Nerian: A Peer-to-Peer Data Processing Network

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Abstract

Nerian is a peer-to-peer network for data processing[1], where data is shared securely and privately. On the one hand, Internet users nowadays who produce data using all kinds of applications find themselves in a position not being able to manage the data they produced and are presented with irrelevant marketing elements not corresponding to their current needs. On the other hand, businesses invest in marketing strategies that do not prove fruitful and fail to reach individuals in the right place at the right time. Nerian is building an open-source blockchain-based framework for all parties involved and proposing a solution to the traditional need for a third party to the custody of personal data. In this model, everyone can manage the processing of their data and is rewarded for its utilisation, which in turn allows for more specific and efficient advertisements, that address their needs.

1 Introduction

Although a lot of data is produced daily in both the private and public sectors, there is currently no framework for the processing of data and so digital advertising depends on the management of data by third parties. While marketers must compete for the attention of Internet users, they lack the core information about their consumers' intention to purchase goods or services, resulting in mass advertising that is not tailored to the needs of their target market.

What is needed is a peer-to-peer network for data processing where individuals handle their personal data and share their intentions for purchasing with marketers. This way, marketers will have access to specific datasets allowing them to create accurate advertisements for individual consumers while respecting the data's sovereignty and integrity.

Using a public blockchain removes the need for a third party. It allows individuals to verify the provisioning of data and the transactions between the parties involved in full transparency while keeping the data secure at the same time.

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[1] The paper focuses primarily on the implementation of the network for data processing within the advertising industry. This platform can be used for applications in other industries as well like media and entertainment, healthcare, manufacturing, transportation, government, energy and utilities or retail and wholesale.

2   Data Market

Nerian defines three major roles within the data market namely: the Data Host (the "Host"), the Data Provider (the "Provider") and the Data User (the "User"), creating an alternative three-way peer-to-peer economy which enables relationships and dynamics within the market.

The Data Host: The Host is any entity, business(es), or individual(s), who makes and maintains cloud applications. Through these applications data is produced by Providers as well as used and consumed by Users (and, for example, turned into digital advertising).

The Data Provider: The Provider is any entity, business(es), or individual(s), who owns the data produced through the use of cloud applications.

The Data User: The User is any entity, business(es), or individual(s), who uses the data shared on the network by Providers. Reasons for using these datasets could include, but will not be limited to, the purpose of optimising marketing strategies for personalised advertisements.
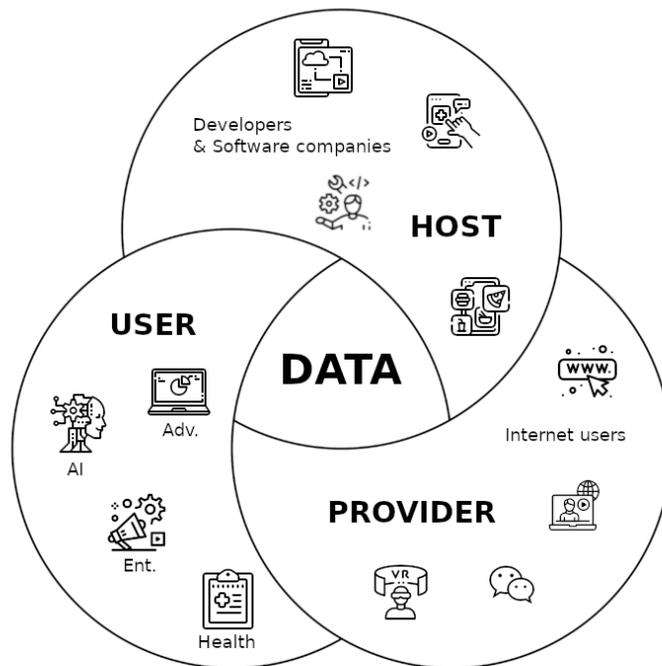

Figure 1: A three-way peer-to-peer market model

3 Nerian Network

The Nerian Network also referred to as the Nerian Grid is built out of 3 main elements: Data Vaults for storing the Data, Digital Twins for processing the Data and the Nerian Blockchain for reaching consensus within the network.

