Live Streaming Network (LSN)

Whitepaper

A decentralized media distribution network based on blockchain technology

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Abstract

There has been rise in the adoption of video streaming solutions such as pay TV, Internet Protocol Television, and Over-The-Top (OTT) solutions among marketing companies. One of the major cost components of live streaming is the cost of network bandwidth. Traditional server centric streaming platform suffers from high client-server network bandwidth cost. The Live Streaming Network (LSN) project aims to deliver a live video streaming network that is fully decentralized, highly scalable, crypto token incentivized, and economically efficient. In effect, we provide broadcasters an effective alternative to centralized broadcasting solutions. In this document we describe the LSN vision, architecture and development roadmap.

Introduction and Background

Video streaming is growing progressively and has been adopted by users for watching live and on-demand videos, live events, advertisements, and communicating with other individuals through video calling features. More and more people are canceling their cable subscriptions and turning to the internet for their entertainment. According to a new market research report, "*Video Streaming Market by Streaming Type (Live Video Streaming and Non-Linear Video Streaming), by Solution, by Service, by Platform, by User Type, by Deployment Type, by Revenue Model, by Industry, and by Region - Global Forecast to 2021*", published by ***MarketsandMarkets***, the global market is forecasted to grow from USD 30.29 Billion in 2016 to USD 70.05 Billion by 2021. The new research report, "*Digital TV & Video: Networks & OTT Strategies 2017-2022*", from ***Juniper Research*** posits that original content and sports to push SVOD (Subscription video on-demand) revenue to $120 Billion by 2022.

Network bandwidth is one of the biggest factors in the cost of live streaming. The more people that watch a live stream, the more network bandwidth the live stream consumes. Therefore, current centralized media distribution network posts high requirement on the client-server network bandwidth in order to reduce the broadcast traffic. For example, with current average bandwidth cost of ¥20/1MB, assume 1 million peak-time concurrent viewers and 800k bitrate, it would cost ¥30 million per month on network bandwidth alone. This is a huge expense for the live streaming service providers. The latest earning report of Inke, a popular live show broadcasting company, it spent ¥122 million on bandwidth and servers annually. For all live show broadcasting companies in China alone, they spend about ¥1.5 billion expenses per year on network bandwidth.

On the other hand however, a lot of network bandwidth is not fully utilized from network providers, commercial and householder users by time or by usage quota. For example, most network bandwidth is unused by most commercial users during night time and weekends, or by most household users during weekdays work hours. Also, in many countries, household users usually have certain amount (for example, 700GB) monthly bandwidth quota in their subscription package, but they may only consume much less amount (say 500GB) on average

each month. If we can utilize these idle bandwidth resources and reallocate them for live streaming, it can substantially reduce the cost for live streaming providers, and therefore propel the development of live streaming technology.

Peer-2-Peer (P2P) architecture tried to offer an alternative solution to reducing centralized client-server bandwidth constraint by utilizing idle network bandwidth, as well as improving network efficiency by retrieving data packets from the closest peer node. However, the performance of traditional P2P network are limited by low contribution level[1] due to the lack of economic incentive for P2P participants to provide stable node for the network,.

With the emergence of networks like Ethereum to enable trustless computing, Swarm and IPFS/Filecoin to enable decentralized storage and content distribution, Bitcoin and various token projects to facilitate p2p transfer of value, and decentralized name registries like Blockstack and ENS to provide human accessible names to content and identities, there is the basis to build a creative solution, Live Streaming Network (LSN) - a decentralized live streaming distribution network based on blockchain technology.

In LSN network, participants deploy LSN-enabled router or server as P2P node to share their network bandwidth for live media streaming. In return, they are compensated with LSN crypto tokens based on their recorded bandwidth contribution in the network. In this way, they are economically incentivized to share their idled network bandwidth resource and therefore help guarantee a reliable and high-performance live streaming distribution network.

