

Economic Model

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🔒 Locked on April 3rd 2020



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Abstract

This paper outlines the characteristics and uses of a cryptographic token RADIX (XRD), which is intended to be issued and used on the Radix Public Network (RPN). [The Radix Public Network](#) is a permissionless distributed ledger which functions in accordance with open source code.

Invitation for Comment

This Invitation for Comment has been issued by The RADIX FOUNDATION and in this paper “we” or “us” means The RADIX FOUNDATION.

This paper is a public draft to seek comments and suggestions. By taking part in this debate you grant your consent to any ideas, concepts and materials that you provide being used in further iterations of the Radix Economic Model, and any implementation of the Radix Public Network without limit and without entitlement to any remuneration, benefit or recognition (including a full waiver of moral rights).

Changes from Previous Economic Model

The recently released Radix [consensus white paper, Cerberus](#), changes the Sybil model for the Radix Foundation’s Public Network to Proof of Stake (PoS). Supplementing the change to PoS, this Radix Economic Model updates any preceding versions.

Proof of Stake is a value-based Sybil protection mechanism; the more valuable the token, and the greater the number of tokens staked, the more expensive the platform is to attack (all else being equal).

To help support appropriate network security incentives, the Radix Foundation’s Economic Model now includes a periodic emission of tokens ([Network Emission](#)), equivalent to an annual 2.5% rate of inflation¹ to the total token supply. This emission is earned by [Staking Nodes](#) for their work in securing the network.

When combined with the Radix [use-based fee burn](#), this creates a model that is inflationary via the emission, and deflationary² via use.

All previous publications should be considered withdrawn and superseded by this document.

Our Commitment to Decentralisation

The Radix Foundation has a commitment and mandate to deliver a Decentralised Public Network. For Proof of Stake plus [Cerberus](#), this means delivering a network on which the public controls over 67% of the available staking supply.

Proof of Stake does not affect the Radix Foundation’s ability to deliver linear scalability, but it does substantially affect the security parameters of the network. This Economic model lays out an automatic mechanism in which 67% public control is reached within the first 140 days of the Radix Public Network’s life.

To learn more about how we plan to balance security and public control, please see the [Unlocking Schedules](#) section.

Governance

A full governance paper (the Governance Paper) will be released by the Radix Foundation prior to the public launch of the Radix Public Network. This will describe a structure and method for achieving Radix community consensus for the adoption of changes to the Radix Public Network by the Radix Community.

This will also deal with the interaction of the Radix Foundation with the proposed community-led governance of the Radix Public Network, and development of the governance process itself.

Governance is not covered in this paper.

¹In this context, inflation means that the total number of tokens in circulation increases over time.

²Deflationary in the sense that tokens used are burned and removed from the total supply.

Executive Summary

The RADIX token (XRD) is a non-redeemable Utility Token. RADIX is intended to have two principal functions on the RADIX PUBLIC NETWORK (the Network): first, it may be used to pay for services on the Network; second it may be used to secure the Network against attack.

Most on-Network operations will incur a fee that is payable in RADIX tokens. The RADIX token is intended to serve as the mechanism whereby users pay for use of the Network.

The Network is planned to be secured against attack by a Proof of Stake sybil prevention mechanism. Token holders can choose to Stake a portion of their RADIX token balances to a Node they run, or they may delegate a portion of their token balances to a Node run by someone else. Staking is designed to cause the cost of attacking the Network to rise in proportion to the total value of RADIX tokens Staked.

To pay the token holders that choose to secure the Network with their stake, the Network is designed to have a constant rate of new token emission. These new tokens are programmatically paid by the Network to all Nodes running the Network, in proportion to the stake they control.

In addition to the programmatic new token emission, a total of 12Bn RADIX tokens are intended to be issued in the source code of the first Network published by the Radix Foundation. These RADIX tokens are intended to be programmatically locked to the Network and are planned to be automatically released over a period of 10 years. It is intended that only unlocked tokens can be Staked.