3.1 Data Vault

The Digital Vault is a data storage solution built on top of an autonomous cloud infrastructure and technology in which privacy and security are implemented in its architecture by default. The open-source blockchain-based cloud technology (refer to Appendix II: Technology/ThreeFold) allows an individual to store Data through a Quantum-Safe FileSystem on as many servers or shards as needed. Moreover, an individual can choose on which servers, or in other words in which geographical location, they would like to store their Data. When a server goes offline, workloads and data are redistributed, without any human intervention, along other servers, i.e. a self-regulating and self-healing cloud. Imagine a global autonomous cloud infrastructure and technology where data and workloads move around on their own – a cloud for digital nomads.

"Web3 applications on a Web2 infrastructure? It just doesn't add up."

3.2 Digital Twin

Each Host, Provider and User is represented in the network through its Digital Twin, which is a bot that can be customised and educated to meet their needs. Digital Twins play an essential role within the network. They handle all the communication and process all the Data within the Nerian Grid between the Host, the Provider, and the User.

The Provider's Digital Twin enables the storage of data produced through various applications in a Data Vault encrypted with a private key. Through the Digital Twin, they can choose whether or not to provide whole or partial datasets to the Nerian Grid. The latter acts as a Data Pool comprised of the Data Vaults of all Providers. By sharing data with the Nerian Grid, the Data Capacity of the Nerian Grid increases. In this way, Providers make their data available for utilisation and monetisation. As the Digital Twin constantly acquires new datasets within its Data Vault, it matures over time and becomes a more accurate representation of the Provider's intentions.

The User's Digital Twin allows for the use and consumption of the data shared by Providers. It pools datasets according to the preferences and intentions of the User, for example, to optimise marketing strategies. This, in turn, allows the User to orient the relevant advertising toward the needs of the Provider. Therefore, if Users consume more data, the Data Utility on the Nerian Grid increases.

The Host's Digital Twin allows managing all data produced and consumed through its application. For example, through the Digital Twin, they can choose whether or not to allow Users to post advertisements through their applications.

The Data Vault and its datasets reside in the Cloud. To remain operational, it requires storage and computing power also referred to as Cloud Capacity. This results in a cost for the owner of the Vault, i.e. the Provider, regardless of whether they choose to share and monetise their data to the Nerian Grid. This is the direct cost of one's privacy.

"If the product is free, you're the product."

3.3 The Nerian Blockchain

3.3.1 Consensus Mechanism: Proof of Stake

A consensus mechanism, such as a Proof of Work or a Proof of Stake, selects Validators, who verify and validate transactions on the blockchain and rewards them accordingly. Although the objectives of the Proof of Work and the Proof of Stake consensus mechanisms are the same, they both handle transactions differently.

Within the Proof of Work consensus mechanism, a Validator constantly solves mathematical puzzles. The higher the computational power of a Validator, the higher the chances for a Validator to solve the puzzles. In this way the chances of being selected for verifying and validating transactions and creating a new block in the blockchain increase.

However, the Proof of Stake consensus mechanism does not involve solving mathematical puzzles for the selection process of a Validator. Instead, an alternative mechanism is implemented through which the probability of creating a new block is proportional to the number of tokens staked by a Validator. In other words, the higher the token stake of a Validator, the higher the chances for a Validator to be selected for verifying and validating transactions and creating a new block in the blockchain.

3.3.1.1 Implementation

The Proof of Stake consensus mechanism is integrated within the Nerian Blockchain (refer to Appendix II: Technology/Substrate) by implementing two algorithms namely Proof of Data Capacity and Proof of Data Utility.

Proof of Data Capacity

By providing data to the Nerian Grid and thus increasing the Data Capacity of the Nerian Grid, tokens are minted (refer to 3.3.2. Token Economics). The first part of the minting process is done through the Proof of Data Capacity algorithm which is implemented to verify and validate the data provided to the Nerian Grid. In other words, the Proof of Data Capacity algorithm verifies and validates the Data Capacity of the Nerian Grid. Hosts and Providers can sell the minted NRN tokens on the market.

