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Aleph, a decentralized application network

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March 7, 2019

Abstract

This will be a great abstract when I finally get around to writing it.

Contents

1. Introduction

The Internet was originally built to connect computers together. It has been used as a marvelous communication and data storage model. Protocols originally designed for decentralization (TCP, HTTP, SMTP... and even blockchains) are already showing their limitations.

In a purely economically driven world; simplicity, centralization, and non-standard data models tend to win out.

What is our internet today? Silos loosely connected together, users having data in each of those silos (Facebook, Google, and many others), with no simple way to port it over. (see Drake 2015)

There are a lot of attempts at breaking those silos, from connection from silo to silo (ifttt, rgpd for data request, opendata programs...), to decentralized networks of silos (mastodon). We are living in a world of data silos.

In itself, that isn't bad if those silos were easily accessible and decentralized. Users don't know it, but they need to reclaim their data.

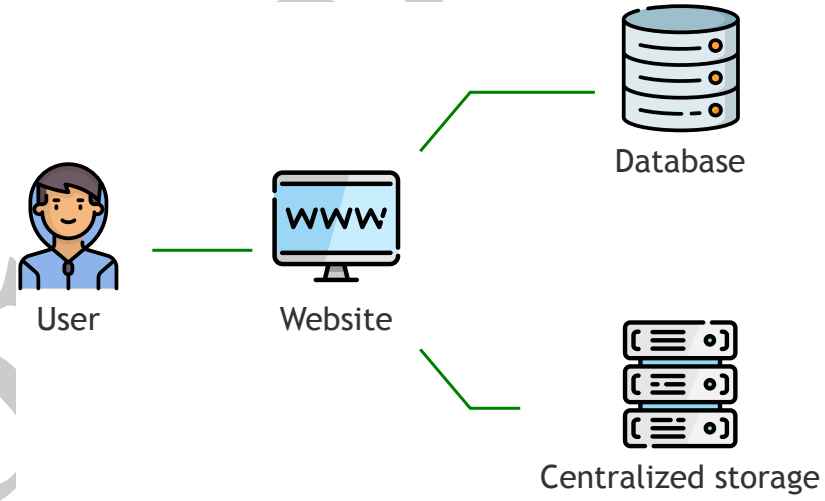


Figure 1.1: Typical centralized application

2. Existing solutions

2.1 Blockchain

DLT[1] allows us to have a single data silo (albeit specialized) that is spread across all users of the network. SmartContracts make use of that ability to allow decentralized computing (among other benefits).

Common naming of dApps[2] is using smart contracts on blockchain platforms like Ethereum. A few issues arise from its model:

- Paid transactions by the user (meaning a dApp user should buy some underlying network asset to use the Dapp)
- Reliance on inclusion in a block (dependant on the block time of the relevant blockchain, making dApps slow)
- On-chain storage is very expensive, making it unsuitable for media content or large documents.

There are a lot of existing blockchain platforms currently active (see "Coinmarketcap" 2019).

[1] Distributed Ledger Technology, mostly BlockChain
[2] Decentralized applications

2.2 DHT storages like IPFS

Storage networks like IPFS or Swarm are great to find a resource based on its hash in the network. Some things are currently needed or not easily useable for our dApps:

- Incentivization of storage (to be implemented in their FileCoin for IPFS, implemented on Ethereum for Swarm)
- Unique resource naming system (provided in a slow way currently by IPNS, fix being worked on, or through Ethereum smart contracts in Swarm)

