

# GPUCoin: A Peer-to-Peer decentralized zero-knowledge GPU accelerated distributed computing & live-streaming blockchain protocol

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## **Abstract**

The GPUCOIN team is building the next generation technology for zero-knowledge Peer-to-Peer live streaming & distributed computing services based on block-chain technology. This new innovative open source decentralized GPU accelerated protocol would eliminate expensive content delivery networks. The zero-knowledge live-streaming and computing are incentivized by GPUCoin mining validated by **Proof of Streaming(PoS)** and **Proof of Compute(PoC)** respectively using zk-snarks.

This platform will provide a web scale cryptographically secure, fault-tolerant, self-amending distributed computing environment creating the world's first **Inter-Planetary Compute Network(IPCN)**.

The IPCN network & GPUCoin crypto-currency token, a token-based native intelligence and economic layer for video and distributed computing, will build the first protocol to upgrade the video and compute infrastructure for the web3 decentralized systems. This is an alternative compute protocol for building secure, decentralized and privacy-preserving distributed applications.

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# 1 Introduction

## 1.1 GPU accelerated computing review

Before discussing Proof of Compute & Proof of Streaming, GPUCoin's innovative technique for distributing coins, lets review GPU accelerated computing at a high level. **Graphics Processing Units (GPUs)** can significantly accelerate the training process for many deep learning models. For example, GPUs can accelerate the training process for deep learning models designed for image classification, video analysis, & natural language processing because the training process for those models involves the compute-intensive task of matrix multiplication and other operations that can take advantage of a GPU's massively parallel architecture. This architecture is well-suited for algorithms designed to address embarrassingly parallel workloads across more than a dozen areas of computer science & other fields, including live streaming, VR/AR computer generated rendering, speech recognition, computer vision, robotics, information retrieval, natural language processing, geographic information extraction, & computational drug discovery.

GPUCoin IPCN takes computations and maps them onto a wide variety of different hardware platforms, ranging from running inference on mobile device platforms such as Android & iOS to modest-sized training & inference systems using single machines containing one or many GPU cards to large-scale training systems running on hundreds of specialized machines with thousands of GPUs. Having a single system that can span such a broad range of platforms significantly simplifies the real-world use of GPUs, as we have found that having separate systems for large-scale GPU training & small-scale deployment leads to significant maintenance burdens & leaky abstractions.

Training a deep learning model that involves intensive compute tasks on extremely large datasets can take days to run on a single processor. However, if you design your program to offload those tasks to one or more GPUs, you can reduce training time to hours instead of days. GPUCoin IPCN network is designed to address such embarrassingly parallel workloads and use GPUCoin GPC token as the currency of exchange & transaction fees for these workloads using block-chain smart contracts.



## 2 Bitcoin, Ethereum, EOS, Blockstack, Toshi, Status & the decentralized web revolution

The internet is in the middle of the august beginnings of decentralization revolution: centralized proprietary services are being replaced with **decentral-**

ized open ones with open source code; trusted parties replaced with verifiable mathematical computation; brittle location addresses replaced with resilient content addresses; inefficient monolithic services replaced with peer-to-peer algorithmic markets ; complex inefficient unverifiable data-structures with verifiable efficient data-structures, Merkle Trees. The traditional web stack is composed of building blocks like TCP/IP, DNS, databases, web servers, authentication systems and CDNs, and these thin protocols are being improved and decentralized by using the blockchain as the underlying base layer. Bitcoin, Ethereum, & other block-chain networks have proven the utility of decentralized transaction ledgers. These public ledgers process sophisticated smart contract applications & transact crypto-assets worth tens of billions of dollars every day. These systems are the first instances of internet wide open services, where participants form a decentralized network providing useful services for pay, with no central management or trusted parties. Virtually none of the ideas underpinning Bitcoin are new. The technology for this revolution which surely will be both a social and economic revolution can all be traced to the academic literature going back decades, based upon public-key encryption, zero-knowledge interactive proof systems, and software protocols for cryptographic interaction, secure authentication, & verification.

Cryptographic signatures & public-key cryptography, cryptographic hash functions, cryptographic proof-of-work, time-stamping, Merkle trees, chains of transactions blocks, Byzantine fault tolerance, smart contracts - all of these ideas were old when Bitcoin was invented. Satoshi Nakamoto's achievement lays in the complex, ingenious way in which he (or she, or they) combined these ideas into a new distributed algorithm<sup>1</sup> laying the foundation of the decentralization revolution.

**Netscape moment:** *Cambrian* explosion of crypto-currency Dapps

			
Phase	Internet	Crypto-currency	Reach
Protocol	TCP/IP, SMTP	e-gold, digicash, bitgold, <b>Bitcoin</b> , Ethereum	1M People
Infrastructure	ISPs, lay fiber	<b>Exchanges</b> , secure storage	10M people
Consumer Interface	Browser	User controlled <b>btc/eth wallets</b>	100M people
Decentralized Dapps	Web 2.0	Finance 2.0 Dapps	1B people
Fat Protocols	Web 3.0	FileCoin, <b>GPU-Coin</b> empower next-gen Dapps	2B people

Protocol layers like **FileCoin** & **GPUCoin** will form the next Web 3.0

<sup>1</sup><http://queue.acm.org/detail.cfm?id=3136559>

Firefox, Chrome & IE have dominated the centralized web. New decentralized technology platforms such as Blockstack are ushering in the auspicious beginnings of decentralized web. We are now entering a new era of decentralized applications, block-chain technologies collectively known as Web 3.0. In the centralized web, the users are the product, their interests, preferences are managed by companies such as Facebook, Twitter & Google and sold to advertisers, enriching their small group of shareholders driven by profit, with significant barriers to entry. In the decentralized web, the user information is private & value creation is not about advertisements & shareholder enrichment only. Decentralized technologies such as Status, Toshi & GPUCoin empower the network token holders, who can have many motivations including privacy, altruism & a more inclusive distribution of control & information. The emergence of Bitcoin & subsequent block-chain technologies has generated a new digital asset class in which scarcity is based on mathematical properties & equations re-balancing variables to maximize economic inclusiveness & activity. Through cryptographic verification and game-theory based equilibrium, block-chain-based digital assets can be created, issued, and transmitted using software. Ownership of these cryptographic digital assets can be easily verified using public key cryptography and transfer of ownership maintained in an immutable decentralized distributed database ledger known as the block-chain. This lays the foundation for democratic transfer of value among entities in the decentralized web. We are in the very early big-bang stages of the crypto-currency decentralized web revolution on block-chain and several miracles are happening everyday harkening to the early merry days of web 1.0.

