Comparative Study of Data Availability Schemes in Various Blockchains

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***Abstract*—We make a Comparative benchmarking study of currently polkadot's ELVES data availability protocol with emerging data availability solutions which includes Avail, Celestia, Espresso's-Tiramisu and NEAR's sharded DA.**

We made a comparison in terms of bandwidth, time, latency, block time, block size, robustness degree and cost per megabyte of data availability.

I. Introduction

The Blockchain technology is a constantly evolving field that has garnered significant attention and value in recent years. However, despite its growing prominence, the decentralized systems are facing challenges in scaling Blockchains in terms of data availability. Data availability is a critically important aspect of blockchain technology. Data availability refers to the ability of a blockchain network to ensure that all necessary data is accessible and retrievable by all its participants. In a decentralized system, Where multiple nodes work together to validate and store data/transactions, ensuring that the data is avaliable, valid and accessible is quite a important factor for maintaining the integrity and decentralized nature of the network [1].

This study provides a Comparative study among the latest avaliable Data availability solutions/models in terms of bandwidth, time and other criteria to provide a bigger overview of pro's and con's of every model.

The Models included in study are as follows:

- Polkadot's ELVES
- Celestia
- Espresso Tiramisu
- NEAR
- Avail

The below is a breif short introduction of the models that will be discussed and analyzed in the study.

A. Polkadot ELVES

Polkadot is a sharded L0 multichain network the enables cross-chain interoperability and scalablity. It utilizes ELVES (Economic Last Validation Enforcement System) to ensure data availability and validity of the parachains. Polkadot uses a hybrid consensus mechanism which uses BABE for block production and GRANDPA for its block finality. ELVES uses Reed Solomon encoding to split the data into chunks and then disperse it all across the network.

Polkadot uses Nominated Proof of Stake (NPoS) consensus mechanism which allows token holders to nominate entrusted validators to secure the network.

B. Celestia

Celestia is one of the first mover in the modular Data Availability solution space playing a major role in L2 and rollups developments. Celestia as of now utilizes 2D-Reed Solomon Erasure coding to split data into chunks and then encode into a matrix extension Namespaced Merkel Trees are then used to ensure the retirval and validity of the data. The root of the NMT is then stored in the block header.

As of now Celestia uses Tenderming consensus mechanism which uses BFT (Byzantine Fault Tolerance) style mechanism to ensure the finality of the blocks

C. Espresso Tiramisu

Espresso-Tiramisu DA resolves the Data availability scaling issue with a three layred system below is the short overview of these three layers.

- Savoiardi (VID Layer) - Erause codes and stores data across all the nodes [2].
- Mascarpone (DA Committe Layer) - A Small elected Committee stores the full data and guarantees to efficiently recover data [2].
- Cocoa (CDN Layer) - Uploads the data on web2 based CDN solution for seamless and speedy data recovery [2].

Espresso utilizes Hotshot consensus which is a optimistically responsive, communication-efficient consensus protocol in a proof-of-stake setting that is resistant to bribing adversaries and scalable to large number of nodes.

D. NEAR

NEAR provides a high speed DA solution which porvides high transaction volumes with cost-effectivenes. NEAR utilizes the nightshade sharding mechanism, which parallelizes the network into multiple shards.Each shard processes its own transactions allowing the network to handle a higher volume of transactions approx 100,000 TPS [3].

As of now NEAR uses sharding-based proof of stake consensus mechanism.NEAR also implements unique validator elections to ensure security and decentralization of the network

E. Avail

Avail DA helps blockchains scale by providing an abundance of data availability capacity. Its modular design scales data availability capacity with demand, and transaction data can be cryptographically verified quickly by anyone running an Avail light client [1].Avail utilizes Erasure coding, KZG commitments along with light client to ensure its data availability.

As for consensus Avail uses BABE/GRANDPA hybrid consensus used by polkadot for block production and finality. Avail also provides Application Specific Data Retrieval (ASDR) this helps rollups to fetch and decode their own blobs even tho the block might contain many app's data. [4].

TABLE I
SHORT COMPARISON OF ALL DA SOLUTIONS

Feature	**Polkadot**	**Celestia**	**Espresso Tiramisu**	**NEAR**	**Avail**
Consensus	BABE/ GRANDPA	Tendermint	HotShot	Night-shade	BABE/ GRANDPA
Storage	Erasure Coding	Reed-Solomon	Three-layer system	Sharding	KZG + Erasure Coding
Block Time	20s	15s	˜6s	1s	20s
Max-Throughput	-	0.0159 MiB/s	5 MB/s	-	0.2 MiB/s
Block Size	5 MB	8 MB	1 MB	4 MB	4 MB
Total Validators	600	100	100	300	1000
Cost/mb	-	0.08 USD	-	100kb per NEAR token	0.0173 USD
Native Token	DOT	-	TIA	NEAR	AVAIL
Latency	6-30s	5-15s	-	1-2s	20-40s
TPS	10	-	-	53	420
Txs per block	-	-	-	-	-
Nakamoto Coeff	174	-	-	10	-

II. METHODOLOGY

In this section, we detail the methods and approaches used in our research. The methodology is structured as follows:

A. Research Design

We employed a quantitative research design to gather and analyze data systematically.

B. Data Collection

Data was collected through surveys distributed to a sample population. The survey included questions designed to assess various parameters relevant to our study.

C. Data Analysis

The collected data was analyzed using statistical methods, including descriptive statistics and inferential statistics, to draw meaningful conclusions.

D. Limitations

We acknowledge certain limitations in our methodology, including potential biases in survey responses and the representativeness of the sample.

Future research may address these limitations by employing a more diverse sample and utilizing mixed methods for data collection.

III. RESULTS

In this section, we present the results of our research. The findings are summarized in the following subsections.

A. Data Analysis

We conducted a thorough analysis of the collected data, which revealed significant trends and patterns. The results are illustrated in Figure .

B. Findings

The key findings from our research indicate that [insert key findings here]. These results contribute to the understanding of [insert relevant field or topic].

C. Discussion

The implications of these results are discussed in relation to existing literature. Our findings suggest that [insert discussion points here]. Further research is needed to explore [insert future research directions].

IV. CONCLUSION

In this paper, we have explored the significance of [insert key findings or contributions]. The results indicate that [summarize main results]. These findings have important implications for [discuss implications]. Future work could focus on [suggest future research directions]. Overall, this research contributes to [state the broader impact of the work].

REFERENCES

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