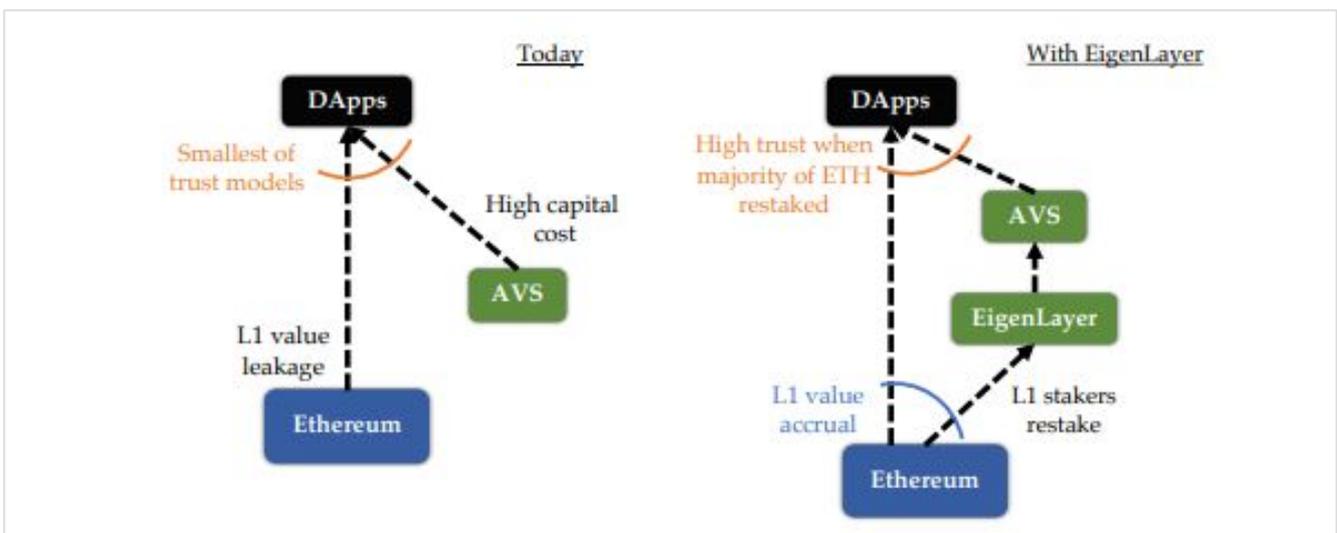
AVS to watch:

1. **Espresso**: Introduces decentralised sequencing using restaking for Ethereum alignment and strong economic security. Aims to eliminate centralised sequencers seen in optimistic rollups today and therefore enhance credible neutrality.
2. **Hyperlane**: Using EigenLayer to enable interchain app developers to secure messages using restaked economic security. For example this allows an account on one chain to make smart contract calls on remote chains therefore increasing interoperability.
3. **NEAR**: Building a fast finality layer to improve composability and liquidity within the Ethereum rollup ecosystem. NEAR is at the forefront of account abstraction and aggregation, a segment we believe will see substantial growth in 2024.
4. **WitnessChain**: A watchtower network using restaking for Proof of Diligence in order to ensure rollup sequencer security in a decentralised manner using Proof of Location to assure trustlessness.

Significance:

We believe EigenLayer as a protocol is significant for several reasons:

