Zero Gas Whitepaper

Abstract

ZeroGas represents a pioneering leap in blockchain technology, initiated by the ZeroGas Foundation with a vision to revolutionize the industry. Historically, emerging technologies often begin with prohibitive costs, only to become widely accessible and affordable over time. This trend is evident in the evolution of the Internet, which transitioned from an expensive novelty to a universally available service with minimal interaction costs beyond a subscription.

Web3 technology is poised for a similar transformation. Currently, every action on a blockchain ledger incurs a transaction fee, which poses a significant barrier to widespread adoption. ZeroGas aims to overcome this hurdle by introducing a groundbreaking approach: Proof of Holding. This paradigm shift is set to make Web3 interactions more accessible by removing transaction fees for most interactions once an initial holding is established.

Central to this innovation is the Central Pay Master (CPM), which implements delegated payment at a chain-wide level. This mechanism is designed to eliminate the transaction fee barrier, facilitating the application of blockchain technology to real-world use cases.

The ZeroGas Foundation is dedicated to refining and advancing the Proof of Holding model, striving to make Web3 as intuitive and cost-effective as traditional Internet interactions, thereby paving the way for mass adoption.

Keywords: Blockchain, Fees, Gas, Layer 1

1 ZeroGas Overview

ZeroGas represents a pioneering leap in blockchain technology, initiated by the ZeroGas Foundation with a vision to revolutionize the industry. Historically, emerging technologies often begin with prohibitive costs, only to become widely accessible and affordable over time. This trend is evident in the evolution of the Internet, which transitioned from an expensive novelty to a universally available service with minimal interaction costs beyond a subscription [1].

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Central to this innovation is the Central Pay Master (CPM), which implements delegated payment at a chain-wide level. This mechanism is designed to eliminate the transaction fee barrier, facilitating the application of blockchain technology to real-world use cases [2].

The ZeroGas Foundation is dedicated to refining and advancing the Proof of Holding model, striving to make Web3 as intuitive and cost-effective as traditional Internet interactions, thereby paving the way for mass adoption. The primary objective of ZeroGas is to drive mass adoption of blockchain technology by eliminating transaction fees, a significant barrier to widespread use.

The main space of competitiveness for all blockchain concepts includes:

- **Transaction Speed:** Rapid transaction processing to enhance user experience.
- **Transaction Cost:** Reducing costs to make blockchain interactions more accessible.
- **Security of the Blockchain:** Ensuring robust security measures to protect the network and its users.

To achieve an ideal blockchain technology, ZeroGas incorporates the following features:

- **EVM Compatible:** Ensuring compatibility with the Ethereum Virtual Machine.
- **Breakneck Transaction Speed:** Optimized for high-speed transactions.
- **Large Number of Transactions Per Second:** Scalability to handle a large volume of transactions.
- **Developed in Rust:** Using Rust programming language for enhanced safety, speed, and concurrency.
- **GASLESS Transactions:** Eliminating transaction fees for most interactions.

A new concept must be introduced for the above technology to be feasible.

1.1 Proof of Holding (PoH)

"Proof of Holding" is a new protocol that allows coin holders to enjoy a certain number of free transactions per epoch. The philosophical foundation of PoH is the intrinsic alignment between the strength of a blockchain and the engagement of its users. Typically, a blockchain's robustness is derived from its token holders, yet requiring these holders to pay for each transaction undermines their participation.

PoH addresses this by rewarding token holders with the ability to transact freely, enhancing their incentive to remain active in the network. This model ensures that holding the chain's tokens not only contributes to the network's strength but also provides practical benefits. The mechanics of PoH can be summarized as follows:

- Users must hold a minimum amount of ZeGas in their wallet to receive FTC.
- Eligibility for FTC is determined by snapshots taken during the last epoch, with the minimum amount held during that period qualifying for FTC.
- FTC are allocated at the end of each epoch based on the amount of ZeGas held during the epoch.
- FTC do not expire, ensuring that users can accumulate and utilize them over time.

1.2 Central Pay Master

In account abstraction, Pay Masters are specialized smart contracts that facilitate flexible gas fee policies. They enable decentralized applications (dApps) to cover gas costs on behalf of their users, allowing for operations to be sponsored without users needing to pay gas fees in the blockchain's native currency. Alternatively, paymasters can accept gas fee payments in ERC-20 tokens, such as USDC, instead of the blockchain's native currency.

Introduced through Ethereum Improvement Proposal (EIP) 4337 [3], paymasters integrate with other Account Abstraction components like bundlers and the entry point smart contract. This integration compensates these components for fronting the gas required to execute user operations, thereby streamlining the user experience and expanding payment options within the ecosystem.

ZeroGas extends this same approach to become an intrinsic part of the blockchain itself by introducing the Central Pay Master (CPM). The function of the CPM is to pay the transaction fees on behalf of the user if the user has access to enough credit. By adopting the CPM, ZeroGas not only provides the ability to have gasless transactions but also rewards the nodes in a compatible way with the current chain architecture.

1.3 Free Transaction Credits (FTC)

At the core of the ZeroGas chain is the Free Transaction Credits (FTC) system. The main innovation provided by the FTC is that instead of inflating the current circulating supply of the ZeroGas token, namely ZeGas, it introduces a credit token only usable to pay for the transaction fees. The FTC is converted to ZeGas at the transaction time by the CPM in order to pay for the transaction.

- The number of FTC generated per epoch is proportional to the total amount of ZeGas held or staked.
- Projects within the ecosystem can prepay for FTC or leverage node validators' unused capacity, providing flexibility for managing transaction costs.
- FTC do not expire, allowing users to accumulate them across multiple epochs.

1.4 Organizational Node

Most current blockchains primarily cater to individual wallet transactions and overlook the needs of enterprises and organizations [4]. For businesses to effectively integrate blockchain solutions, they must be able to cover transaction fees on behalf of their users. Expecting end customers to bear both service costs and transaction fees is impractical—akin to a business accepting credit card payments but also requiring customers to cover the card's transaction fees. To address this challenge, ZeroGas introduces the Organizational Node (ON). This innovative feature allows organizations to pay transaction fees on behalf of designated contracts or whitelisted users. The ON enables businesses to offer blockchain-based services without passing transaction costs onto their users, while also contributing to network security. The main functions of the ON are as follows:

- Users can stake ZeGas to create nodes, requiring approximately 74,600 ZeGas.

- Node creators can whitelist other wallet addresses to cover their gas fees.
- Nodes have the option to either whitelist addresses or send FTC credits directly.
- If a node chooses to send FTC credits out, a tax is applied to the transaction.
- The tax rate starts at 10% and progressively increases to 100% over a specified period.
- Stakers receive additional ZeGas rewards and a bonus in FTC for contributing to network security.

2 Concepts

Some important concepts that must be understood before reading the following whitepaper are:

- **ZeroGas (ZeGas):** Native token of the blockchain, it generates Free Transaction Credits (FTC) by holding or staking it, and also has multiple uses for platform creators, users, etc.
- **Free Transaction Credits (FTC):** Method generated by holding or staking ZeroGas (ZeGas) to pay for gas fees.
- **Epoch:** Period of time in a blockchain. It is evaluated through a certain number of blocks resolved.
- **Network Capacity:** Total transaction amount that a blockchain can process per epoch, which also translates to the total amount of gas consumed per epoch.
- **Production Ratio:** Amount of Free Transaction Credits produced by 1 Native Coin per epoch.
- **Held Amount:** Minimum amount of ZeroGas (ZeGas) stored in the staking address during the last epoch.
- **Minimum Held Amount:** Minimum amount of ZeroGas (ZeGas) stored in the staking smart contract address that will generate Free Transaction Credits.
- **Transactions Per Second (TPS):** Number of transactions a blockchain can sustain without failing in a second.
- **Time To Finality (TTF):** Amount of time that takes from the manual approval of a transaction to the block confirmation in the ledger, for the transaction to be validated.
- **Computational Power:** Type of power that is exchanged in a blockchain to provide a robust network with strong security, fast transactions, and low transaction costs.

3 Technical Overview

A distributed system guarantees the acceptance of Byzantine fault tolerance (BFT) for information transmission [5]. Distributed systems generally share information with all participating nodes. After data is shared, the systems reshare it. Thus ensuring BFT consumes a considerable amount of time.

ZeroGas Chain uses Decision search protocols that apply the gossip protocol for distributed networks with guaranteed BFT, which is entirely asynchronous and leaderless. It has an eventual consensus but no round-robin or proof-of-work.

