Reppo: The Resource Coordination Layer for AI

Daniel Gretzke, Trevor Jacka, Kiran Karra, Raghav Rmadya

Reppo Foundation

Abstract

As artificial intelligence becomes commoditized and most of the value accrues at the agentic and application layers, access to the foundational elements required to build and deploy AI, namely—**data**, **infrastructure**, and **capital** (collectively referred to as *Resources*)—remains highly fragmented, permissioned, and disproportionately controlled by entrenched actors. We present Reppo, a unified and decentralized architecture for a **user-centric, permissionless coordination layer**, designed following the principles of intent-centricity so that AI developers, agents, and physical AI can discover, negotiate, commit, settle, and access resources on demand, on-chain or off-chain, in real time. In this paper, we outline motivations and discuss the architecture of the capital coordination layer, providing an intuition for the rationale of the design, and describe how Reppo disentangles the choices of protocol, product, and security.

1 Background and Motivations

We are entering a world where AI agents and physical AI will soon surpass humans in their consumption power (and eventually in number), and this set of users need permissionless ways to access and consume Specialized Data, Infra, and Capital (collectively defined as'Resources'), on demand, without allegiance to a specific L1 or Ecosystem lock-ins. This involves three steps:

1. Enabling AI agents, developers, and physical AI to discover relevant resources based on real-time demand, not contracts, integrations, or partnerships, through an intent-centric architecture.
2. Composable tooling and frameworks to facilitate price negotiation and resource commitment, settlement and consumption between users and providers.
3. Long-term incentive alignment for Data, Infrastructure, and Capital owners to benefit from compounding value of AI production through alternative monetization schemes instead of one off spot pricing at sale.

Although decentralized AI (DeAI) projects have made significant progress in incentivizing crowdsourcing of data and hardware, they are still stuck in supply side games with significant spending on partnerships, business development, and marketing to convince users that theirs is the best warehouse. Fortunately, non-human users such as AI agents and Physical AI don't care about these tactics and prefer to have real-time access to resources, regardless of supplier and source. The reality today is that developers, agents, and physical AI are forced to either plug into a single LLM or opt for a specific L1 for AI chain/ecosystem stack without the freedom to opt for a modular approach for their evolving data and infra needs across web2 and web3 stacks. As far as capital access is concerned, hackathons, fellowships, accelerators, and traditional venture capital still remain the norm, and any efforts to tokenize AI applications and agents have led to tokens akin to memecoins. A notable exception, which we acknowledge with healthy skepticism, is Bittensor. However, the Bittensor ecosystem is plagued with three inefficiencies - High cost of entry, Centralized validator assessment (which dTAO may or may not meaningfully address), and Subnet ejection without cause. Furthermore, the market cap is not necessarily a strong indicator of actual network usage.

Large incumbents in the AI industry today are accustomed to Foie gras style backing from VCs, giving them seamless access to data, infra, and capital while independent developers and emerging consumers such as AI agents and Physical AI face steep barriers: siloed and permissioned data access, monopolized compute infrastructure requiring interaction with human-in-the-loop decision makers, and capital flows that depend more on location, connections, or prestige than merit. In our view, this was not the promise of AI x Web3.

2 Introduction

To address these concerns, we introduce **Reppo**, a decentralized network that enables **on-demand and permissionless access** to Resources. Reppo achieves this through two key innovations:

- First, Reppo leverages **Solver Nodes**, which act as programmable matchmakers within Reppo's native **Data and Infrastructure Exchanges**, allowing AI developers, agents and physical AI to independently discover, negotiate, commit and settle specific data and infra of needs, independent of individual constraints of the supply side actor. In doing so, we shift from the current setup of burdening the end user with information distillation and choice selection to a declarative paradigm for interacting with resources. Solver nodes aggregate demand signals and flow traffic to relevant data and infra providers and networks in real-time, which streamlines the user experience for users who only care about their constraints and the outcome.
- Second, Reppo implements a novel version of **veTokenomics**, introducing a differentiated incentive design that directly aligns the interests of AI builders - both human and autonomous - with network contributors, without relying on centralized governance capture. Critically, this model enables builders to access network emissions that are governed by the community, **without giving up an equity stake in AI models, apps and agents**, unlocking new pathways for the development of sustainable and sovereign AI projects.

In this paper, we focus primarily on this second innovation. Reppo's **coordination and incentive mechanism**, which redefines how value is created, distributed, and sustained in the AI development stack. Separate technical overviews with details about architectures behind the Data and Infrastructure Exchanges and Solver Nodes will be subsequently released.

3 Core Concepts and Stakeholders

As AI becomes a commodity as critical as electricity, the focus must shift from creating the single largest god model to a network of smaller specialized apps, models, and agents. This requires empowering users i.e. individual AI developers, agents and physical AI, with on-demand access to specialized resources, i.e. data, infra and capital. On the Reppo network, they are represented by a "pod" - an on-chain entity/collective in which users import their digital commodities i.e. apps, models, agents, and even datasets to interact with the Reppo ecosystem. Each pod can be seen as an intelligence service provider that monetizes the commodities it owns and hosts, both on-chain and off-chain. To interact with the Reppo ecosystem, users are not expected to "build on Reppo". Rather, they can build using their preferred stack wherever they want.

Reppo enables users to access token emissions to expand their pod operations and be part of a network that allows their pod services to be discoverable by potential users. To realize this benefit, users must create pods. Pods interact with Reppo's economic model, which extends the vote-escrowed tokenomics (veTokenomics) model to incentivize resource marshalling and coordination between these Pods and Governance voters.

