Lambda Paradigm: A New Blockchain Based on a P2P Dynamically Programmable Incentive Protocol

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Abstract:

The essence of economics can be succinctly summarized as: "People respond to incentives. The rest is merely explanation." (1)

Blockchain represents a novel method of organizing societal resources, redefining the propositions of "what incentives to use" and "what to incentivize."

This paper introduces a new paradigm, the Lambda Paradigm, which is a novel P2P dynamically programmable incentive protocol capable of operating incentive systems on a large scale and in parallel. It continuously evolves within a self-propagating system, constantly reconfiguring to enable social self-organization to meet its goals, ultimately facilitating the mass production of consensus assets.

This paradigm constructs a permissionless ownership-based monetary container. This monetary container interoperates with the external world through a dynamically programmable incentive protocol and separates incentive consensus computation from the monetary container, thereby accommodating any application, any protocol, and any form of asset.

The goal of the Lambda Paradigm is to adapt to the production, distribution, and trading markets of all consensus assets. Its application scope can extend to any blockchain, any domain, and any form of asset.

In physics, lambda (Λ) represents the cosmological constant, seen as a manifestation of dark energy, influencing the large-scale structure and evolution of the universe.

In the Lambda Paradigm, lambda (Λ) symbolizes a form of consensus asset, impacting the formation and evolution of human assets.

1. Abstraction of Incentive Functions

We view all organic systems as incentive feedback systems. What an organic system becomes depends on what it incentivizes and the effectiveness of these incentives.

1.1 Human Society

The content of economics can be simply summarized as: "People respond to incentives. The rest is merely explanation." (Mankiw, N. Gregory.)

In an economic abstraction, the entire human society can be conceptualized as a function:

$$\text{Human Society}(x) = I\ \ (F(x), M(x), P(x))$$

- **I(x)** represents the **Incentive Function**.
- **F(x)** represents Force Competition.
- **M(x)** represents Meme Competition.
- **P(x)** represents Productivity Competition.

1.2 BTC Network

Satoshi Nakamoto's genius in abstracting and designing human society's incentive systems led to the creation of the world's largest hash computing network, establishing the most effective and antifragile monetary system known to mankind, and the safest ledger system in history. (2)

$$\text{BTC}(x) = I(H(x), S(x))$$

- *H(x)*: Hash Power Competition
- *S(x)*: Digital Signature Chain

1.3 Ethereum 1.0

Building on the understanding of the BTC network's hash power competition, Vitalik Buterin updated the incentive model of the BTC network to create Ethereum 1.0: (3)

$$\text{Ethereum } 1.0(x) = I(H(x), State(x), V(x))$$

- *H(x)*: Hash Power Competition
- *State(x)*: State Machine
- *V(x)*: Virtual Machine

The difference from the BTC network is the transformation of the digital signature chain into a new account world state machine and expanded incentives for the Ethereum Virtual Machine (EVM), resulting in the broadest Turing-complete blockchain network.

1.4 Ethereum 2.0

On December 1, 2022, the Ethereum Foundation upgraded Ethereum 1.0 by changing the hash power competition function to a proof-of-stake competition. Nodes in each beacon chain need to hold 32 ETH to become validators and join the upgraded Ethereum 2.0 incentive system. (4)

$$Ethereum2.0(x) = I(Stake(x), State(x), V(x))$$

- *Stake(x)*: Staking Competition
- *State(x)*: State Machine
- *V(x)*: Virtual Machine

This resulted in the liberation from competition constraints and accelerated the development of the Ethereum network.

1.5 SOLANA

SOLANA introduced the concept of a high-performance public blockchain, replacing BTC's network synchronization heartbeat with Proof of History (PoH), and applied high-performance storage and other technologies suitable for high-performance public chains, adjusting the incentive function. (5)

$$\text{SOLANA}(x) = I(Stake(x), HS(x), HV(x))$$

- *Stake(x)*: Staking Competition
- *HS(x)*: High-Speed State Machine
- *HV(x)*: High-Speed Virtual Machine

The result is the creation of the highest TPS high-performance public blockchain currently available.