Proof of Data Utility

Users can use datasets, made available by Providers to the Nerian Grid, with NRN tokens obtained from the market. When data on the Nerian Grid is used, tokens are minted (refer to 3.3.2. Token Economics). A second part of the minting process is done through the Proof of Data Utility algorithm, which is implemented to verify and validate the use of data within the Nerian Grid. In other words, the Proof of Data Utility algorithm verifies and validates the Data Utility of the Nerian Grid. The datasets that are open for utilisation will be monetised according to market valuations.

Virtual Stake

Traditional Proof of Stake consensus mechanisms allow Validators to purchase and stake tokens to increase their chances to be selected for verifying and validating transactions and creating a new block in the blockchain. In the Nerian Blockchain, the selection process depends on the Virtual Stake of a Validator.

A Validator's Virtual Stake is generated through the Proof of Data Capacity and Proof of Data Utility algorithms and is directly related to the Data Capacity and Data Utility on the Nerian Grid. In other words, the Virtual Stake of a Validator is the embodiment of the work done by a Host, a Provider, or a User within the Nerian Grid. It is important to note that Hosts, Providers, or Users are not automatically Validators, but the dependency holds that to be eligible to apply for the role of Validator, a peer needs to maintain at least one of these three roles.

For example, when a Provider applies for the role of Validator, its Virtual Stake is related to the data provided and utilised on the Nerian Grid. In other words, the more data a Provider provides to the Nerian Grid and the more these datasets are utilised, the higher the Virtual Stake becomes and thus the higher the chances are to be selected for verifying and validating transactions by creating a new block in the blockchain.

3.3.1.2 Randomisation

Next to the Virtual Stake selection mechanism, two other selection mechanisms namely the *Coin Age* and the *Randomised Block* are used for the selection process of a Validator. These two selection mechanisms are implemented into the Proof of Stake to avoid monopolisation within the peer-to-peer network.

Coin Age Selection

The *Coin Age* selection mechanism chooses a Validator based on the period that their Virtual Stake has been active. Staking time is calculated by the sum of the number of tokens at stake, multiplied by the number of days the tokens have been held.

A minimum period of 30 days on the *Coin Age* is set before considering the tokens to be in a Virtual Stake. Thus, the older the tokens within the Virtual Stake are, the higher the chances of being selected for validating the next block and receiving the reward. When a Validator confirms a new block, their Virtual Stake tokens' age is reset to zero days allowing for the selection of other Validators. A maximum coin age of 90 days determines the automatic reset point for Virtual Stakes to avoid over-maturity.

Randomised Block Selection

The *Randomised Block* selection mechanism selects Validators for the process of validating based upon a hit and target value. When the hit value is below the target value Validators are selected for the process of validating.

The hit value is calculated by encrypting the hash of the previous block with the private key of the Validator. As every private key is unique, a unique hit value is calculated for each Validator within the Network. The target value V_t is calculated by multiplying the base target value V_b, the amount of time S passed since the last block was validated and the size Y of the coins staked by the Validator. The higher the stake, the higher the target value and so the higher the chance for a Validator to be selected for the process of validating.

$$V_t = V_b * S * Y$$

The combination of these two selection mechanisms adds to the randomness of the overall Validator selection process of the peer-to-peer Network and thus makes it more secure.

3.3.1.3 Security

The security of traditional blockchain networks could be compromised by a 51% attack. However, as a network grows, the chances for double-spending attacks decrease as the effort required to execute such an attack becomes larger and thus less profitable. By implementing the concept of Virtual Stake through the Proof of Data Capacity and Proof of Data Utility algorithms in the Nerian Blockchain, manipulation through pure token stake is eliminated and the chance for a 51 % is reduced. A Validator who wants to perform a malicious action will have to provide more than half of the Data Capacity as well as acquire more than half of the Data Utility on the Nerian Grid, which will be very difficult to achieve.

