

ARRAY

Array.IO litepaper  
*version 2*

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## 1 Intro

Blockchain technology has been a hot topic ever since it emerged in 2009. What started out as a cryptography experiment is now pushing boundaries of financial institutions and acting as a driving force of the tech evolution. There lies a great technology behind all the cryptocurrency hype and as you are reading these lines, an ever-growing number of companies are already incorporating blockchain technology in their operation. By doing so, they are changing the lives of regular people and shaping the future of IT. The blockchain technology is still in its early years - it's not an infant anymore, but a child, that stands well on his feet and it's up to these companies to decide what will it become when it matures.

The blockchain technology is rapidly evolving. It owes its publicity primarily to the Bitcoin cryptocurrency paradigm. Ethereum came in later and brought crypto tokens and smart contracts to the game. The latter are pieces of code that run on every full node in the network and record the output to the blockchain where it is stored forever. Now we are seeing the third generation of blockchains with customized networks, evolving smart contracts called Decentralized Applications (DApps), and inter-connected environments.

There is a number of projects that open up the DApp development for general public, but since its a fairly new trend, non of them have yet delivered a functioning platform that would make creating, deploying and running DApps easy. Developers want to create DApps the way they are used to - in a language they know, in an environment they like, while end users don't want to see any difference between using a DApp and an application that they would download, say, from an App Store or Google Play. They need a marketplace and a way to run these DApps. This is where Array.IO comes in.

## 2 The Idea

The Array.IO platform is a combination of a blockchain backed by the Delegated Proof of Stake (DPoS) consensus algorithm and support for smart contracts, an extensive toolkit that simplifies creation and deployment of DApps, and the marketplace with a user-friendly app that breaks down the entry barriers for regular users into the world of decentralized applications.



### 3 Key Features

1. A blockchain based on DPoS consensus algorithm that boasts high transaction execution speed and the innate support for smart contracts written in Solidity;
2. State machine proxies which connect the party to other blockchains, such as Ethereum, Bitshares, and EOS; with the IPFS storage; and additional networks a party requires for her DApp;
3. IPFS-based DApp storage;
4. A customized Array Virtual Machine (AVM) that executes smart contracts and runs on Forth language;
5. A client application with a user-friendly interface, which gives access to the DApp marketplace and runs the installed DApps in a isolated environment;
6. An isolated cross-platform app KeyChain, which manages private keys and signs transactions;
7. A Toolkit which includes:
  - Software Development Kit, consisting of:
    - the smart contract compiler and debugger,
    - a set of APIs which allow the cross blockchain applications with the support of atomic swaps, payment channels and the lightning network protocol;
  - IDE plugins;
  - Array.IO Node set-up tool; and
  - Knowledge base with exhaustive documentation, usage tutorials and guidelines.

#### 3.1 DApps on the Array.IO

The Array.IO platform allows to create lots of different kinds of decentralized applications across various domains, including:

- Indie games with out-of-the-box P2P connectivity based on IPFS peer-to-peer connection;



- Web applications that make use of the blockchains transaction capabilities;
- Distributed social networks;
- Cross-blockchain applications.

As of June 2018, the smart contracts language Solidity has become a community standard. Solidity is a Javascript-like language created by the Ethereum Foundation. To facilitate the transition of existing blockchain engineers to the Array.IO platform, it will support Solidity for writing smart contracts. The rest of the application code (both frontend and backend) for Array.IO DApps will be written in JavaScript (Node.JS) + HTML - the de facto standard web development stack. All the code written for a DApp, apart from the smart contract will be stored in a peer-to-peer storage network - IPFS.

### 3.1.1 IPFS

IPFS, short for Interplanetary File System, is a peer-to-peer distributed file system that eliminates the need for a centralized server to store and access the data. Each file in the system is broken down into hashed blocks that are spread across the network, ridding users from deficiencies of centralization. IPFS has many advantages for content creators, like permanent file availability and the lack of need for a content distributor, but the most important one is that the network is censorship-free, which in case of DApps means that once the application bundle is uploaded, it stays in the network permanently, unless of course the developer chooses to take it down.

## 3.2 State Machine Proxy

State Machine Proxy (SMP), is a software which allows nodes to connect to other blockchains and perform cross-chain exchange. The user selects an SMP from the SMP Registry and establishes a connection over IPFS protocol to that specific SMP. For example, the user wishes to connect and adopt the Ethereum or Bitcoin blockchain. SMP allows her to do that through Array blockchain, and additionally accepts requests from the user for validation of requests for alerters.