1.6 BITTENSOR

Bittensor profoundly deconstructed the BTC network, reinterpreting the significant implications of Satoshi Nakamoto's creation of the BTC network as a revolutionary moment for humanity because it reshaped the way human organizations self-organize. This was based on a decentralized monetary incentive system that incentivizes original hash computing power to ensure that all miners can accurately and truthfully replicate the Bitcoin account balances without creating false ledgers. The Bitcoin network pioneered the great paradigm of P2P computational capitalism.

While Ethereum was the first to mimic and develop the paradigm of P2P computational capitalism, it was not until Bittensor that it was first pointed out that this represents a great innovative unity of two separate yet integrated concepts.

Bittensor, building on the great legacy of the BTC network and based on the YUMA consensus, evolved BTC's static type incentive protocol into a dynamic, probability consensus-based programmable incentive protocol. (6)

$$TAO(x) = I(R(x), A(x), State(x))$$

- *R(x)*: Rating Voting Competition
- *A(x)*: Subnet AI Power Competition
- *State(x)*: State Machine

The result is the creation of the most effective AI computing blockchain system currently available.

1.7 BITLAMBDA

The BitLambda network, building on the Bittensor paradigm, has developed a new blockchain paradigm designed to achieve consensus capitalism, named the Lambda Paradigm.

The development of blockchain technology has yielded many great achievements but also produced a large amount of inefficient computational and staking capitalistic assets. Many public blockchains possess computational power, yet consensus assets are rare on them.

As Bittensor pointed out, the industry should move from initially defining "keys" to now defining "locks" and letting the network find the "keys." (7)

The "locks" in this industry should not be a stack of useless computational power but rather "assets." Supporting, servicing, producing, and trading "assets" are the purposes of the blockchain industry. And the fundamental principle of assets is clearly "consensus."

$$\text{Lambda}(x) = I(C(x), N(x), S(x))$$

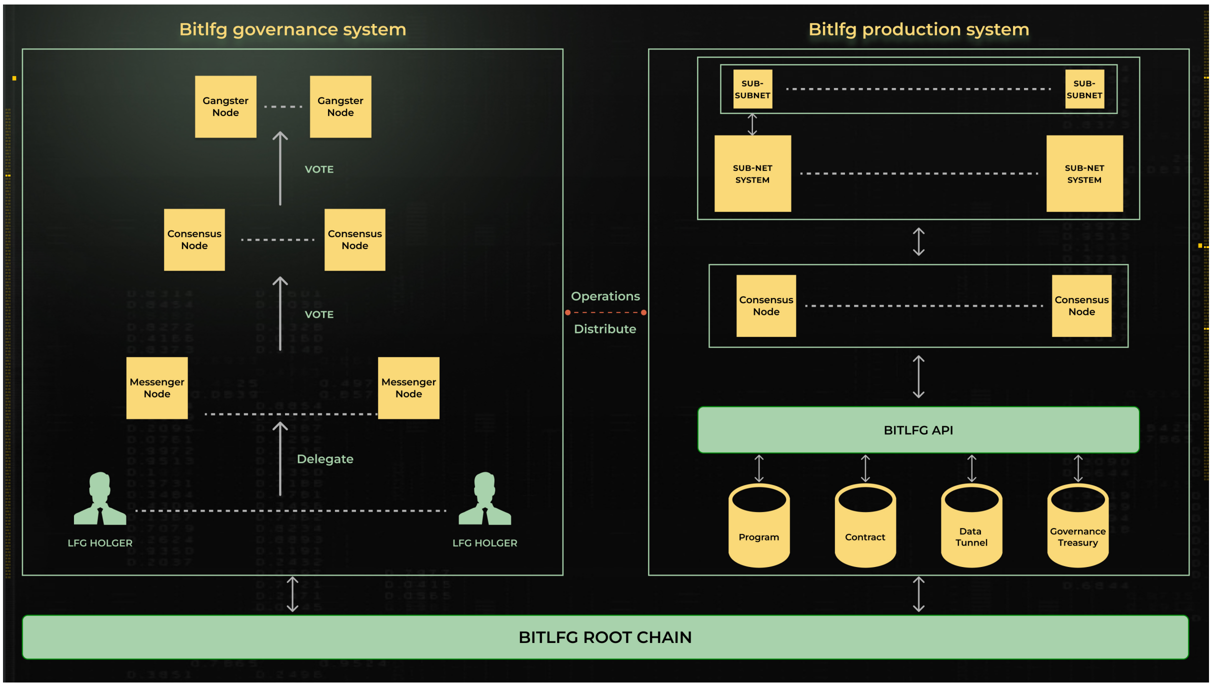
- *C(x)*: Community Consensus Competition Function
- *N(x)*: Subnet Consensus Asset Model Competition Function
- *S(x)*: Consensus State Machine Function

The goal of BitLambda is to create the largest consensus asset issuance and trading network in human history.