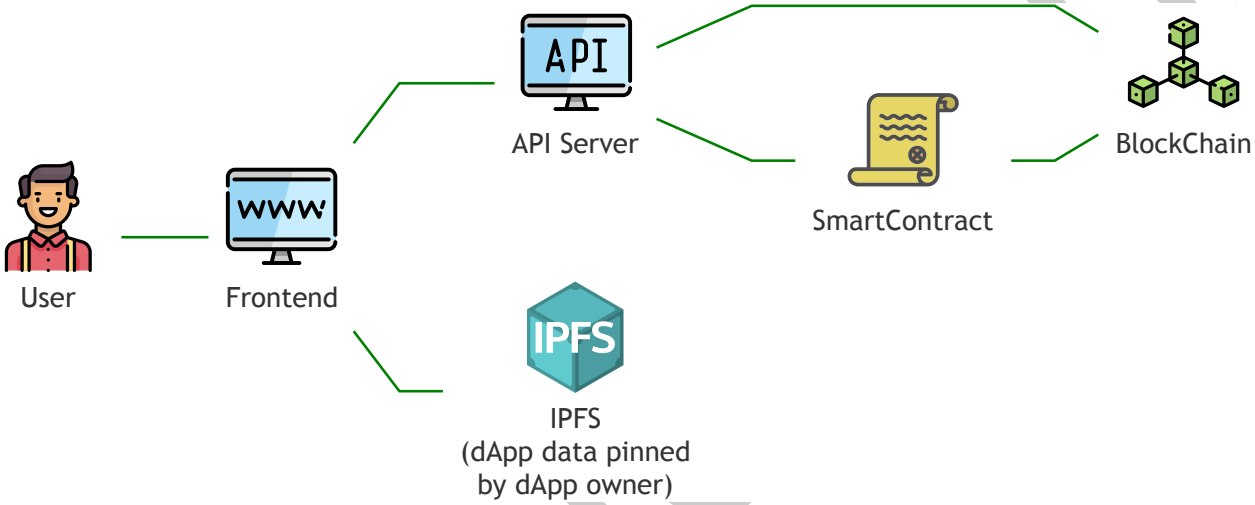


Figure 2.1: Typical smart-contract based dApp using IPFS

3. Aleph Architecture

In current solutions involving smart contracts, the current state of applications is written (or computed from) on a blockchain, this is immutability. But what if you want instantaneous actions, batching user requests for non critical items?

You'll need a second layer of truth, a distributed state that you can influence by signing messages.

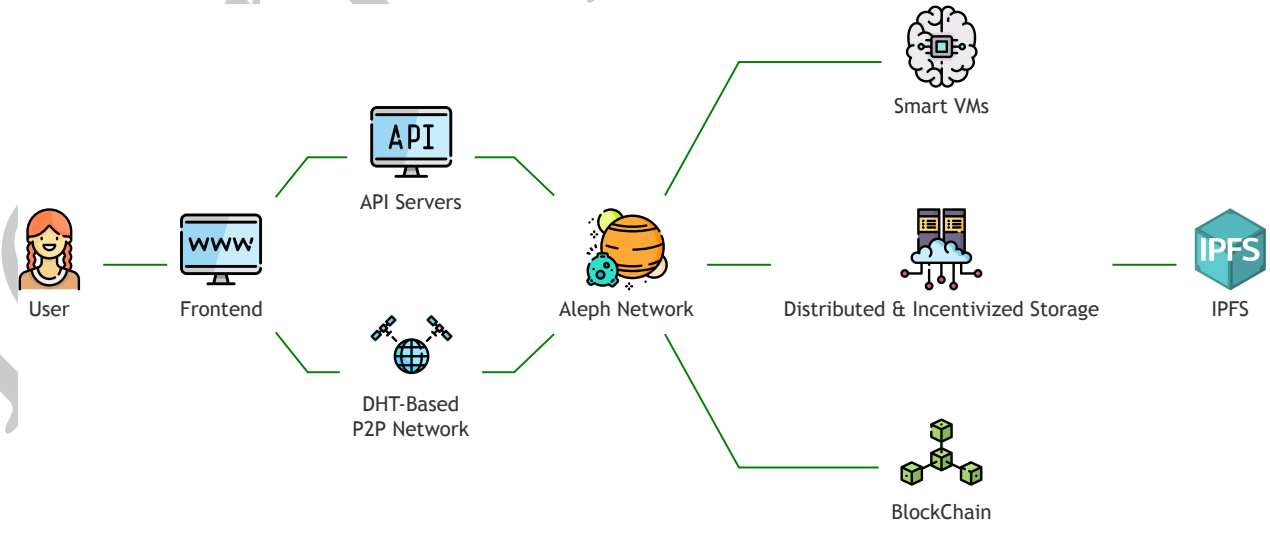
Agents will then commit the messages on the blockchain for the users, incentivized by the network token. They will spend the native chain asset and will receive the token in exchange for their service, provided by the next authorized agent. Then that agents work will be verified by the previous agent, changing it's credit score on the fly.

