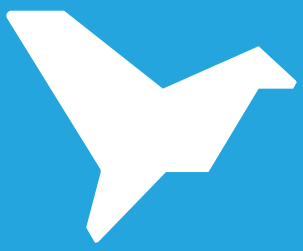


boid

white paper

v. 2.0

Contents

Abstract

The Boid Network or “Boidnet” is a decentralized platform which acts as an accessible gateway for a broad audience of users to participate in and benefit from distributed computing and blockchain networks. Realizing this objective requires a focus on an accessible user experience (UX) combined with a novel consensus mechanism which evolves over time based on sentiment of the community members. This paper describes the alpha implementation of Boidnet which was launched on the EOS Blockchain in early 2018 as well as the future plans to realize the full maturation of the platform.

Background

Volunteer Computing

Distributed computing networks are based around the concept of an arbitrary number of loosely connected devices contributing resources towards some larger computational task. Volunteer Computing (VC) is a form of distributed computing that aggregates resources from volunteer contributors who install client applications and connect to VC distribution servers which are responsible for distributing, verifying, and aggregating results from small computational tasks which are computed on connected devices (Mengistu, T. , 2019). VC networks became popular with the release of SETI@Home, a VC project launched in 1999 where volunteers help process data from radio satellites operated by Berkeley researchers searching for signs of alien life. The NSF helped fund the development of the technology behind SETI@Home called “The Berkeley Open Infrastructure for Scientific Computing” or BOINC. The BOINC technology stack has been used to deploy thousands of independent volunteer VC projects focused on a myriad of scientific research causes. These projects aggregate resources from volunteers who install and run the BOINC client software on their

personal computers or home servers. Volunteers are incentivized to contribute mostly out of an intrinsic motivation to contribute towards something they see as important and meaningful. Many BOINC projects implement various levels of gamification such as virtual medals, leaderboards, and user operated teams to engage volunteers and improve the social stickiness of the platform. Today over 136,000 people, using over 700,000 devices, contribute computational resources to volunteer distributed networks. The computational power provided towards VC projects globally is greater than many of the world's fastest supercomputers (University of California, 2020).

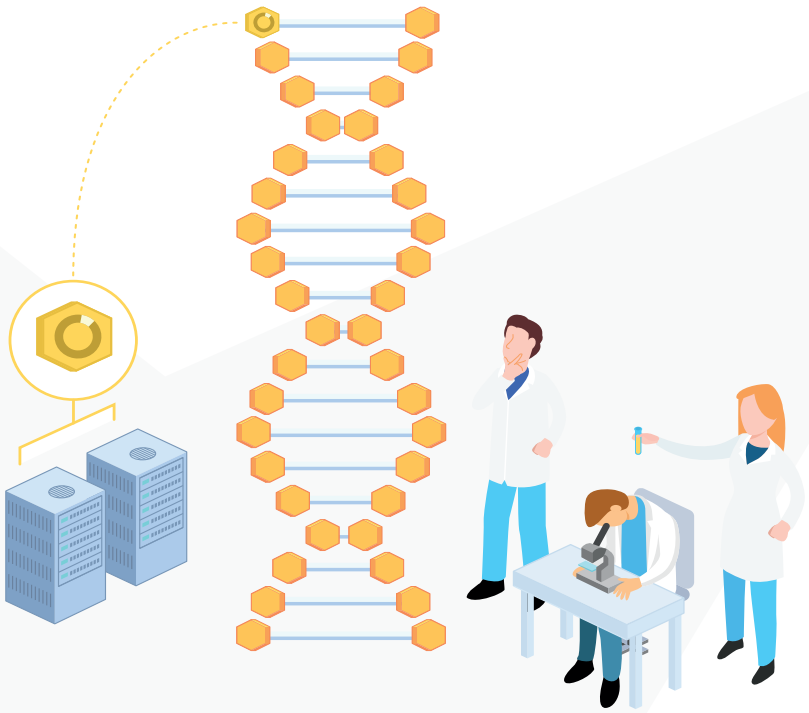
Blockchain Networks

The Bitcoin whitepaper introduced the concept of hashing transactions into blocks which are linked together (Blockchain) and using a Proof-of-Work (PoW) consensus mechanism to prevent double-spending. Assuming that a malicious actor does not control 51% of the network hashpower, the blockchain is an immutable store of data and transactions can't be reversed. The Bitcoin Whitepaper states "one-CPU-one-vote" (Nakamoto, 2008) when describing PoW. This statement is core to the ideology of decentralization which blockchain adopters strive for. Stated more explicitly, the value of a public blockchain comes from broad adoption and participation in network consensus. PoW originally started as something that individual contributors could participate in using regular home computers. As the network difficulty increased and the software matured, GPU accelerated mining software overtook CPU mining, making CPU mining impractical. GPU miners were superseded by purpose built FPGAS and ASIC hardware produced by a small number of companies. Today most PoW blockchains are mined by large-scale operations which benefit from efficiency of scale. This lack of broad participation in blockchain networks degrades the security model of PoW and centralizes power and control of the networks around a few large players (Mulders, 2019). Alternative consensus mechanisms which introduce tradeoffs such as Proof-of-Stake (PoS) or Delegated Proof-of-Stake (DPoS) no longer require specialized hardware, but instead are reliant on on-chain staking or voting for network validators. Stake/vote based consensus mechanisms essentially replace energy expenditure with social signaling. The degree of decentralization of staking chains rests in the hands of the token holders who make subjective decisions about the network architecture with on-chain messages.

Motivation

Early adopters in the blockchain space believe in the core values of the network above and beyond the pure utility value, advanced users understand the importance of decentralization and participation. Without many layers of abstraction, most people are not technically savvy enough to do much more than interact with a blockchain on a superficial level. Technical barriers to entry are still very high,

driving more users to rely on centralized solutions which offer an easier user experience. Users do not have full confidence in their ability to safely control funds and are quite uncertain about sending transactions (FIO, 2019). There are no 'accounts' in the traditional sense in most cryptocurrencies, and public and private keys are hard to read and near impossible to remember (Shyu, 2018 & Vishmidt, 2018). The fact that many applications have inconsistent UI/UX and require technical



skill or know-how impairs the average user in handling their cryptocurrency (Keshtcher, 2018 & Vishmidt, 2018). For blockchains to scale to a broader audience while also maintaining the core ideals of decentralization and security, systems which meet or exceed the user experience offered by centralized solutions need to be provided. The Boidnet is architected specifically as a solution to these participation problems in the blockchain ecosystem. Boidnet aims to enable unprecedented participation in decentralized systems by a broader range of individual contributors than previously realized.

Introduction

The Boid Network is a decentralized social network featuring a novel user experience which combines the intrinsic and extrinsic incentives from blockchain protocols and volunteer distributed computing networks. The network is modular in design with tokenized governance built into the core. On-chain governance enables token holders to signal for modifications of global parameters and implement network-wide upgrades. The network is based around a metric called Boid Power which (combined

with other variables) dictates the weight/influence (also called governance weight) of an account in the system. The primary method of generating Boid Power is by contributing towards network supported protocols. Today, the supported protocols are based around various computing resources as well as some social contributions. The modular structure of the platform enables "protocols" to be added, removed, and modified over time. Contribution of computational resources is orchestrated by an intuitive native application which simplifies the complexity of allocating resources to protocols. Users interact with the network using a social web interface where they can customize their account, join teams, view their account wallet and compete against each other for various rewards. Gamification mechanics are integrated into the core of the platform to incentivize interaction from network participants while the Boid team structure helps to consolidate decision making around network participants which are the most active and informed. The entire platform can be operated on an EOSIO blockchain as a set of smart contracts.

