Lightlink Whitepaper V1

Abstract on Lightlink

1. Problem

In the early 2010s, enterprises began adopting blockchains for their ability to provide secure and transparent transaction recording and verification. This digital ledger technology allowed businesses to create a shared record of transactions that could not be easily altered, making it useful for a variety of enterprise applications such as supply chain management and financial transactions.

In practice, blockchain technology provides an array of value propositions. However, in most enterprise cases, transaction speeds and privacy are often focal points when compared to decentralisation. To achieve these ends in a secure manner, private blockchain infrastructure is commonly utilised. As a result, enterprises miss out on the opportunity to leverage the network effects of public blockchains like Ethereum. Network effects refer to the phenomenon where a product or service's value grows exponentially as more individuals use it. Public blockchains, such as Bitcoin [1] and Ethereum [2], benefit from strong network effects. As more individuals participate in a network, utility and hence network value increases. This effect compounds as subsequent users join and capitalise on the value created by the prior phase of onboarded users. This allows public chains to attract a large and diverse user base, improving their security, stability, and liquidity. In contrast, private blockchains are only used by a limited number of participants, restricting their network effects and preventing them from realising the full benefits of a decentralised network. All private chains are siloed, ergo lacking the interoperability that gives rise to the network effect. This has limited the potential advantages of blockchain technology for enterprises and has hindered their wider adoption of the infrastructure.

A key issue facing the on-chain gaming and metaverse industry is the lack of scalability of the underlying blockchain technology. Due to the limited throughput of most blockchain networks, it is difficult to support large numbers of users and transactions without encountering significant delays or detrimental spikes in gas fees. Limited throughput has hindered on-chain gaming and metaverse platforms' ability to attract large user bases and provide a smooth and seamless user experience (UX). Another issue facing the industry is the lack of interoperability between different blockchain platforms, which creates barriers to entry across different on-chain gaming and metaverse applications. Overall, these challenges have made it difficult for the on-chain gaming and metaverse industries to fully realise their potential and become mainstream.

Transaction fees on blockchain networks are traditionally paid in the native gas token of the network, which is a special type of cryptocurrency that is used to power the network and incentivise transaction processing. End users who are not familiar with cryptocurrency may find it difficult or intimidating to purchase and manage native gas tokens in order to pay transaction fees and thus use the network. Additionally, the volatility profile of most cryptocurrencies forms a

sense of transactional cost unpredictability, further impeding the usability of a network. Ultimately, the use of native gas tokens as a means of paying transaction fees can be a barrier to entry for end users who are not familiar with cryptocurrency and blockchain technology.

2. Solution

Our remedy for these challenges and problems is LightLink - an enterprise-focused layer 2 blockchain that is specifically designed for the on-chain gaming and metaverse industry. The network is built atop Ethereum and concentrates on providing the necessary scalability, interoperability, and user-friendly features that are required to support the growth and adoption of on-chain blockchain applications for enterprises.

LightLink scales far better than Ethereum's maximum capacity of 15 transactions per second (tps) [2] given its use of optimistic rollup technology. High gas fees and execution bottlenecks often faced by layer 1 blockchains supporting projects with significant transaction throughput (games and metaverses) can be avoided by LightLink's processing of transactions off-chain. Periodically, these transactions are compressed into a rollup by a sequencer node and posted onto Ethereum. This enables LightLink to exceed efficiency levels of other layer 2 networks, on average facilitating over 400k transactions per day at a maximum capacity of 5,172 tps. Gas fees incurred by the sequencer node, when pushing transaction proofs on Ethereum, are distributed between all transactors involved in the batch. As a result, LightLink's fees will be as low as $0.001.

Rather than requiring the use of its own token, LL, as the native token for gas fees, LightLink enables users to satisfy these costs with ETH. Users can simply bridge their ETH from Ethereum's Mainnet onto LightLink via the official bridge. This singular feature acts to differentiate LightLink from other layer 2 rollups, making the former more user friendly than alternatives.

Additionally, LightLink renders itself more unique with its Enterprise Mode. This feature enables enterprises to proactively subsidise the cost of transactions through paying for the creation of a gas station. By enabling said gas station, a smart contract running on the network nullifies gas costs for user transactions on that enterprise's protocol over a predetermined period of time. Accordingly, protocols leveraging Enterprise mode are able to offer its clients feeless transactions, removing traditional barriers that discourage businesses from moving their products on-chain.

As an optimistic rollup, when transactions are compressed into a batch which are eventually posted on the Ethereum mainnet, an assumption is made that all transactions are valid. Over a short period of time, network participants can challenge this assumption with cryptographic proofs which locate flaws in the transaction batch. Once the window to challenge batches has ended, the relevant transactions have reached finality given that they cannot be reversed. The use of this technology allows LightLink to be highly compatible with Ethereum, encouraging

developers that desire to use the optimised technology to move to the layer 2 and bring along existing Solidity-based smart contracts.

3. Design Principles

LightLink represents the work of a group of experienced blockchain developers all driven by 3 design principles and philosophies: ease of use, adoption and composability. As detailed throughout the remainder of the whitepaper, LightLink's underlying architecture and UX is fundamentally focused on achieving these guiding principles.

3.1. Ease of Use

In the ever-changing context of blockchains, simplicity and ease of use are two features that are invariably challenging to come by. Hence, through a number of features, LightLink strives to offer its users with a superior user interface (UI) and UX.

As detailed above, rollups are typically limited in their usability because of the need to pay gas in its native token. LightLink renders itself a usable platform given that users are not required to pay for transaction execution with LL, but can instead utilise their bridged ETH. This feature means that users can efficiently bridge their ETH onto the layer 2 and immediately be able to transact, interact and utilise the various applications present on the network.

