



v1.1



LYNX

Technical White Paper 1.1¹
March 17, 2019

<https://getlynx.io> info@getlynx.io [@getlynxio](https://twitter.com/getlynxio)

Lynx is an eco-friendly cryptocurrency that discourages mining for profit.

¹ Written by Ben Wilson and Alexis Carreiro. This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License



| | |
|---|-----------|
| Summary of Changes from the 1.0 version | 5 |
| Abstract | 6 |
| PART 1: NON-TECHNICAL OVERVIEW | 6 |
| History | 6 |
| The Problem | 7 |
| Summary | 7 |
| Proof of Work | 8 |
| Sustainability | 9 |
| Scalability | 10 |
| The Solution | 13 |
| Summary | 13 |
| Hybrid Proof of Work | 13 |
| Non-Technical Summary | 14 |
| PART 2: TECHNICAL SPECIFICATIONS | 14 |
| Basic Coin Parameters | 14 |
| Hybrid Proof of Work Rules | 15 |
| Hybrid Proof of Work Phases of Activation | 18 |
| Hybrid Proof of Work Phase 1 Visualization | 19 |
| Block Validation Process | 22 |
| LynxCI - Lynx Cryptocurrency Installer | 22 |
| LynxCI ISO | 23 |
| LynxCI for Linode | 23 |
| LynxCI Functions | 23 |
| Mining | 23 |
| Transaction Verification | 24 |
| Block Crawler | 24 |



| | |
|--|-----------|
| Network Topology | 24 |
| Local RPC functions | 24 |
| News Feed & Links | 24 |
| Seed node capable | 24 |
| Mitigated Risks | 25 |
| 51% Attack | 25 |
| Transaction Malleability | 26 |
| PART 3: ROADMAP | 27 |
| In-Progress: Identify additional discount VPS vendors | 27 |
| In-Progress: Builder project for the Raspberry Pi platform | 28 |
| Outstanding: Jaxx Mobile Wallet Integration | 28 |
| Complete: Blocknet DX trading platform Integration | 28 |
| Outstanding: Real-time global map of the Lynx Network | 29 |
| Outstanding: Real-time energy calculator of the Lynx Network | 29 |
| Outstanding: Dynamic HPoW Parameters | 29 |
| Outstanding: Implementation of HPoW Rules 4 and 5 | 29 |
| Complete: Solo mining only by 2019 | 30 |
| In-Progress: Application Integration | 30 |
| References | 31 |



Please note: Lynx is a platform that anyone (from the Boy Scouts of America² to experienced application developers) can use. Our goal is to attract a broad range of collaborators who will directly benefit from our equitable and sustainable approach. *To reach the widest possible audience, Part 1 of this white paper was written for a non-technical, broad audience.*³

² Lynx can be used to meet the 'Projects' criteria for the Boy Scouts' "Programming Merit Badge." See: <http://usscouts.org/mb/worksheets/Programming.pdf>

³ Throughout the paper, we've done our best to simplify advanced concepts. However, some of the ideas presented require a basic understanding of cryptocurrency and blockchain technology. For more information, please see the "References" section for additional resources.



Summary of Changes from the 1.0 version

To save the reader time, the following changes differentiate this document from v1.0 in the following ways:

1. Updated the [Abstract](#)
2. Updated Rule 2 in the [Hybrid Proof of Work Rules](#)
3. Added Rule 4 & 5 in the [Hybrid Proof of Work Rules](#)
4. Added Block Targets in the [Hybrid Proof of Work Rules](#)
5. Added [Hybrid Proof of Work Phase 1 Visualization](#)
6. Added 4th question to [Block Validation Process](#)
7. Updated the [LynxCI Functions](#)
8. Updated the [Mitigated Risks](#)
9. Updated the [Roadmap](#)



Abstract

For blockchain to be considered a secure platform for business in today's global marketplace, it must be created with global sustainability in mind. As an eco-friendly decentralized ledger technology (DLT), LYNX strives to solve this problem. LYNX is a decentralized blockchain that prioritizes environmental sustainability and ease-of-use for the everyday, non-technical user. Unlike Bitcoin's business rules which promote a consolidated, competitive, inefficient, and profit-driven mining strategy that create an over-reliance on fossil fuels, LYNX business rules promote the opposite. The Lynx code discourages high-volume mining rigs because the code purposefully lacks incentives to mine it for profit. In addition, the entire LYNX network is designed to operate on a collaboration of low power devices that anyone can run, resulting in a collective global mining cost of only dollars a day.⁴ This includes mining the coin and confirming transactions. As a result, LYNX is more user-friendly to mine and more eco-friendly than other blockchain projects that have unsustainable energy requirements. And, with an abundance of coins yet to be mined, the LYNX network can be sustained for thousands of years.⁵

PART 1: NON-TECHNICAL OVERVIEW

History

Lynx is cryptocurrency from the past designed for the future because it evolved from an existing coin: Kittencoin (MEOW).⁶ Released in 2013⁷ in response to the Dogecoin project⁸ Kittencoin was initially met with enthusiasm in the crypto community. However, because of a lack of continual development and deliverable solutions, the project remained dormant

⁴ This calculation is based on running a 3.2 watt Raspberry Pi 3 at USD \$0.11/kWh (3.2w X 24h x 0.11)/1000 = \$0.008448/day per single Raspberry Pi 3.

⁵ This is based on the idea that ~15 billion Lynx blocks remain with a 30 second average block time which equals 7.5 billion minutes or the equivalent of ~14,259 years.

⁶ "Kittencoin." *Github*. <https://github.com/kittencoin/kittencoin>

⁷ "Kittencoin launched! Come get some MEOW now. U haz it! DOGE sad." *Bitcointalk*. December 24, 2013.

⁸ Palmer, Jackson. "My Joke Cryptocurrency Hit \$2 Billion and Something Is Very Wrong." *Motherboard*. Jan 11, 2018.

https://motherboard.vice.com/en_us/article/9kng57/dogecoin-my-joke-cryptocurrency-hit-2-billion-jackson-palmer-opinion



for years. During this time, hackers identified a design flaw in the code that allowed them to increase the amount of coins released with each block they mined. (In non-technical terms, this is similar to hacking into an ATM machine to receive \$20,000 on a \$20 withdrawal.) This hack upset the fixed scarcity of the coin, immediately devalued it, and users lost confidence in the project. As a result, ongoing interest in the coin waned and it was considered dead.

In 2017, Ben Wilson, a technical application designer with over 25 years of software development experience, decided to fix the coin and revive the dormant community.⁹ In fact, Kittehcoin's existing community and user-base is one of the reasons he decided to develop an existing project instead of launch a new one; why try and build a new audience from scratch when one already exists - especially when the existing audience already has an economic incentive to support the project? And, an additional criteria also factored into his decision to develop an existing coin instead of create a new one. New crypto projects and ICO's are often correctly met with skepticism because many of them are scams that don't solve any real problems. So, he decided to demonstrate his ability to solve real problems using cryptocurrency by solving a real cryptocurrency problem. With this in mind, he set out to fix the design flaw in Kittehcoin and re-brand the updated project as Lynx. To accomplish this, he successfully cloned Litecoin and ported the Kittehcoin blockchain to it. Now, LYNX has all the benefits of Litecoin with the full transaction history of Kittehcoin. This fixes the original design flaw, benefits the existing Kittehcoin holders, and implements all of the security features of Litecoin.