2. Lambda Network Structure

In biological systems, social behaviors, economic systems, and technological development, the essence is inherently distributed, bottom-up, adaptive, and evolves in parallel. Individuals follow simple rules, yet the overall system can exhibit highly complex structures. Without central control, complex behaviors and structures emerge spontaneously from many simple interactions. (8)

The Lambda Paradigm is designed following this essence.



The Lambda structure is abstractly designed as two interdependent subsystems: the Community Self-Organizing System (CSO) and the Subnet System (Consensus Asset Protocol).

2.1 Community Self-Organizing System (CSO)

The CSO is a consensus competition system, a fractal governance structure, comprising four roles:

- **Governance Token Holders**

  Governance token holders are the equity holders of the entire network. They earn network rewards by delegating their equity to messenger nodes or consensus nodes.

- **Messenger Nodes**

  Qualified individuals can open messenger seats in the root network. Messenger nodes hold messenger value computing power and act as proxies for governance token holders. Each messenger node must possess a certain amount of $Lambda to have valid voting rights.

  Only messenger nodes can govern proposals such as subnet additions and earn income and incentives from these activities. They receive K% of the equity income they represent as messenger income.

- **Consensus Nodes**

  Consensus nodes operate a decentralized consensus computing network, recursively computing the incentive models for all subnets and nodes, and transmitting the consensus results to the root network, which executes the consensus and issues currency incentives.

  The consensus node network is separate from the root network. As the network for computing the entire network's incentive model, it addresses the limitation of the Bittensor blockchain, which could only support a limited computational load of subnets.

  Consensus nodes also have the right to propose, with CSO voting on these proposals. Proposals have a p% profit sharing allocation.

- **Gangster Nodes**

  Gangster nodes can apply to open subnets, write their own incentive models, allocate subnet incentives, and seek messenger node votes to earn subnet revenues.

2.2 Subnet System (Consensus Asset Protocol)

The SUBNET defines specific outcomes and organizes resources to achieve these outcomes through specific application protocols. SUBNETs define their own income distribution and incentive models via the root network API, and these are computed for consensus by the consensus node network before distribution.

SUBNETs can be either blockchain systems or off-chain systems.

- **Issuance Protocols**

  They build various consensus asset issuance protocols and earn protocol income and Lambda emission rewards.