Each node in the algorithm has a set of k most preferred neighbors. Upon receiving a transaction, the node generates an event block and connects with all its neighbors. Each event block is signed with the hash of the generation node and has k peers.

The consensus structure of the event block uses a DAG that guarantees aBFT. The consensus mechanism uses Lamport timestamps and concurrent common knowledge. The protocol can reach a consensus when two-thirds (2/3) of all participants agree to an event block without any additional communication overhead using gossip protocol.

By creating a dynamic flag table that stores the connection information between blocks, the gossip protocol achieves a consensus in fewer steps than existing aBFT protocols.

3.1 Generic Framework of ZeroGas Chain Consensus Mechanism

ZeroGas Chain implements a generic framework for decision search protocols. The consensus protocol generates each block asynchronously, and the consensus algorithm achieves consensus by confirming the number of nodes that know the blocks using the structure.

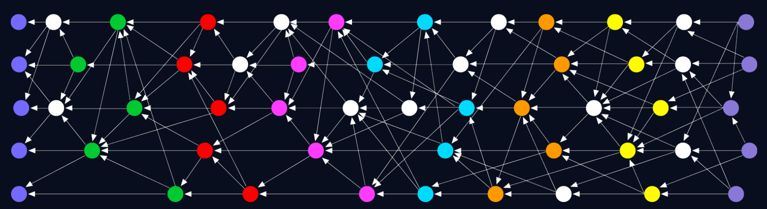


Fig. 1: Consensus Structure

This structure is the result of guaranteed finality. That is after completing the entire process. It is grouped by colors among events where you can see at least two-thirds (2/3) of the different stages until reselected.

The consensus protocol is based on the following main concepts:

- **Event Block:** All nodes can create event blocks at time t. The structure of an event block includes the signature, generation time, transaction history, and hash information to references. The information of the referenced event blocks can be copied by each node. The first event block of each node is referred to as a leaf event.

- **Decision search protocol:** It is the set of rules that govern the communication between nodes. When each node creates event blocks, it determines which nodes choose other nodes to broadcast to. Node selection can either be random or occur via a cost function.
- **Happened-before:** It is the relationship between nodes that have event blocks. If a path exists from an event block x to y, then x is Happened-before y, which means that the node creating y knows the event block x.
- **Root:** An event block is termed a Root if either:

  1. It is the first generated event block of a node, or
  2. It can reach more than two-thirds (2/3) of other Roots. Every Root can be a candidate for subDecision.

- **Root set:** Root set (R) is the set of all Roots in the frame. The cardinality of the set is $2n/3$, where n is the number of all nodes.
- **Frame:** Frame f is a natural number that separates Root sets. The frame increases by 1 in the case of a Root in the new set (f + 1). Moreover, all event blocks between the new set and the previous Root set are included in the frame f.
- **Flag Table:** It stores the reachability from an event block to another Root. The sum of all reachabilities, namely all values in the flag table, indicates the number of reactions from an event block to other Roots.
- **Lamport timestamps:** For topological ordering, the algorithm responsible for Lamport timestamps uses the happened-before relation to determine the partial order of the entire event block based on logical clocks.
- **subDecision:** A subDecision is a Root that satisfies being known by more than $2n/3$ nodes and more than $2n/3$ nodes know the information that is known in nodes. A subDecision can be a candidate for a Decision.
- **Decision:** A Decision is an assigned consensus time by using the Decision search algorithm and is utilized for determining the order between event blocks. Decision blocks allow time consensus ordering and responses to attacks.
- **Re-selection:** To solve the Byzantine agreement problem, each node reselects a consensus time for a sub-selection, based on the collected consensus time in the Root set of the previous frame. When the consensus time reaches the Byzantine agreement, a subDecision is confirmed as a Decision and is then used for time consensus ordering.
- **Consensus Structure:** The consensus structure is the local view of the DAG held by each node, this local view is used to identify topological ordering, select subDecision, and create time consensus through Decision selection.

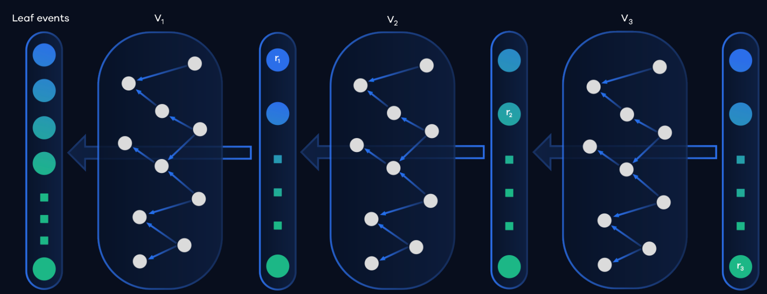


Fig. 2: Consensus Method that employs path-search in a DAG

The illustration shows how the consensus is reached via a path search in the consensus structure. In the figure, the leaf set, denoted by Rs0 Rsi, consists of the first event blocks created by individual participant nodes. V is the set of event blocks that belong to neither Rs0 nor any Root set Rsi. Given a vertex v in V U Rs0, there exists a path from v that can reach a leaf vertex u in Rs0. Let r1 and r2 be the Root event blocks in Root set Rs0 and Rs1 respectively. Here, Rs0 is the block in which a quorum or more blocks exist on a path that reaches a leaf event block. Every path from r1 to a leaf vertex contains a vertex in Rs0. Thus, if there exists a vertex r in Rs0 such as r is created by more than a quorum of participants, then r is already included in V1. Likewise, r1 is a block that can be reached for including r1 by using blocks created by a quorum of participants. All leaf event blocks that could be reached by r1 are connected with more quorum participants through the presence of r1. The existence of the Root r1 shows that the information of r1 is connected with more than a quorum. This kind of path search allows the chain to reach consensus in a similar manner as the aBFT consensus processes. It is essential to keep track of the blocks that satisfy the aBFT consensus process to accelerate path search.

The algorithm used allows a node to identify lazy participants from its cost-effective peers – say, it's k peers. A generic Decision search protocol does not depend on any k peer selection algorithm: Each node can choose k peers randomly. Each message created by a node is then signed by the creating node and its k peers. It uses a flag table data structure that stores the connection information of event blocks. The flag table allows us to quickly traverse the consensus structure to find reachability between event blocks. The consensus structure is used to optimize the path search. By using certain event blocks (Root, subDecision, and Decision), a set of Decisions maintain reliable information between event blocks and reach consensus. Generating event blocks via the Decision search protocol, the consensus structure is updated frequently and can respond strongly to attack situations such as forking and parasite attack. Further, using the flag table over the consensus structure, consensus can be quickly reached, and the ordering between specific event blocks can be determined.

Consensus structure G = (V, E) is a DAG (i.e., a directed graph with no cycles), where V is a set of vertices and E is a set of edges. A path with its source and destination at the same vertex does not exist. A path is a sequence of vertices that uses no edge more than once. An asynchronous system consists of the following sets: A set P of process identifiers, a set C of channels, a set of possible local histories for each process i, a set A of asynchronous runs, and a set M of all messages. Each process of a node selects k other nodes as peers. For a certain gossip protocol, nodes may be constrained to gossip with their k peers. In such a case, the set of channels C can be modeled as follows: If node i selects node j as a peer, then (i,j) is in C. In general, one can express the history of each node in the DAG-based protocol in general or in the gossip protocol.

3.2 Summary

ZeroGas uses Asynchronous Decision search protocols and consensus structure. Lamport timestamps were used to improve the intuitiveness and reliability of the topological ordering of event blocks in distributed systems. We added a flag table at each top event block to improve Root Detection. The protocol uses a new flag table in each top event block as a shortcut to check for reachability from an event block to a Root along the consensus structure. The path search is used as proof of aBFT consensus. To ensure the distribution of participating nodes, the Decision search protocol defines a new cost function and an algorithm that efficiently and quickly selects peers. We use algorithms for Root selection and subDecision selection based on the flag table for Decision selection by weight after time consensus ordering.

This protocol can protect the chain against malicious attacks such as forks, double spending, parasite chains, and network control. These protections guarantee the safety of the consensus structure. We can also verify the existence of a Decision within the consensus structure, confirming that it guarantees finality and liveliness. The time ordering ensures the safety of the process by using the weight value of the flag table.

3.3 Smart Contract

ZeroGas Virtual Machine is a Register-based Virtual Machine that is completely compatible with Ethereum Virtual Machine (EVM). It provides more flexibility in terms of developing, writing, and testing smart contracts, alongside the security it provides.