On the other side, the SMP owner registers his node in the Registry. Upon the initial registration with the Registry, the SMP operator deposits funds in RAYs using the smart contract. If, for some reason, the SMP deposit is



smaller than the required amount, the SMP owner must refill the amount of its collateral to continue working in the Array system.

Most of the state machine proxies will be free for all users. However, some capabilities of an SMP may be accessible only to premium ones. The instance SMP operator makes a decision on how to classify users of his proxy. Some may allow donations, while others subscriptions.

The Registry is bundled within the client app for fast bootstrapping. Once the client is successfully connected to Array blockchain, it updates the Registry from the smart contract. Upon the introduction of the main features, it is necessary to discuss the advantages of Array blockchain which will allow the cross-blockchain applications. The Array blockchain interacts with Array Virtual Machine which runs on Forth language. A blockchain is essentially a deterministic state machine that operates in terms of transactions.

### 3.3 Delegated Proof of Stake

Consensus is the agreement on a deterministic transaction order and a process of filtering out invalid transactions. Over the last few years, a number of consensus algorithms have emerged, starting with the original Proof of Work (PoW), and Proof of Stake (PoS), followed by their modifications. In PoW, miners solve complex CPU or GPU consuming problems, which hence require a lot of gas. This process is highly dependent on the token prices and recently became very costly. PoS algorithm solved the financial issue of mining. This algorithm chooses the block creators - *Validators* from the pool of stakeholders who hold the cryptocurrency.

A relatively recent addition to the pack is the Delegated Proof of Stake, or *DPoS*, which has proven to be the most secure and performant, allowing up to 100k transactions to be processed each second as opposed to PoW, whose transaction processing speed is between 3.3 and 7 tx/sec. The primary idea of DPoS algorithm is that no complex mining process is involved, instead transactions are processed and packed into blocks by a small subset of special nodes, called *Delegates*. Delegates are chosen from the pool of Witnesses. Witnesses represent the stakeholders who vote for a specific number of Delegates. The minimum of 21 Delegates are chosen for Array blockchain. Minimum 70% of the Delegates need to reach the consensus and verify the block. As opposed to PoW, that came to life along with Bitcoin in 2009, DPoS is more secure, robust and more performant by orders-of-magnitude. On the other hand, it is more fair than PoS, since the probability of becoming a Delegate is not higher for the stakers who hold most of the funds. Thus, DPoS algorithm is less prone to the possibility of cartelization, while



provides the speed necessary for the validation of transactions.

## 4 Target Audience

Array's user base are decentralized apps' developers, who are looking for a sophisticated and accessible platform that simplifies the creation and distribution of their DApps. Array is creating a platform that is easy to use and provides a set of tools to initialize a DApp, thus it's second part of the base are junior developers, or even *newbies* to the DApp development. Our client is specifically designed to make the development process as easy and efficient as possible.

Lastly, our features - the speed, and the user-friendly client - allow general public to easily engage in the business if they wish to start using decentralized applications without having to worry about technical details. These users will enjoy the Array.IO Client application whose job is to run DApps in a safe sandbox that prevents DApps from tampering with one another or the OS. The Client will come bundled with a Marketplace app familiar to all smartphone users. It will be just like an App Store - one click, and the app is ready. True plug-and-play.

## 5 Financing

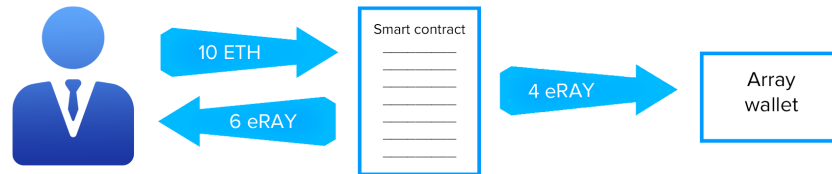
In December 2017, the Array.IO project received the seed funding from our initial investors, however the amount of accessible funding is not enough to deliver all the promised functionality in reasonable time. To cover the development expenses, the Array.IO team will attract external funding in form of an Initial Development Offering (IDO). This is the first time the model will be introduced to the general public.

## 6 Initial Development Offering

*IDO*, or Initial Development Offering, is an alternative approach to fundraising a project. In a way similar to ICOs, it will be based around temporary Ethereum-based tokens called eRAY that will be distributed among the project backers in return for their contribution in ETH. However, this is where the similarities end. The core ideas of the IDO are as follows:



- The IDO is conducted in a series of Token Generation Rounds, or *TGR*, with the hard cap expressed in ETH. Hence, each TGR has a cap, or the indicated amount of funds which are necessary to close the round.
- For each sent ETH, the IDO Smart Contract issues one eRAY token, locking the ETH inside the smart contract. This guarantees that the price of an eRAY is not lower than 1 ETH.
- The eRAYs issued after the ETH deposit are split into two parts: payment fund and contribution. The contribution eRAYs are transferred to the backers wallet upon sending ETH to the IDO Smart Contract. The payment fund eRAYs are transferred to the Array.IO wallet to be used by the project team as a means of payment to the developers, designers i.e anyone whos involved in creating the platform. The exact token split percentage depends on the stage of each TGR.