### 3 Values

GPUCoin is beginning an effort to build quality open source software that would benefit people throughout the world.

Our goal is to develop decentralized software protocols sustainably while preventing for profit mindset from forcing engineering compromises. By doing so, we can keep our product visions intact, giving maximum benefit to our users. To do this we ensure that the community of GPUCoin developers and actual users have strong voting rights in our governance model.

We lovingly craft the software protocols that we want to use.

## 4 GPUCoin Crypto-currency & Token Issuance

The GPUCoin IPCN network includes its own built-in crypto-currency, GPU-Coins GPC, which serves the dual purpose of providing a primary liquidity layer to allow for efficient exchange between various types of digital assets &, more importantly, of providing a mechanism for paying transaction fees.

The issuance model will be as follows:

- GPUCoins will be released in a crypto-currency sale, a mechanism intended to fund the GPUCoin organization and pay for development that has been used with success by other platforms such as Mastercoin, Filecoin, Ethereum, Tezos and NXT. Earlier buyers will benefit from larger discounts. The BTC, ETH, XMR, and LTC received from the sale will be used entirely to pay salaries and bounties to developers and invested into various for-profit and non-profit projects in the GPUCoin crypto-currency ecosystem.

### 4.1 GPUCoin math and token economics

Running the lowest cost unit containing a GPU, an AWS p2.xlarge, costs about  $awsdc = \$0.9/hr$ . This unit is equipped with a Tesla K80 GPU or similar GPU, along with 32GB or 64GB RAM and a 4 core CPU. Hence assuming the dollar cost of an average AWS<sup>2</sup> GPU instance per hour at about 1\$ per hour is a fair assumption.<sup>3</sup>

The **monthly dollar cost of AWS GPU instance** is

$$p = awsc*24*30 = 1*24*30 = \mathbf{720\$}$$
 [1\$ per hour per aws GPU instance \* 24 hours per day \* 30 days per month]

The GPUCoin instance cost is pegged at 1/5th AWS costs to stay competitive and as GPUCoin nodes do not pay infrastructure and electricity costs in the decentralized model. This can be generalized as *peg* variable that GPUCoin miners can tweak based on the availability and scarcity of GPUs and render farms in their region. Thus we recommend pegging to fiat only in the short term as a bootstrapping mechanism. In the long term, this variable will be dynamically adjusted using a vickrey auction, eliminating the dependence on fiat currency, while maintaining decentralization, efficiency and economic price stability.

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<sup>2</sup>as AWS and GCP have comparable costs

<sup>3</sup> as the cost of one GPU instance varies between 0.9 - 1.45 \$ in both Google compute platform and Amazon web services based on region and demand



$$peg = 0.2$$

The dollar cost for a GPUCoin instance comparable to an AWS gpu instance

$$gpcdc = peg * awsdc = 1/5 * \text{AWS cost} = 1/5 * 1\$ = 0.2\$.$$

Hence 0.2\$ is the dollar cost per comparable GPUCoin instance per hour as the GPUCoin IPCN network does not have to pay for infrastructure and real estate, these are sunk costs for the GPUCoin network miners. This model holds true even if there is no peg and we assume about 1/5th idle network utilization, i.e., the network utilizes the GPU null cycles for 1/5th of the time.

The **monthly dollar cost of a comparable GPUCoin instance** is

$$q = gpcdc * 24 * 30 = 0.2 * 24 * 30 = \mathbf{144\$}$$

[ 0.2\$ per hour per GPU instance \* 24 hours per day \* 30 days per month ].

Taking  $t = 20\$$  for transaction fees and margins

GPUCoin mining revenue per month for 1 GPUCoin instance  $r = q - t = 144 - 20 = 124\$$

Ethereum mining revenue from one AWS GPU instance

$$e = 31\$$$

$$r = 4 * e$$

Hence GPUCoin mining is 4x more profitable than ethereum mining which is a profitable gpu mined cryptocurrency, even at 1/5th network utilization. This is a reasonable profit for something that takes no effort, and comparable to Bitcoin mining profits during the golden GPU mining era circa 2009-2011.

Initial GPUCoin token difficulty for mining follows the bitcoin mining model i.e., the token max limit is a hard cap of  $c = 21$  million GPUCoins to honor Satoshi Nakamotos invaluable bitcoin contribution to the fellow crypto brethren. Early decentralized GPUCoin nodes earn more GPUCoins as a block reward as there are fewer nodes in the network; the Proof of Compute and Proof of Streaming difficulty increases with the number of GPUCoin nodes in the network.

Whereas earlier *1000 GPUCoins* would be needed to buy time in *1 single GPUCoin instance*, later as the network size increases as more nodes join the GPUCoin network 1 single GPUCoin would be able to buy time in *1000+ GPU-Coin nodes* few years down the line as GPUCoin tokens appreciate in value due to scarcity of mining, a hard cap of  $c = \mathbf{21 million}$  GPUCoins and strong sustainable demand for GPUCoin instances that will be generated by the cheaper than AWS pricing of comparable GPU instance.

An example scenario is when there are just 10 GPUcoin nodes in the network the PoC and Proof of Streaming difficulty is roughly 1 hour of streaming needed to earn 1 GPUcoin as block reward. As more GPUcoin nodes join the GPUcoin network the PoS difficulty goes up, when there are 10000 GPUcoin nodes in the network the mining difficulty is about 1000 hours of streaming needed to earn 1 GPUcoin as block reward.

Irrespective of the GPUcoin price and mining difficulty the GPUcoin instance dollars costs are recommended to be cheaper than their corresponding AWS GPU instance dollar costs. This ensures that the GPUcoin dollar costs stay competitive and attractive compared to the AWS instance dollar costs in order to drive sustained GPUcoin instance demand.