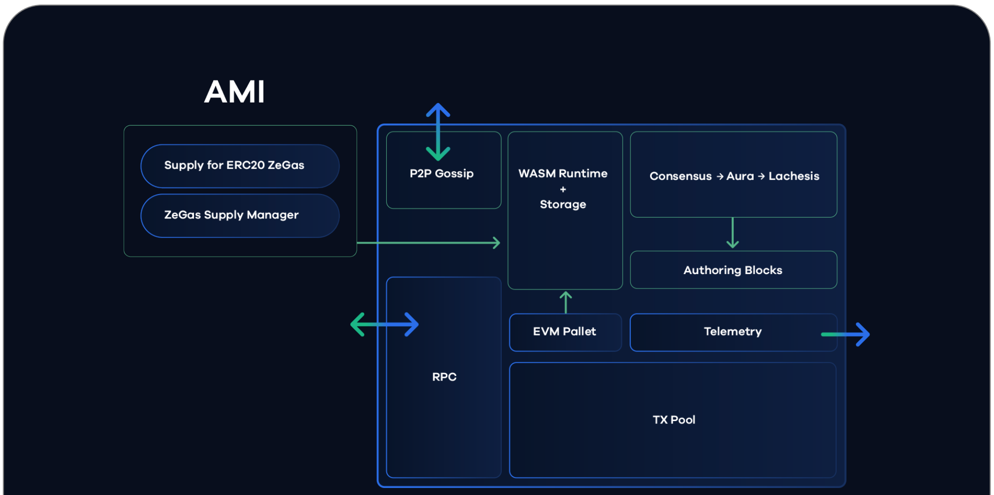


Fig. 3: ZeroGas Chain Structure

Since it is EVM-based and built in Rust, it will support the WASM-based contracts, which can be written in any language that supports WebAssembly and, most importantly, Rust. This will facilitate the development of future projects that decide to build on top of ZeroGas, including the performance that they will have.

The process will take place by applying the EVM Pallet that Frontier provides as a WASM-based module, allowing the construction of new Web3 tools through smart contracts over the ZeroGas Chain.

4 ZeroGas as a Utility Blockchain

Every blockchain requires computational power to sustain the ecosystem within, allowing everyone to use a secure, fast, and user-friendly environment. Going step by step, a couple of parameters must be set up to have the desired product, a Utility Blockchain.

A Utility Blockchain is our proposition as an accessible blockchain for anyone, everywhere. This allows beginners with almost no knowledge to interact in the ecosystem and the different projects that will be developed underneath it.

It was decided to work with an EVM-based blockchain, providing a stable environment for ZeroGas Chain to be built in. The Ethereum Virtual Machine (EVM) will provide a solid and robust environment with the WASM integration, allowing all the languages supporting WebAssembly and allowing new projects to create or port their projects into ZeroGas easily.

Having the EVM-based blockchain alongside the DAG-based aBFT Proof-of-Holding mechanism described in the Technical Overview, ZeroGas Chain will provide a secure blockchain with a robust operating system that allows 35,000 TPS, including a TTF of 0.9s, while consuming the minimum number of resources available to comply with the demand the chain may incur at any time.

These numbers will be improved considering the versatility and complexity that the Rust language provides to the developers, giving a scalable solution that evolves along the way.

This defines ZeroGas as a fast and secure blockchain, but we have to include the transaction cost in order to maintain the network.

4.1 Proof of Holding (PoH)

ZeroGas Blockchain provides a new concept: Proof of Holding (PoH). This concept requires two methods: ZeroGas (ZeGas), the native coin of the blockchain, and Free Transaction Credits (FTC), the intrinsic gasless transaction availability measurement of the blockchain [6].

ZeroGas (ZeGas) will be the main coin of the blockchain. This coin will provide the following utilities:

- Provide a certain number of Free Transaction Credits (FTC) to Holders of the last epoch.
- Gas payment alternative when running out of Free Transaction Credits (FTC).
- Allow the creation of new projects in the ecosystem.
- Stake them to ensure free transactions to all the users using your ecosystem, allowing users to receive rewards from the staking program.
- Main form of exchange inside the ZeroGas Blockchain between different cryptocurrencies, such as BTC, ETH, USDT and USDC.

The native coin will be the one held to receive Free Transaction Credits each epoch. Free Transaction Credits will be a secondary method assigned to the wallet address that holds the ZeroGas (ZeGas). If you become a Staker or Validator, these Free Transaction Credits won't be transferable but can be assigned to a certain number of whitelisted wallet addresses selected by the wallet owner.

The Free Transaction Credits value will be evaluated as ZeroGas (ZeGas) in terms of gas payment.

For ZeroGas, holding and staking are two different concepts:

- **Holding:** By holding at least the minimum required amount of ZeGas, you will receive Free Transaction Credits (FTC) after the epoch ends. This option remains fully liquid and can transfer your tokens at any time.

- **Staking:** Become a validator by participating in the node creation contract to receive ZeGas rewards, free transactions, and being able to whitelist users. To create a node requires 74,600 ZeGas.

4.2 Network Capacity

To have a long-term mechanism that works without system disruption, the gas amount available and the network capacity will be deeply correlated.

For example:

As an initial value for network TPS, the team assumes a current capacity of 35,000 Transactions per Second. Each transaction will have a gas consumption limit of 21,000 gas units, with a gas price of 1 GWEI.
Considering an approximate epoch time of 6 hours, this requires the equivalent of 15,876 ZeGas per epoch to sustain the free transactions. An initial total supply of 450,000,000 ZeGas and a Free Transaction Production Ratio of 103 Free Transaction Credits per 1 ZeGas; it will use 2% of the total Free Transaction Credits Generation Capacity.
The network capacity example provided above defines the Free Transaction Credits Production Ratio, giving the total amount of Free Transaction Credits required to run the network without using ZeroGas (ZeGas) as fuel.
The network will be sustained with the computational power supplied by the ZeroGas node validators (stakers) of the network, which will include a reward model, giving an attractive incentive.
To provide the security and stability the network requires, ZeroGas Foundation will lock indefinitely 9,474,200 ZeGas in order to provide 127 in-house bootnodes that will be the initial core of the blockchain.
Once the project begins to grow in terms of users and projects, it is expected to have node validators (stakers) that will make the chain more decentralized and robust.

4.3 Projects inside Relativity

One of the main features the chain provides is the ability to allow a certain number of wallets with access to Free Transaction Credits produced through a whitelist.
This is an important concept since it will be the strategic point of ZeroGas. Projects within the ecosystem will be able to share their owned gas with their token holders, avoiding gas costs for the transactions involving their project.
The concept reduces the entrance barrier since a new user would only require a wallet to receive that specific project token, making it widely available for day-to-day projects such as loyalty points in an airline or redeemable products with a gym membership.
To create a project, the minimum amount of ZeroGas (ZeGas) that should be held in the administrator address is the required ZeGas for the contract deployment. Additionally, they will need to become a node validator to enable a whitelist of their users for them to receive free transactions in the ecosystem. The node validation (staking) process requires to lock the staked ZeGas a certain period of time to protect the users

under the project.
The amount staked as a validator will provide the project users with approximately 7,680,000 free transactions per epoch without paying any gas fees, allowing gas-consuming ecosystems access to free transactions for their users.
If the project doesn't want to create more nodes to run their project or just wants a certain amount of free transactions without becoming a validator, there will be an option to prepay Free Transaction Credits, provided by node validators with unused capacity. The option provided will allow a diversity of strategies for new projects in terms of delivering gasless alternatives to their users.
Once the project is created, the administrators will be able to whitelist their token holder addresses, therefore they won't have to pay gas fees, since they are already covered with the locked amount of ZeroGas (ZeGas) or the prepaid number of Free Transaction Credits, as long as the project doesn't reach their available Free Transaction Credits. Nonetheless, if the amount of gas available for the project is consumed before the epoch ends, it would need to be topped off to continue making transactions. At this point, it would be recommended to step up the number of nodes provided, avoiding the gas barrier for the project users.

4.4 ZeroGas Coin Schedule

Having a strong mathematical model for the release of new tokens will provide a good economical projection, which is why the project has designed a model that will reward early investors while allowing a good revenue model for the sustainability of the chain long term.

Model:

$$RR = 156,321,300,000,000 + \left[\frac{450,000,000 - 156,321,300,000,000}{1 + \left(\frac{t}{520,247,300}\right)^{0.7562364}} \right]$$

RR : ZeroGas Release in Coins t : Time period in years

With the model provided, it is estimated that by 20 years, the chain will have a total supply of 835,820,000 ZeGas in circulation. This is less than double the amount, considering a time period as vast as 20 years. It is important to take into consideration the burning mechanism aligned with the project creation method, in which projects will stake indefinitely a certain number of ZeroGas (ZeGas) according to their gas needs for their users. A graphical representation for a visual estimation of coins for the next 34 years can be observed in Fig. 4.