This allows for free and instant interaction with dapps for users, with efficient batched inserts on the blockchain for immutability.

Moreover, this more easily facilitates agents running API servers that can be used by the dapps as entry points to the network.

Below are a few focal actions of the Aleph network:

- Instant (low-latency) global status update
- Bulk content write on blockchain to allow fee-less commits
- Pinning IPFS data (data replication)
- API server decentralization
- Virtual machines code execution and verification



3.1 Blockchains used by Aleph

The first underlying blockchain supported by Aleph is NULS. To allow easier port of existing dapps and ecosystems, later in the developement process, other blockchains can be supported such as Ethereum, NEO and even the Bitcoin blockchain.

The address in the Aleph network is the underlying network of choice (NULS, Ethereum, NEO...) address used to sign messages. A user can post in his personal aggregate (key-value hash table linked to his primary address) his addresses on other networks. That way he can redeem or receive tokens from other blockchains.

If a user has a NULS account and an Ethereum account both linked together, a request for his aggregates (profile or settings for example), posts (images, blog posts...), or any other linked content will return the same information from any of the two addresses.

3.2 Data storage

The hashes of the data are stored on chain. The data itself is stored encrypted or not on IPFS. Data is pinned by participating nodes.

Posting is done either via API by the dapps to an API node, or by IPFS directly if available on the browser.

The current state is stored on both blockchain (nodes are made of a blockchain explorer) and current received data that is not posted yet (queue, mempool).

Once the data signature is verified, and it is broadcasted to at least 2 nodes, it is considered validated and included in the coming blocks.

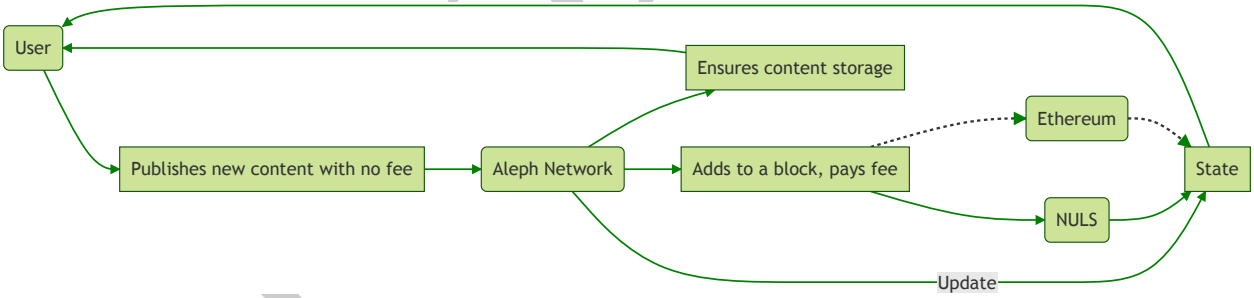


Figure 3.1: Data posting procedure

3.3 Data type

Table 3.1: Data types

Data Type	Description	Details
Aggregates	Key-value store linked to an account[1]	Each key can be updated separately and its content is merged with previous. *Example*: user profile
Posts	Single data entry	Has a type field, an optional ref (reference) field that references another post or application-specific string. Can be amended with new posts with type "amend" and ref to the previous post. Data inside post content can be optionally encrypted with either owner key or a recipient key. *Example:* blog post, comment, picture gallery, video entry, new data point, new event...
VM State	State of a virtual machine	Fields depending on underlying engine (dockerized language-specific contracts or WASM for example)

3.4 Data exchange

The exchange of data between the dapps and the nodes is done either by pubsub (if available) or API posting. The node will do the pubsub action on behalf of the user.

Using pubsub, all nodes will get the user posts and actions.

Pubsub is using dht and ensuring all subscribed nodes will receive all users posts to get the current state.

