ETH2 CLIENTS DEVELOPMENT REPORT 2021

Chainstack

CONTENT

ABOUT CHAINSTACK

Chainstack provides managed blockchain services, making it simple to launch and scale decentralized networks and applications—complete with an intuitive user interface, seamless orchestration, and predictable pricing.

We offer enterprise-grade tools and services that empower developers, solution providers, and consortia to safely experiment and run in production.

By building on Chainstack, you reduce the time, cost, and risk involved with leveraging decentralized technologies. With a secure API, membership management, and flexible deployment options, you can immediately accelerate and future-proof your development of transformative solutions.

This report has been researched, coordinated, and led by Evgeny Konstantinov, Knowledge Manager at Chainstack.

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EXECUTIVE SUMMARY

This report provides objective development data on Eth2 clients as of the beginning of 2021. Until this report, it had been mostly testnet data analysis attempts and various individual reviews.

This report also reveals the impressive client diversity of Eth2 and the factors contributing to the success of an open-source project—an especially relevant point for the largest decentralized network with smart contract functionality.

Key findings

20 work years	Collectively, roughly 20 years of work by 10 independent Eth2 client teams have contributed to the launch of the mainnet.
5 clients	The effort put in by all the teams has made Eth2 a truly multiclient network with five clients supporting the mainnet right on launch.
Client-diverse	The Eth2 mainnet is supported by the clients with different target user groups and written in different programming languages.
~$2M in grants	The Ethereum Foundation has granted the publicly disclosed amount of over $2,000,000 to the development of Eth2 clients.
5000 developers	Over 5000 developers have engaged with and contributed to the five client projects that are a part of the Eth2 mainnet today.
Go and Rust	The programming language choice follows the Eth1 mainnet client popularity, where the number one client is Geth written in Go and number two is OpenEthereum (formerly Parity) written in Rust.
One major client	Prysm, written in Go, has almost twice as much developer activity as the rest of the clients. Prysm is shaping up to be the major Eth2 client, similar to Go Ethereum in Eth1.
One pure-play Ethereum company	Unlike all other companies that develop the clients in the list, Prysmatic Labs is a pure-play Ethereum company.
x7 code pushes per developer	Prysm is the leading client project whose average push activity per developer grew almost seven times from 2018 to 2019 and remained consistent since then.
Enterprise has the most devs	In the number of unique developers that actually pushed the code that makes the clients what they are, Teku—touted as the enterprise client—takes the first place.
Popular for light devices	The Nimbus client, created to run on resource-restricted devices, receives enough developer interest to get to number three in popularity.

METHODOLOGY

The research focuses on tracking the development and developer engagement data of the Eth2 clients, all of which host their code on GitHub.

The protocol developer data used is retrieved from the historical GitHub data collected by GH Archive from 2011 until the end of 2020.

The GH Archive project collects and stores all GitHub events—collectively called activity—triggered by any GitHub account.

This means that any time a developer does anything on GitHub relative to an open repository, it triggers an event, gets recorded, and is stored for anyone curious to explore it.

The data analyzed is from the moment the Eth2 client code went online on GitHub until the end of 2020.

While the full list of GitHub events is significantly long, this report uses only the events exhibited by the analyzed Eth2 clients.

The events are:

- CommitCommentEvent — a comment on a commit is provided.
- CreateEvent — a branch or a tag is created.
- DeleteEvent — a branch or a tag is deleted.
- ForkEvent — a repository is forked.
- GollumEvent — a Wiki page is created or updated.
- IssueCommentEvent — an issue comment is created, edited, or deleted.
- IssuesEvent — an issue is manipulated in any way: created, edited, labeled, etc.
- MemberEvent — an account is added to or removed from a repository.
- PublicEvent — a private repository is made public.
- PullRequestEvent — a pull request is manipulated in any way: created, edited, assigned, etc.
- PullRequestReviewCommentEvent — a comment on a pull request is created, edited, or deleted.
- PushEvent — a commit is pushed to a branch.
- ReleaseEvent — a release is manipulated in any way: created, edited, published, etc.
- WatchEvent — a repository is starred.

The events comprise the activity on GitHub.

INTRODUCTION

The Eth2 mainnet has started as a truly multiclient network with validators having the option to use any of the five clients developed by different independent teams and companies.

Validators are the backbone of the Eth2 network.

Being a validator on the Eth2 mainnet today means:

- Supporting today's largest decentralized network with smart contract functionality in the world.
- Committing funds as a stake to the network.

Both individuals and enterprises commit to the network based on the image of Eth2 and the data and the track record of Eth1. Becoming a validator on Eth2 today, even with the promise of a higher ROI than later in the Eth2 lifecycle, is a risky endeavor as the staked funds can only be withdrawn in approximately two years from the date of this report with the introduction of Phase 1.5.

Phases

The Eth2 mainnet has officially launched on Dec 1, 2020 with Phase 0.

The transition from Eth1 to Eth2 will be done in four phases, namely Phase 0, Phase 1, Phase 1.5, Phase 2. The Eth2 mainnet will depend heavily on the Eth1 mainnet until Phase 1.5.

Phase 1.5 is also the likeliest phase when those staking Eth2 will be able to withdraw their ether.

At the time of this report, there is yet no specific date for the start of each of the phases past Phase 0.

The Eth2 mainnet is run by Eth2 nodes and clients, all open-source and developed by independent teams.

This report provides objective development data on Eth2 clients as of the beginning of 2021.

High-level overview of the components of an Eth2 validator

There are three main components required to become a validator on Eth2:

- Beacon Chain client — the core component of Eth2. This is the blockchain node responsible for the network consensus, synchronization, the lifecycle of validators, connection to Eth1 nodes, provisioning of RPC and P2P services.
- Validator client — the lightweight component that connects to the Beacon Chain node. The validator client is responsible for the proposition and attestation of blocks. A single validator client can run multiple validators represented by keypairs with 32 ether stakes.
- Eth1 client — the Eth1 node to which the Beacon Chain node connects to retrieve the data on the validator stake deposits.

Eth2 clients

The clients analyzed:

Client	Programming language/ framework	Ethereum Foundation grant	Development status	Eth2 mainnet	Company/ team brief
Cortex	.NET	N/A	Abandoned	No	Nethermind, a blockchain company that has also developed and maintains an Eth1 .NET client.
Harmony	Java	USD 189,000 [1]	Abandoned	No	An independent team.
Lighthouse	Rust	USD 485,000 [2]	Active	Yes	Sigma Prime, an information security and blockchain company.
Lodestar	TypeScript	USD 217,500 *	Active	Yes	ChainSafe, a blockchain company that has also contributed to Cosmos, Polkadot, and Ethereum Classic.
Nimbus	Nim	USD 500,000 *	Active	Yes	Status, a blockchain company.
Prysm	Go	USD 725,000 *	Active	Yes	Prysmatic Labs, a pure play Eth2 company.
Shasper	Substrate	N/A	Abandoned	No	Parity Technologies, a blockchain company that has also developed the second most popular Eth1 client and Polkadot.
Teku	Java	N/A	Active	Yes	ConsenSys, a blockchain company focused on Ethereum.
Trinity	Python	N/A	Active	No	A team of independent developers contracted by the Ethereum Foundation.
Yeeth	Swift	N/A	Abandoned	No	A team of two independent engineers.