1. **Diversifying ETH Staking:** It reduces centralization risks inherent in protocols like Lido, by decentralising the staked ETH pool through different operators with differing risk appetites and governance. In doing so it also allows ETH stakers to gain more choice in allocating their capital, we are beginning to see this come to fruition through Liquid Restaking Tokens (LRTs) such as Swell's rswETH.
2. **Aligning with Ethereum's Principles:** EigenLayer is permissionless at base level and incentivizes increased levels of ETH staking, enhancing network security and helping to build towards the vision for Ethereum's endgame of fast data availability and light nodes through EigenDA and a modular stack.
3. **Advancing Ethereum's Scaling Solutions: I**t contributes to Ethereum's scaling strategies by allowing for greater flexibility in security and fees, therefore further incentivizing innovation and product development within the Ethereum ecosystem.
4. **Hyperscales ETH And Increases ETHs Network Effect And Security:** EigenLayer solves the problem for new decentralised services on Ethereum that don't use the Ethereum Virtual Machine (EVM) and, as a result, need to establish their own trust networks, which can fragment security and liquidity. EigenLayer allows any service to leverage Ethereum's staker security and its settlement layer, enhancing interoperability and the use of ETH as a security asset for various protocols. This enables developers to concentrate on innovation rather than building new trust networks. Additionally, EigenLayer aims to improve Ethereum's fee model by facilitating exchanges of security with applications, which pay fees in ETH, thus supporting ETH's value and leveraging the EIP-1559 burn mechanism. As a result, users get a fee model that scales with the network beyond activity that was previously limited to the EVM.

Source: EigenLayer Whitepaper

3.0 RESTAKING: A NEW PARADIGM IN BLOCKCHAIN SECURITY

What is Restaking?

Restaking is the rehypothecation of staked ETH in order to secure trust across different networks. This is achieved by validators opting-in to provide ETH to AVSs where their pooled ETH is then submitted to new slashing conditions in return for additional rewards on the staked ETH. This works as an open market allowing users to opt-in based on their risk tolerance and perception of where value lies. As such, this creates an ecosystem where innovation is key as only the best applications will continue to accumulate ETH from validator pools.

Key Players

Major players include LST providers like Lido, Swell, RocketPool, Stader, and Coinbase. Some of these entities are increasingly introducing Liquid Restaking Tokens (LRTs) to maintain liquidity for users wishing to restake with EigenLayer and provide governance to users looking to navigate the restaking market. Alongside ETH staking services, there has been considerable interest in accessing EigenDA from rollup infrastructure providers. Notable projects include: AltLayer, Mantle, and CELO. AltLayer recently opened its airdrop claim allowing users with EigenLayer 'Restaked Points' to claim an allocation of the project that now has a FDV of $3.5 billion. This will likely be the first of many airdrops allocated to EigenLayer restakers by AVSs in the future as projects within the ecosystem begin to launch publicly and reward validators. As such, it is expected that strong liquidity will continue to flow into restaking due to the strong presence of the airdrop farming community.

