SWAN CHAIN —

DECENTRALIZED AI BLOCKCHAIN WHITEPAPER

Swan Chain Team

November 2024

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Abstract

Swan Chain, initiated in 2021, is the first artificial intelligence (AI) Super Chain dedicated to decentralized AI computing and development. Leveraging OP Super chain technology, Swan Chain integrates Web3 and AI by providing a comprehensive ecosystem that spans computing, storage, and AI applications. This includes specialized marketplaces for computing, storage, and AI agent applications, enabling seamless development, deployment, and scaling of AI models.

Swan Chain harnesses underutilized computing power from a global network of community data centers, reducing costs by up to 70% and creating new opportunities to monetize idle resources. Its AI Agent Market and advanced toolsets, including inference and development tools, establish Swan Chain as a premier AI cloud blockchain. By unifying decentralized infrastructure and AI innovation, Swan Chain accelerates the adoption of AI, making development accessible, cost-efficient, and scalable. Swan Chain's mission is to redefine decentralized computing and drive innovation at the intersection of blockchain and AI.

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Swan Token are designed to be utilised, and that is the goal of the Swan Token distribution. In particular, it is highlighted that Swan Token:

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(b) does not have any tangible or physical manifestation, and does not have any intrinsic value/pricing (nor does any person make any representation or give any commitment as to its value);

(c) is non-refundable, not redeemable for any assets of any entity or organisation, and cannot be exchanged for cash (or its equivalent value in any other digital asset) or any payment obligation by Swan Chain or any of its affiliates;

(d) does not represent or confer on the token holder any right of any form with respect to Swan Chain or any of its affiliates, or their revenues or assets, including without limitation any right to receive future dividends, revenue, shares, ownership right or stake, share or security, any voting, distribution, redemption, liquidation, proprietary (including all forms of intellectual property or licence rights), right to receive accounts, financial statements or other financial data, the right to requisition or participate in shareholder meetings, the right to nominate a director, or other financial or legal rights or equivalent rights, or intellectual property rights or any other form of participation in or relating to Swan Chain or any of its affiliates;

(e) is not intended to be a representation of money (including electronic money), payment instrument, commodity, bond, debt instrument;

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(g) does not provide the token holder with any ownership or other interest in Swan Chain or any of its affiliates.

Notwithstanding the Swan Token distribution, users have no economic or legal right over or beneficial interest in the assets of Swan Chain or any of its affiliates after the token distribution.

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To the extent a secondary market or exchange for trading Swan Token does develop, it would be run and operated wholly independently of Swan Chain. Swan Chain will not create such secondary markets nor will it act as an exchange for Swan Token.

Swan Chain shall use all proceeds of the sale of the Swan tokens to fund Swan Chain's cryptocurrency project, businesses, team development, and operations.

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In addition, there are other risks in the process of development, maintenance, and operation of the Swan Chain ecosystem, many of which are out of Swan Chain's control. You acknowledge that you understand and agree to the assumption of the following risks, including but not limited to the following:

- **Uncertain laws relating to digital token offerings**: The regulatory position of Swan token and distributed ledger technology is unclear and/or unsettled in certain jurisdictions, and there may be risks that the Swan token may be considered to be a security, or that it might be considered to be a security in the future, in these jurisdictions. Swan Chain may cease operations in a jurisdiction in the event that regulatory actions, or changes to law or regulation, make it illegal to operate in such jurisdiction, or commercially undesirable to obtain the necessary regulatory approval(s) to operate in such jurisdiction.

- **Security issues**: Hackers or other malicious groups or organizations may attempt to interfere with the Swan token and/or the Platform in a variety of ways, including, but not limited to, malware attacks, denial of service attacks, consensus-based attacks, Sybil attacks, guerilla-style attacks, smurf attack and spoofing. Furthermore, there is a risk that a third party or Swan Chain may unintentionally introduce weaknesses into the core infrastructure of the Platform and/or the Swan tokens, which could negatively affect the Platform and/or the Swan token.

- **Ethereum-based protocols**: As the Swan token and the Platform are based on Ethereum-based protocol and architecture, any malfunction, breakdown or abandonment of the relevant Ethereum-based protocol or architecture may have a material adverse effect on the Swan token and/or the Platform. Moreover, advances in cryptography, or technical advances (including, but not limited to, the development of quantum computing), could present unknown risks to the Swan tokens and/or the Platform by rendering ineffective the cryptographic consensus mechanism that underpins the Ethereum-based protocol.

- **Imperfect information disclosures**: The Platform is at the stage of development as of the date of these Terms and its algorithm, code, consensus mechanism and/or various other technical specifications and parameters could be updated and changed frequently and constantly. While the White Paper and other marketing materials (as the case may be) released relating to the development of the Platform has been prepared with the then up-to- date key information of the Platform, it is subject to adjustments and updates from time to time following the growth and development of the Platform and/or the ecosystem on the Platform. Due to the decentralized nature of the Platform, Swan Chain may not be able to, and is not obliged to, update you on all details relating to the development of the Platform (including, but not limited to, its progress and expected milestones). By purchasing, holding and using the Swan token, you accept that there may be an insufficiency of the information disclosed.

- **Early development risks**: You understand and accept that the Platform is currently in a development phase and requires substantial development. Due to unforeseeable material conceptual, technical and commercial changes before the final release, you understand and accept the risk that the development of the Platform may not be executed or implemented as planned, for reasons including but not limited to, the event of a decline in the prices of any digital asset, virtual currency or Swan token, unforeseen technical difficulties, and the shortage of funds for developing Swan Chain's cryptocurrency project.

- **Uninsured losses**: The Swan token is uninsured unless you specifically obtain private insurance to insure them. In the event of loss or loss of utility value of the Swan token, there is no public insurer or private insurance arranged by Swan Chain to offer any recourse to you.

- **Tax treatment**: The tax characterization of the Swan token is uncertain. You must seek your own tax advice in connection with the purchase, holding and/or usage of the Swan tokens, which may result in adverse tax consequences to you, including withholding, taxes, income taxes and tax reporting requirements.

- **Competitors**: It is possible that alternative networks could be established that utilize the same or similar code and protocol underlying the Swan token and/or the Platform and attempt to re-create similar facilities. The Platform may be required to compete with these alternative networks, which could negatively impact the Swan token and/or the Platform.

- **Risks arising from insufficient interest**: It is possible that the Platform may not be used by a large number of individuals, companies and other entities or that there may be limited public interest in the creation and development of distributed ecosystems (such as the Platform). Such a lack of use or interest could negatively impact the development of the Platform and therefore the potential utility of the Swan token.

- **Risks of dissolution**: It is possible that, due to any number of reasons, including, but not limited to, an unfavorable fluctuation in the value of cryptographic and fiat currencies, decrease in the utility of the Swan token due to negative adoption of the Platform, the failure of commercial relationships, or intellectual property ownership challenges, the Platform may no longer be viable to operate and Swan Chain may be dissolved.

- **Risks arising from lack of governance rights**: As the Swan token confers no governance rights of any kind with respect to the Platform or Swan Chain, all decisions involving the Platform or Swan Chain will be made by Swan Chain at its sole and absolute discretion, including, but not limited to, decisions to discontinue the services and/or the ecosystem on the Platform, to create and sell more Swan tokens for use in the ecosystem on the Platform, or to sell or liquidate Swan Chain. These corporate decisions could adversely affect the Platform and the Swan token that you hold.

- **Loss of talent**: The development of the Platform depends on the continued co- operation of the existing technical team and expert consultants, who may have specialized knowledge and expertise in their respective sectors. The loss of any member may adversely affect the Platform or its future development.

- **Risks relating to "forking"**: The Platform is based on certain open-source elements and Swan Chain does not monopolize the development, marketing, operation or otherwise of the Platform. Any entity may independently develop a patch or upgrade to the Platform and the acceptance of these patches or upgrades by a sufficient percentage of Swan token holders could result in two or more divergent networks. The community on the Platform may split in support of the divergent networks respectively. The temporary or permanent existence of forked networks could adversely affect the operation of the Platform and the Swan token that you hold.

- **No ownership and control rights**: Ownership of the Swan token does not grant you the right of ownership or right to share in Swan Chain. The Swan token does not give Swan token holders the right to participate in the decision-making about the direction and development of the Swan Chain business. However, the opinions of Swan token holders and the Platform users are very important to Swan Chain and may be taken into account by Swan Chain when such decisions are being made. But you may be able to participate in community governance.

- **Risk on the number and value of the Swan tokens**: The quantum and value of the Swan token may be affected by factors, within or outside Swan Chain's control, including but not limited to the supply and demand for Swan tokens in the market. These factors could adversely affect the quantum and value of the Swan token.

Contents

1. Technology and Industry Overview

1.1 The Internet of Value

Swan Chain pioneers the **Internet of Value** by integrating decentralized infrastructure with AI innovation, creating a unified platform that facilitates the seamless exchange of computational resources, data, and payments. Key contributions include:

1. **Decentralized Marketplaces**
   Swan Chain provides marketplaces for computing, storage, and AI applications, where users and providers can transact without intermediaries. This enhances accessibility and reduces costs, fostering a true peer-to-peer economy.
2. **AI-Driven Ecosystem**
   By leveraging AI tools and decentralized AI agents, Swan Chain empowers businesses and developers to monetize their contributions while addressing the growing demand for scalable and secure AI services.
3. **Universal Basic Income (UBI)**
   Swan Chain introduces an innovative UBI model for computing providers, ensuring fair compensation and incentivizing sustained network participation.
4. **Tokenized Value Exchange**
   Swan Chain's token economy facilitates microtransactions and incentivizes ecosystem growth, creating a robust framework for value exchange that supports scalability and interoperability across blockchains.

1.1.1 Blockchain Technology Development

Blockchain technology is a comprehensive technology system based on distributed systems, computer networks, cryptography, data structures, and other research results in various fields. The technology in blockchain records and maintains data in multiple ways, ensures data transmission and access security by applying cryptography, and the data is stored in a chain structure and can only be read or written so as to ensure its consistency, prevent tampering, and cannot be denied. Blockchain technology represented by Bitcoin and Ethereum implements peer-to-peer credit transactions between distributed nodes by adding technologies such as data encryption, consensus mechanisms, timestamps, and economic incentives. It has solved the problems of cumbersome and inefficient transaction cycles, high costs, and unsafe data storage, which have become commonplace in traditional centralized systems, and has become the nuclear technology of the modern digital cryptocurrency system. This technology system enables information consensus, sharing, and co-responsibility among all participants that can be entirely ported to the underlying applications of most trust-based business models and organizations.

Satoshi Nakamoto published the Bitcoin Design Paper *Bitcoins: A Peer-to-Peer Electronic Cash System* in 2008, where he indicated to creation of a new decentralized electronic payment system, which is "based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party [1]". From then on, the blockchain technology represented by Bitcoin began to be known to the world.

Blockchain technology is typically divided into two generations by industry and academia:

- Bitcoin — solves the problem of encrypting ledger and decentralized payments.
- Ethereum — enriches the application value of blockchain technology. The smart contracts used by Ethereum can use virtual machines and contract programming to provide new ideas for the development of cryptocurrencies. At the same time, a large number of Decentralized Applications (DApps) and ICO financial innovations came into being, opening up new territory for financial markets.

As the first application of the blockchain, Bitcoin realized the mode of the decentralized cryptocurrency ledger system. Bitcoin relies on the completion of computational tasks based on a particular algorithm and does not depend on any individual or organization, thereby ensuring consistency with the distributed ledger system. Vitalik Buterin applied the concept of smart contracts in his design of Ethereum [2], giving us a common framework for blockchain with Turing completeness.

The application of blockchain technology establishes credible peer-to-peer transmission, which provides us with a new social trust mechanism, supporting common decision-making whilst protecting individual rights and interests, and both opening transaction information whilst protecting node privacy. This mechanism enhances the efficiency of value exchange and reduces the cost, laying a new foundation for the development of the digital economy. It marks the beginning that society evolves from the Internet of Information to building a genuinely credible and efficient Internet of Value. At the same time, the application of blockchain innovation is thriving, reflecting the new direction of public service development and industrial innovation revolution.

1.1.2 DApp and Artificial Intelligence

DApp is a kind of application that runs on the node of the decentralized P2P network server. It mainly consists of a front-end presentation layer, background server and smart contract. With the rapid development of Ethereum, a few million DApps have emerged in all walks of life, and the Internet of Value ecosystem is increasingly complete.

In recent years, many breakthroughs have been made in the field of artificial intelligence, and there is a wave of research on artificial intelligence on a global scale. The research and application of artificial intelligence have now penetrated every gap in human society, which has also been integrated with the application of DApps. However, the research on artificial intelligence requires strong computational power, which has been promoted from the early stage of CPU computation to GPU computing. The large-scale application deployment has higher requirements on hardware performance and system concurrent processing.

Swan Chain blockchain, as a new generation of AI blockchain, is dedicated to solving the computing power needs of human beings in the process of AI, expediting the inter-regional transfer of resources and writing integrated and decentralized AI applications more conveniently, so as to realize a seamless integration of blockchain micropayments, hyperledger, decentralized features, and AI applications and achieve the transformation from DApp + AI to DAI App.

Swan Chain is dedicated to building a decentralized AI computing blockchain platform to accelerate the adoption of AI. By integrating Web3 and AI technologies, Swan Chain provides comprehensive solutions for storage, computing, bandwidth, and payment needs. Its Lagrange platform supports efficient AI model deployment, potentially reducing computing costs by up to 70% while enabling the monetization of idle computing resources.

Swan Chain's innovative approach introduces a universal basic income (UBI) model for computer providers in its Zero-Knowledge (ZK) marketplace, ensuring a stable income and incentivizing ongoing contributions. Additionally, Swan Chain leverages Kubernetes for container orchestration, combined with blockchain technology, to establish a highly efficient, scalable, and secure decentralized computing infrastructure.

Through these initiatives, Swan Chain is redefining the development, deployment, and scaling of AI and Web3 projects, providing accessible, secure, and high-performance computing resources for developers and enterprises alike.

Swan Chain will inject fresh blood into the Internet of Value and provide cost-effective basic services for global artificial intelligence development.

1.1.3 AI Agents for Decentralized Intelligence

Swan Chain is designed to be a powerful enabler of **AI agents**, providing the necessary infrastructure for their development, deployment, and scaling. Leveraging its **full toolset AI blockchain** capabilities, Swan Chain empowers developers and organizations to integrate decentralized AI solutions seamlessly into their applications.