Governance

The ideal network participant is a user who is active in the community, up-to-date on latest developments and participating in decision-making by voting on proposals. The network is designed under the assumption that the majority of participants don't fit this ideal. Boid aims to combat voter apathy (the non-participation of network contributors in governance decisions), which is an issue in other decentralized networks with on-chain governance such as Dash & PIVX, by using robust integration of user tiers, voter proxy support and team structures. Advanced users who want a more direct role in governance can vote manually as well. This voter proxy support is similar to DPoS implementations such as EOS, where users delegate their vote weight towards block producers and proxies (EOSIO, 2018).

The voting weight of an account on the network is based on an algorithm that takes into account many variables including current Boid power, power tier, amount of powered stake and stake expiration time. Being able to contribute towards governance decisions may be subject to a maximum weight per tier, this mechanism helps to prevent top users from having an undue level of control and could help to ensure that average participants will feel that their voice is heard. While various mechanics are implemented to discourage sybil attacks, a unique ID system could also be used to help prevent abuse of this system in the future.

These factors, taken together, could be more robust and equitable than the majority of current governance systems in PoS and DPoS networks, which are based purely on token weighted voting (Dash, 2018 & PIVX, 2019) or rely on a few network participants for their decision-making (Mulders, 2019). The system described above draws some inspiration from Decred, which features a hybrid

PoW/PoS consensus and governance system (Decred, 2018).

Network Components

Boidnet is made of various logical and physical components which are mediated by on-chain logic. This section covers the most important core components which will help to clarify technical details covered in subsequent sections.

Accounts

All actions on Boidnet are performed by authenticated Boid accounts. Accounts store metadata as well as associations to other elements on the network. The flexible structure of Boid accounts makes onboarding simple for new users, while giving advanced users control when they need it.

Boid Account Data Structure

Authentication

- Any EOSIO Account (cross-chain compatible)
- Keypair only
- Social OAuth + 2FA
- Email/PW
- WebAuthn

Metadata

- Team membership
- Validator status
- Governance details
- Social Data (Username, profile picture, social links)
- Linked Devices
- Boid Power

Wallet

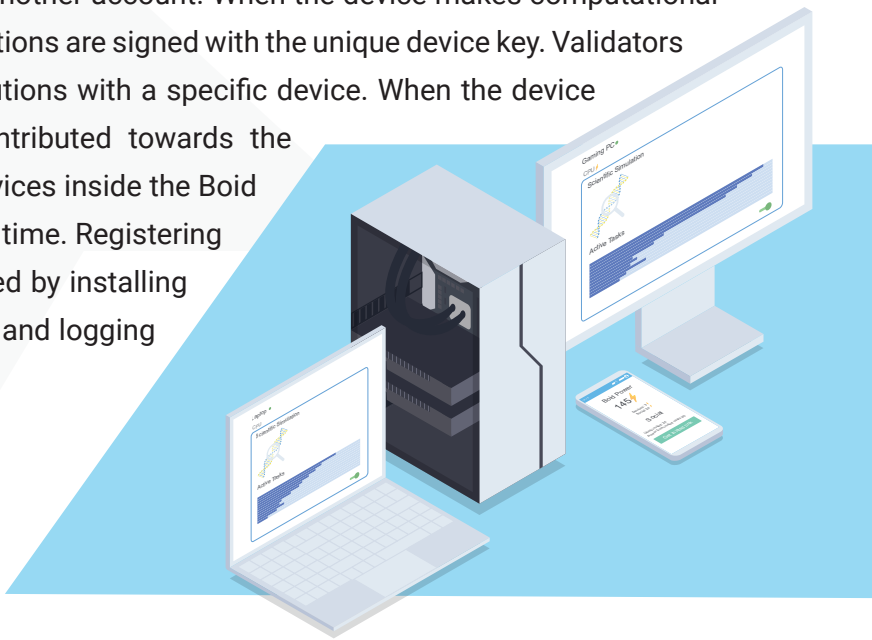
- Any EOSIO Token
- NFTs
- Blockchain addresses of other blockthains (BTC, ETH, etc...)
- Pegged tokens from other chains

Protocols

On the Boidnet, a “protocol” is a contribution a device or account can make which in turn results in the generation of Boid Power. The first protocol implemented was BOINC CPU contributions. The second protocol implemented was Ravencoin PoW mining for GPU. Additionally there is a social invite protocol that enables users to generate some power when they invite active users using their account invite link. The platform is designed to add and remove protocols over time based on community sentiment. Each protocol is registered on-chain with relevant details that validators can use to make deterministic power reports. Each protocol has a difficulty parameter which can be modified to adjust how much Boid Power is generated from contributions towards that protocol. Redundant computational resource protocols could be implemented, and the software would be able to dynamically switch between them based on metrics such as availability or profitability. Future protocols could also include human centric tasks such as social media participation or tagging of machine learning training datasets.

Devices

A Boid device is a registration of a physical computer or VM. Each device is registered to a specific supported network protocol with a unique key and a Boid Account owner. The owner of a device can delete the device or migrate ownership to another account. When the device makes computational contributions to the network, those contributions are signed with the unique device key. Validators use this key to associate resource contributions with a specific device. When the device generates Boid Power, that power is contributed towards the device’s owner account. Users can view devices inside the Boid UI, which displays device performance over time. Registering a device to an account can be accomplished by installing the Boid application on the physical device and logging in with the owner account.



Validators

Calculating the Boid Power generation of a device requires querying and parsing off-chain data. The underlying datasets are large and do not need to be stored on-chain. Given a certain set of data, a Boid Power rating can be calculated deterministically on a per-device basis. This final value is reported on-chain by validator nodes. Validators cache data locally, and their local dataset can be used to serve off-chain history APIs. Inflation rewards are set aside for validators, who are rewarded based on valid reports they make

each round. To prevent abuse, registering as a validator requires a minimum BOID token stake + collateral deposit.

Power Oracle

Validators report power ratings into the Power Oracle on-chain contract. Each validator has a consensus weight, and reports for the same device during the same round (24 hours) will accumulate until the minimum weight threshold is reached. The oracle contract uses a median formula to derive a final power rating value for the device that round. The final result of the median formula is pushed to the token contract to update the power rating of the account that owns the device.

Teams

Each Boid account is associated with a Boid Team. When users join a team, the power and stake of that user counts towards the overall score of that team. Some inflation is set aside for Boid teams based on team performance and rankings in the leaderboards. Competitive gamification encourages competition between teams. Each team is generally built around a specific brand and could be used to cross promote additional products and services outside of Boid. Boid teams also act as a governance proxy, meaning that by default, the team inherents the governance weight of team members. Registering a BOID team requires a minimum BOID stake from the team leader. Teams can only be registered/deregistered during a season break.

Team Leaders

Each Boid Team is controlled by a special team leader account which could be operated by an individual, group or organization. Team Leaders have an incentive to attract users to join their team, increasing the relative ranking of their team vs others. During a season break, a team leader can easily adjust parameters which determine how team inflation will be distributed for the next season. For example, the leader might dictate that team inflation rewards be diverted into a team bonus, as a donation to charity, or to fund public worker proposals. The Boid system makes it easy for a team leader to distribute additional promotional tokens, NFTs or physical prizes, to help differentiate and promote

their team. Public polls can be used to gauge the opinions of participants, enabling the leaders to make network governance decisions that are attractive to team members.

Seasons

A Boid season represents a period of time where global governance variables are less dynamic and team bonus promotions are activated. Traditionally Boid seasons are 60 day periods with a 30 day break, but these mechanics could change over time. The break period between each season is for adjusting network consensus and difficulty/inflation rules, activation of new Boid teams, protocols, and other major network governance changes. Team promotions are synchronized with the Boid seasons, including a promotional prize for teams at the end of the season based on their performance. Boid seasons give team leaders an opportunity to coordinate promotions and social media outreach. Users have an incentive to lock their BOID stake for a season, called a “Season Pass”.