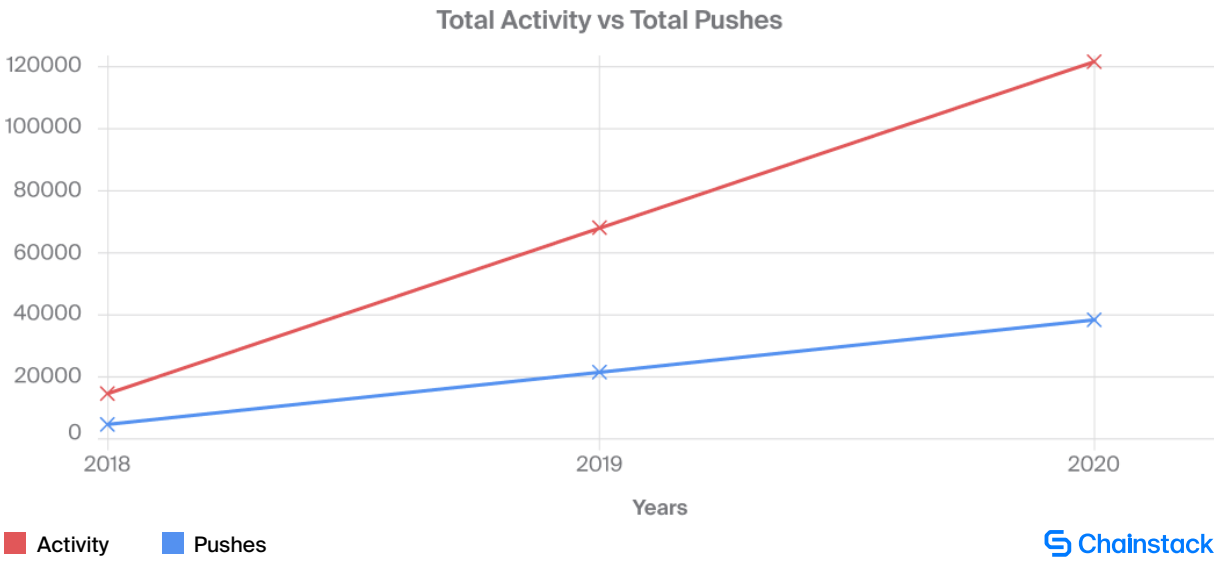
[1] Announcing Ethereum Foundation and Co-Funded Grants. ethereum.org. (accessed January 18, 2021)

[2] Co-funded with ConsenSys. Announcing Ethereum Foundation and Co-Funded Grants. ethereum.org. (accessed January 18, 2021)

Total activity and total pushes of Eth2 clients

The Eth2 mainnet running today is composed of the Eth2 clients deployed and validating the network.

What follows is a look into all the work that made the current Eth2 mainnet a practical reality from the client perspective, including the contribution of the projects that did not launch.



To have a point of reference for the numbers and the charts, we can compare the Eth2 activity and pushes over time to the data of Polkadot.

Polkadot, sharing very similar ancestry and culture with Eth2 and much of the same developer network, is the closest project Eth2 can be compared to.

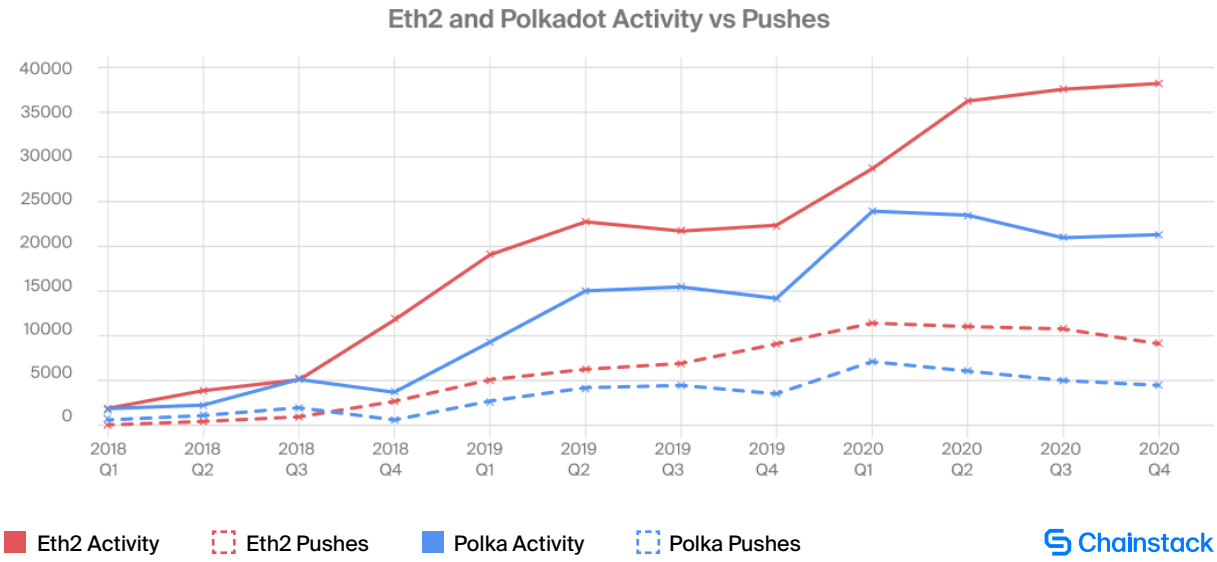
Other reports—for example, the recent developer report from Electric Capital[3]—inevitably compare Polkadot and Ethereum as well.

