RSS3: The Open Information Layer

Natural Selection Labs

***Abstract*—Inspired by the original RSS Standard [1], this paper presents RSS3, the Open Information Layer for the Open Web. The paper serves as an enhanced version of the initial whitepaper titled "RSS3: A Next-Generation Feed Standard" [2]. Following the release of the initial whitepaper, we have consistently adhered to the proposed architecture it outlines to conduct experiments and advance the development of the RSS3 Network [3]–[5]. The Network has evolved into what is now known as the Open Information Layer as a part of the ever-changing dynamics of the Open Web. This paper summarizes the research and development output since then, providing insights into RSS3's vision and its novel decentralization architecture. Finally, we present the Network's tokenomics and governance model and discuss the future of RSS3.**

I. Introduction

RSS3 is the Open Information Layer, structuring Open Information. It is RSS3's mission to construct the Open Web by enhancing the free flow of Open Information.

Inspired by the original RSS standard [1] and the spirit of openness it represents, the Open Information Layer (OIL) aims to be a decentralized and permissionless layer where information flows openly without any restrictions.

II. RSS3 Network

The RSS3 Network is a decentralized network that is formed by two Sublayers: the Data Sublayer (DSL) and the Value Sublayer (VSL). This novel network structure is the outcome of a series of research and development experiments that were conducted to address the challenges faced by the Open Web.

Open Information (OI) is typically found across various types of networks, including decentralized, federated, and centralized networks that allow permissionless access. The Data Sublayer (DSL) is responsible for indexing and structuring OI for interoperability. This is achieved by introducing a crucial standard, known as the RSS3 Protocol (Protocol), see Section III-A, enabling network-agnostic applications to be built on top of the DSL. The DSL then leverages the Value Sublayer (VSL), see Section IV, to build an ownership economy for the Open Web (OW).

A. $RSS3

$RSS3 is the Network's native utility token. It is used to cover gas, settle request fees, operate Nodes, participate in staking and trust, distribute incentives, and engage in various network activities. See Section V for more details.

B. Epoch (ϵ)

An Epoch (ϵ) is a period of time used as a reference to measure the RSS3 Network's operation, during which the Network's parameters are fixed. The duration of an epoch is determined by the Network and is subject to potential future changes.

At the end of each ϵ, the Network will distribute the Network Rewards (R) to the RSS3 Network's participants and update the Network's parameters when necessary.

III. Data Sublayer

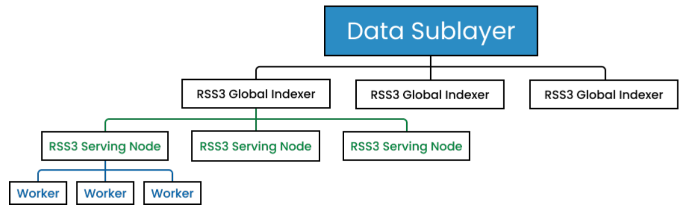

Fig. 1: A topology of the Data Sublayer.

The Data Sublayer (DSL) is responsible for the Open Information life cycle management, which includes indexing, transformation, storage, dissemination, and consumption [6]. In this section, we introduce the DSL and its fundamental components; see Figure 1.

The DSL is formed by two components (see section III-B and section III-C) and uses the Protocol (see section III-A) to structure the information for applications in social, search, AI, and beyond.

A. RSS3 Protocol

The RSS3 Protocol is used to structure Open Information for interoperability [7].

Open Information, indexed from multiple Open Data Protocolss (ODPs), is structured by Nodes (Nodes) into the Protocol format for interoperability.

ODPs use different data structures; Within a ODP, there might be multiple products, services, and protocols that leverage different data structures to suit their needs. This lack of standardization means limited interoperability, limiting the creation of scalable applications.

The Protocol addresses this issue by offering a unified set of data structures that serve as an abstraction. This abstraction simplifies the integration process, making it more manageable and scalable for developers to work with data across various ODPs.