With the optimistic rollup technology used by LightLink, compatibility with the Ethereum Virtual Machine (EVM) [2] can be optimised. As such, smart contracts can be executed in the EVM bytecode, enabling developers to create and deploy their contracts on LightLink using the same tools and languages used for the Ethereum mainnet. In addition, this feature ensures interoperability between LightLink, other layer 2s as well as other EVM-compatible blockchains.

Finally, LightLink champions ease of use for its enterprise partners and their clients through gasless transactions and unparalleled speed. Enterprises running protocols on LightLink pay an amount of money each month to cover all gas fees that would typically be incurred by transactors. On the front-end, users transact for free, resulting in more demand for the network from these individuals and correspondingly, larger enterprises. Whether the application relates to supply chains, ticketing or metaverse projects, if the execution of transactions were to halt, the resulting impact would be severely negative. LightLink guarantees constant uptime with no stagnation with respect to transactions, offering a seamless experience for users and encouraging enterprises to leverage the network given the absence of detrimental UI bugs.

3.2. Composability

In order to support a range of different enterprise and non-enterprise applications, LightLink is driven to offer unparalleled composability and flexibility in its design. Composability is an important design principle for blockchains, as it allows the technology to be used in combination with other systems and technologies. This design principle is important because it allows

businesses to tailor the technology to their specific needs. Indeed, LightLink is able to support custom smart contracts that enable enterprises to automate complex processes and reduce the need for manual intervention.

LightLink's composability as it relates to NFT games and metaverses drives adoption given that it allows for one in-game item to be used across multiple platforms. Notably, due to LightLink's prioritisation of composability and thus interoperability, NFTs minted on the layer 2 can be used on games and metaverses that exist on other blockchains and networks. This results in each NFT having more utility and value as they are not siloed to a single protocol. Accordingly, the composability feature has the potential to drive the development and use of a wider ecosystem, correspondingly catalysing adoption.

With respect to the network effect, composability is crucial for layer 2s, like LightLink, given that it results in more interoperability whereby Solidity, the coding language for Ethereum [3], contracts and compilers can be used. LightLink's composability as an EVM-compatible chain permits efficient communication with numerous blockchains and other layer 2 networks. This heralds benefits for the protocol as it captures more liquidity, inevitably leading to stability and further adoption.

3.3. Adoption

Since the Bitcoin whitepaper established the presence of blockchain technology, cryptocurrency platforms have constantly been seeking to bring this technology into the mainstream. Rather than the mere presence of blockchain technology being a selling point, successful adoption is often achieved when the benefits that distributed computation brings to businesses and individuals is a focus. Many enterprises make use of blockchain or distributed ledger technology for multiple reasons:

- **Increased transparency and traceability**: Blockchain technology enables enterprises to create transparent, secure, and auditable systems for tracking the movement of goods, assets, and data within a supply chain. This can help improve supply chain management, reduce the risk of fraud, and increase trust between different parties.
- **Improved security and data integrity**: Blockchains use cryptography and distributed consensus mechanisms to create secure and tamper-resistant systems for storing and sharing data. This can help enterprises protect sensitive information from unauthorised access and tampering, and ensure the accuracy and integrity of their records.
- **Reduced costs and increased efficiency**: Blockchains can help enterprises streamline their operations and reduce the need for intermediaries, lowering costs and increasing efficiency. For example, blockchain-based payment networks can enable faster and cheaper transactions, while supply chain management systems can help reduce the need for manual tracking and reconciliation.
- **Greater interoperability and network effects**: Blockchains can help enterprises to more easily and securely collaborate with other organisations, both within and outside their industry. By using standardised protocols and open networks, enterprises can connect with a wider range of partners and customers, and exchange value and

information more seamlessly. These levels of trustless interoperability are unparalleled, giving rise to significant network effects for businesses that are leveraging blockchains.

With a large client base and the undeniable benefits of using blockchain technology, enterprises have a meaningful role to play in taking cryptocurrencies and web3 into the mainstream. LightLink's enterprise clients are currently leveraging this technology on private networks, however, are moving onto the public layer 2 to obtain the initial benefit of the network effect.

Outside the context of enterprise blockchains, LightLink is purposefully built for metaverse, NFT and gaming applications with its speed, security and cost-effectiveness. These features further extend to decentralised finance (DeFi) applications. With support from the LightLink's ecosystem fund (detailed below), a thriving, interoperable ecosystem of applications will exist on the layer 2. This generates incentives for developers to build projects on the network as they too obtain the network effect benefit.

As an enterprise-focused, layer 2 network, LightLink delivers on all the above verticals. LightLink heralds more scalability and transparency than layer 1 blockchains, offering enterprise protocol users gasless transactions and other network participants cheap fees. Importantly, as detailed below, LightLink further increases adoption by avoiding the need for users to swap ETH (or other ERC-20 tokens) into LL by having ETH as the native gas token.

4. The LightLink Protocol

4.1. Layer 2

To optimise on the current roadmap of Ethereum, LightLink is launching as a layer 2 network. In this context, LightLink is built on top of Ethereum to improve its scalability and performance by executing transactions off-chain and post batches on the layer 1 mainnet which encapsulate proofs of the validity of such transactions in a compressed manner. Initially, with a focus on bootstrapping the growth of the layer 2 network, LightLink will optimise its network's scalability and gas fees, leveraging Ethereum for security and decentralisation. Through the passage of time, LightLink plans to increase its degrees of native security and decentralisation. Nevertheless, LightLink's effective use of Ethereum enables it to meet all three prongs of the Blockchain Trilemma [4] as scalability is achieved on the layer 2 and security as well as decentralisation is obtained via the underlying layer 1.

