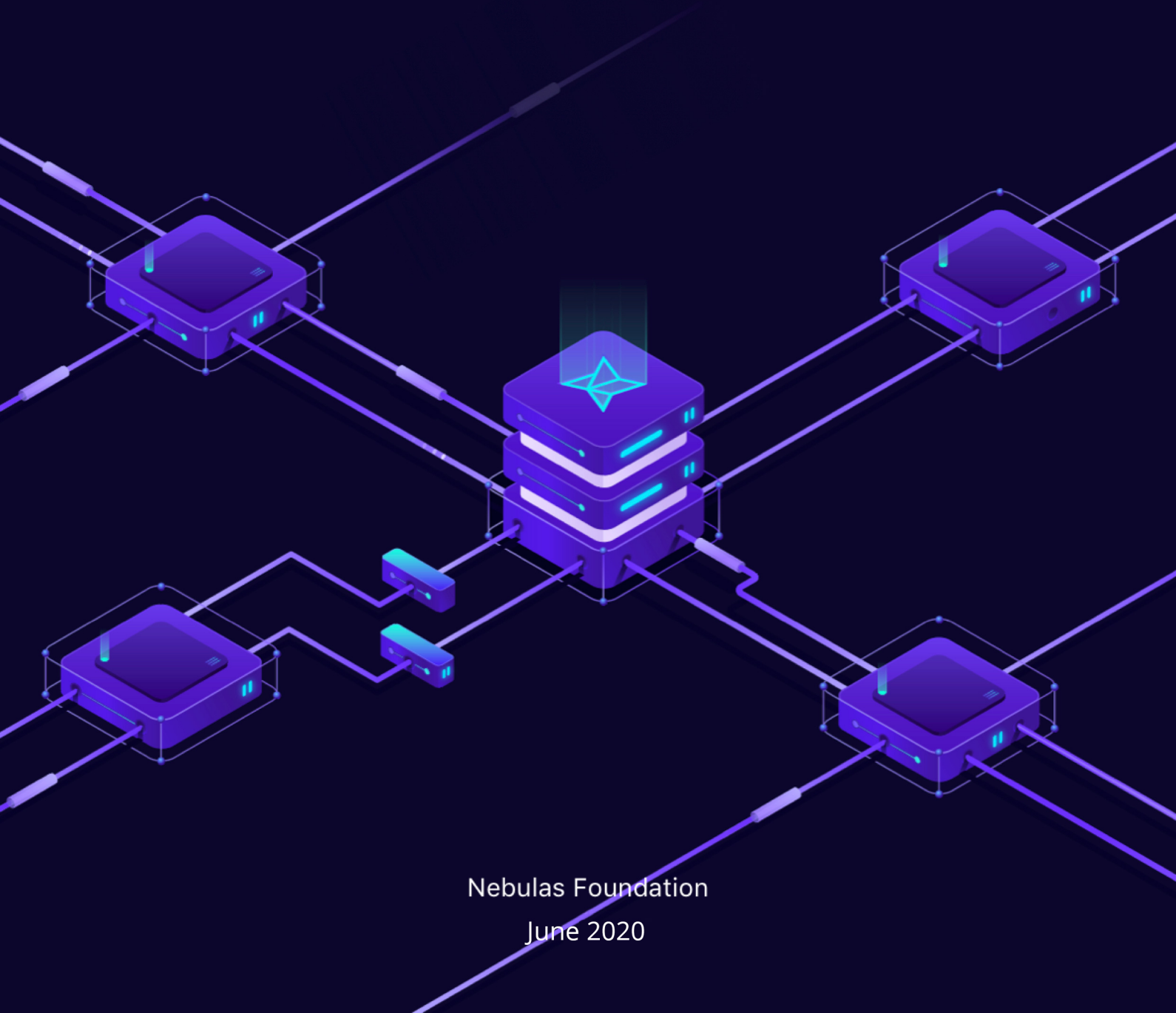
NEBULAS

Nebulas PoD Node Decentralization Strategy

Based on the Proof of Devotion (PoD) Mechanism

V 1.0.2



Nebulas Foundation

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Content

Overview

Nebulas began it journey with the vision of "Let everyone get values from decentralized collaboration fairly."[1] With the continued evolution of the “Autonomous Metanet,”[2] Nebulas is proceeding to it’s ultimate goal.

At the core of Nebulas’ PoD Node Decentralization Strategy is the Proof of Devotion (PoD) [3] Mechanism. This idea behind Proof of Devotion is to provide a measurable value of all users based on the size of their contribution to the ecosystem which includes pledging, consensus and governance mechanisms. With PoD, we plan to not just decentralize Nebulas’ blockchain nodes but to also decentralize community governance via the formation of a representative system and government committees.

Nebulas is building a new Decentralized Autonomous Organization (DAO)[4] for complex data networks that will fully embrace community, decentralization and autonomy on a contribution measured basis.

1. Proof of Devotion (PoD) Mechanism Overview

1.1 Design Objectives

In order to build a sustainable and beneficial public chain, it is necessary to take into account both the speed and irreversibility of the consensus mechanism as well as the fairness of governance.

At present, we face new application scenarios including simple data interactions to complex, multi-level, on-chain functions. This diverse environment is spawning the creation of new user roles as well as significantly increasing the complexity of the system. Communication scenarios have evolved from in person collaboration to collaboration that ecompasess the world. The goal of collaboration has also changed with the end results going from the physical to the virtual world. This results in time spans for collaborative projects becoming longer and more flexible.[5]

To ensure a fair governance system within these new scenarios, a new approach to collaboration is required. Traditional centralized governance cannot cope with these new and complex scenarios that we face daily in our technologically evolving world. In this new world filled with complex data interaction patterns and expanding user roles, centralized single evaluation options are difficult to be adaptable and comprehensive leading to considerable limitations.