Moreover, just like the hashing power within a Proof of Work blockchain, the Virtual Stake is used and consumed outside of the network, hence the stake is called *virtual*, to verify and validate transactions within the network. If a fork occurs, whether it is an accidental fork or a deliberate transaction reversal attempt also known as double-spending, Validators will have to split their Virtual Stake, which will be economically unviable, to validate more than one chain. There must always be something at stake.

3.3.2   Token Economics

Our data cannot be carried around everywhere we go, let alone exchanged on the spot with people interested in using it. Therefore, a token (NRN) is issued, which serves as the digital embodiment of the data.

The token economics depend on the state of the Nerian Grid, which is determined by the ratio of Data Utility over Data Capacity. The former is determined by the Utility Transactions, whereas the latter is determined by the Capacity Transactions:

$$G_s = D_u \ / \ D_c, \ where:$$
$$G_s = Grid \ State$$
$$D_u = Data \ Utility$$
$$D_c = Data \ Capacity$$

3.4   Capacity Transactions

By providing data to the Nerian Grid, tokens are minted and burned by computer code, i.e. the Proof of Data Capacity algorithm, through Capacity Transactions. These transactions determine the Data Capacity of the Nerian Grid. The size of a Capacity Transaction is related to the amount of data provided to the Nerian Grid and depends on the market value of the Cloud Capacity (used to store and share the data) as well as on the market value of the NRN token.
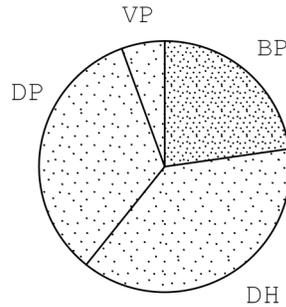

Figure 2: Distribution of the Capacity Transactions:
        (1) DP: part of the transaction that goes to the Data Provider (variable %)
        (2) DH: part of the transaction that goes to the Data Host (variable %)
        (3) VP: part of the transaction that goes to the Validator Pool (variable %)
        (4) BP: part of the transaction that is burned (variable %)

3.5 Utility Transactions

By using data on the Nerian Grid, tokens are minted and burned by computer code, i.e. the Proof of Data Utility algorithm, through Utility Transactions. These transactions determine the Data Utility of the Nerian Grid. The size of a Utility Transaction is related to how much the data is used on the Nerian Grid and depends on the market value of the Data as well as on the market value of the NRN token.
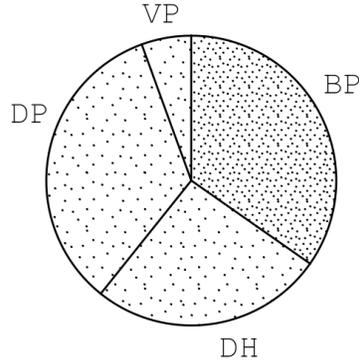

Figure 3: Distribution of the Utility Transactions:
  (1) DP: part of the transaction goes to the Data Provider (variable %)
  (2) DH: part of the transaction goes to the Data Host (variable %)
  (3) VP: part of the transaction that goes to the Validator Pool (variable %)
  (4) BP: part of the transaction that is burned (variable %)

3.6 Circulation

The Proof of Data Capacity and Proof of Data Utility algorithms operate as communicating vessels and incorporate incentive mechanisms that respond to the Grid State even though they function independently. In other words, the number of tokens circulating is affected by the Grid State and will be subject to change. These incentive mechanisms are based on economical principles that have been re-interpreted and respond in a randomized sequence relative to the following formula:

S * v = P * V, where:
S = Supply of Tokens
v = Velocity of Token Circulation
P = Price of Tokens
V = Volume of Token Transactions

The purpose of these automated incentive mechanisms implemented is to stabilise the network and the overall token economy. For instance, Users are charged for the use of data based on the amount of NRN tokens available in their wallet. Depending on the Grid State, this automatic form of staking encourages Users to stake tokens in their wallet in exchange for discounts on their data usage.