As mining difficulty is adjusted based on the number of the nodes compute capacity that the network controls and the maximum number of GPUcoins that can ever be mined is hard-capped at 21 million GPUcoins the GPUcoin cryptocurrency is designed to be a deflationary currency relative to fiat currencies similar to bitcoin and litecoin.

While the miner who finds the winning block earns the GPUcoin block reward all the competing GPUcoin streaming nodes earn the transaction fees. Hence in Bitcoin there is one winner and multiple losers whereas in GPUcoin there is one winner and no losers i.e., multiple miners sharing mining rewards corresponding to their *Proof of Stake* or the number of GPUcoin nodes they used for PoC or PoS mining.

## 4.2 GPUcoin carbon footprint, mining, scarcity and profitability

Bitcoin has made crypto-currencies popular and brought it to the mainstream, but it has a dark side, its ever increasing carbon footprint. In late 2013, 8.25 megatons (8,250,000 tonnes) of CO<sub>2</sub> per year was estimated to be the carbon footprint of Bitcoin per year<sup>4</sup>. In August 2017, One Bitcoin transaction uses enough energy to power 5.58 US households for 1 day and the Bitcoin network consumes 30 times more energy than the VISA network<sup>5</sup>. These computers are consuming so much electricity that its already unprofitable to mine in some regions of the world. Since excess bandwidth and compute capacity is utilized towards streaming, encoding, object recognition and security of video and audio streams the resources otherwise would be utilized are profitably used. Since GPUcoin tokens are fairly distributed/mined to miners corresponding to their compute and bandwidth availability irrespective of how much CPU they control, the GPUcoin carbon footprint will be exponentially lower than the Bitcoin

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<sup>4</sup><https://pando.com/2013/12/16/bitcoin-has-a-dark-side-its-carbon-footprint/>

<sup>5</sup><https://digiconomist.net/bitcoin-energy-consumption>

network which depends on continuously increasing complexity of the hashing required for mining. Since GPUcoin tokens can only be mined or acquired from the platform and since they are capped at a hard cap of 21 million GPUcoins, they will tend to be a scarce and valuable deflationary cryptocurrency token.

### **4.3 The GPUcoin token**

The GPUcoin Token (GPC) is a native digital token with up to 18 decimal places. The total number of GPUcoin tokens to be issued is 100,000,000. For details of the distribution of these tokens, see Section 10.3 Token Allocation & Distribution.

### **4.4 Uses of GPUcoin token**

GPUcoin Token can be used for using the IPCN platform to get bandwidth and GPU accelerated compute time on the network.

### **4.5 Insuring inflation rate does not out-pace growth of underlying economy**

The sum total of all the GPUcoins GPC coins minted at each interval can be guaranteed to be less than the calculated rate of economic growth similar to the variable bitcoin hash-cash difficulty innovation, such that current token holders can be better assured that prices are not likely to inflate and that their tokens will fall below their original value because of an over inflation of excess GPUcoin Token supply.

A further percentage of the growth can be retained as explained above to provide a price floor as an assurance of value maintenance to GPUcoin Token holders.

### **4.6 Choice of Blockchain**

The seed protocol will run on top of the EOS blockchain protocol which makes the decentralized app abstraction. We take advantage of EOS blockchain technology to ensure a fair democratic usage of the network for all participants miners, consumers and users of GPC GPUcoin tokens.

We are also exploring using the EOS blockchain to run the IPCN network on top of.

GPUCoin IPCN can instantiate any blockchain based protocol. Its seed protocol specifies a procedure for stakeholders to approve amendments to the protocol, *including* amendments to the amendment procedure itself. Upgrades to GPUCoin IPCN network are staged through a testing environment to allow stake-holders to recall potentially problematic amendments. We believe that proof of stake blockchains are lighter alternatives to proof of work blockchains such as Bitcoin, as the proof of work blockchains tend to have exponentially increasing CPU mining requirements as the number of participants keep growing and bringing on more GPU accelerated compute to the IPCN network.

## 5 Technical Problem & solution

### 5.1 Current Centralized Streaming Solution

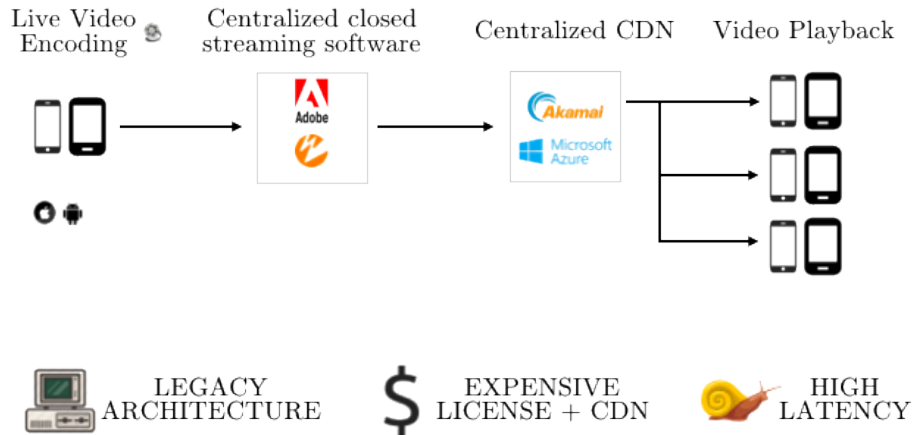


Figure 1: Current closed, centralized, expensive, censorable live-streaming system

Figure 1 shows the state of current live-streaming system. There are 4 components to a live-streaming system. They are explained below.

#### 5.1.1 Broadcasting Software

A proprietary mobile video encoding software is used. The primary purpose of this software is to capture video frames and audio, from mobile, desktop, or stand alone cameras. The software encode the captured video and audio frames

into a video standard, and a closed/proprietary video streaming protocol and is published to Streaming software.

### 5.1.2 Broadcasting Server Software

Current software that solves this problem are Wowza<sup>6</sup> and Adobe<sup>7</sup>. The Broadcasting software receives the encoded live streams and generates small fragments of video files that are then published to a Content Delivery Network.