DAC

Daniel Larimer proposed the DAC concept in 2013 and implemented it first in Bitshares a year later. This concept is the predecessor of the DAO (Decentralized Autonomous Organization) concept which was coined by Vitalik Buterin (Buterin, 2014). Larimer described a DAC as a community that should not depend on a single individual or organization for its value, of which the operation should be entirely independent of any actors, secrets or legally binding contracts (Larimer, 2013). The Boid DAC (Decentralized Autonomous Collective) is based on similar ideals in the sense that the network enables and incentivizes participants to enact changes that impact the entire network. Many variables are exposed by the Boid smart contracts which dictate inflation and power generation mechanics. These values can be adjusted programmatically or manually through automated multisig transactions when sufficient consensus is reached in the community. This ability to enact changes also extends to functions such as upgrading/repairing contracts, extending Boid protocol support, and other core level utilities.

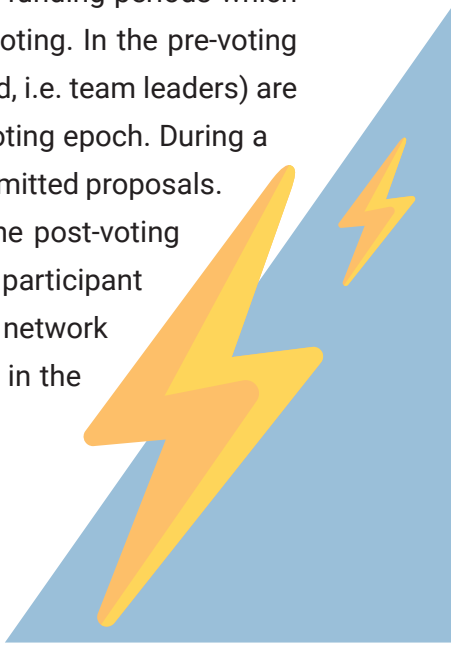
WPS

The Worker Proposal System (WPS) is a community controlled system for decentralized collaborative decision-making and sustainable funding. The Boid WPS is inspired by The Dash Budget System (DBS) which was the first major blockchain based decentralized governance system which is still operational today. The DBS sets aside 10% of the block reward to be used for funding community

and team proposals as voted on by the Dash Masternodes (Dash, 2018). The aim of the DBS and other similar decentralized governance systems is to enable network participants to vote directly on proposals and governance decisions in order to enable better collaborative intelligence.

Voting is done either manually by each individual account or through a vote delegation proxy. The Boid Worker Proposal System (WPS) allows the DAC to reward users for making contributions to the network that are more subjective in nature and don't fit into the Boid Power/Teams mechanics. For example, a user might submit a worker proposal which explains how they will create an instructional video about Boid or perform technical development work. The DAC would then vote yes/no and provide feedback to the worker. If the proposal is passed, then the worker could receive the funds from the WPF (Worker Proposal Fund).

Approval voting through a threshold system has advantages for WPS applications (Zhang et al, 2017). In order to guarantee an efficient voting mechanism, Boid could use funding periods which are divided into three separate voting epochs: pre-voting, voting and post-voting. In the pre-voting epoch, proposals can be submitted and voters (both individual and delegated, i.e. team leaders) are registered. After the registration is complete, the system moves on to the voting epoch. During a set period of time, registered voters will be able to cast their votes on the submitted proposals. After the set period of time has expired the results will be tallied during the post-voting epoch, and agreed upon proposals will be funded. Each registered network participant has a governance weight which is based on (among other things) their network contributions, such as their Boid Power and tier, which we will elaborate on in the next few paragraphs.



Boid Power

High levels of churn are normal for all distributed networks, this means it is normal for new devices to come online for short periods of time and only a small minority of connected devices in a network remain connected and contributing over longer periods of time (Storj Labs, Inc., 2018). In many real world peer-to-peer systems, the median time a network participant is active in a network before leaving is of no more than within a range of several minutes to several hours (Rhea et al, 2004). The amount of redundancy required to make up for the node loss increases with higher levels of churn, which in turn puts a strain on the network resources needed to operate without fault, causing efficiency to suffer. Without a cumulative decay mechanic, the network would reward high churn and low churn participants at an equal contribution ratio. Boid Power decay is a solution to bias rewards towards reliable contributors over time while also giving some additional leeway to users who contribute casually. Each account on Boidnet has a Boid Power rating. Boid Power is generated by Boid Protocol contributions. If an account stops generating Boid Power actively, the

power rating for that account will decay to zero. If an account is reliably generating Power, their overall power rating increases until a relative plateau is reached based on the current global power decay settings. With the current power decay mechanics it takes a device on the network an average of three weeks to build up to the relative power level plateau. This means that during the initial build up time, the device is being rewarded at a much lower rate vs a device that has already reached the plateau. The formula to update and decay Boid Power is below.

bp_{curr} : *current boidpower*
bp_{new} : *boidpower update*
$c_{bp,decayrate}$: *boidpower decay rate*
$c_{bp,update}$: *boidpower update exp*
$c_{bp,decayconst}$: *boidpower const decay*

$$bp = max(bp_{curr} * (1-c_{bp,decayrate})^{(tc-ts)} + bp_{new}{}^{(1-c_{bp,update})} - (t_c-t_s)/t_{day} * c_{bp,decayconst}, 0)$$

Power Tier

All Boid user accounts are sorted into six or more tiers based on a global assessment of their relative contribution to the network. For example, The bottom 5% of accounts may be sorted into Tier 0. Tier 1 - 4 generally includes the majority of average participants while Tier 5 might be defined as the top 10% of network contributors. A small bonus increases with each tier to encourage users to consolidate their power generation potential under as few accounts as possible. The scaling tier bonus also increases the opportunity cost of sybil attacks.

Power tiers diminish the impact of pareto distribution. The most common form of pareto distribution is the '20-80' distribution, meaning that 80% of the impact or effects of a system tends to come from 20% of its causes, or participants. In networks such as Boid, where the amount of power or stake contributed impacts the vote weight of an individual contributor, left unattended this distribution would dictate that and a small number of contributors would hold a large amount of voting weight. Power tiers are also critical to ensure more equitable participation in the DAC by requiring consensus weight from users in each tier, ensuring that a wide range of contributors can have an influence on network governance. Both power tiers and a voting weight formula are used together to diminish and equalize the effect of this distribution. Power tiers are not 'fixed' - it is possible that additional tiers will be added or removed, or that power requirements per tier are adjusted, in order to properly mitigate the effects of the pareto distribution.