Traction & Growth

Restaking has seen sizable interest from the LST community and the airdrop farming community, looking to qualify for airdrops from LST protocols, EigenLayer, and EigenLayer's associated AVSs at the same time. This has seen a huge growth in LST protocols as well as the amount of ETH re-staked to EigenLayer. EigenLayer LST deposit caps recently reopened and saw the LST share increase from 3.5% to 6.6% in a matter of two days, showing large interest in re-staking among LST users. This growth trend can be identified clearly by looking at LST protocol Swell (another Apollo investment covered here) which has seen their TVL grow **505%** since December 2023 as a result of the increased interest in LSTs and LRTs, the wider awareness of the re-staking narrative, and users looking to qualify for airdrops from both Swell and EigenLayer, simultaneously.
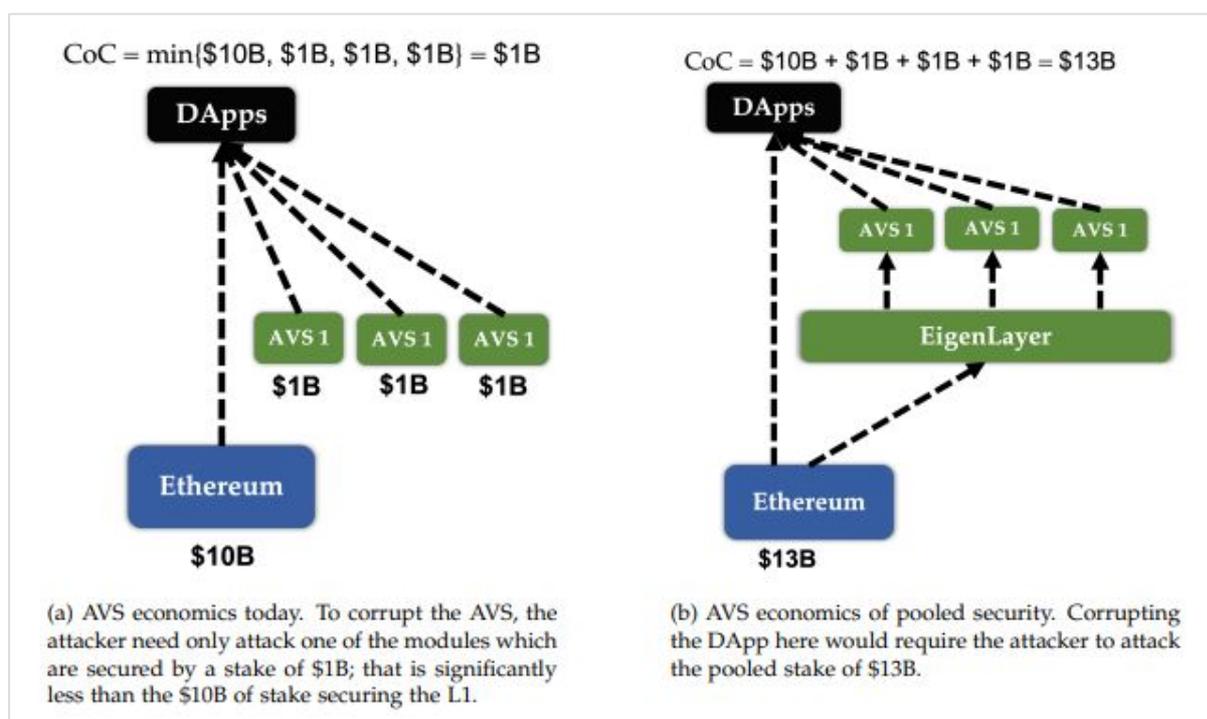
Why is it Important?

Improves innovation and growth of AVSs: Ethereum's security model is limited in what it allows to be built on top of it. Specifically, dApps that cannot be deployed on EVM cannot utilise the settlement layer of Ethereum. This applies to any application that requires its own actively validated system (AVS), which includes any project that has an alternative consensus protocol or a different virtual machine as well as general infrastructure that is critical to the Ethereum ecosystem such as bridges and data availability layers. EigenLayer aims to fix this and allow innovation to occur using Ethereum's security model again.

Reduced Capital Cost: Reusing ETH to provide security across many services reduces capital costs for a staker and therefore is a significant improval in value accrual due to a removal of opportunity cost. Reusing ETH also significantly increases the viability and sustainability of a project long-term by reducing capital and opportunity costs for app builders that would otherwise be incurred in assembling its own validator set.

Greater Liquidity & Security: Reusing ETH significantly increases the trust guarantees to individual services due to the Pooled Security of restaked ETH. This is due to the fact that the attack cost becomes greater when attached to the security of the Ethereum network. Further, the rehypothecation of ETH reduces fragmentation of liquidity and fixes an inherent value leak in Ethereum's current security model by aggregating and consolidating security into ETH. Considering the strong underlying security of ETH, EigenLayer has aptly become known as the "marketplace for trust" for AVSs.

(a) AVS economics today. To corrupt the AVS, the attacker need only attack one of the modules which are secured by a stake of $1B; that is significantly less than the $10B of stake securing the L1.

(b) AVS economics of pooled security. Corrupting the DApp here would require the attacker to attack the pooled stake of $13B.