LSN Solution

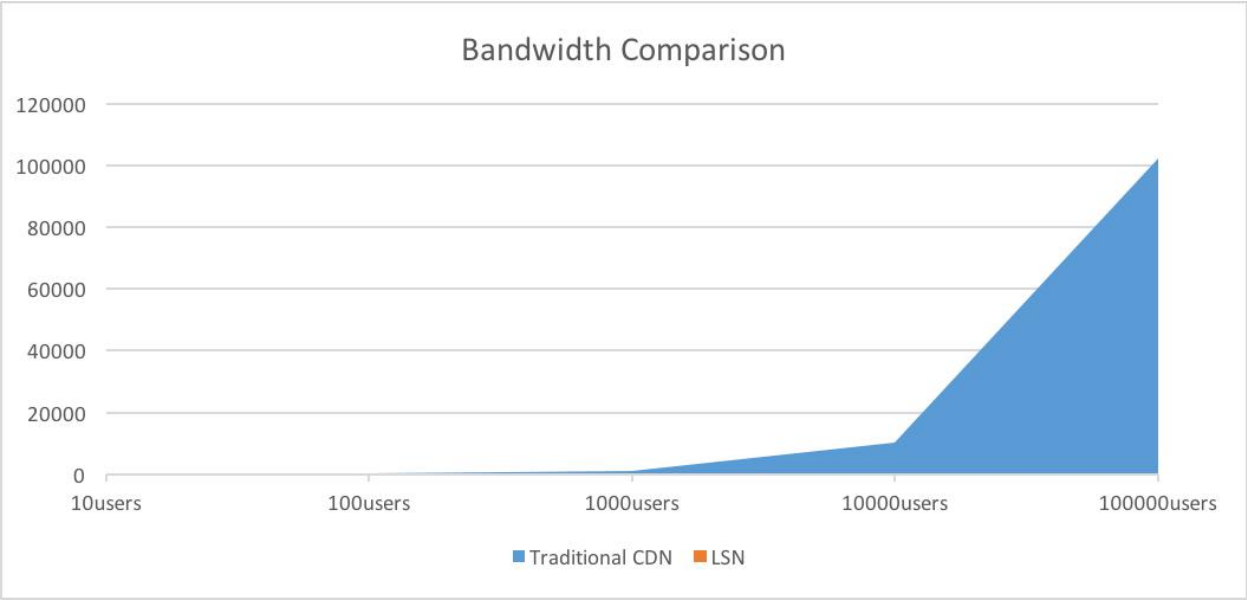
LSN aims to reduce CDN cost by 75%

Assume with 1 million peak-time concurrent viewers and 800k bitrate, based on current average bandwidth cost of ¥20/1MB, traditional centralized Content Distribution Network (CDN) would cost ¥30 million per month on network bandwidth alone. LSN doesn't rely on the traditional centralized platform. Instead, its blockchain-based P2P decentralized distribution architecture and incentive mechanism enables the solution to maximize shared network bandwidth. Based on our measurement, with the continuous improvement of network technology and upcoming 5G network, LSN could potentially reduce CDN cost by 75%.

Bandwidth Comparison

Traditional CDN	10 Mbps 10users	100 Mbps 100users	1 Gbps 1000users	10 Gbps 10000users	100 Gbps 100000users
LSN	10 Mbps 10users	20 Mbps 100users	40 Mbps 1000users	80 Mbps 10000users	100 Mbps 100000users

*Assumed transcoding rate is 1Mbps



Design Disciplines

The LSN network is designed with the following disciplines:

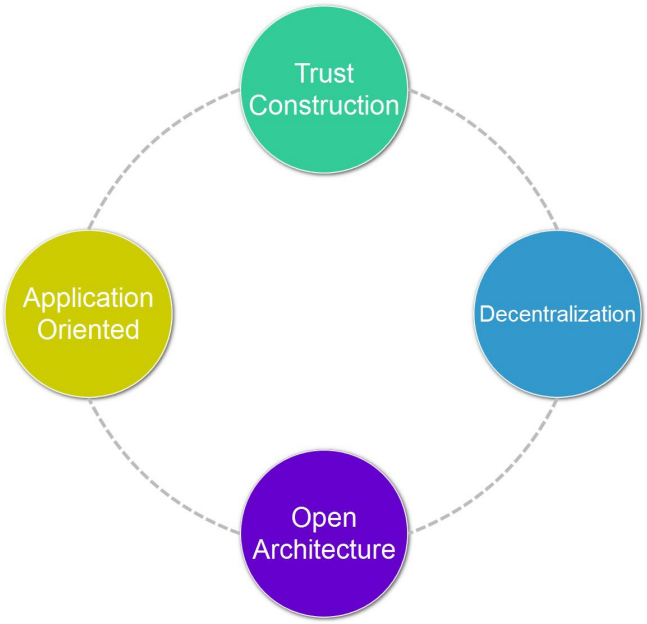
- *Trustless*
  This is the core mission of blockchain technology. It removes the single central authentication entity by building the absolute truth of the state of system on encryption and machine consensus.

- *Decentralization*
  Decentralization is the core feature of blockchain. A distributed ledger is the foundation to build trustless network.

