Pyrin Structure

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Abstract

Confronted with the escalating demand for computational resources driven by advancements in AI, alongside the limitations posed by the centralized and often overburdened cloud infrastructure, the demand for resources far outpaces the supply, creating bottlenecks that hamper AI innovation. Moreover, the centralized nature of cloud services leads to dispersion issues, where resources are not optimally allocated. Utilizing blockchain technology, we propose a strategic shift: reallocating computational power from traditional Proof of Work (PoW) [23] mechanisms towards the advancement of AI technologies. This decentralization not only aims to provide a more secure, transparent, and efficient platform for smart contracts (SC) and Proof of AI Work (PAIW) but also addresses the challenges of dispersion by leveraging a distributed network of contributors. Through this approach, Pyrin seeks to democratize access to computational resources, thereby de facto standard where the blockchain significantly empowers AI applications, facilitating a future where technological progress is made accessible to all.

1 Introduction

In an era marked by the burgeoning demand for artificial intelligence computational resources, traditional cloud infrastructures reveal their limitations, unable to efficiently cater to this growing need. Against this backdrop, The Pyrin network [26] introduces a forward-looking vision, aimed at fundamentally reshaping the balance between demand and supply in the digital realm. At the heart of this vision is the strategic utilization of blockchain decentralization, with Pyrin anchoring its framework on the innovative GhostDAG protocol [1, 2, 25]. This groundbreaking approach aims to repurpose the computational power traditionally dedicated to POW [23] towards accelerating AI development.

By harnessing the collective hardware capabilities of individuals worldwide, Pyrin proposes an attractive platform for contributors to earn but also significantly advances AI research and development. This initiative seeks to democratize access to computational power, enabling the AI community to tap into a vast pool of GPUs. Such an approach promises to reduce the time and financial barriers associated with AI model training and execution.

This white paper explores the Pyrin architecture, emphasizing its potential to revolutionize the digital landscape by overcoming the current limitations of cloud services. Through its support for smart contracts and PAIW, it is poised to establish a new paradigm for blockchain and AI integration, fostering a future where technological advancements are both accessible and sustainable.

It's important to note that while this represents a strategic direction and aspiration for Pyrin, the specific implementations and outcomes of this vision are still in the planning stages and yet to be realized. This approach underscores Pyrin's commitment to leveraging advanced technology for creating a more accessible, efficient, and equitable digital future.

2 Background

The objective of overcoming the constraints of traditional cloud GPU infrastructures enables broad access to computational resources for AI development. By tapping into the vast, yet underutilized, pool of GPUs globally; from personal devices to large-scale hardware farms; Pyrin seeks to redefine computational power distribution for AI innovation. At its core, the network focuses on enhancing the experience for both users and developers, offering an intuitive platform for seamless access to necessary resources. With a forward-looking strategy, Pyrin is committed to evolving alongside technological advancements ensuring the democratization of AI development and facilitating a new era of innovation in the AI and blockchain domains.

3 Market Fit

With the current landscape of GPU/TPU demand and cloud computing services, Pyrin positions itself as a revolutionary force capable of capturing significant market share. By offering a more accessible, cost-effective alternative for computational resources, Pyrin stands to redefine the economics of AI development and blockchain technology deployment.

4 Structure

The current Pyrin ecosystem is structured around a strong blockchain infrastructure to provide essential functionalities for network participants. Central to this infrastructure are:

Web Wallet [3]: A key feature that allows users to securely manage their assets, perform transactions, and keep track of their balance directly through an intuitive interface.
Blockchain Explorer [4]: Offers transparency by enabling users to easily access detailed information about transactions, blocks, and the overall state of the blockchain in real-time.
Mining Pool [5]: Facilitates the aggregation of computational resources from various miners to increase the efficiency of mining activities, ensuring stable and fair reward distribution for contributing to network security and block validation.
Additionally, the ecosystem benefits from the incorporation of Archive Nodes. These nodes are crucial for preserving a complete historical ledger of all network transactions. By maintaining this comprehensive archive, the Pyrin structure ensures data integrity and supports thorough auditability and transparency. This integration of Archive Nodes fortifies the network's resilience and adaptability

By concentrating on these core components, the Pyrin network [26] aims to enhance the blockchain landscape, providing a decentralized platform.