### 5.1.3 Centralized Content Delivery Network

The Broadcasting Server Software publishes the generated video fragment files to Content Delivery Network such as Amazon Cloud-front <sup>8</sup> or Microsoft Azure <sup>9</sup>

### 5.1.4 Video Player

This is the final step in live video streaming. Media/Video/Audio clients for platforms: mobile, desktop, play out the video files from the content delivery networks.

These are the drawbacks with current live-streaming system:

- Centralized points of failures: Backend streaming software, relying on content delivery networks
- Proprietary and closed source software
- Prone to censorship as easy to control/shutdown the service
- Expensive licensing fees

## 5.2 GPU Coin Solution

Figure 1 is the proposed live-streaming system. They are explained below.

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<sup>6</sup><https://www.wowza.com/products>

<sup>7</sup><https://www.adobe.com/products/catalog.html>

<sup>8</sup><https://aws.amazon.com/cloudfront/>

<sup>9</sup><https://azure.microsoft.com/en-us/services/media-services/>

 Inter-Planetary Compute Network
  GPUCoin Compute Network
  GPUCoin

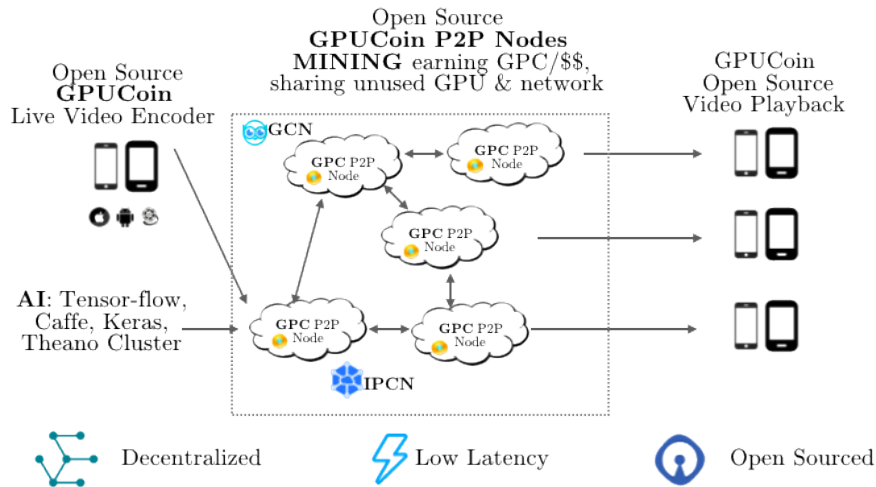


Figure 2: Open Source, decentralized, GPUCoin IPCN mining, distributed computing system

### 5.2.1 GPUCoin Open Source Broadcasting Software powered by Real-Time Satoshi Streaming Protocol

GPUCoin Open Source Broadcasting software captures video frames and audio. All major platforms: iOS, Android, Mac, Windows, Linux will be supported. The captured video frames and audio data are encoded to widely accepted open video and audio formats: H.264 and AAC. The encoded H.264 and AAC audio is published to the GPUCoin Network with **Real-Time Satoshi Streaming Protocol**(RTSSP).

### 5.2.2 GPUCoin Peer-to-Peer mining Node

Miners in the GPUCoin GCN mining network Peer-to-Peer node will run GPU-Coin software sharing unused bandwidth and earning GPUCoins for doing so. This is a highly resilient fault tolerant network, and miners will be able to join or leave the network anytime. The GPUCoin P2P Node replaces the need for a broadcasting server software and expensive content delivery network.

### 5.2.3 GPUCoin Open Source Video player

GPUCoin Open Source Video player plays the live stream in realtime. All major platforms: iOS, Android, Mac, Windows, Linux will be supported.

### 5.2.4 Archived videos

Broadcasted video is continuously archived, and will be stored in decentralized file system IPFS.<sup>10</sup> Hence GPUCoin live stream protocol makes the live-streaming faster, safer, and more open by

- + having no single centralized points of failures - byzantine fault tolerant p2p network
- + Highly resilient fault tolerant network with Peer-to-Peer nodes
- + Censorship resistant as there are no centralized points of control
- + core Peer-to-Peer and networking software is open source

### 5.2.5 Work Tokens - Token Velocity

Pioneered by Multicoin Capital<sup>11</sup>, the Work Tokens model ensures that price of utility token increases linearly with the usage of the network. GPUCoin Network utilizes the Work Token Model.

In the work token model, a service provider stakes (AKA bonding) the native token of the network to earn the right to perform work for the network. In GPUCoin Network the probability that a given service provider is awarded the next job is proportional to the number of tokens staked as a fraction of total tokens staked by all service providers.

The beauty of the work token model is that, absent any speculators, increased usage of the network will cause an increase in the price of the token. As demand for the service grows, more revenue will flow to service providers. Given a fixed supply of tokens, service providers will rationally pay more per token for the right to earn part of a growing cash flow stream.

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<sup>10</sup>Decentralized IPFS File system <https://ipfs.io/>

<sup>11</sup>New Models for Utility Tokens <https://multicoin.capital/2018/02/13/new-models-utility-tokens/>

### 5.2.6 Probabilistic Micropayments

Ethereum Probabilistic Micropayments can send an arbitrary number of payments to an arbitrary number of recipients, without any per-recipient initialization or settlement transactions<sup>12</sup>. Payment channels allow for the sending of arbitrary number of transactions while only requiring two on-chain transactions:

- + One transaction to initialize the payment channel.
- + One transaction to close the channel and settle total amounts transferred.

GPUcoin network will leverage the Ethereum Probabilistic Micropayments system based on payment channels, to overcome the settling on Ethereum and current scaling issues associated with Ethereum Blockchain.

Example Probabilistic Payment Scenario:

- + You are the video streaming host, charging \$1 per hour of video streamed.
- + A new user connects to your service and watches exactly 10 seconds of cute kittens.
- + Every 4s, the user sends you a off-chain ticket with 1/2500 probability of winning. The winning amount is set to \$2.78.
- + If you do not receive a payment ticket every 4s (within some margin to account for network latency), you simply disconnect the viewer
- + If the viewer does not receive any video feed, they immediately cease sending payment tickets.
- + When you receive a winning ticket, you claim it with an on-chain transaction, which transfers the winning value to you from the tokens locked up by the sender.

