Marinade: Delegation Strategy - draft

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Contents

1 Delegation Strategy **1**
1.1 Overview . . . 1
1.2 Scoring . . . 1
1.2.1 Vote credits . . . 2
1.2.2 Block production . . . 3
1.2.3 Inflation commission . . . 3
1.2.4 MEV commission . . . 3
1.2.5 Stake concentration – Country/City/ASO . . . 4
1.2.6 Stake concentration – Node . . . 4
1.3 Basic Eligibility Criteria . . . 5
1.4 Stake assignment . . . 6
1.4.1 Algorithmic stake target assignment . . . 7
1.4.2 Directed stake target assignment . . . 8
1.4.3 Cap overflow . . . 9

1 Delegation Strategy

1.1 Overview

The Delegation Strategy describes the automated process Marinade follows when delegating stake to validators. There are two major components in the Delegation Strategy:

Algorithmic staking Marinade has developed a scoring system to decide efficiently and in an automated way which validators to delegate to. Every epoch, validators are assigned a score based on their long-term performance, yield shared with the stakers, operator's diligence and decentralization efforts. Marinade delegates stake to validators who score better than others while also meeting strict eligibility criteria.

Directed stake Part of Marinade's total stake is decided on by a popular vote between mSOL and MNDE holders. Validators who meet Marinade's eligibility criteria and who have a good community support can then receive extra stake delegation from Marinade.

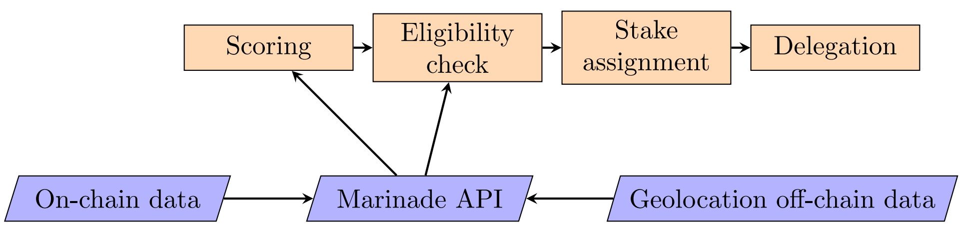

Figure 1: Delegation Strategy flow.

The diagram 1 shows the process and the following chapters dive into specifics for each part.

1.2 Scoring

Let C be a set of score components, let w_c be the weight of component c and let s_c be the calculated value of component c for validator V. The score assigned to validator (S_V) is computed as the weighted average of the values of all components:

$$S_V = \frac{\sum\limits_{c \in C} w_c \cdot s_c}{\sum\limits_{c \in C} w_c}$$

The components can be split in the following logical groups:

Node Performance Validators execute transactions and vote on blocks built by other validators to advance the state of the chain. Block production and participation in the consensus are basic indicators of high-quality node operations.

Yield for stakers While the yield for stakers is directly affected by node's performance (e.g. when a node is down, its stakers earn no rewards), this group is dedicated to the commission of the validator for both inflation and MEV rewards.

Decentralization If more than a third of total stake goes offline the consensus on blocks cannot be reached and the network halts. It is crucial to spread the stake between different nodes, server providers, countries and cities.

The weight for each scoring component is described in table 1.

Table 1: Weights of score components

Component (c)	Weight (w_c)
Vote credits	10
Block production	5
Inflation comission	$5 - \lambda$ (dynamically evaluated)
MEV commission	λ (dynamically evaluated)
Stake concentration – Country	2
Stake concentration – City	3
Stake concentration – ASO	4
Stake concentration – Node	2

1.2.1 Vote credits

Vote credit is a tally for each validator's successful vote on a block with maximum lockout (a block that is a root). More credits earned by a validator compared to credits earned by other validators lead to higher relative inflation rewards. It is a good on-chain indication of uptime of each validator. The differences between validators are very narrow. Let T_e denote target vote credits for epoch e (stake-weighted average of credits of all validators in that epoch), let V_e denote vote credits earned by a specific validator, then:

$$s_{\text{vote credits}} = \min\left(\left(\frac{\sum_{e \in E} \frac{V_e}{T_e}}{|E|}\right)^{10}, 1\right)$$

This formula calculates the average voting performance relative to other validators over the course of 14 finalized epochs and raises it to the 10th power to make even small differences between validators pronounced. The final value is capped at 1, so the vote lagging mods are not incentivized. The cap may be removed once the Vote timeliness proposal [2] is live.