4.1 Infrastructure

Pyrin's infrastructure is designed to embrace scalability and agility, employing cutting-edge technologies and serverless cloud solutions, rapid deployment of updates - allowing us to concentrate our efforts on enhancing the product. At the heart of our infrastructure are microservices [12], which operate in concert to create a cohesive, efficient, and resilient system.

These microservices [12], modular in design, facilitate a distributed approach to application development and deployment. Ensures seamless scalability as the ecosystem grows and system's fault tolerance and ease of maintenance. By leveraging serverless computing, we further optimize resource utilization, and operational efficiency, ensuring that our infrastructure can dynamically scale to meet demand without compromising on performance or security.

4.2 User Gateway

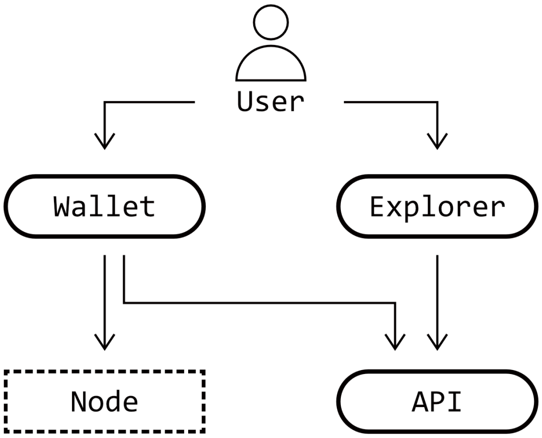

Figure 1: Users engage with services through API-driven architecture, connecting to the blockchain's explorer and wallet, with CDNs to serve statically built files for worldwide access. The front-end employs TypeScript and the Preact framework [6, 7], optimized for performance and user experience with the wallet utilizing client-side sandboxed WebAssembly (WASM) [8] with private key encryption and decryption, enabling secure, user-defined password protection.

Core wallet operations, including transaction signing, are managed internally to maximize security and efficiency built with Rust-based modifications of rusty-kaspa [9, 10] including updates to gRPC interface communication to meet the current node specifications and the incorporation of the BLAKE3 cryptographic hash [11].

A network of load-balanced microservices forms the API layer, streaming real-time data with µWebSockets [13] and implementing custom logic with TypeScript and NodeJS [6, 14].

4.3 Blockchain Integration

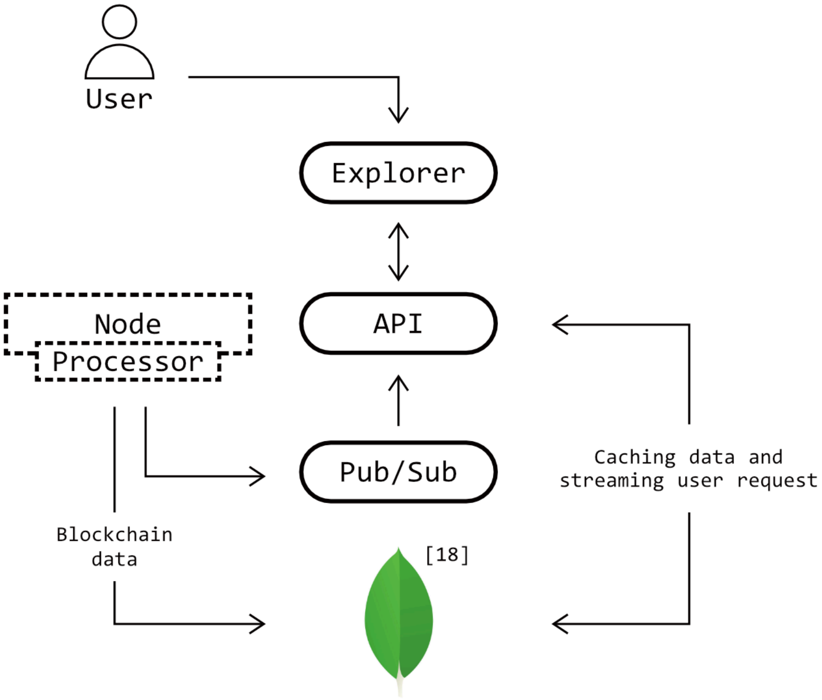

Figure 2: When users browse, they visit the explorer backend by the same API-backend the stream and subscribe to new changes in real-time using the pub-sub component, Processor is a component in the same Virtual Machine (VM) [15] as the node for best latency and performance. Processing and syncing the MongoDB [18] to be later served for the users.