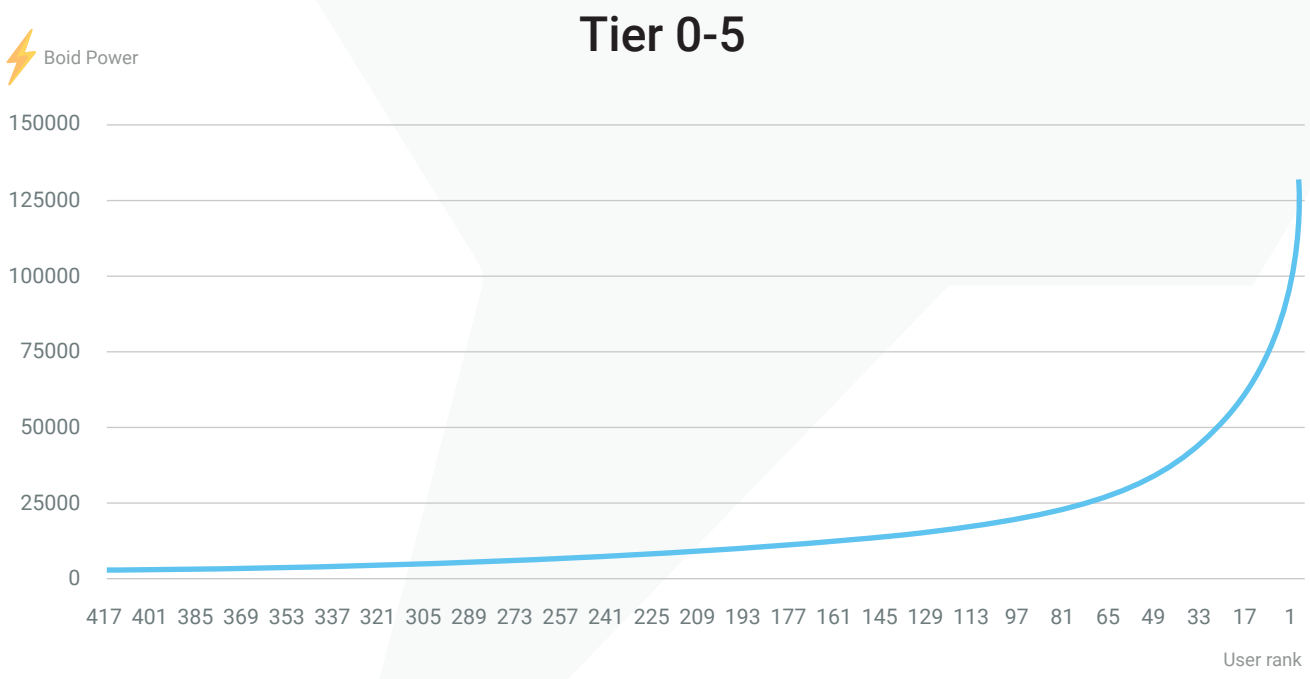
Power per Tier

	Current
tier 0	93,572
tier 1	201,468
tier 2	311,288
tier 3	448,068
tier 4	578,198
tier 5	576,721

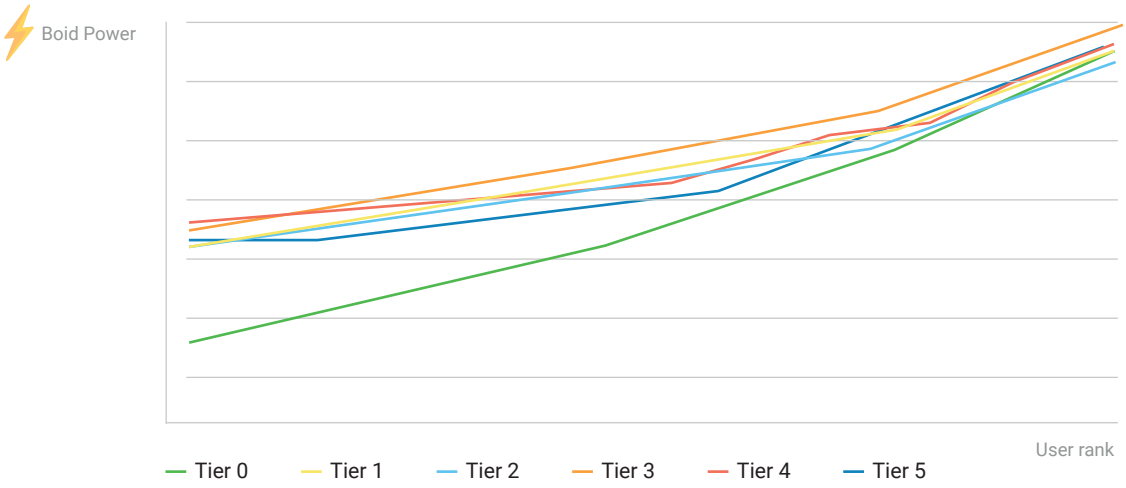
Average Power per Tier

	Current
tier 0	517
tier 1	2,143
tier 2	5,188
tier 3	12,446
tier 4	26,282
tier 5	64,080

Data from the live network above shows that the average power per user is more than twice as large for each subsequent tier, whilst total power per tier climbs slightly slower. The amount of users per tier, from tier 0 to tier 5, roughly halves each tier and currently is (respectively) around 180, 95, 60, 35, 20 and 10. This means that, without taking power and stake contributed to the network into account, the least contributing users are to have the most say in the governance decisions. The actual power pareto distribution of the Boid network is below. By using a vote weight formula, and granting a bonus per a users power tier, the vote weight can be redistributed amongst network participants giving a more equal distribution of vote weight.



In order to pass simple governance decisions, it might be sufficient to get a certain percentage of total governance weight to vote, regardless of tier, whilst voting on more fundamental changes may require a minimum threshold of participation from each tier in order to pass.



The above charts display the power distribution per user for each tier in the Boid network. The graphs show a close-to linear distribution of power per user in each separate tier. In case one tier starts to display a more pareto-like distribution, the tier limits can be changed or an extra tier can be added, to realign the per tier distribution.

Boid Social UI

Most users interact with Boid using the web interface. The reference web interface is open-source and connects to blockchain data sources to enable end users to perform all Boid functions. Because all data and authentication is on-chain, alternative front ends can be deployed to unlock different user experiences on top of the same network.

Web App Pages

Dashboard

The main dashboard of the Boid web interface gives the end user an overview of the entire network as well as a summary of their own account details.

- Login or create a new Boid account.
- View Account Boid Power and tier details.
- View Boid Devices attached to the account.
- View the number of active users invited using the account invite link.

- Update user profile information (image, tagline, username).
- View the team leaderboard and change teams.
- View the user leaderboards which are organized by tier.
- View upcoming Boid Team promotions.
- View account balance/stake information.

User Page

The user page shows historical details about a user contribution over time. Additionally this page can display the account devices, wallet, team, and power information.

Team Page

View details about the team branding and social links. Historical team performance is visualized as well as the current team leader and team promotion details. Users can select an individual team promotion to view the promotion specific leaderboard details.

Wallet Page

Users can view information about Boid seasons as well as staking and transferring their BOID tokens. Advanced users can delegate their stake to other accounts.

Boid Commons

Users can post on the forum and share information with the community. Additionally users can register to join the DAC, submit proposals or view proposals available for voting. Users can have discussions around governance proposals and issue on-chain votes.

Boid Alpha

The Boid platform alpha was launched in Q1 2018 in a highly iterative state. This has enabled Boid to grow a small grassroots community that is able to test concepts and grow the ecosystem organically. The data collected and lessons learned from the alpha help to drive the direction of the Boid network in the future. Over 10,000 accounts have been created and the web/native application sees an average of 1000 weekly users. Over 20 Boid Teams have been registered and are operated by popular apps token communities and block producers in the EOSIO ecosystem. Network activity can be tracked over time at stats.boid.com.

Alpha Milestones

2018 Q1

- Web and Native applications launched
- Boid Power and global leaderboards operational

2018 Q3

- Initial BOID token contract deployed on EOS mainnet
- First Boid Teams onboarded

2019 Q1

- BOID token upgraded with basic staking functionality
- Boid Team automated promotion functionality activated
- Boid Season functionality implemented

2019 Q2

- Boid decentralized mining pool alpha launched
- GPU PoWprotocol added to Boid network
- Boid Desktop app rewrite with GPU mining support

2019 Q3

- Boid Validators alpha program off-chain
- BOID Token upgrade with timed and delegated staking support

2019 Q4

- Boid DAC alpha live on testnet
- Boid Validators live on-chain

BOID Token

The BOID token is the core utility governance token of Boidnet. The token has advanced staking functionality tied into Boid Power mechanics. Many actions on Boidnet require some staked tokens.

BOID Token Actions

Transfer

Liquid tokens can be sent to/from Boid accounts without any fees. Staked tokens can not be transferred until they are unstaked.

Stake

Staking tokens locks them up making them unable to be transfered. When the stake action is called, you can specify who the stake should be directed towards. When you stake towards your own account this is called a self stake. When you stake towards another account, this is called a delegated stake. An expiration time can be set for the stake to expire in the future. If the expiration time is not set, then the stake will never expire, this is called an indefinite stake. Indefinite stakes can be unstaked at any time. If a stake/delegation is made with an expiration time set, that stake can not be unstaked until the expiration deadline has passed.