At a high level, the system works as follows: $REPPO holders stake their tokens and receive veREPPO which gives them voting power. They use this voting power to decide how $REPPO emissions per epoch are directed to different pods. Pods, in return for network emissions, provide value to veREPPO voters by offering a portion of their generated yield, closing the economic loop. The awarded emissions can be spent directly on network native data and infrastructure exchanges. This mechanism enables any AI builder to access the necessary bootstrap + growth support without forcing them to build on Reppo, seeking permission from a gatekeeper, or incurring a high cost of entry to the ecosystem.

3.1 Stakeholders

There are three stakeholders in the Reppo Ecosystem:

- **Pod Owners and Operators:** These are creators and maintainers of *Pods*, as well as the digital commodities and intelligence services hosted within the pods. The definition of a pod is sufficiently general to incorporate any collective that has a cohesive set of intelligence capabilities, such as a group of talented builders, an existing company with AI expertise, a collective/swarm of AI agents trained for a specific purpose, a group of physical AI collaborating on a task in the physical world etc. When a user creates a Pod, they can either choose to have IP guarantees for their digital commodities through Story Protocol or skip to leverage decentralized key management powered by Lit Protocol. Each pod on the network has a unique on-chain ID. Pod creators and owners can change over time, and all digital commodities within a pod generate individual and collective value by offering these services and generating revenue. Pod operators utilize the network's mechanisms to attract network emissions to bootstrap and maintain their operations, and generate fees from monetizing their intelligence services with a core set of consumers, interacting with other pods on the Reppo Network or a combination of go-to-market and monetization strategies for the digital commodities a pod owns.

- **Token Holders:** Individuals or entities that hold $REPPO can actively participate in veReppo governance by locking their tokens in exchange for voting power, which is used to determine how many emissions are directed to each pod. As mentioned above, governance participants earn pod yields.
- **Pod Users:** Consumers of intelligence services offered by pods, in exchange for consumption fees. The demand generated by pod users and their digital commodities drives pod yield and underpins the value of the $REPPO.

3.2 Reppo Token Utility

The $REPPO token serves several integrated functions within the ecosystem:

- **Governance (veREPPO):** $REPPO tokens locked by holders become veREPPO, which provides governance rights. veREPPO holders allocate votes to pods, directly influencing pod emissions eligibility and guiding ecosystem development.
- **Intelligence Index:** A representation of the total value of all Pods on the network

- **Resource Access Utility:** As the network evolves, $REPPOtokenswillalsohaveadditionalutilityasthepaym$

4 Technical Architecture Overview

The Reppo network consists of several components that work together to enable resource coordination for AI. We describe them in the following sections.

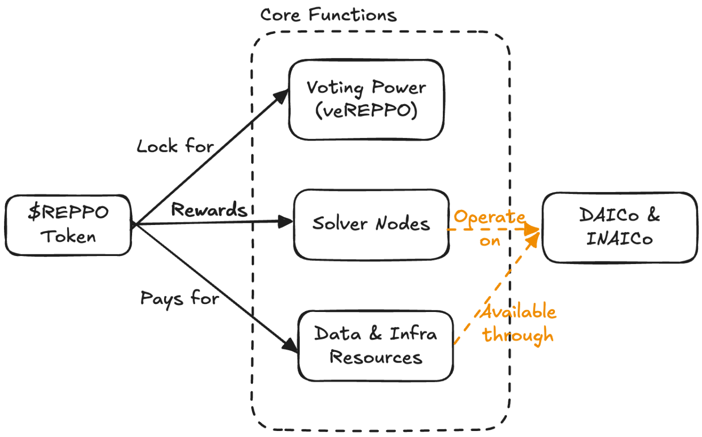


Figure 1: REPPO Token Flow and Core Functions

4.1 System Components

The Capital-AI Coordination (CAICo) layer leverages the veTokenomics model as follows: $REPPO tokens are locked to receive voting power, denoted by veREPPO, a vote-escrowed token mechanism that grants voting power proportional to both quantity and duration of the lock. Voting power is then used to direct protocol emissions to pods which are eligible to receive these emissions. In addition to governing protocol emissions, the $REPPO token will be used to reward solver nodes on the native resource exchanges of the network, namely the Data-AI Coordination (DAICo) and Infra-AI Coordination (INAICo) layers, as well as to pay for data assets and sources of infra services sourced through the exchanges.

DAICo and INAICo can also be accessed as standalone exchanges without interacting with the veToken mechanism and allows users including not limited to AI agents and Physical AI, to transact in stablecoins in addition to $REPPO token.

A key innovation to align stakeholder incentives are **Fee Claim Units** (FCUs). FCUs function as on-chain certificates that represent claims on pod-generated yield, with configurable parameters for activation timing and duration.

The entire system operates in an Epoch-based governance framework, where voting power allocations and emissions are processed in discrete time periods, allowing for regular reassessment and reallocation of resources.

4.2 Interaction Flow

Three primary interaction patterns define Capital-AI Coordination (CAICo) in the Reppo network:

Capital-AI Coordination : Capital-AI Coordination begins when a token holder locks REPPO to receive veREPPO. The token holder must decide the duration and amount of REPPO to lock to gain proportional amount of voting power in the form of veREPPO. veREPPO is then used to make allocation decisions in the form of voting power to help the protocol decide which Pods deserve the network emissions in the given epoch. Pods receive protocol emissions proportional to the votes they receive in the said epoch. To attract votes, pods issue FCUs which represent a promise of yield and incentivize veREPPO Voters to be proactive and conduct the necessary work to make meaningful contributions to protocol governance.