The Problem

Summary

Cryptocurrencies who rely solely on Proof of Work (PoW) have four primary, and related, design flaws. First, PoW encourages competitive, profit-driven mining. Second, competitive, profit-driven mining demands the use of expensive, high-powered computer processing to secure the network. Third, expensive, high-powered processing power is a barrier to entry for individuals who want to participate by mining the coin. This creates a hierarchical and inequitable system based on who can afford high-powered mining rigs and the electrical costs associated with them, and as a result, few miners control the entire network. Fourth, mining farms are filled with mining rigs that consume an ever-growing and arguably unsustainable amount of electricity. Often, fossil fuels supply power used by these mining

⁹ The name Lynx is an homage to Kittehcoin's loyal, cat-loving fan base and to the early text-only web browser (Lynx) Wilson used in college.



farms and the associated environmental impact is measurable in the form of climate change.

Proof of Work

Bitcoin, the first and most popular cryptocurrency, relies on Proof of Work for mining. Proof of Work is “a piece of data which is difficult, costly, and time-consuming to produce but easy for others to verify [and also a] random process with low probability so that a lot of trial and error is required.”¹⁰

According to Investopedia:

Bitcoin mining is the process by which transactions are verified and added to the public ledger, known as the blockchain, and also the means through which new bitcoin are released. Anyone with access to the internet and suitable hardware can participate in mining. The mining process involves compiling recent transactions into blocks and trying to solve a computationally difficult puzzle. The participant who first solves the puzzle gets to place the next block on the block chain and claim the rewards. The rewards, which incentivize mining, are both the transaction fees associated with the transactions compiled in the block as well as newly released bitcoin.¹¹

Because it can be a random process with low probability that requires lots of trial and error, PoW drives global competition through hashing¹² power to win blocks.

Historically, miners (individuals) compete to win a block. This is done by acquiring a ‘mining rig’ (a computer with specific processing capabilities)¹³ that can compete with other similar devices on the network to win a block. By selling the block reward and its associated fees, the miner can pay the cost of the hardware, software license, power and (potentially) make a profit. When Bitcoin (and other cryptocurrencies using PoW) was originally created, mining for blocks could be done on a laptop or PC, but greed fueled global competition. Now, mining rigs require the use of specialized hardware (capable of

¹⁰ “Proof of Work.” *Bitcoin Wiki*. https://en.bitcoin.it/wiki/Proof_of_work

¹¹ “Bitcoin Mining.” *Investopedia*. <https://www.investopedia.com/terms/b/bitcoin-mining.asp>

¹² “Hashing power” refers to computer processing capacity and has a direct relationship to electricity consumption.

¹³ For the non-technical audience, please note that “miner” can be used to explain the person who is mining and the computer that is mining. (You know, because understanding crypto isn’t hard enough.) Where applicable throughout the paper, we use “miner” to explain the person and “mining rig” to explain the machine.



much higher hashing power and, along with it, increased energy consumption) to win a block. In addition, the number of mining rigs on the network increase the competition between miners to win the block and win the reward (\$), but generally¹⁴ the reward stays the same. When a new miner enters a coin eco-system to mine it for profit, the cost to generate a new block increases yet the function of the block does not change; it is still only one block. In short, Proof of Work incentivizes global competition and energy consumption. This is expensive and environmentally unsustainable for coins that use PoW as their mining algorithm. It's scalable - but not environmentally sustainable.

Sustainability¹⁵

To increase the likelihood of winning a block, miners have scaled their mining rigs and operations. Today, Bitcoin mining is consolidated to a handful of large global mining farms which then send their work to mining pools. A mining farm is a computer data center focused on mining cryptocurrency, and a mining pool is a group of miners who work together to reduce unpredictability of their mining reward. Miners 'point' their hashing power to a particular pool and when the pool wins a block, each miner gets their share measured by the hashes completed by their mining rig. So, miners with more hashing power or more powerful mining rigs, earn a greater percentage of the return. This model helps miners better predict their return on investment. In order for participants in the pool to stay competitive and earn rewards, their hashing power constantly needs to increase.¹⁶ To accomplish this, the pool members invest more money in faster and more efficient chips.¹⁷ Over time this, unfortunately, consolidates the collective mining power of the whole network within a handful of mining pools and farms. This is risky because it can give more power to the miners than to the developers of the project.¹⁸ It consolidates the amount of

¹⁴ Various cryptocurrency projects have unique schedules where the mining reward changes (usually decreases) over time. For the sake of simplicity, we are glossing over that discussion in the Non-Technical Overview section.

¹⁵ For additional reading about Bitcoin's negative environmental impact and sustainability problem, see: <https://digiconomist.net> and Dr. Jonathan Koomey's blog, <http://www.koomey.com/post/171808646518>

¹⁶ This relates to Moore's Law. As defined by Merriam Webster, it refers to "an axiom of microprocessor development usually holding that processing power doubles about every 18 months especially relative to cost or size."

¹⁷ As we see in older larger PoW coin projects, a few mining pools end up competing with each other, ruling out the opportunity for a solo miner to possibly win a block. This isn't necessarily an issue for the miner (because they miss out on the mining reward); it is more of a security risk for the network because of the consolidated power of the pools.

¹⁸ Several articles discuss how miners have throttled innovation in project development by not accepting and/or implementing updates published by the developers of the coin. See: Chester, Jonathan. "The Battle For Bitcoin: What You Need To Know About Bitcoin And Bitcoin Cash." November 17, 2017. *Forbes*. See also:



power to only a few individuals who control the mining pools and farms within the network and creates an imbalance within the coin's ecosystem. For cryptocurrencies driven by Proof of Work algorithms, the desire for profit drives users' participation in the network. Therefore, miners' participation isn't necessarily to support the project's long term progress, but to earn money. In a perverse application of Gresham's Law¹⁹, this pushes out individuals who want to participate and support the project but can't afford it. For example, according to a May 2018 *Market Watch* report, the average cost to mine a single Bitcoin in the United States is approximately \$4700.²⁰

Scalability

This section highlights some of the recent research that addresses the scalability issue:

According to an article in the *MIT Technology Review*, "Bitcoin is Eating Quebec":

- These computers, often called "rigs," are purpose-built. Able to withstand dramatic shifts in temperature and humidity, they are singularly programmed not only to perform just one computation trillions of times each second, but to repeat those computations around the clock and without pause. They are also energy hogs: the 7,000 in Saint-Hyacinthe alone consistently draw more energy than the Montreal Canadiens' nearby hockey arena, even on a sold-out game night.... Factor in additional energy consumption required to cool the computers (they can't function in temperatures over 40°C), and Malone estimates that Bitcoin alone is consuming as much electricity as the entire nation of Ireland at any given moment. And while Bitcoin is the largest proof-of-work cryptocurrency, it's far from the only game in town: at last count, there were nearly 1,500 in operation, each with its own energy demands.²¹

Bustillos, Maria. "Inside the Fight Over Bitcoin's Future." *The New Yorker*. August 25, 2015.
<https://www.newyorker.com/business/currency/inside-the-fight-over-bitcoins-future>