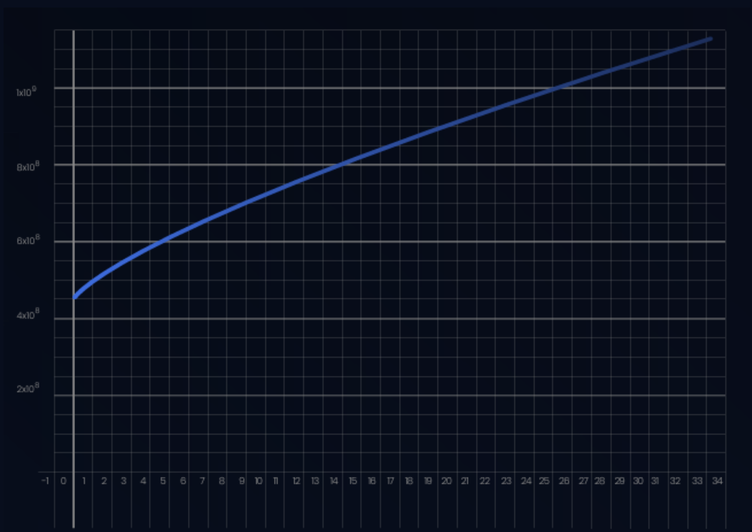


Fig. 4: Graphical Representation of the ZeroGas Release Schedule

4.5 Chain Traffic and Gas Production Rate

An estimate regarding chain traffic and their respective gas production rate has been considered to have an estimated value for transactions, gas cost and network gas consumption. The table considers values like the current total supply regarding the ZeroGas Release Schedule shown before and the free transaction production rate.

Year	2024	2025	2026	2027	2028	2029
ZeGas Total Supply	450,000,000.00	490,000,000.00	517,600,000.00	541,900,000.00	564,240,000.00	585,230,000.00
Free Transaction (FT) Poduction Rate	102.91199	102.91199	102.91199	102.91199	102.91199	102.91199
TPS	35000	100000	150000	200000	250000	300000
Total TX / epoch	756000000	8640000000	12960000000	17280000000	21600000000	25920000000
Total Gas (GWEI)	1.5876E+13	1.8144E+14	2.7216E+14	3.6288E+14	4.536E+14	5.4432E+14
Gas Price (GWEI)	1	1	1	1	1	1
Total Cost (ZeGas)	15876	181440	272160	362880	453600	544320
Total Production (FT)	46,310,395,500.00	50,426,875,100.00	53,267,246,024.00	55,768,007,381.00	58,067,061,237.60	60,227,183,907.70
FT Capacity used	2%	17%	24%	31%	37%	43%
Supply APR	8.89%	5.63%	4.69%	4.12%	3.72%	3.42%

Fig. 5: Five-years Chain Traffic Scenario Analysis

The analysis showcases an ideal situation which considers an equal usage by each project inside ZeroGas. Certainly, this won't be the case. Reason why a resource efficiency mechanism was created to avoid gas spikes, TTF delays and computational outages.

4.6 Main Concerns

Providing a new blockchain solution into a broad space, such as utility ecosystems like ZeroGas, includes many difficulties and challenges that must be sorted out to be successful. After a fundamental analysis of the infrastructure proposed for the project, the team identified some issues that could arise at deployment:

4.6.1 Mechanism Complexity

Providing a new solution in terms of a blockchain will incur a new level of complexity which will require certain limits to avoid any technical malfunctions. The Proof-of-Holding (PoH) mechanism will bring a higher complexity to the performance of the network. Therefore, this new mechanism will require a number of set parameters initially:

- Number of Whitelisted Addresses per Node Creator: +100,000 Addresses

- Minimum amount of Held ZeroGas (ZeGas) to receive Free Transaction Credits: 10 ZeGas

4.6.2 Transaction Spam Prevention

In order to prevent transaction spam [7], ZeroGas Chain allows an amount of earned Free Transaction Credits to their users. This doesn't mean that gas is necessarily free. The project aims to value the time the token is held, therefore, translating the time value of their native token into the Free Transaction Credits provided. To be eligible for Free Transaction Credits, you will need to hold ZeroGas (ZeGas) for the whole previous epoch. Snapshots of the blockchain will be taken at the end and the beginning of an epoch to evaluate the addresses. Those two values must be the same to be rewarded. If one of them is smaller, then the smallest amount will be the one considered for the Free Transaction Credits distribution of the next epoch. This will avoid last-second exploits that could cause unbalances in the gas mechanism.

4.6.3 Network Staking Incentive Model

The network staking model is the most essential section of the blockchain since it provides the security and sturdiness required to sustain the network. The reason why the incentive model is crucial for us. The minimum staking amount will be one (1) node. To create a node, it will be required to pledge 74,626.87 ZeGas for six (6) months. All the nodes created will share the ZeroGas (ZeGas) generated in that period proportionally. For example, let's assume there are 249 nodes running at a certain period of time and a user wants to create a node. An extra node is created giving a total of 250 nodes. Taking into consideration the total amount of ZeroGas generated for section 5.4, the ecosystem will generate 40,000,000 ZeGas. Considering the assumption that each node initiated at the same time and will receive equitable amounts; each will receive 160,000 ZeGas.

Recalling that to create a node requires 74,626.87 ZeGas, the Annual Percentage Yield (APY) would be 214.4%. The ZeGas Release model is designed this way to incentivize early node validators (stakers) in the project. This APY is subject to the number of nodes created and using the values shown above. Continuing the example, the same person that staked 74,626.87 ZeGas to create a node is also holding 74,626.87 ZeGas that are producing Free Transaction Credits. Given the amount of ZeGas staked, it will produce an estimated 7.7M Free Transaction Credits per epoch.

To provide utility to the Free Transaction Credits produced by Network Stakers, there will be the possibility that project owners interact in smart contracts with the Network Staking Contracts, letting them buy those generated Free Transaction Credits at a discount instead of staking more into their projects.

- Free Transaction Credits Cost: 0.000021 ZeGas
- Free Transaction Credits Sold by Network Staker: 25% Cost = 0.00000525 ZeGas
- Earnings model: 0.00000262 ZeGas for the Network Staker / 0.00000262 ZeGas Burnt.

The smart contracts will allow the project administrators to reserve a certain number per epoch for a certain timeframe, providing a second alternative for projects that are seeking a temporary increase in transactions but don't want to force a long-term solution such as pledging more ZeGas nodes into their Project Contract. This could be compared to a Lease. A project's specific event is a good scenario where it can buy Free Transaction Credits from the Network Stakers could solve a momentary demand. Assuming an epoch duration of 6 hours and using the example of the first year shown in Fig.5, the amount accrued would represent up to 29,454.04 ZeGas per year to the network staker, making the network staking protocol a dual incentive system.

4.7 Tools

One of the added values that ZeroGas Blockchain is providing to Project Administrators, Organizations, and end users are an on-chain integrated tool kit. Including:

- Decentralized wallet extensions for internet browsers;
- Decentralized exchanges with liquidity to port crypto assets in ZeroGas Blockchain;
- Cross-chain bridge between ZeroGas and the most used blockchains, such as Ethereum, Binance Smart Chain, Solana, Avalanche, among others;
- Smartphone wallet app that allows multiple cryptocurrencies management and crypto purchases;
- NFT Marketplace.

5 Token Economics

5.1 Overview of ZeGas Tokenomics

ZeroGas (ZeGas) Token: The primary utility token of the ZeroGas blockchain, ZeGas, serves multiple purposes, including:

- Generating Free Transactions Credits (FTC): Holders of ZeGas receive FTC based on the amount held during each epoch.
- Gas Payment Alternative: ZeGas can be used as an alternative to FTC when users run out of free transactions credits.
- Project Development: Enables the creation and support of projects within the ZeroGas ecosystem.
- Staking Rewards: Users can stake ZeGas to become validators or Organizational Nodes, earning rewards and contributing to network security and decentralization.
- Medium of Exchange: Facilitates transactions within the ZeroGas blockchain, including trading with other cryptocurrencies like BTC, ETH, USDT, and USDC.

Free Transactions Credits (FTC): FTC are gasless transaction credits generated by holding or staking ZeGas. They provide users with a cost-free way to interact with the blockchain, promoting accessibility and ease of use.

5.2 Organizational Nodes and FTC Management

- Organizational Nodes: Special nodes that can whitelist addresses or send FTC credits directly to users.