B. RSS3 Node (N)

A Node, also known as an RSS3 Node, is responsible for indexing, transforming, storing, and ultimately serving the Open Information to the end users. The source code is openly available [8].

The operation of a Node is permissionless and is subject to a set of requirements set by the Network.

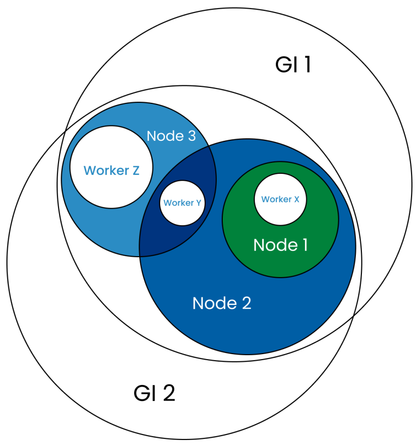

Fig. 2: A Venn diagram illustrating the relationship between the worker, the Node, and the Global Indexer.

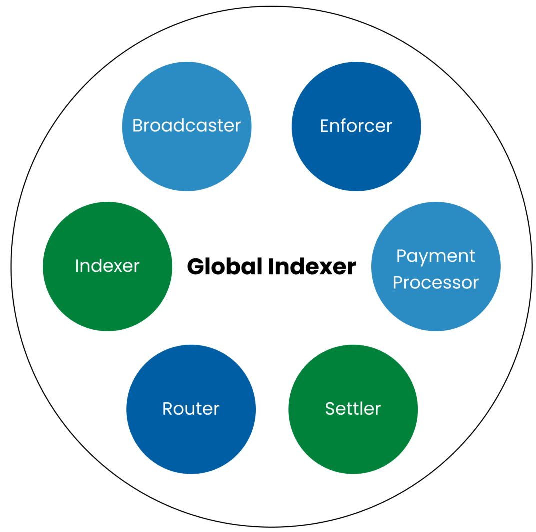

Fig. 3: Components of a GI. See Section III-C for more details.

1) Indexing

Each Node operates a number of workers that index and structure OI from ODPs. Workers are community-maintained "rules" that define how OI is indexed and transformed into the Protocol format.

Since each Node is independent, it is possible for different Nodes to employ different combinations of workers to cover different ODPs. This design enables node operation to be flexible, accessible, and affordable, in turn offering a high degree of decentralization and robustness.

2) Serving

Each Node operates a standard set of interfaces that serve structured OI.

Each successful request served on the DSL is recorded, and the corresponding request fees paid by requesters will be distributed to the Node base on the records. See Section V-B1 for more details.

C. RSS3 Global Indexer (GI)

Global Indexers (GIs) are responsible for facilitating coordination among Nodes and engaging with the VSL and perform critical duties via the contracts [9]–[11] to ensure the DSL is robust and reliable. The source code is openly available [12].

Given the permissionless nature of the DSL, robust quality assurance is essential to maintain the integrity and reliability of the RSS3 Network. As such, the operation of a GI is subject to a set of stringent requirements imposed by the Network.

Each GI is composed of several components, each with a unique set of responsibilities and functions that collectively contribute to the overall reliability and robustness of the DSL.

1) Broadcaster

The broadcaster is a component that continuously monitors all Nodes to detect any unusual or unexpected behavior.

2) Enforcer

The enforcer maintains demotion and slashing records, and implements measures to encourage Nodes to meet the established requirements.

3) Indexer

The indexer component provides structured information through its network transparency API, offering comprehensive insight into Network operations.

4) Payment Processor

The payment processor collects request fees from requesters. In addition, it calculates the Network's average tax rate and updates the settlement contract on the VSL accordingly.

5) Router

The router is responsible for routing requests to corresponding Node with optimal performance and minimal latency. The distinctive architecture of the DSL requires GIs be equipped with enhanced computational capabilities to determine the most efficient routing path for incoming requests. Typically, a request retrieves Open Information from a distributed group of Nodes concurrently.

6) Settler

The settler component submits Nodes' work records to the VSL. Subsequently, the settlement contract on the VSL verifies these records and facilitates the distribution of network rewards.