4.2. Optimistic Rollup

LightLink is a bottom-up optimistic rollup; after a number of transaction blocks on the network, a proof is generated that can be verified efficiently by network participants. LightLink is optimistic by nature as all proofs computed by the sequencer are assumed to be correct, relying on the existence of honest actors to authenticate the proofs when searching for monetisation opportunities via errors in transaction batches. In the case where a network participant finds such an error, they will receive a reward to incentivise this type of behaviour in the future, and

the batch will not reach finality, with the relevant transaction(s) and their impact on the LightLink state being reversed. Honest network participants verifying the validity of LightLink blocks will have a challenge window to locate any false transactions in batches.

Notably, with the launch of other numerous rollup networks in the past few years, it is clear that the layer 2 wars are beginning. Most involved parties have leveraged Optimism forks to enter into the space. However, LightLink is not a fork of Optimism. Instead, LightLink has been built up independently of other layer 2s and coded using Go, focusing on providing the best experience for ecosystem partners and other participants.

4.3. EVM-Compatibility

Unlike zero knowledge rollups, LightLink is directly compatible with the Ethereum Virtual Machine (EVM). This means that developers can efficiently move from the Ethereum mainnet to LightLink whereby Ethereum-native smart contracts can be deployed and executed on LightLink. This compatibility enables LightLink to utilise Ethereum's go-ethereum (Geth) codebase, including the layer 1's extensive ecosystem of tools and libraries. Furthermore, at its core, LightLink makes use of the same JSON RPC endpoints of Ethereum and can thereby be used as a direct drop-in replacement for the blockchain.

4.4 A Green Network

Similarly, to better the Ethereum ecosystem and its energy consumption, LightLink strives to be a green network. With an average of less than 200 kilograms in carbon emissions per year, LightLink performs significantly better than other chains; Ethereum and Solana respectively emit over 900 tons of CO_2 and 1.65k tons [5] of CO2 per year. By striving to be a green network, LightLink is helping to reduce the environmental impact of blockchain technology and improve the overall sustainability of the Ethereum ecosystem.

4.5. LightLink's Use of ETH For Gas Fees

Further differentiating itself from other layer 2 rollups, Lightlink does not require its users to acquire its own native token to satisfy gas fees. Instead, ETH acts as the token used by addresses on non-enterprise protocols to transact. This enables LightLink to make strides on its design philosophy of ease of use - there is no necessity for everyday-users of the rollup to purchase LL or swap other tokens for it in order to execute transactions. Utilising ETH as the token used for gas fees effectively reduces the time taken between bridging assets and subsequently transacting on the network when compared to other rollups.

4.6. LightLink Blocks

Each LightLink node runs their own copy of the network's transaction pool which acts as a memory pool (mempool) akin to that of Ethereum [2]. To prevent scam transactions from inundating the mempool, a number of variables are required to be included in transactions,

including `tx per account limit`, `total txn limit` and `tx size limit`. Before transactions are submitted to the mempool, they are initially validated by the sequencer node that is currently operated by LightLink. Upon entering the mempool, transactions are sorted based on `nonce`, the nonce of the sender account, and `gasPrice`, the gas cost in wei. Beyond these variables, as LightLink mirrors Ethereum's legacy transaction type, the following data is included in each transaction:

- `gas` - the gas limit
- `to` - the recipient address
- `value` - the amount of wei to be transferred
- `data` - contract invocation input data

Every 500 milliseconds, the sequencer node creates a block, taking transactions from the mempool in order of the transaction's gas fee. The sequencer selects transactions from the transaction pool and places them into a new block. This process continues until either the block gas limit or the predefined block transaction limit variable is reached. If there are no transactions in the pool, the sequencer will still create an empty block and add it to the blockchain. As LightLink uses its own version of blocks, certain data points are included:

- `hash` - Keccak256 [6] hash of block data
- `previousHash` - hash of the previous block in the chain
- `merkleRoot` - Merkle root of the transactions within the block
- `timestamp` - when the block was created
- `nonce` - integer used to find the correct difficulty level was reached
- `index` - index position of the block in the chain
- `transactions` - transactions which have been committed to the block
- `miner` - the address of the Sequencer which mined the block
- `state` - PENDING or PROCESSED
- `protocol` - version number of the protocol which the block was created on
- `stateRoot` - Merkle root of the account states after this block is processed
- `signature` - ECDSA signature of the hash of the block

Using the Keccak256 function, the following function is used to determine the block hash:
Block Hash = `keccak(b.PreviousHash + b.TimeStamp + b.Nonce + b.MerkleRoot + b.Index`
Once computed, the sequencer will sign the hash of the block using geth's `crypto.Sign()` function; this signature is then appended to the block, indicating that the block was minted by the sequencer node and not another network participant. Before the sequencer compresses all of the blocks on LightLink, a transformation will occur such that the LightLink block is identical to the Ethereum format JSON blocks. As such, blocks returned via the `eth_` JSON RPC endpoints will be in the Ethereum block format whilst blocks in the LightLink format can be retrieved using the `prime_` JSON RPC endpoints.

4.7. Storing and Posting Batch Information

The need for rollups emerged from the scalability limitations of Ethereum. Before layer 2s had dominated blockspace on Ethereum, calldata was not an issue as nodes only stored the state of the chain at each block. Calldata is the data that is passed to the smart contract as part of a transaction, and it is used to provide input to the contract and specify how it should be executed. With the rise of rollups, many more state changes required validation and storage along with the functions executed by smart contracts, resulting in expensive calldata structures for the Ethereum-native contracts. Consequently, many of the potential cost benefits of rollups have been cut short by the continued and asymmetric price increase of storing layer 2 calldata.

