**Solana (SOL)**

* **Slashing**
* **Current APY about 6.4%**
* **Current commission for staking solana about 10%**
* **Uses a timestamping system known as Proof-of-history (PoH) consensus, Proof of history, a proof for verifying order and passage if time between events, used to encode trusltess passage of time into consensus algorithm proof of work or proof of stake**
* **PoH can reduced messaging overhead in the BFT algorithm replicated state machine, resulting in sub-second finality times**
* Solana staking rewards can be earned by users participating in the network as validators or delegated stakers.
* Validators are responsible for processing transactions and maintaining the Solana Network
* Delegated stakes are SOL holders who delegate their tokens to stake pool operators for staking rewards using Solana wallets like Phantom
* Validators are required to run and maintain a node (called a “Cluster”), which requires consistent uptime and hardware with sufficient specs
* Solana implements slashing, which occurs when validators act maliciously or suffer poor performance. To offset the costs associated with maintaining a cluster, validators can collect commission fees from delegators
  + **Solana Blockchain Breakdown:**
    - Solana is unique from other notable PoS blockchains because it uses a timestamping system known as Proof-of-history (POH) consensus
    - By combining PoS and PoH, Solana is able to clock incredibly fast block time of 400 milliseconds. Compared to Cardano’s block time of 20 second, Ethereum produces a new block every 13 seconds
    - SOL’s yearly inflation rate started at 8%, but is decreasing by 15% every year until it hits a rate of 1.5%
    - SOL added into the ecosystem through Solana’s inflation schedule is distributed to delegated stakers and validators every epoch (two days)
  + **Profitability of Solana Staking**
    - The rewards structure for validators and delegators on Solana is mutually aligned
    - Validators with more SOL delegated receive more opportunities to record transaction on the blockchain, which provides more rewards for both the validator and delegator, in turn validators may reduce their commissions earned from delegators in order to stay more competitive against other validators
    - Both validators and delegators are affected by slashing, which gives delegators an incentive to stake with the best-performing validators
    - Both validators and delegators staking rewards depend on Solana’s adjusted staking yield
    - Under the staking dilution structure, staking rewards are dynamic and change relative to the amount of tokens staked out of the total current supply of SOL
    - The current annual % yield (APY) for delegated staking is around 6.41%, with the majority of validators now charging a 10% commission
    - Assuming your are staking 1,000 SOL, you would earn around 64.1 sol next year

Based on SOL’s 52-week high of $26m you would be staking $26K for an annual profit of $1,666.99

**Top Solana Protocols by Total Value Locked**

**Graphical user interface, application

Description automatically generated**

**Analysis of Downtime: (Solana)**

-Solana sources for Analysis: Solana JSON RPC API, Solana Beah API, Validators.app API, are all relevant for Mainnet, unless another time period is specified

-Validator support network operation by providing highend hardware resources & properly configuring their systems to keep the network running as fast & smoothly as possible

- More stake dedicated to a validator, the more it is frequently chosen to process new transactions on the ledger and so is exposed to greater hardware and network load

-Validators economically motivated to keep their hardware & software running without interruptions, also to timely update Solana Software & Improve their nodes and network connection as their stake, and solana network increases

**Solana Validators downtime:**

* Normal for a nide to be temporarily unavailable/offline sometimes as every technical system needs periodic maintenance and reconfiguration
* Reasons for Server unavailability:
  + Planned reboots to update host configuration or software
  + Emergencies (power outage)
  + Network problems in the data center or at the provider
* The longer a node is unavailable, the fewer staking rewards and transaction fees it receives
* Staking rewards are paid proportionally to node’s vote transaction count which it cannot post if it is offline or functioning incorrectly
* Validator downtime duration negatively affects its delegates’ rewards, thus reason to check validator downtime history duration before delegating to it
* Delinquent- during periods of downtime, the unavailable validator is delinquent and it’s status can be checked using Solana CLI solana validators command or by parsing corresponding JSON response ( Solana—output json validators)
* By constantly fetching statuses of all validators on the network it is possible to measure delinquency periods, which is a good approximation for downtime duration for further quantitivel analysis

**Factors Influencing downtime duration**

* Node operation reaction time (node operators may or may not use specialized monitoring and alerting systems)
* Node operator skill (inexperienced enthusiasts nd mature professionals who have been working with high-load systems for yeas)
* Time taken to repair breakdowns in the power grid or communication network (which does not depend on a node operator)
* Time needed to debug and fix specific configuration errors or replace hardware parts
* Complexity and duration of software update (I.E., different Solana versions take different time to install) node startup duration, etc
* Solana Network Node Unavailibility:
  + Downtime duration statistics overtime
  + Variability across nodes as well as duration of node software updates

**Downtime data analysis:**

* **Downtime statistics of protocol nodes that were active in the period between different epochs**
* **Historical data can reveal trends in the dynamoics of downtime making it eaiser to understand and the normal behavior of the metrics as well as to identify the abnormal fluctuations**