1.2 Market Prospects

Blockchain technology has achieved global application deployment. All countries are closely watching the development of the blockchain and planning the application of the blockchain. According to market research firm Gartner, the value of blockchain-based businesses will reach $176 billion by 2025 and $3.1 trillion by 2030 [3]. In addition to the large-scale application of blockchain technology to the financial sector, blockchain technology will create over one trillion US dollars in value in the manufacturing and supply chain industries. This growing embrace of blockchain is reflected in the strong interest among traditional financial firms. In early 2024, BlackRock, JP Morgan, Standard Chartered, HSBC, Goldman Sachs and other major financial institutions have all announced projects that deepen their involvement with blockchain. Bank of America predicts blockchain infrastructure may reshape how value is exchanged and stored — not just in finance, but in every industry [4]. Klaus Schwab pointed out that the blockchain is the fourth industrial revolution after mechanization, electrification, and digitization. It is estimated that by 2025, 10% of the global GDP will use blockchain technology for data storage [5]. The blockchain technology market is anticipated to expand annually at a CAGR of almost 68% throughout the projected period, according to the latest report of Custom Market Insights. The blockchain technology market was estimated to be roughly USD 4.8 billion in 2021 and is expected to increase to USD 69 billion by 2030 [6]. The market prospects of blockchain technology mainly lie in social public services and economic model optimization.

At the level of social public service, blockchain technology is penetrating into areas of social security, intellectual property, and public administration, and mainly focuses on four areas: identity verification, forensic authentication, information sharing, and transparent governance. In 2016, the United States set up a "Congressional Blockchain Caucus" and the governments of Russia, Singapore, Dubai, Japan and China all accelerated the social application of blockchain technology [7]. Nowadays, many governments in Southeast Asia, Europe, North America, and South America have been discussing the legalization of virtual currencies, and Apple Pay has begun to support the use of BTC in real life. Under the influence of the underlying philosophy of distributed consensus, transparent open source, and social collaboration of blockchain technology, the public service realizes an overall change from data management process optimization to management thinking, that helps to increase public participation, reduce social operating costs and improve the quality and efficiency of social management, which plays an important role in promoting the level of social management and governance.

At the level of economic optimization, the core philosophy of the blockchain economy lies in the reconstruction of business logic, creating a new pattern of finance and economy in the future, not just a technological revolution [8]. As early as 2015, the blockchain has become the highest-paid sector in U.S. venture capital. As of November 2024, the number of blockchain projects worldwide has exceeded 31,000 [9], and the global value of cryptocurrency assets amounts to 2.7 trillion US dollars [10]. Blockchain has high application value regarding finance, shared economy, and Internet of Things, which has attracted the wide layout of business groups such as Goldman Sachs, Citigroup, Nasdaq, Deloitte, IBM, Microsoft, Samsung, Sony, Amazon, Google, Airbnb and more. User groups in the fields of blockchain/cryptocurrency assets are also growing rapidly: from 2 million users worldwide in early 2013 to 560 million users in early 2024 [11]. In the blockchain system, participants can trade without having to know each other's basic information so as to achieve "trustless trust" and change the third party-based trust model in the traditional mode, and the economic system can be out of the current system's constraints or endorsement by third parties, resulting in the situation whereby two sides realize the delivery of value. An economy based on blockchain solutions can improve existing business rules, build a new industrial collaboration model, and improve the efficiency of collaborative logistics. Blockchain can provide systematic support for economic and social transformation and upgrading [12]. The significant advantages are the optimization of business processes, lower operating costs and synergy, and these advantages have emerged in all areas of society, including financial services, supply chain management, smart manufacturing, education and employment.

After almost 70 years of ups and downs, the artificial intelligence (AI) industry is finally recovering with the rise of machine learning. As it has now formed a new round of development in the world, countries have sounded the horn to explore the mysteries of human wisdom. As of 2024, the AI market has continued its rapid expansion. According to Fortune Business Insights, the global AI market size was valued at $515.31 billion in 2023 and is projected to grow to $621.19 billion in 2024, with expectations to reach $2,740.46 billion by 2032, exhibiting a compound annual growth rate (CAGR) of 20.4% during the forecast period [13]. Similarly, MarketsandMarkets reports that the worldwide AI market size is projected to grow from $214.6 billion in 2024 to $1,339.1 billion by 2030, at a CAGR of 35.7% during the forecast period [14].

DApp will form the backbone of the internet of value in the future. Artificial intelligence will cover all application areas. Blockchain, as the infrastructure of the former two, will undoubtedly become popular and will inevitably bring significant changes to the traditional Internet, society, and the natural environment.

1.3 Existing Challenges

1. Highly Centralized

Google and Amazon have started to provide cloud services for artificial intelligence computing. However, as single-commerce companies, they could stop providing the service at any time, given special circumstances, which are based on their own interests and the pressure of, for instance, governments and other organizations. For example, Google was banned by the Chinese government, leaving Chinese users unable to utilize their services.

The blockchain is a new decentralized protocol that securely stores data information through a distributed ledger (a type of database distributed across multiple addresses, multiple regions, or multiple participants) [15]. The blockchain is based on the architecture of "decentralization". The rights and obligations of any nodes are equal; the data blocks in the system are jointly maintained by all nodes, and each node shares rights and obligations, is verified by node distribution in the world, to ensure that the information cannot be forged and tampered with; and technically guaranteeing the transaction, without the need for a third-party structure to provide a trust mechanism. Corporations use decentralized distributed ledger technology to process and verify transactions or other types of data exchange, and the records are stored in the ledger. Once most participants agree, each record is given a time stamp and a unique encrypted signature. The distributed ledger provides verifiable and auditable information history, and all participants can view suspicious records [16]. This technique guarantees that it is impossible to shut down the entire network as long as more than one node is in operation. This makes it possible to design a decentralized AI cloud service that cannot be blocked.

Besides, centralized cloud providers dominate the market, leading to potential issues such as single points of failure, data privacy concerns, and high dependency on a few providers. This centralization can hinder the resilience and security of AI and Web3 applications.

2. Data Privacy Security

Although centralized companies have various security agreements, it is still difficult for companies to ensure data privacy when faced with internal leaks. Also, when the government requests for data, the centralized company is limited to geographical restrictions of the host country, leaving the only option to cooperate with the government and transfer ownership of the data. As a result, users' data security cannot be 100% guaranteed.

Based on cryptography technology, blockchain is a kind of low-cost, high-security, customizable, and encapsulated decentralized trust solution tool based on encryption technology, which relies on the encryption algorithm, peer-to-peer transaction, and information stored in each node without trusting a single center [17]. Each node is involved in maintaining the security and accuracy of the information by keeping a copy of a complete set of historical databases. The peer-to-peer blockchain encryption technology can be used to ensure that only the owner of the private key can access specific information, while other users cannot decrypt data. This is of great significance for a variety of high-value training data and models. The advantages of blockchain in terms of data security are as follows:

- Use highly redundant databases to ensure the integrity of the information.
- Verify data using cryptography-related principles to ensure that the data cannot be tampered with.
- Use multiple private keys for access control.

3. Maintenance Costs

Advanced AI applications and Web3 projects require significant computational resources, leading to high operational costs. The maintenance of a centralized computing center will cost heavily on the workforce and can create barriers to entry for smaller developers and startups. Thus, the use of blockchain micropayments makes it easier to pay for maintenance and allows anyone to lend their computing power. The shared economy model dramatically reduces maintenance workforce costs as well as computing costs.

4. Blockchain Application Development Environment

With the rapid growth of various applications (DApps) on the blockchain, a good state of the ecosystem is at the heart of the user experience. This includes how users can retrieve their expected DApps in massive blockchain applications, how to motivate developers to provide more DApps to users, and how to help developers develop better DApps in a faster manner. Take Ethereum as an example, there are tens of thousands of DApps based on Ethereum. Imagine if the scale of DApps in the blockchain world is close to that of the Apple App Store, it would be a serious problem to discover and find a user's expected DApps. With the popularity of blockchain technology, more and more application scenarios of blockchain technology have been discovered. Blockchain technology scenarios have been gradually expanded from the original cryptocurrency to more scenarios and user groups. For example, the community represented by Ethereum introduced the concept of smart contracts in blockchain technology, and Ripple used the blockchain technology to implement the real-time gross settlement system. With the increasing diversity of application scenarios, user demands for blockchain is also increasing, and we will expect to face more challenges:

- Underutilization of Global Computing Resources

  Despite the proliferation of data centers worldwide, a substantial portion of their computing capacity remains underutilized. This inefficiency is evident in the low average server utilization rates, which often hover around 20% to 30%. Such underutilization not only represents a waste of potential computational power but also incurs unnecessary operational costs and environmental impacts.

  For instance, the Uptime Institute's 2022 Data Center Capacity Trends Survey highlights that many data centers operate below optimal capacity, leading to inefficiencies in energy consumption and resource allocation [18].

- Lack of Incentives for Consistent Network Participation

  In decentralized networks, maintaining continuous participation from computing providers is crucial for stability and reliability. However, without robust and stable incentive structures, providers may lack the motivation to commit long-term resources to the network. This inconsistency can lead to fluctuations in network performance and availability, undermining user trust and the overall efficacy of decentralized applications. Research on incentive approaches for cloud computing underscores the challenges in designing effective reward mechanisms that ensure sustained provider engagement and mitigate risks of resource withdrawal.

- Complexity in Deploying and Managing AI Models

  The deployment and management of AI models are inherently complex processes that require substantial computational resources and technical expertise. Developers, especially those without access to advanced infrastructure, often face significant barriers in bringing AI solutions to fruition. This complexity can stifle innovation and slow the adoption of AI technologies across various sectors. A study on blockchain-based collaborative edge computing highlights the efficiency and incentive challenges in decentralized AI deployments, emphasizing the need for streamlined processes and supportive infrastructure to facilitate AI model management.

1.4 Project Objectives

In order to improve the status quo of the current centralized cloud computing ecosystem, we intend to utilize the decentralization of blockchain technology to rent and distribute the computing power of artificial intelligence machines globally. Blockchain encryption technology efficiently avoids the problem of internal leakage, and the maintenance of distributed AI calculation units is handed over to the owners of various AI calculation units, which considerably reduces the workload of maintenance. We split this overall goal into the following sub-goals:

1. Reducing High Computational Costs for AI and Web3 Projects

   Swan Chain leverages decentralized networks of idle computing resources to offer computing solutions that are up to 70% cheaper than traditional cloud services. This makes large-scale computational resources more accessible at lower costs, particularly benefiting smaller developers and startups.

2. Addressing the Limitations of Centralized Infrastructure

   Swan Chain creates a decentralized cloud infrastructure by integrating globally distributed computing resources, eliminating single points of failure and enhancing network resilience and security. Additionally, it safeguards user data privacy and reduces reliance on a few centralized cloud providers.

3. Maximizing the Utilization of Global Computing Resources

   Through Swan Chain, underutilized computing resources—whether from data centers or individual devices—can be tapped into by AI and Web3 projects. This maximizes the use of computational power, reduces waste, and meets the growing demand for computing capacity.

4. Providing Stable Incentives for Consistent Network Participation

   Swan Chain ensures continuous participation of computing providers through token incentives and long-term reward mechanisms. By offering staking, liquidity mining, and other incentive models, Swan Chain motivates computing nodes to remain online and committed long-term, ensuring network stability and reliability.

5. Simplifying AI Model Deployment and Management

Swan Chain simplifies AI model deployment and management through its LagrangeDAO smart contract platform. Developers can easily deploy and manage AI models without the need for complex infrastructure, accelerating project development and fostering innovation. This lowers the barrier to AI development and speeds up progress.

2. Introduction to Swan Chain

2.1 A Full Toolset AI Blockchain

Swan Chain, initiated in 2021, is a full toolset AI blockchain infrastructure designed to accelerate AI adoption. Utilizing OP super chain technology, Swan Chain merges Web3 with AI, offering comprehensive solutions across storage, computing, bandwidth, and payments. Through Lagrange, it enables efficient AI model deployment while reducing computing costs by up to 70% and monetizing idle computing resources.

Swan Chain's innovative approach introduces a Universal Basic Income (UBI) model for Computing Providers within its ZK market, ensuring stable income and incentivizing continuous contributions.

2.2 Core Objectives and Motivation

- Decentralized AI Computing Market: At the heart of Swan Chain's ambition is the creation of a marketplace that empowers AI developers with the necessary computational resources for training and deploying sophisticated AI models on AI platforms like Lagrange. This initiative is designed to fill the void between the high demand for premium computing in AI research and the resources available within the blockchain ecosystem.
- Support for Web3 Projects: Swan Chain acknowledges the transformative essence of Web3 technologies, aspiring to lay down a foundational infrastructure that underpins the deployment and functioning of decentralized applications (DApps). This includes a suite of decentralized storage solutions, computing power, and ancillary services, all aimed at propelling the decentralized web's expansion.
- Innovative Ecosystem Products: The ecosystem of Swan Chain is augmented with groundbreaking products like MultiChain.storage for decentralized data storage, the Lagrange platform for decentralized computing, and a Decentralized Task Orchestrator, which collectively streamline the management and distribution of computing tasks across the network.
- Universal Basic Income (UBI) Model: A standout feature of Swan Chain is its commitment to fostering a fair and equitable ecosystem via the implementation of a UBI model for computing

providers. This innovative approach guarantees compensation for participants' contributions, promoting inclusivity and sustainability within the network.

2.3 Enhanced Technologies and Infrastructure

Swan Chain incorporates state-of-the-art technologies to materialize its ambitious objectives:

- Kubernetes and Blockchain Integration: Utilizing Kubernetes for container orchestration alongside blockchain for securing transactions and automating processes, Swan Chain establishes a highly efficient, scalable, and secure infrastructure for decentralized computing.
- Global Data Center Connectivity: By orchestrating data centers globally, Swan Chain accesses an expansive pool of computational resources, ensuring utmost availability and redundancy for its services.
- Zero-Knowledge (ZK) Proofs: Emphasizing security and privacy, Swan Chain adopts ZK proofs for the benchmarking of computing providers and facilitating privacy-preserving transactions within its ecosystem.

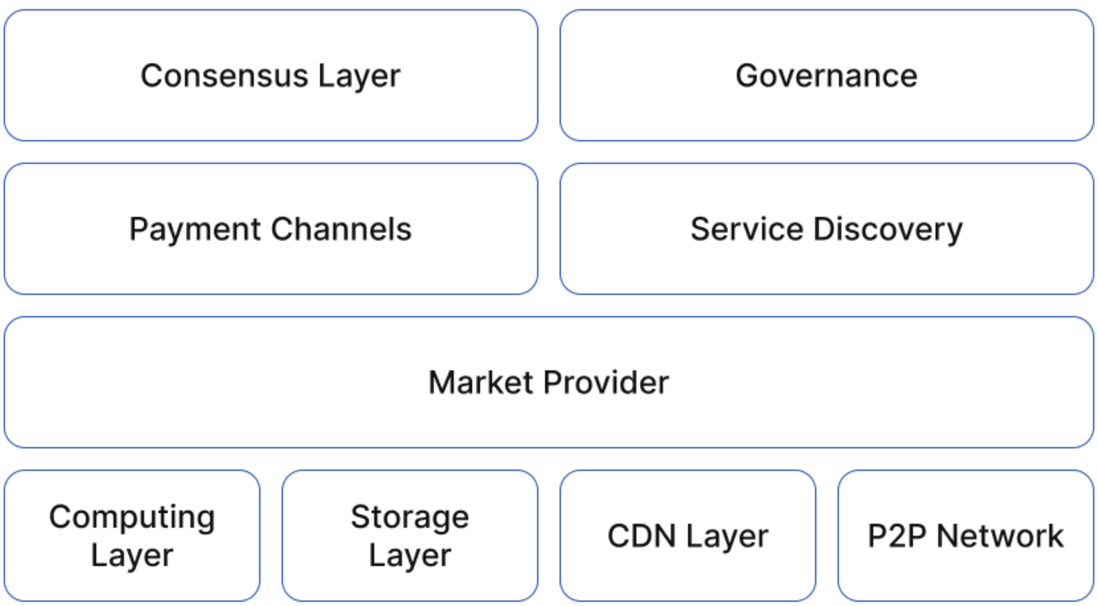
2.4 Financial Innovations and ZK Market Development

Swan Chain significantly enhances AI computing payment systems through smart contract implementation, notably reducing fees for micro-payments as a Layer 2 solution and ensuring efficient computing task validation. Moreover, Swan Chain pioneers the development of a ZK computing market, bolstering the AI ecosystem with a robust framework for computing benchmarking and validation. This ZK market not only supports the AI computing demands but also underpins the UBI model by providing a sustainable income source for computing provider.