Unstake

Staked tokens must be unstaked to become transferable. During the Boid alpha all staked BOID was locked during an active Boid Season however this limitation has since been lifted. Today staked tokens can be unstaked instantly at any time so long as they are expired or indefinite. In the future it is likely that there may be more limitations around how much BOID could be unstaked over a certain time period such as a time-delay or rate-limiting formula similar to Steem blockchain power down mechanics (Steem.com, 2017).

Claim

When an account calls the claim action, pending reward tokens are issued to the account. The rewards generated come from Boid Power as well as BOID stake profitability calculations. The payout is calculated from the last time the claim action was called. This means that pending payouts will accumulate over time. Potential rewards from unpowered stake are deposited into the Worker Proposal fund. An account must generate Boid Power in order to receive any

power/stake rewards.

Recycle

BOID tokens can be recycled, meaning the tokens are removed from the owning account and total circulating supply. The tokens are not “burned” because it’s possible for those tokens to be re-issued again in the future through the normal inflation issuance. When fees are paid towards the system, the funds paid are recycled out of supply. The intention of the recycle action is to ensure that stake/power rewards can be properly funded in the long-term.

Token Utility Usage

Powered Stake Inflation

A unique relationship between Boid Power and BOID stake means that staked BOID can be powered or unpowered. The determination of powered versus unpowered stake for a specific account is made by the formula below. The parameters of the formula (multiplier and ratio) are global system variables that change over time. When users generate Boid Power they can call the claim action to claim their share of BOID token inflation linked to their powered BOID stake. Depending upon the power level of an account, there is an optimal amount of BOID stake the account could power. Staking below the account max reduces the powered stake rewards you receive. Any stake above the max powered stake is unpowered. Stake rewards from unpowered stakes are diverted towards the WPF. A useful calculator is available at https://stake.boid.com.

s_{pow} : *powered stake*
c_{pow} : *powered stake multiplier*
bp : *boidpower*
$r_{pow,max}$: *max powered stake ratio*
$s_{pow,tot}$: *total stake for all accounts*

$$s_{pow} = min(c_{pow} * bp, r_{pow,max} * s_{pow,tot})$$

Team Staking

To create a team, a team leader needs to self stake a minimum amount of BOID tokens. Additionally, other accounts can delegate stake towards the team leader in order to improve the team bonus. The team bonus is designed to provide a slight advantage to lower-performing teams. The team bonus is expressed as a simple earnings multiplier with a natural range between .1% (The team at the top of the leaderboard) to 3% (the team at the bottom of the leaderboard). When new users join Boid and need to decide which team to join, the join team

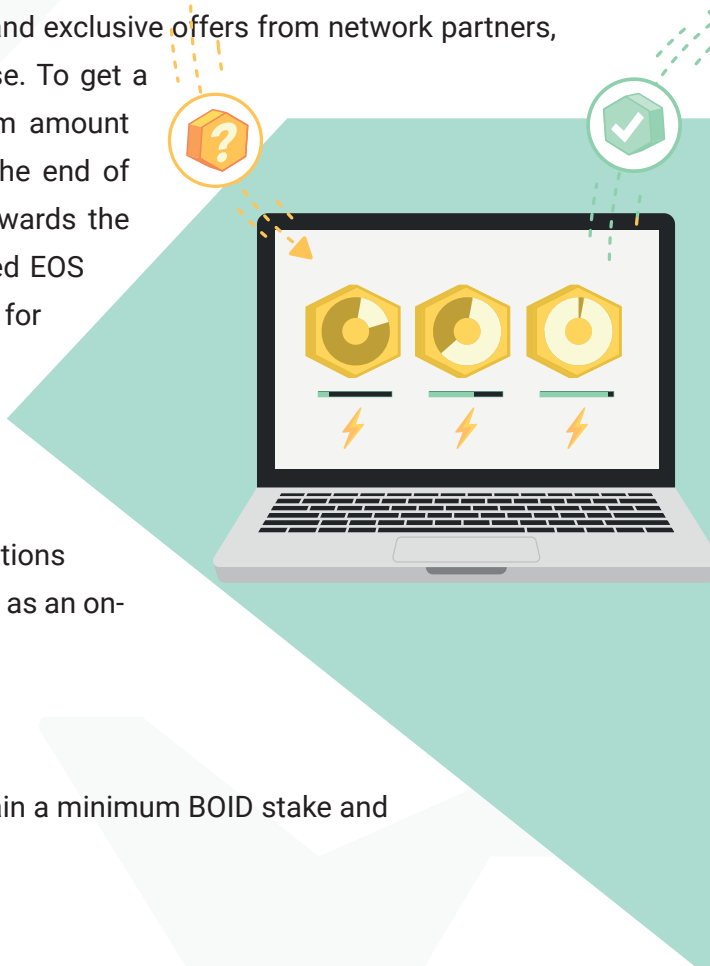
dialogue presents teams to them in the order of highest team bonus to lowest. Effectively, a higher team stake can help improve a team's visibility and bonus to give the team an advantage in attracting new users and moving up the team leaderboard. The advantages of the team stake diminishes as the team rises in the global leaderboard, meaning the team leader can't rely exclusively on the team bonus in order to retain a position high on the leaderboards.

Validator Stake + Deposit

To register a validator, an account needs a minimum self-stake with a 3+ month expiration in the future. Additionally the validator needs to deposit BOID token collateral into the power oracle contract as part of the registration process. After each round where the validator has made some valid reports they can call the payout action to receive a portion of the deposited tokens back plus a small bonus. If a validator fails to make enough valid reports or makes too many outlier reports, their deposited BOID for that round may be recycled out of supply or shared with validators which are in-consensus. These validator token mechanics will evolve over time in order to discourage bad actors and encourage long-term contributors who provide trustworthy data into the oracle contract.

Boid Season Pass

A Boid Season Pass is a non-transferable NFT attached to a Boid account which can be upgraded based on the performance of that account during a season. The season pass grants the owner access to additional advanced functionality and features on the platform as well as a new tier of cosmetic upgrades, collectibles, and exclusive offers from network partners, as well as discounts or free physical merchandise. To get a season pass, the user needs to have a minimum amount of self-stake with an expiration that ends after the end of the season. Additionally a minimum donation towards the WPF is required in the form of multiple whitelisted EOS currencies. The pass is mostly meant as a way for users to get public recognition for donating to the worker fund to help fund proposals that grow the Boid ecosystem. Users can collect passes and associated collectibles over time and display them on their public account page. Additional applications which utilize these collectibles could be built, such as an on-chain card battle game.



BOID DAC Governance

DAC membership is available to users who maintain a minimum BOID stake and

register their acceptance of the terms of Boid network governance. As a member you can submit worker proposals (submission fee in BOID + stake required) and you can redirect how your vote weight is directed. The DAC controls a multisig with dynamic authority that changes over time based on the distribution of vote weight. When a user joins a team, their vote weight is automatically directed towards the team leader who acts as a governance proxy. The user can manually vote if they disagree with the team leader governance decisions.

Boid Swarm Prioritization

When researchers upload work units to the Boid Swarm service which may be deployed in the future on Boidnet, they could be required to have a long-term BOID stake + recycle some BOID out of circulation based on the amount of CPU time they need from the network. Whitelisted work units generate Boid Power but researchers could also choose to attach tokens to individual work units. The device that completes a verified work unit is able to unlock and receive the attached tokens. Since Boid Devices will automatically prioritize the most profitable work units, researchers could use stake + attach to increase the speed at which results will be returned by the network.

Boid Team Trophies and collectibles

Team Leaders can run time-limited contests to create some incentive for their users where the top contributors win a prize. Additionally, they can create rare collectibles that users can earn and trade based on their team contributions. They might incentivize users to do some social activity or to contribute CPU cycles towards a specific science project. To activate these advanced features, they need to pay in BOID tokens. The tokens spent in these promotions may be recycled out of supply or attached to team promotions.