¹⁹ "Gresham's Law." *Merriam Webster*. <https://www.merriam-webster.com/dictionary/Gresham's%20law>

²⁰ Hankin, Aaron. "Here's How Much it Costs to Mine a Single Bitcoin in Your Country." *Marketwatch*. May 11, 2018.
<https://www.marketwatch.com/story/heres-how-much-it-costs-to-mine-a-single-bitcoin-in-your-country-2018-03-06>

²¹ Miles, Kathryn. "Bitcoin is eating Quebec." *MIT Technology Review*. April 11, 2018.
<https://www.technologyreview.com/s/610786/bitcoin-is-eating-quebec/>



According to the 2017 *Wired* article, “The Hard Math Behind Bitcoin’s Global Warming Problem,” “Bitcoin emits the equivalent of 17.7 million tons of carbon dioxide every year.”²² But that number is increasing.²³

According to a 2018 article from *Politico* about miners taking over a small town in Washington state²⁴:

- By the end of 2018, according to some estimates, miners here could account for anywhere from 15 to 30 percent of all bitcoin mining in the world, an impressive shares of other cryptocurrencies, such as Ethereum and Litecoin. And as with any boomtown, that success has created tensions. There have been disputes between miners and locals, bankruptcies and bribery attempts, lawsuits, even a kind of intensifying guerrilla warfare between local utility crews and a shadowy army of bootleg miners who set up their servers in basements and garages and max out the local electrical grids. More broadly, the region is watching uneasily as one of its biggest natural resources—a gigantic surplus of hydroelectric power—is inhaled.

According to a 2018 article from *Vox*, “electricity consumption from Bitcoin rose to a record high of 47.4 terawatt-hours... That’s roughly the energy used by all of Singapore, a country of 5.6 million people. It brings the rate of carbon dioxide emissions from Bitcoin up to 23.2 million metric tons per year. And it’s not showing any signs of slowing down.”²⁵

According to a March 2018 article from *The Atlantic*:

To keep up, bitcoin miners have had to make tremendous leaps in scale. In 2012, a bitcoin mining outfit might have measured its consumption in the kilowatts.

²² Rogers, Adam. “The Hard Math Behind Bitcoin’s Global Warming Problem.” *Wired*. December 15, 2017. <https://www.wired.com/story/bitcoin-global-warming/>

²³ According to this chart, you can see the exponential growth of the miners consumption of electricity: <https://blockchain.info/charts/hash-rate?timespan=all>

²⁴ Roberts, Paul. “This is What Happens When Bitcoin Miners Take Over Your Town.” *Politico*. March/April 2018. https://www.politico.com/magazine/story/2018/03/09/bitcoin-mining-energy-prices-smalltown-feature-217230?utm_source=digg&utm_medium=email

²⁵ Irfan, Umair. “Bitcoin’s Price Dropped but It’s Still Devouring an Obscene Amount of Energy.” *Vox*. Feb 6, 2018. <https://www.vox.com/energy-and-environment/2018/1/18/16901422/bitcoin-price-crash-energy-emissions>



Now, the sites are scaling up so fast that we're talking about gigawatts, which are thousands of megawatts, which themselves are thousands of kilowatts²⁶... To realize the technology's backers' visions, the electrical consumption would have to keep growing at this breakneck pace. At a time when climate change requires that energy demand be bent downward, bitcoin miners sucking up city-size supplies of cheap and carbon-free hydroelectricity is a massive problem. And in China, where most mining is done with subsidized electricity produced in coal-fired power plants, it's an even bigger problem. This externality alone could wipe out a range of the benefits that bitcoin advocates imagine could result from the use of cryptocurrencies. Let's stipulate that blockchains are useful and interesting. But will they be worth the energy it takes to do all that computation?"²⁷

*Unchecked, exponential scaling is unsustainable. This is the problem; Lynx has a solution.*²⁸

²⁶ Remember (as stated earlier): *the cost to generate a new block increases yet the function of the block does not change*; it is still only one block minted at a regular interval. This contributes to the global competition required to mine Proof of Work coins.

²⁷ Madrigal, Alexis. "Bitcoin Mining Turns Mining into Profit." *The Atlantic*. May 12, 2018. Within this quote, Madrigal also references the 2017 *Vox* article by Umair Irfan, "Bitcoin's Price Spikes is Driving an Extraordinary Surge in Energy Use."
<https://www.vox.com/energy-and-environment/2017/12/2/16724786/bitcoin-mining-energy-electricity>

²⁸ Other projects are also trying to solve this problem (like Proof of Capacity, BurstCoin, and Spacemesh), but not like Lynx. What differentiates Lynx are the five rules in the Hybrid Proof of Work.



The Solution

Summary

Lynx created the Hybrid Proof of Work solution. Lynx business rules encourage the use of low-cost computing (like a Raspberry Pi which only consumes around 3 watts of electricity) to mine the coin. As a result, the electrical cost to maintain the Lynx network is a fraction of Bitcoin's, yielding a low environmental impact. The emphasis on low-cost computing also creates a more decentralized, broad miner base which strengthens the stability and security of the currency. And, the easy-to-use tools and broad miner base creates a more equitable cryptocurrency that anyone can use for generations to come. Lynx was designed to have minimal environmental impact because it's committed to creating global solutions and maintaining a small carbon footprint.

Hybrid Proof of Work²⁹

For a cryptocurrency to be considered eco-friendly³⁰, the electricity requirements to run the global network (including the hardware and software) must have a minimal impact on the environment.³¹ To ensure environmental sustainability, Lynx developed Hybrid Proof of Work (HPoW). Lynx HPoW still uses PoW *but modifies it so it isn't profitable* and, as a result, creates an entire cryptocurrency network that can run on energy efficient, easy to set-up, low-cost computers or cloud services. This removes any barriers to entry for non-technical individuals or organizations who want to get involved with, support, and build applications on a stable and secure cryptocurrency project.

HPoW removes the profit incentive for miners because the mining reward is so low. In fact, mining farms would actually lose money if they tried to mine Lynx, meaning they will leave Lynx to the individuals who want to solve the sustainability problem. This takes control away from mining farms and pools and puts it squarely into the hands of individuals (solo miners) who want to build upon and use Lynx. HPoW supports network maintenance by incentivizing and empowering those who want to use Lynx. With every new solo miner that

²⁹ The "technological specifications" section explains the parameters and business rules for Hybrid Proof of Work.

³⁰ Brown, Mike. "Bitcoin's Energy Consumption is Killing the Planet but There is a Solution." *Inverse*. <https://www.inverse.com/article/39138-bitcoin-energy-consumption> December 12, 2017.

³¹ Verma, Sid. "Bitcoin's Exorbitant Energy Costs May Prove to Be Biggest Risk." *Bloomberg*. November 9, 2017.



connects, the network becomes more secure by reducing the risks associated with a centralized and hierarchical cryptocurrency network. This security is achieved through redundancy: the more individual nodes on the network, the stronger the network becomes. If an individual node or miner fails, or if an entire region of nodes fail due to widespread power outages or war, the network is still secure because mining rigs are plentiful.

The following criteria bring stability to Lynx and maintain network integrity.