The Capacity as well as the Utility Transactions are built out of minting and burning sub-transactions (see Figures 2 and 3). The first sub-transaction is a minting transaction that goes to the Provider as a reward for the data produced and consumed on the Nerian Grid. The second sub-transaction is a minting transaction that goes to the Host as a reward for making and maintaining the application through which the data is produced and consumed. The third sub-transaction is a minting transaction that goes into the Validator Pool and is related to the Validator's reward for verifying and validating transactions within the Network. Finally, the fourth sub-transaction is a burning transaction that goes to the Burning Pool and contains tokens which will be burned permanently. If the Grid State changes because, for example, the Data Utility on the Nerian Grid increases, fewer tokens will be burned and so more tokens will remain in circulation. If the Grid State changes because, for example, the Data Utility on the Nerian Grid decreases, more tokens will be burned and so fewer tokens will remain in circulation.

The proportion, as well as the distribution of these sub-transactions within the Capacity and Utility Transactions and how they relate to one another, is variable. As mentioned before, both depend on the Grid State. From the Capacity and Utility Transactions, the total minting and burning rate within the network can be calculated.

4   Theoretical Case Study

Alice produces data and decides to join Nerian as a Provider. She sets up her Digital Twin and activates her Data Vault, both of which are linked to her Digital Twin.

She sends a request through the Nerian Grid to retrieve her data from around the Internet, for example, by invoking the General Data Protection Regulation (GDPR). In this way, Alice can collect and store personal data that exists on the current Internet - Web2. Furthermore, she can store newly produced data through applications built by Hosts on Web3, such as search engines or social media applications, that integrated the functionalities of Nerian. All this data is first organized and then encrypted with Alice's private key before storing them efficiently in the Data Vault linked to her Digital Twin.

Alice's Data Vault is deployed in the Cloud and consumes Cloud Capacity for which Alice pays a monthly fee. If it is free, you are the product. She now has the option to provide whole or partial datasets to the Nerian Grid. In other words, she can choose which datasets she will like to provide to the Nerian Grid and which she likes to keep private.

The Proof of Data Capacity then verifies and validates the data Alice likes to provide to Nerian Grid. Once validated, Alice is rewarded with part of the tokens from the Capacity Transactions for making her data available to the Nerian Grid. That way she can recoup her incurred costs for the Cloud Capacity consumed by the Data Vault of her Digital Twin.

Imagine Alice producing data while using a search engine built by Tom, a Host. If she decides to provide this data to the Nerian Grid, Tom will receive a part of the newly minted tokens from the Capacity Transactions. Just like Alice receives several tokens in proportion to the Cloud Capacity she consumes by storing data in her Data Vault in the Cloud, Tom receives several tokens in proportion to the Cloud Capacity he consumes by deploying his cloud application in the Cloud.

The more data Alice produces through Tom's application and provides to the Nerian Grid, the more tokens are minted and thus the more tokens Alice and Tom receive. Alice and Tom can exchange their tokens for fiat currencies, such as euros, and dollars, or other digital tokens, such as bitcoin or ether.

Alice now chooses to become a Validator for the Nerian Grid. As she is a Provider, she can apply for the role of Validator which activates a validator node linked to her Digital Twin. Once her validator node has been activated, her Virtual Stake in the network starts to grow. The longer Alice

provides datasets to the Nerian Grid and the more these datasets are used by Users, the larger her Virtual Stake grows which in turn increases her chances of being selected for validating a block in the Nerian Blockchain. Being selected to validate a block results in Alice being rewarded from the Validator Pool.

Bob is a User who runs an advertising company. He has an active marketing campaign targeting individuals who match Alice's profile. Since Alice and other Providers with matching profiles made their datasets available to the Nerian Grid, Bob can use their datasets.

It is important to note that Alice's datasets never leave her Data Vault. Digital Twins handle all the processing of data within the Nerian Grid. Bob's Digital Twin will communicate with the Digital Twins of Providers and when a match occurs, he will be able to send specific advertising to Alice through the different cloud applications she uses. Her data stays in her Vault, untouched. Only Alice has access to the data in her Vault with her private key.

