A Quantum Blockchain

Quantum Chain

WHITEPAPER

This whitepaper explains the concept and technical structure of Quantum Chain, a blockchain mainet based on quantum computing.

Issued by - Quantum Chain Foundation
Contact - quantumchainlab@gmail.com

Quantum Chain leverages the unique characteristics of quantum computing to overcome performance and security challenges that are difficult to address in traditional blockchain systems.

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01 Introduction

This document presents the technical design of Quantum Chain, a cryptocurrency that leverages the performance of quantum computers to perform high-performance computing operations within a mainnet and blockchain token ecosystem. This platform supports the exchange of data across various digital ecosystems on its proprietary blockchain infrastructure, thereby establishing a distributed computing environment where quantum computers act as validators. This setup provides a foundation for various applications within the network to interact with one another.

Quantum computers process information based on the principles of quantum mechanics, using qubits as their fundamental unit of operation. Qubits can exist in a superposition state, allowing them to represent both 0 and 1 simultaneously. This provides exponentially improved parallel processing capabilities compared to traditional binary-based computers. As a result, Quantum Chain can efficiently perform complex calculations that are challenging for existing computing environments, thereby presenting new possibilities for blockchain technology.

Quantum Chain is set to incorporate quantum-resistant algorithms to address potential security threats posed by quantum computers. These algorithms are designed to counter the ability of quantum computers to quickly decrypt existing encryption methods, ensuring the security of the network and resolving potential security issues that may arise as quantum computing technology advances. This approach will allow Quantum Chain to protect the integrity of the network and provide a secure and reliable blockchain environment even in the era of quantum computing.

This system aims to build a next-generation blockchain network by leveraging the exceptional performance of quantum computing. It seeks to address scalability issues within blockchain systems and overcome the limitations of future technologies based on enhanced computing capabilities.

02 Outine

Quantum computing is a new computing paradigm that utilizes the principles of quantum mechanics to process information with qubits, or quantum bits, rather than the traditional bits of 0s and 1s used by classical computers. Unlike classical computing technologies that represent information solely as 0s and 1s, qubits can exist in a superposition state, allowing them to represent both 0 and 1 simultaneously, as well as intermediate states. This superposition enables the storage of significantly larger amounts of information.

Additionally, entanglement refers to the phenomenon where two or more qubits remain connected as a single state, even when they are separated by large distances. This allows for instantaneous information transfer between entangled qubits. Quantum computing leverages the superposition of qubits to perform parallel processing, enabling the simultaneous handling of problems that classical computers must address sequentially.

Quantum computing is recognized as an innovative technology capable of addressing critical global issues such as environmental challenges, agriculture, health, energy, climate, and materials science, based on its immense performance capabilities. Quantum Chain promises to solve major problems facing our generation by combining the advantages of blockchain and quantum computing technologies. The mission of Quantum Chain is to transcend technological and universal human challenges through the harmonious application of blockchain and quantum computing.

The era of quantum computers is already upon us. IBM is a leader in the field of quantum computing, offering various sizes of quantum processors through the cloud. They provide an open-source framework called Qiskit to support the development of quantum algorithms. Additionally, companies like Microsoft and Amazon are also supporting the development of quantum computer-based applications through their cloud services. The field of quantum computing is poised to reach a level of commercialization within a few years, and it is expected to emerge as a game-changer in the existing Web 2.0 and 3.0 domains due to its high computing performance.

Quantum computing is both a solution to existing computing problems and a disruptor of established rules. In particular, the blockchain industry predominantly relies on algorithms such as RSA and ECC, which are vulnerable to quantum computers. Another mission of Quantum Chain is to establish itself as the most secure blockchain mainnet that can serve as a foundation in a future where quantum computing is implemented.

To achieve this mission, Quantum Chain proposes the adoption of quantum-resistant encryption algorithms standardized by NIST (e.g., Kyber, Dilithium). It emphasizes the necessity of applying these algorithms to the encryption processes of on-chain data. Additionally, by implementing post-quantum cryptography (PQC), Quantum Chain aims to provide a blockchain system that is secure against quantum computer attacks, ensuring the protection of core information and users within the industry.

02-1 The Significance of Quantum Computers in Blockchain

Integrating quantum computers into blockchain systems for data validation represents a groundbreaking advancement in improving the performance, scalability, and security of decentralized networks. By leveraging the unique computational capabilities of quantum computers, many limitations faced by traditional blockchains can be overcome. While the current generation of quantum computers is still in its early stages due to the limited number of qubits, continuous technological advancements will lead to a steady increase in qubit numbers. As a result, blockchain networks will evolve into faster, more scalable, and more secure systems. Quantum Chain aims to lead these technological advancements, realizing next-generation blockchain performance improvements powered by quantum computing.

1. Revolutionary Improvement in Blockchain Performance.

Quantum computers, based on the principles of superposition and entanglement in quantum mechanics, can process data exponentially faster than classical computers. Although their parallel processing capabilities are currently constrained by the limited number of qubits, they are sufficient to meet the requirements of early-stage blockchain networks.

Parallel Validation: Quantum computers can validate multiple transactions simultaneously, maximizing network processing speed.

Efficient Consensus Formation: By optimizing the data validation process, quantum computers reduce consensus formation time and ensure stable network operation, even in high-transaction environments.

Exponential Computational Power: As the number of qubits increases, the parallel computational capabilities of quantum computers grow exponentially. For instance, increasing qubits from 50 to 100 results in a dramatic rise in the number of states, from 2^50 to 2^100.