Existing decentralized collaboration methods do not take into account the new distribution of benefits caused by the existence of expanded user roles. As a result, there is an uneven distribution of benefits leading to slow development and eventually, an unsustainable ecosystem.

We must protect the interests of all community members so that value comes from the depth of Nebulas' ecosystem which in turn follows our core beliefs. Under the premise of ensuring efficiency and irreversibility first, we have designed PoD to pursue fairness from the perspective of contribution and to protect the interests of the community.

1.2 Composition

Nebulas' Proof of Devotion (PoD) can provide a simple overview of mechanisms built on the basis and magnitude of community contributions which include both consensus mechanisms and governance mechanisms. See Figure 1.1.

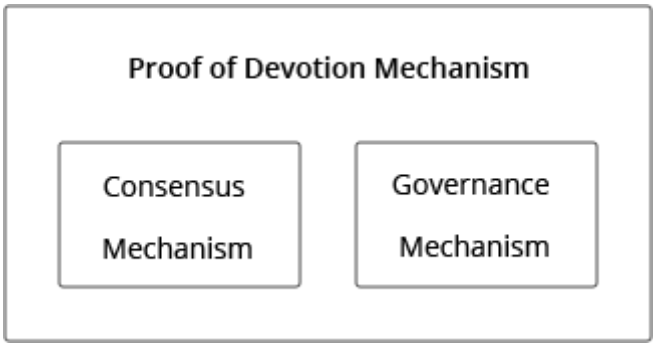

Figure 1.1 PoD Composition

The composition of the PoD mechanism will involve two executive committees split into consensus and governance.

- The consensus mechanism shall be implemented by the Consensus Committee. The consensus committee is selected from all the available nodes via a comprehensive ranking algorithm.
- The governance mechanism shall be implemented by the Governance Committee. The governance committee is composed of the most dedicated contributors of the Consensus Committee.

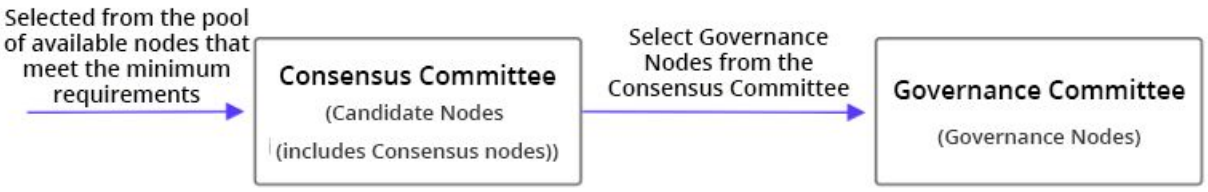

Figure 1.2 PoD Executive Committee

1.3 Incentive Allocation

Since the launch of the Nebulas mainnet on March 31, 2018, DPoS[6] has been used as the interim consensus mechanism until the release of PoD. The DPoS consensus mechanism generates 8,219.1744 NAS in revenue per day; generating 2,999,941 NAS per year.

This collected revenue will be used exclusively for the Nebulas PoD Node Decentralization Strategy.

The incentive ratio of the two PoD Executive Committee (consensus and governance) will be about 5:1. Which equates to:

- The total incentive amount for the consensus mechanism per year will be: 2,499,951 NAS
- The total incentive amount for the governance mechanism per year will be: 499,999 NAS

The incentive for the consensus mechanism will be evenly divided by the consensus nodes who have generated blocks during the active polling cycle (selection) of the consensus committee. Any candidate nodes that have not been selected during the polling cycle (selection) will not receive any incentive during this period.

The incentive for the governance mechanism will be evenly divided by the governance nodes who has participated in all voting proposals during the governance cycle. Any governance nodes that do not participate in **ALL** voting proposals during the governance cycle will not receive any governance incentive during this period.

1.4 Contribution Measurement: NAX

The measurement for the weight of contribution to the Nebulas ecosystem is the NAX[7] Smart Asset. As a smart asset, NAX can only be obtained by decentralized staking (dStaking)[8] the NAS asset. As per the *Nebulas NAX White Paper*[9], NAX adopts a dynamic distribution model where the daily total issuance quantity is related to the pledge rate of the entire Nebulas ecosystem; the number of NAX obtained by an address is related to the quantity of NAS pledged and the age/duration of the pledge (the longer, the better), which

can be considered a measure of the contribution of that address to the community and ecosystem. Therefore, NAX can be considered effective proof of those who contribute to the Nebulas ecosystem.

The Go Nebulas (go.nebulas.io) community collaboration platform will also utilize NAX as an ecosystem contribution incentive to encourage community members to continue to build communities.

2. Consensus Mechanisms

The consensus mechanism utilizes smart contract management which is primarily comprised of node selection rules and the consensus algorithm. This smart contract jointly completes the block generation and ensures the normal operation of the mainnet.