First, Bob determines the type and number of datasets that he requires for his marketing campaign. The Proof of Data Utility then verifies and validates the data Bob will like to use within the Nerian Grid. Once validated, Bob is billed by the hour in tokens which he purchased on the market. A part of these Utility Transactions goes to Alice, as her data is used, as well as to Tom, as through his cloud application the information is produced.

Imagine Bob being billed 12 NRN worth of data by the hour for using Alice's datasets and sending her advertising. If Bob has 54,000 NRN tokens in his wallet (which is approximately 6 months of NRN tokens), depending on the Grid State he could, for example, get a 25% discount and only be billed 9 NRN worth of data by the hour.

So, Alice and Tom receive newly minted tokens through the Proof of Data Capacity as well as tokens through the Proof of Data utilisation. This makes storing and providing data to the Nerian Grid as well as building cloud applications on the Nerian Grid profitable. It is important to note that neither Alice's nor Tom's profit depends on the value increase of the token within this economic model.

So the more Tom's application is used by Providers to produce data and the more it is consumed by Users - turning data into advertising - the more tokens Tom receives. The more data Alice produces using applications built by Hosts and the more this data is consumed by Users, the more tokens Alice receives. The more data is provided by Providers and the more applications are built by Hosts, the more datasets Users can use.

Imagine more and more Users, like Bob, start using the available data within the Nerian Grid, so more Utility Transactions occur, increasing the Data Utility within the Nerian Grid. Consequently, the Grid State changes. When the Grid State changes, different incentive mechanisms are triggered. In this example, when the usage of the Nerian Grid increases, fewer tokens will go to the Burning Pool thus more tokens will remain in circulation. As more Providers, like Alice, start providing data to the Nerian Grid, so more Capacity Transactions occur, increasing the Data Capacity within the Nerian Grid. Consequently, fewer tokens will remain in circulation. Changes in the Grid State are not related to the size of the Capacity and Utility Transactions directly but are related to the proportions of the minting and burning sub-transactions. In other words, the Grid State influences the circulation of tokens.

Alice as a Provider plans a trip to Zanzibar and searches for the best-priced flight tickets to purchase. Bob as an active User can now compete for Alice's intention to fly, by presenting her with specific advertisements as opposed to merely competing for her attention, by using the Nerian Grid.

5 Conclusion

We have proposed an alternative data infrastructure in which personal data can be processed with privacy and security as the core focus. The system involves multiple incentives encouraging participants to contribute to the Network using the utility token NRN issued on the public Nerian Blockchain, allowing for the necessary transparency to create trust in the ecosystem.

While Providers providing data to the Nerian Grid are incentivised through the minting of tokens and compensated for their data being monetised; Hosts are rewarded for the data that is produced and consumed using their applications; Users are equipped with the necessary datasets required to make advertisements that hold value for the Provider while capturing their intention instead of their attention unlocking competitive advantage.

All building blocks exist to build a framework for the processing of data. Nerian envisions bringing these components together in a cohesive ecosystem, enabling new perspectives and opportunities.

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Questions   We welcome feedback related to this document be it conceptual or technical. Any questions or suggestions can be sent to hello@nerian.net.

A
Appendix I: Blockchain

A.1 Migration

To enable the functionalities described within this document, Nerian Network will proceed with a migration process from the XRP Ledger (Nerian V0) to the newly developed Nerian Blockchain (Nerian V1) which will be built using Substrate (refer to Appendix II: Technology/Substrate).

In this process, the total supply of the existing NERIAN token will be reissued on the Nerian Blockchain under the new ticker NRN. This will generate a Genesis Pool of tokens on the new blockchain at a 1:1 ratio.