2.5 Road Map

Year	Milestones
2021	Swan Chain was officially founded (Formerly FilSwan)
2021Q4	Data Market (Polygon/Chainlink)
2022Q1	Storage Network (200 PB storage)
2023Q1	Computing Network (100 GPUs, 17 locations, 70 nodes)
2023Q2	AI Computing (Lagrange Computer- Web3 Hugging Face)
2023Q3	Saturn Testnet (L2 OP Stack)
2024Q2	Mainnet Launch (DAO governance)
2024Q4	Swan Token TGE

3. Swan Chain Protocol Layers



3.1 Consensus Layer

The Consensus Layer is responsible for maintaining the integrity and security of the Swan Chain network by validating transactions, securing data, and ensuring consistency across the network. Swan Chain operates on a layered architecture that uses Ethereum Layer 1 as the foundation for security and finality, while Layer 2 (OP Stack) handles scalability and off-chain processing.

3.1.1 Key Components

1. Layer 1 (L1) – Ethereum: Ethereum serves as the base consensus layer that provides security, data availability, and settlement. Swan Chain inherits Ethereum's robust Proof-of-Stake (PoS) consensus mechanism, which ensures that all transactions and data processed on Layer 2 are secure and immutable.
2. Layer 2 (L2) – Optimism OP Stack: The OP Stack is a modular Layer 2 framework that powers Swan Chain by enabling fast and low-cost transactions while leveraging Ethereum's security for final settlement. It provides scalability through Rollups, which batch multiple transactions into a single one and post it on Ethereum, significantly reducing gas costs and improving throughput.
3. Layer 3 (L3) – Application-Specific Chains (Optional): Layer 3 can be introduced to handle more specialized functionalities, such as privacy, AI-specific workloads, or cross-chain interoperability. This layer builds on top of Layer 2, allowing developers to optimize and customize their applications without compromising security.

3.1.2 How Swan Chain Consensus Works

1. Transaction Processing on Layer 2:

- Swan Chain's computational tasks and transactions are processed on Layer 2 (OP Stack), where they are batched and compressed using Rollup technology. This reduces computational costs and network congestion while increasing transaction speed.
- The Rollups aggregate multiple transactions and submit them to Ethereum's Layer 1 for finality and security.

2. Security and Finality on Layer 1:

- After processing on Layer 2, transaction data is submitted to Ethereum Layer 1, where it is verified and stored for immutability.
- Ethereum's Proof-of-Stake (PoS) consensus mechanism ensures that Swan Chain transactions are cryptographically secure, tamper-proof, and finalized with strong guarantees of validity.

3. Consensus Validation:

- Validators in the Layer 1 network are responsible for verifying the blocks and ensuring the security of the Swan Chain ecosystem. They confirm the validity of the transactions processed on Layer 2 and store them on Ethereum's blockchain for long-term record-keeping.

4. Multi-Layer Security:

- Layer 2 Fraud Proofs: To ensure the integrity of transactions processed on Layer 2, fraud proofs are implemented. If a malicious actor tries to submit an invalid transaction, other validators can challenge it, maintaining the security and reliability of the network.
- Data Availability Guarantees: By leveraging Ethereum's L1, Swan Chain benefits from Ethereum's extensive network of validators and its inherent data availability, ensuring the network can scale without compromising data integrity.

3.1.3 Benefits of the Swan Chain Consensus Layer

1. Scalability:

- By utilizing Optimism's OP Stack, Swan Chain achieves high throughput and low latency, making it suitable for AI/ML workloads and large-scale decentralized applications. The L2 Rollup mechanism significantly reduces gas costs while improving transaction speed.

2. Security and Immutability:

- Transactions on Swan Chain are protected by Ethereum's PoS consensus, ensuring that once a transaction is finalized, it is immutable and secure. This provides a strong security foundation for all decentralized applications running on Swan Chain.

3. Cost Efficiency:

- Layer 2 Rollups allow multiple transactions to be bundled and posted on Layer 1, minimizing gas fees and making Swan Chain an affordable option for intensive AI computing tasks, model training, and decentralized applications.

4. Flexibility with Layer 3:

- The option to introduce Layer 3 chains allows developers to create application-specific chains that optimize performance and security for their unique use cases, such as enhanced privacy, interoperability, or specialized AI processing.

3.2 Storage Layer

Swan Chain, as a prominent player in the decentralized computing domain, has strategically positioned itself to leverage multiple storage solutions, ensuring optimal data availability and versatility. Here's a breakdown of how Swan integrates various storage platforms:

1. IPFS (InterPlanetary File System): Swan utilizes IPFS for decentralized file storage. Given IPFS's peer-to-peer nature, it's an ideal choice for distributing and ensuring the availability of files across a decentralized network. This ensures that data is not only stored securely but is also

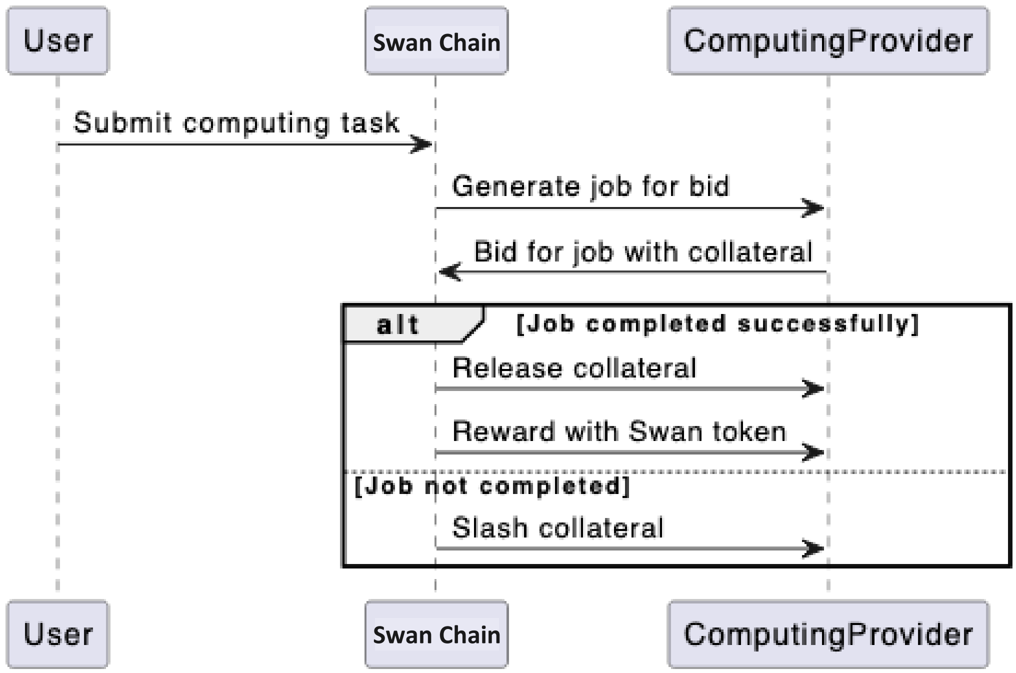
easily retrievable from any point in the network.

2. Storj: Recognizing the increasing demand for media content streaming, Swan integrates Storj, which is optimized for streaming media files. Storj's decentralized cloud storage ensures that media files are delivered seamlessly, providing an uninterrupted streaming experience for users.
3. Filecoin: For archiving larger files, Swan leverages the Filecoin network. Filecoin's decentralized storage marketplace is perfect for long-term storage solutions, ensuring that large datasets are securely archived and remain accessible when needed.
4. BNB GreenField: As an innovative blockchain and storage platform, BNB GreenField offers a unique approach to data management and ownership. Swan's integration with GreenField further enhances its storage capabilities, allowing for more flexible and efficient data management solutions.
5. Cross-Chain Contracts: One of Swan's standout features is its ability to use cross-chain contracts to interact with different storage solution providers. This means that Swan can dynamically choose the best storage solution based on the specific needs of a task, be it decentralized file storage, media streaming, or large file archiving.

In essence, Swan's multi-faceted approach to data availability ensures that it can cater to a wide range of storage needs, from decentralized file sharing to media streaming and large file archiving. By integrating multiple storage platforms and utilizing cross-chain contracts, Swan is setting a new standard for decentralized data storage and management.

3.3 Computing Layer

Swan's Computing Layer is a crucial component of its decentralized cloud computing ecosystem. It's designed to facilitate the execution of computing tasks across a network of providers, ensuring efficiency, reliability, and security. Here's an introduction to the key aspects of the Swan Computing Layer:



1. Computing Providers (CPs)

   Computing Providers are entities within the Swan network that offer computational resources. They must provide collateral in Swan tokens to join the network, ensuring accountability.

2. Ask Submission and Bidding

   Users can submit computing tasks to the network. CPs can bid for these tasks, and jobs are generated for each CP that joins the bid. The system may use a randomized allocation method to fairly distribute jobs among providers.

3. Execution and Rewarding

   CPs execute the tasks and are rewarded with Swan tokens upon successful completion. The reward mechanism may follow a Proof-of-Work (PoW) auction style, where CPs have a chance to win a ticket if they complete the job.

4. Collateral and Slashing

   CPs must collateralize a certain amount of Swan tokens to participate in the network. If a CP fails to complete a job as promised, a portion of their collateral is slashed. This incentivizes providers to fulfill their commitments.

5. Cross-Chain Capability and Payment

   Swan's computing layer has cross-chain capabilities, allowing payments from multiple blockchain tokens. A swap engine converts user-paid tokens to Swan tokens before paying the

CPs.

6. Decentralized and Secure

   The Swan Computing Layer operates in a decentralized manner, leveraging blockchain technology to ensure transparency, security, and trust.

7. Integration with Other Swan Services

   The Computing Layer is part of a broader ecosystem that includes storage provider selection, data management, and seamless integration from IPFS to the Filecoin network.

Swan's Computing Layer represents a significant advancement in decentralized cloud computing. By leveraging blockchain technology and a sophisticated system of task allocation, collateral, and rewards, it offers a scalable and reliable solution for executing computing tasks across a decentralized network. Its integration with other Swan services and its cross-chain capabilities further enhances its appeal as a comprehensive solution for decentralized storage, payment gateway integration, and computing.

4. Swan Chain Product Overview

4.1 Computing Provide

4.1.1 Fog Computing Provider (FCP)

Fog Computing Provider (FCP)**:** Offers a layered network that extends cloud capabilities to the edge of the network, providing services such as AI model training and deployment. This provider utilizes infrastructure like Kubernetes (K8S) to support scalable, distributed computing tasks.

FCP hardware requirements:

- Possess a public IP
- Have a domain name (*.example.com)
- Have an SSL certificate
- Have at least one GPU
- At least 8 vCPUs
- Minimum 100GB SSD storage
- Minimum 64GB memory
- Minimum 50MB bandwidth

4.1.2 Edge Computing Provider (ECP)

ECP (Edge Computing Provider) specializes in processing data at the source of data generation, using minimal latency setups ideal for real-time applications. This provider handles specific, localized tasks directly on devices at the network's edge, such as IoT devices.

At the current stage, ECP supports the generation of ZK-Snark proof of Filecoin network, and more ZK proof types will be gradually supported, such as Aleo, Scroll, starkNet, etc

ECP hardware requirements:

- Possess a public IP
- Have at least one GPU
- At least 4 vCPUs
- Minimum 300GB HDD storage
- Minimum 32GB memory
- Minimum 20MB bandwidth

ECP (Edge Computing Provider) Status:

The ECP (Edge Computing Provider) status indicates the current operational state of the provider:

- **Inactive**: Previously had an ECP taskType, but no longer does.
- **Online**: Has an ECP taskType, query is successful, sufficient collateral, and not rejecting tasks (Normal operation).
- **Offline**: Has an ECP taskType, but query is unsuccessful.
- **NSC (Not Sufficient Collateral)**: Has an ECP taskType, but insufficient collateral.
- **NSR (No sufficient resource):** Has an ECP taskType, but lacks the necessary resources (e.g., CPU, memory, or storage) to perform tasks.
- **Declined**: Has an ECP taskType, but rejecting tasks (due to insufficient resources or sequencer).
- **Inconsistent**: Local information does not match on-chain information (e.g., CP account, multiaddress, nodeID).

4.2 Market Provider

4.2.1 Introduction

A Market Provider (MP) in the Swan network is a crucial entity that offers various computing and storage tasks to the network. These tasks can range from storage tasks like dataset management, network tasks like CDN, to GPU tasks such as zk proofs or AI computations. MPs utilize the vast computing resources of Swan's decentralized community and, in return, can earn revenue through commissions or by issuing their own tokens based on the Swan network.

Key Features of Market Providers:

1. Diverse Task Offerings:

- Storage Tasks: Handling datasets and ensuring efficient, secure storage solutions.
- Network Tasks: Providing content delivery network (CDN) services to enhance data distribution.
- GPU Tasks: Managing complex computations like zk proofs and AI model training.

2. Utilizing Decentralized Resources:

- MPs leverage the distributed computing power of the Swan community, optimizing resource usage and ensuring high performance.
- This decentralized approach reduces costs and enhances scalability.

3. Revenue Generation:

- Commissions: MPs can earn commissions by facilitating various tasks on the network.
- Token Issuance: MPs have the option to publish their own tokens based on the Swan network, creating additional revenue streams.

Existing Market Providers:

1. Swan Storage Market:

- Specializes in decentralized storage solutions, managing large datasets and ensuring data integrity and availability.

2. Orchestrator AI Market:

- Focuses on AI tasks, providing the necessary infrastructure for training and deploying AI models.

3. ZK-UBI ZK Proofing Market:

- Handles Zero-Knowledge (ZK) proofs, supporting privacy-preserving computations and decentralized identity solutions.

Advantages of Being a Market Provider:

1. Access to a Decentralized Ecosystem:

- MPs can tap into Swan's extensive network of computing resources, enhancing their service offerings and operational efficiency.