Improved Transaction Processing Speed: With a higher number of qubits, quantum computers can validate more transactions simultaneously, significantly enhancing blockchain speed and scalability.

2. Supporting Blockchain Ecosystem Scalability

As blockchain use cases and network participants grow, traditional systems face scalability challenges. Quantum computers offer a powerful solution to address these issues.

Large-Scale Data Processing: Quantum computers can perform complex computations simultaneously, enabling seamless large-scale transaction processing and block validation. also Quantum validation reduces the computational burden on traditional nodes, increasing network efficiency and reducing energy consumption.

3. Strengthening Security

While blockchain security traditionally relies on classical cryptography, advancements in quantum computing pose a growing threat to these methods. However, integrating quantum computers into blockchain validation processes enhances security.

Quantum Encryption and Validation: Quantum computers provide new encryption algorithms and data validation techniques that surpass traditional methods, ensuring the integrity of the network.

Enhanced Network Resilience: Quantum validation nodes reduce network vulnerabilities and strengthen defenses against malicious attacks.

4. Building a Sustainable Blockchain Environment

Quantum computer-powered data validation creates an energy-efficient blockchain environment. Unlike the traditional Proof of Work (PoW) model, quantum computers validate significantly more transactions with fewer resources, contributing to environmental sustainability.

Conclusion

Using quantum computers for data validation in blockchain systems holds immense technological, economic, and environmental significance. It stands as a cornerstone of next-generation blockchain technology, unlocking new possibilities for decentralized networks. With quantum computing, blockchains will evolve intosystems that are more scalable, secure, and efficient than ever before.

03 Quantum Technology for Mainnet Performance

Enhancement1：Bloch Superposition

In quantum mechanics, unlike classical systems, if two states are valid quantum states, any linear combination of those states is also a valid quantum state. This principle is known as quantum superposition, and it forms the foundation of quantum computing.

A general superposition of two quantum states can be expressed as:

$$|\alpha|A\rangle+\beta|B\rangle$$

where α and β are complex probability amplitudes. The probabilities of measuring each state are given by:

$$P(A)=|\alpha|^2,\ P(B)=|\beta|^2$$

These probabilities satisfy the normalization condition:

$$|\alpha|^2+|\beta|^2=1$$

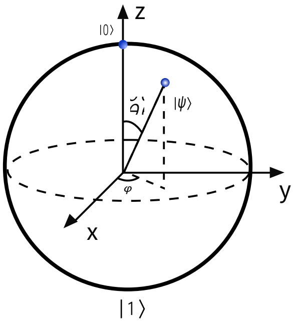
This means that a quantum system can exist in multiple states simultaneously, with the measurement outcome determined probabilistically.

In the context of quantum computing, a qubit—a two-level quantum system—can be represented as:

$$|\psi\rangle=\cos(2\theta)|0\rangle+e^{i\phi}\sin(2\theta)|1\rangle$$

This formulation captures the full range of possible pure states of a qubit, parameterized by angles θ and ϕ.

To provide an intuitive understanding of qubit states, the Bloch sphere, introduced by physicist Felix Bloch, offers a geometric representation of the state space. Each point on the surface of the sphere corresponds to a unique pure state of a qubit, enabling clear visualization of superposition and phase relationships.



The Bloch sphere is particularly useful for understanding how quantum gates and operations transform qubit states. By representing quantum states geometrically, it becomes easier to analyze rotations, phase shifts, and other transformations that occur during quantum computation.

One of the most powerful aspects of quantum computing is the ability of qubits to exist in superposition, effectively representing both 0 and 1 simultaneously. This property enables quantum systems to perform parallel computations, significantly enhancing computational efficiency compared to classical systems.

04 Quantum Technology for Mainnet Performance

Enhancement2 : Quantum Entanglement

One of the fundamental characteristics of quantum computing is quantum entanglement, which enables correlations that cannot be realized in classical systems. Entanglement refers to a phenomenon in which two or more quantum systems cannot be described as independent entities but instead must be treated as a single, unified system.

Mathematically, a composite quantum system is considered separable if it can be expressed as a tensor product of its subsystems:

$$|\psi\rangle=|\psi_A\rangle\otimes|\psi_B\rangle$$

If such a representation is not possible, the system is defined as entangled. This non-separability implies that the states of the subsystems are intrinsically linked and can only be fully described by the state of the entire system.

In an entangled system, the state of one qubit is inherently correlated with the state of another. As a result, operations or measurements performed on one part of the system directly affect the overall state. This behavior represents a form of correlation that goes beyond classical probabilistic relationships and is unique to quantum systems.

A canonical example of entangled states is given by the Bell states, which represent maximally entangled two-qubit systems:

$$|\Phi^+\rangle = \frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$$

$$|\Phi^-\rangle = \frac{1}{\sqrt{2}}(|00\rangle - |11\rangle)$$

$$|\Psi^+\rangle = \frac{1}{\sqrt{2}}(|01\rangle + |10\rangle)$$

$$|\Psi^-\rangle = \frac{1}{\sqrt{2}}(|01\rangle - |10\rangle)$$

These states cannot be factorized into tensor products of individual qubit states, demonstrating maximal entanglement. Measuring one qubit determines the correlated outcome of the other, reflecting the intrinsic nature of quantum correlations.