Performance Evaluation : To ensure that protocol resources are allocated efficiently (i.e. token emissions and inflation correspond to value being added to the network), Pod performance is measured against network-wide benchmarks. When a pod makes itself eligible to receive emissions, the emissions directed to it are ramped up according to the pod's performance relative to other pods on the network. High-performing pods receive full emissions, while under performing pods receive reduced emissions. This approach incentivizes healthy competition amongst Pods within the network.

4.3 Governance Framework

Governance operates at two levels, allowing for parameter adjustments Pod-specific and network-wide.

Pod-Level Governance Pod operators configure FCU parameters to optimize their emission acquisition strategy. The Yield Split Ratio (α) determines the percentage of yield that is shared with FCU holders. The FCU Delay (δ) sets the time between FCU issuance and activation, while the FCU Active Period (τ) defines the duration for which FCUs remain active. These parameters give Pods flexibility in structuring their relationship with FCU Holders.

Protocol-Level Governance The Reppo DAO governs system-wide parameters that affect all network participants. These include the base emission rate, emission adjustment thresholds, performance benchmarking criteria, and Pod registration mechanisms. This governance layer ensures that the network can adapt to changing conditions and maintain alignment with its overall objectives.

4.4 System Interfaces

The network provides interfaces for stakeholders to interact with the system. Pod operators access functionalities for registration and FCU configuration. Token holders utilize interfaces for token locking, vote allocation, and FCU management.

Network Users interact with the system to access intelligence services provided by pods.

The system architecture creates a closed economic loop where token emissions incentivize pod development, pods generate yield through commodities and service provision, and the yield flows back to token holders who undertake the critical task of helping govern network emissions and actively support valuable pods in their AI innovations. This incentive alignment between VeReppo Holders and AI Builders is critical to the permissionless and on-demand nature of the Reppo Platform and Ecosystem.

5 Token Mechanics

We now discuss how the Reppo network extends traditional veTokenomics with novel features designed to align incentives between veReppo Holders and Pods. This section details the two primary token mechanisms: the vote-escrowed token system (veREPPO) and Fee Claim Units (FCUs).

1. Vote-Escrowed Token System (veREPPO) veREPPO forms the basis of the network's governance and incentive alignment mechanism. When users lock their REPPO tokens, they receive veREPPO tokens in return, with the amount of veREPPO proportional to both the quantity of tokens locked and the duration of the lock period.

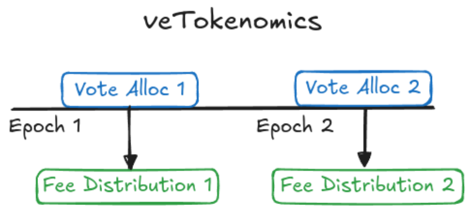
The relationship between lock duration and voting power follows a non-linear function where longer lock durations yield disproportionately more veREPPO. This can be expressed mathematically as:

$$V_u = X_u \cdot \left(\frac{L_u}{L_{max}} \right)^{\gamma} \tag{1}$$

Here, X_u represents the amount of base tokens locked, L_u is the user's chosen lock duration in epochs, L_{max} is the maximum allowed lock duration, and γ is a parameter controlling the non-linearity of the veToken power issuance. When $\gamma > 1$, longer lock durations are incentivized through higher voting power.

Voting epochs provide the temporal framework for governance and resource allocation. At the beginning of each epoch, veREPPO holders allocate their voting power across various pods on the network. These allocations determine the proportion of protocol emissions directed to each pod during that epoch. Note that while base tokens remain locked for the specified duration, voting power can be reallocated each epoch, providing capital allocation flexibility despite long-term capital commitment.

The voting process occurs on-chain - allocations are fixed at the start of each epoch and applied for the duration of that epoch. Any adjustments made by voters during an epoch are queued for the subsequent epoch, allowing for regular adaptation without disrupting current operations.



5.1 Fee Claim Units (FCUs)

Fee Claim Units (FCUs) represent a significant innovation in the Reppo tokenomics model. FCUs are on-chain certificates, in the form of NFTs, that represent claims on future yield generated by pods, creating a flexible and forward-looking alignment mechanism. Each pod configures three parameters that define their FCU characteristics:

1. Yield Split Ratio (α): The percentage of yield generated during an epoch that is distributed to FCU holders. The remaining portion $(1-\alpha)$ is retained by the pod for operational expenses and development.

2. FCU Payout Delay (δ): The time period, measured in epochs, between the issuance of the FCU and the beginning of the active period. This delay allows pods to structure their capital acquisition with forward-looking obligations. Note that at the start of the network, $\delta = 0$, and this feature will be implemented in further iterations of the network.

3. FCU Active Period (τ): The duration, in epochs, for which the FCU remains active.

When users allocate their veREPPO voting power to a pod, they receive FCUs according to the agreed-upon terms. The time-bounded nature of FCUs creates a distinct lifecycle. FCUs acquired at epoch E become active starting at Epoch $E + \delta$ and remain active until epoch $E + \delta + \tau$. During the active period, FCU holders are entitled to their proportional share of the pod's generated yield.

FCUs are implemented as NFTs, creating a secondary market for trading claims on a Pod's yield. Reppo smart contracts enforce proper distribution of these fees. FCU configuration parameters enable pods to configure their FCU parameters to optimize their capital acquisition strategy. Pods seeking to attract more initial capital might offer higher fee split ratios or shorter delays, while established pods might prioritize long-term sustainability with more conservative parameters.