- The eRAYs may be exchanged back to ETH, refunded, via the IDO smart contract at any time until the Mainnet Launch Event - *MLE*. After the refund, the respective eRAYs are burned.
- At the time of MLE the remaining, non-refunded ETH is returned back to the original backers.

## 6.1 eRAY tokens

eRAY tokens will be based on the Ethereum blockchain and will exist only until the Mainnet is launched. Besides being a measurable representation of each backers trust level, they serve a more important purpose by being a foundation for RAY token distribution once eRAYs are dismissed.

eRAYs don't entitle their holder to a share in the assets of the Array.IO Foundation nor they generate any passive income. eRAY tokens are intentionally temporary. Once the Mainnet goes live, all of the eRAYs will be burned and their holders will be awarded with RAY tokens that will live on the Array.IO blockchain.





### 6.1.1 The incentive to support the project / eRAY usage scenarios

An eRAY token holder has three courses of action.

1. Burn the eRAYs to get his ETH back in case he loses interest in the project.
2. Sell his eRAYs on an exchange at a price not lower than the baseline - 1 ETH.
3. Wait until the MLE to receive a batch of RAY tokens.

In case a token holder is an early backer who was one of those who essentially minted the eRAYs with his ETH, he will receive some, perhaps even all of his ETH back. The exact percentage of returned ETH will be known at the time of MLE. We expect the majority of eRAY holders to be either developers who wish to get their DApps featuring at the platform as fast as possible, or the project believers because, from a financial standpoint, holding eRAY will prove worthy as RAY is a utility token, whose price will increase as the platform grows and flourishes.

## 6.2 Participation in IDO

All backers willing to take part in the IDO need to undergo KYC and AML procedures and a review by the Array.IO compliance team. There is also a minimum size of the contribution which will be determined in the later stage of the project.

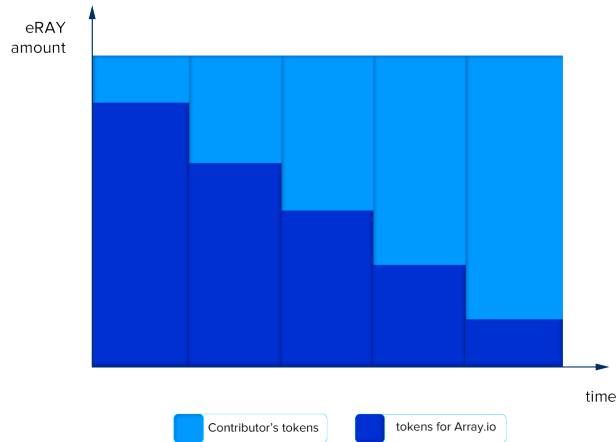
## 6.3 Token Generation Round (TGR)

Unlike the ICO which is a single continuous process (mind the pre-sale events), IDO is conducted in a series of Token Generation Rounds. Each TGR is determined by two numbers - the lower bound, which is the minimum ETH needed to deliver the next iteration of the product and the maximum ETH that can be raised - the upper bound.

Each round is broken down into equal time intervals, also called *stages*, with each stage determining the token split percentage. As it was mentioned earlier, the minted eRAYs are split between the backer and the Array.IO team. In each following stage more eRAYs are distributed to the backer. For example, in the first stage of TGR, the split is equal to 80:20, meaning that for each ETH invested, 0.8 eRAYs will be sent to Array.IO and the



Backer A will receive 0.2 eRAYs. On day three, the ratio is 60:40, so Backer B will receive 0.6 eRAYs.



In terms of token prices, Backer B will buy more tokens than Backer A for the same amount of ETH. Bearing the gradual price decrease scheme in mind, it makes sense for a backer to wait for the later stages of a TGR, however since a TGR has a relatively small hard cap, its possible that the cap will be met before the scheduled end date, thus closing the round. This approach creates a sense of competition and entails a huge incentive to get in in the early stage.