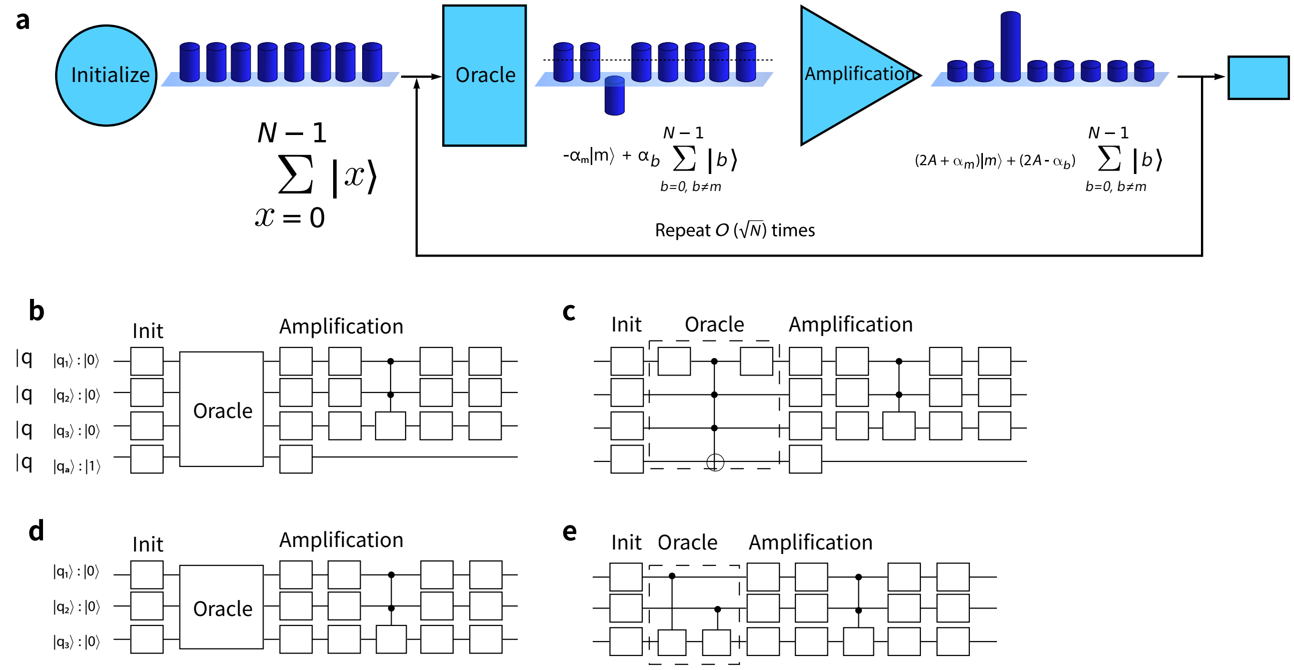
From a computational perspective, entanglement enables efficient representation and manipulation of high-dimensional state spaces through strong correlations between qubits. When multiple qubits are entangled, the system behaves as a single entity, allowing complex operations to be processed more efficiently.

04-1 Shor's Algorithm

This algorithm is a quantum algorithm that efficiently performs the factorization of large numbers, a task that would take classical computers billions of years to complete, but can be done by a quantum computer in just a few minutes. By maintaining a strong correlation between qubits through entanglement, the algorithm maximizes its efficiency.

04-2 Grover's Algorithm

This algorithm is a quantum algorithm that efficiently performs the factorization of large numbers, a task that would take classical computers billions of years to complete, but can be done by a quantum computer in just a few minutes. By maintaining a strong correlation between qubits through entanglement, the algorithm maximizes its efficiency.


a
Initialize
$\sum_{x=0}^{N-1} |x\rangle$
Oracle
$-\alpha_m|m\rangle + \alpha_b \sum_{b=0,\, b\neq m}^{N-1} |b\rangle$
Amplification
$(2A + \alpha_m)|m\rangle + (2A - \alpha_b) \sum_{b=0,\, b\neq m}^{N-1} |b\rangle$
Repeat $O(\sqrt{N})$ times
b
Init
Amplification
Oracle
|q
|q
|q
|q
$|q_1\rangle : |0\rangle$
$|q_2\rangle : |0\rangle$
$|q_3\rangle : |0\rangle$
$|q_a\rangle : |1\rangle$
c
Init
Oracle
Amplification
d
Init
Amplification
Oracle
$|q_1\rangle : |0\rangle$
$|q_2\rangle : |0\rangle$
$|q_3\rangle : |0\rangle$
e
Init
Oracle
Amplification

Grover's algorithm is designed to solve the problem of searching for a specific item in a database, performing the task at a much faster rate than classical methods. It achieves this by allowing parallel exploration of the state space during the search process, thereby increasing the search speed.

In a quantum computer, operations are carried out through quantum gates. Quantum gates are similar toclassical logic gates but can maintain and manipulate the superposition and entanglement states of qubits.

For example, the CNOT gate (Controlled NOT gate) is used to create entanglement between two qubits or to manipulate entangled qubits. Various quantum gates, including the CNOT gate, perform complex quantum operations by entangling qubits or manipulating entangled qubits. Through qubits, quantum computers demonstrate computational capabilities that classical computers cannot match.

05 Why a Quantum Mainnet? The Technological Foundation of a Quantum Mainnet

This article discloses the technical design of Quantum Chain, a cryptocurrency that supports a token ecosystem and a decentralized application infrastructure that can perform significant computing operations using quantum superposition and entanglement effects. It provides a decentralized computing infrastructure that enables mutual data exchange between various digital ecosystems on a proprietary blockchain platform, giving mining rights to infrastructure providers and founders who act as verifiers within the network, and a mainnet designed to allow a variety of applications to interact.