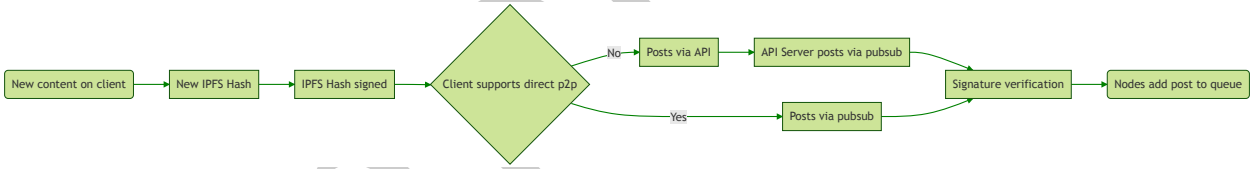


Figure 3.2: Data posting procedure

3.5 State

State encompasses both onchain committed data and uncommitted data received by pubsub. State can be recomputed by getting all TX from a user or containing messages signed by him, and adding the uncommitted messages.

- For smart contracts/VMs, it should be recomputed from last committed, signed and non revoked (no litigation) onchain state.
- For aggregates (user hash tables) from the last onchain commit for each key.
- For posts, from the original post plus all the amends. If last amend contains all the fields, original plus last amend is acceptable.

[1] Underlying blockchain of choice address and linked public key.

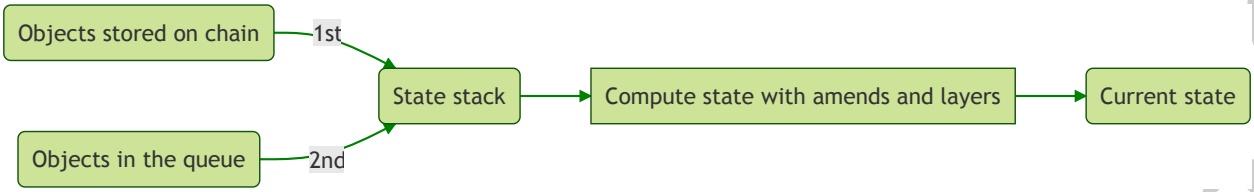


Figure 3.3: State composition

3.6 Virtual machines

Sometimes called smart contracts, the virtual machines have a state that is commited as an object in the chain. All nodes don't need to keep all the VM's states, only the last one if no litigation occurred.

3.6.1 Hash links

Each mutation to a VM state contains a relation to a previous state (previous hash). If two data blocks relate to the same hash, the first to be commited on-chain will prevail (in case of data sync), and the first to be received (in case of off-chain processing before block inclusion).

In the event a new block is posted with a different history than what is computed off-chain, two possibilities occurr:

- On-chain content is deemed bad (according to specific rules) and discarded in a new commited transaction, off chain content taking its place
- Off-chain content is discarded and clients are notified

3.6.2 VM State content

The VM state object is specific to the engine used (WASM, docker-like language specific VM, JVM...), but typically contains:

- Relation to the previous state (object chain using hashes)
- Function called
- Arguments
- Function result
- New serialized state (can be a diff only for big states, in special cases)

3.6.3 Concurrency

While view-only functions that don't modify the state can be done concurrently, the write functions can't happen concurrently (or will end up in a fork). A node can send a pubsub message to broadcast it is working on/executing a "write" function on a specific VM. Once that has been completed, it will broadcast the new state to the other nodes in the same pubsub channel, thus enabling them to execute a write function from this point in history.

3.7 Cross-application data exchange and data ownership

All applications in the Aleph ecosystem are talking to the same data storage entity. Conventions exist and have to be documented on data structures to be used by applications.

This enables applications to use the same user profiles (example nuls.space and nuls.world/social using the same profiles, and nuls.world/apps/vote using the profile and same post format than the formers for its content) and content sources if needed. A new developer can come and make a new frontend to all the existing data posted by users. Users own their data.

3.8 Moderation and requests for removal

3.8.1 Network and data moderation

Each application can have its own storage of black-listed content and addresses to handle its own moderation features (the application will then omit certain content or content creators from the user interface).

For illegal content, the network will also have its own storage that will be synchronised between nodes of black-listed content and addresses. Linked content hashes will be automatically unpinned from all nodes, leading to its destruction from the Aleph network.