Total activity and total pushes of Polkadot clients

Polkadot has three clients that have collectively been in development for the past three years::

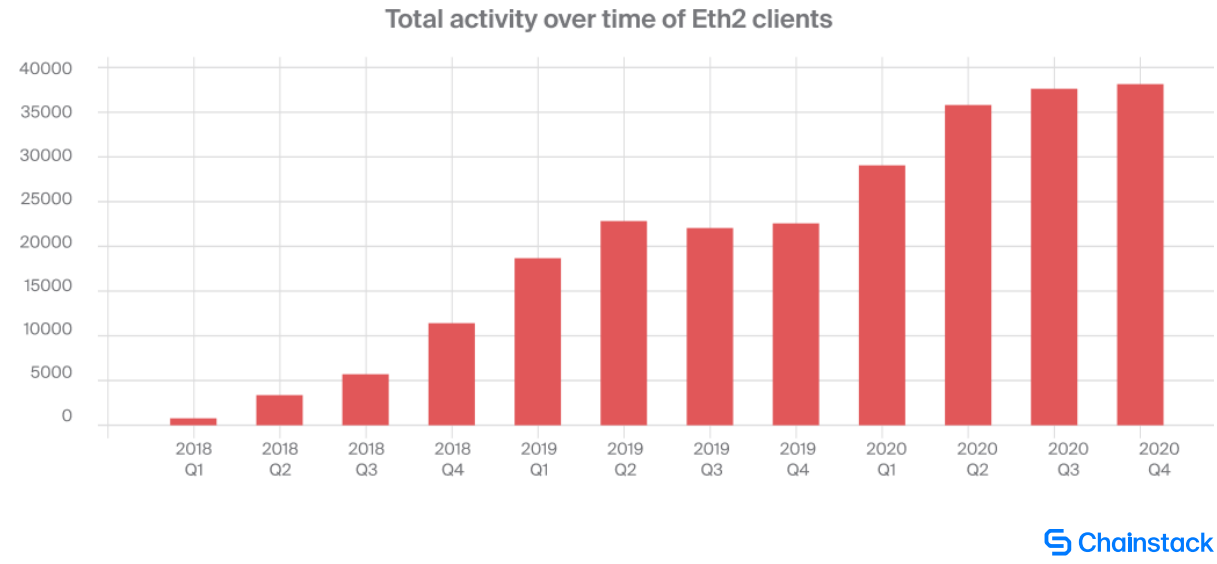
- Polkadot — the main Polkadot client from the Parity Technologies. The same company that developed the second most popular client on Eth1 and abandoned the development of an Eth2 client.
- Gossamer — a Polkadot client by ChainSafe. The same company that successfully developed and launched an Eth2 client.
- Kagome — a Polkadot client by Kagome. A fintech and blockchain company that also contributes to the development of Hyperledger Iroha.

[3] Electric Capital Developer Report (2020)



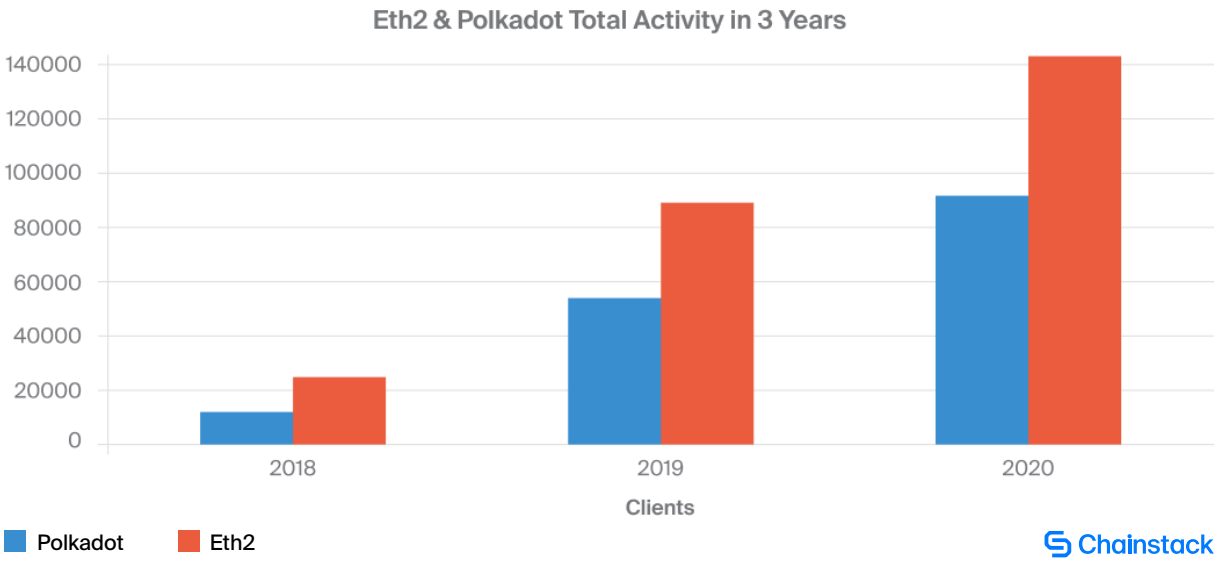
Total activity over time of Eth2 clients

The overall developer activity and engagement is on a steady growth.



Total activity over time of Polkadot clients

For reference, a look at the total activity of the three Polkadot clients compared to Eth2:

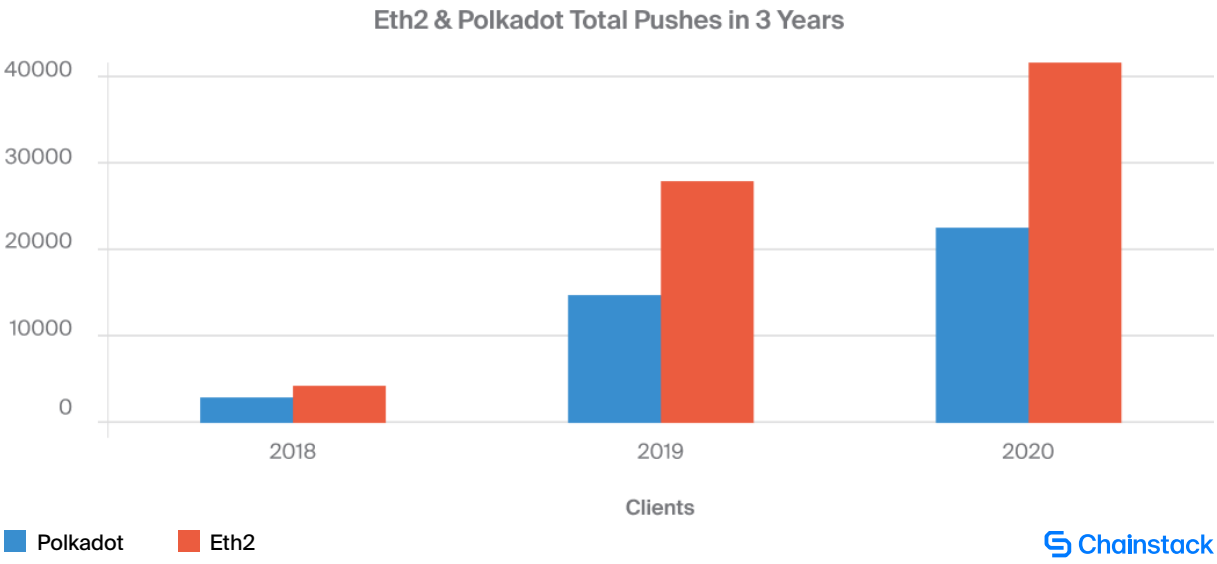


Total pushes over time of Eth2 clients

While total developer activity is a good indicator of the project's health and the network effect, pushes are what actually make the Eth2 clients run.