- 1) The low cost to maintain each mining rig in the global Lynx network.
- 2) The low work output of each mining rig in the global Lynx network.
- 3) The lilliputian impact to the global Lynx network should an individual mining rig fail.

Each mining rig only requires a low power computer and the free Lynx Cryptocurrency Installer (LynxCi). The cost is minimal and the set-up can be accomplished by non-technical users.³²

Non-Technical Summary

In short, Lynx business rules discourage mining for profit and this differentiates Lynx from most other cryptocurrencies currently in production. By rendering mining unprofitable, the electricity needed to mine and run the global Lynx network is minimal. Ultimately, this is an eco-friendly solution because it supports environmental sustainability. And, because of the redundancies in the network design and the enhanced coin parameters, the coin is secure.

PART 2: TECHNICAL SPECIFICATIONS

To ensure environmental sustainability, Lynx developed Hybrid Proof-of-Work (HPoW). Lynx HPoW still uses PoW *but modifies it so it isn't profitable*. Below are the coin parameters and the HPoW business rules.

Basic Coin Parameters

1. 30-second block time
2. Cost of a transaction is .0001 Lynx/kilobyte

³² The following non-technical video contains everything you need to buy, know, and do to set up the LynxCi on a Raspberry Pi 3. Visit: <https://getlynx.io/can-non-techies-mine-lynx-crypto/>



3. 1 week block reward maturity³³ for miners
4. 1 Lynx block reward plus fees

The coin parameters are changes from Lynx's upstream, Litecoin. These parameters reduce the likelihood of miner profitability. Removing the profit incentive for miners ensures that Lynx developers can maintain control of the project's innovation and continue to pursue efforts of lowering mining costs.

1. The first parameter makes for fast first confirmation times on transactions. Additionally, with a ~1MB block size, as transaction volume grows, we will be able to handle higher transactions per second.
2. The cost of a transaction is not zero, to reduce dust³⁴ attacks, but is still so inexpensive, that transaction fees will not be a barrier to using Lynx regularly.
3. The Miner must wait one full week to gain access to their block reward. This modification makes it very difficult for a miner to immediately sell their mining reward on an exchange.
4. The fourth parameter is that Lynx's block reward is so low, it is intentionally unprofitable to mine. By removing as many incentives as possible for ASIC miners, only individuals who actually use Lynx are incentivized to run a LynxCI node either on a low power device or in the cloud.

The coin parameters plus the Hybrid Proof of Work create Lynx primary business rules and, as a result, these business rules create barriers for high-powered ASIC mining.

Hybrid Proof of Work Rules

1. A single miner can't win a block more than once every 30 minutes.
2. The miner's reward address balance must be greater than or equal to a required fluctuating minimum amount of Lynx to win a block.
3. By using random selection, the fastest miners are not always guaranteed to win the block reward.
4. Reward address used by miners must have an age that fit within a fluctuating block number.
5. The miner must sign the block with a private key.

³³ This is the amount of time a miner must wait to claim the block reward and fees from winning a block. This slows down the velocity of money on the network and restricts miners from quickly selling their mining rewards on exchanges.

³⁴ The smallest amount of Lynx is 0.00000001 Lynx. This amount is also called a 'liv', inspired by the idea that "all cats have nine lives" and the author's housecat, Olivia, who is possibly the best cat ever.



Lynx implements a series of business rules that must be met by the miner to successfully get a candidate block accepted by the network. Taken together, the five business rules result in “Hybrid Proof of Work” (HPoW).³⁵

1. The first rule requires the miner's address cannot have been the recipient of a mining reward in the previous 60 blocks (~30 minutes). The address supplied within the candidate block coinbase header value is checked during verification by other nodes. If a match is found in the previous 60 blocks, the candidate block is refused even if they have the fastest solve time for the hash. The verification fails and the block is considered invalid.
2. The second rule requires the address supplied for the coinbase reward must have minimum balance at the time the candidate block is submitted. The minimum amount is the difficulty value of the previous 10th block³⁶ from the current one being solved multiplied to the power of 4. A minimum and maximum threshold of 1,000 and 100,000,000 will be enforced.
3. The third rule concerns the reward address submitted in the candidate block. After executing a single SHA256 hash on the miner's reward address, the last 3 characters found must match the last 3 characters of the block hash value submitted by the miner in the candidate block. This randomizes who can actually win the block. Even the fastest miner can't be guaranteed to win the block or a series of blocks in succession. The chances are 1 in 4,096 that the miner will be able to win the block.
4. For a miner to win a block, the address used for the mining reward must have its first transaction occur on a block no older than 600,000 blocks prior and no younger than 100,000 blocks to the current respective block. This will reduce miners from mining with rewards addresses they don't control and fly-by-night miners who start mining for the short term gain. Old addresses with large balances that fall out of range can no longer be hijacked by other miners.
5. In the lynx.conf file, the miner specifies a private key (instead of the public address of the wallet). The public address can easily be derived from the private key (privkey). The miner uses the public address to mine but since it has the privkey, it

³⁵ These rules are subject to change.

³⁶ This is intended to remove issues with network latency. Global network latency will sometimes delay propagation of the previous block's status. This means a miner might start mining the next block too late and this isn't fair to the respective miner. However, the likelihood the mining node has the previous 10th block (from the one they are working on) is high. So, the rolling nature of the update allows for all nodes to always know the difficulty value they should be working with and it removes the reliance upon the timestamp value in the block. If the miner is working with the wrong coin age value, it can be assumed they are not fully in sync or experiencing network latency issues. This rule also scales with Nielsen's Law. See the References section for more information.



can sign the block. No more than 25 blocks can pass on the chain without a signed block being found by miners. If 25 unsigned blocks have passed, ONLY miners that mine with the privkey will be allowed to mine the next candidate block. The task of mining with privkey will always be handled by seed nodes, so public miner won't be required to shoulder the additional risk of storing privkey values in the lynx configuration script.

Additionally, the Hybrid Proof of Work requirements can be independently checked by all other nodes on the network during the confirmation phase. It's easy to see if a submitted block is valid. Due to the low miner reward, the intended network topology would ideally consist of mostly low power mining rigs. As a result of the HPoW rules, the likelihood is good that every miner that complies could win a block, not just the most powerful miner. These business rules won't work well for mining pools so solo mining will become the primary mining method.

Collaborative mining pools will lose interest due to the low mining reward and the long block maturity. Without the profit incentive, the collective effort of a mining pool poses no benefit. As a result, high-capacity miners with expensive mining hardware will reject Lynx as a profitable coin project to mine.

If a high capacity miner still decides to mine Lynx, they will realize solo mining only brings them a reward of 1 Lynx per block. A creative miner might try to manipulate the system by rotating new addresses after each block is won.³⁷

Lynx has implemented an aggressive difficulty adjustment algorithm³⁸ that prevents inordinately long block times after an ASIC leaves the network. While a small disruption in average blocktime may occur, the protocol will tolerate the change.

Taking power away from ASICS allows the network difficulty to drop further along with the network hash rate.³⁹ This lowers the electrical and hardware cost of the network and further secures the network by flattening the miner base and increasing the likelihood that truly anyone could mine blocks and confirm transactions.