3.8.2 Removal request

To comply with regulations (GPDR in particular), in a similar fashion to the illegal content data unpinning, a user can request certain hashes he posted to be removed, or even his full address data to be put into blacklist by signing a message using his public key.

3.9 Nodes

3.9.1 Clients

Simple clients to the network are either using the API to API node or p2p pubsub connection to the network. If they are using the p2p system then they can act like a full node and validate messages themselves (and run VM themselves if it's available for their platform, WASM working in web browsers).

They should be careful to verify the signatures of the received messages and states if they don't trust the API server or if they are connected directly to the network.

3.9.2 Packing nodes

The Packing nodes are those which validate the messages and submit their hashes to the underlying blockchains. They get rewarded for their action (token reward) or punished if they don't do their duty correctly.

If a packing node is found committing nefarious acts by the consensus, its address is blacklisted and his rewards (and/or deposit, this is to be defined, see Roadmap chapter) frozen.

Those nodes must be both API nodes and storage nodes too.

3.9.3 Storage nodes

The storage nodes pin incoming IPFS hashes to ensure distributed (geographically and accross multiple hosts to ensure the data won't go away) storage of the content.

Those nodes must be API nodes and may optionally be packing nodes too.

They are rewarded in tokens for their duty.

3.9.4 Full Node

Packing and storage nodes are using this codebase, activating some modules and configuration to do their work.

The APIs are a module that can be activated (mandatory one for incentivized nodes).

Features of an Aleph Node:

- Indexes the underlying blockchain it is configured for (can be more than 1).
- Has an IPFS client built-in
- Keeps track of modifications to the chain (forks, history rewrite...)
- Connected to pubsub channels to update its off chain state
- Retrieves IPFS content (from storage nodes or sender) commited onchain or recieved in pubsub to review and index content (and pins it if needed)
- Executes VMs code (if configured for it, and only relevant ones)

3.9.4.1 Indexing

Depending on the underlying chain volume, a full index will be done, or only an index based on specific events (triggered by a smart contract for example -on Ethereum-, a tx type -business data on NULS- or op_return & similar).

For maximum security, the incentivized Aleph nodes in charge of sensitive parts of the network will connect to a local node of this blockchain (to detect forks for example), simpler nodes can connect to explorers or public api servers of those chains to act as light wallets. The blocks informations will also be published on IPFS for faster sync of nodes.

4. Aleph Token

4.1 Rewards

Three main sources of reward and token creation are:

- Reward each signed message written to the underlying blockchain
- Reward storage of application data (pin items) and availability of API, both are mandatory for nodes
- POCM NULS token locking in NULS underlying chain (see token distribution section)

Of those rewards, a part will come from monetary creation, and a part from dApp owner incentive to prioritize their apps and their user fees.

If a dApp owner wants to get the benefit of the network without having to rely on third parties only, he can run a node of the network where he prioritizes his dApp data (but he can't completely ignore others, having a backup for his users on other nodes, while he gives the same allowance to other dApps).

4.2 Token use

Most node owners will accept free storage of dApp data, especially at start of the network. Once the data grows bigger, and it begins to become impratical for hosts to have all the data, dApp owners can pay for storage and writes to the blockchain of his dApp data.

Alternatively, application users can pay themselves for the storage of their data (example, big data volume like picture storage applications).

4.3 Token details

Initially, the first issuance of the Aleph utility token will be made as an NRC-20 token. This will be able to be swapped for the native asset at a later date.

If technically possible (part under research):

- the switch between NRC-20 and native Aleph token will be available in both directions.
- the token will also be made available as an ERC-20 token

4.4 Initial token distribution

The exact details of the initial token distribution plan will be announced at a later date. Below is what is currently planned for the token distribution (can be subject to changes).

To reward the NULS community and ecosystem, a large percntage of the supply will be airdropped to NULS token holders.

1,000,000,000 (1 billion) tokens will be issued initially.