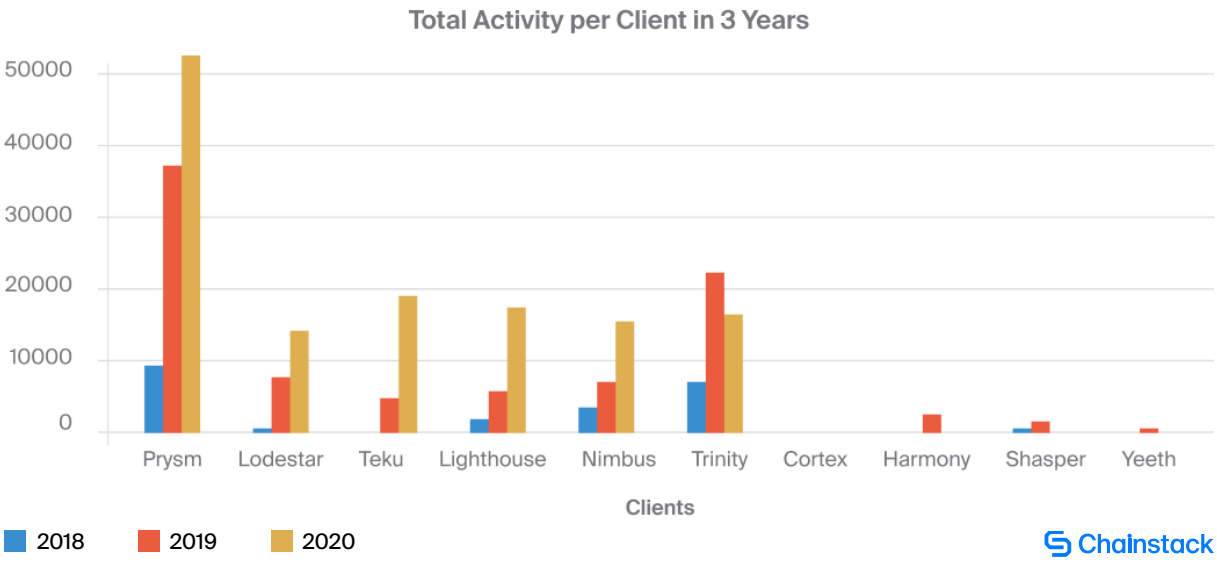
Total pushes over time of Polkadot clients

For reference, total push numbers of the three Polkadot clients compared to Eth2:



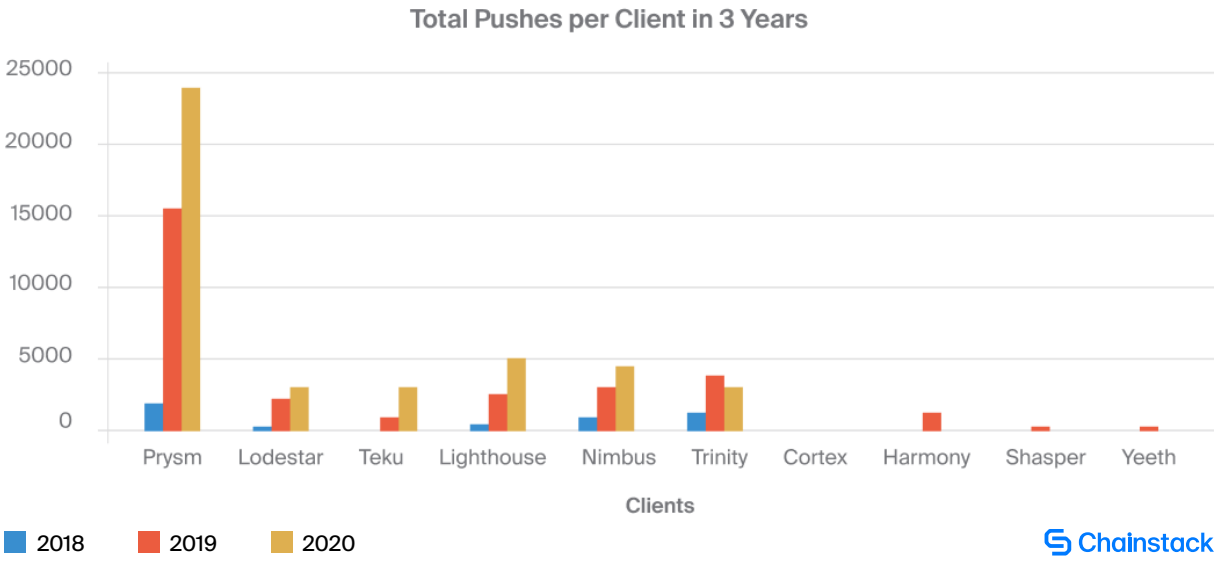
Total activity per Eth2 client compared year to year

All five clients that currently support the Eth2 mainnet have seen a steady year-over-year growth, which includes developer engagement.



Total pushes per Eth2 client compared year to year

Same as with the total activity, only the five clients that currently support the Eth2 mainnet have been consistently showing increasing code contributions year-over-year.



Total activity per Eth2 client compared

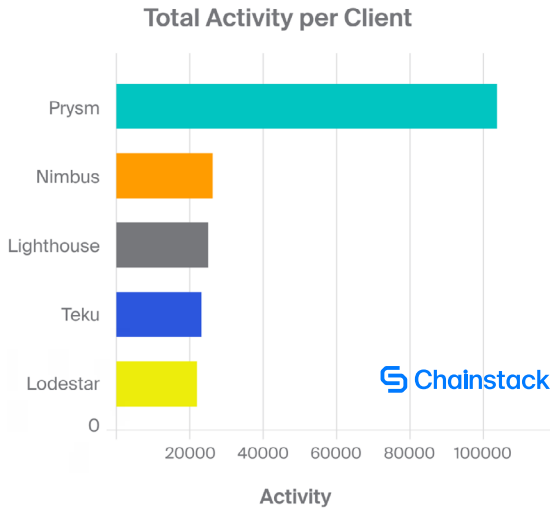
While the Eth2 mainnet is diverse in clients, with each client having its own target user group, the client distribution in development activity has its popularity ranks.