Token Overview

This section covers key details around the use of the RADIX token, some security considerations for Proof of Stake, and how public control is achieved and maintained.

System Stages

The Radix Foundation's novel consensus mechanism, [Cerberus](#), is the Radix Foundation's blueprint of how we plan to build a scalable, decentralised, public network that can support and connect billions of users.

Not all features of Cerberus will be enabled in the first version of the Radix Public Network. Instead, the Network will be published in multiple stages, starting with one called RPN-1 (Radix Public Network 1). This will start with a basic, unsharded version that will establish the foundations of the subsequent networks. Sharding will be implemented in later phases after the basic security model in RPN-1 has been tested.

Although this is a conservative approach to launching a public network, it has the advantage of ensuring a short timeline to the first release and a greater degree of staged security testing.

Transaction Fees

All Network operations that require a change of ledger state (e.g. transaction, token creation, messaging, conditional state creation) must be submitted with a Transaction Fee, in RADIX.

Once the requested Network operation has been validated, the Transaction Fee is burnt. This creates a direct relationship between the frequency of token burn with the frequency of Network use.

Proof of Stake Considerations

Staking is the process by which a user can lock their RADIX tokens so that they can participate in consensus and earn [Network Emission](#). Once locked, these users can either run the [Node Runner](#) client, or delegate their stake to another Node Runner. Any Node Runner that has RADIX locked to it is called a [Staking Node](#). The locked stake is then used by the Staking Node to participate in validating transactions and other on-ledger operations. This work forms the core of running the Radix Public Network.

As [Cerberus](#) is a 3-phase BFT consensus algorithm, it has strict bounds on liveness and safety. Controlling greater than 33% of stake weight gives the controller the ability to both halt liveness (stop the network from being able to reach consensus) and break safety (cause a double-spend).

For the unsharded RPN-1, the number of Staking Nodes is targeted to be approximately 100. Later versions of the Network are planned to substantially increase the number of nodes that can act as full consensus nodes and move the Network to a fully sharded configuration. Any balance holder that is not running a [Staking Node](#) may delegate their stake to a Staking Node to share in the [Network Emission](#).

Unlocking Schedules

The PUBLIC (the Public), the RADIX FOUNDATION (the Foundation) and the RADIX TEAM (the Team) form the three key groups of intended initial token holders on the Radix Public Network. The Public can be broadly defined as any RADIX holdings not granted to the Foundation, or the Team. To learn more about the Foundation or the Team, please see the [Organisational Components](#) section below.

To provide a short security “bootstrapping period”, as well as to help ensure the long term commitment of key parties, the 12Bn RADIX tokens issued at the genesis of the Network are intended to be subject to automatic unlocking schedules. When implemented, these schedules are programmatically enforced by the Network:

Public:	1 year of daily unlocking (1/365 per day)
Radix Foundation:	1 year full lock followed by 6 years of daily unlocking (1/2190 per day)
Radix Team:	1 year full lock followed by 3 years of daily unlocking (1/1095 per day)