Source: EigenLayer Whitepaper

4.0 CELESTIA AND EIGEN-DA: PIONEERING MODULAR APPROACHES

Celestia: Brief Overview

Simply put, Celestia is a modular data availability (DA) blockchain that scales with user growth.

It facilitates the deployment of smart contracts as blockchains, offering fast throughput and dynamic scaling through concepts such as sovereign rollups, Data Availability Sampling and Light Nodes.

Its DA service has seen considerable growth in users and is currently being used by various rollups and crypto infrastructure protocols in order to scale.

Traction & Growth

Celestia has seen significant growth in its valuation with its token's (TIA) price appreciating **724.27%** since inception in October 2023. Celestia's adoption and price action has largely been fueled by the TIA airdrop which was allocated to DeFi users before its launch.

On top of this, there is continued demand for the TIA token as it serves as an eligibility criteria for many airdrops from dApps utilising Celestia for data availability.
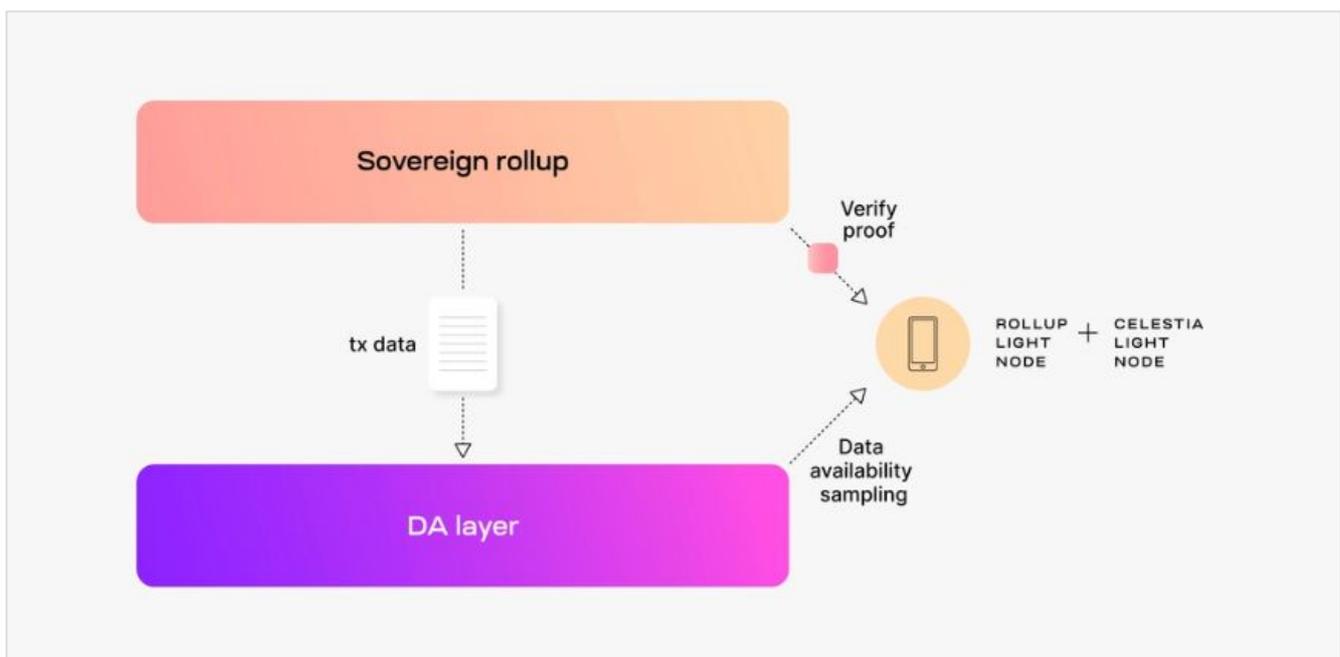
The Celestia token has received strong support from stakers with almost 50% of the current supply being staked. In comparison, ETH only has 24% of total supply being staked.

Why is it Important?