Similar to Geth on Eth1, which is a Go implementation of Eth1, Prysm is a Go implementation of Eth2.

Geth is the most popular Eth1 client. Purely in terms of developer activity and engagement, Prysm is the most popular Eth2 client.

Nimbus is the only client for resource-restricted devices and is the most popular choice after Prysm.

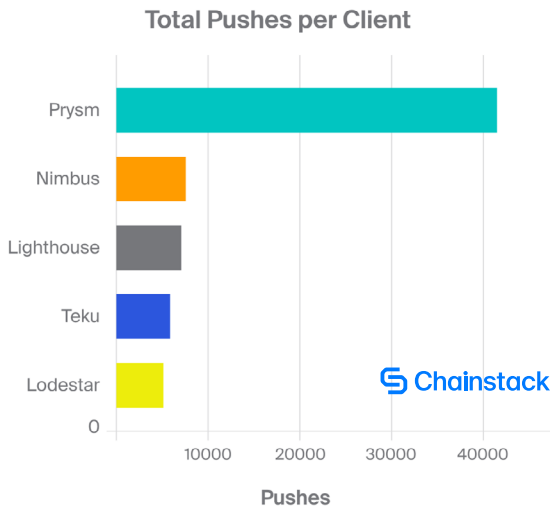
Lighthouse follows closely in the third place. On Eth1, the OpenEthereum client (formerly Parity), also a Rust implementation like Lighthouse, is the second popular choice after Geth.



Total pushes per Eth2 client compared

Prysm is the client by Prysmatic Labs. Unlike all other companies that develop the clients in the list, Prysmatic Labs is a pure-play Ethereum company.

Prysmatic Labs is also the company has received the most substantial grant from the Ethereum Foundation of all the clients.

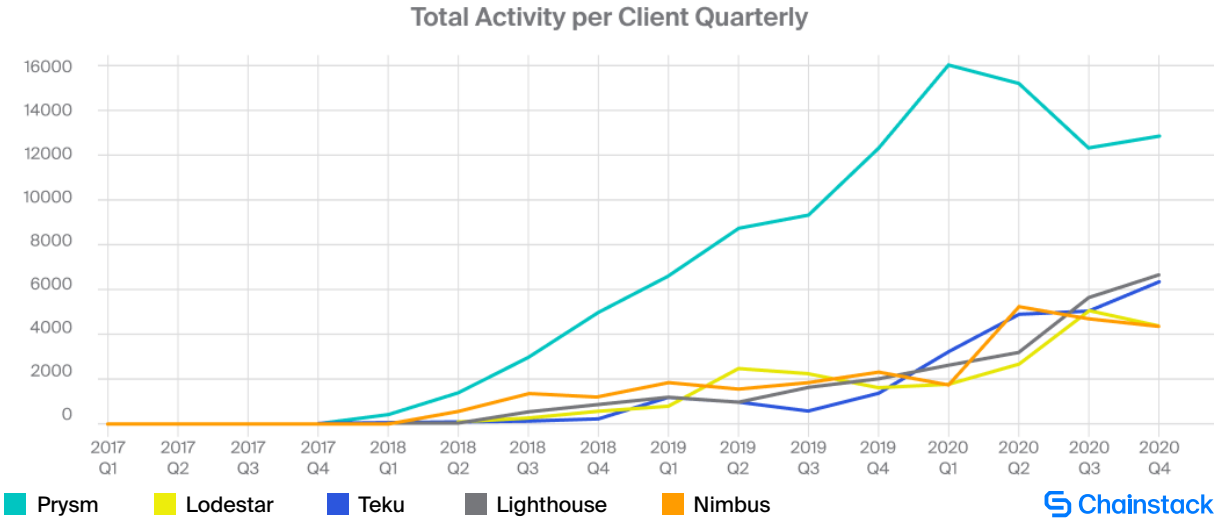


Activity per Eth2 client quarterly

Prysm has peaked in developer interest in Q2 2020 when the first completed testnet that follows the Eth2 mainnet configuration was launched. The testnet—called Topaz—was launched by Prysmatic Labs and received significant community support.

Teku is the only one of the five clients that currently support the Eth2 mainnet that keeps getting increased traction in terms of developer activity and engagement.

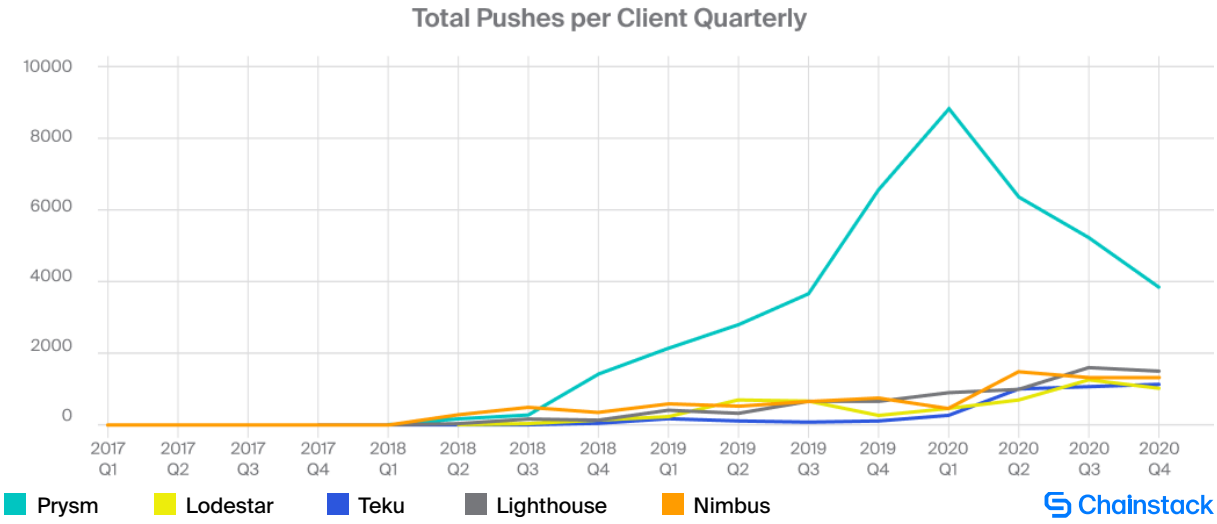
January 2020 was also when Teku received its official name. Before January 2020, what is today known as Teku by ConsenSys was Artemis by PegaSys. PegaSys was an internal development team at ConsenSys.



Pushes per Eth2 client quarterly

Prysm was mostly done and ready to support the Eth2 mainnet in Q1 2020, which resulted in Prysmatic Labs launching the Eth2 testnet Topaz in April 2020. Topaz was the first completed testnet that followed the Eth2 mainnet configuration.