**Node Downtime duration by Epochs**

* Quantile values of 5%- and 95% LEVEL reflect the maximum downtime among the top 5 and top 95% of validators respectively for each epoch
* Average downtime is the simple arithmetic mean and the median defines a downtime duration which divides the top 50 and 50% of validators
* **Downtime Duration for Updates and Other Causes**
* Downtimes may happen due to upgrades, solana node software updates as well as hardware upgrades and unexpected halts
* Available on-chain data allows us to distinguish between downtimes related to software updates and those related to other causes and compare downtime duration distributions for the supermajority and superminority of validators
* According to distributions of downtime not related to software updates, validators groups are quite similar apart from the fact that supermajority validators are more likely to have very long outages that greatly increase the average value of downtime duration (69 vs 34 minutes for the superminority group)
* Even if the P2P validators foes down/delinquent, on average it happens for an extremely short amount of time 1.5minutes
* **Downtime due to Software updates: distributions for the groups differ considerably:** the supermajority group there is much more variable in downtime duration, when compared to superminority and again supermajority validators frequently have longer update times leading to higher average (195 vs 76 minutes for superminority group)
* Super minority validators including the P2P Validator demonstrate high consisteny in update duration presumably due to specific administration standards developed by professional engineers who operate these validators.

**Solana Node software:**

* Different Solana node software versions vary significantly in the complexity and the duration of the installation process, which directly affects the downtime duration associated with updates, figure below shows average update time of Solana node software versions by validators from the supermajority and superminority groups
* **Update 1.6.25** took the longest for both supermajority (4.5 hours on average) and superminority (3.5 hours on average) validators.
* **Overall,** validators from the superminority group usually perform the updates faster ensuring less rewards losses for them and their delegators

**Skip Rate Analysis: Solana Validators**

* **Skip Rate:** Skip rate measures the percentage of cases that a leading validator (a validator selected to process a block of transactions during its scheduled slot) fails to produce a transaction block which is subsequently confirmed by consensus on the network. A low number of skip rate means that the leader is successfully producing blocks at a high rate which are not on forks not chosen by the network
* **Skip rate:** measures the percentage of cases that a leading validator fails to produce a transaction block which is subsequently confirmed by confirmed by a consensus on the network.
  + - **Low Skip Rate number:** means that the leaser is successfully producing blocks at a high rate which are not on forks not chosen by the network
  + **Skip rate:** Calculated as the number of skipped leaders slots divided by the number of total leader slots in a epoch
  + The more staked is delegated to the validator, the more frequently this validator is chosen to be a leader to process blocks of transactions and so is exposed to greater harder and network load
  + Validators are economically incentivized to no skip blocks are they are losing their shares of fees for transaction in the processed blocks
  + Leading validators do not skip blocks intentionally. Node operators understand that skipped blocks are bad for the Solana network overall as high skip rate increase latency for end users, so they are always monitoring and trying to lower skip rate of their validators.
  + In most cases, validators produce blocks very well, but there are several factors which have a high impact on blocks skips rate:
    - **Solana node software version:** Solana node software versions constantly updated by the joint efforts of the Solana foundation and community developers in order to eliminate bugs and errors in the source code to increase stability and speed of the network. Once stable version available, validator operators gradually update their nodes software. Updates usually lead to significant improvements in overall network performance, and decrease skip rate
    - AS a rule, most validators prefer the stable versions recommended by the Solana Foundation as their the most reliable and properly tested ones.
    - Dev community constantly working to improve implementation of the protocol, expanding its capabilities and performance, and propose Solana software version updates approximately once a month. Each new stable version decreases skip rate except version 1.6.27 which was used by a large share of validators (but not for long) and 1.7.10 which has been used by a few validators for a relatively long time
  + **Node Downtime:** Node downtime directly affects skip rate because when a node is offline it can not produce blocks
    - Should be strong linear dependency between node downtime duration (expressed in % of epoch duration) and skip rate, if there were no other influencing factors
    - Downtime is more determinative factor for skip rate especially for long downtimes.
    - Very small number of cases where the downtime is high, but the skip rate is very low,
    - If small validator goes offline for greater than 80% of epoch duration, it still has a chance to successfully process a small number of blocks that fall into the remaining uptime
  + **Data Center Location**
    - Node data center may have an impact on skip rate as some of the nodes are located in the data centers that are very far from the majority (in terms of signal latency) as well as quality of technical support and network stability can vary greatly in different data centers as well as from country to country.
    - High network delays for such nodes increase the probability that the produced block will reach the rest validators too late and will not be accepted by the majority of closely located nodes after they have already agreed on another block
    - Geographic and data center distribution of nodes is gradually changing for various reasons:
      * Cost of service in data centers to the regulatory environment in different countries and also depending on staking pools or Solana Foundation Delegation score criteria
    - It is not only the data center itself that affects the skip rate of the node located in it, *Since block confirmation depends on consensus process within the global solana network, concentration of nodes is also a determining metric*
    - To improve network security, increase its geographical decentralization
    - Increasing geographical decentralization, increases skip rate and allows down the network,
* Skip rate is a very informative indicator of the efficiency and productivity of validators
* Skip rate reflects performance during transaction blocks production, consistency of the consensus process and the Solana network overall stability.
* For validators, skip rate should be carefully monitor as higher skip rate leads to loss of rewards resulting from confirmed transaction fees
* For users, lower average skip rate means higher speed and stability of the Solana network
* **Factors that have an impact on skip rate:** 
  + - Duration of node downtime
    - Solana node software version
    - Data center location and concentration
    - TPS spikes as well as memory leaks during continuous operation without validator restarts or software updates