However, Ethereum's rollup-centric roadmap [7] seeks to resolve these issues through the establishment of a sharded, data availability layer which stores information in Binary Large Objects (BLOBs). This layer is an important step that must be taken to reduce rollup fees and scale Ethereum; yet, effective innovation that lowers calldata costs is needed now.

Accordingly, LightLink is presently using a modular solution whereby only transaction batches, which purely store the changing state of the rollup each block, are posted on-chain, incurring the normal Ethereum gas fees. On the other hand, the calldata from the execution of LightLink smart contracts is zipped and subsequently stored on the InterPlanetary File System (IPFS) [8] to ensure that it is secured in a decentralised fashion. Utilising IPFS for storage call data simultaneously guarantees that fraud proofs can be levied against transaction batches as all relevant information is available and that network transactors do not incur elevated fees due to the data availability guarantee [9]. This innovation is an early step toward a fully modular Ethereum blockchain, whereby different layers, such as the Execution Layer and the Data Availability Layer operate independently.

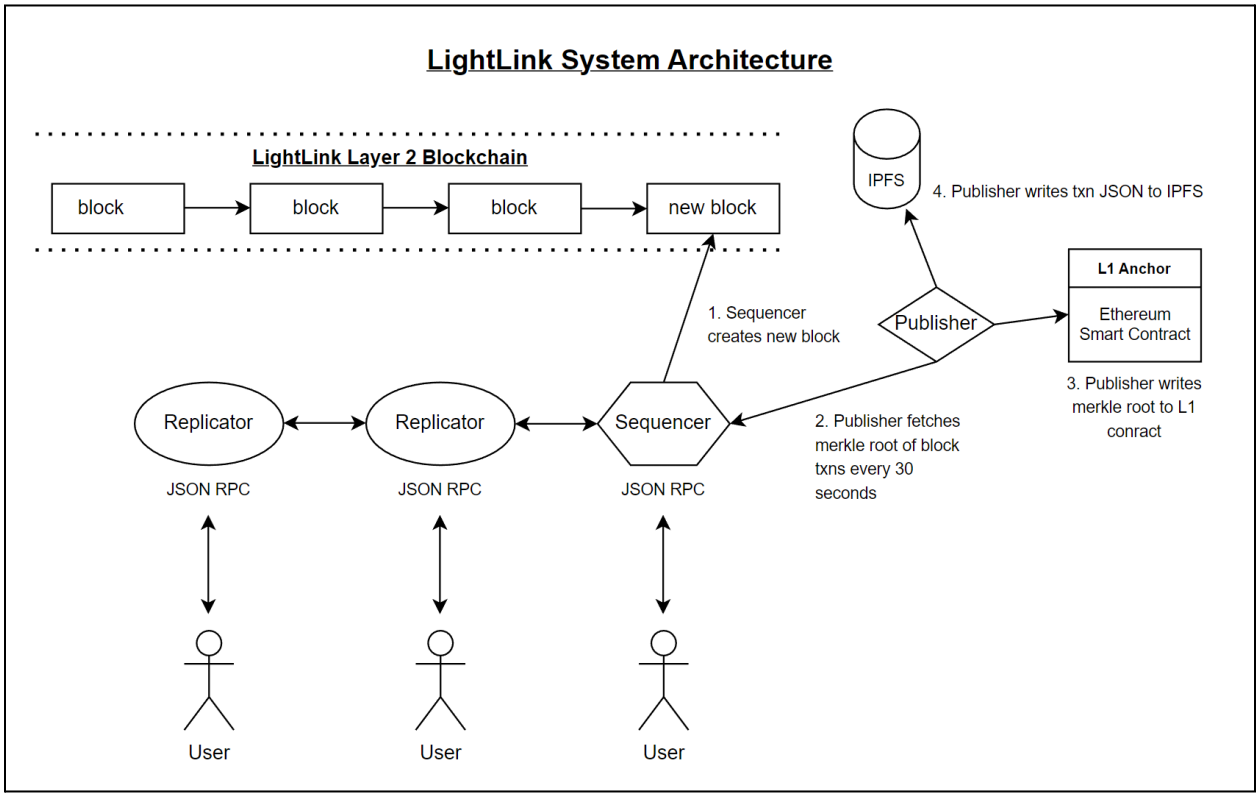
4.8. Batch Production

The sequencer additionally assumes the role of leveraging Patricia Merkle Trees [10] to compress and minimise the amount of state data published onto Ethereum. The computation of the compressed batch of transactions results in the sequencer incurring gas fees. These fees, along with the fees of pushing transactions onto Ethereum, are distributed amongst all network users through the sequencer gathering gas fees when said users submit transactions.

After a number of blocks are dynamically determined by the network, the sequencer nodes processes all transactions in said blocks, computationally compressing them into a transaction batch that is posted onto the Ethereum layer 1 Anchor contract (0xa653486b6a89281D8354CAdD406793872D69F633). Each batch pushed on-chain contains the following information:

- `the start block`: the LightLink block number of the first block in the range of blocks on the layer 2 that have been compressed.
- `end block`: the LightLink block number of the last block in the range of blocks on the layer 2 that have been compressed.