Celestia has been influential due to being first of its kind as a modular DA chain and the myriad of benefits it brings to protocols utilising it for DA. These benefits include:

1. **App Acceleration:** The acceleration of dApp roll outs by allowing users to deploy smart contracts as blockchains and bootstrap the TIA token's security.

2. **Modular Design:** Due to its modular design, it allows for any virtual machine to utilise it and therefore, it instantly attracts the largest pool of developers gaining access to builders across the entire crypto ecosystem.

3. **Enhanced Throughput:** Celestia's design incorporates sovereign rollups, data availability sampling, and light nodes, enabling dynamic scaling of throughput in line with user growth. The sovereign rollups architecture eliminates the need for the slower peer-to-peer gossip protocol, fostering a user-scalable network. Data availability sampling facilitates nodes in verifying computations while downloading only a minimal fraction of data, thereby fostering a robust network of light nodes verifying data instantaneously. Consequently, transactions are verified by the light nodes within the rollup and by Celestia light nodes, rather than on the settlement layer seen in smart contract rollups.
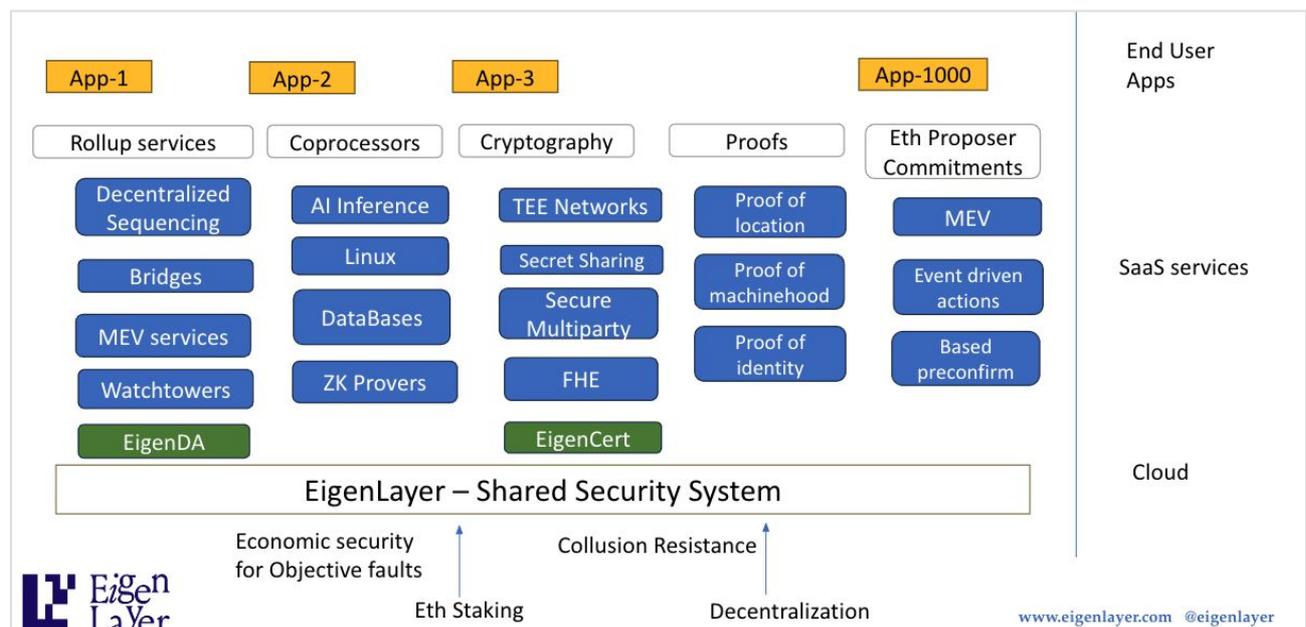

Source: Celestia

EigenDA: Brief overview

EigenDA operates in a similar fashion to Celestia as a data availability service for Layer 2s. allowing them to access the data availability layer in a more scalable manner while still preventing centralisation risks due to low constraints on node operators. However, EigenDA differs from Celestia as it derives its security from ETH validators and also delivers value back to ETH validators rather than launching its own token as seen with TIA. As such, it can be argued that EigenDA provides greater security due to Ethereum's large existing network effect and therefore greater pooled security.