Even if a ticket is not winning, you still have cryptographic proof that you're being paid, since neither the sender nor the recipient can manipulate the value that determines if a ticket wins. With the proof, you're happy to continue streaming video to the viewer. As thousands of (new) viewers connect to you, there is no overhead per viewer - the only overhead is when you claim your winning tickets. For a given average total payment, the odds of winning (and frequency of tickets) determine the number of on-chain transactions required. Thus, the higher the winning amount, the less transaction fees paid over time by the recipient. The lower the winning amount, the less tokens have to be locked up by the sender, lowering their liquidity cost.

<sup>12</sup>Ethereum Probabilistic Micropayments <https://medium.com/@gustav.simonsson/ethereum-probabilistic-micropayments-ae6e6cd85a06>



## 6 Traction & Usage

A mobile consumer application is currently live on the iOS AppStore and Google Play-store. Hoot has received streams from

Tables 1 and 2 show the usage statistics.

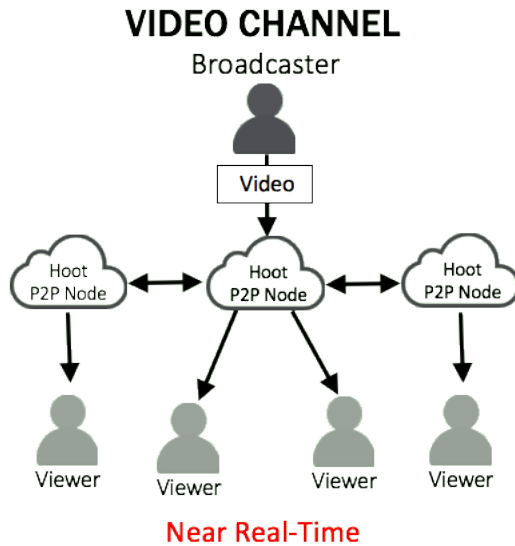
User Statistics	
Monthly Active Users (MAU)	214,769

Table 1: User Statistics

Live Video Streaming Statistics	
Number of Videos	48,207
Average Viewers per stream	155
Average Stream Duration	4 minutes 35 seconds
Total Time Watched	37k days or 100 years

Table 2: Live Video Streaming Statistics

## 7 RTSSP Architecture



### 7.1 Broadcast Side - mobile iOS client

The protocol for realtime livestreaming video is called Real-Time Satoshi Streaming Protocol[RTSSP]. Video frames are captured at a resolution of 540x960 to 720x1280 based on network connectivity. Audio stream is captured using the built in iOS device microphone at a sampling rate of 44.1 KHz. Optionally, real time filters (Black and White, Glow, Fisheye, Sepia) can be applied to captured video frames in real-time. Video and audio are encoded using the native hardware H.264(H.265 in android) and AAC encoders, respectively. The video frames are encoded using a VBR algorithm with a maximum bitrate of 1 Mbps, this can be increased for usecases such as VR streaming. Audio stream is encoded in AAC format with a bitrate of 128 Kbps. The H.264 + AAC stream is encoded into an RTSSP stream and is transmitted to Hoot RTSSP server.

### 7.2 Broadcast Side Desktop Mac client

Video frames are captured at native screen resolution, and audio stream is captured using the built in microphone at a sampling rate of 44.1 KHz. Hoot native cocoa Mac app written in Objective-C supports capturing FaceTime, Screen-share, and a combination of FaceTime and Screenshare. Video frames and audio stream are encoded using the native H.264 and AAC encoders, respectively. The video frames are encoded with a VBR algorithm. Audio stream is encoded in

AAC format with a bitrate of 128 Kbps. The H.264 + AAC stream is encoded into an RTSSP stream and is transmitted to the open source RTSSP server.

### 7.3 Viewer Side mobile iOS/Android client

Hoot open source Native mobile media player decodes RTSSP + H.264 and AAC data to make the live broadcast available to viewer in real-time. The HLS (HTTP Live Streaming) stream that is made available can be played using the iOS/Android Native media players, when the Hoot RTSSP player or app is not available.

### 7.4 Viewer Side Mac/ Destkop PC client

The RTSSP stream is played using Adobe Flash technology supported by modern browsers. The HLS stream can be played using HTML5 player available in modern browsers.

### 7.5 Server Side Peer-to-Peer decentralized Technology

Similar to Bitcoin blockchain technology, any node can join or leave the Hoot network at anytime. Each node runs a realtime broadcasting server. The GPU-Coin network has several RTSSP servers that serve to bootstrap the Network. We use commodity servers with modern processors and with 1 Gbps duplex ethernet; specialized servers are not needed. The hoot server generates two variants of streams: a RTSSP stream and a HLS stream in order to make them accessible in browsers across Windows, Mac OS, Linux and Android platforms. A server with 1 Gbps duplex ethernet can support up to a total of 1000 viewers. A stream is replicated horizontally across multiple servers (without additional latency) to stream to virtually an unlimited number of simultaneous viewers.

Streamed videos are instantly archived [*H.264+AAC, mp4 container*] in the cloud for later viewing. The archived videos are indexed (scrubbable and quick to scan). We have access to datacenters in the following geographically distributed locations through RTSSP servers to provide the least latency to viewers globally: Amsterdam Netherlands, Frankfurt Germany, Hong Kong, London UK, Melbourne Australia, Queretaro Mexico, Milan Italy, Montreal Canada, Toronto Canada, Paris France, Singapore, Sydney Australia, Tokyo Japan, Dallas TX, Houston TX, San Jose CA, Seattle WA, Washington DC. Streams are replicated and pulled to the closest node to the viewers location, i.e., a viewer in Tokyo Japan viewing a stream from Washington DC would be connected to a replicated stream on the Tokyo Japan hoot node in order to reduce latency.