- Dynamic Tax Mechanism: FTC transfers from Organizational Nodes are subject to a progressive tax, starting at 10% and increasing to 100% over time.
- Tax Implications: The tax encourages efficient use of FTC, promotes whitelisting, and contributes to deflationary pressure on FTC supply through burning.

This innovative tokenomics model balances user accessibility, network security, and long-term sustainability, creating a robust ecosystem for various blockchain applications and services.

5.3 Token Supply and Distribution

- The initial total supply of ZeGas is set at 450,000,000, with a controlled release model designed to support long-term growth.
- The supply model incorporates a gradual increase to approximately 835,820,000 ZeGas over 20 years, considering the burning mechanisms and staking requirements.

$$RR = 156,321,300,000,000 + \left[\frac{450,000,000 - 156,321,300,000,000}{1 + \left(\frac{t}{520,247,300}\right)^{0.7562364}} \right]$$

RR : ZeroGas Release in Coins t : Time period in years

5.4 Interaction Between ZeGas Token and Free Transaction Credits (FTC)

The ZeroGas tokenomics model intricately balances the value and utility of the ZeGas token with the provision of Free Transaction Credits (FTC) credits, ensuring that FTC credits do not undermine the economic integrity of ZeGas. This section details the relationship between ZeGas and FTC, highlighting their equivalence, allocation, and the integration of the EIP-1559 upgrade to enhance the ecosystem.

5.4.1 Value Equivalence and Usage

- **Equivalence**: FTC credits and ZeGas tokens are valued equally for the purpose of paying gas fees. One FTC is equivalent to one ZeGas in covering transaction costs, ensuring a straightforward and predictable system for users.
- **Usage Restriction**: FTC credits are used exclusively for gas payments within the ZeroGas blockchain. They cannot be transferred, traded, or used for any other purpose, preserving their role as a utility for reducing transaction costs without affecting the ZeGas market dynamics.

5.4.2 FTC Allocation and Accumulation

- **Distribution Mechanism**: FTC credits are awarded to users based on the amount of ZeGas held in their wallets during an epoch. This mechanism rewards active participants who maintain a balance of ZeGas.
- **No Expiry**: FTC credits do not expire, allowing users to accumulate them over time. This feature encourages long-term holding of ZeGas and provides a buffer for transaction costs, enhancing user experience without impacting ZeGas liquidity.

5.4.3 ZeGas as a Payment Alternative

- **Fallback Mechanism**: When users deplete their FTC credits, they must use ZeGas to pay for gas fees. This fallback mechanism ensures continuous demand for ZeGas, as users must hold a reserve to cover transactions when FTC credits are exhausted.
- **Continuous Circulation**: The necessity of using ZeGas for gas fees when FTC credits are unavailable ensures ongoing circulation and utility of ZeGas within the ecosystem. This demand supports the token's market value and utility.

5.4.4 Staking and Network Security

- **Dual Incentives**: Stakers, who create nodes by locking ZeGas, receive both ZeGas rewards and FTC credits. This dual incentive system strengthens network security and decentralization, motivating validators to participate actively.
- **Reduced Circulating Supply**: ZeGas staked for node creation are locked for a specified period, reducing the circulating supply. This scarcity can potentially increase the token's market value.

5.5 Integration of EIP-1559 with ZeGas and FTC

EIP-1559 introduces a base fee that adjusts dynamically based on network congestion[8]. Here's how EIP-1559 will work with ZeGas and FTC:

5.5.1 Dynamic Fee Structure

- **Base Fee Adjustment**: EIP-1559 introduces a base fee that adjusts dynamically based on network congestion, ensuring a predictable and stable gas fee environment.
- **FTC and ZeGas Payment**: Users pay the base fee using FTC if available. If FTC are exhausted, users pay the base fee using ZeGas.

5.5.2 Fee Burn Mechanism

- **Burning ZeGas**: A portion of the base fee paid in ZeGas is burned, reducing the total supply of ZeGas. This mechanism helps deflate the supply over time, potentially increasing the token's value.
- **Deflationary Pressure**: The burning of ZeGas creates deflationary pressure, aligning with the controlled supply model and ensuring long-term value retention for ZeGas holders.

5.5.3 Incentive for Holding and Staking

- **Continuous Demand**: By incorporating EIP-1559, the ZeroGas network ensures continuous demand for both FTC and ZeGas as the base fee is always required.
- **Value Proposition**: Stakers and holders benefit from the reduced supply of ZeGas due to the burning mechanism, enhancing the value proposition of holding and staking ZeGas.

5.5.4 Ensuring Value Stability

To ensure that FTC credits do not negatively impact the value of ZeGas, the following strategies are employed:

- **Non-Transferability of FTC**: By restricting FTC credits to gas payments only and preventing their transfer or trade, the impact of FTC on the ZeGas market is minimized. FTC function purely as a utility for reducing transaction costs without influencing ZeGas liquidity or trading dynamics.
- **Direct Demand for ZeGas**: The requirement for users to fall back on ZeGas for gas fees when FTC credits are exhausted ensures continuous demand for the native token, supporting its value and market presence.
- **Incentive Alignment**: Rewarding both holding and staking with FTC and ZeGas aligns incentives across different types of network participants. This alignment ensures that both users and validators have a vested interest in maintaining the value and utility of ZeGas.

5.6 Dynamic Gas Fee Model

Optimizing for network efficiency and user experience, we employ a dynamic gas fee model, drawing inspiration from Ethereum's EIP-1559 [9], formulated thus:

$$G(t) = \int_0^t \left(\text{BaseFee}(t) + \text{Tip} + \epsilon \left(\frac{P_{\text{target}} - P(t)}{P(t)} \right) \right) \cdot (\Delta C(\tau) + \Delta N(\tau)) \, d\tau \quad (1)$$

- **BaseFee(t):** Dynamically adjusts based on block space utilization, ensuring adaptability to network demand.
- **Tip:** An optional incentivization for validators to prioritize transactions, enhancing throughput during peak times.
- $\Delta C(\tau)$ **and** $\Delta N(\tau)$**:** Represent the rate of change in transaction complexity and network congestion, respectively.
- ϵ**:** A sensitivity parameter for the token price stabilization mechanism.
- $P_{\textbf{target}}$ **and** $P(t)$**:** Target and current token prices, guiding fee adjustments to market conditions.

5.7 Storage Fee Formulation

Reflecting considerations of data size, redundancy, and depreciating storage costs over time:

$$S(D, t, R) = \text{StorageBaseFee} \cdot D \cdot R \cdot e^{-\lambda t} \tag{2}$$

- **StorageBaseFee:** Cost per unit of data storage.
- D**:** Size of the data stored.
- R**:** Redundancy factor for data reliability.
- λ**:** Reflects decreasing storage technology costs over time.

5.8 Fee Distribution Mechanism

Encouraging a collaborative network through a model that rewards validators based on their contributions:

$$F_{\text{Node}} = F \cdot (\alpha + \beta P) \tag{3}$$

- F**:** Total transaction fees collected.
- α**:** Base coefficient for fee distribution.
- β**:** Adjusts distribution based on performance metrics.
- P**:** Performance metric for nodes.

This mechanism ensures that nodes are incentivized proportionally to their performance and contributions to the network, promoting a fair and efficient blockchain ecosystem.

5.9 Wallets Rewards Dynamics

To ensure a fair and dynamic distribution of Free Transactions Credits (FTC) to users holding ZeGas above a certain threshold, we have formulated an advanced equation that accounts for the number of eligible users and the varying Annual Percentage Yield (APY). This equation considers multiple snapshots of the user's balance within an epoch (6 hours) and uses the minimum balance from these snapshots to calculate the rewards.

5.9.1 Variables and Definitions

- T: Total supply of FTC to be distributed per epoch.
- N: Number of eligible users.
- B_i: Minimum balance of ZeGas held by user i during the epoch.
- $B_{\textbf{min}}$: Minimum threshold balance of ZeGas to be eligible for rewards.
- R_i: Reward in FTC for user i for the epoch.
- $APY_{\textbf{start}}$: Initial APY (100%).
- $APY_{\textbf{end}}$: Stable APY (10%).
- E: Total number of epochs in a year ($E = 4 \times 365 = 1460$).

5.9.2 Dynamic Reward Calculation

Determine the Adjusted APY

The APY decreases from 100% to 10% depending on the number of eligible users. The adjusted APY (APY_{adjusted}) is calculated as follows:

$$APY_{\text{adjusted}} = APY_{\text{end}} + (APY_{\text{start}} - APY_{\text{end}}) \times \left(\frac{N_{\max} - N}{N_{\max} - N_{\min}} \right)$$

Where $N_{\max}$ and $N_{\min}$ are the maximum and minimum thresholds for the number of eligible users, respectively. This ensures a smooth transition of APY from 100% to 10%.