- *Open Platform*
  Decentralized, closed-source applications require users to trust that the app is as decentralized as the core developers say it is, and that they don't have access to their data through a central source. Closed-source applications thus raise a red flag to users and act as a barrier to adoption.
  So, open source, open API and open platform enable true decentralization. Also, open platform will enable LSN to embrace other technologies.

- *Application Oriented*

In order to stimulate LSN platform to thrive, we want to attract more applications to operate on the system. It is in LSN team DNA to provide open APIs for developers in LSN community to develop their own applications on top of the LSN platform.

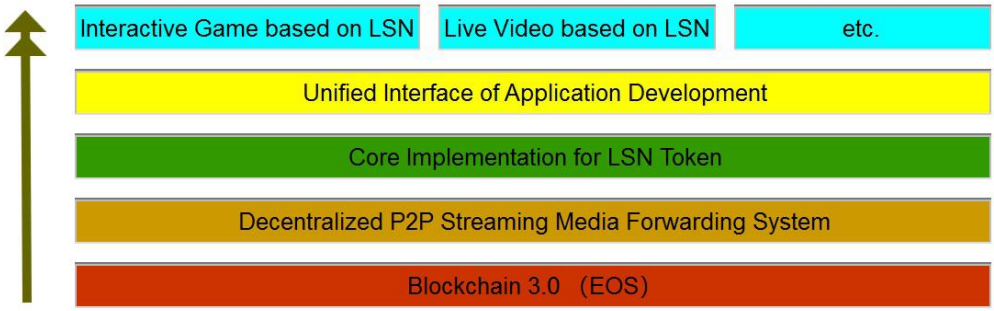


Design Discipline of LSN

LSN System Architecture

The following diagram illustrates the high-level system architecture of LSN platform.

System Architecture



LSN Streaming Mechanism

Video source is pushed to Streaming Media Forwarders (SMF) and distributed by them in LSN network via tiered tree structure. SMF is a software program developed by LSN team based *Real Time Messaging Protocol* (RTMP). User can deploy it on PC, server, virtual machine, or even on router as a plugin (openWRT compatible).

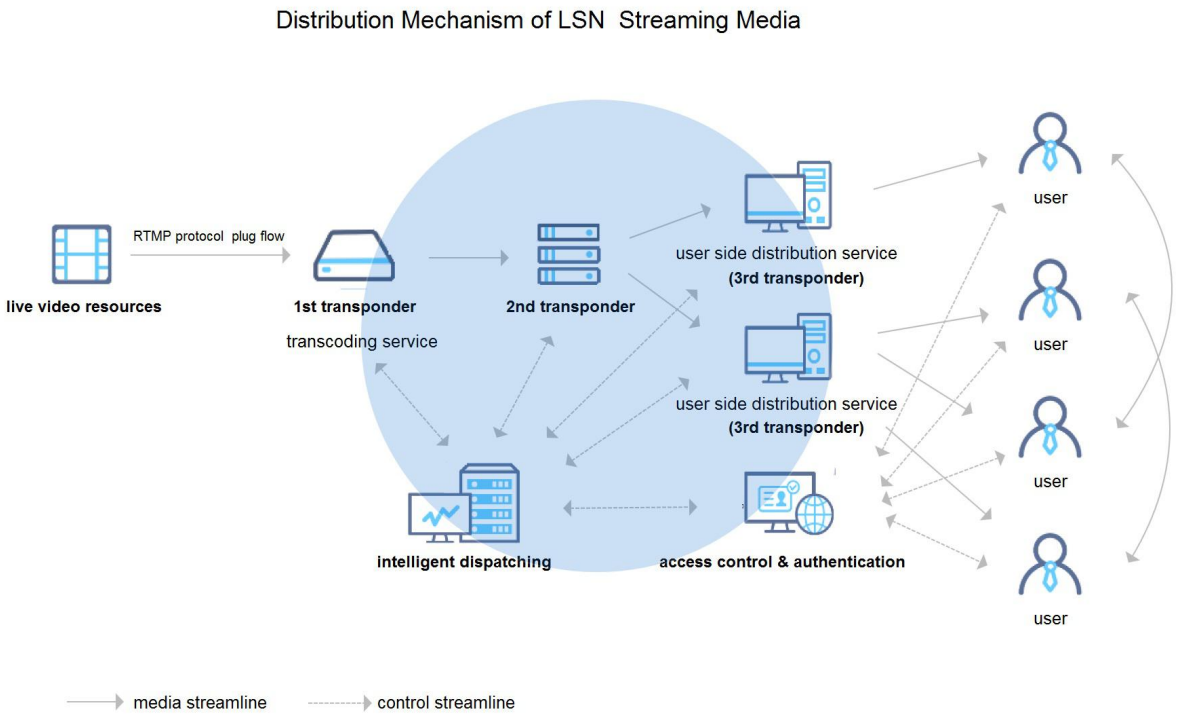
SMF enables P2P connection, receives media data from upstream video source or/and peers, and forwards the data to downstream peers to further distribute or to end users to view. Each SMF maintains P2P connection to multiple upstream peers. It elects one connection as the active real time data streaming connection, and keeps others as backup connections. In case the current active connection is disconnected, one of the backup connections is elected as active connection right away. In the meantime, the backup candidates are continuously updated by dropping any disconnected ones and adding closest active peers.