1.2.2 Block production

The Solana network automatically assigns leader slots to validators. A leader slot is an opportunity for a validator to produce a block by executing incoming transactions and streaming them to other validators. Validators with poor hardware setup may struggle to produce blocks. When no blocks are produced, no transactions are executed on chain. Leader slots are assigned proportionally based on stake. Some validators nodes have a few thousands of SOL delegated to them, while others have millions. The block production for low stake nodes is very sensitive to outliers. Marinade calculates z-score for average block production of the validators; Validators with z-score greater than -1 (being within 1 standard deviation from the mean or better than mean) have maximum score, score for others approaches 0 linearly. Let L_V and B_V denote leader slots assigned to validator V and blocks produced by valdator V over 14 epochs, then P_V denotes block production of validator V:

$$P_V = \frac{B_V}{L_V}$$

Let $\bar{P}$ and σ_P denote mean and standard deviation of block productions of all validators, then the z-score for a validator's block production is calculated as:

$$z = \frac{P_V - \bar{P}}{\sigma_P}$$

And the score component is calculated as:

$$s_{\text{block production}} = \begin{cases} \frac{P_V}{\bar{P} - \sigma_P} & \text{if } z \leq -1 \\ 1 & \text{if } z > -1 \end{cases}$$

1.2.3 Inflation commission

Delegated stake earns inflation rewards every epoch based on performance of the validator and validator's commission. Marinade tracks maximum observed commission C_M over the past 14 epochs and calculates the score of this components as:

$$s_{\text{inflation commission}} = \begin{cases} 100\% - C_M & \text{if } C_M \leq 10\% \\ 0 & \text{if } 10\% < C_M \end{cases}$$

1.2.4 MEV commission

Validators running Jito client choose commission on MEV rewards (denoted as C). Validators not running Jito client are considered to have the MEV commission set to 100 %

$$s_{\text{MEV commission}} = 100\% - C$$

Unlike inflation rewards, MEV rewards are very volatile and change epoch from epoch. Therefore, weights of this parameter and the inflation commission parameter are evaluated dynamically based on the observed size of MEV rewards relative to inflation rewards over past 1 month.

1.2.5 Stake concentration – Country/City/ASO

Each validator node broadcasts its IP address using gossip protocol[3]. Marinade uses IpWhois's geo-IP data.[1] to geo-locate validators - this allows Marinade to estimate stake concentration in countries, cities and ASOs. Tracking the concentration is important to ensure the liveness of the whole network. A natural disaster causing power outage in a single city must not affect the function of the whole network. The same applies to a country e.g. deciding to block all internet traffic - or ASO doing that.[2]

Validators located in less concentrated countries, cities and ASOs receive higher score. The formula for this component is designed to return similar results for low concentrations and to start dropping significantly when the concentration approaches halt line (33 % of total stake).

Arguably, for the scoring purposes it is more important to consider the latest concentration rather than concentration a week or a month ago. For this reason, only the last finalized epoch is used to calculate the score.

Let x denote value for any of the three components: Stake concentration in country/city/ASO, and s_c denote score for that specific component, then:

$$s_c = \begin{cases} \sqrt[3]{1 - 3 \cdot x} & \text{if } 0 \leq x \leq 33.\overline{3}\% \\ 0 & \text{if } 33.\overline{3}\% < x \end{cases}$$

This formula is visualized in the figure 2.

1.2.6 Stake concentration – Node

Stake concentration on a single node requires a formula different from the formula used for stake concentration in e.g. a city. Marinade does not want to support oversized validators by the algorithmic delegation strategy - Marinade wants to help spread the stake on many smaller nodes. Validators with relatively low stake ($<$ 0.1 M SOL) will receive maximum score for this component, validators with high stake ($>$ 4 M SOL) will receive minimum score.

Let x denote non-Marinade stake delegated to a validator in millions of SOL, let s_c denote score for this component, then:

[1] https://ipwhois.io

[2] A good example is Hetzner server provider who decided to blackhole all Solana traffic while validators with 90 M SOL delegated in total had their nodes hosted there. It was about 20 % of total Solana stake at the time for mainnet and the cluster survived. However, Solana's testnet network halted and remained halted for over 2 weeks.

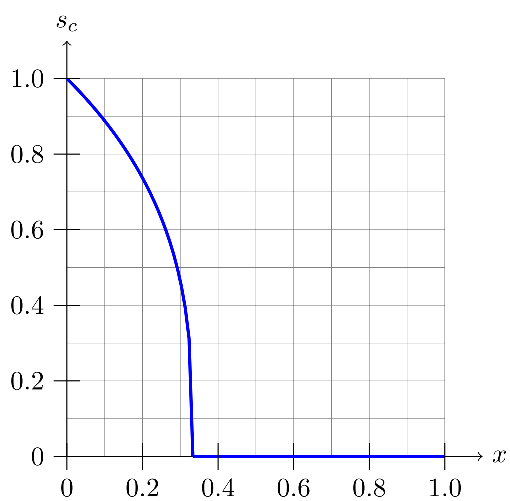

Figure 2: s_c plotted for different values of stake concentration in country/city/ASO.

$$s_c = \begin{cases} 1 & \text{if } 0 \leq x < 0.1 \\ 1 - \frac{x-0.1}{4-0.1} & \text{if } 0.1 \leq x < 4 \\ 0 & \text{if } 4 \leq x \end{cases}$$

This formula is visualized in the figure 3.