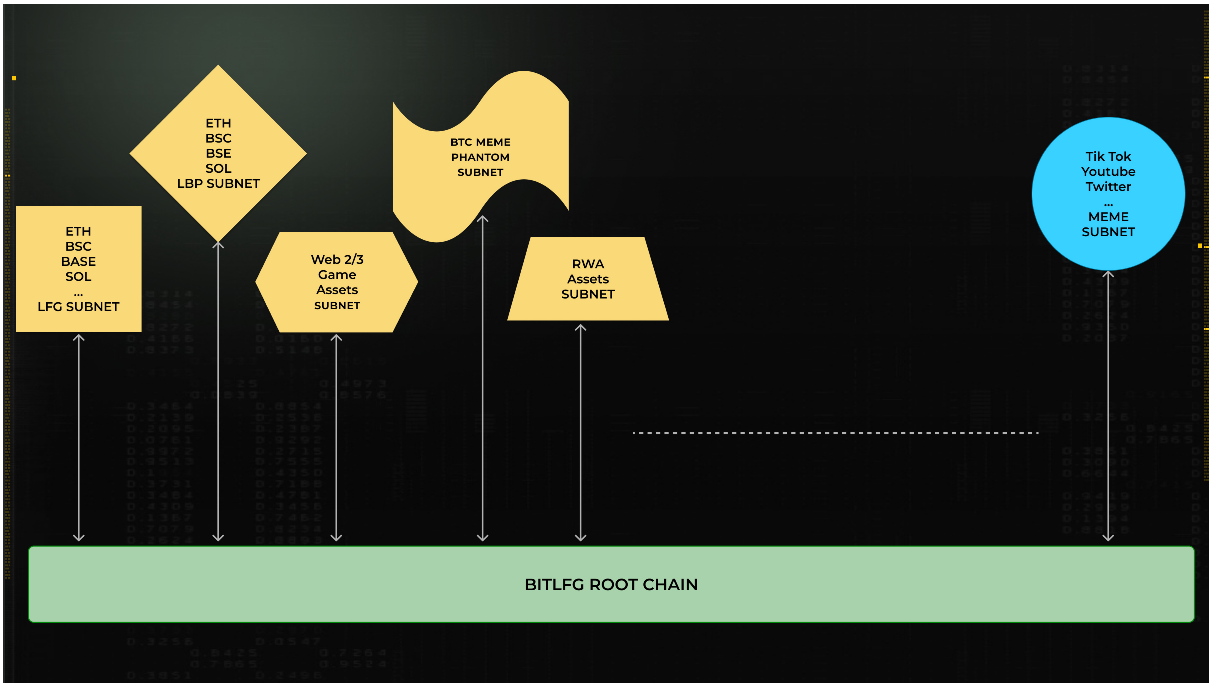
- **Trading Protocols**

  They construct various consensus asset trading protocols and earn protocol income and Lambda emission rewards.

- **Other Protocols**

  Other protocols approved by CSO voting.

The BitLambda network allows different consensus asset protocols from across the entire network and all states to operate as subnets.



Because Bitlambda separates the production system and consensus into two modules, and also separates the monetary container from the DPIP, Bitlambda is capable of supporting any application, any public blockchain, and any type of consensus asset protocol as a subnet.

Example:

A MEME asset issuance protocol linked to TikTok, where each time a user uploads a MEME VIDEO, they simultaneously issue a MEME asset. This asset can immediately enter the market for pricing. This asset issuance protocol can exist as a subnet, with its own incentive model written for it. The root network allocates token emissions and incentives based on the subnet's weight.

3 Brief Algorithm of P2P Dynamically Programmable Incentive Model

Each node's incentives are determined by the weight of the subnet it resides in, the node's own weight within that subnet, and the subnet's incentive model. The weight of the subnet, in turn, is determined by the consensus weight of the messenger nodes, creating a recursive composite incentive structure.

Definitions:

- **V Vector (Consensus votes received by each subnet from messenger nodes):**

$$V = [v_0, v_1, ..., v_{n-1}]$$
$$\text{where } v_i \text{ represents the consensus votes received by the } i\text{th subnet from messenger nodes.}$$

- **V_total Scalar (Total consensus votes across the network):**

$$V_{total} = \sum_{i=0}^{n-1} v_i$$

- **P Matrix (Consensus votes received by each node within each subnet):**

$$P = \begin{bmatrix} p_{0,0} & p_{0,1} & \cdots & p_{0,m-1} \\ p_{1,0} & p_{1,1} & \cdots & p_{1,m-1} \\ \vdots & \vdots & \ddots & \vdots \\ p_{n-1,0} & p_{n-1,1} & \cdots & p_{n-1,m-1} \end{bmatrix}$$

- **P_sum Vector (Total consensus votes for nodes within each subnet):**

$$P_{\text{sum}} = \left[\sum_{j=0}^{m-1} p_{0,j}, \sum_{j=0}^{m-1} p_{1,j}, \ldots, \sum_{j=0}^{m-1} p_{n-1,j} \right]$$

- **R Scalar (Total emissions across the network):**

$$R$$

- **M - Subnet Node Incentive Model Factor:**

$$M = \begin{bmatrix} M_{0,0} & M_{0,1} & \cdots & M_{0,m_0-1} \\ M_{1,0} & M_{1,1} & \cdots & M_{1,m_1-1} \\ \vdots & \vdots & \ddots & \vdots \\ M_{n-1,0} & M_{n-1,1} & \cdots & M_{n-1,m_{n-1}-1} \end{bmatrix}$$