- `transaction root`: the Merkle root of all transactions in the block range generated by the LightLink sequencer
- `state root`: the Merkle root of the layer 2 account state after all transactions in the block range have been processed by the sequencer on LightLink
- `cid`: the content identifier of the layer 2 calldata stored on IPFS for the range of blocks compressed into the current transaction batch block range transactions



4.9. Fraud Proofs

Leveraging optimistic rollup technology allows LightLink to execute transactions efficiently as a layer 2 without losing EVM-compatibility like zero knowledge rollups. As well as deriving security from Ethereum, LightLink enables network participants to use fraud proofs to demonstrate that a transaction in a batch, that is pending approval on the Ethereum mainnet, is true or false. If the fraud proof is valid, that is, an incorrect, impossible or imperfect transaction was appended to the batch by the sequencer node, the rollup will negate and revert any of the state changes impacted by the transaction.

LightLink will provide the specific infrastructure to create fraud proofs via github docs. However, the process is as such: users must utilise the smart contract on the Ethereum mainnet to obtain the proof, and subsequently compare it with their own generated proof that is generated from hashed transactions that were executed and calldata stored via IPFS. Notably, as LightLink will be an open source software, the computational approach used by sequencer to compress

transactions will be publicly available. Consideration relating to the incentivisation and disincentivization of respectively publishing correct and incorrect fraud proofs is taking place. Developments and conclusions made relating to the issue will be announced in the second iteration of the LightLink whitepaper.

Fraud proofs are a key part of the security and trustlessness nature of LightLink as they allow users to verify the correctness of the rollup's state without placing all their faith in the sequencer, a third party or an off-chain oracle. During a period of time, known as the challenge window, participants are able to verify transactions; this is possible because the batch has not reached finality on the Ethereum blockchain, meaning that the rollups state can be reversed. For the foreseeable future, LightLink will be utilising a 7 day challenge window. Accordingly, 7 days after the compressed transaction rollup has been posted on chain, it will reach finality.

In the case of a fraud proof being levied against a transaction batch, network participants initiate a validation process to determine whether the relevant transaction was valid or invalid. In the case of successfully challenged batches, the invalid transaction will be rolled back on LightLink and removed from the commitment posted on the Ethereum Anchor. Notably, this ensures that all the blocks in the batch do not need to be reversed, saving users gas fees in the face of reverifying and publishing state changes.

5. Protocol Economic Parameters

Early predictions paint a positive picture relating to the performance of LightLink. The use of optimistic rollup proving technology enables LightLink to reach a theoretical capacity of 5,712 tps, far outpacing Ethereum's maximum throughput of 15. Whilst the layer 2's throughput will only get this high during times of substantial demand, the network is estimated to facilitate over 400k transactions per day. Concurrently, on LightLink, transactions reach finality, that is, they cannot be reversed directly on the layer 2 network, after 500 milliseconds - this value far eclipses the finality speed of other networks.

Importantly, the state of LightLink, and hence transactions, can be reversed, in the face of successful fraud proofs whereby invalid transactions are located in a batch posted on Ethereum. Network participants will have 7-day challenge window when they can question the validity of transactions in a batch, through the process detailed above, before batches are deemed final on the Ethereum mainnet; at this point, the transactions that were executed on LightLink have reached finality on both the layer 1 and layer 2.

As explained in section 4.6., after a number of blocks of transactions on the layer 2, a Patricia Merkle Tree is used to compress transactions into a batch. The hashed root transaction from the compression approach is included in the block posted on the Ethereum mainnet. With thousands of LightLink-facilitated transactions being included in each batch, layer 1 gas fees and Merkle Tree computation fees are distributed amongst a large number of transactors. Accordingly, it is predicted that the average transaction cost is $0.01, yet can be as little as $0.001. These low fees are possible for LightLink given its use of IPFS when storing zipped

calldata that do not relate to the state of the network. Notably, upon the implementation of ProtoDanksharding and Danksharding [11] at the Ethereum-base layer, these gas costs are expected to drop further.

6. Enterprise Mode

Unique to LightLink is its Enterprise Mode. This feature is analogous to a gas station whereby the enterprise running the protocol tops up the funds in the gas station each month in order to ensure that those utilising the platform are not subject to transaction fees. On LightLink, Enterprise Mode is facilitated through the use of unique smart contracts, be they ERC-20 or ERC-721 contracts - depending on the application.

In collaboration with LightLink administrators, enterprises can be set up with their own smart contract for their protocol(s). On the LightLink network, enterprises will register by providing `organisation name`, `lightlink wallet address`, `gas units` and `gas price`. The latter two variables will be initialised as zero, increasing relative to the payment described below. Correspondingly, based on the `gas price` per user interaction with the contract, the `gas units` will be equated to the `quota` × `gas price`, ensuring enterprise users receive the fair number of transactions for what the underlying organisation paid.

Each enterprise client gets a single smart contract whitelisted on LightLink. At the beginning of every month, the enterprise that is running their protocol on the layer 2 pays a fixed fee based on a tier structure outlined below. These costs equate to a `quota`, determined by the tiers outlined below, for enterprises which cover the gas fees that users on that platform would normally incur when actioning transactions. Furthermore, the monthly amount collected from these enterprise transactions go to purchasing LL and subsequently burning them, applying upwards pressure on the token's price. These users will interact with the enterprise's whitelisted smart contract which permits them to not pay gas fees. Contingent on the enterprise's fee tier, the daily cumulative gas fees that users avoided through interacting with the whitelisted smart contract is capped as the `quota` approaches 0; at this point, protocol users on Enterprise Mode will need to pay transaction fees in ETH like normal users. If this daily maximum is frequently reached as result of growing platform demand, the enterprise will need to increase tiers so as to raise the smart contract cap.