The average block time on the Nebulas mainnet is 15 seconds. During each polling period, the 21 selected consensus nodes take turns generating 10 blocks each. As a result, one polling cycle is 210 blocks which takes about 52.5 minutes. The consensus mechanism execution process during each polling cycle is shown in the following figure:

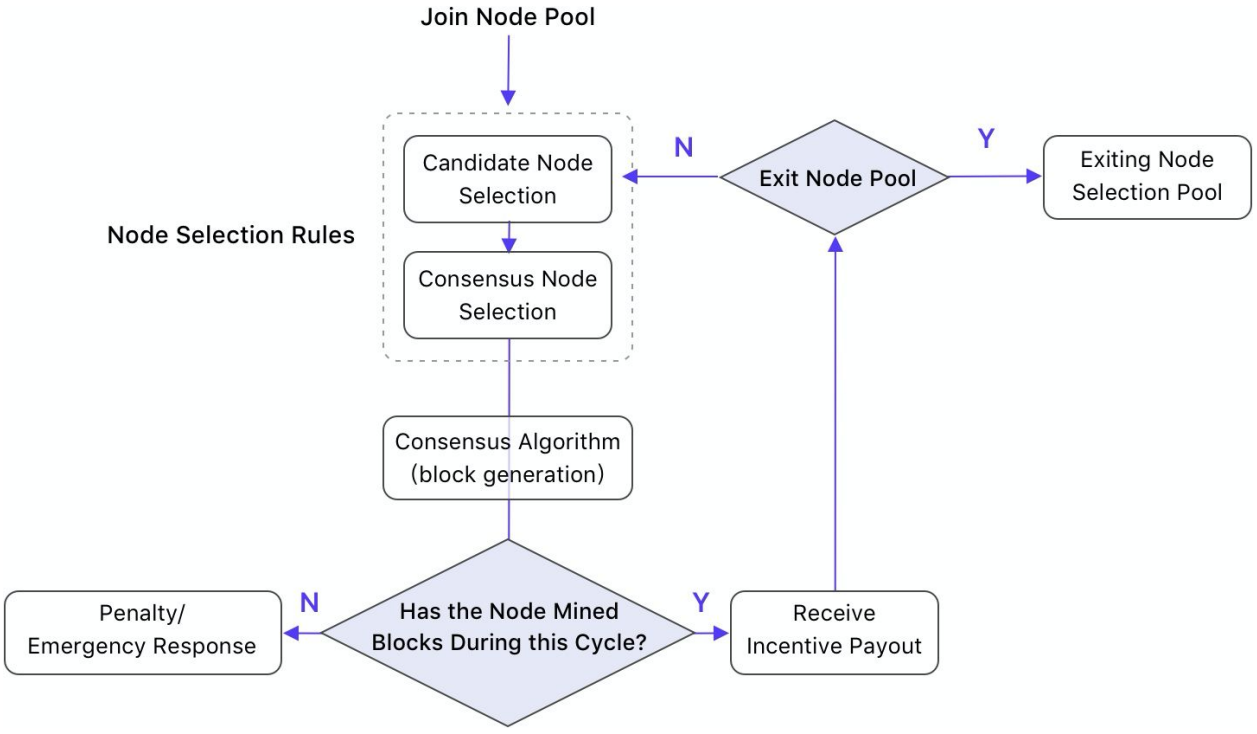

Figure 2.1 The consensus mechanism execution process for each polling cycle

2.1 Minimum Requirements for Node Selection

Any individual or organization can apply to become a consensus node and must meet all of the following eligibility requirements to participate in the candidate selection process:

- The server meets the minimum requirements (see Appendix A - recommended hardware configuration);
- The server is guaranteed to be in operation;
- The node pledge (vote) is not less than 100,000 NAX;
- Pledge of 20,000 NAS as deposit;
- No record of severe level abuse or manipulation on the network (see 2.5.1 penalties)

2.2 Node Selection Rules

The node selection rule consists of two steps:

1. **Candidate node selection:** During each polling cycle, among all nodes that meet the minimum selection requirements, a total of 51 nodes are selected according to the comprehensive candidate node ranking algorithm via smart contract;
2. **Consensus node selection:** During each polling cycle, the algorithm selects 21 consensus nodes which are selected in a consistent method and best represents the user's rights and interests in a group of candidate nodes which is based on the consensus node selection algorithm via smart contract. The consensus nodes are responsible for block generation and can obtain consensus incentives as long as they participate in the process of block generation (online, creating blocks, not manipulating the network, etc…).

The candidate node and the consensus node together constitute the consensus committee. The selection process is shown in the following figure:

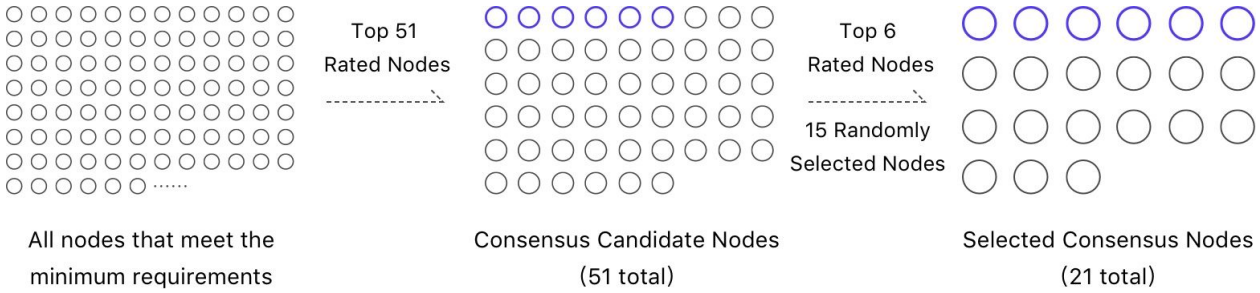

Figure 2.2 Node Selection Process

2.2.1 Candidate Node Comprehensive Ranking Algorithm

Under the premise of meeting the minimum requirements of becoming a candidate node (2.1 Minimum requirements for node selection), all nodes are ranked by the comprehensive candidate node ranking algorithm; the top 51 nodes selected via the ranking algorithm will be selected as candidate nodes.

The candidate node ranking algorithm references two primary factors: NAX poll number $V_{(i)}$ and block stabilization index $S_{(i)}$. The final candidate node ranking index "$R_{(i)}$" is:

$$R_{(i)} = V_{(i)} \times S_{(i)}$$

Assuming that $S_{(i)}$ is the same for multiple nodes and the NAX vote $V_{(i)}$ is also the same for multiple nodes, the first node to reach the required NAX vote $V_{(i)}$ is selected.