D. Reliability Score

A GI routes requests to Nodes based on their information coverage and a Reliability Score (σ). The calculation of σ is based on a range of factors, including but not limited to the Node's uptime, work, slash records, operation deposit, and staking/trust pool size. Nodes with a higher σ have an increased likelihood of receiving requests.

IV. VALUE SUBLAYER

The Value Sublayer (VSL) is a modular Ethereum Layer 2 blockchain built with a customized OP Stack [13], leveraging NEAR DA [14] as the Data Availability layer. It is responsible for handling value derived from Open Information activities and applications, establishing a healthy ownership economy for the Network.

A. Ethereum Layer 2

Blockchain technology, by its inherent design, is adept at managing value and ownership through consensus mechanisms. Among various blockchain construction methodologies, we have chosen to establish an Ethereum Layer 2 solution. This preference is justified by the widespread adoption of Ethereum's EVM (Ethereum Virtual Machine) for smart contract deployment, its substantial potential for liquidity, and the existing issuance of $RSS3 on the Ethereum Mainnet. This strategic choice facilitates a seamless transition of $RSS3 into a utility token for the RSS3 Mainnet.

B. Scaling

The VSL is built with a customized OP Stack by RSS3 as its scaling solution. The stack is selected for its efficiency, robust ecosystem, and the shared vision of an open and decentralized future. The choice is further justified by the proven maturity of the Optimistic rollup technology, which is currently facilitating multiple Layer 2 solutions. To cater to the distinct requirements of the RSS3 Mainnet architecture, we have initiated a fork of the OP Stack and implemented necessary customizations.

C. Data Availability

The VSL is responsible for handling value derived from OI activities and applications. Therefore, the VSL is expected to process a large volume of microtransactions. To further reduce both the transaction costs and the overall operational expenses of the VSL, NEAR DA is chosen as the Data Availability layer after a rigirous testing and selection process. The implementation maintains a careful balance between scalability, stability, and cost-efficiency, all while ensuring the security and decentralization of the VSL remain uncompromised.

D. Native Token

$RSS3 is the native token of the VSL.

V. TOKENOMICS

In this section, we introduce the detailed tokenomics of the RSS3 Network. We present the concept of Reward Pools, the Network Rewards's calculation and allocation formulas, and the slashing mechanism employed to enforce the Network's security and stability.

A. Node Operation

Node Operators are incentivized to operate and maintain the Network by receiving $RSS3 as rewards.

1) Anyone can become a Node Operator to launch an RSS3 Node and join the RSS3 Network without requiring prior permission.
2) A Node Operator has the ability to configure the Node's coverage, which directly influences the Node's capability to respond to various types of requests. A broader coverage means more computational resources are required and an increased likelihood of receiving requests.
3) A Node can be operated in either a Normal mode as N or a Public Good mode as N_p. A Normal Node is eligible for Network Rewards but requires a deposit of $RSS3 into its P_o. A Public Good Node is ineligible for Network Rewards but requires no deposit.
4) A Normal Node has a corresponding P_o and a P_s. All Public Good Nodes collectively share a single P_p.

B. Reward Pools

The RSS3 Network incentivizes network participants with a portion of $RSS3's total supply, referred to as the Network Rewards (R), and allocates it into reward pools.

This section introduces three reward pools: the Operation Pool (P_o), the Staking Pool (P_s), and the Public Good Pool (P_p). See Figure 4 for an illustration.

1) Operation Pool (P_o)

An Operation Pool (P_o) is used to store tokens that are allocated to a Normal Node from two sources:

1) The request fees (F) collected from requests served on the DSL
2) The Operation Tax (T) collected from the Node's P_s

The Node Operator can set a tax rate, τ, which is applied to its P_s, in conjunction with its Deposit (D) to determine the amount of Tax collected from its P_s. See Section V-D4. The tax applies to the Network Rewards being allocated to the Node's P_s but does not apply to the staked tokens.

Only the corresponding Node Operator can withdraw tokens from its P_o, and the withdrawal is subject to a waiting period imposed by the Network.