Blockchain systems involve two types of participants: users who issue transactions and users who approve transactions. In a simplified environment, the system's design can create inevitable discrimination against certain participants, which in turn generates another conflict that consumes resources for conflict resolution among all elements. These conflicts often arise from the lack of sufficient computing resources. The issues mentioned earlier justify the exploration of solutions that are fundamentally different from the blockchain technology underlying Bitcoin and several other cryptocurrencies. Over the past six years, the rise and success of Bitcoin have demonstrated that blockchain technology holds real value. However, this technology has several drawbacks that prevent it from being used as a universal platform for cryptocurrencies worldwide. Key issues include the performance of the mainnet, whether the encryption methods remain secure in an era where quantum computers are becoming mainstream, and whether it possesses adequate scalability.

The two main issues with blockchain systems are performance degradation and security threats. The scalability problem of blockchain is one of the critical challenges that this technology must address to achieve widespread global adoption. Current blockchain networks experience a rapid decline in throughput when transaction volumes surge, significantly impacting the overall performance of the network. These performance issues pose obstacles to the establishment of blockchain as a global financial and commerce system. Therefore, the future of blockchain technology needs to be redesigned while considering the following factors.

1. Quantum-resistant Cryptography

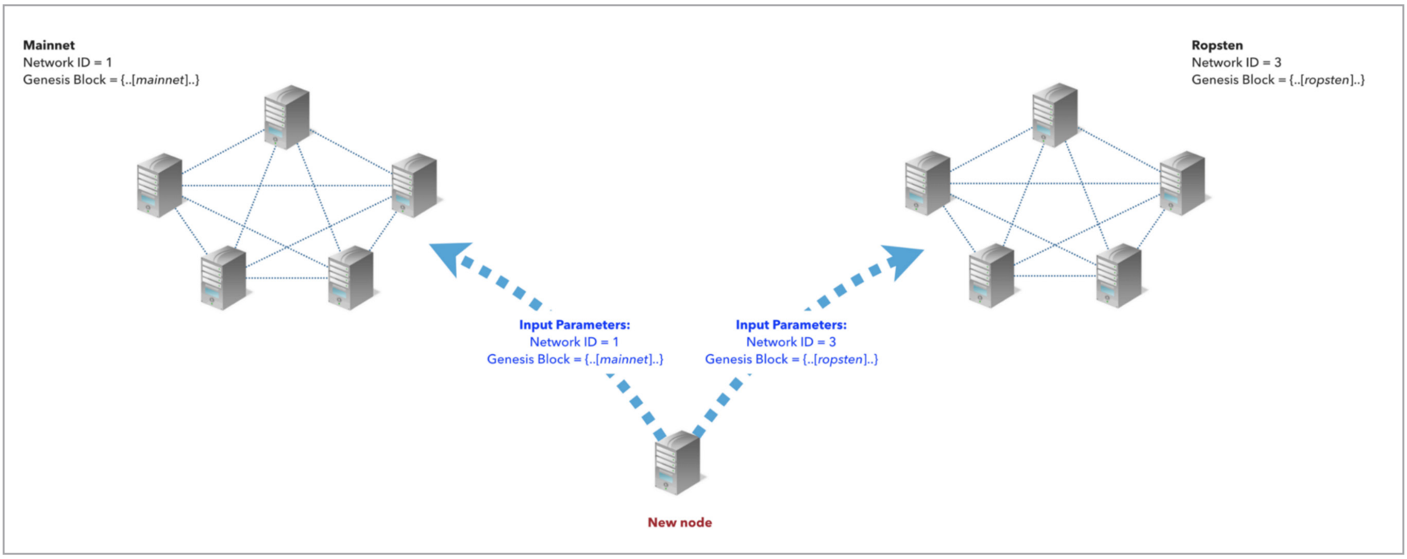
The development of new cryptographic algorithms that can withstand attacks from quantum computers is essential. This will help maintain the security of blockchain networks and establish a foundation to respond to future technological advancements.

2. Scalability

It is necessary to improve the structure of the blockchain to allow the network to process more transactions quickly. This can be achieved through various technical approaches, such as sharding and off-chain solutions.

3. Energy Efficiency

Current blockchain networks, particularly the Bitcoin network, consume a massive amount of energy. This has been identified as a factor threatening environmental sustainability. Therefore, the development of consensus algorithms that can enhance energy efficiency is crucial.


Mainnet
Network ID = 1
Genesis Block = {..[mainnet]..}
Ropsten
Network ID = 3
Genesis Block = {..[ropsten]..}
Input Parameters:
Network ID = 1
Genesis Block = {..[mainnet]..}
Input Parameters:
Network ID = 3
Genesis Block = {..[ropsten]..}
New node

4. Governance Model

There is a need for a more efficient and fair governance model to resolve conflicts within the blockchain community and to determine the direction of the network's development. Although blockchain operates as a decentralized system, transparency and trust must be ensured in the coordination of opinions and decision-making processes among participants.

At the same time, the rapid advancement of quantum computing introduces new threats to existing cryptographic systems.Most encryption techniques currently in use are designed for classical computing environments and cannot guarantee security in a future where quantum computers become widespread. In particular, widely used algorithms such as RSA and Elliptic Curve Cryptography are vulnerable to quantum-based attacks, posing a critical risk to the fundamental security of blockchain systems.