- **Vr - Rewards obtained by each governance token equity:**

$$V_r$$

Expressions

$$\text{Calculate subnet weight (W):}$$
$$W = \frac{V}{V_{total}}$$

$$Calculate\ the\ incentives\ received\ by\ the\ subnet\ (I_{net}):$$
$$I_{net} = W \times R$$

$$Calculate\ the\ weight\ of\ each\ node\ within\ the\ subnet\ (W_{node}):$$
$$W_{\text{node}} = \begin{bmatrix} \frac{p_{0,0}}{P_{\text{sum},0}} & \frac{p_{0,1}}{P_{\text{sum},0}} & \cdots & \frac{p_{0,m-1}}{P_{\text{sum},0}} \\ \frac{p_{1,0}}{P_{\text{sum},1}} & \frac{p_{1,1}}{P_{\text{sum},1}} & \cdots & \frac{p_{1,m-1}}{P_{\text{sum},1}} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{p_{n-1,0}}{P_{\text{sum},n-1}} & \frac{p_{n-1,1}}{P_{\text{sum},n-1}} & \cdots & \frac{p_{n-1,m-1}}{P_{\text{sum},n-1}} \end{bmatrix}$$

$$Calculate\ the\ incentives\ for\ each\ node\ (I_{node}):$$

$$I_{\text{node}} = \left(\begin{bmatrix} I_{\text{net}[0]} \\ I_{\text{net}[1]} \\ \vdots \\ I_{\text{net}[n-1]} \end{bmatrix} \otimes \begin{bmatrix} 1 & 1 & \cdots & 1 \end{bmatrix} \right) \odot \begin{bmatrix} W_{\text{node}[0,0]} & W_{\text{node}[0,1]} & \cdots & W_{\text{node}[0,m-1]} \\ W_{\text{node}[1,0]} & W_{\text{node}[1,1]} & \cdots & W_{\text{node}[1,m-1]} \\ \vdots & \vdots & \ddots & \vdots \\ W_{\text{node}[n-1,0]} & W_{\text{node}[n-1,1]} & \cdots & W_{\text{node}[n-1,m-1]} \end{bmatrix} \odot \begin{bmatrix} M[0,0] \\ M[1,0] \\ \vdots \\ M[n-1,0] \end{bmatrix}$$

$$\text{Calculate incentives based on Vr:}$$

$$V_r = \frac{K \times \begin{bmatrix} I_{\text{node}[0,0]} & I_{\text{node}[0,1]} & \cdots & I_{\text{node}[0,m-1]} \\ I_{\text{node}[1,0]} & I_{\text{node}[1,1]} & \cdots & I_{\text{node}[1,m-1]} \\ \vdots & \vdots & \ddots & \vdots \\ I_{\text{node}[n-1,0]} & I_{\text{node}[n-1,1]} & \cdots & I_{\text{node}[n-1,m-1]} \end{bmatrix}}{\begin{bmatrix} P[0,0] & P[0,1] & \cdots & P[0,m-1] \\ P[1,0] & P[1,1] & \cdots & P[1,m-1] \\ \vdots & \vdots & \ddots & \vdots \\ P[n-1,0] & P[n-1,1] & \cdots & P[n-1,m-1] \end{bmatrix}}$$