LSN end-user viewer program also includes all SMF functionalities. It can forward media data to any downstream peers (i.e., other peer end-user viewers).

SMFs at the top-level, we called them "1st-tier SMF", have specific features and therefore has additional requirements. Since they connect to the media source, they require powerful transcoding capability and high network bandwidth. For example, in order to forward data to 200 concurrent downstream nodes, it needs at least 300M network bandwidth. 1st-tier SMF can record and store the media data it forwards in order to enable media replay and Video On Demand (VOD). Also, 1st-tier SMF could enable content examination.

LSN is a dynamic DAG (Directed Acyclic Graph) topology structure from media source to the end-user viewers. It harnesses an advanced algorithm to dynamically calculate SMF connections

based physical location, ISP carrier, network bandwidth limitation, transcoding power, etc., therefore achieves the most optimized and efficient network topology.



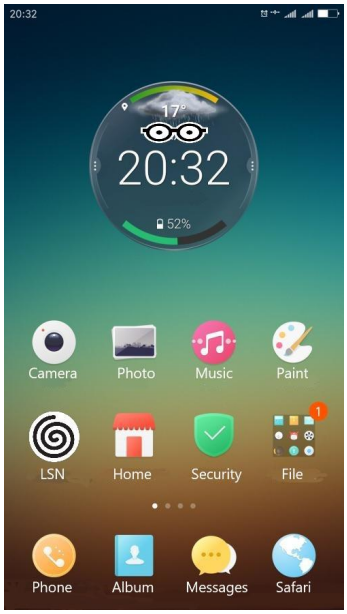
Mining on LSN network

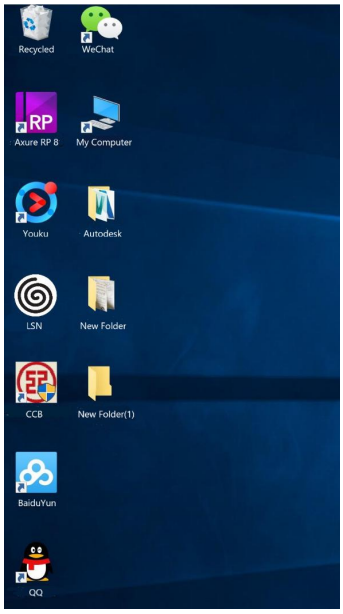
***Note**: LSN mining mechanism is implemented with "Reward Points System" instead of cryptocurrency coins in countries and regions where cryptocurrency is banned or restricted. The LSN reward points, LSN cryptocurrency coins and fiat currency are not exchangeable in these countries and regions unless it is legally permitted. For easy of description, we refer both reward points and cryptocurrency coins as LSN Token in the rest of this document.*

User can "mine" on LSN network to receive their economic rewards for sharing their idle network bandwidth. "Mining" is achieved by deploying LSN's SMF to contribute media forwarding power to LSN network. Compensation is calculated based on several parameters, such as contribution of network bandwidth, calculation power, data forwarded, data stored, data replayed, stability of data forwarding, etc. The compensation is awarded as LSN Token.

LSN provides "One-Key Install" router plugin and standalone PC/server installers for user to easily launch SMF into LSN network to start mining. LSN also has partnership with many router manufacturers to offer plug-and-play custom routers to launch SMF even easier.

SMF provides options for user to configure parameters, such as time period and bandwidth amount, for contribution. So, user's normal network usage and experience will not be impacted.