Of those :

- 100M will be airdropped (details will be announced through official channels)
- 500M will be reserved for the NULS community/foundation (400M locked for the POCM mining program and 100M for other incentives)
- 100M for private / institutionnal investors / OTC sales
- 300M to the Aleph team (who will use this for bootstrap period rewards, might be able to sell some for development funding, allocate a part for a community or foundation fund or any other use it might deem necessary)

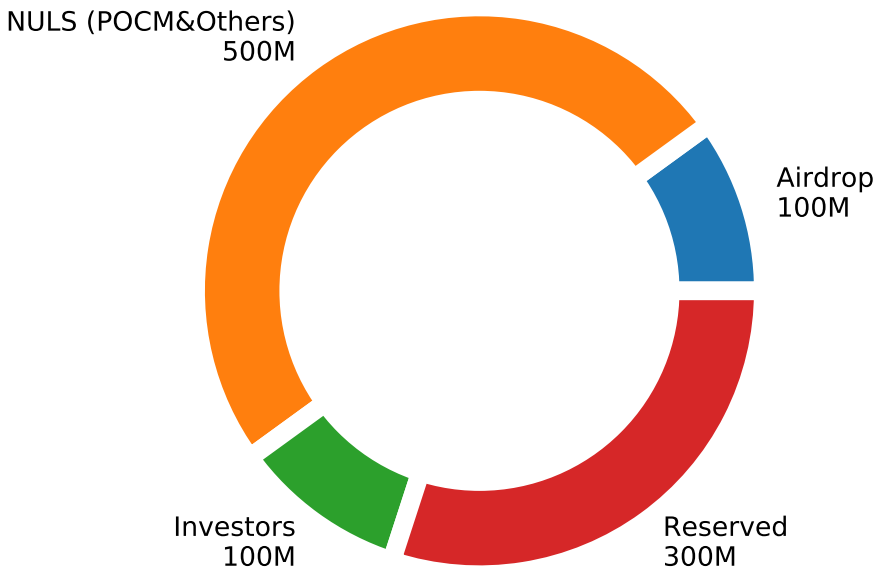


Figure 4.1: Token Distribution

4.4.1 NULS staking program (POCM)

In addition to a regular airdrop, NULS holders can lock a part of their NULS tokens to get Aleph tokens.

While their tokens are locked, they will receive Aleph tokens based on the NULS amount they have "staked"/"locked".

Those tokens will come from an initial pool of 400M tokens, locked for that specific purpose. Once that pool dries up (after approximately 5 years), the reward will be lowered and the tokens minted using this program will be taken from the Supply Evolution.

4.5 Supply evolution

Once the full network is ready (see roadmap chapter) and through the described rewards, the token supply will grow by approximately 10% the first year. Then the inflation rate will decrease by 2% each year until it reaches 4% per year and stay at that value.

Table 4.1: Supply per year

	1st year	2nd year	3rd year	4th year	5th year	6th year
inflation	10%	8%	6%	4%	4%	4%
tokens minted	100M	88M	71.28M	50.37M	52.38M	54.48M
total supply eoy	1100M	1188M	1259M	1309M	1362M	1416M

While the part devoted to the team and developement may seem high on issuance, the inflation rate makes it lower than the rest of the circulating supply during the 3rd year.