## 7.6 First Video protocol

Hoot Live is building the first protocol for decentralized delivery of videos. At the core of its patent-pending approach, Hoot Live removes a number of high cost processes to deliver video in real-time. Today video delivery requires integrating expensive video players, streaming servers and encoders from third party companies (such as Adobe) and delivering the content over expensive, centralized delivery networks (CDNs) (such as Akamai) to speedup live video playback. The existing process not only depends on a decades old architecture with expensive licensing costs but it suffers from high latency in its delivery. Hoots completely new approach eliminates the need for and high costs of a third party CDN, video player and streaming server. Instead it will depend on a new architecture and use a decentralized peer-to-peer network to provide near real time delivery. The costs of running the Hoot Live network will be even further reduced vis a vis competitors because cryptocurrency GPUcoin proof of stake network will incentivize Hoot Live nodes and users to contribute their excess processing power and bandwidth. This network of decentralized nodes of GPUs will be extended to build an open source protocol for applications that leverage GPUs such as AI Training, Machine Learning, Genome Sequencing, and Rendering.

## 7.7 Technology benefits

When compared to other products on the market, this has several defensible advantages:

- \* Optimized for 2G/3G networks around the world, low CPU and GPU usage, saves battery and bandwidth consumption
- \* Next-gen live-streaming product that enables mobile phone self-serve streaming
- \* Allows to interleave background music in a seamless manner
- \* Breakthrough patent-pending technology designed from the ground up requiring no licensing fees
- \* the livestreaming app offers instant archival of live-stream videos making it unnecessary to upload files again at the end of live-stream
- \* Modular architecture allows building Tor/VPN modules in order to enable censorship resistant live-streaming to promote free speech

## 8 Security

The live connection is encrypted using AES\_256\_CBC, with HMAC-SHA1 for message authentication and DHE\_RSA as the key exchange mechanism. Every Hoot opensource player connection is authenticated. An authorization key is needed to view a private Hoot video stream. Signup, interactions, HLS streams and archived static content are end-to-end HTTPS SSL encrypted to ensure strong security.

### 8.1 Anonymity and privacy over VPN and Tor

Anonymity and privacy are key to enable free speech, and this matters more in countries where free speech continues to be an ongoing human rights issue. In combination with blockchain technology, the network is designed to route video streams and meta data over VPN and optionally Tor network to avoid censorship and promote free speech.

## 9 GPUCoin Monetizing Engine

GPUCoin tokens based on crypto-currency technology power the GPUCoin marketplace and economy. GPC miners earn GPUCoin tokens running their own open source decentralized Peer-to-Peer GPUCoin nodes utilizing the unused networking bandwidth and compute capacity they may have. In countries where censorship is an issue they may run decentralized GPC nodes with Tor/VPN modules enabled so they can support free speech through Hoot live-streaming. GPUCoin tokens can also be used by viewers to support their favorite artists, musicians and gamers. They may send GPUCoin tokens to the streamers they love watching and for events that they want to support. Streamers can also earn GPUCoin tokens by enabling subscriptions in order to have a dependable source of recurring revenue. This enables them to make a living off their fan base from the comfort of where they are at their best without having to spend for event space and the complicated off-line co-ordinating schemes needed to assemble all their fan base for their events.

For micro-payments, artists can safely accept the GPUCoin payment immediately. The size of the payment is too small for the effort to steal it. Micro-payments are almost always for intellectual property, where there is no physical loss to the merchant.

GPUCoin IPCN network will also build marketing and sales tool to help streamers and gamers market their events and build a paid subscriber base using email lists and SMS lists among other social media channels. Musicians can

also use the album selling tools to list and sell their albums, singles and release music videos. They can choose to exchange their GPU Coin tokens earned for crypto-currencies or fiat currencies. Streamers can also use GPU Coin tokens to purchase advertising space to feature events or utilize the marketing and sales tools to drive more viewers to their streaming events such as an album launch, book launch, movie launch or e-sports gaming event. GPC miners, streamers and viewers can also load GPU Coin tokens on to their respective accounts using crypto-currencies such as Bitcoin, Ethereum, Litecoin, Monero, Zcash and fiat currencies such as USD, EUR among others.

### 9.1 MerkleDB: GPU Coin’s censorship resistant peer-to-peer identity, trust & reputation block-chain

Since there is an economy of trading in the marketplace of the GPU Coin network, having a Peer-to-Peer identity & reputation database MERKLEDB to enable seamless, non-custodial decentralized, trust-free interactions becomes essential. Users/Agents may be identified using Civic, UPort, or using what the Decentralized Identity Foundation<sup>13</sup> is building. Feedback & reviews as well as point scoring out of a maximum of 5 & minimum of 1 for quality of interactions factor into an agents reputation trust score. The trust score of each agent is hashed into the block-chain using their public GPG key & hashed user-name or decentralized identity so as to make them censorship resistant. Trust score & reviews may only be added by anyone to the database & nothing can ever be removed making this the trust reputation blockchain. *Merkle trees*, an efficient verifiable data-structure, is used to ensure the reputation database is usable by making it possible to download the relevant sub-tree for a particular user’s sub-network hash even as the reputation blockchain grows very large in size as the GPU Coin IPCN network MerkleDB grows exponentially in size as the default reputation block-chain database. The blockchain currently cannot in its current avatars store Equifax type of reputation database in a decentralized fashion, as there are no decentralized trustless anonymized Peer-to-Peer reputation databases, where anyone may add trust/credit/metadata scores but no one may remove data, but GPU Coin has a superior decentralized crypto solution to the Equifax hacks with our own GPC Trust & Reputation DB MERKLEDB to the Equifax problem designed using the best practices of cryptography & computer science fundamentals including GPG public/private key anonymity, Merkle trees to efficiently download/query trust/credit scores, & mathematically ensure integrity of encrypted anonymized data including identity and their trust/credit scores.

We address this widespread Equifax<sup>14</sup> hack concern as GPU Coin has a mar-

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<sup>13</sup><http://identity.foundation>

<sup>14</sup>Can Blockchain Stop the Next Equifax? <http://fortune.com/2017/10/01/blockchain-equifax/>

ket place component & we need a reliable censorship resistant identity & reputation database to support reliable credit worthiness and trust. We believe that centralized systems such as Equifax are long obsolete & need to be replaced by multiple decentralized trust/reputation databases, one, hopefully the most important among them being the MerkleDB, the trust & reputation database for the decentralize crypto-block-chain web.