TGR parameters, including the upper bound, the lower bound and the number of stages can and will be altered before each round to adapt to the financial state of the project. The exact formula for the TGR stage breakdown and a full list of tunable parameters is described on the IDO specifications page and is out of scope of this document. The final number of TGRs is unknown, as it may happen that the development will require more funding than previously expected. In this case the Array.IO team will start a new TGR to fund the development of the subsequent iteration.

## 6.4 Refund

The eRAYs may be exchanged back to ETH at a 1:1 ratio at any time until the MLE. To get a refund, an initial investor should transfer his eRAYs to the IDO Smart Contract, which will burn them and refund the respective amount of ETH back. This procedure naturally reduces the Total Supply of



eRAYs. The refund scheme allows investors who don't believe in the project to get rid of eRAYs, not fearing that they will lose their money in case it takes a long time for RAY tokens to reach a certain price level. Asking for a refund is not an exclusive opportunity of the original investors - any holder can do it, no matter how he got his eRAYs.

## 6.5 Mainnet Launch Event

The Mainnet Launch Event is preceded by the following steps. All eRAYs are frozen on the wallets, prohibiting token transfer and trade. All the remaining ETH is returned to the original backers. All eRAYs are burned and their holders are awarded with RAYs.

### 6.5.1 The return of ETH

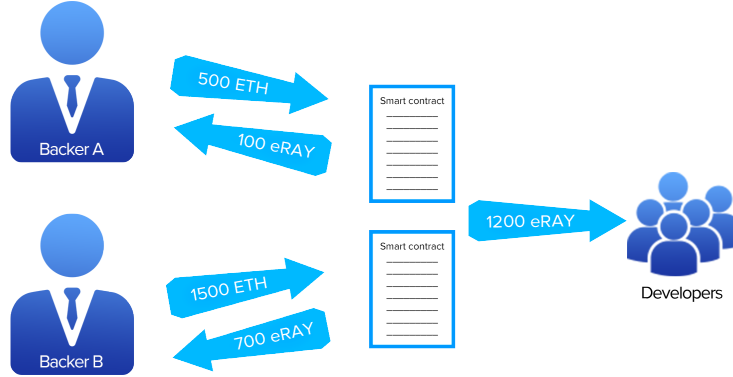
This is the primary difference between the ICO and the IDO scheme. By returning all of the remaining ETH, we ensure that the project development is fully funded by eRAYs. The original backers minimize their risk of losing money when supporting the project.

Only those who invested during any of the TGRs will get an opportunity to have the ETH back. Holding eRAYs at the time of MLE does not entitle a person to any of the ETH that backs up his eRAYs. Additionally, it is impossible to predict how much ETH each backer will receive as this value will depend on the total size of refunds.

#### ETH Return Example

Here's an example of how the return works.

Assume there were two backers, A and B. Backer A sent 500 ETH and received 100 eRAYs, Backer B sent 1500 ETH and received 700 eRAYs making the Total Supply equal to 2000 eRAYs. The Array.IO team in this case will have 1200 eRAYs to pay the developers.



The formula for ETH return is as following:

$$R_k = \frac{ETH_k}{E_{issued}} * E_{MLE}$$

$$E_{MLE} = E_{issued} - E_{burned}$$

where  $ETH_k$  is the amount of ETH, contributed by the backer K,  $E_{MLE}$  is the eRAY supply at the time of MLE, or final supply, and  $E_{issued}$  is the overall number of issued eRAYs. In case no eRAYs were refunded, the  $E_{MLE}$  is equal to  $E_{issued}$ , so all backers have all of their ETH returned, 500 and 1500 respectively, regardless of how many eRAYs they hold at that moment.

$$A_r = \frac{500}{2000} * 2000 = 500ETH$$

Now assume backer B got impatient and burned 200 of his eRAYs. The  $E_{MLE}$  is now equal to 1800 eRAY, which makes the backer A receive 450 ETH. The backer B in this case will have 1350 ETH back.

$$A_r = \frac{500}{2000} * 1800 = 450ETH$$

### The creation of RAY

The RAY share calculation formula is as following:

$$RAY_k = \frac{eRAY_k}{E_{MLE}} * RAY_{holders}$$

where  $eRAY_k$  is the number of eRAYs a person holds at the time of MLE, and  $RAY_{holders}$  is the supply of RAY dedicated to token holders (85% of the total RAY supply).



Lets revisit the previous example and figure out how many RAYs each backer will receive. Assuming the RAY supply is equal to 18kk tokens, the backer A will receive 1kk RAYs and the backer B will get 7kk RAYs.

$$A_{RAY} = \frac{100}{800} * 18kk = 1kk$$

The same formula applies to all eRAY holders.