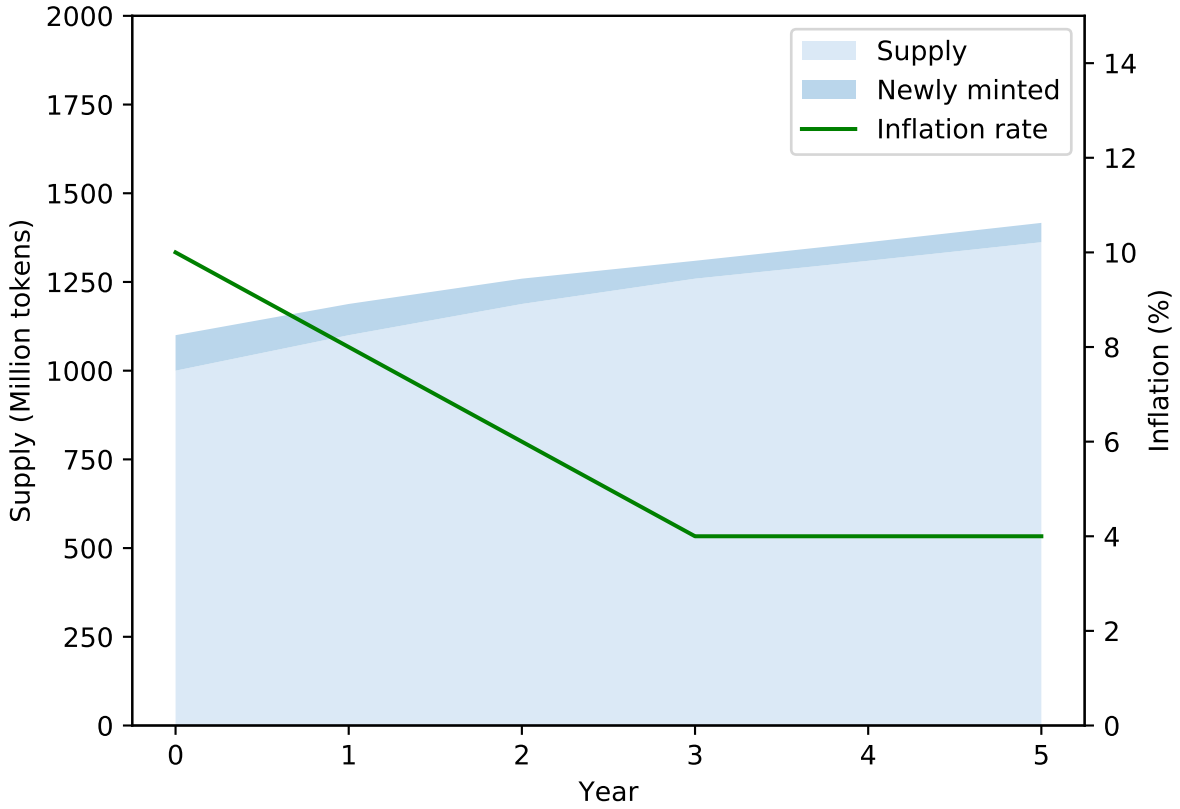


Figure 4.2: Supply evolution

5. Roadmap

5.1 Genesis (NULS Only)

In the first step of the project, the token will live on the NULS blockchain as an NRC-20 token. Rewards to the nodes of the network will be given from the Aleph reserve funds.

The only address format and public keys supported on the network will be NULS addresses.

At the start of this period, a proof of concept will be ready and applications can be developed on Aleph, supporting all but cross-chain and virtual machines.

5.2 Cross-chain

The cross-chain infrastructure will be developed at this milestone, allowing other types of addresses to be used on the Aleph network (Ethereum first).

5.3 Virtual machines

The "Smart Apps" virtual machine will be developed for this milestone, allowing the Aleph native token to live in a virtual machine by itself.

A token swap will take place from the NRC-20 (and ERC-20 if issued) token to the native token.

5.4 Network nodes and economy

If technically possible, other chains tokens (aleph token as nrc-20, erc-20 or nep-5 for example) will be able to be swapped from and to the Aleph native token.

The network nodes will now receive their token rewards corresponding to the plan described in the Token chapter.

5.5 Specialized nodes

The priorization feature will now be developed and all nodes won't store all the data or run all the VMs. Some nodes can focus on a few dApps for their owners while still being able to help the whole network (and their dApp content can still be accessible to others).

5.6 Future

There are a lot of possibilities for the future (not defined yet):

- Decentralized exchanges and encapsulation of other assets
- Use of Aleph as a monetary 2nd layer (like lightning or plasma)
- ...

6. Notes and appendices

6.1 Hardware wallet and 2 factor support

Since the signing is done using the underlying chains mechanisms, their support for hardware wallets is used. Wherever possible, those supports will be used.

Examples:

- NULS has hardware wallet support done on ledger, we use the built-in signing mechanism to sign the messages.
- Ethereum supports Ledger and Trezor, we use their support and signing mechanism.

Another way to go is using the webauthn standard, that will use whatever hardware support is available (built-in crypto chip in mobile device as 2 factor auth, usb u2f key), specific to used website. Wherever possible, webauthn support will be added (generating NULS addresses using secp256k1 support). An exception to the underlying protocol signing mechanism can be done to support json object signing specific to webauthn.

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