Token Inflation Mechanics

BOID token inflation is allocated in four main ways:

Power Profit

Rewards earned by users for contributing towards network protocols which generate Boid Power.

Stake Profit

An additional payout on top of the power profit which takes into account staked BOID tokens and total Boid Power (PoweredStake vs UnpoweredStake).

Validators

Validators are only rewarded for the contribution of data to the power oracle contract which reaches majority consensus.

Teams

Teams receive a portion of base level inflation. Team leaders can opt for the team rewards to automatically be distributed toward users who contribute towards their team in the form of a team bonus.

Token Inflation Adjustment

Power and stake difficulties need to be adjusted regularly to accommodate for changes in the amount of power that is contributed to the network by participants as well as changes in the amount of allocated stake. In order to ensure long-term flexibility Boidnet utilizes a recursive inflation adjustment formula which balances its token emission.

New values for power difficulty $P_d(n+1)$, and stake difficulty $S_d(n+1)$, are calculated each month by multiplying the current power- and stake difficulties and with an adjustment ratio A_m. This adjustment ratio is based on the differences between the projected & realised emissions of all past months (1, 2, …, n). The adjustment ratio is larger than 1 in case the total realised emission is greater than the projected emission, resulting in higher difficulties for month $n+1$ and will be lower than 1 in case the total realised emission is less than the projected emission, resulting in lower difficulties for month $n+1$.

The adjustment ratio can be expanded as a summation over multiple months, by taking the summation of differences between realised and planned emissions over m months and subtracting this from the planned emission of next month:

$$A_m(n+1) = \frac{E_r(n)}{E_{am}(n+1)}$$

$$E_{am}(n+1) = E_p(n+1) - \sum_{i=1}^{n} \left(E_r(i) - E_p(i)\right)$$

In the above formula $E_r(n)$ is the realised emission in month n and $E_{am}(n+1)$ is the adjusted emission for month $n+1$. The adjusted emission is equivalent to the projected emission $E_p(n+1)$ for month $n+1$, with the difference between realised and planned emission of all prior months subtracted from it.

Realised emission $E_r(n)$ is the amount of BOID that's being rewarded to participants in the BOID network. Realised emission is the result of total power contributed to the network divided by power difficulty, plus total stake allocated divided by stake difficulty, per day, plus total monthly rewards for validators & teams and the Worker Proposal System. Hence the total realised emission of a certain month can be calculated using the following formula:

$$E_r(n) = \left(\frac{P_t(n)}{P_d(n)} + \frac{S_t(n)}{S_d(n)} \right) \cdot d(n) + V_r(n) + T_r(n) + W_r(n)$$

Projected emission $E_p(n)$ has been set in a table, based on an exponential growth formula. The target emission for BOID is to increase the current supply of 1.750.000.000 BOID to a total of 20.000.000.000 BOID over a period of 30 years (= 360 months). Therefore we can calculate the relative monthly increase as follows: $\frac{20.000.000.000}{2.750.000.000}^{\frac{1}{360}}$ = 1,0055266 ≃ + 0.5526692% per month. This growth factor will be used to map out the projected emission.

The difference between projected and realised emission is calculated recursively: $\sum_{i=1}^{n} \left(E_r(i) - E_p(i) \right)$. Here, the projected emission is subtracted from the realised emission in each month $i=1,2...n$ • – and the sum is taken of all these differences. This summation is the amount of BOID that has been paid out either over (in case of a positive output) or under (in case of a negative output) the total projected emission in months 1 through n .

The output of the summation 1 through n is subtracted from the projected $E_p(n+1)$ for month $n+1$, giving the adjusted emission $E_{am}(n+1)$ for month $n+1$. The realised emission $E_r(n)$ of month n is divided by this adjusted emission $E_{am}(n+1)$ for month , creating the adjustment ratio for power and stake difficulties:

$$A_m(n+1) = \frac{E_r(n)}{E_{am}(n+1)}$$

This can be written in full and using total power & stake or using average power & stake and users.

$$A_m(n+1) = \frac{E_r(n)}{E_p(n+1) - \sum_{i=1}^{n} \left(E_r(i) - E_p(i) \right)}$$

$$= \frac{\left(\frac{P_t(n)}{P_d(n)} + \frac{S_t(n)}{S_d(n)} \right) \cdot d(n) + V_r(n) + T_r(n) + W_r(n)}{E_p(n+1) - \sum_{i=1}^{n} \left(\left(\left(\frac{P_t(i)}{P_d(i)} + \frac{S_t(i)}{S_d(i)} \right) \cdot d(i) + V_r(i) + T_r(i) + W_r(i) \right) - E_p(i) \right)}$$

This formula comes with two conditions based on stake power multiplier and stake/power ratio: (1) being that realised emission may never be greater than the possible emission based on the allocated stake and power in the network and (2) being that the stake/power ratio should never be smaller than 2 – meaning the benefit of staking BOID ánd contributing power, should be minimum twice as great as the benefit of just contributing power to the network.

$$E_r(n) \leq S_m \cdot \frac{SP_t}{SP_s}$$

$$SP_s \geq 2$$

As stated earlier, the adjustment ratio $A_m(n+1)$ can be used to determine the new power & stake difficulties for a certain month $n+1$, by multiplying it with the power and stake difficulties of month n:

$$P_d(n+1) = P_d(n) \cdot A_m(n+1) \cdot SP_r$$
$$S_d(n+1) = S_d(n) \cdot A_m(n+1)$$
$$SP_r = 1.2 \text{ if and only if } SP_s < 2, \text{ otherwise } SP_r = 1.$$

If the network grows immensely at once, producing a multiple of the projected emission in a single month, the adjustment ratio might give a negative value. If this happens, both power & stake difficulties will be multiplied by 3 instead, to up the network resilience and prevent any issues.

$$\text{IF } A_m(n+1) < 0, \text{ use } A_m(n+1) = 3 \text{ instead.}$$

List of variables and parameters:

$U(n)$	users in month n
$d(n)$	days in month n
$P_a(n)$	average power per user per day in month n
$S_a(n)$	average stake per user per day in month n
$P_t(n) = U(n) \cdot P_a(n)$	total power per day in month n
$S_t(n) = U(n) \cdot P_a(n)$	total stake per day in month n
$P_d(n)$	power difficulty in month n
$S_d(n)$	stake difficulty in month n
SP_m	stake power multiplier
$S_m(n) = S_t(n) \cdot S_p(n)$	maximum stake in month n

$P_b(n) = \frac{P_t(n)}{P_d(n)}$ — BOID emission (through power) in month n

$S_b(n) = \frac{S_t(n)}{S_d(n)}$ — BOID emission (through stake) in month n

$V_r(n)$ — BOID emission to validators in month n

$T_r(n)$ — BOID emission to teams in month n

$W_r(n)$ — BOID emission Worker Proposal System

$SP_s(n) = \frac{P_b}{S_b}$ — Stake/Power Ratio for stake in month

$SP_p = 1$ — Stake/Power Ratio for power

$SP_t(n) = SP_s(n) + SP_p$ — Stake/Power Ratio total

$E_p(n+1)$ — Planned emission for month n+1

$E_r(n)$ — Realised emission (calculation below)

$$E_r(n) = (P_b(n) + S_b(n)) \cdot d(n) + V_r(n) + T_r(n) + W_r(n)$$

$$= \left(\frac{P_t(n)}{S_d(n)} + \frac{S_t(n)}{S_d(n)}\right) \cdot d(n) + V_r(n) + T_r(n) + W_r(n)$$

$$= \left(\frac{U(n) \cdot P_a(n)}{S_d(n)} + \frac{U(n) \cdot S_a(n)}{S_d(n)}\right) \cdot d(n) + V_r(n) + T_r(n) + W_r(n)$$

$$= U(n) \cdot \left(\frac{P_a(n)}{S_d(n)} + \frac{S_a(n)}{S_d(n)}\right) \cdot d(n) + V_r(n) + T_r(n) + W_r(n)$$

Potential Impact

Charity

The idea of mining cryptocurrency for charity has been tried before, and with quite reasonable success. UNICEF introduced 'Game Chaingers' in 2018, a service through which participants could use their graphics cards to mine cryptocurrencies and donate their earnings directly to charity. Their service was live for only a short period of time, but showed great participation from the computer gaming & streaming community, raising over $33,000 in a 2 month period, using 12,000 computers worldwide (UNICEF & BETC Paris, 2018). Besides Game Chaingers, UNICEF launched 'HopePage', which is a website you could visit in your browser and would automatically mine and donate

cryptocurrency which was spent on water, food and vaccines for children. These efforts and their success show people are willing to donate their resources, and if done well, this can provide quite a substantial means of charitable donations to charities and humanitarian causes worldwide.