2) Staking Pool (P_s)

A Staking Pool (P_s) is used to store staked tokens for a Normal Node. Network participants can stake tokens into a Normal Node's P_s to increase the Node's chance to receive requests on the DSL.

The allocation of Network Rewards into a Node's P_s at the end of each epoch ϵ is determined by two factors:

1) Operation Rewards (R_o), the Node's normalized work contribution W in proportion to the total work done on the DSL (See Section V-D2)
2) Staking Rewards (R_s), the Node's P_s size in proportion to the total staked tokens on the VSL (See Section V-D1)

A tax T set by its Node Operator is then applied to the received Rewards.

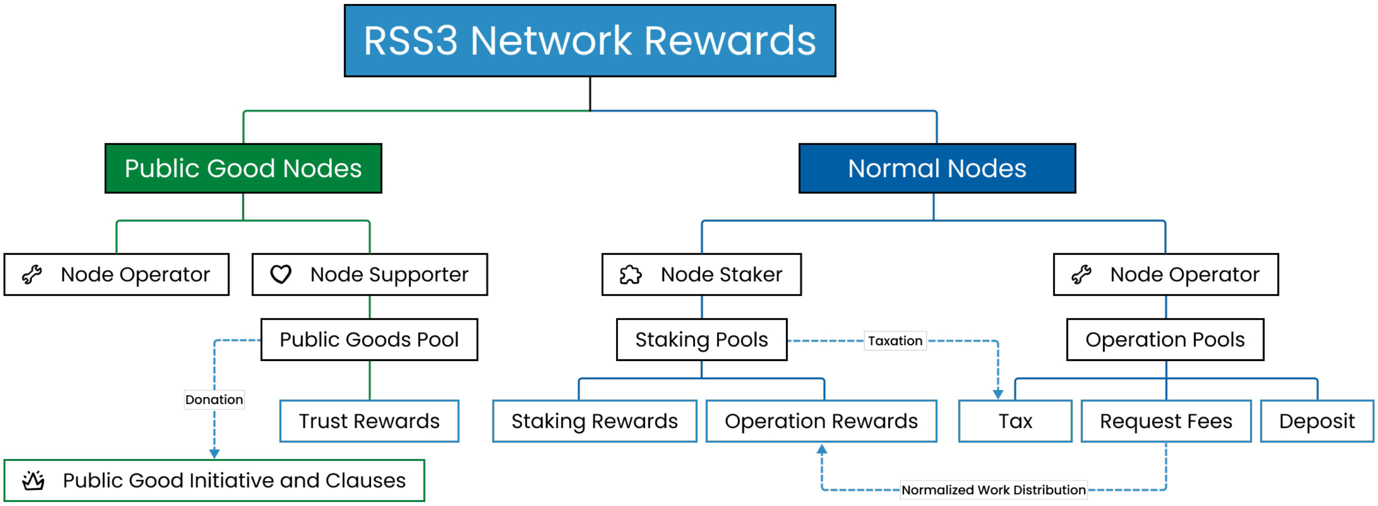

Fig. 4: The RSS3 Network Rewards are allocated differently to Normal Nodes and Public Good Nodes. See Section V-B for details.

3) Public Good Pool (P_p)

As Public Good Nodes do not participate in incentivization, they collectively share a Public Good Pool (P_p) for network participants to show their support toward Public Goods provision.

This pool plays a crucial role in facilitating the provision of public goods and reinforcing the robustness of the Network. The pool has a unique T set by the Network, and the proceeds are donated to initiatives and clauses that are oriented toward public goods.

C. Staking, Trust, and Chip

Network participants are incentivized to secure and improve the Network with their $RSS3 tokens. The staking contract [10] is responsible for managing the staking, trust, and Chip issurance.

1) Staking

A Normal Node accepts staking into its P_s; The amount of staked $RSS3 signifies its quality and reliability, and this increases the likelihood of receiving requests for a Node.