Calculate Total FTC to be Distributed in the Epoch

$$T = \frac{APY_{\text{adjusted}} \times \sum_{i=1}^{N} B_i}{E}$$

Calculate Individual Rewards

The reward (R_i) for each user i is proportional to their minimum balance of ZeGas held during the epoch:

$$R_i = \frac{B_i}{\sum_{j=1}^{N} B_j} \times T$$

5.9.3 Summary

Combining the above steps, we get the dynamic equation for calculating FTC rewards for each user i:

$$R_i = \left(\frac{B_i}{\sum_{j=1}^{N} B_j} \right) \times \left(\frac{APY_{\text{end}} + (APY_{\text{start}} - APY_{\text{end}}) \times \left(\frac{N_{\max} - N}{N_{\max} - N_{\min}} \right)}{E} \times \sum_{k=1}^{N} B_k \right)$$

This equation ensures that the FTC rewards are dynamically and fairly distributed based on the minimum balance held by each user during the epoch, while the APY adjusts according to the number of eligible users, maintaining a balance between rewarding early participants and ensuring long-term sustainability.

5.9.4 Calculation Steps

To calculate this dynamic reward distribution in the ZeroGas blockchain, the following steps are taken for each epoch:

1. **Snapshot Collection:** Collect multiple snapshots of user balances throughout the epoch.
2. **Minimum Balance Calculation:** Determine the minimum balance for each user from the snapshots.
3. **Eligibility Check:** Identify eligible users who meet the minimum balance threshold.
4. **Adjusted APY Calculation:** Calculate the adjusted APY based on the number of eligible users.
5. **Total FTC Calculation:** Compute the total FTC to be distributed in the epoch.

6. **Reward Distribution:** Distribute FTC to eligible users based on their proportional share of the total minimum balance.

By following these steps, the ZeroGas network ensures a fair and dynamic distribution of FTC rewards, promoting active participation and long-term engagement.

5.10 Staking Rewards Dynamics

To ensure a fair and dynamic distribution of Free Transactions Credits (FTC) and ZeGas to nodes holding more than a certain threshold of ZeGas, we have formulated an advanced equation that accounts for the number of eligible nodes and the varying Annual Percentage Yield (APY). This equation considers the total ZeGas staked by each node and dynamically adjusts rewards based on the number of eligible nodes. Rewards are distributed every epoch, with the APY starting at 100% and gradually decreasing based on the number of nodes.

5.10.1 Variables and Definitions

- T_{FTC}: Total supply of FTC to be distributed per epoch.
- T_{ZeGas}: Total supply of ZeGas to be distributed per epoch.
- N: Number of eligible nodes.
- S_i: ZeGas staked by node i during the epoch.
- $S_{\mathbf{min}}$: Minimum threshold of ZeGas to be staked to be eligible for rewards.
- $R_{FTC,i}$: Reward in FTC for node i for the epoch.
- $R_{ZeGas,i}$: Reward in ZeGas for node i for the epoch.
- $APY_{\mathbf{start}}$: Initial APY (100%).
- $APY_{\mathbf{end}}$: Stable APY (10%).
- E: Total number of epochs in a year ($E = 4 \times 365 = 1460$).

5.10.2 Dynamic Reward Calculation

Determine the Adjusted APY

The APY decreases from 100% to 10% depending on the number of eligible nodes. The adjusted APY (APY_{adjusted}) is calculated as follows:

$$APY_{\text{adjusted}} = APY_{\text{end}} + (APY_{\text{start}} - APY_{\text{end}}) \times \left(\frac{N_{\max} - N}{N_{\max} - N_{\min}} \right)$$

Where $N_{\max}$ and $N_{\min}$ are the maximum and minimum thresholds for the number of eligible nodes, respectively. This ensures a smooth transition of APY from 100% to 10%.

Calculate Total FTC and ZeGas to be Distributed in the Epoch

$$T_{FTC} = \frac{APY_{\text{adjusted}} \times \sum_{i=1}^{N} S_i}{E}$$

$$T_{ZeGas} = \frac{APY_{\text{adjusted}} \times \sum_{i=1}^{N} S_i}{E}$$

Calculate Individual Rewards

The reward ($R_{FTC,i}$) for each node i in FTC and the reward ($R_{ZeGas,i}$) for each node i in ZeGas are proportional to their staked ZeGas during the epoch:

$$R_{FTC,i} = \frac{S_i}{\sum_{j=1}^{N} S_j} \times T_{FTC}$$
$$R_{ZeGas,i} = \frac{S_i}{\sum_{j=1}^{N} S_j} \times T_{ZeGas}$$

5.10.3 Summary

Combining the above steps, we get the dynamic equations for calculating FTC and ZeGas rewards for each node i:

$$R_{FTC,i} = \left(\frac{S_i}{\sum_{j=1}^{N} S_j} \right) \times \left(\frac{APY_{\text{end}} + (APY_{\text{start}} - APY_{\text{end}}) \times \left(\frac{N_{\max} - N}{N_{\max} - N_{\min}} \right)}{E} \times \sum_{k=1}^{N} S_k \right)$$

$$R_{ZeGas,i} = \left(\frac{S_i}{\sum_{j=1}^{N} S_j} \right) \times \left(\frac{APY_{\text{end}} + (APY_{\text{start}} - APY_{\text{end}}) \times \left(\frac{N_{\max} - N}{N_{\max} - N_{\min}} \right)}{E} \times \sum_{k=1}^{N} S_k \right)$$

These equations ensure that the FTC and ZeGas rewards are dynamically and fairly distributed based on the staked ZeGas of each node during the epoch, while the APY adjusts according to the number of eligible nodes, maintaining a balance between rewarding early participants and ensuring long-term sustainability.

5.10.4 Calculation Steps

To calculate this dynamic reward distribution in the ZeroGas blockchain, the following steps are taken for each epoch:

1. **Snapshot Collection:** Collect multiple snapshots of node balances throughout the epoch.
2. **Staked Balance Calculation:** Determine the staked balance for each node from the snapshots.
3. **Eligibility Check:** Identify eligible nodes that meet the minimum staking threshold.
4. **Adjusted APY Calculation:** Calculate the adjusted APY based on the number of eligible nodes.
5. **Total FTC and ZeGas Calculation:** Compute the total FTC and ZeGas to be distributed in the epoch.
6. **Reward Distribution:** Distribute FTC and ZeGas to eligible nodes based on their proportional share of the total staked balance.

By following these steps, the ZeroGas network ensures a fair and dynamic distribution of FTC and ZeGas rewards, promoting active participation and long-term engagement.

5.11 Dynamic Tax Mechanism for Node FTC Transfers

To encourage efficient use of Free Transaction Credits (FTC) and promote long-term engagement, ZeroGas implements a dynamic tax mechanism for FTC transfers from Organizational Nodes. This mechanism applies a progressive tax rate that increases over time, starting at 10% and eventually reaching 100%. The tax applies when nodes send FTC credits directly instead of whitelisting addresses.

5.11.1 Tax Rate Equation

The tax rate $T(t)$ at time t is given by:

$$T(t) = T_{\min} + (T_{\max} - T_{\min}) \cdot (1 - e^{-\lambda t}) \tag{4}$$

Where:

- $T_{\min}$ is the minimum tax rate (10%)
- $T_{\max}$ is the maximum tax rate (100%)
- λ is the rate of increase parameter
- t is the time elapsed since the FTC credits were received by the node

The parameter λ can be adjusted to control how quickly the tax rate approaches the maximum. A larger λ will cause the tax rate to increase more rapidly.

5.11.2 Effective FTC Transfer

When an Organizational Node transfers FTC credits, the amount received by the recipient $R(t)$ is calculated as:

$$R(t) = A \cdot (1 - T(t)) \tag{5}$$

Where A is the original amount of FTC credits intended for transfer.

5.11.3 Implementation Details

- The tax is calculated based on the age of the FTC credits being transferred, with newer credits being taxed at a lower rate.
- The taxed portion of the FTC credits is burned, effectively removing them from circulation and potentially creating deflationary pressure on the FTC supply.
- Nodes are encouraged to use the whitelisting feature for frequent transactions to avoid the tax penalty.
- The tax mechanism does not apply to FTC credits used for gas fees within the whitelisted addresses or contracts.