2. Flexible Revenue Models:

- By earning commissions or issuing tokens, MPs can create multiple revenue streams, ensuring financial sustainability and growth.

3. Innovation and Expansion:

- MPs can continuously innovate by introducing new types of tasks and services, expanding their market reach and attracting a diverse user base.

4. Community Engagement:

- MPs contribute to the growth and development of the Swan network, fostering a collaborative and thriving community.

By providing a wide range of tasks and utilizing decentralized resources, Market Providers play a pivotal role in the Swan network, driving innovation and ensuring efficient, scalable, and secure computing and storage solutions.

4.2.2 Swan Storage Market

Swan Storage Market simplifies and optimizes the process of finding and utilizing decentralized storage on Filecoin. It addresses key challenges faced by users, such as lack of information on service quality, limited matching functionality, and high costs for beginners.

Key Features:

1. Auction System:

- Manual Bid: Users can actively select storage providers based on specific criteria like bandwidth, storage capacity, and geographic location, and participate in an open public deal.
- Auto-Bid: A reputation-based system where storage providers are automatically matched with users, ensuring fairness and efficiency.

2. Transparency and Efficiency:

- Open and transparent matching system reduces the learning curve for users.
- Ensures quick and efficient pairing of users and storage providers, promoting time-efficient storage and backup services.

3. Task Management:

- Introduces the concept of "tasks" to manage and batch send multiple deals, simplifying the process of handling large datasets.

4. Swan Provider:

- Runs on the same node as lotus miner nodes and assists in deal processing.
- Requires authentication from the Swan Chain platform for better information sharing.
- Provides a Restful API interface for easy integration into other systems.

By integrating these features, Swan Storage Market enhances the accessibility and usability of decentralized storage, offering a comprehensive and user-friendly solution for both novice and experienced users.

4.2.3 AI Computing Marketplace

The Swan Chain AI Market is a cutting-edge decentralized platform specifically designed to cater to the needs of AI development by streamlining the distribution of AI model training tasks to a global network of computing providers. Utilizing a sophisticated AI auction engine, Swan Chain facilitates a transparent and competitive marketplace that operates on blockchain technology.

Here’s how the Swan Chain AI Market functions:

AI Model Training Distribution

Swan Chain's AI Market is a conduit for distributing intensive AI training tasks, which require substantial computational resources, including GPUs for processing large datasets and performing complex calculations inherent in machine learning and neural network training.

AI Auction Engine

1. Task Listing: AI developers or businesses in need of computational power for model training can list their tasks on the platform, providing detailed requirements for processing power, memory, storage, and specific preferences for hardware capabilities.
2. Bidding System: Computing providers equipped with the necessary hardware and capabilities review the listed tasks and place competitive bids to offer their services. The bidding system is designed to balance the cost with the quality and efficiency of service.
3. Provider Selection: The AI auction engine processes the bids and selects the most appropriate provider based on several factors, including cost, provider reputation, and resource availability. This ensures that AI tasks are assigned to providers who can offer optimal value and performance.

Task Execution and Verification

1. Task Performance: The chosen provider performs the AI training task using their computational infrastructure. Progress and performance can be monitored through the platform to ensure that the task is carried out according to the agreed-upon standards.
2. Validation: Upon task completion, the results are subject to validation to confirm they meet the predefined criteria. The validation process is crucial to maintain high standards and trust within the marketplace.

3. Reward and Rating: After successful validation, the platform's smart contract system automatically processes the payment to the provider in $SWAN tokens, the native cryptocurrency of SwanChain. Participants can also rate each other, contributing to a trust-based ecosystem.

Advantages of Swan Chain AI Market

- Accessibility: Developers worldwide can access computational resources without heavy upfront investments in hardware.
- Economies of Scale: Providers can leverage idle computational resources, and users benefit from competitive pricing due to the marketplace's scale.
- Decentralization and Security: The decentralized nature of blockchain provides enhanced security, transparency, and data integrity.
- Incentivization: The use of $SWAN tokens as a form of payment incentivizes participation and investment in the Swan Chain ecosystem.

4.2.3.1 Orchestrator

The orchestrator within the Swan Chain ecosystem serves as a critical component, designed to efficiently manage and distribute computing tasks across its decentralized network. This sophisticated system plays a pivotal role in ensuring that the computational resources available within the Swan Chain are utilized optimally, facilitating seamless operation and interaction among various stakeholders. Below is an overview of the orchestrator's functionalities, architecture, and its significance in the Swan Chain ecosystem.

Core Functions

- Task Allocation and Distribution: The orchestrator is responsible for assigning computing tasks to the most appropriate providers within the network, based on criteria such as computing power availability, task complexity, and provider performance history. This ensures that tasks are completed efficiently and effectively.
- Computing Provider Registration: It allows computing providers to register themselves within the Swan Chain ecosystem, making their resources available for tasks. This registry is crucial for maintaining an up-to-date inventory of available computational resources.
- Task Validation and Verification: After a task is completed, the orchestrator verifies the output against predetermined criteria to ensure accuracy and integrity. This step is vital for maintaining

trust within the ecosystem.

- Auto Payment Execution: Upon successful task verification, the orchestrator facilitates automatic payments to the computing providers through smart contracts, ensuring timely and fair compensation for their services.
- Resource Optimization: The Orchestrator continuously monitors the network to optimize the allocation of computing resources, ensuring high efficiency and minimizing idle resources.

4.2.6.2 Auction Engine

The auction engine is a critical component of the Swan system. It manages the bidding process for tasks, ensuring that tasks are assigned to the most suitable computing providers. Here's a breakdown of its key functionalities:

1. Load Provider Pool: The auction engine initially loads all active computing providers into a pool. These providers are potential bidders for tasks.
2. Place Bid: When a task is open for bidding, the auction engine allows a computing provider (bidder) to place a bid on the task. The bid is only successful if the task is currently accepting bids, the bidder has not already placed a bid, and the bidder's collateral is sufficient.
3. Load Tasks from Redis: The auction engine fetches all tasks from Redis that are in a state where they can accept bids. It also handles state transitions for tasks, such as moving a task from the 'accepting_bids' state to the 'bidding_closed' state when the bidding period ends.
4. Select Bidders: The auction engine selects bidders based on certain criteria. For example, it might select the bidders with the highest collateral.
5. Run Bidding Process: For each task that is open for bidding, the auction engine runs the bidding process. It allows the selected bidders to place their bids on the task.
6. List Tasks Available for Bidding: The auction engine can provide a list of all tasks that are currently open for bidding.

The auction engine is designed to be fair and efficient, ensuring that tasks are distributed evenly among computing providers and that the bidding process is competitive. It plays a crucial role in the operation of the Swan network.

The data structure for each task in the platform includes:

- uuid: A unique identifier for the task.
- status: The current status of the task (e.g., open, closed, in progress, completed).
- task_detail_cid: A content identifier for the task details, stored on a decentralized storage system

like IPFS.

- type: The type or category of the task.
- reference_id: A reference ID for linking related tasks or resources.
- name: The name or title of the task.
- leading_job_id: The ID of the job currently in the leading processing status, used for tracking purposes.
- created_at: The timestamp when the task was created.
- updated_at: The timestamp when the task was last updated.
- user_id: The ID of the user who created the task.

When a user publishes a task, multiple providers (blockchain nodes worldwide) can bid on the task. The Bidding Engine evaluates these bids and assigns the task to several bidders with the potential to complete the task effectively. Once they complete the task, the Bidding Engine assesses the quality of their work, updating the leading_job_id as necessary to keep track of the best-performing bidder.

Finally, the provider who delivers the highest-quality work is marked as successful and receives a reward from the task publisher. By employing this mechanism, the Bidding Engine promotes efficiency and transparency in the Decentralized Bidding Marketplace, ensuring that tasks are matched with the most suitable providers and completed to the highest standards.

Autobid

The Decentralized Bidding Marketplace can be configured to include an auto-bid mode for providers, which allows them to automatically participate in all bids without manual intervention. This feature can be particularly useful for providers who want to streamline their bidding process and maximize their chances of securing tasks.

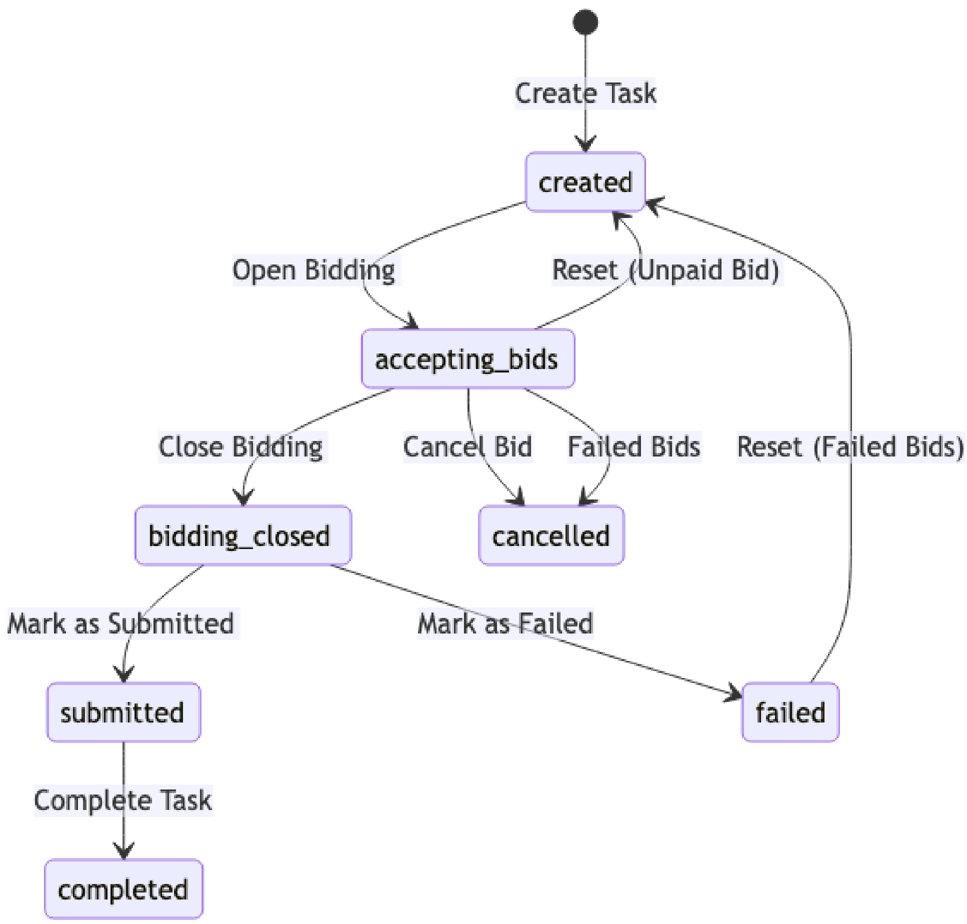
To enable the auto-bid mode, providers need to set up their capability and resource availability for bidding. This information includes the type of resources they can offer (such as storage, network bandwidth, CPU, and GPU), their capacity for each resource, and any other relevant details that may impact their ability to complete tasks.

When auto-bid mode is enabled, the Bidding Engine automatically pushes tasks to the provider based on their configured capabilities and resource availability. The Bidding Engine evaluates the provider's suitability for each task and includes their bid in the competitive bidding process. This automatic participation ensures that providers have a constant presence in the marketplace and can secure tasks that match their expertise and resources.

4.2.6.3 Bidding Task State Machine

The bidding task state machine is a system designed to manage the bidding process for tasks, taking into account task details such as price and timeout. In this setup, each task allows a maximum of three bidders to compete simultaneously, with each bidder being assigned a job to complete.

Bidders have the ability to set a limit on the number of bids they can process at the same time. This feature prevents them from accepting new bids once they reach their specified limit, enabling bidders to effectively manage their workload and participate in multiple tasks without overextending themselves.



States

The Bidding State Machine has several predefined states:

1. created: This is the initial state when a task is first created. The task stays in this state until bidding is opened.
2. accepting_bids: In this state, the task is open for bidders to place their bids. The task remains in this state until bidding is closed, the bid is cancelled, or the bid fails.
3. bidding_closed: This state indicates that the bidding process for the task has ended. The task

transitions to this state from the 'accepting_bids' state. From here, the task can either be marked as 'submitted' or 'failed'.

4. submitted: This state signifies that the task has been submitted successfully. The task moves to this state from the 'bidding_closed' state. Once a task is in the 'submitted' state, it can then be completed.
5. completed: This is the final state indicating that the task has been completed successfully. The task transitions to this state from the 'submitted' state.
6. failed: This state indicates that the task has failed. The task can enter this state from the 'bidding_closed' state. If a task fails, it can be reset to the 'created' state.
7. cancelled: This state signifies that the bid for the task has been cancelled. The task can enter this state from the 'accepting_bids' state. If a bid is cancelled or fails, the task can be reset to the 'created' state.

The transitions between these states are managed by the state machine, which ensures that the task moves through its lifecycle in a controlled and predictable manner.

- open_bidding: Transition from Created to Accepting_Bids.
- close_bidding: Transition from Accepting_Bids to Processing.
- cancel_bid: Transition from Accepting_Bids to Cancelled.
- failed_bids: Transition from Accepting_Bids to Cancelled.
- complete_task: Transition from Submitted to Completed.
- mark_as_submitted: Transition from Processing to Submitted.
- mark_as_failed: Transition from Processing to Failed.
- reset_accepting_bids_to_created: Transition from Accepting_Bids to Created.
- reset_failed_bids_to_created: Transition from Failed to Create.

The Bidding State Machine has defined transitions between states:

Transition Between States

1. open_bidding: Transition from 'Created' to 'Accepting_Bids'.
2. close_bidding: Transition from 'Accepting_Bids' to 'Processing'.
3. cancel_bid: Transition from 'Accepting_Bids' to 'Cancelled'.
4. failed_bids: Transition from 'Accepting_Bids' to 'Cancelled'.
5. complete_task: Transition from 'Submitted' to 'Completed'.
6. mark_as_submitted: Transition from 'Processing' to 'Submitted'.

7. mark_as_failed: Transition from 'Processing' to 'Failed'.
8. reset_accepting_bids_to_created: Transition from 'Accepting_Bids' to 'Created'.
9. reset_failed_bids_to_created: Transition from 'Failed' to ‘Create’.

Rules

The bidding task state machine should include the following rules:

- A bidder cannot place a bid if they have exceeded their limit on the number of jobs they can process simultaneously.
- Once a bidder has completed a job, they cannot be assigned any further jobs on the same task.
- If the task is cancelled, all bids and jobs associated with the task are cancelled as well.

4.2.7 ZK Proof Marketplace

The Swan Chain ZK market is an embodiment of how distributed computing power, particularly GPUs, can be harnessed to fulfill the demands of Zero-Knowledge (ZK) proof generation on a large scale. By creating a specialized ZK market, Swan Chain offers a platform where these compute-intensive tasks can be outsourced to a global network of computing providers, incentivized by the prospect of earning through the platform's Universal Basic Income (UBI) model.