Q1 2020 is also when Teku—after internal changes and having gone from being Artemis by PegaSys to Teku by ConsenSys—started ramping up its code contributions.



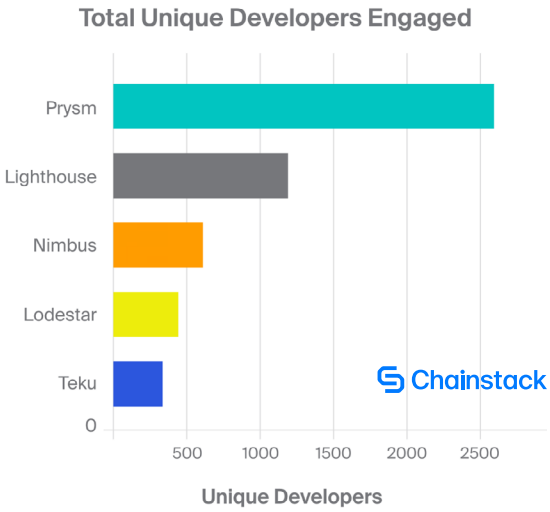
Total unique developers engaged

In unique developer numbers that engage, Prysm remains number one. Being a pure-play Eth2 company, the company that started the first testnet that fully follows the Eth2 mainnet specs, and developing a Go implementation, Prysm has always been the likeliest candidate to attract the biggest developer numbers.

Lighthouse moves one position up from the third place (similar to OpenEthereum on Eth1), while Nimbus moves one position down from second place.

The programming language choice follows the Eth1 mainnet client popularity, where the number one client is Geth written in Go and number two is OpenEthereum written in Rust.

Since the consensus of Eth2 is Proof-of-Stake, the Nimbus client, created with the objective of running on “resource-restricted” devices, receives enough developer interest to get to number three.



In pure numbers:

	Prysm	Lighthouse	Nimbus	Lodestar	Teku
Total Developers	2546	1198	602	452	345

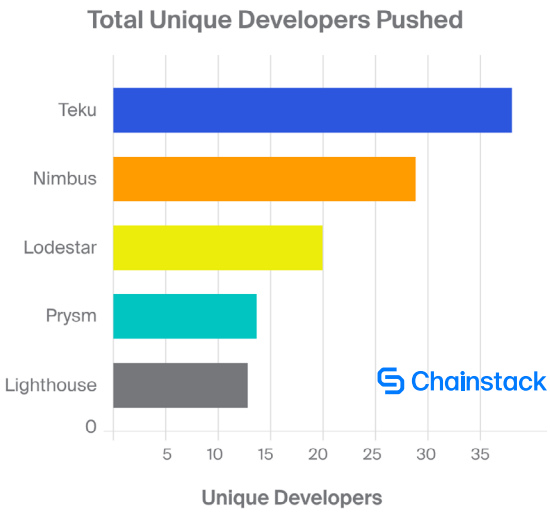
Total unique developers pushed

In unique developer numbers that actually pushed the code that makes the clients what they are, Teku takes the first place, while Prysm loses three positions and becomes number four.

Prysmatic Labs is the only pure-play Eth2 company in the list that also received the most substantial Ethereum Foundation grant of all Eth2 companies and development teams. While being a smaller team, Prysmatic Labs is focused on Eth2.

Teku, being an Eth2 client from ConsenSys—a company with one of the highest number of employees in the blockchain space—has predictably the highest developer count working on the project.

Lodestar, a TypeScript implementation from ChainSafe, moves up to the third place. Nimbus is second.



Unique developers engaged quarterly

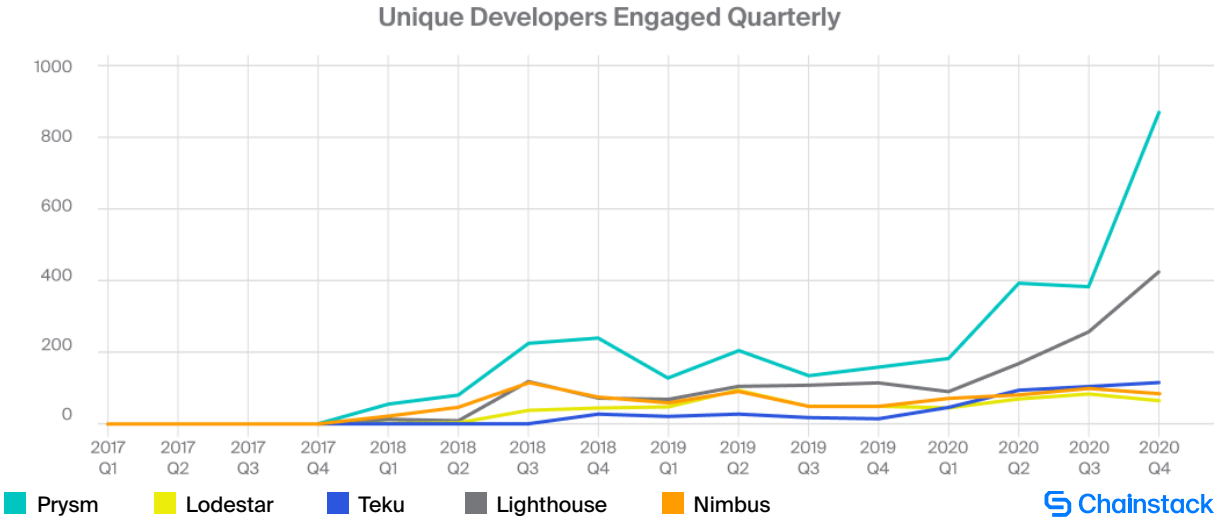
Prysm and Lighthouse have seen the biggest spikes in community engagement in terms of unique developer numbers as the Eth2 mainnet launch approached.

The biggest event gainer that contributed to the spikes is the watch event both for Prysm and Lighthouse. This is when new developers star the repositories of each project the most.

Prysm saw a 229% increase in unique developers starring the repositories from Q3 to Q4, 2020.