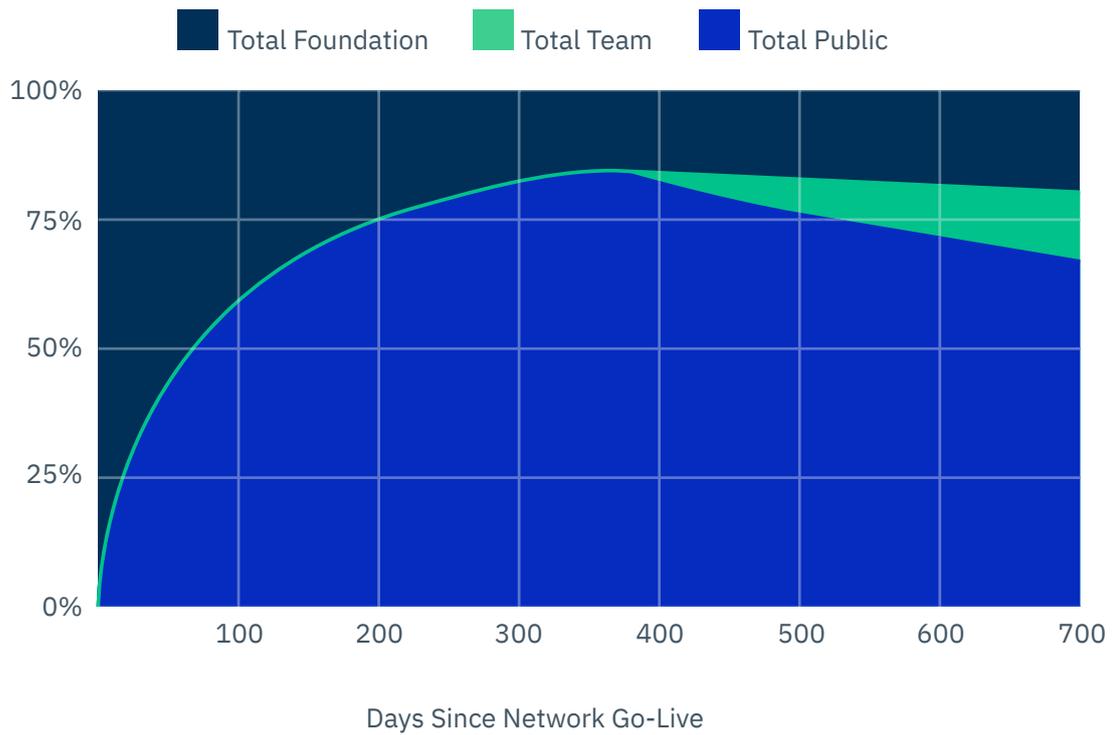
The Radix Foundation is also planned to be issued with an additional 600m unlocked RADIX tokens that it can use to stake from the first day of the RPN-1 being live. This is important for Network security as it is intended that only unlocked RADIX can be staked.

During this initial security “bootstrapping period”, the Foundation plans to stake 100% of the 600m RADIX it controls. This is designed to raise the cost of attacking the newly released network. As the RADIX token supply owned by the Public is unlocked over the course of the first year, the balance of ownership shifts, and by day 133 of the automatic unlocking schedule the Foundation’s ownership of available stake falls below 33% of the total unlocked stake

<i>Year 1: Percentage Control of Unlocked Stake</i>		
Days Since Live	The Public	The Radix Foundation
1	1.38%	98.62%
33	33.53%	66.47%
133	67.08%	32.92%
365	84.85%	15.15%

This process can be plotted as a graph that shows the percentage (%) of total stake controlled by the Public over the first 700 days of the network’s life. This graph assumes no sales to the Public beyond what has already been sold to date.

Percentage of Circulating Stakeable Supply



Token Distribution

To ensure a wide distribution of tokens to the Public, the Foundation is intending to make four token sales/distributions, spread over a period of four years:

- Sale of 25% of total initial supply prior to the launch of RPN-1
- Sale of an additional 10% of total initial supply within two years of launch
- Sale of an additional 5% of total initial supply within three years of launch
- Sale of an additional 2.5% of total initial supply within four years of launch

The effect of these sales/distributions events on Public control of total Stake can be shown as follows. [Network Emission](#) and [Network Subsidy](#) have also been added to the Public Token totals:

Years Since Live	Total Public Tokens	Public % Of Total Unlocked Supply
0	3,000,000,000 XRD	0%
1	3,359,167,947 XRD	84.85%
2	4,794,779,041 XRD	85.22%
3	5,699,260,317 XRD	78.05%
4	6,452,038,230 XRD	71.81%

As the Foundation tokens continue to unlock post year 4, if at any stage Public ownership drops below 67% of unlocked tokens the Foundation will sell tokens in its treasury until Public ownership is above 67% again.