To address these challenges, blockchain technology must evolve into a future-oriented infrastructure that ensures both stability and scalability as a financial asset within the global economy. This evolution requires not only improvements in governance but also the integration of next-generation cryptographic and computational technologies.

The proposed system is designed to overcome the limitations of existing blockchain architectures by enhancing both scalability and security, while establishing a more robust and flexible network environment. In particular, it leverages advancements in quantum computing to optimize block generation speed and improve the efficiency of smart contract execution, enabling faster and more reliable processing of complex computations.

By utilizing the parallel processing capabilities and entanglement properties inherent in quantum computing, the system aims to deliver significantly improved performance compared to conventional blockchain networks, while maintaining a high level of security. Ultimately, it seeks to lay the foundation for next-generation blockchain technology that is resilient, scalable, and prepared for the quantum era.

06 Consensus Algorithm : Quantum Random Sampling (QRS)

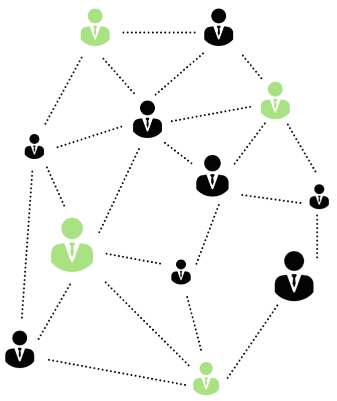
It is a widely proven fact that achieving complete safety (known as finality in the blockchain field) and liveness is impossible. This is the challenge posed by the FLP Impossibility theorem. Safety means that "if consensus has been reached among nodes, any node reviewing the consensus data will find the same value." Liveness signifies that "if there are no issues with the transaction data (transaction or block in the blockchain), consensus will be reached as much as possible within the environment." As the structures of safety and liveness are reinforced, the network consensus algorithm becomes less practical. Therefore, the Practical Byzantine Fault Tolerance (PBFT) algorithm secures safety from a minimal commercialization perspective while allowing for some inefficiency in liveness, enabling consensus to be achieved in various network environments.

Even if there are some nodes that persist in malicious decision-making, the PBFT algorithm ensures the reliability of the consensus reached within the network. Based on this PBFT, we designed the mainnet by adjusting the number of validator nodes to establish a stable consensus method and increase the speed of transactions. The delegated proof-of-stake system can process blockchain transactions more quickly than other consensus algorithms. The proof-of-stake method is overwhelmingly faster than the proof-of-work method and has the potential for broader applications.

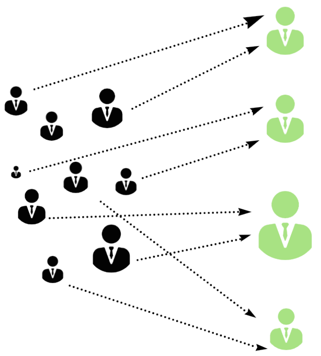
Introducing QRS, a result of this exploration: Quantum Random Sampling leverages the unique random sampling capabilities of quantum computers to select validators in a fair and unpredictable manner within the blockchain network, forming an innovative consensus algorithm that is efficient and secure. QRS maximizes block generation and transaction validation by fully utilizing the parallel processing capabilities of quantum computing while focusing on enhancing the security of the network.

1. Network Initialization

The network implemented with the QRS algorithm is designed based on quantum-resistant encryption technology. Each node (participant) is assigned a unique Quantum Key Pair generated by a quantum computer when joining the network. This key pair plays a crucial role in transaction signing, verification, and the consensus process.

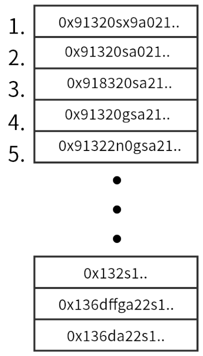


Nodes express Interest in becoming a witness and begin lobbying. making positive contributions to the network and engaging the community.



People in the network allocate their tokens as votes for witnesses

The more tokens they have. the higher their voting weight - hence proof of stake



We end up with a ranking of nodes with the most votes (# tokens allocated to them).

The top N of these will become members of the elected witness panel. N depends on the network.

2. Random Sampling Process

Whenever a block is generated, the QRS algorithm randomly selects a small number of nodes as validators within the network. This process is carried out as follows.

a. Quantum Sampling

Quantum computers generate random numbers based on the collective states of all nodes within the network. These values are utilized for node selection, and due to the inherent randomness of quantum computing, the process remains both unpredictable and fair.

b. Validator Selection

Sampling occurs through the generated random numbers, and the selected nodes participate as validators in transaction verification and block generation. This process is conducted fairly for all nodes in the network, and the unpredictability enhances the security of the network.

3. Transaction Verification and Consensus Formation

The selected validators use a quantum computer to verify transactions. This process is referred to as Proof of Replication (PoR), a concept originally introduced in Filecoin, which proves that data is stored at a specific location. Solana utilizes this concept to verify that data has indeed been stored. Proof of Replication Streaming is a technique used in the Solana blockchain to efficiently handle data storage and verification. This technology focuses on ensuring data integrity within the network while optimizing storage space and reducing resource burdens among nodes. The Quantum Chain incorporates parts of this algorithm to operate as a more robust core logic.

a. Proof of Replication (PoRep)

PoRep is a concept originally introduced in Filecoin, which proves that data is stored at a specific location. Solana uses this concept to verify that data has actually been stored.

b. Streaming Method

Subsequently, Solana introduced a streaming method to make the PoRep verification process more efficient. Data is encrypted, and the encrypted data is hashed, followed by random sampling to verify that the data is correctly stored at a specific point in time. This method is designed to handle large volumes of data while increasing verification speed.

c. Signature Verification

The validity of the transaction's signature is verified through the QRS algorithm. Balance verification and double-spending prevention: It checks whether the sender's balance is sufficient and verifies that the transaction has not been used twice.

d. Consensus Formation

Validators transmit the verification results to the network as messages, and consensus is formed when a majority of validators reach the same conclusion through the Quantum Majority algorithm.