Here's an overview of how this system operates:

Global Network of Computing Providers

Swan Chain taps into a worldwide network of computing providers, each contributing their processing power to form a distributed supercomputer of sorts. This decentralized network allows for the parallel processing of tasks, significantly reducing the time required for generating ZK proofs.

Utilization of GPU Hardware

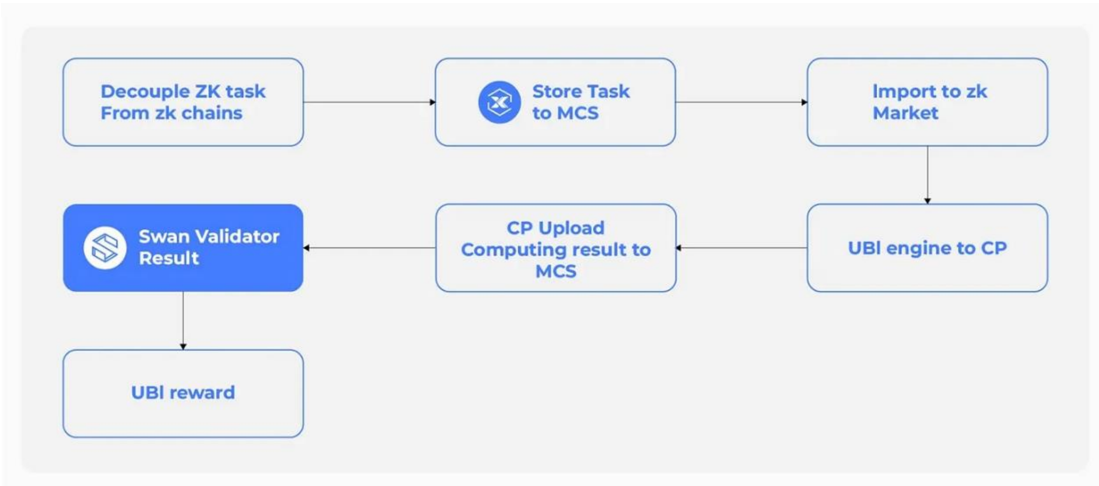
Given that GPUs are particularly adept at handling parallelizable tasks, they are ideal for the computation-heavy process of generating ZK proofs. Swan Chain's infrastructure likely includes nodes equipped with high-performance GPUs to accelerate the creation of proofs, making the process more time-consuming and cost-efficient.

Embedded ZK Market

The embedded ZK market within Swan Chain operates as a marketplace for ZK proof generation. Blockchain protocols and applications that require ZK proofs but lack the computational resources to generate them in-house can outsource these tasks to the Swan Chain network.

ZK UBI Mechanism

The computing providers participating in the ZK market are rewarded for their contributions in the native cryptocurrency of Swan Chain, which forms part of their UBI. This UBI serves as a consistent stream of income, providing an economic incentive for maintaining the necessary computational infrastructure and for the continuous provision of processing power.



Advantages and Innovation

1. Scalability: By leveraging a global network of computing providers, Swan Chain can scale its computational capacity up or down based on the current demand for ZK proofs.
2. Decentralization: The decentralized nature of the network ensures resilience and robustness, with no single point of failure that could disrupt the generation of ZK proofs.
3. Incentivization: The UBI model incentivizes a wide array of providers to join and contribute to the network, ensuring a consistent availability of computational resources.
4. Cost-Effectiveness: For blockchain protocols and applications, using Swan Chain's ZK market is likely more cost-effective than developing and maintaining an in-house solution for ZK proof generation.
5. Privacy and Security: The use of ZK proofs inherently enhances privacy and security, making Swan Chain's offering particularly appealing for applications that handle sensitive data.

4.2.7.1 ZK Task

The ZK (Zero-Knowledge) Task on Swan Chain is an innovative implementation that blends a Universal Basic Income model with the privacy and efficiency of zero-knowledge proofs (ZKPs), underpinned by an embedded ZK market. This integration creates a self-sustaining and privacy-preserving ecosystem for participants who contribute computing resources.

Concept and Functionality

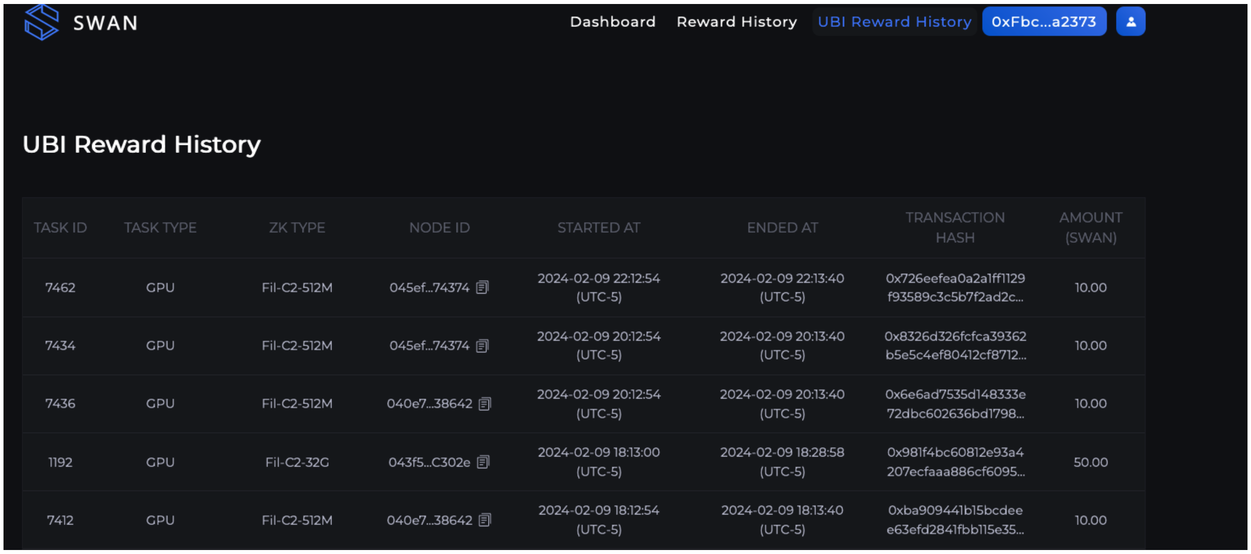
ZK Model: The ZK model within Swan Chain is a groundbreaking economic system designed to provide a guaranteed basic income to network participants. It leverages zero-knowledge proofs to validate the contributions of computing providers without revealing sensitive data.

Zero-Knowledge Proofs: ZKPs are a form of cryptographic protocol that allow one party (the prover) to prove to another party (the verifier) that a statement is true, without revealing any information beyond the validity of the statement itself.

Embedded ZK Market: Swan Chain integrates a specialized ZK market that serves as a platform for various blockchain protocols in need of ZK computation, such as Aleo, Filecoin, and StarkNet. This market is where tasks requiring ZK proofs are listed and sourced.

Workflow

1. Task Generation: Blockchain protocols that require ZK computations generate tasks. These could include private transaction verification for Aleo, proof-of-replication for Filecoin, or scalability solutions for StarkNet.
2. ZK Task Pool: The generated tasks are pooled into a ZK Task Pool, where they are made available to computing providers on the Swan Network.
3. Task Completion for Income: Computing providers on Swan Chain select tasks from the pool, complete the computations, and generate ZK proofs. By completing these tasks, they earn $SWAN, the native cryptocurrency of Swan Chain, as part of their UBI.
4. Proof Submission and Verification: Upon completion, providers submit their ZK proofs back to the Swan Chain for verification. This ensures the integrity and validity of the computations performed.
5. UBI Distribution: Once verified, the ZK proofs trigger the smart contract-based UBI system to distribute $SWAN to the computing providers, ensuring a steady income stream and incentivizing continuous participation in the network.



TASK ID	TASK TYPE	ZK TYPE	NODE ID	STARTED AT	ENDED AT	TRANSACTION HASH	AMOUNT (SWAN)
7462	GPU	Fil-C2-512M	045ef...74374	2024-02-09 22:12:54 (UTC-5)	2024-02-09 22:13:40 (UTC-5)	0x726eefea0a2a1ff1129 f93589c3c5b7f2ad2c...	10.00
7434	GPU	Fil-C2-512M	045ef...74374	2024-02-09 20:12:54 (UTC-5)	2024-02-09 20:13:40 (UTC-5)	0x8326d326fcfca39362 b5e5c4ef80412cf8712...	10.00
7436	GPU	Fil-C2-512M	040e7...38642	2024-02-09 20:12:54 (UTC-5)	2024-02-09 20:13:40 (UTC-5)	0x6e6ad7535d148333e 72dbc602636bd1798...	10.00
1192	GPU	Fil-C2-32G	043f5...C302e	2024-02-09 18:13:00 (UTC-5)	2024-02-09 18:28:58 (UTC-5)	0x981f4bc60812e93a4 207ecfaaa886cf6095...	50.00
7412	GPU	Fil-C2-512M	040e7...38642	2024-02-09 18:12:54 (UTC-5)	2024-02-09 18:13:40 (UTC-5)	0xba909441b15bcdee e63efd2841fbb115e35...	10.00

ZK task reward Dashboard

4.2.7.2 ZK Pool

Swan's ZK mechanism integrates various ZK-proof computations over time, such as Filecoin commit2, Aleo, StarkNet, Scroll, etc.

The ZK Task Pool serves as a centralized hub for various ZK workloads for CPs:

- Storage Providers can contribute their ZK-proof work to enrich the pool of tasks.
- Computing Providers can receive tasks from ZK task pool.
- CPs generate proofs recorded on Swan Chain, allowing Storage providers to directly access the proofs they need.

By deeply integrating Filecoin's intensive workloads and establishing an open task pool, Swan's ZK tasks bring about mutually reinforcing network collaborations.

4.3 Storage Provider

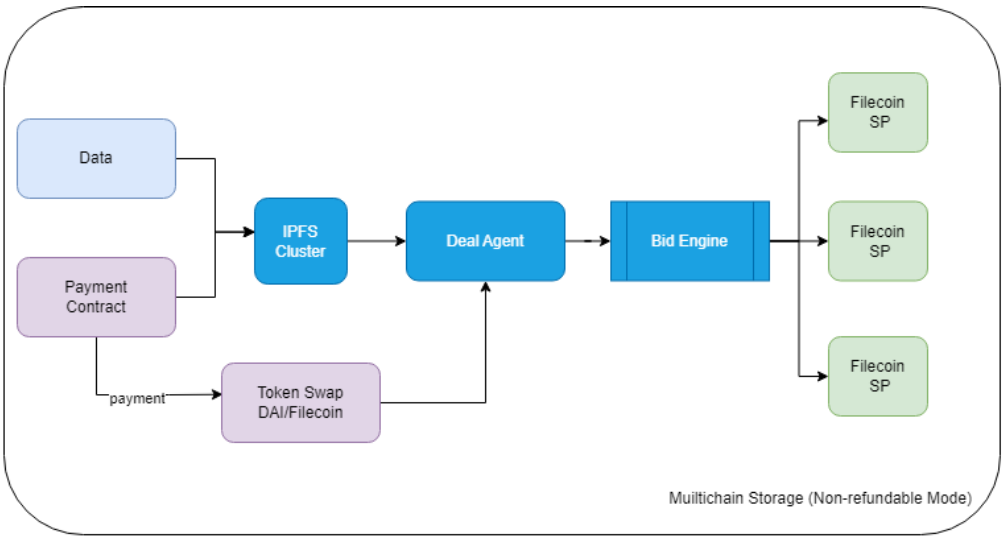
Introduction

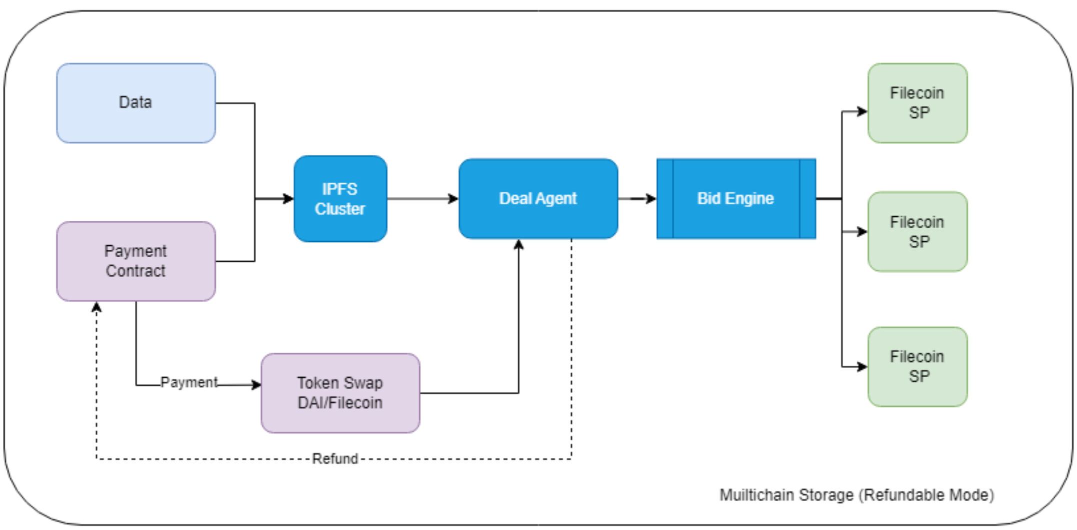
Swan Storage Provider enables hardware owners to make profits on their spare computing resources by releasing them to tenants.

The service Swan provides helps storage providers connect to the Web3 service market, making the Web3 service offering ultimately easier.

Multi Chain Storage (MCS) is a web3 version of S3 storage gateway built with IPFS and Filecoin technology for accelerating the mass adoption of decentralized storage by multiple blockchain networks.

High-Level Design





Multi-chain Storage Design

4.3.1 Storage Auction System

Introduction

Filecoin users need to find suitable storage providers in the first instance. They need to actively seek providers, bargain offline, send data files, lock fees, and proceed with payment once file storage is completed as requested.

Over the course, there remain several key questions:

1. Users can't fully understand the specific service quality of storage providers because of the limited information available.
2. The lack of in-depth matching functionality, and diverse data storage needs are making the dealer market opaque.
3. There are not enough choices available for beginners. It is time-consuming as well as costly to find and compare storage providers that will work best for them.

In this context, having an open and transparent matching system is necessary. Swan's auction system is optimal for simplifying data storage through matching providers and users in need automatically, thereby reducing the learning cost for users.