Currently, there are three tiers that enterprises can opt into:

- **Tier 1** - Enterprises will satisfy a monthly charge of $5k; users of the enterprise's protocol will be able to push through 1k transactions per day before incurring gas fees
- **Tier 2** - Enterprises will satisfy a monthly charge of $10k; users of the enterprise's protocol will be able to push through 10k transactions per day before incurring gas fees
- **Tier 3** - Enterprises will satisfy a monthly charge of $20k; users of the enterprise's protocol will be able to push through 50k transactions per day before incurring gas fees

Enterprises looking to determine which tier is right for them are requested to engage in discussions with the Pellar Technology team.

This novel approach is significant as it enables enterprises to move their protocols off private networks and onto public networks with minimal backlash from their users given that they are not required to pay expensive gas fees. In this context, Enterprise Mode allows LightLink to act on its design philosophy of ease of use; at any moment, one of two events can be occurring:

1. **Available Transactions in the Smart Contract** - in these cases, the daily transaction allocation that bypasses the need to pay gas fees has not been reached. Hence, users do not need to spend ETH on satisfying transaction fees.
2. **No Available Transactions in the Smart Contract** - in these cases, the daily transaction allocation that bypasses the need to pay gas fees has been reached. Subsequently, enterprise users pay in the ETH that they bridged to LightLink

In either of the above situations, the enterprise user is able to efficiently transact on the LightLink network without reaching an inconvenience impasse whereby a decentralised exchange to swap into LL is needed.

There are many examples as to when Enterprise Mode can herald substantial benefits to the business' users. One such example is an on-chain game which leverages NFT technology. If a player must pay transactions for every action they make, including picking up tokens and moving their avatar, the game would become unbearable. In situations where players sign a contract to autopay gas fees for on-chain transactions such that they are not distributed by constant private key signature requests, they are at risk of being exposed to severe spikes in gas fees. For example, if a user allows transactions to be auto-signed on the assumption that gas will remain at `gwei = 10`, then a jump occurs, resulting in `gwei = 30`, this user will continue paying for exorbitant transactions without knowledge of the tokens they are spending. However, if the business offering that game were to opt into using LightLink's Enterprise Mode, their users would not face any inconveniences in engaging with the game or be at risk of accidentally paying exorbitant gas fees.

Furthermore, as detailed in the tokenomics section of the whitepaper, the impact of Enterprise Mode is meaningful given its constant burn pressure on the token. With less tokens in supply, this initiative will both increase the scarcity of LL and reduce the majority of negative price influences from token unlocks.

7. Business Applications

LightLink's unique structure and architecture render it suitable for a multitude of both untapped and/or sectors with insufficiently developed infrastructure. There are 5 primary applications that LightLink focuses on improving and benefiting:

- **Enterprise Size Protocols** - As previously mentioned, many enterprises are utilising private, scalable blockchains for their protocols, thereby failing to obtain the benefits of the network effects. LightLink is a highly secure, cheap and efficient blockchain that can

scale horizontally. Irrespective of the size of the protocol and its throughput, LightLink's composable nature can be tailored to respond to the enterprises' specific needs.

- **Gaming & Metaverse** - With NFT-based gaming and metaverse projects often failing to take off due to scalability limitations and the frequent stagnation of transaction, LightLink concentrates on providing constant uptime, security and execution of all transactions. The layer 2 provides the foundations for ownable, unique digital assets that can be utilised and transferred at scale, allowing for the existence of interoperable games and metaverses.
- **Ticketing** - Among the many benefits that blockchain technology can bring to enterprise businesses, on-chain, NFT-based ticketing is a strong example. Through LightLink, tickets can be represented as NFTs that are tied to individuals. This rectifies many of the issues facing the ticketing industry as NFTs are 1:1, meaning no two wallets can hold the same NFTs. Furthermore, the NFT can shuffle the ticket code upon use, meaning that they cannot be shared once the first individual has been permitted entry. LightLink's efficiency facilitates growth in this industry on the blockchain.
- **Identity** - The LightLink network can be used for identity management by allowing users to create and manage their own digital identities on the layer 2 in a decentralised manner. This can be done using smart contracts and other blockchain technology to securely store and verify identity information. Using LightLink's scalable and interoperable infrastructure, users can easily access their digital identities and share them between protocols. The use of LightLink for identity management can provide enhanced security, privacy, and control over personal data.