The FCU mechanism represents a significant advancement over traditional veTokenomics models by creating persistent claims that continue even if a voter reallocates their votes elsewhere. The innovation is represented in Fig 2.

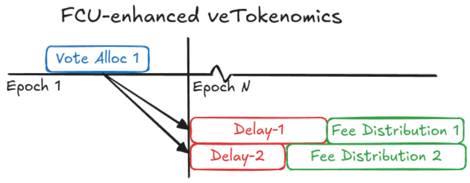


Figure 2: Comparison of veTokenomics and FCU-enhancements

6 Economic Model

The Reppo network's economic model aligns incentives between Pod operators, veREPPO holders, and network users. This section details the economic mechanisms that govern Pod operations, protocol emissions, and the overall value flows within the network.

6.1 Pod Economics

Pods enter the Reppo network through a registration process. Registration involves an underwriting fee, if the Pod is to be eligible to receive Reppo emissions. This fee serves as a commitment mechanism—substantial enough to prevent network spam but calibrated to maintain permissionless access for genuine AI innovators without requiring an absurd amount of lockup as entry threshold. The underwriting fee is determined through an auction mechanism where a set number of slots (S) are auctioned every N weeks. Winners pay the clearing price, with proceeds directed to the protocol.

Reppo implements a uniform-price sealed-bid multi-unit auction as the mechanism for determining the underwriting fee. It works as follows:

1. The DAO sets a minimum underwriting fee.
2. Potential Pod operators submit sealed bids, indicating the fee they are willing to pay. Bids are denominated in $REPPO tokens.
3. When the bidding ends, all bids are ranked in descending order. The top S bids win the available slots. All winning bidders pay the same clearing price, which can be set to the lowest winning bid, or the highest losing bid.
4. Winning pods then pay this fee and become eligible for emissions.

This auction mechanism minimizes strategic complexity, discourages bid shading, simplifies winner determination, and ensures that the underwriting fee accurately reflects market demand and serves as an effective filter for pod quality.

Pods generate yield through two streams:

1. **Direct Revenue**: Pods earn yields from users and other pods by providing access to the digital commodities and intelligence services it owns/hosts.

2. **Protocol Emissions**: Pods attract veREPPO allocations from token holders, which direct protocol emissions to them

6.1.1 Pod Performance Evaluation and Emission Eligibility

The Reppo network implements a merit-based emission allocation system that only rewards Pods based on their ability to generate economic value, measured through fees distributed to FCU holders. There is no validator level assessment of "Quality of Intelligence".

This system includes:

1. **Gradual Emission Ramp-Up**: New Pods start with reduced emission benefits (25% of standard emissions)

2. **Performance Benchmarking**: Pods must consistently meet or exceed the network's median performance to unlock full emission benefits.

3. **Graduation Mechanism**: After demonstrating sustained performance over multiple epochs, Pods "graduate" to full emission eligibility. Similarly, consistent sub-par performance will result in a pod being downgraded.

This creates a filtering mechanism where network resources flow toward Pods delivering value while preventing token farming without corresponding value creation.

6.1.2 FCU Configuration and Pod Strategy

Pod operators can configure their FCU parameters to optimize for a particular economic strategy:

- **Fee Split Ratio** (α): Higher ratios attract more veREPPO allocation but reduce retained capital for Pod development.

- **FCU Payout Delay** (δ): Longer delays align FCU holders with long-term Pod success, but transfer risk to voters.

- **FCU Active Period** (τ): Longer active periods can be more attractive to holders since it is likely to result in larger cumulative proceeds.

These parameters allow Pods to tailor their capital acquisition strategy. Pods seeking rapid capital formation might offer higher fee split ratios with shorter delays, while established Pods may prioritize sustainable operations with more conservative parameters.

6.2 Emission Schedule and Dynamics

The protocol implements a dynamic emission schedule designed to balance network growth with sustainable value creation.

6.2.1 Base Emission Formula

The DAO sets a base emission rate (R_{base}) for the protocol. For an incentive pot P, define: $R_{base} = (1 - \alpha) \cdot P$, where P is the size of the incentive pot. Effectively, the DAO is setting the α parameter, to determine the size of the emission for a give Epoch. A base value of α is set, but the DAO has the ability to additionally modulate it by examining network metrics that compare emission rate to value creation rate, as follows:

The DAO can use the following heuristics to adjust the emissions logic further:

Adjustment Conditions:

- If $\frac{g_e}{g_s} >$ target for N consecutive epochs:
  - Increase emission multiplier up to $X\%$
- If $\frac{g_e}{g_s} <$ target for N consecutive epochs:
  - Decrease emission multiplier by at least $Y\%$

Emission Rate Calculation:

$$R_{\text{emission}} = \text{clip}\left(R_{\text{base}} \cdot \mu,\, \mu_{\text{min}},\, \mu_{\text{max}}\right)$$

Where:

- $g_e = (DEPT(e) - DEPT(e-1))/DEPT(e-1)$ (growth rate of Diluted Earnings Per Token)
- $g_s = EpochEmissions/TotalSupply$ (supply growth rate)

This heuristics enable the DAO to control the network's inflation rate and align with its value creation capacity, while providing additional flexibility to react to market needs/demands.