2.2.1.1 NAX Votes

Number of NAX votes $V_{(i)}$: All community members and node operators can pledge NAX to further support the activation of a node which helps the node improve their overall ranking.

2.2.1.2 Block Generation Stability Index

Block generation stability index $S_{(i)}$: This rating is determined by the ratio of successful block generation when it's chosen as a consensus node. If this node has not yet had the chance to be a consensus node, the initial value of $S_{(i)}$ is 0.8. During each polling cycle, a candidate node has three possible values:

A. Not participating in block generation;
B. Successful/accepted block generation;
C. Invalid block generation.

A. Not participating in block generation

The $S_{(i+1)}$ of the following cycle of candidate nodes that have not participated in block generation is:

$$S_{(i+1)} = S_{(i)} + 0.01$$

B. Successful block generation

Consensus nodes need to generate 10 blocks per polling cycle (polling cycles consist of 210 blocks). If a node generates 10 blocks successfully during the cycle, the $S_{(i+1)}$ of the next cycle is:

$$S_{(i+1)} = S_{(i)} + 0.1 \ (S<=1)$$

$S_{(i)}$ is gradually increased to the maximum level of 1. In general, functioning nodes with stable block generation will reach the maximum level of $S_{(i)}=1$.

C. Invalid block generation

If the node generates an invalid block, the $S_{(i+1)}$ of the next cycle is:

$$S_{(i+1)} = S_{(i)} \times (10 - C) / 10$$

Where C is the number of invalid blocks. The larger C, the lower $S_{(i)}$ value. If $S_{(i)}$ falls to the K threshold (K initial value is 0.5), the consensus node cannot be selected as a candidate node for the next 20 polling cycles, as detailed in 2.5.1 Penalties.

2.2.2 Consensus Node Selection Algorithm

Consensus nodes are selected from the 51 candidate nodes that are initially selected during the polling cycle. The selection method is as follows:

1. The top 6 candidate nodes are selected automatically as per their score (detailed above).
2. 14 consensus nodes are selected from the candidate pool containing the remaining 45 candidate nodes according to the following formula:

   $$R_{Consensus} = (R_{(i)} / Sum(R)) \times Random()$$

   The formula explanation is as follows:

   $\mathbf{R_{Consensus}}$: Consensus node ranking index.

$R_{(i)}$：Candidate nodes ranking index. $R_{(i)}$ is the derived score of two primary factors: NAX poll number $V_{(i)}$ and block stabilization index $S_{(i)}$; as a result, $R_{(i)}$ is treated as the community support rate of the node and its contribution of historical block generation.

Sum(R): The sum score of 51 candidate nodes ranking index; as a result, $R_{(i)}$/Sum(R) can be treated as an individual node contribution ratio within the 51 candidate nodes.

Random()：A random probability.

3. The last consensus node, lucky node, will be selected randomly from the 31 candidate nodes that were not selected.

2.3 Consensus Algorithm

The consensus algorithm is based on the well understood and mature DPoS consensus mechanism where the block generation of the following polling cycle is scheduled to be produced by the nodes within the consensus committee; the selected 21 consensus nodes take turns to generate blocks. After the polling cycle is complete, the next selected 21 consensus nodes take turns to generate blocks in the following cycle.

Byzantine fault tolerant BFT[10] operation is used to ensure the consistency and stability of the blockchain and the PoD mechanism.

2.3.1 Block Generation Order

The order of block generation of the 21 consensus nodes is randomly selected via a Verifiable Random Function (VRF[11]) in one polling cycle. The consensus nodes and the order responsible for the block generation remain unchanged during each polling cycle.

2.3.2 Packaging of Generated Blocks

Consensus nodes package transactions that are contained within the transaction cache pool when it is time to generate a new block. The specific methods is as follows:

1. Consensus nodes package blocks strictly according to the predefined order and duration of the polling cycle.
2. Package as many transactions as possible within packing time-frame;
3. Transactions with a higher overall GasPrice (when compared to other pending transactions) will take priority;
4. A non-verifiable transaction is disregarded when it's execution fails.

2.3.3 On-chain Confirmation

The on-chain confirmation for consensus nodes guarantees the consistency and security of the chain as well as penalizing any nodes that may harm the integrity of the blockchain. The Nebulas blockchain utilizes the following rules:

1. The longest subchain is chosen as the optimal chain.
2. The optimal chain is selected according to hash order of previous blocks if the subchains are with the same length.
3. The use of BFT operation across the network for irreversible transactions requires the confirmation from ⅔+1 of consensus nodes within the network;
4. The penalty mechanism should be adopted for attacks such as generating blocks when unexpected and attempting double-spends (see 2.5.1 Penalties).

2.4 Exit Mechanism

Voting for PoD nodes is a fair and free service. All members of the community can withdraw support via NAX for a node or apply to exit the node pool at any time.

2.4.1 Withdrawal of NAX Support for a Node (votes)

All members or organizations within the community may at any time withdraw their support for a community operated node. When support/votes are withdrawn, the node operators' NAX support level is immediately reduced (2.2.1.1 NAX votes, $V_{(i)}$) and will affect their ranking in following rounds of node selection. As stated in the minimum requirements (2.1 Minimum requirements for node selection), if the total amount of NAX support for a node drops under 100,000 NAX, they cannot be selected as a consensus node.

Quantity of votes to withdraw: The voters may choose how much NAX to withdraw for their support. Community members or organizations can only apply to revoke their own NAX.