5.11.4 Economic Implications

This dynamic tax mechanism serves several purposes within the ZeroGas ecosystem:

- It incentivizes long-term holding and efficient use of FTC credits by Organizational Nodes.
- It discourages speculative trading of FTC credits, maintaining their primary purpose as a utility for gas fee coverage.
- It promotes the use of the whitelisting feature, which aligns with the intended use of Organizational Nodes in supporting user transactions.
- The burning mechanism contributes to the overall tokenomics by potentially reducing the FTC supply over time.

6 Chain Simulations

Blockchain simulation involves creating a controlled environment to replicate the operations of a blockchain network. This approach allows developers, researchers, and organizations to test and analyze blockchain behavior, performance, and scalability under various conditions without the risks or costs associated with using a live network.

6.1 Throughput Simulation over a 4-Year Cycle

This section presents a detailed simulation of blockchain throughput over a 4-year period. The simulation models network performance under two distinct scenarios: an optimistic growth scenario and a realistic market cycle scenario. The combined output using Latent Dirichlet Allocation (LDA) provides a comprehensive and realistic projection of the blockchain's throughput [10].

6.1.1 Simulation Parameters

- **Total Duration:** 4 years
- **Epochs per Year:** 1460
- **Total Epochs:** 5840
- **Scenarios:**
  - Optimistic Growth
  - Realistic Market Cycle

6.1.2 Methodology

Optimistic Scenario:

The optimistic scenario simulates a steady increase in users over 4 years, with transactions per second (TPS) rising linearly from 0 to a maximum of 35,000 TPS.

Realistic Scenario:

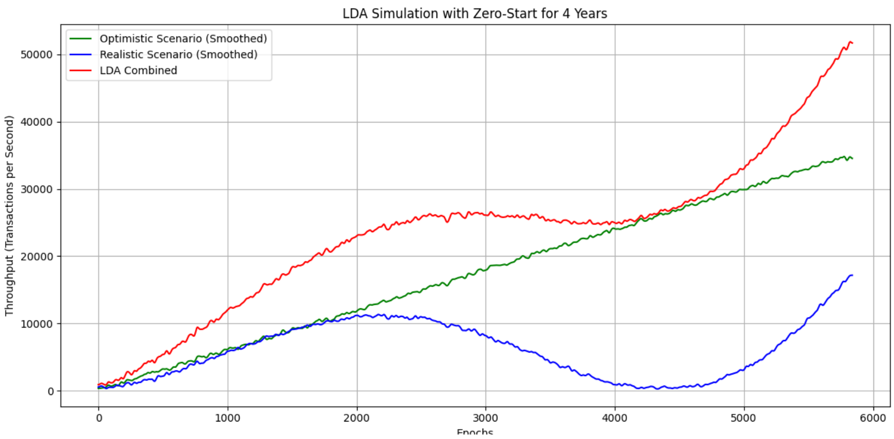
The realistic scenario simulates a market cycle similar to Ethereum's transaction volume, with TPS following a sinusoidal pattern to mimic market fluctuations from a bear market to a bull market, starting from zero.

Combining Scenarios using LDA:

The two scenarios are combined using Latent Dirichlet Allocation (LDA) to produce a more realistic throughput projection [10]. Gaussian smoothing is applied to reduce noise and enhance the clarity of the simulation results.

6.1.3 Simulation Results

The simulation results provide a comprehensive view of the blockchain's potential throughput over a 4-year period under different scenarios. Combining the optimistic and realistic scenarios using LDA offers a balanced and realistic projection, helping to anticipate performance and scalability needs. The application of Gaussian smoothing ensures clarity of results, making the data more interpretable and actionable for stakeholders.



6.2 APR Simulation for Node Staking

This section presents a detailed simulation of the Annual Percentage Rate (APR) for node staking over a 20-year period. The simulation models the APR for both ZeGas and Free Transactions Credits (FTC), providing a comprehensive view of how staking rewards evolve over time.

6.2.1 Simulation Parameters

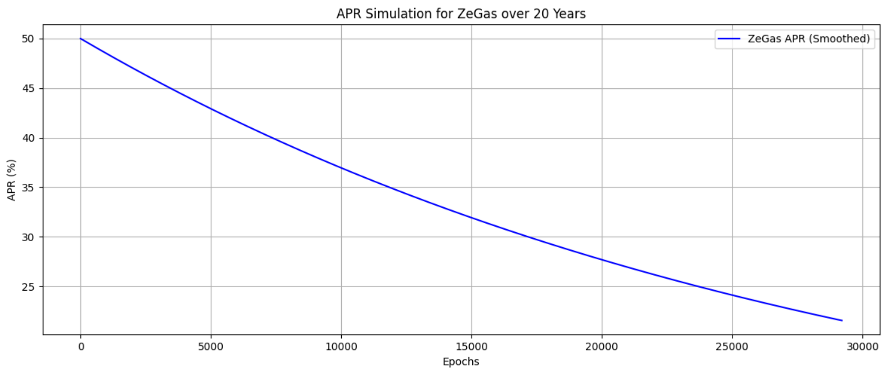
- **Total Duration:** 20 years
- **Epochs per Year:** 1460
- **Total Epochs:** 29200
- **Initial APR:**
  - ZeGas: 50%
  - FTC: 100%

- **Final APR:**
  - ZeGas: 5%
  - FTC: 10%

6.2.2 Methodology

The APR decreases over time using a logarithmic decay function, providing a realistic model of how rewards diminish as the network matures. Gaussian smoothing is applied to the APR data to reduce noise and enhance clarity.

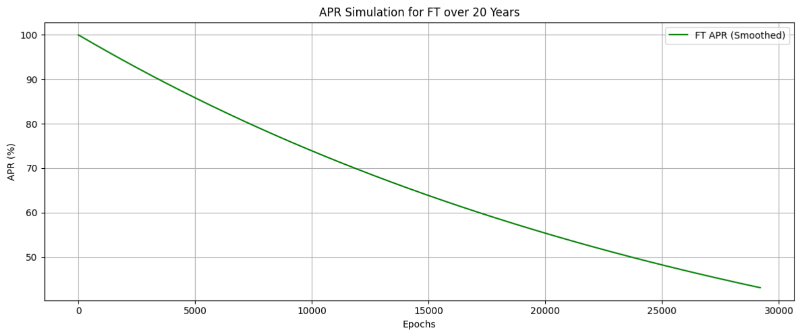
6.2.3 APR Simulation for ZeGas



Explanation:

- The APR for ZeGas starts at 50% and decreases to 5% over 20 years.
- A logarithmic decay function is used to simulate the decrease, providing a realistic model of diminishing rewards.
- Gaussian smoothing is applied to the data to reduce noise.

6.2.4 APR Simulation for Free Transactions Credits (FTC)



Explanation:

- The APR for FTC starts at 100% and decreases to 10% over 20 years.
- A logarithmic decay function is used to simulate the decrease, providing a realistic model of diminishing rewards.
- Gaussian smoothing is applied to the data to reduce noise.

7 ZeGas Token Price Simulation

The price trajectory of ZeGas, starting at $1 and anticipated to rise to $100 over a span of 20 years, is influenced by various market dynamics. This estimation incorporates **exponential growth**, **periodic bear market dips**, and **market fluctuations**, all modeled and smoothed using **Gaussian smoothing** to provide a clearer projection [11].

7.1 Exponential Growth

Exponential growth reflects the initial phase where the token price increases rapidly due to factors such as:

1. Early Adoption: As ZeGas gains popularity and usage, demand increases.
2. Network Effects: The utility of ZeGas rises as more users and applications integrate with the ecosystem.
3. Technological Advancements: Improvements in the ZeroGas blockchain or associated technologies boost investor confidence and adoption rates.

7.2 Formula for Exponential Growth

$$P(t) = P_0 \times e^{rt}$$

Where:

- $P(t)$ is the price at time t.
- P_0 is the initial price ($1).
- r is the growth rate.
- t is time in years.

7.3 Periodic Bear Market Dips

Periodic bear market dips represent temporary declines in price [12], modeled to reflect typical market cycles where:

1. Market Corrections: Corrections occur as market sentiment shifts or when prices deviate significantly from intrinsic value.
2. Regulatory Changes: New regulations or policy shifts can temporarily impact market confidence.
3. External Shocks: Economic downturns or global events can lead to reduced investment in cryptocurrencies.

7.4 Modeling Bear Markets

1. Frequency: Bear markets are assumed to occur periodically, for example, every 4-6 years.
2. Depth and Duration: The price drop during bear markets can vary, typically ranging between 20% to 50% of the current value, lasting for several months.