Traction & Growth

Stage 2 of the EigenDA testnet is currently underway with operators validating the EigenDA as an AVS and rollups being able to use EigenDA for data availability. This is providing real testing for the EigenLayer platform and the EigenDA use case. Stage 3 is expected to follow and introduce further AVSs other than EigenDA to testnet and will push EigenDA to mainnet for validators to secure with ETH. Stage 3 is currently set for 2024, indicating a high likelihood of significant further growth for EigenLayer and EigenDA within the year. Once we see EigenDA on Mainnet, we expect traction to grow explosively in a similar fashion to Celestia. We believe this growth will hold strong as more apps look to make use of EigenLayer's pooled security.
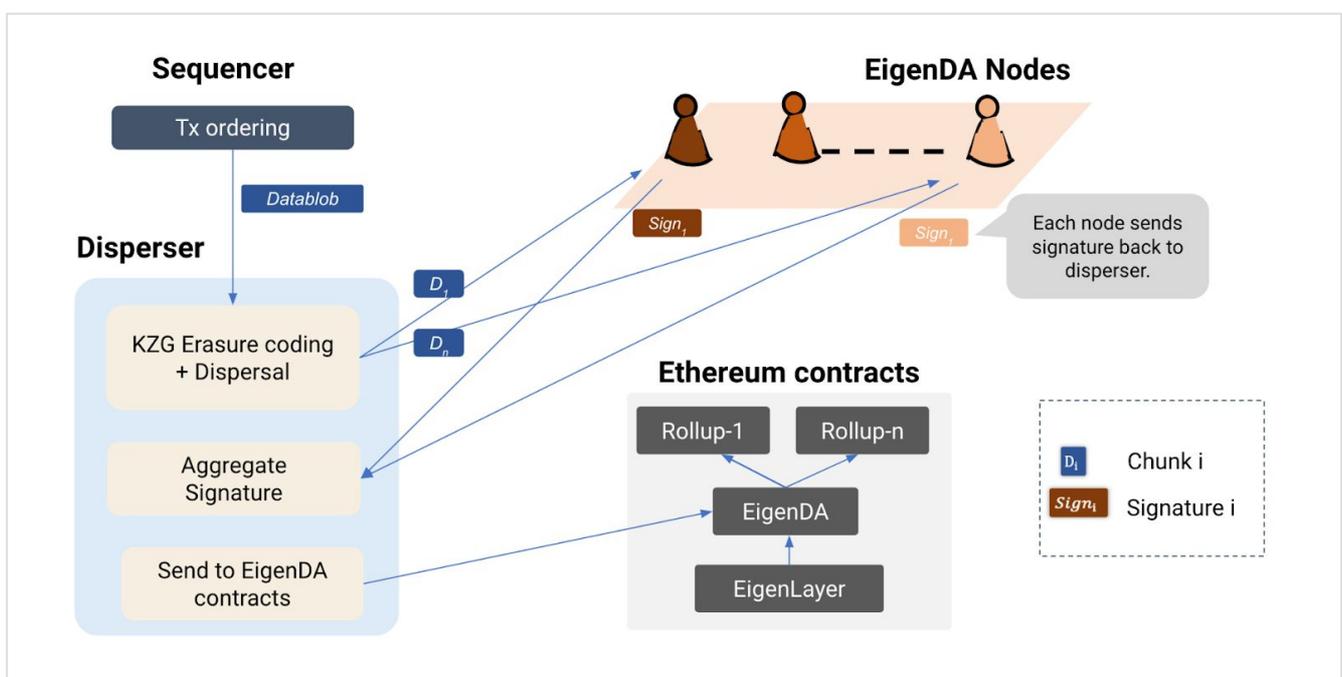

Source: EigenLayer Blog

Why is it Important?