To ensure we reach Public holding of 25% by the release of RPN-1, a further 6% of total supply is still required to be sold by the Foundation. This is expected to be made available to purchase between the publication of this paper and the publication of the Network.

The Foundation also expects to make a number of community Token donations to further support and engage the early Radix Public Network ecosystem.

The effect of Foundation token sales **Network Emission** and **Network Subsidy** can be shown on a graph of total unlocked Public holdings against that of the Foundation and the Radix Team over a 7 year period:



System Components

This section introduces the key system components of the Radix Public Network and some notes about how they interact with each other.

Node Runners & Staking Nodes

The Radix Public Network will be operated by a network of Nodes (computers running the Network client software). Those that choose to run Nodes are called Node Runners. Anyone may become a Node Runner by downloading and running the Node Runner client. Any Node Runner that has **RADIX locked** to it is called a Staking Node.

Although anyone may run the client, only Staking Nodes are able to directly participate in consensus. For the first version of the Radix Public Network (RPN-1), an initial maximum of 100 Staking Nodes will be enforced. Subsequent sharded versions of the Network are planned to substantially extend this initial limit.

Any RADIX balance holder that does not wish to run a Staking Node, or has insufficient balance to do so themselves, will be able to delegate their stake to any of these 100 Staking Nodes. Our target is to make the required balance less than 20 RADIX so that virtually anyone may participate in the network's security and earn from the Network Emission should they wish to do so.

Network Emission

The Network periodically creates new RADIX tokens which are automatically paid to all Staking Nodes that have been participating in consensus. These new tokens, called the Network Emission, are earned by valid Staking Nodes in proportion to the total amount of stake locked to their Node. Network Emission earned by Staking Nodes is called the Staking Fee.

The Network Emission is equal to an annual 2.5% rate of inflation on the total Network token supply. Given that the total starting RADIX supply is intended to be 12Bn tokens, the annual quantity of RADIX tokens available to be earned by the Staking Nodes would be:

Projected Annual Staking Fee:

Year 1: 300m XRD → Year 2: 307.5m XRD → Year 3: 315.2m XRD → Year 4: 323.1m XRD → etc.

This Staking Fee is planned to be subdivided into discrete staking periods and paid (at least daily) to all valid Staking Nodes who, in turn, can share these fees with any RADIX balance holders that have delegated stake to them.

As the Staking Fee is set by the rate of Network Emission, each staking period a fixed amount of new RADIX tokens are available to be earned by the Staking Nodes. The fee earning potential of a particular Staking Node (x) can therefore be calculated using the following formula:

$$\text{Total Period Earnings for Staking Node (x)} = \frac{\text{Staking Node (x) Stake}}{\text{Sum of all Staking Node Stakes}} \times \text{Periodic Staking Fee}$$

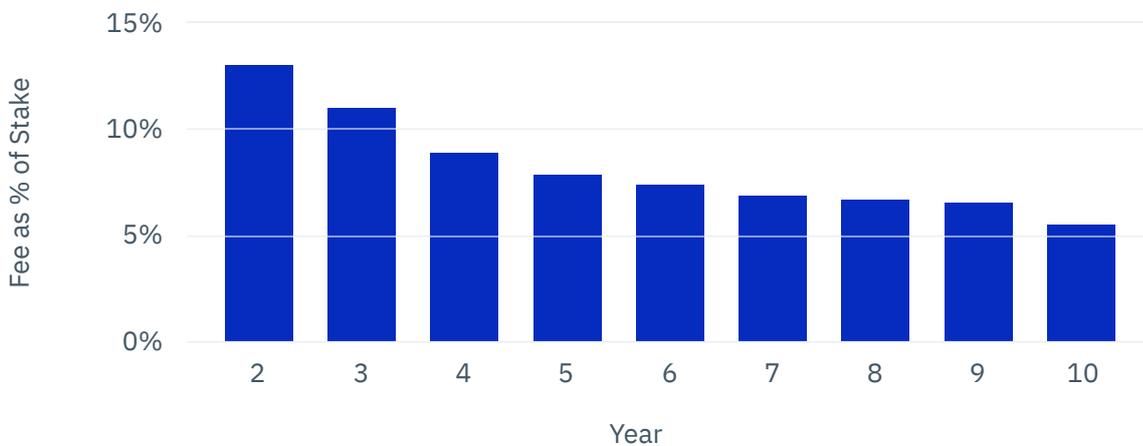
From the perspective of Staking Node (x), assuming the amount they stake is constant, the lower the Sum of all Staking Node Stakes, the larger the total earnings per period a particular Staking Node will earn. For Staking Node (x) this earning potential can then be expressed as a percentage:

$$\text{Fee Earnings as Percentage of Stake for Staking Node (x)} = \frac{\text{Total Period Earnings}}{\text{Staking Node (x) Stakes}}$$

This is designed to create higher Staking Node earnings at the start of the Network’s life, when total circulating supply is low. As the network matures and more potential stake is unlocked, Fee Earnings as a Percentage of Stake are likely to drop as the Sum of all Staking Node Stakes increases.

This can be plotted as a bar chart to show the expected Fee Earnings as a Percentage of Stake over a 10 year period. This chart assumes 68% of the available stake owned by the Public is staked, which is taken from comparable public network staking data. Should the actual number be lower, the Fee Earnings as a Percentage of Stake would be higher.

Emission Fee Earning for Staking



Year 1 has been excluded from this chart as Fee Earnings as a Percentage of Stake is projected to be 87.44% during the first year. This is because the Network Emission is proportionally large relative to the very small amount of circulating supply available to stake during the period in which the Public token supply is unlocked.

Although the Radix Foundation will normally stake any unlocked tokens that it controls to improve network security, it does not wish to increase its total network control or ownership through staking. As a result, it is intended that any Staking Fees received by the Foundation will be immediately paid to non-Foundation Staking Nodes via the [Network Subsidy](#) program.

Network Subsidy

The Radix Network Subsidy (Network Subsidy) is a 600m distribution of additional RADIX token fees for Node Runners, unlocked daily over a 10 year period, to be distributed by the Foundation daily.

The Network Subsidy is intended to help improve the performance of the Network. Any Staking Node that consistently meets or exceeds a set of minimum specifications for computing power, bandwidth and responsiveness will automatically receive the Network Subsidy.

The conditions by which a Node Runner may receive the Network Subsidy will be announced prior to the commencement of the Network Subsidy program, but will likely run to specs similar to that of a mid-sized AWS EC2 instance. Staking Nodes that do not participate in the Network Subsidy will still be able to earn [Network Emission](#).

Organizational Components

This section covers the three key groups of token holders, their relationship to each other and the number of RADIX tokens granted to each group.

The Radix Foundation Grant

The Radix Foundation is a not-for-profit company limited by guarantee, registered in the United Kingdom. This Foundation will promote the Radix Public Network as well as help manage the Radix community and ecosystem.

The Radix Foundation is responsible for administering three grants of tokens: the Network Security Grant; the Network Subsidy Grant; and the Foundation Grant. Each of these Grants have a different purpose and unlocking schedule to match that purpose:

Grant Program	Size (XRD)	Unlocking	Purpose
Network Security	600m	None	The first RADIX stake available to secure the Radix Public Network.
Network Subsidy	600m	10 years	To pay additional fees to all Nodes that meet minimum performance criteria.
Foundation Grant	3,000m*	7 years	To support the Foundation's long-term technical and ecosystem development.

*2Bn of this 3Bn is reserved for our intended Public ownership program; see the [Token Distribution](#) section for further details.

Prior to the release of RPN-1, the Foundation may also make a portion of its Foundation Grant available to be purchased, as well as make a number of grants. Any tokens that are purchased or earned during this period will be added to the Public total and subject to the same 1-year, pro-rata, daily unlocking schedule, as per all other Publicly held tokens.