4 Independent Incentive Calculation Layer

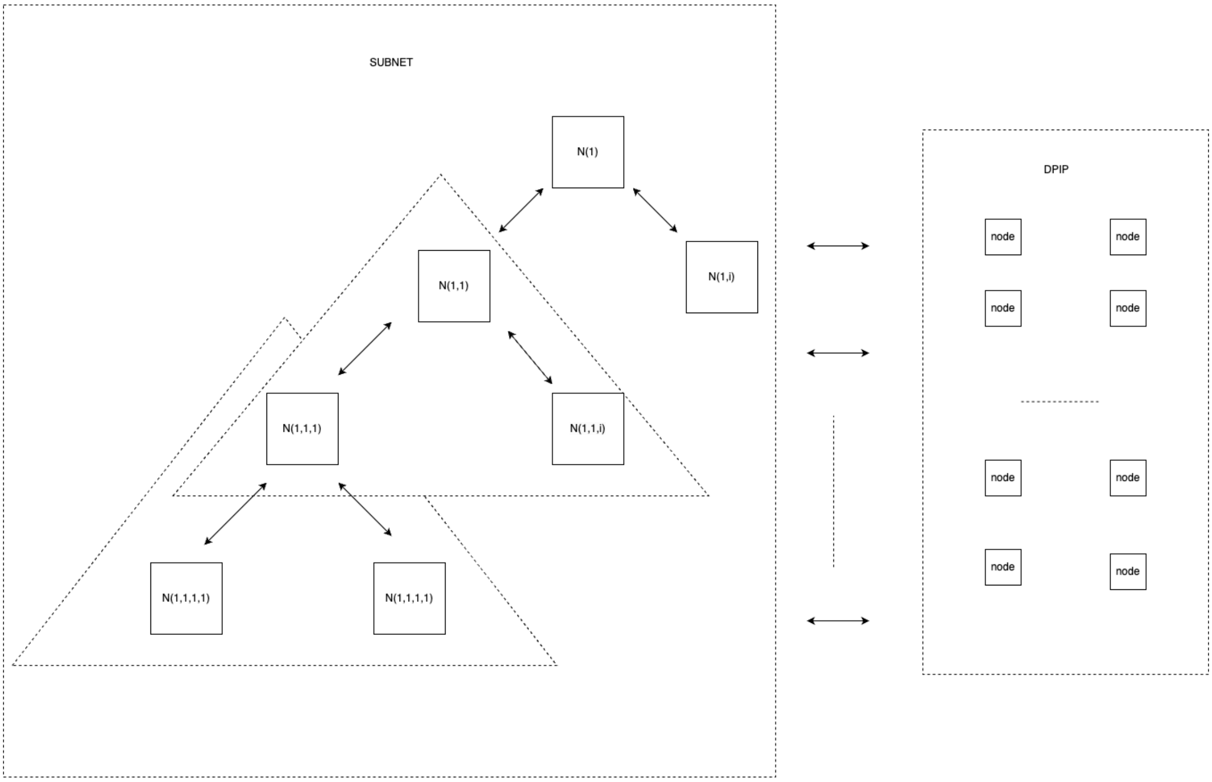
Blockchain should fundamentally be a distributed incentive system. In the BTC network, the incentive layer motivates miners to compete for the priority of ledger-keeping, which originates from a hash computation race among miners. BTC exists as a P2P electronic cash system, using this electronic cash to incentivize miners to keep the ledger, thus coupling the incentive layer with the computational layer. This poses no issue within the BTC network because its design primarily aims for simplicity and anti-fragility, making it a statically programmable incentive system.

Subsequent blockchain paradigms have not deviated from this BTC model, tightly coupling the incentive layer with the computational layer. This results in incentives being directed only towards miners performing the computations, rather than addressing real computational problems. This is as absurd as a company that pays only its accountants, or a bank whose sole purpose is bookkeeping rather than providing financial services.

Another major issue with the strong coupling of the incentive and computation layers is the block size limit. Even in Turing-complete systems, computations must be restricted within a finite number of steps, i.e., the gas limit. This prevents more extensive and complex incentive systems from existing within the old blockchain paradigms. Hence, traditional blockchain paradigms are static, non-adaptive, top-down rather than bottom-up, centralized rather than distributed incentive systems, leading to a lack of progress in public blockchain development over the long term.

We propose a new structure that decouples the incentive layer from the computational layer, allowing the computational layer to be free from the constraints of the distributed ledger system, and to fully realize an adaptive, distributed, bottom-up, and complex type of incentive system.

The incentive layer will merely be a container storing various subnet incentive algorithms, while the computational layer will be undertaken by a separate distributed incentive consensus layer. The incentive consensus layer, utilizing an Enhanced Byzantine Fault Tolerance (EBFT) algorithm, is adopted by consensus nodes of the PoS system to ensure the uniformity and correctness of consensus. This is a new algorithm proposed by the Lambda paradigm, adding a challenge mechanism for all subnet nodes on top of the resistance to 1/3 node attacks. Even if 2/3 of the nodes are controlled by malicious operators, as long as there is any honest node within a subnet, this incentive consensus layer will ensure the correctness of the incentive consensus.