7.5 Market Fluctuations

Market fluctuations account for short-term price volatility influenced by:

1. Speculative Trading: Investor behavior driven by market trends, news, or sentiment can cause rapid price changes.
2. Liquidity Variations: Changes in trading volume and liquidity can affect price stability.
3. Technological or Operational News: Announcements related to ZeroGas, partnerships, or technological developments can lead to price swings.

7.5.1 Modeling Fluctuations

1. Stochastic Processes: Price variations are simulated using random processes to reflect natural market movements.
2. Volatility Assumptions: Fluctuations are modeled based on historical volatility observed in similar tokens or assets.

7.6 Gaussian Smoothing

Gaussian smoothing is applied to the simulated price data to reduce noise and present a clearer long-term trend. This involves:

1. Noise Reduction: Smoothing reduces the impact of short-term price spikes or drops that do not reflect the overall trend. Clarity: The smoothed curve provides a more comprehensible view of the token's expected price progression over time.

7.6.1 Formula for Gaussian Smoothing

$$P_{\text{smooth}}(t) = \sum_{i=-k}^{k} \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{t^2}{2\sigma^2}} P(t+i)$$

Where:

- $P_{\text{smooth}}(t)$ is the smoothed price at time t.
- σ is the standard deviation determining the smoothing window size.
- k is the number of neighboring points considered for smoothing.

7.7 Simulated Price Projection

The simulation combines these components to estimate the price of ZeGas over 20 years:

7.7.1 Initial Phase (Years 1-5)

Exponential Growth: Rapid increase due to early adoption and speculation. **First Bear Dip**: A significant dip due to initial market correction or adverse events.

7.7.2 Intermediate Phase (Years 6-15)

Moderate Growth: Slower, steadier growth as market matures. **Periodic Bear Markets**: Occasional dips reflecting typical market cycles.

7.7.3 Mature Phase (Years 16-20)

: **Stabilized Growth**: Growth levels off as the market reaches a mature state. **Final Dips and Fluctuations**: Less severe dips as the market becomes more resilient.

Explanation

- The price of ZeGas starts at $1 and is predicted to reach $100 over 20 years.
- The simulation considers exponential growth, periodic bear market dips, and market fluctuations.

- Gaussian smoothing is applied to reduce noise and enhance clarity.

7.7.4 Conclusion And Chain Token Price Impact

The simulation results provide a comprehensive view of the APR evolution for node staking over a 20-year period. The logarithmic decay model and Gaussian smoothing ensure that the results are realistic and interpretable, offering valuable insights for stakeholders in the network. Assuming a starting price of $1 per token, we can see a path for the limited cap token to approach $100 over the next 2 decade.

Appendix A Simulation Code Example

A.1 LDA Throughput Simulation Code

```python
import numpy as np
import matplotlib.pyplot as plt
from scipy.ndimage import gaussian_filter1d

# Set up simulation parameters
years = 4
epochs_per_year = 365 * 4
total_epochs = years * epochs_per_year

# Create time array
time = np.arange(0, total_epochs)

# Simulate optimistic scenario: gradually increasing transactions
optimistic_tps = np.linspace(0, 35_000, total_epochs) + 1_000 * np.random.randn(
    total_epochs)

# Simulate realistic scenario: bear to bull market cycle, starting from zero
realistic_market_conditions = np.sin(2 * np.pi * time / total_epochs) * 0.5 + 0.5
realistic_tps = np.linspace(0, 35_000, total_epochs) * realistic_market_conditions
    + 1_000 * np.random.randn(total_epochs)

# Apply Gaussian smoothing to both scenarios
smoothed_optimistic_tps = gaussian_filter1d(np.maximum(0, optimistic_tps), sigma
    =10)
smoothed_realistic_tps = gaussian_filter1d(np.maximum(0, realistic_tps), sigma=10)

# Combine the two scenarios using LDA (sum of both scenarios)
lda_combined = smoothed_optimistic_tps + smoothed_realistic_tps

# Plotting the combined LDA simulation
fig, ax = plt.subplots(figsize=(12, 6))

# Plotting smoothed throughput for optimistic scenario
ax.plot(time, smoothed_optimistic_tps, label='Optimistic Scenario (Smoothed)',
    color='g')
# Plotting smoothed throughput for realistic scenario
ax.plot(time, smoothed_realistic_tps, label='Realistic Scenario (Smoothed)', color=
    'b')
# Plotting LDA combined (sum of both scenarios)
ax.plot(time, lda_combined, label='LDA Combined', color='r')

ax.set_title('LDA Simulation with Zero-Start for 4 Years')
ax.set_xlabel('Epochs')
ax.set_ylabel('Throughput (Transactions per Second)')
ax.legend()
ax.grid(True)

plt.tight_layout()
```

```
plt.show()
```

Listing 1: LDA Throughput Simulation Code

A.2 ZeGas and FTC APR Simulation Code

```
import numpy as np
import matplotlib.pyplot as plt
from scipy.ndimage import gaussian_filter1d

# Set up simulation parameters
years = 20
epochs_per_year = 365 * 4
total_epochs = years * epochs_per_year

# Create time array
time = np.arange(0, total_epochs)

# Simulate APR for node stacking
# Initial APR starts at 50% for ZeGas and 100% for FTC
initial_apr_zeGas = 50
initial_apr_ft = 100
final_apr_zeGas = 5
final_apr_ft = 10

# Use a logarithmic decay to simulate more realistic APR decrease
apr_zeGas = initial_apr_zeGas * np.exp(-time / total_epochs) * (initial_apr_zeGas -
      final_apr_zeGas) / initial_apr_zeGas + final_apr_zeGas
apr_ft = initial_apr_ft * np.exp(-time / total_epochs) * (initial_apr_ft -
     final_apr_ft) / initial_apr_ft + final_apr_ft

# Apply Gaussian smoothing to APR data
smoothed_apr_zeGas = gaussian_filter1d(apr_zeGas, sigma=10)
smoothed_apr_ft = gaussian_filter1d(apr_ft, sigma=10)

# Plotting the APR simulation for ZeGas and FTC
fig, ax = plt.subplots(2, 1, figsize=(12, 10))

# Plotting smoothed APR for ZeGas
ax[0].plot(time, smoothed_apr_zeGas, label='ZeGas APR (Smoothed)', color='b')
ax[0].set_title('APR Simulation for ZeGas over 20 Years')
ax[0].set_xlabel('Epochs')
ax[0].set_ylabel('APR (%)')
ax[0].legend()
ax[0].grid(True)

# Plotting smoothed APR for FTC
ax[1].plot(time, smoothed_apr_ft, label='FTC APR (Smoothed)', color='g')
ax[1].set_title('APR Simulation for FTC over 20 Years')
ax[1].set_xlabel('Epochs')
ax[1].set_ylabel('APR (%)')
ax[1].legend()
ax[1].grid(True)

plt.tight_layout()
plt.show()
```

Listing 2: APR Simulation Code

A.3 Token Price Simulation for ZeGas over 20 Years Code

```
import numpy as np
```

```
import matplotlib.pyplot as plt
from scipy.ndimage import gaussian_filter1d

# Set up simulation parameters
years = 20
epochs_per_year = 365 * 4
total_epochs = years * epochs_per_year

# Create time array
time = np.arange(0, total_epochs)

# Initial token prices
initial_price_zeGas = 1
initial_price_ft = 0.1

# Target token prices after 20 years
target_price_zeGas = 100
target_price_ft = 10

# Calculate the exponential growth rate needed to reach the target price
growth_rate_zeGas = np.log(target_price_zeGas / initial_price_zeGas) / total_epochs
growth_rate_ft = np.log(target_price_ft / initial_price_ft) / total_epochs

# Simulate token prices with exponential growth, bear market dips, and random
    fluctuations
decay_rate = 0.02
random_fluctuation = 0.05

market_cycle = 4 * epochs_per_year

price_zeGas = initial_price_zeGas * np.exp(growth_rate_zeGas * time) * (1 -
    decay_rate * np.sin(2 * np.pi * time / market_cycle)) + random_fluctuation *
    np.random.randn(total_epochs)

smoothed_price_zeGas = gaussian_filter1d(price_zeGas, sigma=10)
fig, ax = plt.subplots(2, 1, figsize=(12, 10))

ax[0].plot(time, smoothed_price_zeGas, label='ZeGas Price (Smoothed)', color='b')
ax[0].set_title('Token Price Simulation for ZeGas over 20 Years')
ax[0].set_xlabel('Epochs')
ax[0].set_ylabel('Price (USD)')
ax[0].legend()
ax[0].grid(True)
```

Listing 3: Token Price Simulation for ZeGas over 20 Years Code

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