8. Tokenomics

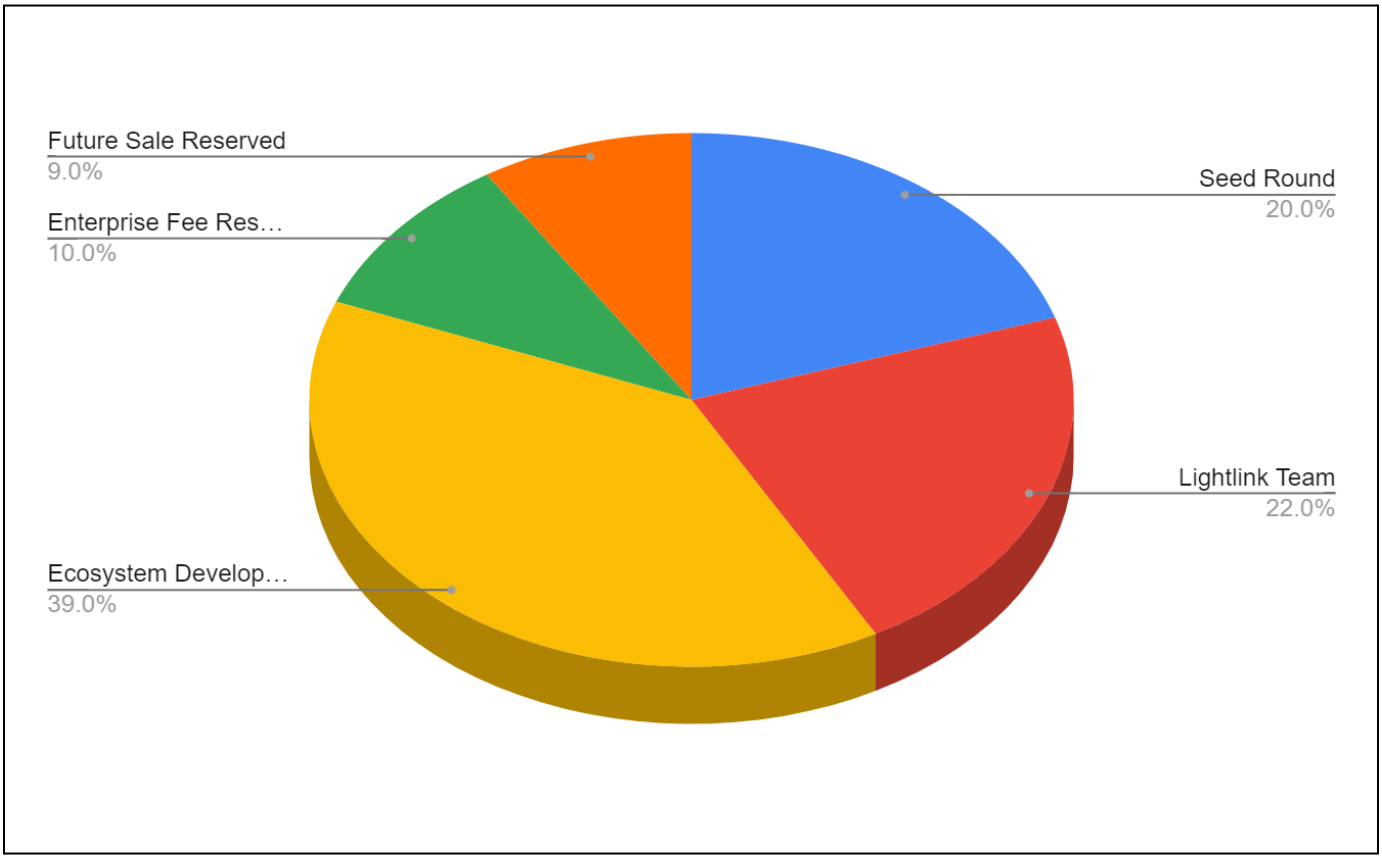
8.1. Allocations & Vesting Schedules

LL are allocated to ensure the long-term health and sustainability of the layer 2 network.

20% of unissued tokens have been allocated to a seed round to raise funds to build LightLink. To ensure that these early investors are unable to apply significant downward pressure on the token price, there is an initial 1 year cliff period, afterwhich 25% of LL is issued each year in monthly payments over 4 years. This vesting period ensures that the seed investors have skin in the game to continue improving and involving themselves in the growth of the network. A further 9% of tokens are allocated to the Private Sale A for future sales for other investors.

Additionally, the team behind LightLink will receive a 22% allocation to be distributed over 5 years in a similar fashion to seed round investors; 1 year cliff period then linear monthly emissions over 4 years. Furthermore, 10% of LL's supply is allocated to the Enterprise Fee Reserve. These tokens will ensure that enterprise customers can leverage OTC desks when purchasing and burning tokens. Once burned, the LL will subsidise gas fees used by transactors on enterprise protocols.

In order to ensure a thriving ecosystem for both enterprise and retail users, 39% of LL tokens have been allocated to our Ecosystem Development Fund. This is a bucket of token allocations that includes treasuries, staking rewards, grant funds, public token sales and tokens for market makers to provide liquidity to LL. With monthly unlocks over a 3 year timeline, the Ecosystem Fund's dry powder will stimulate interest in LightLink on behalf of project founders, resulting in adoption from users in the long-run.