2) Trust

A Public Good Node does not have a Staking Pool and does not participate in any form of incentivization. Instead, network participants may choose to entrust such a Node, and their tokens are stored in a Public Good Pool. The trust level affects the likelihood of routing requests to a Public Good Node.

3) Chip

A Chip C is an ERC-721 Non-Fungible Token (NFT) representing a network participant's stake in a particular Node. Refer to its contract [15].

a) Minting

When a network participant stakes or entrusts tokens to a Node N, the participant automatically receives a Chip-N (C_N). Its value is dynamically calculated by its weight in P_s:

$$C_{N_{\text{weight}}} = \frac{s}{P_s + s} \tag{1}$$

Where $s \in \mathbb{Z}_{>0}$ is always a non-negative integer.

b) Redemption

A Chip can be redeemed for its underlying staked or entrusted tokens at any time, subject to a waiting period imposed by the Network. The redemption amount may be different from the original staking or entrusting amount due to the change of the underlying P_s balance:

$$s_{\text{redeem}} = C_{N_{\text{weight}}} \times P_s \tag{2}$$

D. Network Rewards (R)

In this section, we introduce the detailed Network Rewards calculation and allocation formulas.

The Network Rewards R consists of three parts:

$$R = (R_o + R_s) + R_t \tag{3}$$

See Figure 4 for an illustration. The allocation to each part is determined by the Network and is subject to potential future changes.

1) Operation Rewards (R_o)

To encourage Normal Nodes to operate reliably and consistently to maintain the Network, R_o is allocated to a Node's P_s in proportion to its request fees (F) collected on the DSL during the last ϵ. A higher quality of service attracts more requests, which in turn increases the amount of R allocated to the Node, as well as the taxable amount.

$$W_{N,\epsilon} = \log_2\left(\frac{F_{N,\epsilon}}{\sum_{x=0}^{\infty} F_{x,\epsilon}} + 1\right) * G \tag{4}$$

$W_{N,\epsilon}$ denotes the normalized work contribution for a given Normal Node N, at the end of a given epoch ϵ. G is a constant equal to $\ln(2) \approx 0.693147$ used to offset the effect of replacing $\ln$ with $\log_2$, as the former is more costly in terms of gas when it comes to on-chain computation.

$$R_{o|N,\epsilon} = \frac{W_{N,\epsilon}}{\sum_{x=0}^{\infty} W_{x,\epsilon}} * R_{o,\epsilon} \tag{5}$$

$R_{o|N,\epsilon}$ therefore denotes the Operation Rewards for a given Normal Node N, at the end of a given epoch ϵ.

2) Staking Rewards (R_s)

To encourage participation from all network participants to increase the Network's reliability, R_s is allocated to a Normal Node's P_s in proportion to the amount of staked tokens in the entire Network during the last ϵ.

$$R_{s|N,\epsilon} = \frac{P_{s|N,\epsilon}}{\sum_{x=0}^{\infty} P_{s|x,\epsilon}} * R_{s,\epsilon} \tag{6}$$

$R_{s|N,\epsilon}$ therefore denotes the Staking Rewards for a given Normal Node N, at the end of a given epoch ϵ.

3) Trust Rewards (R_t)

To encourage participation from all network participants to increase the Network's reliability and support Public Goods provision, R_t is allocated to the P_p in proportion to the amount of entrusted tokens in the entire Network during the last ϵ.

$$R_{t|N_p,\epsilon} = \frac{P_{t|N_p,\epsilon}}{\sum_{x=0}^{\infty} P_{t|x,\epsilon}} * R_{t,\epsilon} \tag{7}$$

$R_{t|N_p,\epsilon}$ therefore denotes the Trust Rewards for a given Public Good Node N_p, at the end of a given epoch ϵ.

4) Taxation (T)

A Normal Node's operator sets the tax rate τ which is imposed on the network rewards allocated to its P_s.