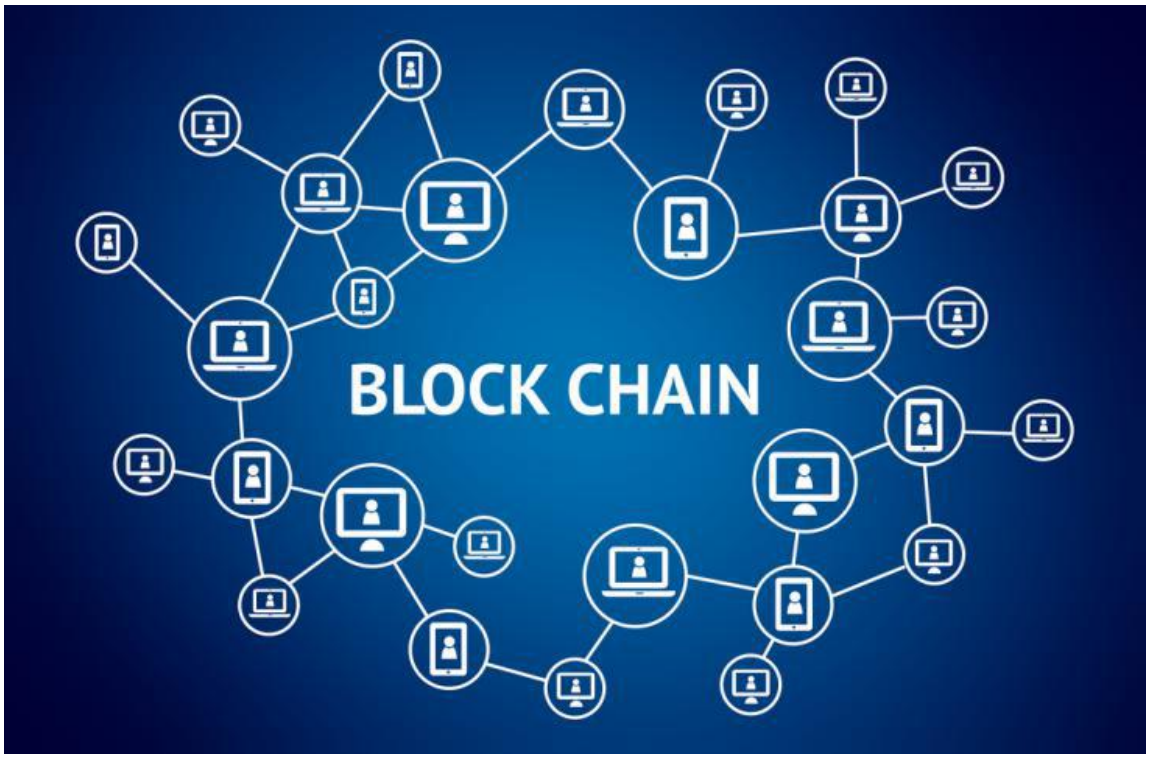


When live streaming source is ready to be broadcast on LSN platform, it needs to first offer some amount of LSN Token as reward into the network, then select one 1st-tier SMF from the system suggested list, and start to up streaming content based on LSN's standard protocol. The end-user viewer is standard media player integrated with LSN SMF as well as content authorization and management functionalities. So, it can receive, forward and authorize LSN media content. The service charges and rewards are auto calculated using blockchain smart contract for media broadcaster, SMF contributor, and end-user viewers.

Blockchain Technology in LSN

LSN takes advantage of blockchain technology to achieve two accomplishments, 1) decentralizing the SMF node-registry database for a disaster-resilient network; 2) leveraging smart contract for a trustless and transparent payment transaction system.

In LSN network, a new SMF (or end-viewer, which is a SMF node too) joins into network by registering itself as a node. This registration information is constructed into a tree-structure for the whole LSN network. Instead of relying a central database for this information, LSN stores this information into blockchain blocks and broadcast them to the entire network. When any node exits from LSN network, its downstream nodes can synchronize registry from peers quickly to reconstruct and rebalance the disconnected tree-structure, and reassume video streaming. In this way, the network is much more resilient from network failure.



Fair and easy economic incentive is the core for stimulating participants to contribute their idled network bandwidth into LSN network. Participant deploys LSN SMF to contribute idled bandwidth and mines reward. For each streaming session the SMF node participates into, it collects its contribution information and calculates the corresponding amount of reward into LSN Token. The collected contribution information, calculated reward and payment transaction are packaged into block and broadcasted into underlying blockchain.

Broadcaster and viewer use LSN Token smart contract to send over payments, rewards and virtual gifts. All these transactions are anonymous within LSN network by leveraging the underlying blockchain technology. Upon receipt of a payment, users are notified through LSN user interface, which listens to events emitted by the LSN Token smart contract. Examples of notification types include:

- You just received X amount of LSN Token reward today.
- You just sent another User X amount of LSN Token.
- Based on X views on your broadcasting channel, you earned Y LSN Token today.