But since MerkleDB is designed to be open, where anyone may democratically add but no one may remove, all identities and trust scores are encrypted/hashed/anonymized<sup>15</sup> using GPG public keys and only if you permit [via your anonymous private key stored encrypted in your private device] a third party you authorize to view your scores may they download and view your scores. We make the ability to download only your scores efficient, as the GPC Trust & Reputation DB MerkleDB grows large in size[imagine GBs in size & millions of users in identity count], using Merkle trees a solid verifiable data-structure that is one of the strong under-pinnings of the Bitcoin block-chain SPV clients. Hence a wide ranging breach like Equifax would be mathematically impossible in the MerkleDB, GPUcoin trust & reputation database. And since all identities are anonymized using GPG public keys they have the added benefit of being censorship resistant as well. We plan to build our own GPUcoin P2P trust & reputation database for supporting GPUcoin market place economics & commerce initially but once its perfected & gains traction, we will open source it to other block-chain networks as well which we hope will be another valuable foundational layer contribution as crypto reputation/trust db layer will support more efficient crypto commerce & economics. We believe by providing such foundational fat protocols including the GPUcoin distributed compute layer and complementary GPC trust/reputation database MerkleDB layer we will substantially increase the overall GDP of the crypto-currency market.

## 9.2 Multi-sig escrow wallets

GPUcoin tokens are first sent to a multi-sig escrow wallet, that is controlled by the buyer/viewer, seller/streamer and an independent 3<sup>rd</sup>-party escrow. Any two out of the three parties need to sign in order for the transaction to be completed. Also the number of times the buyer or seller necessitates escrow agents to mediate a dispute and the time to complete a transaction will factor into the reputation of the buyer and seller. Any trusted agent with a high enough reputation score can register to be an independent 3<sup>rd</sup> party escrow agent. Escrow agents also earn feedback and trust which are hashed and stored in the block-chain using their public GPG key and hashed user-name so it becomes censorship resistant.

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<sup>15</sup>Equifax CEO to Congress: Not Sure We Are Encrypting Data  
<https://www.wsj.com/articles/equifax-ceo-to-congress-not-sure-we-are-encrypting-data-1510180486>

### 9.3 Vickrey Auction to find optimal price

To bootstrap, GPUCoin IPCN network will run Vickrey auctions to find the best service to run on the miners computer that has excess GPU capacity. A *Vickrey auction* is one in which the winner pays the second-highest price, not the price they themselves bid, which has been effectively used by Google AdSense and AdWords. GPUCoin can instantiate any auction protocol, if they find a suitable auction protocol that is superior to Vickrey. Its seed protocol specifies a procedure for stakeholders to approve amendments to the auction protocol, *including* amendments to the auction amendment procedure itself. Upgrades to GPUCoin auction protocol are staged through a testing environment to allow stake-holders and token-holders to recall potentially inferior amendments, that lead to sub-optimal pricing for network stakeholders.

Since the GPUCoin IPCN network may also be used for other tasks than streaming live video, the network can be extended to run any distributed computing task such as computer graphics, business applications, machine learning, cryptography, malware prevention analysis, science and services, making the GPUCoin IPCN network a Uber for computers, enabling miners to rent their unused CPU/GPU cycles & get paid in GPUCoin crypto-currency. Hence the GPUCoin decentralized network powers true distributed cloud computing accelerated by GPUs.

## 10 The GPUCoin Foundation and Governance

The GPUCoin Foundation's primary objective is to promote the real world application of the GPUCoin Decentralized Open Live-Streaming platform. It also aims to initially develop the GPUCoin platform and advocate governance and transparency for the platform. The GPUCoin Foundation will establish an association consisting of members of the GPUCoin ecosystem, which will be empowered to determine the direction of functionality and improvement to the GPUCoin Distributed GPU accelerate computing, mining platform and associated ecosystem.

### 10.1 The dispute resolution process

The GPUCoin Foundation will specify a dispute resolution process, utilizing an internationally accepted dispute resolution system. A rotating board of dispute referees will monitor disputes through the resolution process, & oversee collateral release to plaintiffs. Note that this board of dispute referees is not the dispute resolution process specifically; rather it is the mechanism through



which dispute resolutions can be enacted through the release of collateral on the block-chain.

## **10.2 GPUCoin Token sales**

The GPUCoin Foundation will fund the development of the GPUCoin IPCN Platform discussed in this paper through the issuance of GPUCoin tokens. These tokens will run natively on the Ethereum block-chain and will be offered to backers of the GPUCoin IPCN project via a token sale. The token sale will be launched on or about the March 1 2018. A second token sale will take place once the initial prototype has been developed and tested to fund its deployment.

## **10.3 Token Allocation & Distribution**

The supply of GPUCoin token is limited to the number of one hundred million (100,000,000) in total (including those available for sale during the Token Sale) & will be generated upon the launch ("Token Launch").

The tokens will be distributed in the following manner: 80% (30/30/20) of the tokens will be eventually allocated amongst the community; the remaining 20% will be allocated to the GPUCoin Foundation initiator, early backers, & the GPUCoin protocol network development team.

## **10.4 Restriction on the use of the funds**

To remain in line with the spirit of the projects open and transparent philosophy, all funds shall be tracked and reported according to the GPUCoin Foundations guidelines. A custodian will monitor the usage of the digital tokens and share it with the community periodically.

1. Financial planning and reporting
  - The GPUCoin Foundation shall develop financial planning and review financial performance of the previous quarter.
2. Digital tokens management
  - The digital tokens belonging to the GPUCoin Foundation shall be managed by authorized personnel. The security of digital tokens is ensured by multi signature technology.

GPUCoin Token Distribution Model		
Channels	Percentage	Lock up Period
30,000,000 GPU-Coin token Sale (GTS)	30%	Token Sale - Launch March 1 2018. The initial funding will be used to develop a working prototype, financial setup, legal fees & promotion.
30,000,000 Additional GPU-Coin Token Sale (AGTS)	30%	Additional GPUCoin Token Sale. On the release of a successful prototype, a second token sale will be launched to fund the full production ready launch & development of all relevant technology & organization matters.
20,000,000 GPU-Coin tokens Retained by the GPUCoin Foundation as Treasury	20%	100% of which locked for 24 months. Strategic Planning, Project Support, Token Swap, Emergency Fund, Development & Legal Fees - These will be subject to a 2 year lock-up. Subsequent to the lock-up, these will be used for various development & operation costs of GPUCoin Platform over 2 further years.
20,000,000 GPU-Coin Advisors, Directors and Early Backers	20%	70% of which is locked for 12 months. 30% of which is locked up for 24 months. Distributed to the directors, advisors, and early backers of the project.