EigenDA is important as it provides scalability to Layer 2s on all networks and advances the push towards the Ethereum endgame while drastically cutting costs. It achieves this through four key properties; economics, throughput, security, and customisability.

- **Economics:** EigenDA reduces operational costs by using sovereign rollups with erasure coding, which breaks data into smaller pieces and requires only partial data storage by operators. This approach makes EigenDA cost-effective and scalable, as more nodes can join without being overwhelmed. Additionally, it ensures cost-effective and reliable fee structures for rollups due to its high throughput and congestion reduction, and offers bandwidth preservation for discounted data availability for Layer 2s. Furthermore, EigenDA, through EigenLayer's restaking feature, eliminates the opportunity cost of staking for data availability layers by allowing stakes to be used across multiple applications.

- **Throughput:** EigenDA's throughput is drastically increased through its modular design decoupling DA from the consensus layer. This allows EigenDA to get rid of the complexity of an ordering system and instead focus purely on a DA system that allows nodes to independently verify data. On top of this, EigenDA has dispersers send data blobs directly to EigenDA nodes therefore reducing network latency and reducing the need for an expensive and slow gossip protocol among nodes (similar to Celestia).

Source: EigenLayer Whitepaper

- **Security:** By using restaked ETH, EigenDA borrows the distinct aspects of economic security and decentralisation inherent to the Ethereum ecosystem. Beyond this, due to EigenDA's architecture of instantaneous data, it becomes highly censorship resistant by removing the choke point required to order data blobs and instead instantly receiving signatures from many EigenDa nodes. On top of this EigenDA implements its own unique security features of 'Proof of Custody' as well as 'Dual Quorum' in order to provide another level of independent security.

- **Customisability:** Due to the modular nature of EigenDA developers are able to adjust parameters as required and can opt in to trade offs based on their economic decisions. As such, EigenDA provides highly efficient solutions to rollups.

Criticisms:

Vitalik Buterin, the co-founder of Ethereum, has expressed concerns about the EigenLayer protocol and its practice of "restaking". Buterin's primary concern with this primitive revolves around the risk of overloading Ethereum's social consensus layer. He believes that while using Ethereum's validator set for purposes beyond the core protocol isn't inherently wrong, these applications should not rely on Ethereum's social consensus for resolving issues or recouping losses. Buterin warns against applications that might expect a fork or reorganisation of the Ethereum blockchain as a bailout for their failures when they become "too big to fail" as it may cascade to cause systematic risk. As such in discussions with Kannan (EigenLayer CEO), Vitalik has urged that restaking should be used for 'low-risk' applications and credible neutrality needs to remain in attracting restaked ETH to applications. Such a precedent of reorganisation exists on the Ethereum network where Ethereum had to fork in 2016 as a result of the devastating losses caused by the infamous hack of 'The DAO' causing Ethereum Classic to hard fork.

Conclusion

In conclusion, this report highlights transformative shifts in blockchain technology with EigenLayer revolutionising Ethereum's security model through ETH re-staking and fostering decentralised network enhancement. Restaking emerges as a novel security paradigm, enhancing ecosystem innovation. The rise of modular blockchains indicates a move towards more scalable, flexible, and interoperable architectures, with Celestia and EigenDA pioneering this shift and significantly contributing to rollup development. These advancements collectively signal a maturing blockchain landscape, poised for increased efficiency and wider application adoption through highly customised solutions. This will ultimately lead to improved experiences for end users. We believe that modular blockchains will be a major theme in crypto markets in 2024 and beyond, and we have therefore made investments in EigenLayer, Celestia, Swell Network, and other pioneering protocols as we believe they are best in class and well positioned to benefit from this movement.