6.2.2 Performance-Based Emission Multipliers

Individual Pods receive emissions according to their performance relative to network benchmarks. The emission multiplier ($\mu_{p,E}$) for a Pod p in epoch E adjusts based on the Pod's performance relative to network median:

Parameter	Symbol	Value
Consecutive epochs threshold for adjustment	D	3
Step size for upgrades or downgrades	$\Delta\mu$	0.25
Minimum emission multiplier	$\mu_{\min}$	0.25
Maximum emission multiplier	$\mu_{\max}$	1.00

Table 1: Parameters for Emission Multiplier Adjustment Algorithm

Each pod multiplier increases when its performance exceeds network median performance for D consecutive epochs, and decreases when it falls below for D consecutive epochs, as described in this pseudo code:

Upgrade Rule:

- If a pod's performance measure $p.\text{measure} \geq \text{network\_measure}$ for D consecutive epochs, and $p.\mu_{\text{current}} < \mu_{\max}$:
  - Set $p.\mu \leftarrow \min\left(p.\mu_{\text{current}} + \Delta\mu,\ \mu_{\max}\right)$

Downgrade Rule:

- If $p.\text{measure} < \text{network\_measure}$ for D consecutive epochs, and $p.\mu_{\text{current}} > \mu_{\min}$:
  - Set $p.\mu \leftarrow \max\left(p.\mu_{\text{current}} - \Delta\mu,\ \mu_{\min}\right)$

The performance measure is a convex combination of the fees shared and fees generated by the Pods, described in Section 8.

6.2.3 Emission Distribution

Total emissions per epoch (R_E) are distributed to Pods proportionally to their effective votes:

$$Emission_{p,E} = R_E \cdot \frac{V_{p,E} \cdot \mu_{p,E}}{\sum_{p' \in P} V_{p',E'} \cdot \mu_{p',E'}} \tag{2}$$

Where:

- $V_{p,E}$ represents the total votes allocated to Pod p in epoch E
- $\mu_{p,E}$ is the performance-based emission multiplier for Pod p

This distribution formula ensures that emissions flow to Pods with both strong voter support and demonstrated performance.

7 Governance and Incentive Alignment

The Reppo network's governance framework aligns incentives between pod operators, token holders, and network users. This section details the incentive mechanisms and stability measures which enable sustainable network growth.

7.1 Incentive Mechanisms

Reppo incentive mechanisms create alignment across different time horizons through several coordinated systems:

7.1.1 Performance-Based Emissions

The network implements a graduated emission system that ties pod rewards to demonstrated performance. New pods start at 25% of standard emissions and must consistently meet or exceed network performance metrics for D consecutive epochs to increase their emission multiplier. Conversely, consistent underperformance for D consecutive epochs results in emission reduction.

Performance is measured through a combination of fee generation and fee distribution to FCU holders, creating a direct link between performance and economic value creation. This approach enables protocol resources to flow to pods that deliver tangible benefits to the network ecosystem rather than merely attracting votes without corresponding output.

7.1.2 Long-Term Alignment via FCUs

Fee Claim Units create persistent economic relationships between pods and FCU Holders. Unlike traditional fee sharing mechanisms, FCUs represent time-bounded claims on pod yields. FCUs provide value to holders independent of current vote allocation (because they can activate and expire at configurable times), creating sticky economic relationships.

FCU parameters (α, δ, τ) enable pods to optimize their emission acquisition strategies based on their specific stage and needs. Early-stage pods can attract supporters with attractive fee split ratios, while established pods can structure FCUs to focus on long-term sustainability. FCU transferability creates secondary market price signals about pod performance expectations, providing an additional layer of information for network participants.

This mechanism extends traditional veTokenomics by separating commitment (locked tokens) from allocation (voting power), enabling efficient resource allocation while maintaining long-term network commitment.

7.1.3 Innovation and Competition Incentives

The network creates a competitive environment that rewards innovation through its epoch-based voting system. Capital flows dynamically to pods delivering the most value, while performance benchmarks create continuous pressure for improvement.

7.2 Stability and Risk Management

The tokenomics design incorporates several mechanisms to promote stability and prevent manipulation.

7.2.1 Stability Mechanisms

The underwriting fee creates a meaningful barrier to entry that ensures pod operators have skin in the game, while performance-based emission allocation mechanics ensure network resources flow toward actors generating measurable economic value based on usage and monetization of commodities instead of mere tokenized market cap. The non-linear relationship between lock duration and voting power encourages long-term capital commitment to the network while maintaining capital allocation flexibility through epoch-by-epoch voting and the FCU yield distribution structure. This combination enables voters (and thus the network) to adapt quickly to changing pod performance while keeping base capital locked in the network.

7.2.2 Anti-Farming Protections

The protocol implements multiple defenses against value extraction without corresponding value creation. A portion of pod-generated fees is captured by the protocol as a network fee, creating a cost to cyclic transactions that makes fee farming less profitable. Competition for veREPPO allocations forces pods to compete for voter support, which naturally flows to those offering the most attractive FCU terms and demonstrated performance.

Performance benchmarking requires pods to consistently meet or exceed median network performance to receive full emissions, preventing reward capture without corresponding value creation. The auction-based registration system limits slot availability, preventing mass creation of farming pods and ensuring only committed projects enter the ecosystem.

7.2.3 Governance-Based Protections

The governance system provides additional layers of protection through adaptive mechanisms. The protocol may implement graph analysis techniques to identify suspicious transaction patterns, allowing for targeted interventions when necessary. The DAO can adjust protocol fee parameters based on observed network behavior, responding to emerging threats or changing conditions.

The pod downgrade mechanism automatically reduces emissions to consistently underperforming pods, limiting their ability to extract value without contribution.

This creates a self-regulating system that continuously redirects resources toward value-creating participants.

7.3 Governance Framework

Governance operates at two levels to enable pod-specific flexibility and network-wide coordination.