Boid aims to tap into the charitable donations industry and allow people to donate towards charities and humanitarian causes by simply contributing their spare computational resources. People willing to donate their computational resources through either CPU, GPU and/or HDD can simply install Boid Desktop, set the percentage of computational resources they want to donate and start donating. Boids team structure can be leveraged for partner charities and humanitarian causes as well, by allowing participants to join a charity team which would automatically convert a portion of their earnings into donations to one, or several, charities and humanitarian causes.

Scientific Research

Volunteer computing first emerged as an idea roughly 25 years ago. Researchers were convinced the future of data-driven investigation had arrived. BOINC, specifically, has since been installed by millions of volunteers, yet only several hundred thousand of those are actively contributing to the network. The idea of volunteer computing being a possible solution for data-driven research, however, is not lost. With billions of machines globally that can contribute spare computational resources, there is a serious step forward possible. There has been no advertisement done for the platform since there was no budget to do so, although mass media coverage has enticed about 2 million people to join in the early days of BOINC. There is massive untapped potential left due to the low exposure volunteer computing, and BOIC specifically, has had (Chamberlin, 2015). Computing power has risen with an average of 86% annually in a 20-year period since 1986 (Hilbert & Lopez, 2011) and still increases continuously. Moore's law appears to be holding up over time. This means the contribution an average participant can make increases as well, and the untapped growth potential in the amount of volunteers is staggering.

Since the launch Boid has been completing on average 60,000 work units per day. For comparison, that is the daily equivalent of about 16 years of computing power for a typical PC.

BOINC users as a whole currently contribute over 23,483 TFLOPS to distributed scientific computing projects which is about the same processing power as the world's 5th most powerful supercomputer (Frontera@Texas Advanced Computing Center). Boid hopes to incentivize participation in BOINC and other distributed computing projects since participation rates are currently very low compared to their potential. There are over 2 billion PCs in use globally and over 2 billion smartphones. Right

now, BOINC runs on about 650,000 devices and if you include other volunteer distributed computing projects like Folding@home and DreamLab the total number of active devices is likely still under 1 million. This means that fewer than 0.1% of the available devices are currently being put to use for beneficial scientific computing projects, but they already form the equivalent of one of the world's most powerful supercomputers being provided to researchers a little to no cost.

Computational and User Statistics Across Systems and Platforms

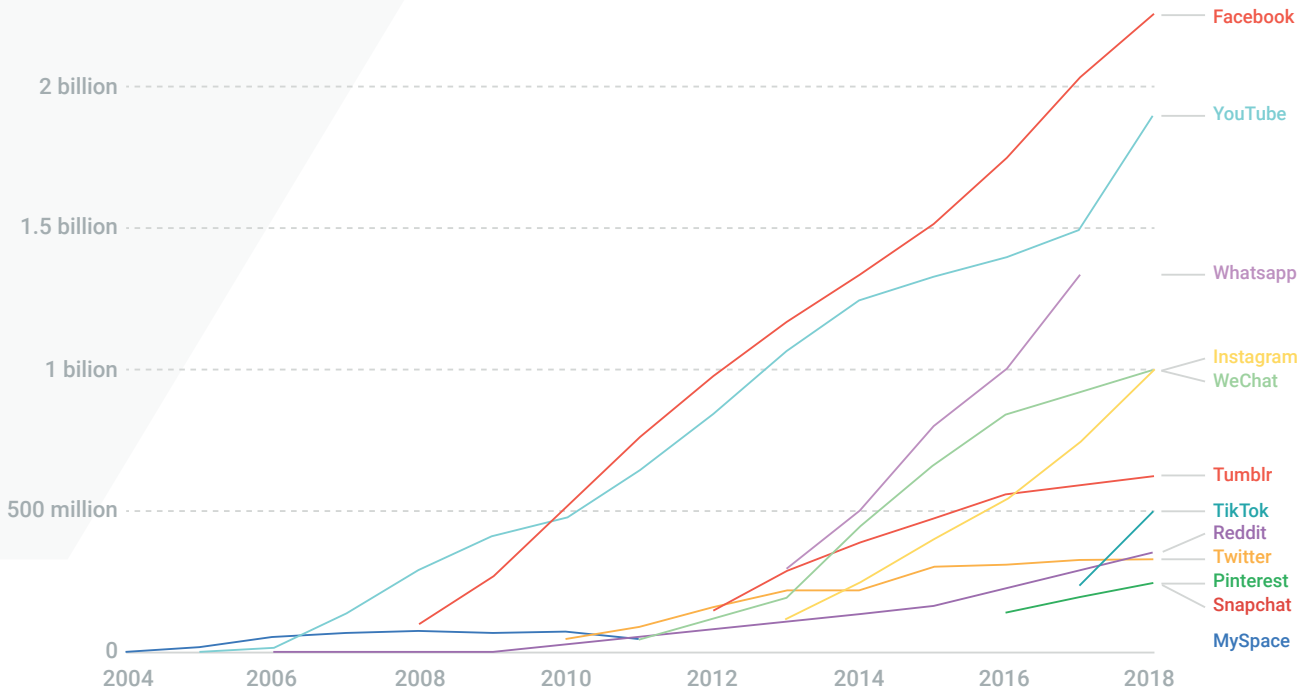
		TFLOP/s			
System	# Cores	Max	Peak	Active Hosts	Active Users
#1 Supercomputer	2,414,592	148,600	200,794	-	-
#10 Supercomputer	288,288	18,200	23,047	-	-
#100 Supercomputer	186,386	2,566	4,701	-	-
#500 Supercomputer	27,520	1,142	2,278	-	-
Folding@Home	327,712	47,344	-	110,685	-
BOINC	-	23,483	-	649,358	135,283

Sources:
https://www.top500.org/lists/2019/11/
https://boincstats.com/en/stats/-5/project/detail
https://www.worldcommunitygrid.org
https://stats.foldingathome.org/os

The above table shows BOINC is virtually within the top 10 of the world's supercomputers. With just several hundreds of thousands of active contributors and a large untapped growth potential, it is within shouting distance of toppling the #1 supercomputer in computing power. The average computing power per active user for BOINC is 0.17 TFLOP/s. Taking a look at the largest social media sites globally, we can estimate the potential contribution even if just 1% of those users were to start contributing their spare computational resources towards distributed computing networks.

As can be seen in the table below, even tapping into 1% of the 10th largest social media network would result in a potential contribution of 3 times the computational power of the current world's

fastest supercomputer. The growth potential being as it is, it is vital to entice the masses to start contributing their spare computational resources towards volunteer computing. The combination of incentives and accessibility that Boidnet provides make for a prime candidate to enable broad participation in these important causes.