Manual bid vs Auto-bid

- **Manual Bid**

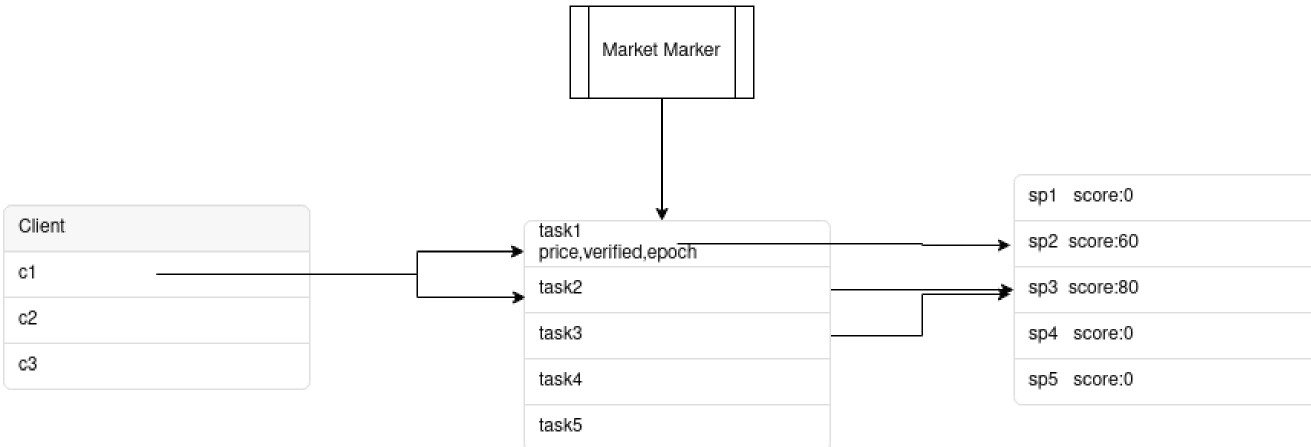
There are two types of bids in the Swan system. One is manual bid, and the other is auto-bid. Manual bidding is a system designed for users who are actively involved in the bidding. When bidding manually, users select providers in accordance with their bandwidth, storage capacity, geographic location, and daily processing ability. Similarly, users compare and filter attributes of assorted products on shopping platforms.

Users cannot avoid other users' interactions because they need to know who they expect to take the deal. Afterward, users can send the deal. It consists of two steps: the first step is to open the deal bid, and the second step is to assign the bid. Users assign transactions to different storage providers to solicit public bids. Providers then store the data as requested after winning the bid. Since this step is open to the public, we call it an "open public deal", which means that anybody in the system can compete for it.

After several satisfying bids, the user may be willing to build long-term private cooperation with the storage provider. So, they may skip the bidding process and send deals directly to each other in the future. We call this case a "private deal".

One advantage of the manual bid system is that tipping the tasks makes it more flexible while bidding.

- **Autobid**



Autobid System

The auto bidding system is a reputation-based system. When users sign up as a storage provider, they will be rated based on the data they processed. The more data they process, the higher score they will achieve.

In the auto-bidding system, users are free from hassles like choosing storage providers. The system selects providers automatically while ensuring fairness. When a user sends out a deal to the auto bidding pool, the storage provider will be assigned the deal based on their reputation score. The higher score you have, the more likely they will win a bid.

The Swan bidding system is a matching platform that enables convenient transactions between users and providers. In the era of decentralized storage, Swan ensures a quick pair of users and storage providers for the sake of time-efficient storage and backup services regardless of data scales.

The Swan bidding system increases the earnings of real data storage. It additionally reduces the leverage difficulty to attract more novice users.

The market matcher program distributes the order following a lambda distribution, which means that even if the storage provider scores low, he is still able to get some deals.

Task

It is of great importance to conceptualize "task" in the Swan system. A task consists of several deals. Currently, Filecoin only accepts deals of specified sizes, e.g., a maximum of 32 gigabytes or 64 gigabytes. If you want to store data more than one terabyte or 10 terabytes, you need to split it to different deals manually to send them. This could make deal management daunting.

In order to batch send deals, we have created a concept called “tasks”. A task is a combination of deals. Users can name it, label it, and define the curated dataset type for future usage.

Swan Storage Provider

The Swan Provider runs on the same node as the lotus miner nodes run, and assists lotus miners to process deals. In order to better share the information with the Flilswan client, authentication from the Swan Chain platform is required.

Swan provider also keeps your status up to date. With the Swan platform, your client can get your shared information about the file sealing life cycle.

We also provide the Restful API interface for developers to integrate the Swan Provider into their own system.

4.4 Use Cases on Swan Chain

When users are familiar with building on Swan Mainnet and need the tools to get started, they can find the following three components in the Swan ecosystem.

Lagrange: Decentralized NLP Platform

Lagrange (lagrange.computer) is a cutting-edge Web3 platform for natural language processing (NLP) development and deployment. Built on the Swan Chain computing network, it offers:

- Cost-effective alternative to centralized cloud services
- Enhanced security and interoperability
- Decentralized infrastructure for NLP tasks

Multi-Chain Storage (MCS)

Developed by the Swan Network, Multi-Chain Storage (MCS) is a revolutionary storage service compatible with various blockchain networks. Key features include:

- Smart contract integration for improved security
- Decentralized architecture
- Cross-chain compatibility

Swan SDK

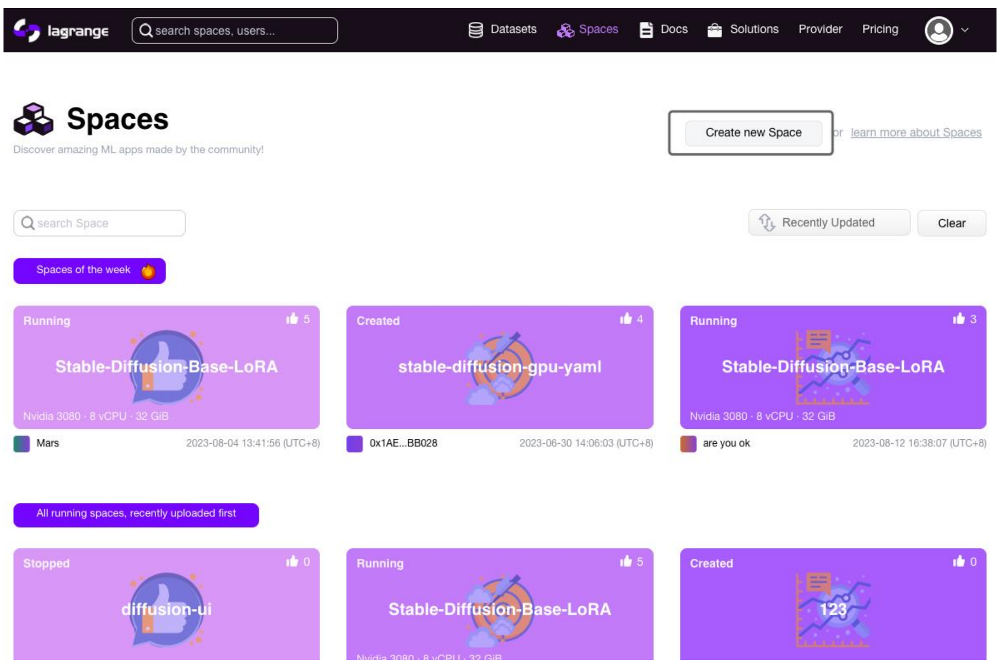
The Swan SDK is your go-to toolkit for interacting with the Swan Chain Network Resource. It simplifies:

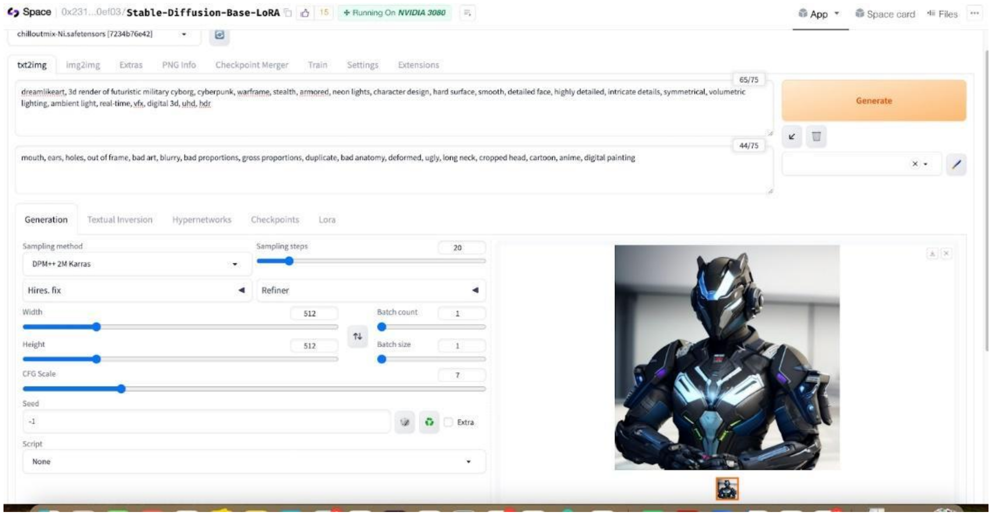
- Creating and managing computational tasks
- Retrieving hardware information
- Processing payments
- Monitoring task statuses

4.4.1 Lagrange Computer

Lagrange is a decentralized Web3 platform for natural language processing (NLP) development and deployment, built on Swan Chain computing network. It aims to provide a more cost-effective, secure, and interoperable alternative to centralized cloud services like AWS.

Lagrange serves as a decentralized version of Hugging Face, leveraging the decentralized computing resources from Swan Chain and utilizing multi-chain storage as the decentralized storage layer to ensure the persistence of important data.



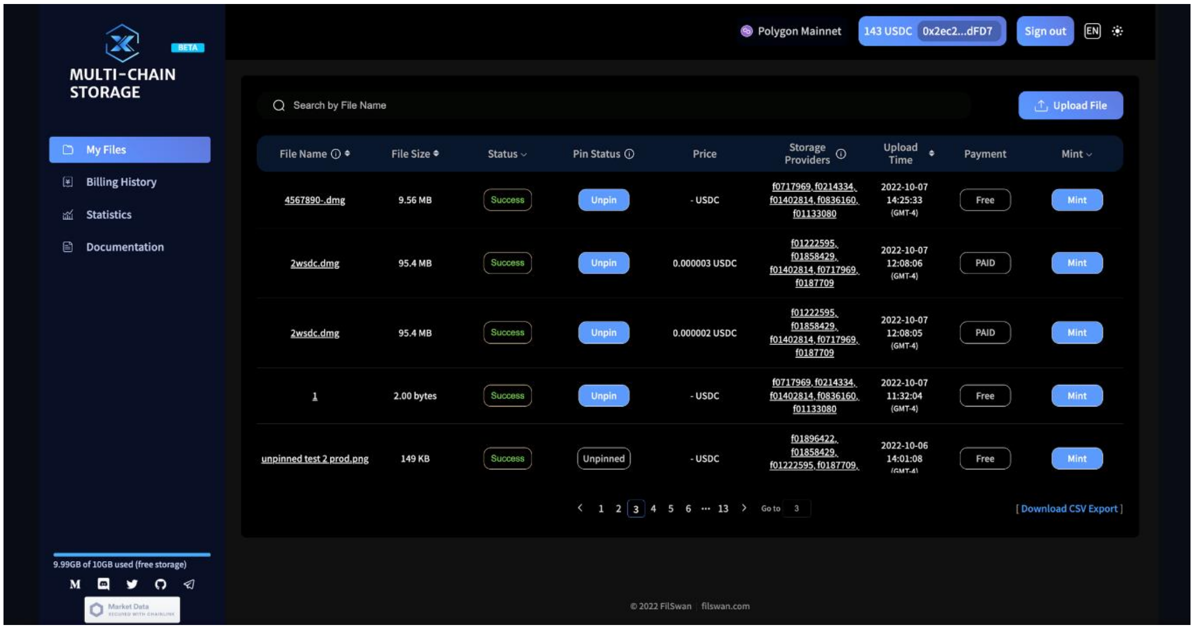


Lagrange leverages the advantages of Swan Chain, such as:

- Cost-Effective: By utilizing decentralized resources, Lagrange reduces operational costs compared to traditional cloud services.
- Security: Ensures data integrity and security through decentralized storage and processing.
- Interoperability: Compatible with various blockchain networks and computing providers, enhancing flexibility and scalability.
- Efficiency: Facilitates efficient NLP model training and deployment using distributed computing power.

4.4.2 Multi-Chain Storage (MCS)

Multi-Chain Storage, or MCS, developed by the Swan Network, is a new kind of storage service that works with different blockchain networks. It transcends traditional cloud storage by using smart contracts for enhanced security, reminiscent of an S3 storage gateway but with the added benefit of decentralization.



Multi-Chain Storage offers several advantages over traditional cloud services, such as:

- Decentralization: MCS eliminates the need for intermediaries and third-party providers, giving users full control and ownership over their data. MCS also prevents censorship and tampering by ensuring that files are replicated and verified across multiple nodes.
- Interoperability: MCS supports multiple blockchains, including Ethereum, Polygon and more. This means that users can access their files from any chain they prefer, without being locked into a single platform or network.
- Cost-efficiency: MCS reduces the cost of storage by utilizing the spare capacity of existing nodes. MCS also optimizes the storage allocation and distribution based on the demand and supply of each chain.
- Scalability: MCS can handle large volumes of data and traffic without compromising speed or quality. MCS also adapts to the changing conditions of each chain, such as congestion, fees, and latency.

Multi-Chain Storage can store any type of file that can be hosted on a website, such as:

- Images, videos, audio, and other media formats
- PDFs, documents, spreadsheets, and other office files
- JSON, XML, CSV, and other data formats
- HTML, CSS, JavaScript, and other web development languages

4.4.3 Swan SDK

The Swan SDK is a toolkit designed to simplify interactions with the Swan Chain Network Resource. It provides a streamlined interface for creating and managing computational tasks, retrieving hardware information, processing payments, and monitoring task statuses.

Chain Node Web Application

In this example, you will deploy a simple web application on the distributed computing provider network using Swan SDK. At the end of this example, you will have a Chain Node Frontend application running on the Swan network.

- Create Task and Deploy Application Instances

```
import swan
import json

api_key = '<your_api_key>'
wallet_address = '<WALLET_ADDRESS>'
private_key = '<PRIVATE_KEY>'

swan_orchestrator = swan.resource(
    api_key=api_key,
    service_name='Orchestrator'
)

result = swan_orchestrator.create_task(
    repo_uri='https://github.com/swanchain/awesome-
swanchain/tree/main/ChainNode',
    wallet_address=wallet_address,
    private_key=private_key,
    auto_pay=True,
    instance_type='C1ae.medium',
)

task_uuid = result['task_uuid']
instance_type = result['instance_type']
task_info = swan_orchestrator.get_deployment_info(task_uuid=task_uuid)
print(json.dumps(task_info, indent=2))
```

```
### get real url (if no url, please wait for a while, then check again)
result_url = swan_orchestrator.get_real_url(task_uuid)
print(result_url)
```

- Sample URL output:

['https://0sz7wqp79q.dev2.crosschain.computer', 'https://grxfl2u0cu.cp.filezoo.com.cn', 'https://0ux851gqmz.pvm.nebulablock.com']

5. Tokenomics

The native cryptographically-secure fungible protocol token of Swan Chain (**Swan Token**) is a transferable representation of attributed utility functions specified in the protocol/code of Swan Chain, and which is designed to be used solely as an interoperable utility token thereon.