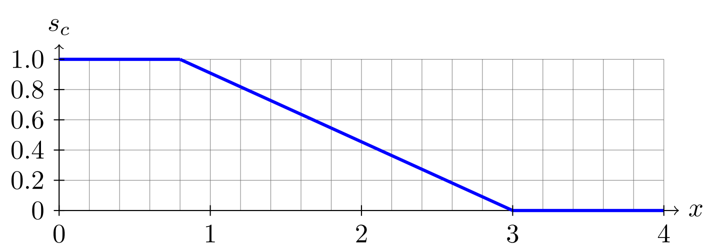

Figure 3: s_c plotted for different values of stake concentration on a node.

1.3 Basic Eligibility Criteria

Score Validator's decentralization score must be ≥ 0.8 to be eligible for stake delegation from Marinade. Decentralization score is a weighted average of just the 4 scoring parameters related to stake concentration (concentration in a country/city/ASO and stake of the node).

Commission If the maximum observed commission of the validator in the 14 most recent epochs is above 7 %, the validator is not eligible to receive stake from Marinade. This check is in place to ensure that the validator has shown a long-term commitment to sharing staking rewards with the stakers and to prevent gamification of the scoring system.

Node version There is a list of client versions that a validator node has to match for the 14 most recent epochs in order to be eligible for Marinade stake.

Uptime Validator is not eligible if it earned less than 80 % of stake-weighted credit average in any of the past 14 finalized epochs.

Blacklist Validators who are on the blacklist are not eligible to receive Marinade Stake. The blacklist is maintained in the Github repository [1]. There are several reasons a validator can be added to the blacklist:

- **Commission rugging** Validators who change commission back and forth between $< 10\%$ and $\geq 10\%$. Some validators have often changed commission to e.g. 100 % right before the end of each epoch in order to extract maximum inflation rewards from the delegated stake and then changed the commission back to 0 % to attract stakers who did not check the effective commission of the validator.
- **Vote lagging** There is no immediate incentive for validators to vote as close as they can to the most recent block. As a result, some choose to lag their votes until they can determine which fork is most likely to reach full lockout. This behaviour is harmful to the whole cluster as the lagged votes usually do not help reach the consensus. This issue will be resolved by activation of the Vote timeliness proposal [2]. Validators purposefully lagging their votes are not eligible to receive stake from Marinade.
- **Other reasons** Administrators of the scoring system may choose to blacklist validators who find other ways to purposefully destabilize Solana network - specific cases are presented by validator community.

Cap by external stake Marinade will limit the delegation to a node to at most 4 times as much stake as was the node's minimum external stake over the past 14 epochs.

1.4 Stake assignment

Initial TVL split is defined as follows:

$$\text{TVL} \begin{cases} 60\% & \text{Algorithmic stake} \\ 20\% & \text{MNDE votes} \\ 20\% & \text{mSOL votes} \end{cases}$$

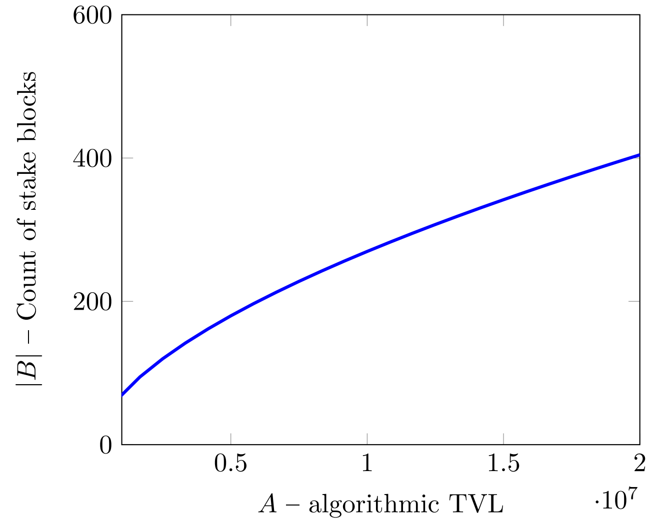

Figure 4: How TVL changes how many stake blocks there are

However, mSOL and MNDE holders can choose not to vote for a specific validator but rather to vote for algorithmic stake - effectively reducing allocation for mSOL and MNDE stake directing, respectively.