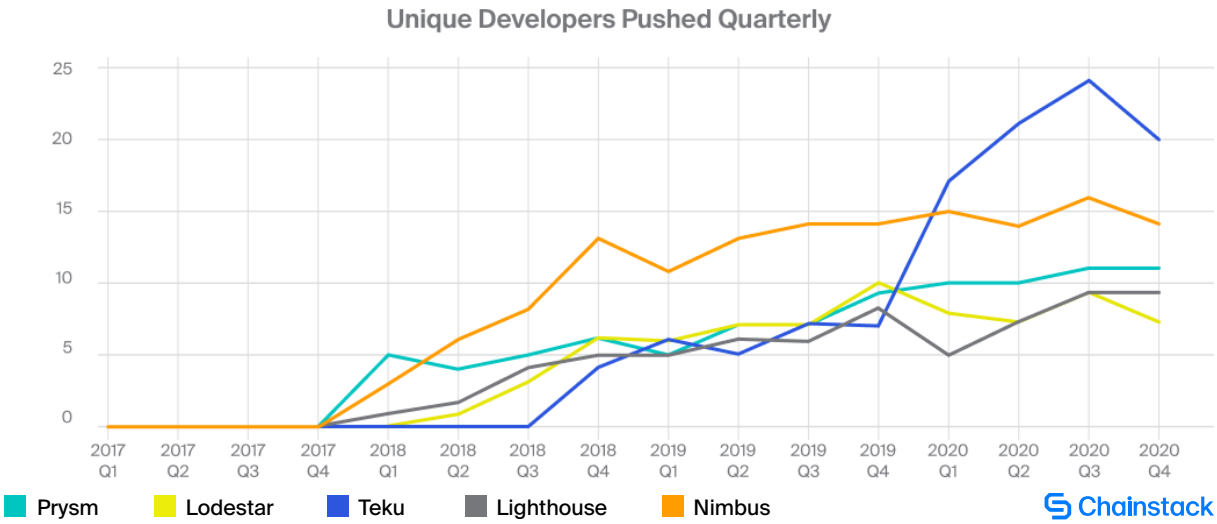
Lighthouse saw a 71% increase in unique developers starring the repositories from Q3 to Q4, 2020.

Prysm and Lighthouse follow the developer engagement of the Eth1 clients based on the programming language—Go at number one (Geth, Prysm) and Rust at number two (OpenEthereum, Lighthouse).



Unique developers pushed quarterly

Teku, having migrated from being an Artemis by PegaSys to Teku by ConsenSys, has drastically increased in the number of developers working on the client.



Activity vs unique developers engaged year-to-year

	Prysm		Lighthouse		Nimbus		Lodestar		Teku	
	Activity	Unique Developers	Activity	Unique Developers	Activity	Unique Developers	Activity	Unique Developers	Activity	Unique Developers
2018	9627	571	1225	213	2677	252	615	82	161	31
2019	36430	658	5888	378	7185	248	7262	247	3979	101
2020	55987	1844	18134	927	16091	317	14167	266	19545	363

Prysm is the only client whose average activity per developer dropped from 2019 to 2020. This is due to the large influx of new developers in Q4, 2020.

Pushes vs unique developers pushed year-to-year

	Prysm		Lighthouse		Nimbus		Lodestar		Teku	
	Pushes	Unique Developers	Pushes	Unique Developers	Pushes	Unique Developers	Pushes	Unique Developers	Pushes	Unique Developers
2018	1618	20	298	12	819	30	136	10	12	4
2019	15274	28	2059	25	2471	52	1820	30	655	25
2020	24373	42	4927	30	4550	59	3403	31	3439	81

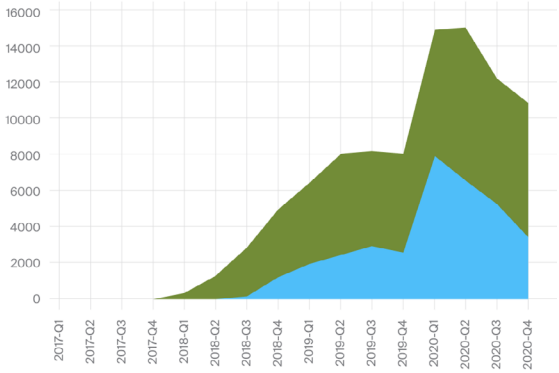
Prysm is again the outstanding project. This time, Prysm is the only client whose average push activity per developer increased ~6.7 times from 2018 to 2019 and remained consistent since then.

Push events compared to all other events

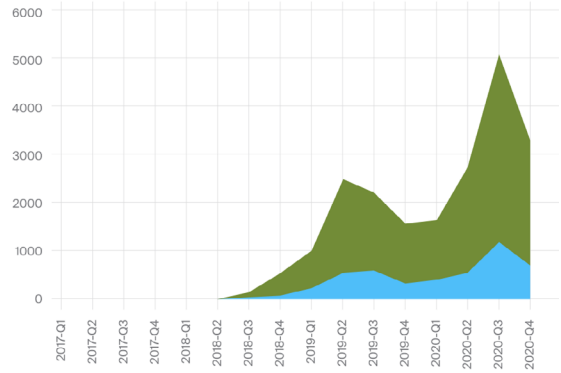
Push events—the events that actually make up the code of each client—compared to all other events.

Prysm is the most balanced in the relation of push events to all other events of all the analyzed clients.

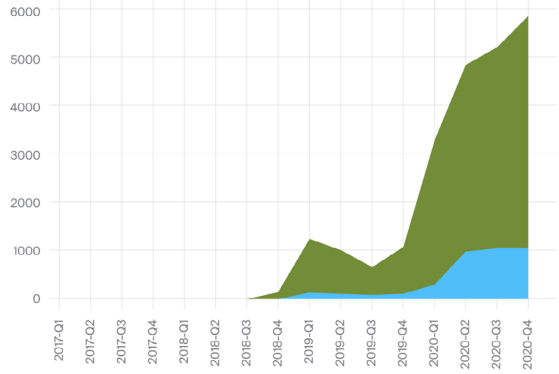
Prysm Push Events vs All Other Events



Lodestar Push Events vs All Other Events



Teku Push Events vs All Other Events

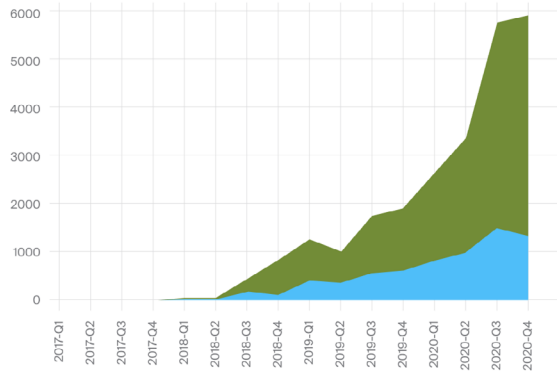


Teku, consistent with the image of an enterprise client, has pull request events making the significant percentage of non-push events with the following distribution:

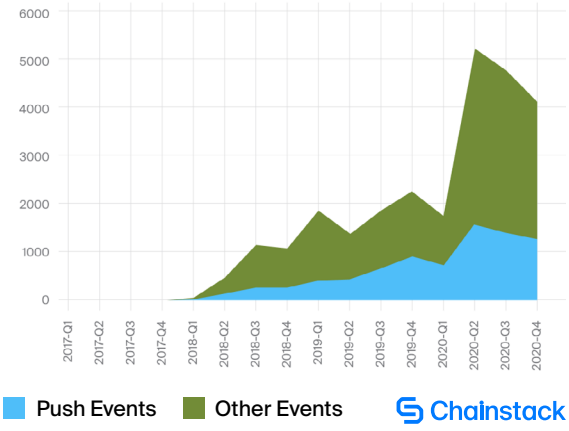
- PullRequestReviewComment: 27.5%
- PullRequest: 18.9%
- PullRequestReview: 12.2%
- Issues Event: 9.8%

Teku gets more engaged around every code push attempt before actually pushing the code when compared to other projects in this report.