The amount of taxiable R_s is capped at a maximum of c times the amount of the current P_o, where c is set by the Network.

$$T_{N,\epsilon} = \min(P_{o|N,\epsilon} * c_\epsilon, (R_{s|N,\epsilon} + R_{o|N,\epsilon}) * \tau_{N,\epsilon}) \tag{8}$$

The tax rate for all Public Good Nodes is determined by the Network. These funds are deposited into the Public Good Pool and are allocated to support various Public Good initiatives and clauses. The allocations of these resources will be collectively decided by all Network participants.

5) Final Allocations

The total amount of tokens allocated to a Normal Node's P_o for a given epoch ϵ is therefore:

$$F_{N,\epsilon} + T_{N,\epsilon} \tag{9}$$

The total amount of tokens allocated to a Normal Node's P_s for a given epoch ϵ is therefore:

$$R_{o|N,\epsilon} + R_{s|N,\epsilon} - T_{N,\epsilon} \tag{10}$$

The total amount of tokens allocated to a Public Good Node's P_p for a given epoch ϵ is therefore:

$$R_{t|N_p,\epsilon} - T_\epsilon \tag{11}$$

Refer to Figure 4 for a visual illustration of the Network Rewards allocation.

E. Slashing Mechanism

The slashing mechanism is used to enforce the Network's security and stability. It is applied to both Normal Nodes and Public Good Nodes, albeit in slightly different ways.

1) Demotion

A demotion is automatically triggered when a Node fails to meet the requirements set by the Network. This can be due to a variety of reasons, including but not limited to: 1) the Node is offline for an extended period of time; 2) the Node is not serving requests in a timely manner; 3) the Node is serving requests but with incorrect information.

The Node's σ will be negatively impacted, diminishing its likelihood of receiving requests on the DSL. This, in turn, will reduce the Node's potential R_o and R_s allocated from the VSL.

2) Slashing

A slashing is automatically triggered when a Node is repeatedly demoted. Should a slashing occur, the Node's P_o and P_s will be slashed by percentages determined by the Network. Public Good Nodes are not subject to token slashing.

The Node's σ will be set to 0, effectively preventing it from receiving requests on the DSL during the current epoch.

The disposition of the slashed tokens is as follows:

- a portion of the slashed tokens will be burned, with the amount determined by the Network
- a portion of the slashed tokens will go to the reporter, provided the Node's misconduct was not auto-detected by the Network
- the remaining portion of the slashed tokens will go to the P_p

3) Challenge

When a Node is slashed, its Node Operator has the ability to challenge the slashing within a certain period. A successful challenge will result in the slashed tokens being returned to the Node's P_o and P_s.

VI. Conclusion

We have presented the design of the decentralized RSS3 Network that is capable of efficiently handling Open Information indexing, structuring, disseminating, and materializing without relying on a centralized entity.

The dual Sublayer architecture combines the DSL and the VSL to ensure efficient information indexing and integrate an ownership economy. While enabling interoperability through the RSS3 Protocol, the Network breaks down barriers in information accessibility and paves the way for a more interconnected digital future. By integrating a customized Optimistic rollup scaling solution and a robust tokenomics model, the RSS3 Network enhances the flow and value of information across permissionless platforms on the Open Web.

We hope to continue contributing to the evolution of the RSS3 Network into the backbone of the future Internet that is truly open and inter-connected.

At the heart of Natural Selection Labs, we firmly believe in the freedom of information: No organizations or authorities shall prohibit the free exercise of the right of people to create, store, and distribute their information.

References

[1] RSS Advisory Board, "RSS 2.0 Specification (Current)," https://www.rssboard.org/rss-specification, 2009.

[2] RSS3 Network, "The RSS3 Whitepaper," https://github.com/RSS3-Network/Whitepaper, 2022.

[3] ——, "RSS3-Network/DSL-v0.2," RSS3 Network, 2021, https://github.com/RSS3-Network/DSL-v0.2.

[4] ——, "RSS3-Network/DSL-v0.3," RSS3 Network, 2021, https://github.com/RSS3-Network/DSL-v0.3.

[5] ——, "RSS3-Network/DSL-v0.4," RSS3 Network, 2022, https://github.com/RSS3-Network/DSL-v0.4.