NAX return time-frame: Once a withdrawal request has been issued, NAX is returned to the voter's original address after 120 polling cycles (approximately 5 days) has passed.

2.4.2 Exiting the Node Pool

All nodes can exit the pool at any time. Once the exit request has been issued, the node will immediately lose its candidacy for following cycles.

Return of NAS security deposit: All NAS deposit required for candidacy is returned in one sum (partial refund is not an option).

NAS security deposit return time-frame: Once the exit request has been issued, the security deposit is returned after 820 polling cycles (approximately 1 month) and will be returned to the original address.

Return of NAX deposit: Any NAX that has been voted/issued for a node which is exiting the pool will be returned to the corresponding address after 120 polling cycles (approximately 5 days).

2.5 Penalties and Emergency Response

2.5.1 Penalties

2.5.1.1 Block Generation Penalties

In order to maintain the security of the PoD system, the corresponding Penalties are carried out according to the situation; the more malicious act of a node, the higher the punishment.

The three block generation penalties for the consensus node are as follows:

Security level	**Damage**	**Examples**	**Punishment**	
			Limits	**Penalty**
low	Causing instability to the network	Intermittent participation in consensus such as failure to generate a block when expected.	Block stability index $S_{(i)}$ (2.2.1.2) decline; if reduced to 0.5 or less, the node cannot participate in the candidate node selection for 20 polling cycles (approximately 1 day).	No penalty
Medium	Causing instability to the network	No blocks generated for an entire cycle.	The node cannot participate in the candidate node selection for 20 polling cycles (approximately 1 day).	Freeze 5% of NAS deposit
Severe	Threat to the security of the system or assets	Multiple blocks generated at the same height or failure to revoke a "bad" block.	Permanent removal from the Governance pool	Freeze all NAS deposit and all NAX for this node (include the votes from community)

Table 2.1: Consensus Mechanism Safety Rating Table

Medium and Severe punishment process:

1. Once a medium and severe penalty occurs, restrictions are automatically executed, and the node will be observed to see if it generates a minimum of one block within 200 polling cycles (approximately 7 days) after the incident.

   a. If the node proceeds to generate at least one block, the penalty will be disregarded.
   b. If there is still no block, it is deemed that the problem has not been resolved, the node will have 1,000 NAS (5% of NAS deposit) frozen.
   c. If after a penalty occurs, the node can also exit the node strategy. Afterward, NAX will be returned to the original address after 120 polling cycles (approximately 5 days) after the successful submission of the node exit application.
2. During the voting phase of the next governance cycle, the governance committee votes to determine whether the node punishment is justified.
   a. If the governance committee votes that the punishment is justified, the NAS that has been frozen will be donated to the Go Nebulas Community Collaboration Fund (See 3.2.2 Community Assets).
   b. If the governance committee votes that the node did not cause intentional harm to the network, the block generation stability index $S_{(i)}$ of the node will be restored to the level prior to the punishment and the NAS will be unfrozen.

See the 3.2.3 Penalties for consensus mechanism and 3.3.3 Processing of voting results of 3.2 Governance scope.

2.5.1.2 Governance Penalties

In addition to the block generation penalties (listed above), when a consensus node is selected as a governance node, the governance node must complete all governance tasks (taking part in votes). If the governance node does not take part in the governance process for two consecutive governance cycles, it cannot be selected for the next 820 polling cycles (approximately one month). See 3.4.1 Individual governance node penalties.

2.5.2 Emergency Response

In the event of an attack on the Nebulas mainnet from a hacker or other unforeseen threats/emergencies and in order to ensure that the network can quickly respond to these attacks and reduce the harm of them, the Nebulas Foundation has reserved emergency

smart contract management methods. The Nebulas Foundation can immediately blacklist the address in question and prohibit transfers from blacklisted addresses.

The entire process is open and transparent. The Nebulas Foundation will thoroughly review the incident and openly accept the supervision from the community.

3. Governance Mechanism

Nebulas' focus on the contribution of different roles to the diverse ecosystem via decentralized collaboration and the utilized governance mechanism is an important portion of PoD mechanism.

The governance mechanisms are a range of tools for community self-governmenance via the organization of community collaboration and management of community assets by the governance committee.

3.1 Governance Committee

The implementation of governance mechanisms is managed by the Governance Committee and is made up of governance nodes.

Governance cycle: One governance cycle will occur every 820 consensus node polling cycles (approximately 1 month).

Governance node selection: Governance nodes are selected from the consensus committee and the selected 51 consensus nodes where the largest number of block generators for the past 820 consensus node polling cycles are eligible to become governance nodes in the governance cycle. If there are equally qualified nodes available to become governance nodes and not enough spaces are left, the node(s) which have achieved the number of generated blocks first will be selected.

3.2 Governance Scope

3.2.1 Community Collaboration

The proposal operation of the Nebulas community is an important part of the continuation of the Autonomous Metanet. All proposals and projects of the Nebulas community are public

information which are displayed and managed via the Go Nebulas collaboration platform (go.nebulas.io). All community members can put forward their own ideas, opinions and suggestions on the future development of the Nebulas via this platform. Ideas and suggestions include but are not limited to[12]:

1. Research and development of the Nebulas mainnet;
2. Community collaboration process optimization, governance recommendations, etc…;
3. Improvement suggestions and bug reports for existing Nebulas community products;
4. Development and maintenance of community eco-products;
5. Community operations and market expansion.

For a proposal to go from idea to implementation, it will go through multiple steps including:

- Proposal establishment;
- Project execution;
- Project acceptance.

Each step needs to be voted for and approved by the Governance Committee. The Governance Committee has three types of voting tasks in each governance cycle:

1. **Proposal establishment voting:** Vote on the proposals submitted from the Nebulas community and decide whether to approve the project and its budget.
2. **Project acceptance voting:** Review and vote on projects that have been established, completed and issue funding.