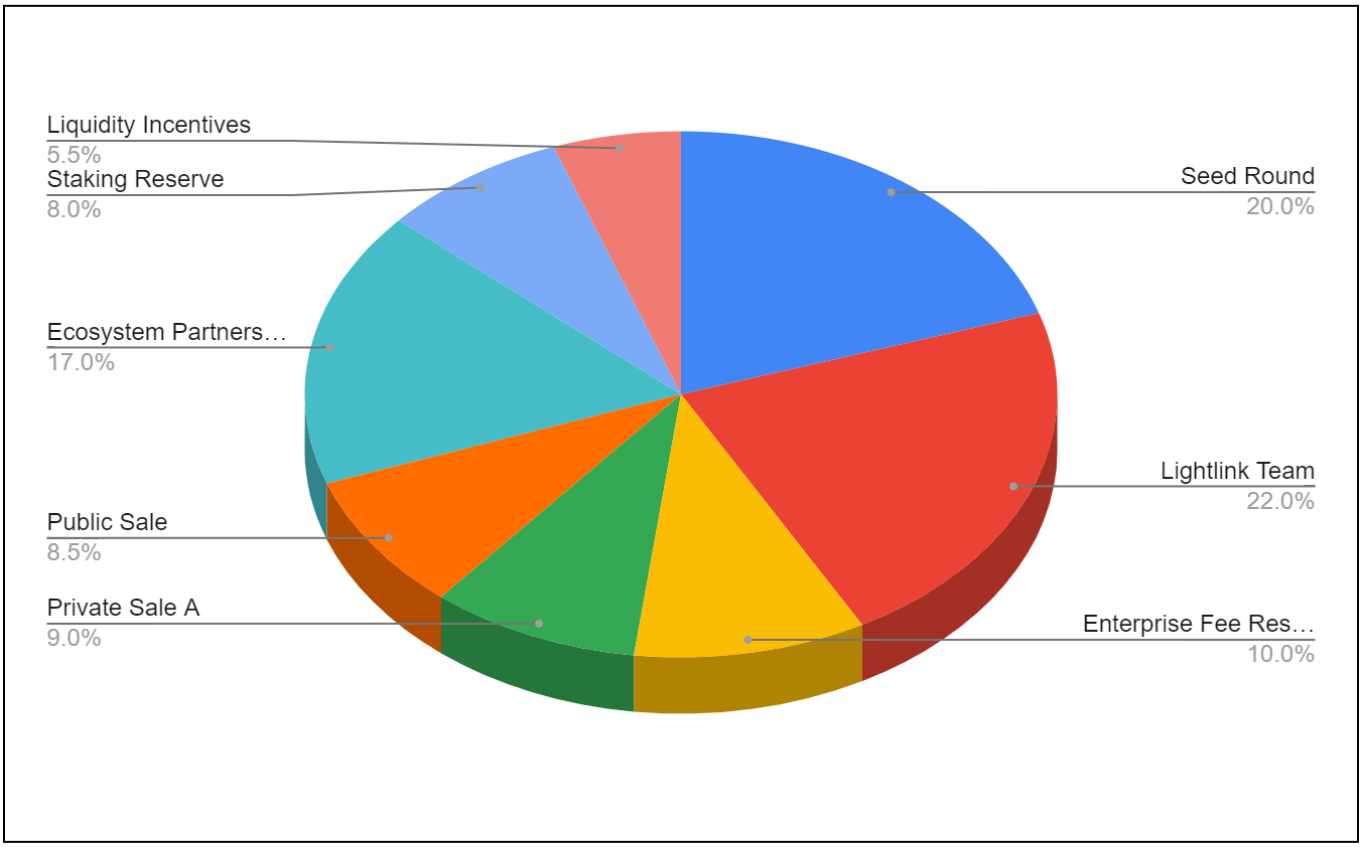
The Enterprise Development Fund will be broken down into a number of smaller categories. 8.5% of tokens are set aside for public sales. This public sale will occur upon the launch of the second iteration of our whitepaper. Once most enterprises involved with the layer 2 network have been onboarded, along with all of their clients and users, LightLink will begin establishing a thriving ecosystem of decentralised applications. At this point, the official public sale will occur with the 8.5% of LL allocated to this event.

LightLink is fundamentally different given its use of an Enterprise mode and a normal mode; in the long-run, each will be equally important to the ecosystem. With numerous enterprises already committed to LightLink, 17% of LL has been allocated to Ecosystem Partners. This will include providing grants to new projects looking to build on LightLink across a range of vertices like DeFi, decentralised social media, NFT platforms and many more. Under the funds allocated to the Ecosystem Partners, an additional focus will be on funding community events and projects based on the guidance of LightLink users and community.

Upon launch, LightLink will not rely on staking to guarantee the security of the layer 2. However, as the sole Enterprise focus is sharded to consider crypto-native applications, staking will be introduced. 8% of the tokens will be allocated to our staking reserve and will be minted periodically to pay out stakers.

Finally, 5.5% of LL will be minted and allocated to liquidity incentives for trading pools across multiple decentralised and centralised exchanges. With a small initial supply of LightLink, compressing the spread of trades on centralised and decentralised exchanges will prove arduous. These funds will go to assisting market makers in compressing spreads and deepening liquidity across LL trading pairs.

The combined tokenomics breakup, with specific consideration for the Ecosystem Development Fund, can be found below.



8.2. Issuance & Burn Dynamics

Despite inflation arising from the vesting schedule, we anticipate that in the long-run LL will be deflationary. Deflationary mechanics within the tokenomics model works to reduce the supply of the token, theoretically resulting in a positive impact on the token price given that the equilibrium which determines the value a token is exchanged is heavily influenced by circulating supply. If

demand remains the same and supply falls (due to token burns), the novel scarcity of LL would apply positive token pressure given there are less tokens available.

Every month all enterprises onboarded will purchase tokens using fiat currency depending on their tier; these tokens are set aside to subsidise gas fees used by transactors on the enterprise protocols. So as to apply positive price pressure, the value obtained monthly from this purchase is used to purchase LL tokens which are subsequently burnt.

Additionally, for protocols external to those using Enterprise mode, ETH is used for gas fees. An extra 20% will be levied to ensure further token buybacks and burns depending on the network demand. Following each transaction, the additional 20% collected will be transferred to a single multi-signature wallet. At the end of every month, this ETH is used to purchase LL via an OTC desk which is consequently burnt to decrease the circulating supply and offset the impacts of token unlocks.

Expansion of these dynamics such that stakers generate real yield based on network demand is under consideration and will be addressed in future roadmaps and iterations of the whitepaper.

9. Conclusion

In conclusion, LightLink offers a unique solution for enterprises and individuals looking to leverage the power of blockchain technology. By providing faster, cheaper transactions, enhanced security and privacy, and seamless interoperability with other blockchain networks, LightLink is equipped to help businesses in a variety of industries unlock the full potential of blockchains and its network effect. The robust, scalable architecture and strong partnerships with leading organisations in the blockchain space render LightLink suited to help enterprises create new opportunities for growth and innovation. We will continue to improve and evolve the network, with a second version of our whitepaper set to be released early 2023.

Disclaimer

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