Swan Chain introduces a comprehensive tokenomics structure designed to support its ecosystem's growth, incentivize participation, and ensure operational sustainability. This document outlines the strategic allocation, governance mechanisms, planned token release schedule, and specific formulas for the Fog Computing Providers (FCP), Edge Computing Providers (ECP), and Market Providers (MP) to provide a clear understanding of how Swan Chain utilizes its native tokens to drive network engagement and development.

Total Token Supply and Token Allocation

Total Supply: 1,000,000,000 Swan Tokens

The token distribution is as follows:

- 20% - Early Purchasers
- 20% - DAO Treasury
- 25% - Ecosystem Fund
- 15% - Core Contributors
- 20% - Airdrops

Swan Token is a functional multi-utility token which will be used as the medium of exchange between participants on Swan Chain in a decentralised manner. The goal of introducing Swan Token is to provide a convenient and secure mode of payment and settlement between participants who interact within the ecosystem on Swan Chain without any intermediaries such as centralised third party entity/institution/credit. It is not, and not intended to be, a medium of exchange accepted by the public (or a section of the public) as payment for goods or services or for the discharge of a debt; nor is it designed or intended to be used by any person as payment for any goods or services whatsoever that are not exclusively provided by the issuer. Swan Token does not in any way represent any shareholding, ownership, participation, right, title, or interest in the Company, the Distributor, their respective affiliates, or any other company, enterprise or undertaking, nor will Swan Token entitle token holders to any promise of fees, dividends, revenue, profits or investment returns, and are not intended to constitute securities in the British Virgin Islands, Singapore or any relevant jurisdiction. Swan Token may only be utilised on Swan Chain, and ownership of the same carries no rights, express or implied, other than the right to use Swan Token as a means to enable usage of and interaction within Swan Chain. The secondary market pricing of Swan Token is not dependent on the effort of the Swan Chain team, and there is no token functionality or scheme designed to control or manipulate such secondary pricing.

For the avoidance of doubt, neither the Company nor the Distributor deals in, or is in the business of buying or selling any virtual asset or digital payment token (including Swan Token). Any sale or distribution of tokens would be performed during a restricted initial period solely for the purpose of obtaining project development funds, raising market/brand awareness, as well as community building and social engagement; this is not conducted with any element of repetitiveness or regularity which would constitute a business.

Further, Swan Token is required as virtual crypto "fuel" for using certain designed functions on Swan Chain, providing the economic incentives which will be distributed to encourage users to exert efforts towards contribution and participation in the ecosystem on Swan Chain, thereby creating a mutually beneficial system where every participant is fairly compensated for its efforts. Swan Token is an integral and indispensable part of Swan Chain, because without Swan Token, there would be no incentive for users to expend resources to participate in activities or provide services for the benefit of the ecosystem. Given that additional Swan Token will be awarded to a user based only on its actual usage, activity and efforts made on Swan Chain and/or proportionate to the frequency and volume of transactions, users of Swan Chain and/or holders of Swan Token which did not actively participate will not receive any Swan Token incentives.

To promote decentralised community governance for the network, Swan Token would allow holders to propose and vote on governance proposals to determine future features, upgrades and/or parameters of Swan Chain, or provide feedback, with voting weight calculated in proportion to the tokens staked. The right to vote is restricted solely to voting on features of Swan Chain; it does not entitle Swan Token holders to vote on the operation and management of the Company, its affiliates, or their assets or the disposition of such assets to token holders, or select the board of directors or similar bodies of these entities, or determine the development direction of these entities, nor does Swan Token constitute any equity interest in any of these entities or any collective investment scheme; the arrangement is not intended to be any form of joint venture or partnership.

Swan Chain itself is simply a blockchain protocol which, as designed, does not own or run any computing/storage servers. It relies on an open, decentralised network of third party actors such as Computing Providers (CPs) and Market Providers (MPs) which operate on an open source algorithm to ensure network security and prevent attacks. Accordingly, third-party computational and storage resources are required for processing transactions and running applications on Swan Chain, as well as the validation of information. Providers of these services / resources would require payment for their work, and Swan Token will be used as the native currency to quantify and pay the costs of the consumed resources.

5.1 UBI Allocation Curve

5.1.1 Introduction

Swan Chain is a decentralized network that connects computing providers with users requiring computational resources. To foster early network growth and incentivize CPs to join and contribute resources, a dual compensation mechanism has been designed:

1. Universal Basic Income (UBI): Provides CPs with a predictable Swan Token income when their resources are underutilized.
2. Paid Jobs: Offers market-priced compensation for computational tasks requested by users.

This mechanism ensures a fair and gradual distribution of tokens to providers, supporting the network's expansion until it reaches a critical mass of user-paid tasks. Importantly, the UBI distribution rate is influenced by the resource usage rate, and CPs earn market-based compensation when engaged in paid jobs.

5.1.2 Compensation Model

$$I(x) = A \cdot x^{B} \cdot e^{-Cx} \cdot (1 - u(x)) + P_{\text{market}}(x) \cdot u(x)$$

The total daily income $I(x)$for a computing provider on day (x) comprises two components:

1. UBI Income $y_{\text{UBI}}(x)$
2. Paid Job Income $y_{\text{Paid}}(x)$

The UBI income is modeled using a gamma-like function adjusted by the resource usage rate

$$y_{\text{UBI}}(x) = A \cdot x^{B} \cdot e^{-Cx} \cdot (1 - u(x))$$

Where:

- A=20,000 (Scaling factor)
- B=0.3100 (Growth rate exponent)
- C=0.0017 (Decay rate constant)
- x is the day number, starting from 1
- $u(x)$ is the resource usage rate on day (x) (ranging from 0 to 1)

The paid job income depends on the market demand and the resource utilization:

$$y_{\text{Paid}}(x) = P_{\text{market}}(x) \cdot u(x)$$

Where:

- $P_{\text{market}}(x)$ is the total market value for computational resources on day (x)
- $u(x)$ represents the proportion of a CP's resources utilized by paid job

Defining $u(x)$

(1) Calculate the total duration of real GPU orders across the network

$$T_{day} = \sum_i Task_{ECP}, i\,(\text{GPU}_k) \times f_k + \sum_j Task_{FCP}, j\,(\text{GPU}_k) \times f_k \times W_{FCP}$$

Where:

- $Task_{\text{FCP}},i(\text{GPU}_k)$ represents the time that the i-th FCP task uses GPU_k.
- $Task_{\text{ECP}},j(\text{GPU}_k)$ represents the time that the j-th ECP task uses GPU_k.
- f_k represents the earnings growth factor
- W_{FCP} represents the FCP resource bonus ratio, currently set at a constant value of 1.2.

NOTE: The value of W_{FCP}, 1.2, means that if the same configuration of servers is deployed for FCP, it will generate 20% more earnings than ECP.

(2) Calculate the total available usage time for all GPUs in the network

$$T_{total} = \sum_k N_{ECP}(\text{GPU}_k) \times 24 \times f_k + \sum_k N_{FCP}(\text{GPU}_k) \times 24 \times f_k * W_{FCP}$$

Where:

- $N_{\text{FCP}}(\text{GPU}_k)$ represents the number of GPU_k *in FCP*
- $N_{\text{ECP}}(\text{GPU}_k)$ represents the number of GPU_k in ECP.

(3) Calculate $u(x)$

$$u(x) = \frac{Tday}{Ttotal}$$

Defining Total Market Value $P_{\text{market}}(x)$

$P_{\text{market}}(x)$ represents the cost in Swan Tokens when all GPUs in the CP are fully utilized:

$$P_{market}(x) = \sum_k N_{ECP}(GPU_k) \times Price(GPU_k) \times 24 + \sum_k N_{FCP}(GPU_k) \times W_{FCP} \times Price(GPU_k) \times 24$$

Where:

- $Price(GPU_k)$ is the price of GPU_k.
- W_{FCP} represents the FCP resource bonus ratio, currently set at a constant value of 1.2.
- $N_{\text{FCP}}(\text{GPU}_k)$ represents the number of GPU_k *in FCP*.
- $N_{\text{ECP}}(\text{GPU}_k)$ represents the number of GPU_k in ECP.

5.1.3 Algorithm Implementation

The compensation mechanism proceeds as follows:

1. Initialization: Set day (x=1).
2. Determine Resource Usage Rate: Calculate $u(x)$ based on the CP's resource utilization by paid jobs.
3. Computer UBI Income:

$$y_{\text{UBI}}(x) = 20{,}000 \times x^{0.3100} \times e^{-0.0017x} \times (1-u(x))$$

4. Computer Paid Job Income:

$$y_{\text{Paid}}(x) = P_{\text{market}}(x) \times u(x)$$

5. Calculate Total Income:

$$I(x) = y_{\text{UBI}}(x) + y_{\text{Paid}}(x)$$

6. Distribute Income: Allocate $I(x)$ to CPs based on their resource contributions and utilization.
7. Increment Day: Increase x by 1.
8. Repeat: Continue the process for each subsequent day.

This algorithm ensures that CPs are incentivized to contribute resources to the network, receiving UBI when their resources are underutilized and earning market-based compensation when engaged in paid jobs.

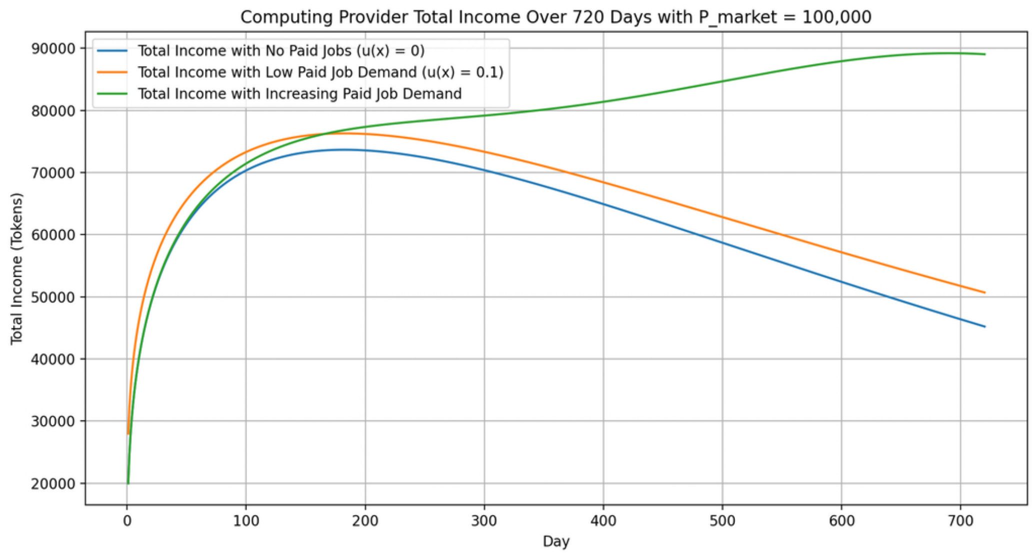
5.1.4 Visualization of Income Over Time

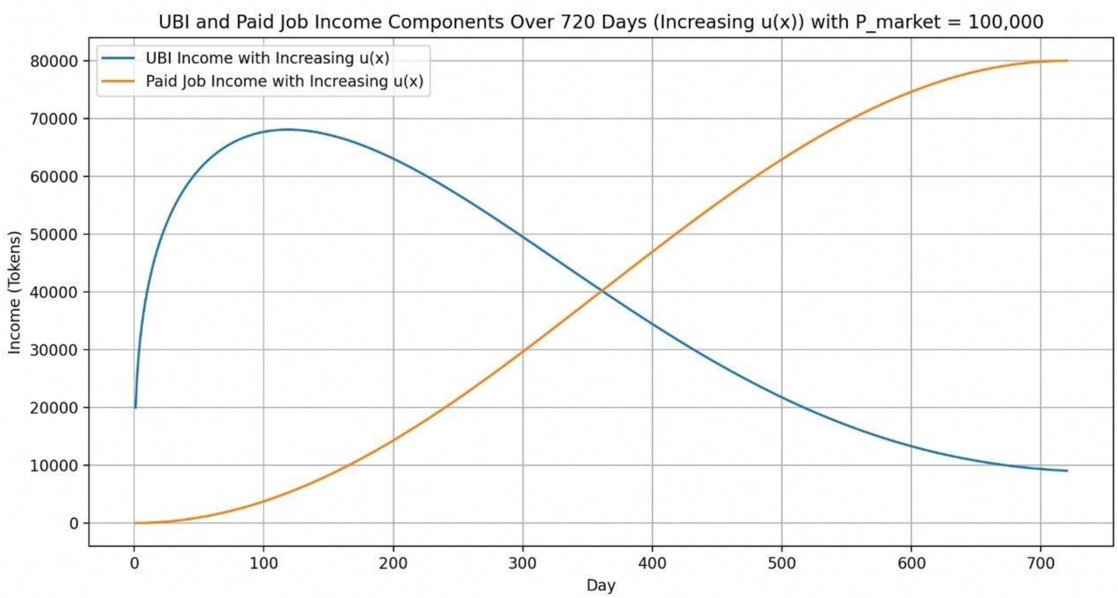
Scenarios

We consider three scenarios to illustrate how CPs' income evolves over time:

1. No Paid Jobs $u(x) = 0$: CPs receive income solely from UBI.
2. Low Paid Job Demand $u(x) = 0.1$: CPs primarily earn UBI income with a small contribution from paid jobs.

3. Increasing Paid Job Demand: Resource usage rate $u(x)$ increases over time, shifting CPs' income from UBI to paid jobs.





5.1.5 Interpretation of the Plots

1. Total Income Over 720 Days

- Scenario 1: $u(x) = 0$
  - CPs receive income solely from UBI.

- The total income decreases gradually over time due to the decay in the UBI function.

- Scenario 2: $u(x) = 0.1$
  - CPs receive slightly less UBI income than in Scenario 1 due to the 10% resource usage.
  - Paid job income contributes minimally, resulting in slightly lower total income.
- Scenario 3: *Increasing* $u(x)$
  - Initially, total income is similar to Scenario 1.
  - As $u(x)$ increases, paid job income increases while UBI income decreases.
  - Total income remains relatively stable or increases slightly, demonstrating that paid job income offsets the reduction in UBI.

2. Income Components for Scenario 3

- UBI Income:
  - Decreases over time as resource usage rate $u(x)$ increases.
  - Reflects the transition from reliance on UBI to paid jobs.
- Paid Job Income:
  - Increases over time with the increase in $u(x)$.
  - Compensates for the decrease in UBI income.
- Total Income Stability:
  - The sum of UBI and paid job income maintains income stability for CPs.

3. Resource Usage Rate $u(x)$ for Scenario 3

- Shows a smooth increase from 0 to 0.8 over 720 days.
- Reflects the gradual adoption of paid tasks in the network.