In short, Lynx remains a Proof of Work project despite borrowing ideas from Proof of Stake. The HPoW rules ensure that blocks continue to get mined by a broad network of

³⁷ For more information, please see the "51% Brute Force Attack" section of the paper.

³⁸ Digishield was implemented in early 2018.

³⁹ "Bitcoin Difficulty." *Bitcoin Wisdom*. <https://bitcoinwisdom.com/bitcoin/difficulty>



miners which makes the network more resilient, as the network cannot be controlled by a few powerful miners or pools.

Hybrid Proof of Work Phases of Activation

On January 9th, 2019, the following block targets were published⁴⁰. The following block targets indicate the phased release plan of the HPoW rules.

Phase 1: Upon the arrival of Block 2,630,000, Rule 1 of HPoW will be implemented with a delay time of 10 blocks.

Phase 2: Upon the arrival of Block 2,680,000, Rule 2 of HPoW will be implemented using the power of 2.

Phase 3: Upon the arrival of Block 2,730,000, Rule 1 of HPoW will be implemented with a delay time of 20 blocks.

Phase 4: Upon the arrival of Block 2,780,000, Rule 3 of HPoW will be implemented using only 1 digit of the hash result to match. This sets a probability of 1 in 16 the miner will win the block.

Phase 5: Upon the arrival of Block 2,830,000, Rule 1 of HPoW will be implemented with a delay time of 30 blocks.

Phase 6: Upon the arrival of Block 2,930,000, Rule 1 of HPoW will be implemented with a delay time of 40 blocks.

Phase 7: Upon the arrival of Block 3,030,000, Rule 1 of HPoW will be implemented with a delay time of 50 blocks.

Phase 8: Upon the arrival of Block 3,230,000, Rule 2 of HPoW will be implemented using the power of 3.

Phase 9: Upon the arrival of Block 3,630,000, Rule 3 of HPoW will be implemented using only 2 digits of the hash result to match. This sets a probability of 1 in 256 the miner will win the block.

⁴⁰ See: <https://github.com/getlynx/Lynx/releases/tag/v0.16.3.2>



Phase 10: Upon the arrival of Block 3,730,000, Rule 2 of HPoW will be implemented using the power of 4.

Phase 11: Upon the arrival of Block 5,630,000, Rule 3 of HPoW will be implemented using only 3 digit of the hash result to match. This sets a probability of 1 in 4,096 the miner will win the block.

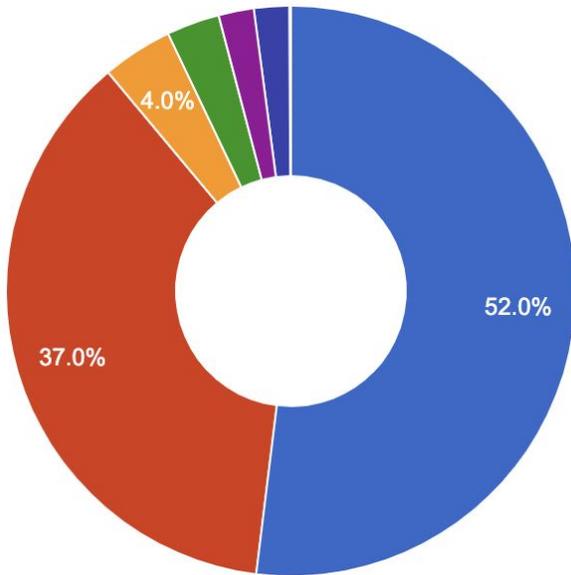
Hybrid Proof of Work Phase 1 Visualization

The images below represent the mining extraction that occurred on the Lynx network within twenty-four hours of activating Phase One of Hybrid Proof of Work.⁴¹ Each pie slice represents a unique mining reward address. The first image shows one, high power miner (Multipool) winning the majority of the blocks. But, soon after activating, all participating miners on the network began to earn block rewards almost equally.⁴² Each slice in the pie charts below represent both ASICs and low-powered, energy efficient miners. The images show how HPoW shifts network concentration away from only ASICs and distributes it amongst all miners. The mining results are the same regardless of the hardware. It demonstrates how the implementation of Lynx Hybrid Proof of Work democratizes Proof of Work.

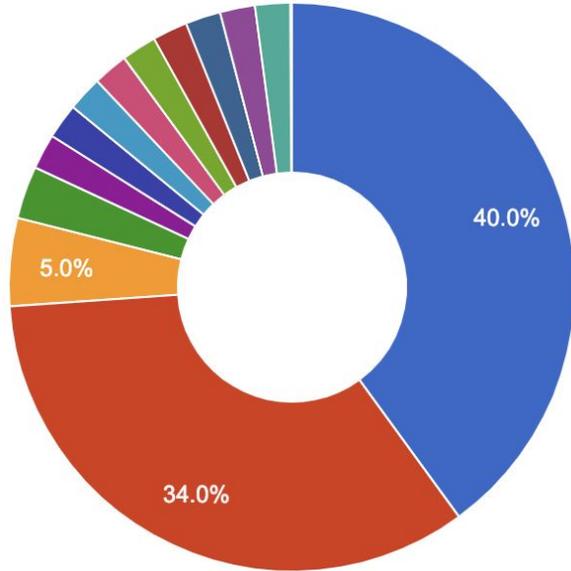
Within forty-eight hours of activating Phase One, the Lynx network went from 1.5GH/s to 12KH/s. This reduces the global mining cost of the network to about \$1/per day.

⁴¹ The images are screenshots taken from the network extraction chart on February 17 and 18, 2019 on the public block explorer: <https://chainz.cryptoid.info/lynx/#!extraction>

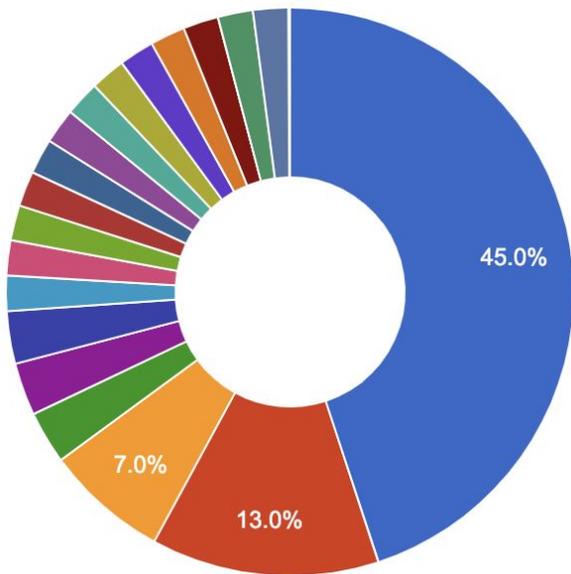
⁴² When viewing the miner reward slices in the extraction pie chart, it's common to see a slight fluctuation in the distribution.