4. Block Generation and Propagation

Once consensus is reached, the verified block is added to the blockchain and propagated throughout the network. In this process, the validators who generated the block receive rewards according to the network's incentive structure.

5. Security and Efficiency

The QRS algorithm maximizes network security by selecting validators in an unpredictable manner through the powerful random sampling capabilities of quantum computers. Communication is protected through quantum-resistant encryption, providing security suitable for the era of quantum computing. Additionally, parallel processing allows for more efficient transaction verification and block generation.

07 Quantum Chain Distribution

The total issuance of Quantum Chain is initially set at 3.5 billion tokens. Out of this amount, 500 million tokens will be permanently removed from the unissued supply and will not be minted. As a result, the final total supply will be adjusted to 3.0 billion tokens. This structure is designed to enhance token scarcity and support long-term value stability.

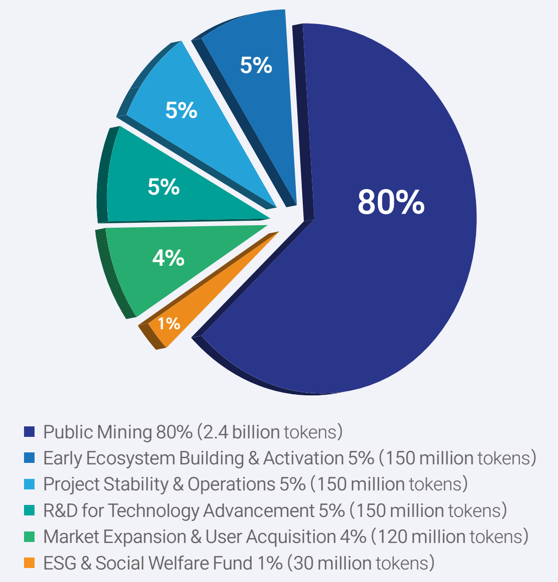
The final supply of 3.0 billion tokens will be allocated to ensure fair distribution, sustainable ecosystem growth, and stable network operation as follows.

A majority portion, 80% (2.4 billion tokens), will be distributed through public mining, enabling decentralized participation and fair access for network users.

To support the initial ecosystem development and activation, 5% (150 million tokens) will be allocated for partnerships, developer incentives, and the expansion of decentralized applications (dApps).

5% (150 million tokens) will be allocated to the foundation to ensure stable governance and long-term strategic direction of the project.

Allocation based on the final supply of 3.0 billion tokens



Another 5% (150 million tokens) will be dedicated to research and development (R&D), focusing on advancements in quantum-resistant cryptography and blockchain infrastructure.

For global expansion and user acquisition, 4% (120 million tokens) will be allocated to marketing activities, including exchange listings and ecosystem promotion.

Finally, 1% (30 million tokens) will be allocated to ESG and social welfare initiatives, reflecting Quantum Chain’s commitment to sustainability and social responsibility.

This issuance and distribution model aligns with the core principles of token economics while ensuring transparency, fairness, and long-term scalability of the network.

08 DeFi and Quantum Superposition Token Swap System

DeFi has led the dApp revolution since the summer of 2020 and continues to be the most dominant force in terms of held value. In November 2021, the total value locked in DeFi across all blockchains exceeded 204billion. The top 10 DeFi protocols achieved a10–fold expansion with an annual growth rate of 1,700%, 2.6 billion, and the cumulative revenue of the top 10 major protocols reached $40 million in daily revenue for a Apps.

This represents an increase of nearly 30 times compared to 2020. The dApp industry showed significant signs of organic growth in 2021. At the time of writing, over 2.7 million unique active wallets (UAW) connected daily to blockchain dApps hosted on more than 30 blockchain protocols tracked by DappRadar. The number of UAW interacting with dApps increased by 592% compared to 2020. The growth has been steady and sustained.

To concretize the value of DeFi and provide liquidity, a new solution is proposed. This swap is named Quantum Superposition Swap. The Quantum Superposition Swap is a solution that meets demand based on probability when effective demand arises on the supply and demand curve, securing the liquidity of assets by sharing incentives. It overlays asset data from each blockchain and waits in a superposition state where transactions may or may not occur until a transaction takes place. In this state, it generates trades in the form of auctions and creates a pool of assets in a superposition state at the point where demand exceeds supply, adjusting the probabilistic supply rate to be close to 1 over a period. When the probabilistic supply rate reaches 1, the demander acquires the asset, and the providers engage in incentive trading of the frozen bid amount as soon as it becomes available from the pool. Of course, not all assets in the virtual world are traded in the SWAP. Only those from virtual worlds that can guarantee sufficient trust can deposit assets to prove their "trustworthiness." Initially, the foundation will be responsible for measuring trustworthiness based on criteria, and by the time the beta version is released, it will be refined through community feedback with quantifiable standards.