5. P2P Dynamic Programmable Incentive Protocol (DPIP): Feedback and Recursion

The formation of the universe is a natural fractal process, from atoms to planetary and stellar systems, and then to the structure of star clusters, displaying a surprising pattern of progressive, self-similar, and self-growing formations. It can evolve from an extremely simple and uniform state through fractal development to its current highly complex and diverse state.

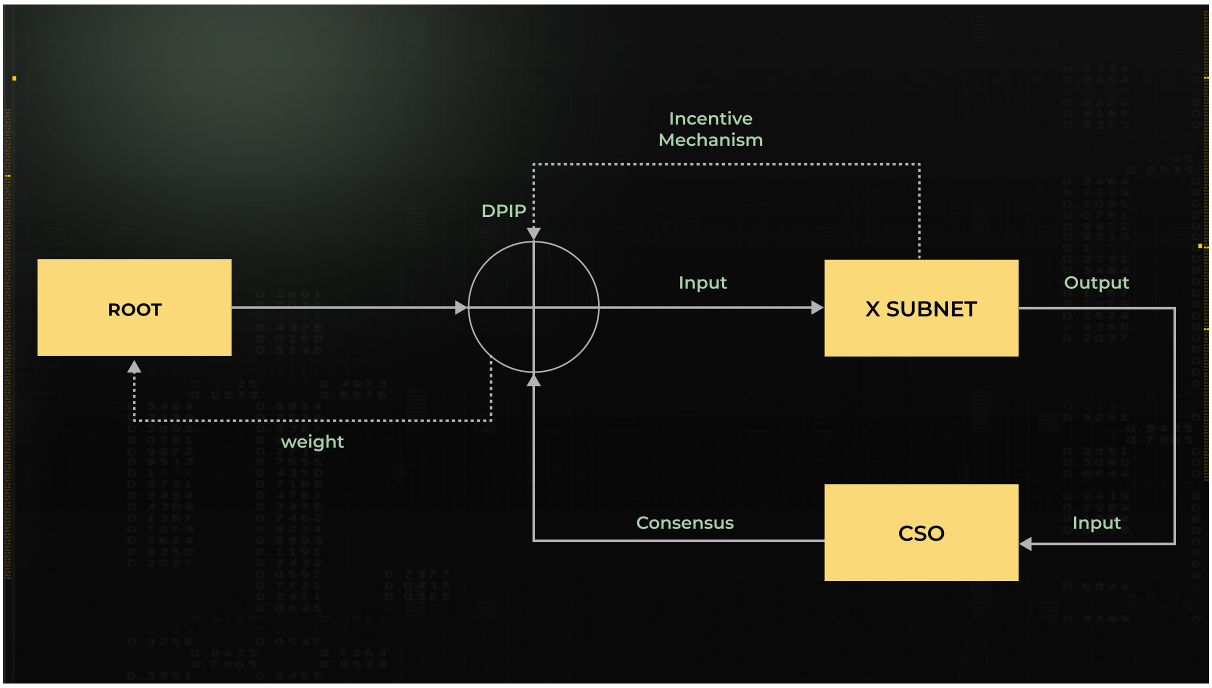
Similarly, in fields such as biology, geography, anthropology, and others, this unified and universal law is evident, showing that from the smallest to the largest scale, the world is composed of similar processes and patterns.

This represents a distributed, decentralized principle where simple feedback circuits and recursive loops can evolve into complex systems.

Blockchain should also be completed based on this principle.

DPIP Feedback Circuit

Each SUBNET's revenue and incentive mechanisms compete with each other. The consensus strength of the CSO for that subnet influences the weight of the subnet, which in turn affects the incentive input to the subnet. The consensus strength also impacts the average income per voting right. These factors interact cyclically, forming an adaptive, evolutionary feedback circuit.