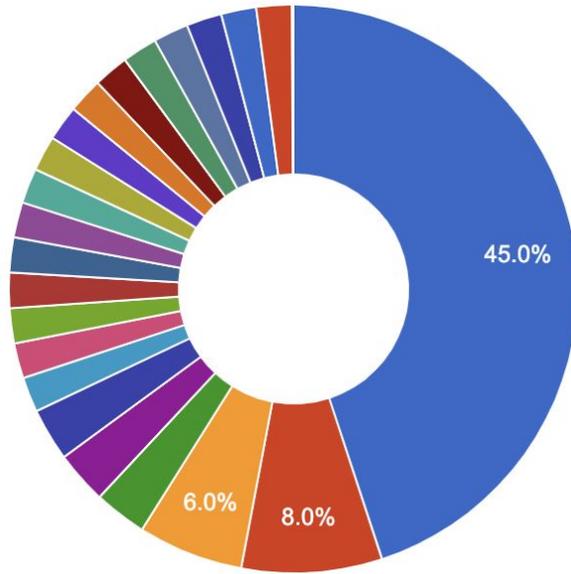
Extraction Share for last 100 Blocks
Feb 17th, 2019 at 5:33 PM EST



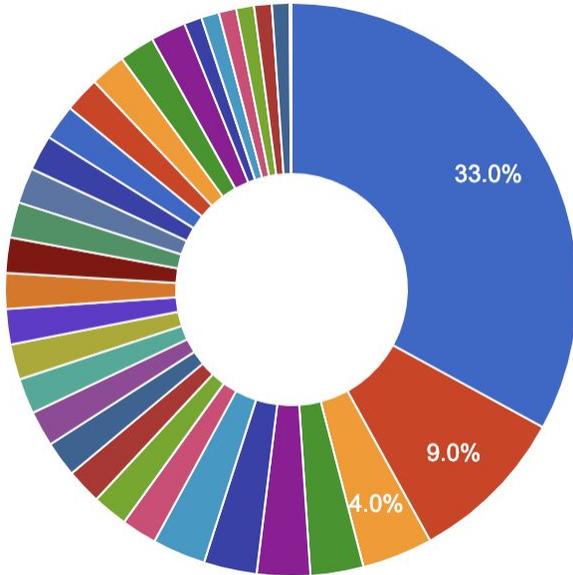
Extraction Share for last 100 Blocks
Feb 17th, 2019 at 6:10 PM EST



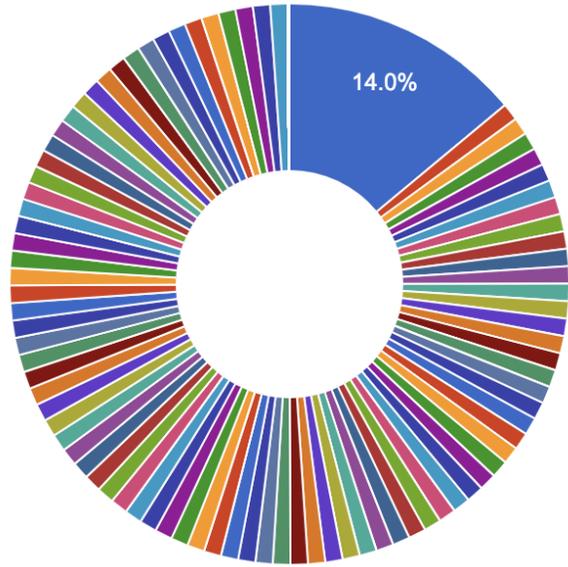
Extraction Share for last 100 Blocks
Feb 17th, 2019 at 6:45 PM EST



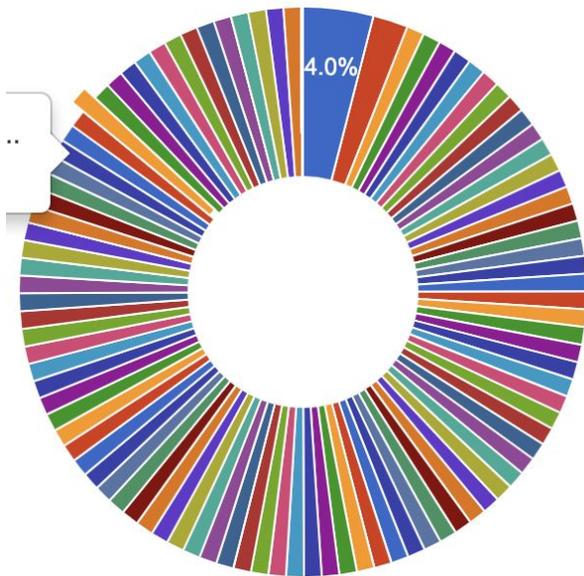
Extraction Share for last 100 Blocks
Feb 17th, 2019 at 7:01 PM EST



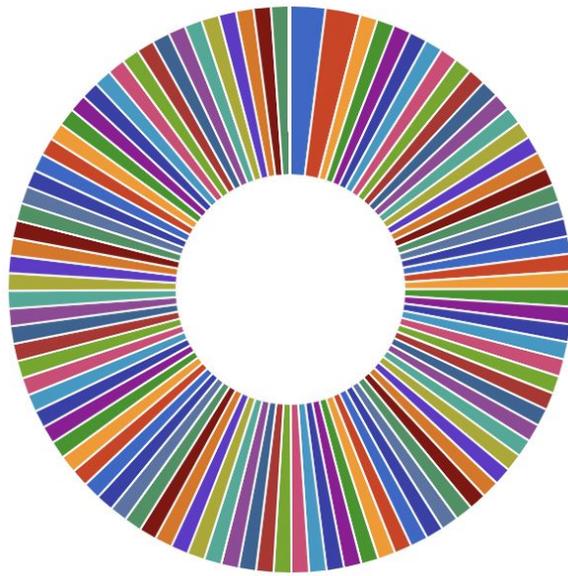
Extraction Share for last 100 Blocks
Feb 17th, 2019 at 8:04 PM EST



Extraction Share for last 100 Blocks
Feb 18th, 2019 at 9:35 AM EST



Extraction Share for last 100 Blocks
Feb 18th, 2019 at 11:58 AM EST



Extraction Share for last 100 Blocks
Feb 18th, 2019 at 2:49 PM EST



Block Validation Process

The Lynx code includes the DigiShield⁴³ difficulty adjustment algorithm. This enhancement better ensures the 30-second block-time average and provides support for low-hash, eco-friendly mining rigs to mine blocks after a high-powered ASIC leaves.

The Hybrid Proof of Work business rules have priority over the difficulty adjustment algorithm. So, when the network is comprised of thousands of mining rigs, the competition between nodes should be balanced. After an occasional ASIC disrupts the network hashing speed, the difficulty adjustment algorithm will quickly retarget the difficulty value. Since each Lynx node is running the same code, each is responsible for confirming transactions received by their peers.⁴⁴ The peers review the pre-existing requirements and HPoW business rules by answering the following questions:

1. Is the coinbase address in the block used in the last 60 blocks? If yes, the candidate block is not confirmed and not propagated to peers.
2. Is the current balance of the miners reward address less than the dynamic required value? If yes, the candidate block is not confirmed and not propagated to peers.
3. Is the last 3 digit value found in the coinbase address (as a hash) different from the last 3 digit value found in the candidate block hash? If yes, the candidate block is not confirmed and not propagated to peers.
4. Is the block height of the first transaction in the coinbase address supplied in the candidate block older than 600,000 blocks or younger than 100,000 blocks? If yes, the candidate block is not confirmed and not propagated to peers.
5. Is the candidate block not signed and the last 25 blocks are also not signed? If yes, the candidate block is not confirmed and not propagated to peers.