Our integration with the blockchain is designed to serve scaled traffic without the need to scale the node instance, a processor microservice that lives in a VM [15] with a local node, listening to new blocks and transactions.

The processor will parse and handle the incoming data and will store it in a serverless NoSQL MongoDB in horizontal scale [16, 17, 18, 19] which is also being read from the API serving the users in a performance of $O(log\, n)$ and execution time of $10ms - 50ms$ as for read specific document holding e.g. an address details[1] where balance[2] and transactions[3] count are being tracked to give $O(1)$ and $\sim 10ms$ performance reading this often accessed data.

The processor also pushes data to a Publish–subscribe serverless [20, 16] which is captured by the APIs instances, with the high-performance µWebSockets we can scale horizontally [13, 19] at an inexpensive compute cost and easily distributed.
Each API instance caches publicly accessed data like the dashboard metrics[a] and streams user-specific processed data of the blockchain from the database [18].

$$E_{stream} = \frac{N_{messages}}{T_{processing} + T_{latency}}$$

Where E_{stream} represents the efficiency of the data streaming process, $N_{messages}$ is the number of messages processed per unit time, $T_{processing}$ is the average processing time per message, and $T_{latency}$ is the network latency involved.

This also includes the explorer [4, 5] subscribing to relevant data on the user current page, metrics[a] of the dashboard, balance and transactions update in the address page etc, all in real-time.

[1] Holding details of an address contains balance, transactions count, last transactions time and more metadata.

[2] Balance of the account is being tracked with the streamed data of the processor, it will query the node for a new address's balance and update the address's document. This can be further improved by tracking the UTXOs[x] and calculating the balance.

[3] Transactions count is being tracked and counted, allow for many reads $O(1)$ while writes are predictable.

[a] Dashboard metrics are real-time data from the blockchain streamed from the processor using the pub-sub, this info being cached and emitted to all connected clients' views in the explorer.

[x] UTXOs hold the records of the address's spendable tokens, account balance is the total amount.

4.4 Pool[1]

The infrastructure of the pool is connected to the explorer ecosystem with additional components unique to the pool. A pool is a bridge that acts as the mining pool[1] [21], spreads across multiple regions covering most of the countries to provide the best latency; the state is managed with that in mind to track the work of each miner [23] to later reward with their corresponding contribution.

$$R_i = R \times \frac{S_i}{S_{total}}$$

R represents the total block reward. Si is the number of shares submitted by miner i and S_{total} is the total shares submitted by all miners. The reward for miner i, R_i is calculated as a proportion of their shares to the total, ensuring rewards are distributed based on individual contributions.

To ensure stable state management with high throughput, we deployed enterprise SLA Redis [24] where all the bridge instances are $incrementing$[2] shares into a single global state as this makes the currency of the pool, converted to coins profit. Redis is taking care of the internal Pub/Sub [20] to sync important data and updates instantly and allow the ecosystem to react to the pool in real-time experience.

Looking ahead, the pool aims to expand its functionality to support AI tasks, aligning with the PAIW concept. This evolution will provide miners with additional avenues for profitability, leveraging their computational power not just for mining but also for contributing to AI development. Such an innovative approach promises to enhance the utility and appeal of mining within the Pyrin ecosystem.

[1] Pool mining in POW [23] blockchains, such as Pyrin [5], involves multiple miners combining their computational resources to increase their chances of successfully mining a block and receiving rewards. Instead of mining individually, miners join a pool where they collectively contribute their computing power. When a block is successfully mined by any member of the pool, the rewards are distributed among all participants based on their contributed computational power.
Pool mining helps smaller miners receive more consistent rewards and reduces the variance in income compared to solo mining.

[2] Ensuring a consistent global state management of critical and high-throughput streamed data we are using Redis $HINCBY$ [28].