1.4.1 Algorithmic stake target assignment

The more TVL Marinade has, the more validators Mariande wants to delegate to while increasing delegation of all already staked validators. This is enabled by abstracting TVL to smaller chunks called stake blocks. When Marinade's TVL grows, the size of the blocks should increase and total count of stake blocks should increase as well. Let A denote part of TVL reserved for algorithmic staking and let B denote a stake block size, then:

$$B = \frac{A}{\left(\frac{6000000}{30000}\right) \cdot 1.5^{\log_2 \frac{A}{6000000}}}$$

This formula is visualized in figures 4 and 5.

Part of Marinade's TVL dedicated for algorithmic stake is distributed to some of the eligible validators, iterating from the highest scoring to the lowest scoring. When a validator is eligible the validator is assigned b stake blocks. Let S denote the score of the validator, then:

$$b = 1 + \left(\frac{\max(0.94, S) - 0.94}{1 - 0.94}\right)^{10}$$

This formula is plotted in figure 6. Blocks are being assigned until there are no more blocks to be assigned (TVL is depleted).

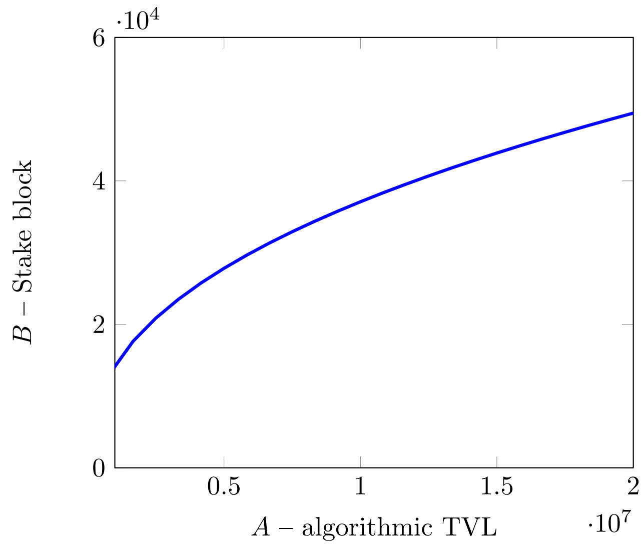

Figure 5: How TVL changes how large every stake block is

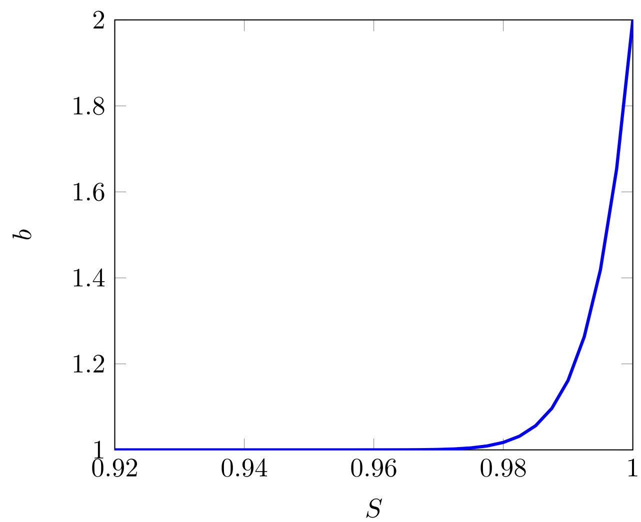

Figure 6: How score affects how much of a stake block a validator receives

1.4.2 Directed stake target assignment

Eligible validators who received votes will each receive stake proportional to the share of votes they received. This stake is still limited by caps.

1.4.3 Cap overflow

Maximum stake of a node is capped by its external stake[3]. When the cap would be reached when assigning stake, different stake sources (algorithmical, from MNDE votes, from mSOL votes) overflow to their respective TVL sources proportionally. For example if a Validator was to receive 500 SOL from algorithmic distribution, 300 SOL from MNDE votes and 200 SOL from mSOL votes but the maximum Marinade stake for that validator was capped at 500 SOL, 250 SOL would be used to delegate to other validators algorithmically, 150 SOL to other validators with MNDE votes and 100 SOL to other validators with mSOL votes.

If there is no more eligible validators or the caps are reached, target delegation for all validators is increased proportionally to utilize and stake all SOL available.

[3] See 1.3

Glossary

ASO Autonomous System Organization. 2, 4, 5, a

References

[1] https://raw.githubusercontent.com/marinade-finance/delegation-strategy-2/master/blacklist.csv

[2] https://github.com/solana-labs/solana/issues/19002

[3] https://docs.solana.com/validator/gossip