5.1.6 Impact of the Design

Incentivizing Optimal Resource Utilization

- Adaptive Compensation: CPs are motivated to engage in paid jobs as they become available, earning higher income through market rates.
- Resource Availability: UBI ensures that CPs keep their resources available to the network, even during periods of low demand.

Sustainable Long-Term Distribution

- Transition to Market-Based Economy: As the network matures and paid job demand increases, CPs naturally shift from UBI reliance to market compensation.

- Controlled Token Issuance: The decreasing UBI allocation over time prevents token oversupply, maintaining economic stability.

Economic Implications

- Income Stability: CPs benefit from a combination of UBI and paid job income, smoothing income fluctuations.
- Market Alignment: Compensation reflects real-time network demand, promoting efficient resource allocation.

The combined UBI and paid job compensation model for Swan Chain computing providers effectively balances incentives, supporting early network growth while promoting efficient resource utilization. By dynamically adjusting CPs' income based on resource usage rates and market demand, the model ensures sustainable network development and economic stability as the network transitions to a mature, user-driven ecosystem.

5.2 Computing Provider Income

Swan Chain is a decentralized network that connects computing providers with users requiring computational resources. To foster early network growth and incentivize CPs to join and contribute resources, a dual compensation mechanism has been designed:

1. Universal Basic Income (UBI): Provides CPs with a predictable token income when their resources are underutilized.
2. Paid Jobs: Offers market-priced compensation for computational tasks requested by users.

This mechanism ensures a fair and gradual distribution of tokens to providers, supporting the network's expansion until it reaches a critical mass of user-paid tasks. Importantly, the UBI distribution rate is influenced by the resource usage rate, and CPs earn market-based compensation when engaged in paid jobs.

Total Income

The total daily income $I(x)$for a computing provider on day (x) comprises two components:

- UBI Income $y_{\text{UBI}}(x)$
- Paid Job Income $y_{\text{Paid}}(x)$

$$I(x) = y_{\text{UBI}}(x)+y_{\text{Paid}}(x)$$

Substituting the expressions for $y_{\text{UBI}}(x)$ and $y_{\text{Paid}}(x)$

$$I(x) = A \cdot x^{B} \cdot e^{-Cx} \cdot (1-u(x)) + P_{\text{market}}(x) \cdot u(x)$$

Resource Usage Rate Impact

- When $u(x)=0$:
  - CP receives a full UBI allocation.
  - No income from paid jobs.
- When $u(x)=1$:
  - All resources are utilized for paid jobs.
  - CP receives full income from paid jobs.
  - No UBI allocation.
- Intermediate Values:
  - CP's income is a combination of UBI and paid job compensation, proportional to resource utilization.

Individual CP's UBI

To calculate UBI for a single CP, we consider both the resource usage and completion rates of tasks. UBI allocation is conditional on sufficient resource contribution and performance metrics:

(1) UBI Workload Calculation

- Calculate the daily completion rate of a single ECP zk-task: P_{ECP}
- Calculate the completion rate of a single FCP sampling task: P_{FCP}
- Number of GPUs: $N_{ECP}(GPU_k)$ and GPU types.
- Calculate the total UBI workload:

$$UBI_{total} = UBI_{ECP} + UBI_{FCP}$$

$$UBI_{ECP} = \sum_i \left(\sum_k N_{ECP}, i\ (GPU_k) \times f_k\right)$$

$$UBI_{FCP} = \sum_j \left(\sum_k N_{FCP}, j\ (GPU_k) \times f_k\right) * W_{FCP}$$

(2) Calculating the UBI for a single CP:

As an ECP:

$$UBI_{ECP}, i(x) = \frac{\sum k\ NECP,i(GPUk) \times fk \times PECP,i}{UBIECP+UBIFCP} \times yUBI(x)$$

As an FCP:

$$UBI_{FCP}, i(x) = \frac{\sum k\ NFCP,i(GPUk) \times fk \times PFCP,i \times WFCP}{UBIECP+UBIFCP} \times yUBI(x)$$

Conditions for CP to Receive UBI

A CP must meet certain conditions to qualify for UBI:

1. Sufficient Collateral:

$$Collateral_{ECP} = \sum_k N_{ECP} (GPU_k) \times C_{base} \times f_k$$

$$Collateral_{FCP} = \sum_k N_{FC}P (GPU_k) \times C_{base} \times f_k \times W_{FCP}$$

Where:

- N_{ECP} (GPU_k) represents the number of ECP for GPU_k
- C_{base} is the base collateral, with an initial value of 3,500 (this value will be dynamically adjusted based on the daily computing units of the entire network; for specific adjustment rules, check here).
- N_{FCP} (GPU_k) represents the number of GPU_k *in FCP*.
- N_{ECP} (GPU_k) represents the number of GPU_k in ECP.
- W_{FCP} represents the FCP resource bonus ratio, currently set at a constant value of 1.2.

NOTE: The value of W_{FCP}, 1.2, means that if the same configuration of servers is deployed for FCP, it will generate 20% more earnings than ECP.

2. Completion of Basic Test Tasks:

- FCP: Sampling task
- ECP: ZK task

3. GPU count and type are also factored into the UBI eligibility.

Exit Mechanism:

- CPs can exit by adjusting the setting of accepting tasks through their TaskType (ECP: 1, 2, 4; FCP: 3, 5).
- CPs can request to withdraw their collateral, but this requires a 7-day confirmation period to ensure settlement before the withdrawal is finalized (first requestWithdraw, followed by confirmRequest after 7 days).

5.3 Computing Provider Collateral

Introduction

In the Swan Chain network, Computing Providers (CPs) contribute their computational resources to support the network's decentralized computing infrastructure. To ensure stability and economic security, CPs are required to provide collateral in Swan tokens. This collateral acts as a financial commitment, incentivizing CPs to act in the best interest of the network while also sharing in the economic rewards generated from providing computing power.

Collateral Model

The collateral amount for each CP is determined by an inverse correlation model based on the total computing power contributed by the CP to the network. The formula for calculating the collateral amount is:

$$C_{base} = \frac{Ctotal}{CUtotal} + b$$

$$CU_{total} = \max\left(\sum_k N_{ECP}(GPU_k) \times f_k + \sum_k N_{FCP}(GPU_k) \times f_k * W_{FCP}, CU\right.$$

$$\begin{cases} CU_0 = 3000 \\ C_{total} = 10{,}000{,}000 \\ B = 200 \end{cases}$$

Where:

- W_{FCP} represents the FCP resource bonus ratio, currently set at a constant value of 1.2.
- N_{FCP} (GPU_k) represents the number of GPU_k *in FCP*
- N_{ECP} (GPU_k) represents the number of GPU_k in ECP.
- f_k represents the earnings growth factor

The formula indicates that the collateral requirement decreases as the total computing power contributed by the CP increases. This is designed to encourage CPs to contribute more computing power, reducing their collateral burden as they scale up their participation.

Revenue Sharing and APR Calculation

Once a CP provides collateral, they are eligible to receive revenue generated from both Universal Basic Income (UBI) tokens and paid jobs. The revenue model includes:

1. UBI Income: CPs receive UBI tokens as a baseline income for their participation, which is inversely related to their collateral and computing power.
2. Paid Job Income: CPs can earn additional revenue by completing paid jobs, which are offered at a market rate determined by user demand.

The Annual Percentage Rate (APR) for the CPs is calculated separately for both their operating revenue and collateral revenue:

- Operator APR: The revenue generated by CPs for providing computing power divided by their total operational costs.
- Collateral APR: Calculated based on the revenue earned by providing collateral relative to the collateral amount itself.

The total APR includes both the operator APR and collateral APR, providing a complete picture of the financial returns for CPs participating in the Swan Chain network.

Impact on Collateral Model

The negative correlation between collateral and computing power has several benefits:

1. Incentivizing Scale: CPs are encouraged to scale up their contributions to the network, as increasing their computing power reduces their collateral requirements.
2. Risk Mitigation: Collateral serves as a safeguard, ensuring that CPs have a financial stake in the network's success and discouraging malicious behavior.
3. Economic Participation: By allowing CPs to share both operator and collateral revenue, the model promotes balanced economic participation, where CPs are rewarded not only for their computational contributions but also for their financial commitment.

5.3.1 Collateral Requirement and Earning Multiplier

The base collateral requirement is 3500 $SWAN. Different GPU models contribute differently to the network and thus have varying earning multipliers and Collateral Requirements Per Card (in $SWAN).

Note: The values provided in the table below are for reference only. These figures may change in real-time based on current GPU prices and market conditions.

5.3.2 DePIN Oracle

Introduction

The DePIN Oracle is a critical component of the Swan Chain network, providing reliable data aggregation and pricing for decentralized computing services. By collecting and processing information from various sources, the DePIN Oracle ensures that participants in the Swan Chain ecosystem have access to accurate and up-to-date data, fostering a fair and efficient decentralized computing marketplace.

What is the DePIN Oracle?

The DePIN Oracle serves as a data aggregator that gathers GPU market prices from different platforms, such as vast.ai and salade.com. The gathered data is input into a smart contract daily, providing a baseline reference for the computing market within the Swan Chain network. This mechanism functions similarly to how Chainlink's pricing oracle operates in the decentralized finance (DeFi) space by delivering reliable and consistent price information to the network.

Key Functions of the DePIN Oracle

1. Data Aggregation: The DePIN Oracle collects GPU pricing data from multiple platforms. By leveraging multiple data sources, it ensures that the information provided is both accurate and comprehensive.
2. Market Price Reference: The aggregated data is input into a smart contract on a daily basis to create a trusted market price reference. This allows Swan Chain to set fair pricing for computing resources, which is crucial for decentralized computing providers and consumers.
3. Baseline for Smart Contracts: The DePIN Oracle feeds data directly into the smart contracts that manage payments and resource allocation in the Swan Chain network. This ensures that the prices for computing power are updated consistently, preventing discrepancies and enabling fair compensation for computing providers.

Benefits of the DePIN Oracle

1. Transparency: By using an oracle to provide publicly accessible data, the Swan Chain network ensures transparency in pricing. This encourages trust among computing providers, users, and stakeholders, which is essential for a decentralized system.
2. Fair Pricing: The DePIN Oracle plays a critical role in maintaining fair market pricing for computing resources. By pulling data from various platforms, oracle reduces the risk of price manipulation and ensures that providers and consumers engage in fair transactions.
3. Efficient Resource Allocation: The DePIN Oracle enables more efficient allocation of computing resources by providing real-time price information. This means that computing providers are better able to allocate their resources in response to demand, optimizing the overall network's efficiency.

Use Cases in Swan Chain Network

1. Decentralized Computing Marketplace: The DePIN Oracle supports the decentralized computing marketplace by providing a trusted reference for GPU pricing. This ensures that computing providers can set appropriate prices for their services based on real-time market conditions.
2. Token Issuance and Incentive Programs: By integrating market data into the network's smart contracts, the DePIN Oracle also helps with the fair distribution of tokens and incentives. For example, the Universal Basic Income (UBI) tokens distributed to computing providers are based on market conditions that the oracle helps determine.
3. Risk Management: The DePIN Oracle reduces the risk of relying on a single data source by aggregating data from multiple sources. This mitigates the risk of inaccurate pricing and

potential economic losses for computing providers or users of the Swan Chain network.

Conclusion

The DePIN Oracle is an essential component of the Swan Chain network, providing accurate, transparent, and reliable data that underpins the decentralized computing marketplace. By aggregating GPU pricing information from multiple sources and feeding it into smart contracts, the oracle ensures fair pricing, efficient resource allocation, and reduced risks for all network participants. Ultimately, the DePIN Oracle helps create a robust, transparent, and equitable ecosystem that supports the growth and sustainability of decentralized computing services on Swan Chain.

5.4 Governance

The SWAN DAO Governance is the backbone of the SWAN network, ensuring that decisions are made in a decentralized, transparent, and community-driven manner. It not only embodies the principles of decentralized autonomous organizations but also oversees the strategic management of the network's treasury.

Key Components of SWAN DAO Governance:

1. Committee Structure:

- Representation: The committee comprises representatives from various stakeholder groups, including SWAN token holders, core developers, builders, and other contributors.
- Election: Committee members are elected through a transparent voting process, ensuring that those with the network's best interests are at the helm.

2. Decision-making Process:

- Proposals: Any member of the SWAN community can submit proposals for consideration. These can range from protocol upgrades to budget allocations.
- Voting: Proposals are put to a vote, with outcomes determined by the majority. The weight of a member's vote can be determined by factors like the number of SWAN tokens held, tenure in the community, or other criteria set by the DAO.
- Implementation: Once a proposal is approved, it moves to the implementation phase, overseen by the relevant sub-committees or teams.

3. Transparency:

- Open Ledger: All financial transactions, decisions, and votes are recorded on a public ledger, ensuring complete transparency.

- Regular Reporting: The committee provides regular updates to the community, ensuring they are kept in the loop about decisions, financial status, and other relevant matters.

4. Community Engagement:

- Feedback Channels: Multiple channels (forums, chats, town halls) are available for community members to voice their opinions, concerns, and feedback.
- Educational Initiatives: The DAO organizes workshops and webinars to educate members about governance processes, ensuring informed decision-making.

5. Treasury Management:

- Allocation: The SWAN DAO oversees the network's treasury, strategically allocating funds for various initiatives, including collateral rewards, ecosystem/infrastructure, community building, Network Tasks, and Creator Rewards.
- Budget Oversight: Regular audits and reviews ensure that funds are being used judiciously and in line with the community's interests.
- Ecosystem Strategy: A portion of the treasury is allocated towards promising projects or assets, aiming to grow the overall ecosystem utility and outreach.
- Compensation: The DAO manages compensation for job creators, especially when the UBI rate exceeds the target. This ensures a balance between incentivizing job creation and providing UBI.

6. Continuous Evolution:

- Adaptability: The governance model is not static. It evolves based on feedback, changing network needs, and the broader blockchain landscape.
- Protocol Upgrades: The DAO is responsible for overseeing and implementing protocol upgrades, ensuring the SWAN network remains cutting-edge.

6. Conclusion

As the world’s first AI blockchain system, Swan Chain is dedicated to driving the advancement of artificial intelligence technologies, building a credible trust-based blockchain, creating social value and serving all of humanity. Swan Chain builds the next generation of AI blockchain infrastructure platform that enables developers in many industries to truly develop, compute and deploy artificial intelligence with high efficiency, low cost, safely and reliably, without worrying about the underlying development, system configuration and environment setup.

Swan Chain can be considered as a consensus system for decentralized data. As the value carrier, Swan tokens realize the value flow of artificial intelligence in the Swan Chain ecosystem. Whilst the traditional Internet connection can solve the problem of data communication, Swan Chain further solves the problem of data consensus on the basis of traditional Internet.

The rapid development of blockchain technology has made it possible to realize a digital credit society. Swan Chain will inject more fresh and vibrant blood into the development of global blockchain technology and look forward to pushing artificial intelligence, an important area where society can change, to new heights.

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