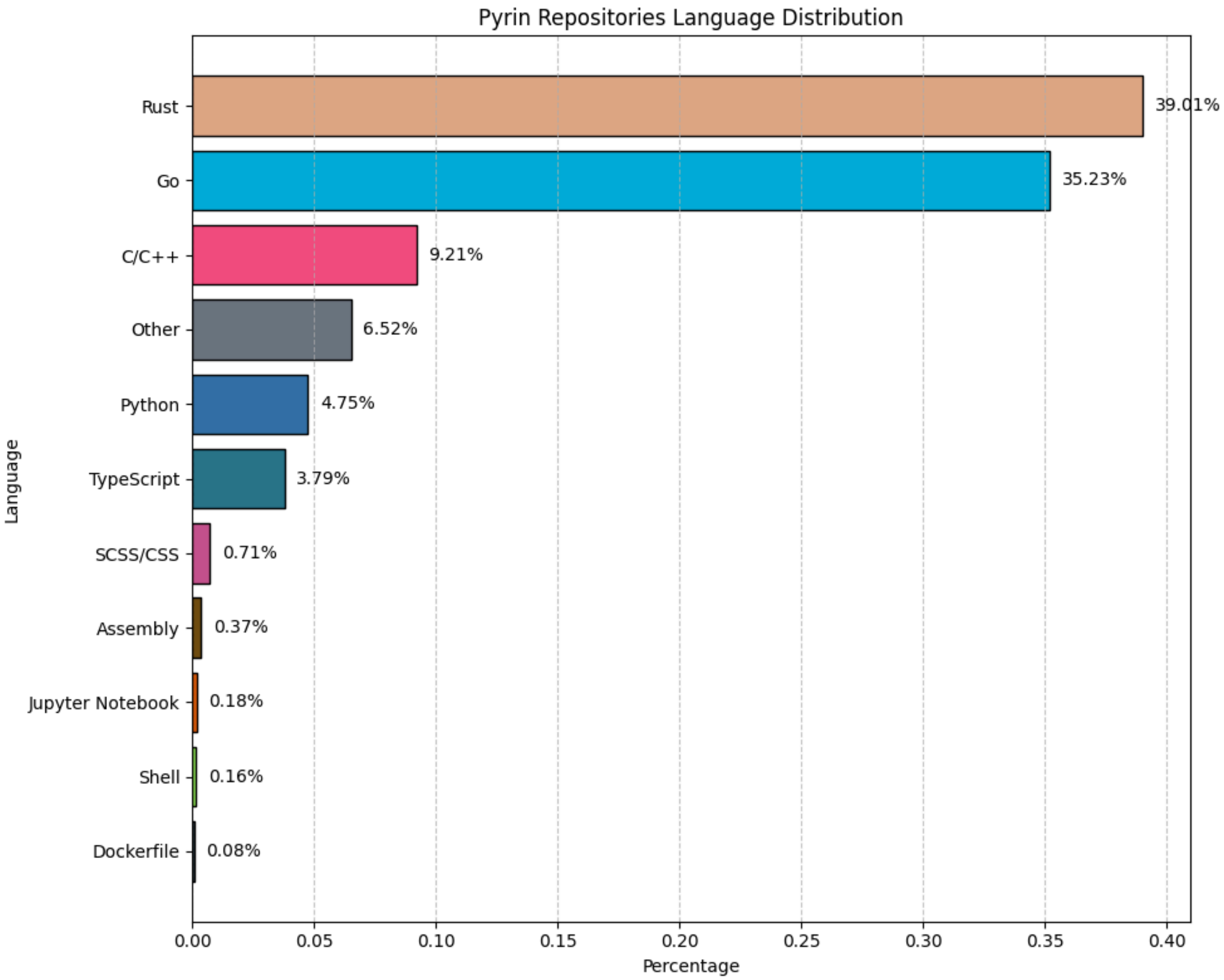

Figure 4: Current repositories languages ratio [27]