To enable the distribution of the new NRN tokens, a snapshot of the state of the Nerian V0 blockchain will be taken at a predetermined block. This will transfer the state of the Nerian V0 blockchain to the Nerian V1 blockchain. That snapshot will serve as the standard to distribute the new tokens based on the tokens held in wallets at that time. Furthermore, token holders will have to send their NERIAN tokens to a dedicated burn wallet to receive the new NRN tokens. In this process, the total supply of existing NERIAN tokens will be reissued on the Nerian Blockchain.

The block at which the snapshot will be taken (and the approximate date and time) along with clear instructions for the SWAP will be communicated with the community well in advance.

After the snapshot, community members will have one year (12 months) to exchange their Nerian V0 tokens for Nerian V1 tokens. Every subsequent month following the initialisation of the SWAP, a 5% incremental penalty will be levied as a mechanism to encourage early swapping of NERIAN tokens to NRN tokens, thus promoting the Nerian Grid growth and the overall health of the network.

Example I: Alice has 25,000 NERIAN tokens in her Xumm wallet. She read the announcement regarding the launch of the new Nerian Blockchain and creates her Nerian Wallet. The snapshot has been taken and she sends her 25,000 NERIAN tokens to a dedicated burn wallet within the first month. Alice will receive 25,000 NRN tokens with no penalties.

Example II: Bob has 10,000 NERIAN tokens on Bitrue. He reads about the snapshot and moves his tokens to his Xumm wallet. Bob decides to buy 2,000 more NERIAN tokens after the moment of the snapshot. He sends 12,000 NERIAN tokens to the burn wallet. As only 10,000 NERIAN tokens got registered on the snapshot, Bob will receive 10,000 new NRN tokens.

Example III: Tom has 20,000 NERIAN tokens in Xumm. After the snapshot, he decides to sell 10,000 NERIAN tokens. Eventually, he sends his remaining 10,000 NERIAN tokens to the burn wallet. Tom will receive 10,000 new NRN tokens.

Example IV: Sara has 5,000 NERIAN tokens in Xumm but does not check on her wallet and does not take any action for over a year post SWAP.

If the CEXs where the NERIAN tokens are listed - Bitrue and SWFT - decide to support the SWAP, no action will likely be required and the tokens will be swapped automatically for you. Clear communications will be conveyed before the SWAP, ensuring that everyone understands how the process will work. Holding your tokens on a non-custodial wallet is, at this stage, the only guaranteed method that will secure tokens for the snapshot.

The Genesis and Fractional Nodes will be migrated to the Nerian Blockchain as a product of Nerian Tech to continue providing the Cloud Capacity required by the Nerian Grid. These individuals will also be considered by the team to participate in the first beta-testing of the Nerian Grid as Data Providers.

Detailed instructions for existing token holders, Genesis Node, and Fractional Node operators will be announced in due time regarding the swapping mechanism which will allow them to exchange their NERIAN tokens for NRN tokens.

B
Appendix II: Technology

B.1   Substrate

Substrate is an open-source blockchain framework with multi-chain smart contracts functionalities and has the interoperability to merge with the Polkadot and Kusama Networks, giving access to its system of parallel transactions, cross-chain transfers, and expanding support Network.

The Nerian Blockchain will be built using Substrate's framework toolbox without being constrained by it. From the beginning, this framework has been designed as a highly customisable, modular, and flexible framework. The team will be able to build the Nerian Blockchain, based on academically researched and field-tested code that has proven valuable on multiple live Networks.

As a result of Substrate, developers do not have to start from scratch. Due to Substrate's large ecosystem of top blockchain projects around the world, they provide a relatively large competitive advantage by leveraging open-source software.

B.2   ThreeFold

ThreeFold is an open-source blockchain-based cloud technology on which Nerian is building its peer-to-peer data processing network. In this way, Nerian helps build a global autonomous cloud infrastructure and technology, i.e. a self-healing and self-regulating cloud. ThreeFold is a very exciting technology. We learned a lot by working with this technology and adopted some essential principles for the proper functioning of the Nerian Network. ThreeFold is rebuilding the cloud from scratch with a focus on privacy and security; values we, the Nerian Community, also hold dear.