7.3.1 Pod-Level Governance

Pod operators control parameters specific to their pod, including FCU configuration parameters (α, δ, τ), revenue models, operational strategies, and development roadmaps. This autonomy enables pods to optimize their strategies based on their specific stage, market conditions, and capital requirements.

Pod operators must balance the attraction of capital through attractive FCU terms against the need to retain resources for sustainable operations. Higher fee split ratios attract more voter support but reduce retained capital, creating a dynamic optimization problem that evolves as pods mature.

7.3.2 Protocol-Level Governance

The Reppo DAO governs system-wide parameters, including: a) base emission rate, b) performance benchmarking criteria, c) protocol fee rates, and d) auction mechanisms for pod registration. The DAO also oversees network upgrade processes and parameter adjustments to maintain economic balance.

Governance decisions follow an epoch-based timeline, providing regular opportunities for parameter adjustment while maintaining operational stability. This approach enables the network to adapt to changing conditions while providing sufficient predictability for participants to plan their strategies.

7.3.3 Voting Timeline

Governance operates on an epoch-based timeline where votes can be allocated throughout an epoch but are finalized at epoch boundaries. Vote allocation changes apply to the subsequent epoch. FCUs are distributed at the end of each epoch based on vote allocations, and fee distributions occur according to FCU activation schedules.

8 Mathematical Formulation

This section details the mathematical representation of the Reppo tokenomics model.

8.1 Notation and Parameters

We define the following system parameters:

- E - An epoch, the fundamental time unit for the protocol
- R_E - Total new tokens minted by the protocol in epoch E for distribution as emissions
- $regFee$ - Underwriting fee for creating a new pod
- L_{max} - Maximum lock duration allowed for users
- θ - Threshold fraction of total votes for triggering concentration penalties
- ω - FCU accrual rate
- δ_p - The time (in epochs) after an FCU is issued when it becomes active for pod p
- τ_p - FCU active period (in epochs) for pod p
- γ - A parameter controlling the non-linearity of veToken issuance

8.2 User Locking and veToken Issuance

For each token holder u who locks tokens:

- X_u - Amount of base tokens the user locks
- L_u - User's chosen lock duration (in epochs)

The veToken voting power for user u is calculated as:

$$V_u = X_u \cdot \left(\frac{L_u}{L_{max}} \right)^{\gamma} \tag{3}$$

Longer lock durations yield disproportionately more veTokens, incentivizing long-term commitment to the network.

8.3 Voting and Pod Allocation

At the start of each epoch E, users allocate their veREPPO across pods.

Let $v_{u,p,E}$ be the veTokens allocated by user u to pod p in epoch E.

Total votes for pod p in epoch E:

$$V_{p,E} = \sum_{u \in U} v_{u,p,E} \tag{4}$$

Total votes across all pods in epoch E:

$$V_E^{total} = \sum_{p \in P} V_{p,E} \tag{5}$$

8.4 Pod Performance Evaluation

The protocol calculates a performance measure for the entire network.

$$M_{network} = \text{median}(\{FEE_{p,E}^{Generated} : p \in P\})_1^{\kappa} \times \text{median}(\{FEE_{p,E}^{Shared} : p \in P\})_2^{\kappa} \tag{6}$$

where κ_1 and κ_2 denote the relative weights of

The same measure is calculated for individual pods to enable performance comparisons.

8.5 Performance-Based Emission Multipliers

Each pod p has an emission multiplier $\mu_{p,E}$ that determines its share of protocol emissions. This multiplier is adjusted based on the pod's performance relative to network standards.

The adjustment logic follows:

$$\mu_{p,E+1} = \begin{cases} \min(\mu_{p,E} + \Delta\mu, \mu_{max}) & \text{if } p \text{ outperforms for } D \text{ consecutive epochs} \\ \max(\mu_{p,E} - \Delta\mu, \mu_{min}) & \text{if } p \text{ underperforms for } D \text{ consecutive epochs} \\ \mu_{p,E} & \text{otherwise} \end{cases} \tag{7}$$

Where:

- D - Number of consecutive epochs required for adjustment (typically $D = 3$)
- $\Delta\mu$ - Step size for multiplier adjustments (typically $\Delta\mu = 0.25$)
- μ_{min} - Minimum emission multiplier ($\mu_{min} = 0.25$)
- μ_{max} - Maximum emission multiplier ($\mu_{max} = 1.00$)

8.6 Emission Distribution

Total emissions R_E per epoch are distributed to pods proportionally to their effective votes and performance multipliers:

$$Emission_{p,E} = R_E \cdot \frac{V_{p,E} \cdot \mu_{p,E}}{\sum_{p' \in P} V_{p',E} \cdot \mu_{p',E}} \tag{8}$$

This formula ensures that emissions flow to pods with strong voter support and demonstrated performance.

8.7 Fee Claim Units (FCUs)

FCUs represent a forward-looking claim on pod-generated yield with configurable delay and duration parameters.

8.7.1 FCU Acquisition

At the end of each epoch E', users earn FCUs based on their vote allocations:

$$\Delta FCU_{u,p,E'} = v_{u,p,E'} \cdot \omega \tag{9}$$

Where ω is the FCU accrual rate per vote.

8.7.2 FCU Activation and Duration

FCUs acquired at epoch E' become active starting at epoch $E' + \delta_p + 1$ and remain active for τ_p consecutive epochs. The active period ends at epoch $E' + \delta_p + \tau_p$.

At any epoch E, the set of active FCUs for user u in pod p is denoted by $FCU^{active}_{u,p,E}$, which includes all FCUs that have entered their active period but have not yet expired.