$$\mathit{A\ typical\ positive\ feedback\ loop\ for\ an\ effective\ subnet\ model\ would\ be:}\ \mathrm{SUBNET(output)} \uparrow \rightarrow \mathrm{CSO(inpu}$$
$$\rightarrow \uparrow \mathrm{SUBNET(weight)}$$

$$\begin{gathered} \mathit{A\ typical\ negative\ feedback\ loop\ is:} \\ \mathrm{SUBNET}_{(\mathrm{output})} \downarrow \rightarrow \ \mathrm{CSO}_{(\mathrm{input})} \downarrow \rightarrow \ \mathrm{CSO}_{(\mathrm{consensus})} \downarrow \\ \rightarrow \downarrow \mathrm{SUBNET}_{(\mathrm{weight})} \end{gathered}$$

$$\begin{gathered} \mathit{Often, signals\ are\ not\ linearly\ transmitted\ but\ interact\ with\ each\ other:} \\ \mathrm{SUBNET}_{(\mathrm{output})} \uparrow + \mathrm{CSO}_{(\mathrm{input})} \uparrow + \updownarrow \mathrm{CSO}_{(\mathrm{consensus})}) \\ \rightarrow \updownarrow \mathrm{SUBNET}_{(\mathrm{weight})} \end{gathered}$$

$$\begin{gathered} \mathit{Or\ it\ could\ be:} \\ \uparrow \mathrm{CSO}_{(\mathrm{consensus})} \rightarrow \uparrow \mathrm{SUBNET}_{(\mathrm{weight})} \\ \xrightarrow{ma} \\ (\uparrow \mathrm{SUBNET}_{(\mathrm{input})} + \downarrow \mathrm{CSO}_{(\mathrm{input})}) \end{gathered}$$

In the absence of mechanism competition, this change can be abstractly expressed as a pair of recursive functions:

$$\begin{gathered} income = f(weight) \\ weight = \Phi(income) \end{gathered}$$

SO

$$\begin{gathered} income = f[\Phi\ \ (income)] \\ weight = \Phi[f(weight)] \end{gathered}$$

Two recursive functions will not produce a completely balanced solution, leading the system into an endless process of change. Once competition among subnets is introduced into this process of change:

$$A \overset{>}{<} B \overset{>}{<} C \ldots \overset{>}{<} X$$

This system will enter a continuous evolutionary process, which will align with the developmental paths found in nature.

In addition to the mutual recursive calls between consensus functions and incentive functions, the Lambda paradigm should also allow for recursive calls of dynamically programmable incentive protocols between networks of different scales, expressed as follows:

$$D(I,k) = \begin{cases} I_{k+1} = Mechanism\ \ (pk)\ \ \cdot I_k & \text{for the next layer network} \\ I_{k,i} = Mechanism(w_{k,i}) \cdot I_k & \text{for each node } i \text{ in layer } k \\ \text{if } k+1 < K & D(I_{k+1}, k+1) \end{cases}$$

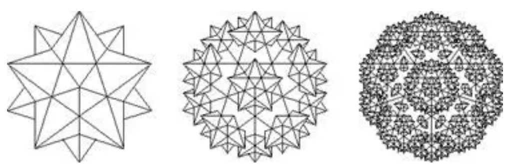
Among them:

$$\begin{gathered} For\ the\ k-th\ level\ subnet,\ the\ total\ incentive\ received\ is\ I_k. \\ The\ mechanism\ \text{Mechanism}(p_k)\ represents\ the\ allocation\ weight\ for\ the\ k_1-th\ level\ subnet\ obtained\ thro \\ The\ mechanism\ \text{Mechanism}(w_{k,i})\ represents\ the\ allocation\ weight\ for\ node\ i, \\ in\ the\ k-th\ level\ subnet,\ also\ obtained\ through\ DPIP. \end{gathered}$$

Initial and boundary conditions:

$$D(\Lambda, 0) \quad \text{where } \Lambda \text{ is the total incentive of the root network (layer 0)}$$

The above completes the vertical fractalization of subnets at different scales.



6. Conclusion

Based on the abstraction and inheritance of the static incentive protocol of the BTC network and the dynamically programmable incentive protocol of Bittensor, we propose a new blockchain paradigm, Lambda. This paradigm provides a fractal blockchain based on P2P dynamically programmable incentive protocols, dividing the incentive layer, consensus layer, and application layer into interdependent yet independent modules, capable of supporting any application scenarios and asset ranges.

The world will witness a revolution in P2P consensus capitalism."

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