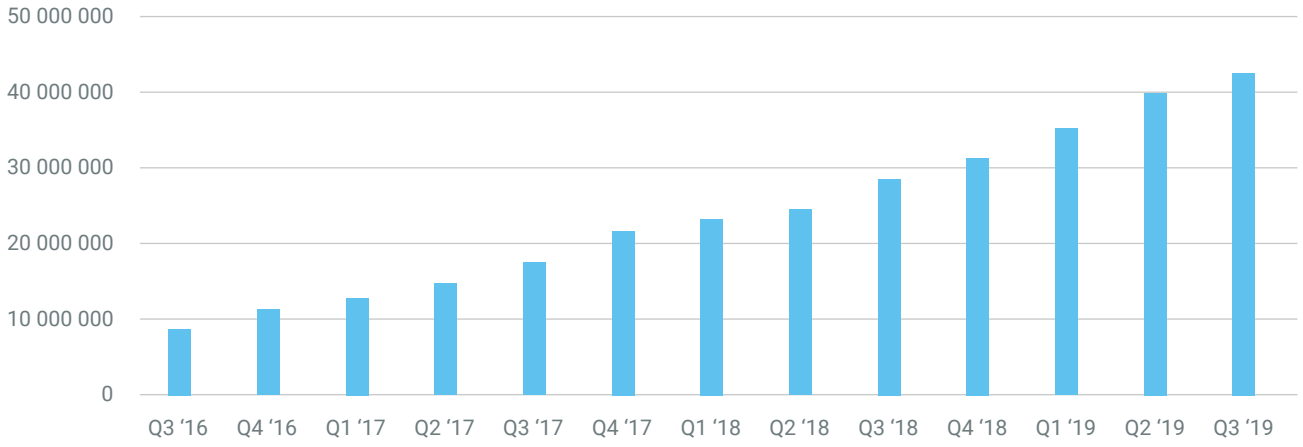
Source: Statista and TNW (2019)

Sources:
https://ourworldindata.org/rise-of-social-media

Social Media platforms: user base and potential contribution

		Potential contribution	
Socila Media	# Users	1% of users	TFLOP/s estimate
Facebook	2,200,000,000	22,000,000	3,740,000
YouTube	1,800,000,000	18,000,000	3,060,000
WhatsApp	1,300,000,000	13,000,000	2,210,000
Instagram	1,000,000,000	10,000,000	1,700,000
WeChat	1,000,000,000	10,000,000	1,700,000
Tumblr	600,000,000	6,000,000	1,020,000
TikTok	500,000,000	5,000,000	850,000
Reddit	350,000,000	3,500,000	595,000
Twitter	325,000,000	3,250,000	552,500
Pinterest	250,000,000	2,500,000	425,000
Snapchat	250,000,000	2,500,000	425,000

Besides using social media platforms to gain network participants, Boid can tap into other industries and platforms as well to allow for expansion of its user base and the contribution of computational resources. An estimate of blockchain wallet users worldwide is shown below. In Q3 '19, the estimate was just over 42 million users worldwide.



Sources:
https://www.statista.com/statistics/647374/worldwide-blockchain-wallet-users/

If 1% of these users were to contribute to Boid, we would have an estimated 4,200,000 users potentially contributing an average 714,000 TFLOP/s (based on 0.17 TFLOP/s per user) - or nearly five times the current #1 supercomputer. This number is especially interesting due to the fact that adoption of blockchain and cryptocurrency technology is at its infancy, and is deemed by many to be (nearly) ready for mass adoption - in which case the amount of users, and therefore the potential contribution of resources by reaching 1% of those users, could immensely increase and become a multiple of this current estimate.

Potential Applications

The modular structure of Boidnet protocols makes it an ideal platform to build products/services on top of. We see a wide range of potential applications of the technology from core architecture to user-facing games.

Decentralized POW Mining Pools

The majority of mining pools are based on a trust model where the pool owner needs to be trusted to payout the correct percentages based on device contributions. Boid PoW Protocol pools are able to publish internal PoW shares data in a way that is independently verifiable. This means that each Boid

validator node could double check that a Boid PoW pool is acting honestly. Alternative pools can be spun up and devices can automatically point at the most reliable pool based on network consensus. Removing the trust element from pool operation reduces friction for pool operators and enables them to focus on infrastructure development instead of marketing and promotion. BOID tokenized incentives enable PoW pool operators to charge a higher percentage fee vs other pools while still remaining competitive with other pools in terms of profitability to end users.

Decentralized Block Production

Purpose

DPoS chains sacrifice node diversity to improve performance and reliability and enable more predictable on-chain governance. EOSIO chains tend to have 21 BP slots which are responsible for consensus. BPs are chosen by preference or votes cast by token holders. Each round a slot of time is set aside for each of the top 21 BPs where it is expected that the node will produce blocks and claim the block reward pay + vote pay. In case a BP misses a block, and has not produced a block in 24 hours time, they are removed from consideration until they notify the blockchain of their availability to produce again. This ensures smooth operation of the blockchain by limiting the negative impact of unreliable nodes (EOSIO, 2018).

Possible Solutions

The Boid Validators each run a block production node. An automated smart contract enables/disables block production keys based on some metrics. The EOSIO chain might vote in a single “boid BP” slot, then our contract determines which node in our network has permission to produce blocks for each round. The rotation of our nodes happens in a round-robin style, and validators can register/deregister as a valid BP node. There is an incentive to participate as a block producer as all participating validator nodes receive a share in the block production rewards. The advantage for Boid is we would have a higher level of redundancy and node variety vs any other block producer. Governance decisions could still be made by the Boid DAC, which means the individual boid validators only need to worry about operating infrastructure, and they benefit from the branding and social engagement of the Boid platform.

Boid Swarm

Boid Swarm is a comprehensive platform that could be built on top of Boidnet. Swarm is designed for researchers and data scientists who need access to large computing resources in order to solve socially or ecologically significant problems. Traditionally, these groups will utilize on-site server farms, or cloud computing solutions.

Problem

Some scientific researchers have utilized distributed computing platforms (BOINC) to save money, but running a distributed computing project introduces many variables into a project, and requires that researchers and data scientists advertise their project, asking people to contribute computing power on a volunteer basis. These extra variables introduced by distributed computing create substantial friction, and are difficult to budget for during the funding process. Additionally, most projects may not be long running enough to make the ramp-up time worth the cost savings of a distributed computing project. This means that only long running projects are able to reap the benefits of discounted computing costs afforded by tapping into distributed computing platforms and communities.

Solution

To solve this problem, Boid Swarm could act as an all-in-one distributed computing as a service platform. Through a semi-automated process, those in need of computational resources can submit work units, which are publicized by the Boid platform, and distributed to be run across all Boid users computing devices.

This means that researchers and scientists in need of computing power can now access distributed computing nearly as easily as they could access cloud computing services. The benefits of distributed computing include an increase in computing power per dollar spent and a quicker turnaround time. Additionally, participation in the Boid ecosystem is a way for researchers to gain free publicity and public engagement with the problems that they are trying to solve. Increased publicity could help smaller projects gain mainstream attention and attract additional funding.

Limitations

Distributed Computing does have some differences from traditional cloud computing solutions, and this places some limits on the types of computing tasks that can be supported by the Boid Swarm platform initially.

- Computing tasks must run inside of industry standard docker containers.
- Work Units must operate independently. In grid computing the term is called “embarrassingly parallel”.
- The code and datasets of the tasks must be open-source or publicly viewable.

Generally, these limitations are acceptable for a wide range of applications, and advancements

in code obfuscation and hardware enclave technology will ensure that these limitations become less relevant in the future. View a demo at swarm.boid.com.

Conclusion

The Boid software makes it simple for anyone to make an impact by contributing towards important scientific computing research projects and decentralized blockchain consensus. Users compete on global leaderboards, while Boid teams rally individuals around brands and communities.Tokenized governance enables network participants to evolve the platform over time. The modular structure of Boidnet provides a basis for additional services to be built and operated by network participants. Boid is creating a future where anyone can easily benefit from direct participation in distributed networks.

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