The Governance Committee process is as follows:

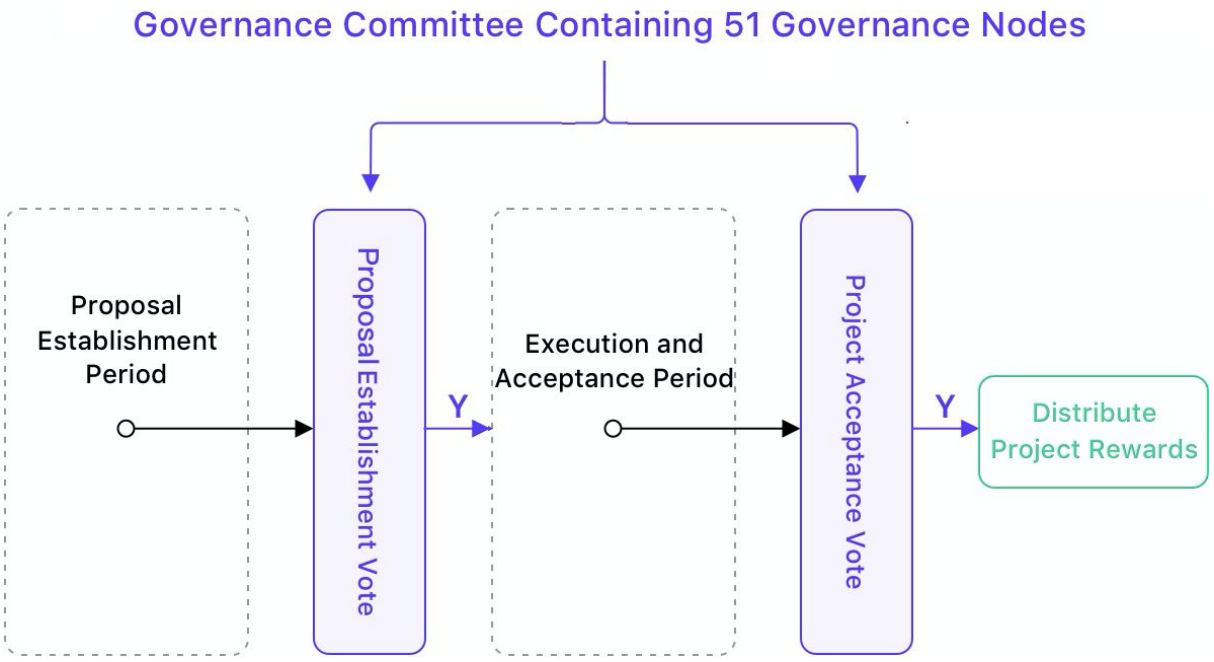

Figure 3.1 Governance Committee Voting Process

Proposal establishment period: All community members are welcome to create and share proposals on Go Nebulas (go.nebulas.io). For projects that are approved, the Nebulas Technical Committee will help to establish the project. All projects are separated into two categories:

1. **No budget required for this project:** For example, proposals that include the discussion of improving existing Nebulas projects. These include suggestions on adjusting the structure of the governance organization and the adjustment of the mainnet parameters. After a proposal is voted on and approved, the relevant person in charge may accelerate the implementation of this proposal.
2. **Proposals that require a budget:** This process is facilitated by the Go Nebulas Operations team, which handles project budgets and fund release. Project creators can submit budgets, project objectives, execution steps and expected duration. Creators can also apply to be the project owner or elect a community member to operate the project. Projects should be submitted in accordance with the standard template available on Go Nebulas.

Project execution and acceptance period: The execution and acceptance period is an internal operational process of Go Nebulas; the governance Committee does not directly participate in this process. The process is divided into three stages:

1. **Set budget period:** The project creator or the Go Nebulas operation team can be set as the project creator. Project creators set the reward for successful completion of the project and members of the community are welcome to participate in projects;
2. **Execution period:** The project creator confirms the project owner/manager. At this point, the project owner begins to execute the project and once progressing and upon completion, submits the project results;
3. **Project Review Period:** Once a project is marked as completed, the project creator and the Go Nebulas Operations Team will review the project and its results. Afterwards, a recommendation on whether the project has been successfully completed or not will be given to the Governance Committee. The committee then decides what further action, if any is required. If none is required, the project will receive its funding as decided in the budget period.

3.2.2 Community Assets

The Governance Committee is responsible for managing the use of the public community assets. Public community assets include:

1. **Use and distribution of the Go Nebulas Community Collaboration Fund:**
   The primary source of this fund is the DPoS revenue generated from Nebulas since the launch of the Nebulas mainnet on March 30, 2018. Some of these assets have been used for programs such as the Nebulas Incentive Program. The remaining assets will be used for the Go Nebulas Community Collaboration Fund after node decentralization.
   Since the maximum amount of NAS issued per governance cycle is capped at no more than $30,000 USDT, the actual use of the governance mechanism within six months of its launch is $180,000 USDT equivalent NAS.
2. **Incentive allocation of the Nebulas PoD Node decentralization strategy:**
   The incentive for Nebulas PoD Node Decentralization Strategy includes two parts: consensus incentive and governance incentive. The source is 8,219.1744 NAS

revenue generated daily via DPoS. For the specific allocation method, review section 1.3 Incentive allocation.

The use of public assets, changes to the allocation program, etc... will require the use of the proposal process and can be implemented only after the adoption of the resolution by the Governance Committee.

3.2.3 Penalties for Consensus Mechanism

During the voting phase of the governance cycle, the governance committee will also need to vote on the results of medium and severe security violations.