Lighthouse Push Events vs All Other Events



Nimbus Push Events vs All Other Events



Other Events is what contributes to the developer engagement numbers when compared to the actual code pushes.

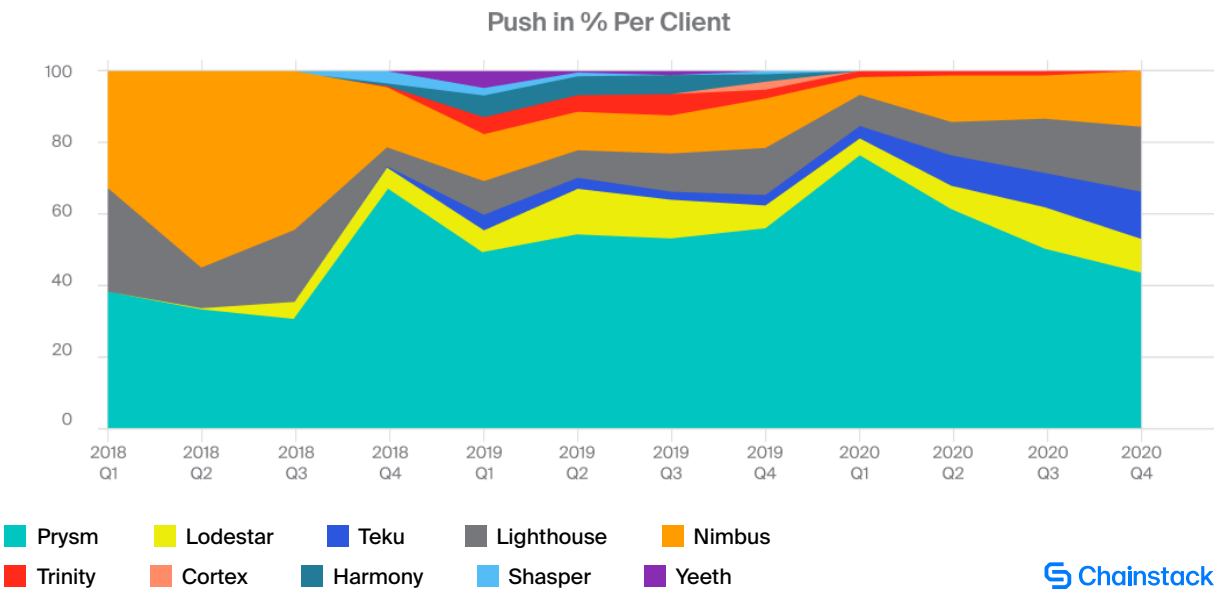
Prysm is consistent with the relation of the push events to the developer engagement numbers and has peaked in both when it launched the Topaz testnet—the first one to fully implement the Eth2 specs.

Teku saw a steep increase in developer engagement, followed by an increase in actual code contributions, after it went through organizational changes and migrated from being Artemis by PegaSys to Teku by ConsenSys.

Both Teku and Lighthouse keep enjoying an increase in the developer interest—the only two projects to do so of the ten that started. That said, Prysm, despite the spike, is leading in both push and engagement numbers by a wide margin.

Push percentage for all clients

To have a clear representation of which of the projects contributed the most to supporting the Eth2 mainnet as a client, let's have a look at the pushes percentage distribution per client:



Prysm has contributed the most to what makes the Eth2 mainnet today client-wise.

As of the date of this report, the Eth2 mainnet has yet to be crawled to get the live client distribution data. When the data is obtained in the future, it would be interesting to see how the data produced in this report correlates to the real-world client usage.

CONCLUSION

A story purported by data is the best story.

The investigation presented in this report has set out the following objectives:

- While the Eth2 mainnet is in it its infancy at the time of this report, to supply the Eth2 client outlook with some objective and neutral data to see how they rank up.
- To see what factors contribute to the success of an open-source project that's setting out to support the largest network with smart contract functionality in the world.
- To understand the client diversity of the Eth2 mainnet.

Regardless of whether you are an individual, an enterprise, or an institution, you do not have to commit to a single Eth2 client from the moment you start staking to the foreseeable future. With the rise of managed service providers, choosing the client is going to be as easy as choosing an operating system on your virtual machine in the cloud. That said, it is always good to have objective data to base your decision on, especially if you have a slew of other services tied to it and rolled out in production.

Until this report, it had been mostly testnet data analysis attempts and various individual reviews. This report provides you with neutral data.

The change of the consensus model from Eth1 to Eth2—from Proof-of-Work to Proof-of-Stake has also attracted significant community attention to the project that would have not been feasible for Eth1—Nimbus, a client for resource-restricted devices.

What this report also reveals is the factors contributing to the success of an open-source Eth2 project and supplies the data to answer the two fundamental questions:

- Does an open-source project need a financial incentive to be successful in the blockchain space?
- Can an independent team, when financially incentivized, build a successful project?

The factors and the data can be summarized in the following way:

- The degree of financial investment in a project is directly relative to the project's success. However, this is not the only key factor contributing to the project's success.
- The choice of the programming language influences the project popularity. Especially so if it relies on the already existing communities from the previous iteration—the communities that formed around Go and Rust in Eth1 make up the numbers of Eth2 as well.
- If you are a company supported by an Ethereum Foundation grant, you have a very good chance of crossing the finish line and becoming a part of the Eth2 mainnet (Lodestar, Lighthouse, Nimbus).
- If you are a pure-play Eth2 company and you are supported by the most substantial Ethereum Foundation grant, you have the biggest chance at becoming the most popular Eth2 client.

The Eth2 mainnet is a truly multiclient network:

- The five clients that support the network have been developed by entirely different teams.
- The clients have been developed in different programming languages.
- The clients target different user groups.
- Each of the clients has its own rank in the developer popularity.

All of these factors make Eth2 not only multiclient, but majorly client-diverse—an important distinction.

As the Eth2 mainnet moves forward in the block number count, sees more client instances deployed, more ether staked, and progresses through the remaining three phases—Phase 1, Phase 1.5, Phase 2—there will be more data available and all sorts of analytical tools deployed to get various insights.