### Receiving RAY

The technical details on this semi-automatic process are being finalized.

## 7 RAY tokens

RAY tokens are the primary fuel of the Array.IO platform. Their use spans from purely technical, as being a foundation for the DPoS consensus protocol, to a more applied, as an internal cryptocurrency to be used across the network.

### 7.1 RAY Token Applications

RAY tokens will serve as:

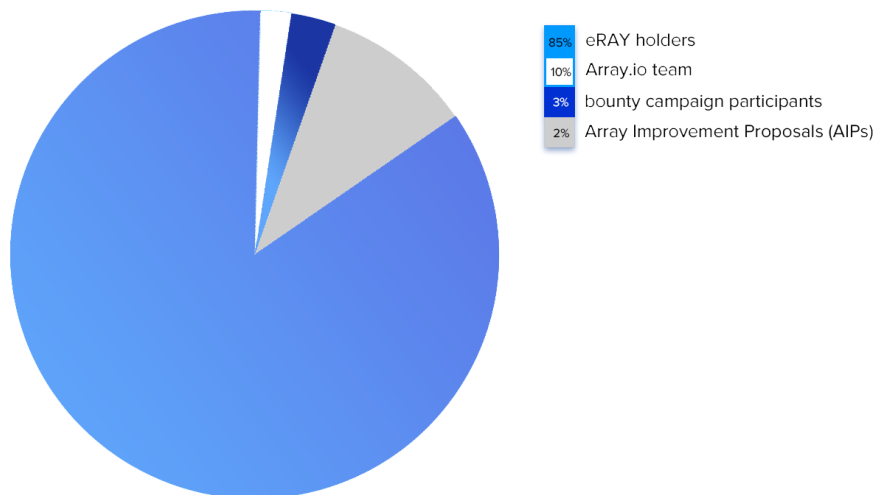
- Gas for smart contracts;
- Price for submitting a transaction;
- DPoS stakes and producer rewards;
- Cryptocurrency within the platform;
- State Machine Proxy stakes;
- In-app/in-game tokens.

Its possible and even encouraged for DApp developers to introduce financial mechanisms to their DApps by issuing their own tokens for app-specific use. For example, the DApp marketplace developed by the Array.IO team will provide app promotion advertisement services in exchange for app tokens or even RAY.



## 7.2 Emission details

In total, XX RAY tokens will be issued and distributed according to the following scheme:



## 7.3 Legal notice

As of June 2018 the majority of blockchain tokens are considered securities. Such tokens are subject to heavy regulation by the government and the authorities, which can result in their delisting from centralized crypto exchanges, inability to issue new tokens and possible penalties to token holders and the issuing organizations. RAY tokens are by nature utility tokens as they don't entitle their holder to a share in the assets of the Array.IO Foundation, nor they generate any passive income.

## 8 Project Planning and milestones

Below is the approximate project timeline and primary milestones scheduled for the upcoming 9-12 months:



1. Launch of IDO (Q4 2018)

2. Listing of eRAY tokens (Q4 2018)

To ensure token liquidity and incentivize early backers to participate in the IDO, the eRAY tokens will be listed on a number of prominent exchanges. With all negotiations done beforehand, eRAYs will become available for trading as soon as the first batch of tokens is issued during the first round of IDO. As of September 2018 it is undecided which exchanges will feature eRAYs upon release.

3. Launch of the Array.IO Testnet and educational marketing (Q4 2018)

The Array.IO blockchain employs the DPoS consensus algorithm, so the operability of the whole system naturally depends on the number of token holders. As soon as the Array.IO Testnet goes live, our team will put heavy focus on spreading the word about the project. Below is a list of marketing activities that the Array.IO team is considering:

- Running DApp hackathons, where developers will learn about the platform and get a chance to win eRAY tokens by creating sample DApps and games for the platform.
- Reaching out to indie game developers to attract their interest in building games on the Array.IO platform.
- Hosting Solidity Bootcamps and conducting Solidity Courses.
- Starting a Bounty Campaign with eRAY rewards for various kinds of help with platform implementation and testing, e.g. reporting bugs (bug bounty) or translating the product pages to other languages.

4. Listing of RAY tokens (Q1 2019)

The financial applications of the RAY token are an integral part of the Array.IO platform. To work, the token has to have certain liquidity and has to be universally accepted. To attain that, RAYs will be listed on a large number of exchanges.



5. Launch of the Array.IO mainnet (Q2 2019)

After the system is thoroughly tested and the blockchain community is well aware of the existence of the platform, it will be time to launch the Array.IO Mainnet marking the beginning of the Array.IO platform as intended.