For example, if 250m tokens were sold by the Foundation after publication of this paper, but before release of RPN-1, the Foundation Grant would be 2,750m RADIX tokens, and the Public total would be 250m higher.

The details of the [Foundation Staking](#) program and the [Network Subsidy](#) program are covered earlier in this paper. The Foundation Grant is allocated to the Radix Foundation with the express purpose of advancing the Radix Foundation's objects. After the launch of the Network, these objectives will be guided via community engagement and the Network Governance.

For a Network of this nature to succeed, it must be adopted by business, developers and consumers. Adoption requires dedication, hard work, evangelism and the careful balancing of the interests of all parties.

Although this list is by no means exhaustive, below is a summary of the contribution that the Radix Foundation will be mandated to provide to the Network and Community:

- 1. Technology Development**
 - a. Core Network Protocol Development
 - b. Open Source Support
 - c. Crisis Management
- 2. Radix Community Development**
 - a. Developer conferences
 - b. Developer meetups
 - c. Hackathons
- 3. Marketing**
 - a. PR/Announcements/Events
 - b. Stakeholder Relations
 - c. Public Education

The Public Token Grant

So far, 2.28Bn RADIX tokens have been allocated to community contributors to the Radix project. These contributors were given an early opportunity to support the Radix network's development between the years 2013 and 2017.

A further 720m RADIX tokens are intended to be made available to purchase or earn via a variety of channels later this year. All token purchased or earned in this manner will be added to the Publicly held token total.

All Publicly held tokens granted before the launch of RPN-1 are subject to the shortest daily unlocking schedule of 1 year. This is critical to help ensure the Network is a fully publicly controlled decentralised network.

The Radix Team Grant

Daniel Hughes (Radix Project Founder) has spent 8 years of full-time work and a significant amount of his personal wealth on the development of the technology and code which forms the basis for the Radix Public Network.

For this extraordinary contribution of time, effort, and intellect, there is intended to be an allocation of 2.4Bn RADIX tokens. To ensure alignment of incentives this grant of tokens will be locked for 1 year, followed by a daily unlocking schedule of 3 years.

Working together with Dan, the Radix Team is helping to turn his vision into reality. To reward the Team for their work, as well as create a more suitable vehicle for accepting further investment, Radix DLT Ltd was formed. Subsequently Dan's entire grant of 2.4Bn RADIX tokens was transferred to Radix DLT Ltd where Dan is the Founder and CTO.

This grant of 2.4Bn RADIX tokens is referred to as the Radix Team Grant, administered via Radix DLT Ltd.

The Stable Token Reserve

Decentralised stable coins such as MakerDAO are often viewed as strategically important components of a thriving public network ecosystem. They provide a mechanism for converting native tokens into stable value tokens and back again, function as a helpful leverage mechanism, create large amounts of lockup, and provide a useful decentralised stable store of value for other applications to use or built on top of.

The Foundation does not wish to discourage any developer from developing their own version of a collateralised decentralised stable coin on the Radix ledger, however we recognise such a task can be daunting.

To help bootstrap important projects of this type, the Stable Token Reserve was formed. This Reserve holds 2.4Bn RADIX tokens that are indefinitely locked and entirely removed from circulating supply.

The Foundation has a 10 year period in which to test different formulations of a stable token, which may or may not require the use of the Stable Token Reserve. Should the Stable Token Reserve not be needed, it will remain locked and be destroyed after the 10 year period.

The following are the most likely scenarios for the Stable Token Reserve not being used

- A Radix built stable coin proves to be unnecessary.
- A Radix built stable coin does not require the Stable Token Reserve.
- Our testing proves unsuccessful.
- Regulatory approval becomes impossible.

Calculations

The figures and charts throughout this document are described in more detail in this calculations sheet: https://docs.google.com/spreadsheets/d/1Pv5BeNvd8w_yNbaaxx5NpD6nmYYtPAgu2k1bdq4Jww8/edit?usp=sharing



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