LynxCI - Lynx Cryptocurrency Installer

The Lynx Cryptocurrency Installer (LynxCI)⁴⁵ is a program that runs on the Debian 9 Linux operating system - and installs the latest stable release of Lynx along with the full historical

⁴³ "What is DigiShield & How it Works to Retarget Difficulty." Bitcoin Forum. March 22, 2014. <https://bitcointalk.org/index.php?topic=526721.0>

⁴⁴ Peers are other Lynx nodes that a respective node communicates with. Due to the large size of the Lynx network, a single node can't talk to every other node, so a short list of peers are selected and this forms a mesh of interconnected nodes.

⁴⁵ "Lynx Node Builder." *Github*. <https://github.com/getlynx/LynxCI>



blockchain history of the project which includes over five years of transactional data. Lynx has a built-in miner, so no external mining software or equipment is needed with LynxCI. Through solo mining, the software allows the node to actively participate in the Lynx network by creating and confirming transactions on the network in the mining process. LynxCI is intended to be used on computers with relatively limited RAM⁴⁶ and processing power, but it can also be used in cloud VM environments.

LynxCI ISO

The ISO is a stand alone file that can be flashed to a micro-SD card and then physically inserted into a low power device.⁴⁷ When the device is powered on, it automatically configures itself and, after a short amount of time, completely runs all functions of LynxCI without a KVM.⁴⁸ This version uses the Raspbian Lite operating system based on Debian 9. The OS will also secure its own firewall, wallet functions and RPC connections. By default, no Lynx are available to steal on the completed build.

LynxCI for Linode

A Stacksript extends the functions of LynxCI for use on the the linode.com platform. This allows an individual to create a node for as little as USD \$5/month and replicate all the features of the Raspberry Pi implementation. This recommended operating system is Debian 9.

LynxCI Functions

LynxCI builds a Lynx node that provides the following functions:

Mining

Lynx now includes a built-in miner. The miner is preconfigured to solo mine. LynxCI includes a list of reward addresses to use. The user can add, edit, or delete these based on their preferences. The administrator can adjust the mining speed, but the default setting of 1% CPU is recommended as increasing the value does not increase mining rewards, only energy consumption and potentially shortens the life of the hardware over time.

⁴⁶ Recommended RAM specification is 2 GB but 1 GB implementation are possible, especially with a Raspberry Pi 2 or 3. Using less than 1 GB of RAM is not recommended for mainnet, though it has been done. For device and VPS environments with less than 1 GB, support of the testnet is recommended and welcome.

⁴⁷ For more information (and to view the URL to the instructional video), see “Can Non-Techies Mine Lynx” in the References section.

⁴⁸ KVM refers to keyboard, video and mouse.



Transaction Verification

Each device runs a full node so a full copy of the blockchain is maintained and verified while Lynx runs.

Block Crawler

If the user opts to enable it, a local Block Crawler can be started. The Block Crawler is written in PHP and the user is free to customize it as they like.

Network Topology

Each node silently sends anonymous usage data to a polling server.⁴⁹ This will allow the mapping functions to render real time maps for users to see the physical global network and collect data that calculates the total network mining costs.

Local RPC functions

To enable support for decentralized exchanges and external application development, all RPC functions are fully supported on each node device. By default, the wallet functions are disabled for security reasons. The device is preconfigured to allow any RPC traffic with proper authentication.

News Feed & Links

In addition to Twitter and Discord, rendering of RSS news information comes from the getlynx.io website, [Lynx reddit.com](https://lynx.reddit.com)⁵⁰ page and potentially other sources in the future. The local node will provide a single source for information about the network and project. To view this information, the local Block Crawler must be enabled.

Seed node capable

If a node owner would like to volunteer, a DNS entry can be assigned to the node so the device is used as a default seed node option for wallets when connecting to the network.

All the above listed functions are configured with default values and allow the user to run them without configuration. This 'headless' design allow users ranging from totally

⁴⁹ Exact data collected can be viewed in function `send_status()` at https://github.com/getlynx/Lynx/blob/master/src/status_sender.cpp

⁵⁰ See: <https://www.reddit.com/r/LYNX/>



non-technical to experienced IT professionals to easily create a Lynx node that supports the network. Each LynxCI node on the network is respected equally.

Mitigated Risks

The coin parameters plus the Hybrid Proof of Work create Lynx primary business rules and, as a result, these business rules address the likelihood of a successful 51% attack.

51% Attack

When a coin project has a relatively low hashing power, it is at higher risk of succumbing to a 51% attack. A 51% attack⁵¹ occurs when a single miner gets to control a majority of the hashing power of the network for a sustained period of time.⁵² This miner then has some degree of control of the blocks mined for a short period of time and normal execution of business rules can be disrupted⁵³ if they are able to retain control of the majority network hashing power. The risk of financial loss to members is low as the attacker can only modify their own transactions or delay the confirmation of other transactions (in addition to a few other things), but they can't undo past transactions or steal anyone's coins. Overall, a successful 51% attack can just be embarrassing for a coin with a low market cap value. In rare cases, if the attack is timed properly with a large purchase or exchange withdraw request, the attacker might be able to pull off a double spend.⁵⁴ Additionally, one could mitigate that risk by waiting for a greater number of confirmations from the network.

One industry answer to this problem is to engage with higher and higher network hashing power as this will require an attacker to lay out a considerable amount of investment for a very low likelihood of success. Additionally, the network would see the bad actor attempt and might decide to proactively ban this miner.

It is reasonable to conclude that because Lynx is run on a network of low power devices for mining and transaction confirmation, it could suffer from a 51% attack. Lynx could avoid this attack with HPoW. Rule 3 alone of HPoW removes the premise that an attacker could

⁵¹ "51% Attack, Majority Hashrate Attack." *Bitcoin.org*. <https://bitcoin.org/en/glossary/51-percent-attack>

⁵² In this instance, the use of "miner" refers to BOTH a mining rig AND the person who owns/controls that mining rig.

⁵³ "What can an attacker with 51% of hash power do?" *Stack Exchange*. <https://bitcoin.stackexchange.com/questions/658/what-can-an-attacker-with-51-of-hash-power-do>

⁵⁴ "Double Spending." *Investopedia*. <https://www.investopedia.com/terms/d/doublespending.asp>



succeed with a 51% attack for a sustained period of time by simply having the highest hashing power rig on the network. By creating business rules that delay and distribute the opportunity for a miner to win a block, Lynx thwarts the ability for a single powerful miner to win a block over and over again. No longer will the most powerful miner win the next block with confidence. The HPoW business rules require the miner to comply as a result of network consensus. If it doesn't comply, the network invalidates blocks created by that miner. These business rules don't completely rule out the opportunity for a successful 51% attack, but they significantly diminish its risk and it removes the requirement of an ever increasing network hashrate to secure the global network. Because the mining reward is so low, the primary reason someone might try a 51% attack is to force users of Lynx to lose confidence in the security of Lynx or attempt a double spend.⁵⁵ To accomplish this, an attacker could create a script that dynamically switches out the mining reward address with a new one each time a block is won to subvert Rule 1. This would need to be done quickly between blocks due to the random nature of Rule 3. Additionally, the cost to the attacker would increase, as a result of the increased mining difficulty. Since the difficulty fluctuates, a considerable amount of Lynx would be required in each address. Throughout this process, the attacker would have to maintain the fastest miners on the Lynx network to complete this task. The cost of having the required number of Lynx addresses with the required minimum amount would be high and unpredictable. Eventually, these business rules will be coded into Lynx so HPoW can dynamically respond based on the network node count, coin market valuation, and algorithm difficulty value.