LSN Token

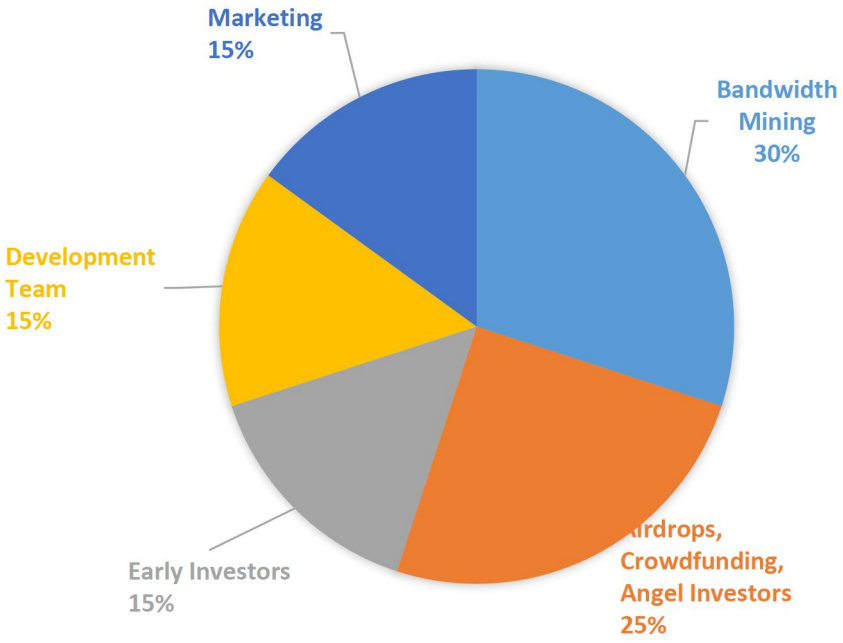
LSN has created a new cryptocurrency, LSN Token, which facilitates a sector-specific transactional economy for the live streaming and video content industry. LSN Token facilitates transparency in how transactions are made and allows broadcasters, their viewers and network bandwidth contributors to be linked across multiple platforms.

We are building LSN Token on top of the Ethereum blockchain to create a decentralized platform that puts the interests of LSN participants (broadcasters, viewers and bandwidth contributors) truly at heart. The smart contract functions callable on LSN Token include all functions in the ERC20 specification, in addition to two contracts enabling the signed transfer of tokens. This allows the LSN participants using LSN Token to pay for the gas used to transfer the token between parties, so that they do not need Ethereum to use LSN Token.

Token Allocation

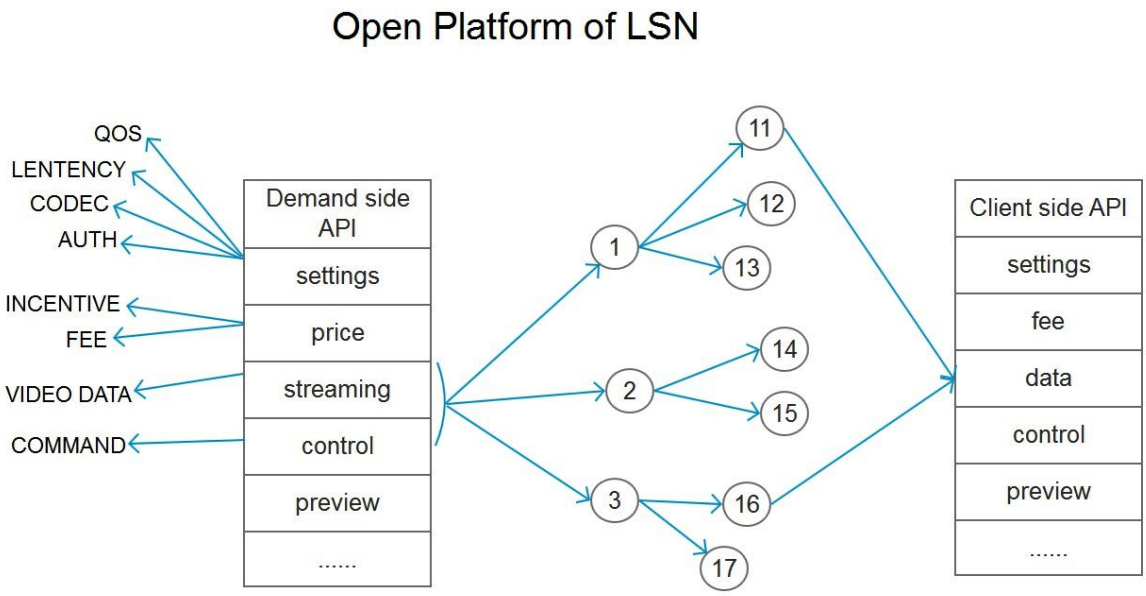
The fixed token pool of 1 billion LSN Tokens will be allocated as follows:

- Bandwidth Mining 30%
- Airdrops, Crowdfunding and Angel Investors 25%
- Early Investors 15%
- Development Team 15%
- Marketing 15%



LSN Open Platform APIs

The following diagram illustrates the high-level API architecture of LSN open platform. LSN platform provides open APIs for broadcaster, viewers, reward configuration, and payments.



① 30% token will be mined in this way: rewards=QOS*time*speed*percent
② demand side pay for the rewards: rewards=incentive*volue (percent)
③ client side pay for the content: they will get the introduction、preview& price of the content and pay after consume

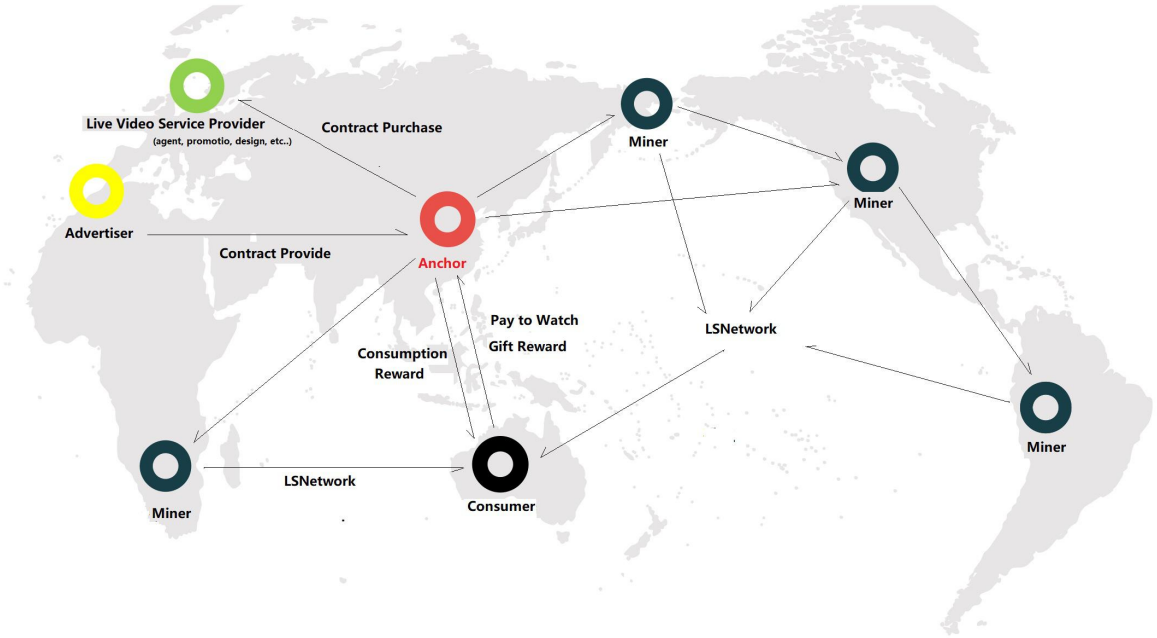
Created by Paint X

Use Case: Pay-As-You-Go video broadcast

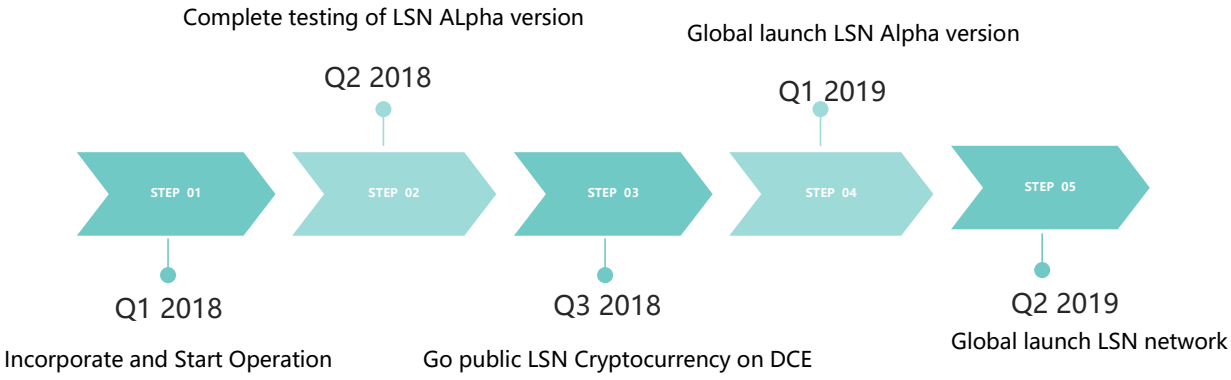
LSN network focuses on decentralizing one-to-many live video multicast (broadcast). It allows a broadcaster to distribute content to their audience faster in a more efficient and transparent cost structures around payment for the service.