1. If the governance committee votes that the punishment is justified, the NAS that has been frozen will be donated to the Go Nebulas Community Collaboration Fund.
2. If the governance committee votes that the node did not cause intentional harm to the network, the block generation stability index $S_{(i)}$ of the node will be restored to the level prior to the punishment and the NAS will be unfrozen.

3.3 Governance Method: Vote

3.3.1 Voting Cycle

Governance nodes must vote within 120 polling cycles (about 5 days) after the end of the previous governance cycle. Not participating in voting is considered an Abstain vote.

3.3.2 Voting Methods

The voting of governance nodes is conducted on the public chain with the results viewable to all. All governance nodes are expected to participate in **all** governance periods. All votable items will have the following options (must choose one):

- Support

- Oppose
- Abstain

Each proposal can only be voted for once by each governance node by utilizing 1 NAX per item being voted. NAX used for voting is destroyed and will not be returned.

3.3.3 Processing of Voting Results

The adoption of a proposal or item requires the following conditions:

Type	**Governance node participation rate**	**Required approval rate**	**Budget constraints**
Proposal Voting	Minimum of 26 nodes	67% or greater ***	A single project budget must not exceed $15,000 USDT *; The total for all approved projects during the governance cycle must not exceed $30,000 USDT **
Project Acceptance Voting	Minimum of 26 nodes	67% or greater	/
Penalties for consensus mechanism	Minimum of 26 nodes	67% or greater	/

Table 3.1: Processing of Voting Results Table

* If a single project budget will exceed the maximum dollar value, it is suggested to split the proposed project into a multi-phase project.

** If the total amount of all approved projects during the governance cycle exceeds the maximum budget, projects are ranked by their support rate. Any proposal that is approved but funding is not available for the current governance cycle is deferred to the next governance cycle.

*** Approval rate = Support votes / (Support votes + Oppose votes)

3.4 Penalty Mechanism

3.4.1 Individual Governance Node Penalties

If a consensus node becomes a governance node for two consecutive governance cycles without taking part in governance voting, the node will not be able to be selected as a governance node for 820 consensus polling cycles (approximately one month).

3.4.2 Governance Failure

1. If there are fewer than 26 (of the 51 selected) governance nodes participating in the voting during a governance cycle, the cycle will be declared invalid; no decision made will be executed and all governance incentives will be donated to the Go Nebulas Community Collaboration Fund (See 3.2.2 Community Assets).
2. If there is no proposal or project in a governance cycle, i.e. there is nothing to vote on, the cycle is declared invalid and all governance incentives will be donated to the Go Nebulas Community Collaboration Fund.

4 Roadmap

In order to best complete the decentralized transition of the mainnet nodes, the Nebulas PoD Node Decentralization Strategy will gradually open the node applications to all. Initially, we invite active project parties, partners and community members within the current Nebulas ecosystem to deploy nodes and explore the governance processes in advance to the public release to provide valuable advice for testing and improvement. The roadmap is as follows:

- **November 20, 2019** - *Nebulas PoD Node Decentralization Strategy - Based on the Proof of Devotion (PoD) Mechanism* officially launched;
- **Early January 2020** - Launch of test bounty program on the testnet;
- **January 2020** - Node application by invitation, consensus mechanism initiated;
- **End of February 2020** - Open application for community nodes;
- **End of March 2020** - First governance vote, governance mechanism initiated.

Appendix

Appendix A Recommended Hardware Configuration for Node Operation

Monthly recommended configuration server expenditure is approximately: $150 USDT/month

- CPU：>=4-Core minimum (Recommended 8-Core)
- RAM：>=16G
- Disk: >= 600G SSD
- NTP: NTP service is required on the server to ensure correct time synchronization for all operational nodes.

Node Installation Tutorial - review the Nebulas Technical Documentation: Nebulas 101 - 01 Compile Installation.

It's recommended to build and deploy nodes via docker:

- Install docker and docker-compose
- Execute the following docker command via root

```
sudo docker-compose build
```

```
sudo docker-compose up -d
```

Appendix B Node Multi-User Participation

Nodes can be operated by an individual, business entity or even a group of individuals acting as a single entity. **The distribution of node incentives is determined by the primary node operator.**

Supporting a node participant is the autonomous ideology of the community members and those who choose to support node operators should only make this decision after fully examining the operation of the node. PoD can only guarantee the pledging and withdrawal of any pledged NAX to a node and is not responsible for the commitment of the node operator to their supporters.

In order to facilitate the participation of community users, the Nebulas Foundation will form a demonstration multi-user participation node. This node will be operated and maintained by the Nebulas Foundation. All community members can support this node by pledging NAX to its existence and the benefits (minus the basic cost of server operation) of the node will be equally distributed to those who are involved in its co-construction based on NAX pledge quantity.

Appendix C Earnings Simulation

Assuming that a node is among the 51 candidate nodes every day for a month, the maximum consensus incentive for the month is approximately 9,920 NAS.

There are over 700 polling cycles per month and considering the existence of random factors in the selection algorithm, the average revenue per node is expected to be about 3,307 NAS. This however can vary greatly depending on multiple factors as detailed in this paper.

Assuming that all 51 governance nodes selected each month participate, the nodes incentive is estimated to be 816 NAS per month per node.

Appendix D Glossary of Terms

[1] https://nebulas.io/vision.html

[2] Autonomous Metanet: An open collaboration system based on blockchain technology, which is oriented around complex data and interaction.

[3] Proof of Devotion (PoD): A consensus mechanism built on the basis of the size of community contributions. This includes both consensus and governance mechanisms.

The establishment of consensus committees through community contributors to achieve nebulas' blockchain nodes decentralization; Participation in community governance through the representation of governance committees.