09 On-chain Data Exchange and Multi-chain Integration on the Mainnet

Multichain is a technology that allows multiple blockchains to interact within a trusted network environment. There are two sophisticated models of multichain. First, there is the digital transaction exchange model, which simply facilitates the interaction of specific transactions on the blockchain. Second, it involves a method of exchanging data by integrating the stored block data and processes within the blockchain. Quantum Chain is convinced that both blockchain interaction technologies are essential for building a trustworthy data-driven ecosystem. The overview is as follows.

Like all other blockchain-based virtual worlds, Quantum Chain utilizes the characteristic of blockchain to record all activities occurring on the network, thereby creating a reliable virtual world. The comprehensive record-keeping and inherent security of blockchain ensure the safety of the virtual world against both internal misconduct and external attacks. Assets in this trustworthy virtual world should not become exclusive privileges that only a few can monopolize. To connect the world in a virtual computing space, it must be an open world that is more accessible, available to everyone, and capable of infinite expansion.

Quantum Chain addresses this by introducing multichain technology. With multiple chains operating simultaneously, security is further enhanced, and Quantum Chain provides interoperability among various chains and the virtual worlds built upon them. As a result, Quantum Chain will serve as a bridge between reality and a trustworthy virtual world, functioning as a decentralized protocol that guarantees value based on real-world assets. It will act as a standard and benchmark for the value of the virtual world and, furthermore, will serve as a connecting point for virtual worlds based on multiple ecosystems. The simultaneous operation of multiple chains strengthens security, while Quantum Chain facilitates interoperability among these chains and the virtual worlds above them.

10 Quantum Chain Project Roadmap

From the third quarter of 2024, the Quantum Chain project will begin to implement key stages in order to establish an innovative blockchain ecosystem.

1. Initial Phase (Q3 2024 - Q4 2024)

From the third quarter of 2024, the Quantum Chain project will begin to implement key stages in order to establish an innovative blockchain ecosystem.

Primary Quantum Epoch Launch

In the third quarter of 2024, we will initiate the first major development stage of the Quantum Chain network through its core theme, "Primary Quantum Epoch." During this phase, we will activate the first quantum computer

Completion of Project Concept and Design

We will finalize the core concept of Quantum Chain and complete the technical design and token economics model. This will clarify the project's vision and goals.

Whitepaper Release

We will publish a whitepaper in Q3 2024 that details the vision, technical structure, token distribution, and economic model of Quantum Chain. This will publicly disclose the project's roadmap and objectives.

Mainnet Beta Launch

In the fourth quarter of 2024, we will launch the mainnet beta, allowing us to test the fundamental features of Quantum Chain and validate the network's stability and performance. This will enable us to identify and address any technical issues prior to the official mainnet launch.

2. Mainnet Launch and Expansion Phase (Q1 2025 - Q3 2025)

Official Mainnet Launch

In the second quarter of 2025, we will officially launch the Quantum Chain mainnet. This mainnet will serve as a new blockchain network that utilizes quantum computing to perform validator roles, providing an infrastructure that offers high performance and security simultaneously.

Integration of Quantum-Resistant Algorithms

Alongside the mainnet launch, we will integrate quantum-resistant algorithms into the network to address security threats posed by quantum computers, thereby enhancing the integrity and safety of the network.

Ecosystem Expansion

We will initiate a developer support program to assist in the development and operation of various dApps and smart contracts on the Quantum Chain network. This will expand the practical usability of the network and invigorate the ecosystem.

Multichain Integration and Swap Function Implementation

Starting in the second quarter of 2025, Quantum Chain will enhance interoperability with various blockchai networks to support a multichain environment. This will enable asset swaps with other blockchain networks, allowing users to seamlessly move assets across different chains. The swap functionality on Quantum Chain will provide a platform for rapid and secure asset exchanges.

3. Global Expansion and Community Enhancement (Q4 2025 - Beyond)

Expansion of Global User Base

Starting in the fourth quarter of 2025, we will launch a global marketing campaign to increase awareness of Quantum Chain in various regions and build a global ecosystem.

Introduction of Community Governance

Alongside the mainnet launch, we will integrate quantum-resistant algorithms into the network to address security threats posed by quantum computers, thereby enhancing the integrity and safety of the network.

Ecosystem Expansion

Alongside the mainnet launch, we will expand the ecosystem by establishing diverse partnerships and increasing the participation of decentralized applications (bApps) and services. We will provide support programs and infrastructure to enable developers and enterprises to build applications on Quantum Chain, while promoting expansion into various sectors such as DeFi, NFTs, and data services. Through these efforts, we aim to enhance network utilization and focus on building a sustainable ecosystem.

Ongoing Technical Upgrades

We will continuously improve performance and security through regular network upgrades that reflect advancements in quantum computing and blockchain technology.

11 Potential Attacks and Threats to the Mainnet

In a blockchain mainnet that uses quantum computing as validators, various attack vectors may exist. Some of these issues stem from the fundamental characteristics of blockchain technology, with critical concerns arising from phenomena such as the Tragedy of the Commons and Eclipse Attacks. These attacks can exploit structural weaknesses in the network or pose potential risks that lead to inefficient use of resources.

1. Tragedy of the Commons

The Tragedy of the Commons refers to a situation in a blockchain network where resources shared by nodes (e.g., network bandwidth, computing power, etc.) are overused, leading to a decline in overall network performance or resource depletion. This issue particularly arises when network participants seek to maximize their own benefits. While each node may act rationally on an individual basis, collectively, this can result in the exhaustion of network resources and a decrease in overall system efficiency.