5 Tokenomics

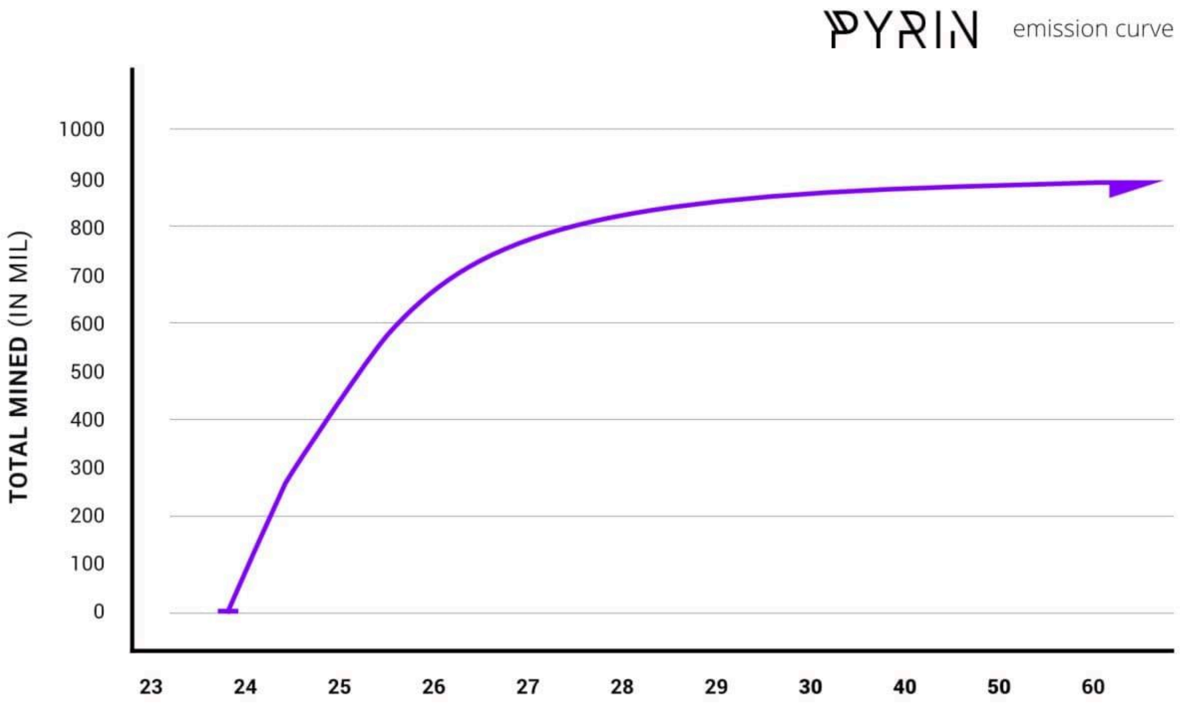

Figure 5: Coins emissions over time [22].

The launch of the PYRIN genesis block on Tuesday, November 22st, 2023, at 4:59:59 p.m. EST, marking the beginning with a fair launch that specifically excluded pre-mining or initial sales, emphasizing the network's commitment to fairness and equity right from the start, marks its operation as a fully decentralized, community-managed project, underscoring its dedication to open-source principles.

The total supply of PYRIN coins is capped at 1 billion, with a unique issuance schedule that features annual halving adjusted by a factor of $(1/2)^(1/12)$ every month, ensuring a steady, controlled release of new coins into the system. This methodical approach to supply management is set to initiate its first reward reduction from 17 $PYI to 14 $PYI in May 2024, marking a significant milestone in Pyrin's economic model.

6 Conclusion

This paper introduces the Pyrin structure [25] meticulously built to serve Pyrin's future interests, detailing all the core system components constructed with wisdom to ensure the network's resilience and full flexibility.

Looking ahead, we are dedicated to refining and expanding Pyrin's ecosystem, with plans to deepen the integration of PAIW across our platform. Our vision includes broadening the network of contributors, enhancing the developer and user experience, and establishing partnerships that will extend the impact and applicability of our technologies. As we forge ahead, we remain committed to our mission of democratizing access to computational resources, thereby empowering developers and innovators around the globe.

We invite the community — researchers, developers, and like-minded people — to join us in this pioneering endeavor. Together, we can explore the vast possibilities offered by the integration of blockchain and AI, through the lens of PAIW. It is our collective creativity and collaboration that will drive the future of this exciting technological convergence, paving the way for a new era of digital innovation.

References

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