[4] Decentralized Autonomous Organization (DAO): An organization that is represented by public and transparent computer code. Financial transaction records and procedural rules of a distributed autonomous organization are stored within the blockchain.

[5] Orange Paper: Nebulas Governance: https://nebulas.io/docs/NebulasOrangepaper.pdf

[6] Delegated Proof of Stake Consensus (DPoS): Delegates are chosen by stakeholder votes, and delegates then decide on the issue of consensus in a democratic way. This includes but is not limited to: All network parameters, cost estimates, block intervals, transaction size, etc.

[7] NAX: This smart asset is generated by decentralized pledging and is the first token on nextDAO. Users on the Nebulas blockchain can obtain NAX by pledging NAS. NAX adopts a dynamic distribution strategy where the actual issuance quantity is related to the global pledge rate, the amount of NAS pledged individually and the age of the pledge.

[8] dStaking Decentralized Pledge: Unlike traditional pledges (staking) that requires the transfer of assets to smart contracts, decentralized pledges record the user's pledge while the assets remain at the user's personal address.

[9] Nebulas NAX White Paper:

- Github：https://github.com/nebulasio/nax_whitepaper;
- PDF：https://nextdao.io/static/docs/nax_whitepaper_en.pdf

[10] BFT (Byzantine Fault Tolerance): It is a fault-tolerant technique in the field of distributed computing. Byzantine fault-tolerant comes from the Byzantine Fault problem. The Byzantine Fault problem models the real world, where computers and networks can behave unpredictably due to hardware errors, network congestion or disruption, and malevolence. Byzantine fault-tolerant techniques are designed to handle real-world abnormal behavior and meet the specification requirements of the problems to be addressed.

[11] VRF (Verifiable Random Function): Verifiable random functions: It is an encryption scheme that maps the input to a verifiable pseudo-random output. The program was proposed by Micali (the founder of Algorand), Rabin and Vadhan in 1999. To date, VRF has been widely used in various encryption scenarios, protocols and systems.

[12] Go.nebulas.io Help Documentation:
https://www.notion.so/Go-nebulas-io-Help-Documentation-cbdeb02e0ff547b2b7cf59f2d249aafb

Appendix E Parameter Table

E.1 Basic Parameters

- Average block time: 15 seconds
- Polling cycle: 210 block height, approx. 52.5 minutes
- Governance cycle: 820 polling cycles (approximately 1 month)
- Consensus nodes: 21
- Candidate nodes: 51 (with 21 consensus nodes)
- Governance nodes: 51 (consensus nodes who generated the largest number of valid blocks per governance cycle)

- Deposit: 20,000 NAS
- Candidate node minimum pledge (vote): 100,000 NAX
- NAS Pledge return time (Once the exit request has been issued): 820 polling cycles (approximately 1 month)
- NAX return time (Once the withdrawal request or the exit request has been issued): 120 polling cycles (approximately 5 days)

E.2 Parameters Related to the Consensus Mechanism

- Number of blocks generated per node within each polling cycle: 10
- Initial Value of Block Generation Stability Index $S_{(i)}$: 0.8
- Max Value of Block Generation Stability Index $S_{(i)}$: 1
- Trigger threshold for penalty mechanism via Block Generation Stability Index $S_{(i)}$: 0.5
- Penalty (Medium): 5% of NAS deposit
- Penalty (Severe): All NAS deposit plus all NAX pledged to that node

- Consensus mechanism penalty duration (low and medium security level): Candidate node cannot be selected for 20 polling cycles (approximately 1 day)
- Consensus mechanism penalty duration (severe security level): Permanent

E.3 Governance Mechanism Parameters

- Governance node voting time: 120 polling cycles (approximately 5 days)
- Governance node minimum participation: 26
- Required proposal approval rate: Greater than 50%
- Required approval rate for the project establishment voting, project acceptance voting, and penalties for consensus mechanism voting: Greater than 67%
- Governance penalty trigger: Not participating in ALL voting proposals (at minimum level) for two governance cycles constantly
- Governance penalty duration: 820 polling cycles (approximately 1 month)

E.4 Incentive Allocation Parameters

- Daily bookkeeping Income (entire network): 8,219.1744 NAS
- Annual bookkeeping income (entire network): 2,999,941 NAS
- Total annual consensus mechanism incentives (entire network): 2,499,951 NAS
- Total annual incentives for governance mechanisms (entire network): 499,999 NAS
- Single project budget: Cannot be greater than $15,000 USDT
- Maximum amount of funds released per governance cycle: Cannot greater than $30,000 USDT

E.5 Addresses

- **Sign-in address:** This address is the only one that you can sign in to the node platform with. Please use the Nebulas Chrome Extension to sign in and manage your node on this node platform.

- **Minner address:** Only used for creating the block, signature, polling check. The keystore is on your server.
- **Incentive address:** Your consensus incentive will be sent to this address. We recommend a cold storage wallet for security. The incentive address can be modified via the server configuration.
- **Governance address:** If your node is selected as a governance node, your vote for proposals and projects will be via this address. In addition, your governance incentive will be sent to this address. To partake in governance and to vote, we recommend using a hot wallet such as NAS nano Pro.

The default governance address is the same as the sign-in address. For security reasons, it is recommended to use a different address and allocate hot and cold wallets according to our recommendations.

E.6 Changelog

- Nov 20, 2019 - v1.0
- June 2, 2020 - v1.0.1 - PoD Penalty Rule Adjustment (NP289).
- June 26, 2020 - v1.0.2 - Modification to the Stability Index for Nebulas Nodes (NP294), Addition of a lucky node in the consensus node selection process(NP296), Node Governance: Remove "abstain" from calculations (NP295).