For example, if quantum computer validators excessively utilize resources to maximize their verification capabilities while generating blocks, there is a risk of depleting the total resources of the network. Such resource consumption can negatively impact the entire network, potentially leading to transaction delays, increased verification costs, and even instability within the network.

2. Eclipse Attack

Eclipse Attack is an attack that isolates specific nodes within the network by blocking or controlling the connections of all peer nodes associated with that node. This attack can lead to the isolated node making incorrect decisions based on false information, negatively impacting the network's consensus process.

For example, a quantum computer validator may be isolated from the network, or a malicious actor may isolate such nodes, causing them to validate incorrect transactions or generate inaccurate blocks. This can undermine the consistency of the network and pose serious risks to the overall integrity of the blockchain.

3. Excessive Staking Concentration

In a blockchain network, a situation where specific nodes monopolize the validator role through excessive staking can undermine the decentralization of the network and grant excessive power to a small number of nodes.
This can lead to governance attacks or security vulnerabilities.

For example, if certain validators maximize their staking using quantum computers and monopolize the majority of the network's validation, a few participants may gain control over the entire network, compromising the fairness and principles of decentralization. This can also increase the risk of a 51% attack.

4. Resource Exhaustion Attacka

Attackers can deplete network resources by sending excessive transactions or executing numerous smart contracts that require complex computations, thereby exhausting the network's processing capacity. Such attacks can slow down the network's processing speed, delaying the handling of legitimate transactions and ultimately threatening the stability of the network.

For example, a scenario could involve exploiting the computational power of quantum computers to continuously request complex operations from the network or generating large amounts of transaction spam to paralyze the network. This not only reduces the efficiency of the blockchain but can also severely degrade the user experience.

5. Staking Influence Attack

In a Proof of Stake (PoS) system, if certain nodes hold excessive stakes, they can exert disproportionate influence over the network's consensus process. This can create a situation where a specific group is able to dictate network policies.

For example, if certain validators concentrate their stakes within the network, they could leverage the computational power of quantum computers to exert excessive influence in the consensus process. This can negatively impact the democratic decision-making process of the network and pose risks of centralization.

12 Mainnet Network Layer

1. Network Layer

The network layer is responsible for communication among participating nodes in the blockchain.
This layer propagates transactions and blocks throughout the network and manages message delivery between nodes.
The network layer consists of the following elements:

P2P Network

Composed of a decentralized peer-to-peer (P2P) network where all nodes hold equal status and exchange transactions and blocks with each other.

Node Discovery and Connection

Includes mechanisms for discovering new nodes within the network and maintaining connections with existing nodes.

Network Protoco

Defines communication protocols for the propagation of transactions and blocks, validation requests, and consensus information exchange.

2. Consensus Layer

The consensus layer is where the core consensus algorithm of the blockchain is executed. In this layer, the validity of transactions is verified, and a consensus process is carried out to add new blocks to the network. The consensus layer of this mainnet is based on the Quantum Random Sampling (QRS) algorithm, with the following key components.

Validator Nodes

Nodes randomly selected by the QRS algorithm validate transactions and generate blocks.

Quantum Sampling

Utilizes the random sampling capabilities of quantum computers to select validators, resulting in fair and unpredictable consensus.

Quantum-Resistant Majority Voting

Consensus is formed based on the results of multiple validators, applying the principle of majority voting to finalize the consensus when it is reached.

3. Data Storage Layer

The data storage layer is responsible for securely storing all transaction and block data within the blockchain network. This layer is designed to ensure the integrity, accessibility, and scalability of the data. The main components include.

Distributed Ledger

A database of the blockchain that is distributed across all nodes, with each node holding the complete blockchain data:

Data Structure

Utilizes cryptographic data structures such as Merkle Trees to maintain the connectivity between blocks and ensure the integrity of the data.

Snapshots

Periodically saves the state of the network as snapshots to reduce data recovery and verification times.

4. Application Layer

The application layer supports smart contracts and decentralized applications (dApps) that operate on the blockchain network. This layer provides various interfaces and tools to enable developers and users to leverage the functionalities of the blockchain.

Smart Contract Engine

Supports the execution of smart contracts and efficiently handles complex computations utilizing quantum computers.

API and SDK

Provides interfaces that assist developers in building dApps on the blockchain and interacting with the blockchain.

User Interface (UI)

Includes front-end interfaces that help end users access and use blockchain applications.

5. Security Layer

The security layer is responsible for ensuring the security of data and communications across all layers of the network. In response to new security threats posed by the emergence of quantum computers, this layer implements various security mechanisms, including quantum-resistant encryption technologies.

Quantum-Resistant Encryption

Utilizes encryption techniques capable of withstanding attacks from quantum computers to protect transaction signatures and communications between nodes.

Access Control

Manages permissions and access controls to prevent unauthorized access to the network.

Intrusion Detection System (IDS)

Monitors for abnormal activities on the network and detects potential attacks in real-time.

System Operation Principles

The system architecture of this blockchain mainnet is designed to form a stable and efficient network through the organic interactionof its layered components.The network layer propagates transactions and blocks, the consensus layer validates them, and the data storage layer securely records them.The application layer provides various services based on this foundation, while the security layer ensures the protection of data across all layers.

In addition, by leveraging the powerful computational capabilities of quantum computing, the system places emphasis on maximizing overall processing speed, security, and scalability.

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