8.7.3 Fee Distribution via FCUs

In epoch E, pod p generates fees $FEE_{p,E}$. A fraction α_p of these fees is allocated to FCU holders. Each user's fee share is calculated as:

$$f_{u,p,E} = \alpha_p \cdot FEE_{p,E} \cdot \frac{FCU^{active}_{u,p,E}}{\sum_{u'} FCU^{active}_{u',p,E}} \tag{10}$$

If no FCUs are active at epoch E (i.e., $\sum_{u'} FCU^{active}_{u',p,E} = 0$), then no fees are distributed to stakers, and the pod retains all of its fees for that epoch.

8.8 Adaptive Emission Adjustment

The DAO can decide to dynamically adjusts its emission rate based on network performance. Define:

- $g_e = \frac{DEPT(E) - DEPT(E-1)}{DEPT(E-1)}$ - Growth rate of Diluted Earnings Per Token
- $g_s = \frac{EpochEmissions}{TotalSupply}$ - Supply growth rate

Where $DEPT(E) = \frac{TotalNetworkEarnings_E}{TotalTokenSupply_E}$ represents the dilute earnings per token in epoch E.

The emission adjustment logic follows:

$$R_{emission} = \begin{cases} \min(R_{base} \cdot (1 + X\%), R_{max}) & \text{if } \frac{g_e}{g_s} > target \text{ for } N \text{ consecutive epochs} \\ \max(R_{base} \cdot (1 - Y\%), R_{min}) & \text{if } \frac{g_e}{g_s} < target \text{ for } N \text{ consecutive epochs} \\ R_{base} & \text{otherwise} \end{cases} \tag{11}$$

This dynamic adjustment heuristic ensures that token emissions align with network value creation, while also retaining flexibility for the DAO to override as needed.

8.9 Integrated FCU Model

The complete FCU mechanics can be formalized as follows:

For a pod p with parameters $(\alpha_p, \delta_p, \tau_p)$:

- FCUs issued at epoch E' to user u: $\Delta FCU_{u,p,E'} = v_{u,p,E'} \cdot \omega$
- Activation epoch: $E_{active} = E' + \delta_p + 1$
- Expiration epoch: $E_{expire} = E' + \delta_p + \tau_p$
- Active status at epoch E: $isActive(FCU_{u,p,E'}, E) = (E_{active} \leq E \leq E_{expire})$
- Total active FCUs for user u at epoch E: $FCU^{active}_{u,p,E} = \sum_{E'} \Delta FCU_{u,p,E'} \cdot isActive(FCU_{u,p,E'}, E)$
- User's fee share at epoch E: $f_{u,p,E} = \alpha_p \cdot FEE_{p,E} \cdot \frac{FCU^{active}_{u,p,E}}{\sum_{u'} FCU^{active}_{u',p,E}}$

This formulation captures the complete lifecycle of FCUs from issuance through activation and eventual expiration, along with the corresponding fee-distribution mechanics.

8.10 Economic Equilibrium Conditions

For stable network operation, the following equilibrium conditions should hold:

1. $\frac{g_e}{g_s} \approx target$ - Value creation aligns with token emission
2. $\frac{1}{|P|} \sum_{p \in P} \mu_{p,E} \approx \frac{\mu_{min} + \mu_{max}}{2}$ - Average pod performance meets expected standards
3. $\frac{F_{net}}{V_E} < 0$ - Fee farming is unprofitable (cost of cycling fees exceeds potential emissions)

These conditions provide quantitative metrics for assessing network health and identifying potential imbalances requiring governance intervention.

9 Network Effects and Value Accrual

This section examines how the tokenomics model drives network adoption and value creation.

9.1 Composable Intelligence Network Effects

The Reppo network facilitates composability of digital commodities and intelligence services through its Pod architecture, creating several types of network effects:

Pod Composition Effects As the network grows, successful Pods become building blocks for more complex intelligence services. As discussed earlier, pods are non-fungible collectives and can exchange ownership and over time, we expect two or more pods to merge to create a larger pool of digital commodities and intelligence service offerings. Early Pods on the network that focus on fundamental AI capabilities will enable the creation of higher-order applications that combine these capabilities. This composability creates increasing returns to scale as each new Pod potentially enhances the utility of existing Pods through novel combinations. The value of the network increases superlinearly with the number of high-quality Pods operating on the network.

Capital Efficiency The FCU system enables efficient capital allocation across the network. As more voters join the ecosystem, they create liquidity and price discovery for FCUs, which improves emission acquisition opportunities for all Pods on the network. This improves the efficiency of the entire network, reducing the friction in matching capital with promising AI projects.

Data and Infrastructure Exchange Synergies Pods utilizing network native decentralized data and infrastructure exchanges in the network will allow them to reduce the friction of swapping payment tokens, be eligible for discounts (DAO permitting) and acquire a reputation that signals legitimacy to voters while assessing FCU issued by pods. Pods interacting with the Data and Infra exchange also incur positive externalities for other Pods and for the broader ecosystem by opting for verifiable and decentralized infra-structure that makes it easier to compose intelligence. As more pods join the network to access on-demand Data, Infra, and Capital, a strong demand engine is created for data and infra providers to find demand for their services, creating a positive sum outcome as the collective intelligence on the network grows. You can learn more about Data and Infra Exchange here and here

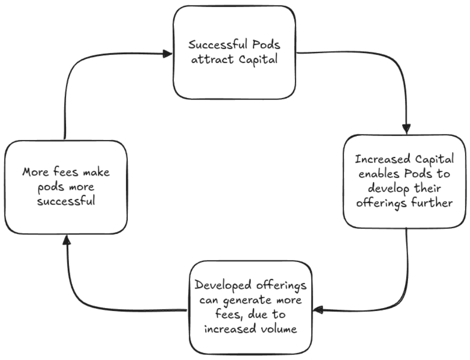


Figure 3: Enter Caption

9.2 Value Accrual Mechanisms

The Reppo network implements multiple mechanisms to drive value accrual to the $REPPO token:

Fee Capture and Distribution Pods generate fees by providing intelligence services to users. A portion of these fees is captured by the protocol and burned, creating a direct flow of value from network activity to token holders.