With blockchain's transfer of value transaction baked into the protocol, broadcasters can now charge viewers directly for the consumption of their live broadcast, without requiring a payment method via a centralized platform. This can be applications in online education, live events, live show entertainment, and many other use cases - all while preserving the privacy of the viewer, and allowing them to pay for only what they consume directly to the broadcaster.

The broadcasters only need to connect their video source into LSN network through standard push streaming protocol, and then configure their expected streaming QoS (Quality of Service) and delay limits, amount of reward they are willing to pay, charge rate for viewers, etc. The video content will be pushed through LSN network tiers to the end viewers in the shortest route.



Development Roadmap



Moving Forward

Once the LSN Network is launched globally, we expect the network to be a self-operating ecosystem which doesn't require much external intervention. Following the initial airdrop, we will be open sourcing the LSN network and helping maintain the codebase for community contributions. We expect the community to take an active and controlling role in the ongoing development of the ecosystem.

Steering Counsil

LSN Steering Council manages the operation of LSN network. The main responsibility of Steering Council is adjusting the configurable parameters of LSN network. These parameters including:

- Fee-related parameters, such as transaction charges, reward ratio.
- Calculation weight parameters, such as contribution calculation factors, blockchain vote factor.
- Any other system operation parameters.

LSN Steering Council members are temporarily represented by the core team of LSN founders. Once the system matures and LSN Token is distributed, the Steering Council members will be elected by LSN Token holders. Members can initiate and review vote for new proposals.

Summary

Video streaming is growing progressively and been adopted by users for watching live and on-demand videos, live events and watch advertisements, and communicate with other individual through video calling feature. One of the major cost components of live streaming is the cost of network bandwidth. Traditional server centric streaming platform suffers high client-server network bandwidth cost. P2P architecture tried to offer an alternative solution to reduce centralized client-server bandwidth constraint by utilizing idle network bandwidth, as well as improve network efficiency by retrieving data packets from the closest peer node. However, the economic incentive is lacking in the existing P2P architecture for participants to contribute stable P2P nodes.

Blockchain technology offers us the opportunity to radically change the incentive structures in multi-sided technology industries in a way that has never previously been possible. We believe that our decentralized, LSN –Token-baked-in P2P technology could provide a perfect solution to improve video streaming efficiency while substantially reducing bandwidth cost for broadcasters. Therefore, it helps propelling the further growth of video streaming industry.

LSN network is an open source project to address existing challenges in the live streaming industry, while simultaneously aiming to create a true consumer application of blockchain technology. We look forward to seeing the LSN ecosystem grow as a result of the efforts of a thriving community of broadcasters, developers, crypto enthusiasts and committed fans. We sincerely invite you to send your questions, suggestions, and feedback to us at admin@lsnet.io.

Team

Jianhe Liao, Chief Executive Officer
Jianhe is a software architect and serial entrepreneur. He founded two IT companies previously. He is currently the CEO of SaaSafras LLC and a member of Apache Hadoop team and PreditionIO team.

Advisory Board

<Coming Soon>

Other Open Source or Competitors

Livepeer project, an open source project aims to build a decentralized live video broadcast platform and crypto token protocol. Livepeer intends to build a protocol to broadcast from anybody and viewed by anybody in the network[2].

Stream, a cross-platform browser extension with an associated utility token that together streamline the transfer of value between creators and their audiences. Stream aims to make content creation profitable for content creators[3].

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[1] ***Incentives in Peer-to-Peer Systems***, Oleg Naroditsky and Weiyu Zhang, http://www.cis.upenn.edu/~mkearns/teaching/NetworksAGT/oleg.pdf

[2] ***Livepeer Whitepaper***, Doug Petkanics and Eric Tang, https://github.com/livepeer/wiki/blob/master/WHITEPAPER.md

[3] ***Stream Whitepaper***, Simar Mangat, Greg Kufera, Chris Barrett, https://streamtoken.net/stream_whitepaper.pdf