[6] National Institute of Standards and Technology, "Information life cycle," https://csrc.nist.gov/glossary/term/information_life_cycle, 2016.

[7] RSS3 Network, "The RSS3 Protocol," RSS3 Network, Apr. 2021, https://github.com/RSS3-Network/Protocol.

[8] ——, "RSS3-Network/Node," RSS3 Network, Jan. 2024, https://github.com/RSS3-Network/Serving-Node.

[9] ——, "RSS3 VSL Settlement Contract," https://scan.rss3.io/address/0x0cE3159BF19F3C55B648D04E8f0Ae1Ae118D2A0B, Mar. 2024.

[10] ——, "RSS3 VSL Staking Contract," https://scan.rss3.io/address/0x28F14d917fddbA0c1f2923C406952478DfDA5578, Mar. 2024.

[11] ——, "RSS3 VSL NetworkParams Contract," https://scan.rss3.io/address/0x15176Aabdc4836c38947a67313d209204051C502, Jul. 2024.

[12] ——, "RSS3-Network/Global-Indexer," RSS3 Network, Oct. 2024, https://github.com/RSS3-Network/Global-Indexer.

[13] ——, "RSS3-Network/optimism," RSS3 Network, 2024, https://github.com/RSS3-Network/optimism.

[14] NEAR, "NEAR | Data Availability," https://near.org/data-availability, 2023.

[15] RSS3 Network, "RSS3 VSL Chips Contract," https://scan.rss3.io/address/0x849f8F55078dCc69dD857b58Cc04631EBA54E4DE, Mar. 2024.

Glossary

Deposit - D
: Tokens required to operate a Node. 3

Data Sublayer - DSL
: A decentralized network where the Open Information flows from its source to its destination. 1–5

Epoch - ϵ
: A period of time used as a reference to measure the RSS3 Network's operation. 1

request fees - F
: Fees paid to Nodes for delivering Open Information from its Open Data Protocols to the requesters. 3, 4

Global Indexer - GI
: A Data Sublayer component that facilitates coordination among Nodes and engages with the Value Sublayer. 2

Node - N
: A Data Sublayer component that indexes, cleans, stores, and ultimately serves the Open Information to the end users. Denoted as N when it is in Normal mode, and N_p when it is in Public Good mode. 1, 2, 7

Network Rewards - R
: Tokens allocated by the RSS3 Network to incentivize network participants. 1, 3

Open Data Protocols - ODP
: Sources that generate information and provide unrestricted access to anyone. 1, 2

Open Information - OI
: Information that is typically found across various types of networks, including decentralized, federated, and centralized networks that allow permissionless access. 1–3

Open Information Layer - OIL
: A decentralized and permissionless information layer where information flows openly without any restrictions. 1

Operation Pool - P_o
: A pool of $RSS3 that consists of 1) Fees collected from serving Data Sublayer requests; 2) Network Rewards allocated based on the Node's work; 3) Tax collected from its Staking Pool. 3

Operation Rewards - R_o
: Tokens allocated to Operation Pool by the RSS3 Network to incentivize Node operation. 3

Open Web - OW
: The next-generation Internet where information flows openly without any restrictions, as it is supposed to be. 1

Public Good Pool - P_p
: A collective pool of staked $RSS3 that is used to improve the RSS3 Network by assigning trust to Public Good Nodes. 3, 4

RSS3 Protocol - Protocol
: A unified set of data structures for interoperability. 1, 2

Reliability Score - σ
: A score used to determine the allocation of requests to Nodes. 2

Staking Pool - P_s
: A pool of staked $RSS3 that is used to improve the RSS3 Network by assigning trust to Normal Nodes. 3

Staking Rewards - R_s
: Tokens allocated to Staking Pool by the RSS3 Network to incentivize network participation. 3

Operation Tax - T
: A tax collected from the Network Rewards that are allocated to a Node's Staking Pool, by its Operation Pool. 3

Value Sublayer - VSL
: A blockchain where the value created by Open Information activities is recorded and distributed. 1–3, 5