Performance-Based Emissions The performance-based emission system ensures that protocol resources flow to Pods generating economic value. This directs network emissions toward productive Pods while preventing value extraction without corresponding contribution. The most unique and high-performing Pods attract more votes and FCU demand, enhance their presence and popularity amongst users and other pods, generating more fees and strengthening the economic loop.

Governance Premium REPPO tokens locked for governance provide holders with voting power that directs emissions and acquires FCUs. This governance utility creates a secondary demand for the token beyond its role in fee distribution. The time value embedded in longer-duration locks and the strategic value of directing protocol resources create a governance premium that accrues to long-term holders.

9.3 Self-Reinforcing Value Cycle

The Reppo network establishes a closed economic loop that drives sustainable growth, as shown in Fig. 3

This cycle creates a positive feedback loop in which network growth enhances token value, which in turn accelerates further network growth.

10 Token Supply Dynamics

This section details the token supply dynamics that maintains economic equilibrium within the ecosystem.

10.1 Token Emission Model

The primary source of new REPPO tokens is the protocol's emission schedule. The Reppo DAO establishes a base emission rate (R_{base}) which determines the quantity of tokens issued each epoch for distribution to pods. This was detailed in the Emission Schedule and Dynamics section.

10.2 Token Sinks

The Reppo network incorporates the following mechanisms that remove tokens from circulation:

Pod Underwriting Fee Pods seeking emission eligibility must pay an underwriting fee that serves as both an economic commitment mechanism and a token sink. The fee is determined through an auction process in which a predetermined number of slots (S) are auctioned every N weeks. The clearing price of the auction establishes the fee amount, which is sent to the protocol treasury.

A portion of these underwriting fees are permanently removed from circulation, reducing overall token supply.

Token Locking (veREPPO) When users lock REPPO tokens to receive veREPPO, they temporarily remove tokens from circulation for the duration of the lock period. The nonlinear relationship between lock duration and voting power incentivizes longer lock periods, with maximum locks extending to L_{max} epochs.

Although not a permanent sink, token locking creates significant illiquidity in the circulating supply, reducing effective token velocity, and increasing scarcity. The lock period commitment provides stability to the token economy by reducing short-term selling pressure.

Protocol Fee Capture The Reppo protocol captures a percentage of all fees generated by the pod that are eligible for emissions as a protocol fee. These fees flow to the protocol treasury, where they can be burned or used for targeted purposes. Discretion on how to use these tokens is left to the DAO.

The fee structure follows:

$$\text{ProtocolFee} = \text{FeeRate} \times \text{PodGeneratedFees} \tag{12}$$

where the FeeRate is determined by the DAO based on network maturity and market conditions.

Performance-Based Emissions The performance-based emission system acts as an indirect sink by tying the token distribution to value creation. Pods must demonstrate consistent performance above the network median to receive full emissions, creating a merit filter that restricts emissions to productive network participants.

Pods begin with reduced emission eligibility (25% of the standard) and must earn higher multipliers through demonstrated performance. This approach prevents value extraction without the corresponding contribution, effectively functioning as a qualitative sink that preserves token value.

10.3 Supply and Demand Equilibrium

The interplay between emission sources and token sinks creates an economic equilibrium that balances network growth with sustainable tokenomics. This equilibrium can be expressed through the ratio:

$$\frac{\text{TokenSinks}}{\text{TokenSources}} \approx 1 \tag{13}$$

In healthy network conditions, the value captured through the sinks approximates or exceeds the value created through sources, maintaining a sustainable token economy.

For long-term stability, the network targets:

$$\frac{g_e}{g_s} \geq 1 \tag{14}$$

Where g_e represents the earnings growth rate and g_s represents supply growth rate. When this ratio exceeds 1, the network generates value faster than it creates new tokens, ensuring sustainable growth.

Adaptive emission adjustments, performance-based distribution, and multiple token sinks work together to maintain this equilibrium under varying market conditions and network growth stages.

11 Conclusion

Reppo introduces a novel architecture for resource coordination in the AI economy, enabling permissionless and on-demand access to data, infrastructure, and capital. By combining intention-centric discovery mechanisms with a robust incentive model without validators in the loop, Reppo allows developers, agents, and physical AI to operate independently of centralized actors while still aligning with broader ecosystem goals.

The core innovation of the protocol, FCUs, establish a foundation for scalable and sustainable coordination. This architecture is designed to reward productive Pods, minimize protocol value leakage, and enable composable collaboration between Pods.

Through dual-level governance, performance-based emissions, and an economic model based on proven veTokenomics, Reppo supports a self-regulating ecosystem where value creation drives token utility. The use of time-locked capital and FCU-based incentive alignment ensures long-term stakeholder commitment while maintaining operational flexibility.

As AI agents and physical AI become increasingly prominent as economic actors, Reppo provides these autonomous entities the infrastructure to transact, coordinate, and marshal resources without permission, Reppo opening a new design space for decentralized AI.