Table 3: GPUCoin Token Distribution Model

3. Digital wallet protocol

- The GPUCoin Foundations digital wallet shall be protected by a multiple signature technology mechanism.

4. Disclosure

- On a regular basis, the GPUCoin Foundation shall disclose on the topics regarding community matters, including status of development, operations, and the usage of tokens, as well as whether the GPUCoin Foundation operates in accordance with the governance policy.

## 11 GPUCoin Development Progress

An example livestreaming application has been built and is live on the ios app-store with 3 million users and android play store and the web. This is a low latency consumer streaming application that leverages the GPUCoin IPCN network serving as a good example of what GPU accelerated network can provide in terms of superior low latency user experience. The Hoot consumer mobile app which uses Facebook or Twitter to authenticate is already live in the iTunes AppStore<sup>16</sup> and Google Android Play Store<sup>17</sup>. A light weight performant native mac app is live on the website <sup>18</sup>. The mac app can be used to screen-share meetings, conferences and webinars. It can also be used to live-stream desktop games such as Minecraft, league of legends, world of warcraft and others.

A native enterprise version that uses Slack for authentication of internal private teams is already live. This requires quite a bit of work to integrate with the slack teams API and also in order ensure security for private teams. Following platforms are supported

- iOS app for slack private teams <sup>19</sup>
- Hoot Mac desktop app for slack private teams <sup>20</sup>
- All modern browsers. <sup>21</sup>

Web browser end points are live on line as well <sup>22</sup>. The minimum requirements are any modern browser such as Safari, Mozilla Firefox, Microsoft Internet Explorer or Google Chrome which fall-back to HTML5 HLS video format for playback of the live-streams.

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<sup>16</sup>Hoot live on iOS AppStore <https://appsto.re/us/40RS-.i>

<sup>17</sup>Hoot Live on Google Playstore <https://play.google.com/store/apps/details?id=com.onhoot.android>

<sup>18</sup>Download link for Hoot Live on Mac Desktop <https://onhoot.com/mac>

<sup>19</sup> iOS private Hoot business client for slack teams <http://hootvideo.com/business>

<sup>20</sup>Desktop Hoot client for Slack teams <http://hootvideo.com/macbusiness>

<sup>21</sup>Slack based private team build of Hoot <https://hootvideo.com>

<sup>22</sup>Hoot live link on Web browser <https://onhoot.com>

### **11.1 Tor and VPN to enable censorship resistant live-streaming**

Tor modules to live-stream video over the onion routed tor network needs to be built. Integration with VPN needs to be built in order to evade censorship. This would enable true zero knowledge live-streams and computing in countries where censorships and free speech continue to be ongoing human rights issues.

### **11.2 Focus on Performance**

We have a strong focus on performance and highly performant applications while still maintaining smaller binary sizes and code integrity. The Hoot iOS app is under 10MB, the latency is under a second plus the network latency. This leads to a superior user experience and efficient usage of unused compute.

### **11.3 Uber for GPU accelerated computers creating IPCN - Inter-Planetary Compute Network**

GPUcoin IPCN network is a dense Byzantine fault tolerant peer-to-peer network - creating the worlds first IPCN - Interplanetary compute network. GPU-Coin IPCN Network is based on a complex architecture revolving around Peer-to-Peer, Block-chain, Smart Contracts, State Channels. GPUcoin IPCN network protocol will enable the creation of decentralized compute network, powered by decentralized crypto-currency micro-payments. This leads to Uber for computers helping create the worlds first IPCN an interplanetary compute network. We will create a platform to create new compute primitives using any Turing compute programming language. We will use container technologies such as docker and kubernetes to efficiently distribute and use excess unused GPU accelerate compute null cycles. The compute results of the network are verifiable using cryptographic and mathematical properties of the cryptographic design. The IPCN takes advantage of the coming Cambrian explosion of computing, crypto-currencies & CPU/GPU miners. While Nvidia is like Tesla and Intel is like GM/Ford, GPUcoin IPCN is like Uber's network but for GPU accelerated computers, helping the network participants i.e., miners turn their null GPU/CPU cycles into valuable crypto-currency GPUcoins GPCs.

## **12 Conclusion**

Over the past several years, advancements in Graphical Processing Unit (GPU) technology and GPU Accelerated Computing have played a significant and grow-

ing role in devices such as mobile phones, personal computers, and workstations, as well as in applications ranging from Artificial Intelligence/Machine Learning to 3D Video rendering to oil exploration to various automotive applications. Every day, GPUs are being applied to a greater range of tasks and applications that can benefit from the chips ability to parallel process large blocks of data more efficiently. GPUcoin is the instantiation of a new and innovative decentralized GPU peer-to-peer network to exploit the power unleashed by GPUs, on applications that could immediately benefit from the performance that such a network could bring to bear.

Today's live streaming video systems are complex to manage and difficult to scale, generally requiring proprietary broadcast software to encode captured video, high cost broadcast server software to push video fragments to expensive content delivery networks (CDNs) which cannot deliver the content in real-time. When applying similar architectures to address the needs of Virtual Reality and Video360 applications, the high latency makes these virtually unusable. CDNs suffer from having been conceived in the Web 1.0 wave of Web acceleration advancements, now 15-20 years old. New GPU accelerated video encoding and decoding techniques have made significant strides in more efficiently handling the processing of video and other vector based graphics.

We are building the layer that will power decentralized trusted secure computation. We have an opportunity, arguably a generational opportunity for reinventing computation thereby fostering a new era for trust, legitimacy & decentralization. We believe several next generation D-applications will be built on the **Inter-Planetary Compute Network** powered and incentivized by GPUcoin crypto-currency tokens. We believe GPUcoin will provide a fertile platform for decentralized cloud distributed computing in trust-less environments. Bet on the future with IPCN GPUcoin mining, distributed computing protocol using GPUcoin for mining and decentralized distributed computing.

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