Exchanges are advised to require 200 confirmations on all deposits. For very large transactions, users would be wise to see 200 confirmations (~100 minutes) and for medium transactions, users should wait for 30 confirmations (~15 minutes). In the case of tipping and other low risk use cases, users only need to wait for a few blocks to pass.

Transaction Malleability⁵⁶

The latest version of Lynx is fully Segwit compliant.

⁵⁵ Oberhaus, Daniel "Cryptocurrency Miners Are Sabotaging Blockchains for Their Personal Gain." *Motherboard*. May 25, 2018.

https://motherboard.vice.com/en_us/article/a3a38e/what-is-a-51-percent-attack-silicon-valley-bitcoin-gold-verge-monacoin-cryptocurrency

⁵⁶ Klitzke, Evan. "Bitcoin Transaction Malleability." July 20, 2017.

<https://eklitzke.org/bitcoin-transaction-malleability>



PART 3: ROADMAP

As of February 2019, Lynx is available for trade on the following public exchanges.

1. <https://www.aitilly.com>
2. <https://novaexchange.com>
3. <https://trade.mct.plus>
4. <https://www.cryptopia.co.nz>⁵⁷
5. <https://blocknet.co>

Lynx is proud to be included in the family of coins supported by the Coinomi⁵⁸ desktop and mobile wallet. The latest QT wallet from the Lynx Core Development group can always be found on our Github Release list, though we recommend the Coinomi wallet for most of our non-technical users.⁵⁹

The list below briefly describes some of Lynx “to-do” list items and goals for the project.

In-Progress: Identify additional discount VPS vendors

While the Raspberry Pi is a convenient device to run LynxCI, many enthusiasts prefer the ease of renting a low cost Virtual Private Server (VPS) to install and run LynxCI. The annual cost can be lower than buying a Raspberry Pi and due to competition, the price of a VPS lowers year after year. Using a quality vendor,⁶⁰ users can expect to pay around \$10 per month for a VPS with 2GB of RAM. But alternate low cost options exist. The long term plan is to grow this list.

1. SparkVPS⁶¹ 2GB KVM VPS is USD \$25/year

⁵⁷ When Lynx was listed on Cryptopia, Kitehcoin was de-listed and removed to avoid any confusion. This was done to phase out the defunct coin (MEOW) and prevent scammers from continuing to work on that broken code base.

⁵⁸ See: <https://coinomi.com>

⁵⁹ See: <https://github.com/getlynx/Lynx/releases>

⁶⁰ See: <https://www.linode.com/pricing>

⁶¹ See: <https://www.sparkvps.com/crm/cart.php?a=add&pid=180>



2. DCNHost⁶² 2GB KVM VPS is USD \$25/year
3. SnowVPS⁶³ 2GB KVM VPS is USD \$30/year
4. HostBrz⁶⁴ 2GB KVM VPS is USD \$35/year
5. KayHosting⁶⁵ 2GB KVM VPS is USD \$35/year

In-Progress: Builder project for the Raspberry Pi platform

By leveraging the LynxCI script, popular builder websites are interested in including cryptocurrency projects. Because Lynx is low risk, low cost and fast, kids can play with the LynxCI script to build a node, customize it and then build applications on it. A local Block Crawler application written in PHP is already included⁶⁶. With a working example of solo mining, kids can get excited about the project and get involved. The feeling of participating in a global project, in even the smallest amount, can be very inspiring for young girls and boys. This roadmap item justifies the numerous amount of comments in the LynxCI code. For a person who is new to Bash,⁶⁷ the included comments can prevent a great deal of frustration.

Outstanding: Jaxx Mobile Wallet Integration⁶⁸

Lynx is already listed in Coinomi. Getting listed on the Jaxx mobile wallet will provide another option for users.

Complete: Blocknet DX trading platform Integration

Centralized exchanges are risky for traders and may eventually become obsolete for a number of reasons. They boast expensive on-ramping cost for emerging projects and are vulnerable to hacking and internal theft. With the advent of Atomic Swaps between compliant coin projects, the idea of centralized exchanges will slowly dissolve. Therefore, decentralized exchanges may be the future of cryptocurrency trading and Lynx is primed for early adoption because Lynx is Atomic Swap compliant.

⁶² See: <https://my.dcnhost.com/cart.php?a=add&pid=150>

⁶³ See: <https://www.snowvps.com/portal/cart.php?a=add&pid=93>

⁶⁴ See: <https://www.hostbrz.com/portal/cart.php?a=add&pid=137>

⁶⁵ See: <https://clients.kayhosting.com/cart.php?a=add&pid=104>

⁶⁶ See: <http://node01.getlynx.io>, <http://node02.getlynx.io> or <http://node03.getlynx.io> for a demonstration.

⁶⁷ "GNU Bash." *GNU Operating System*. <https://www.gnu.org/software/bash/>

⁶⁸ See: <https://jaxx.io>



Outstanding: Real-time global map of the Lynx Network

The objective is to build a real-time map that displays global distribution of LynxCI devices. This idea is modeled after the Global Bitcoin Node Distribution Map.⁶⁹ This map will use real-time publicly accessible data that is globally polled from LynxCI devices. The exact data extracted from LynxCI nodes is limited to the public IP, the block height, and the MAC address. No personally identifiable data will be collected. This code will be open source and available for public audit.

Outstanding: Real-time energy calculator of the Lynx Network

In an effort to be transparent about the eco-friendly nature of the project and the low cost to run the network, this tool allows the visitor to view the real-time electrical consumption of the global Lynx network, specifically the LynxCI nodes. In fact, this calculator will be displayed on the same LynxCI web page as the global map distribution of LynxCI nodes. The calculator will default to the current data set from the global mapping tool, but the user will have the ability to override the default values and enter their own numbers. The calculator will factor in the country of the LynxCI device and query for the average price per kilowatt hour in the respective country. While IP addresses can be spoofed and the exact termination point can't always be verified, this will still provide a useful report of the Lynx network cost by country.

Outstanding: Dynamic HPoW Parameters

Using the real-time data collected from exchanges, the global node map and the algorithm difficulty value, the HPoW parameters will self-adjust. This removes the opportunity for human error and allows the network to scale more smoothly based on price, usage, and node count.

Outstanding: Implementation of HPoW Rules 4 and 5

While the business rules for Rule 4 and 5 are documented previously, the code has not been added to the Lynx daemon yet. The scheduled release of these two rules will be announced in 2019.

⁶⁹ "Global Bitcoin Nodes Distribution." *Bitnodes*. <https://bitnodes.earn.com>



Complete: Solo mining only by 2019

The long term strategy for the Lynx network is to remove node hierarchy within the global Lynx network. Removing mining pools is a critical step in this project.

In-Progress: Application Integration

Our primary long term goal for Lynx is application integration. With its low implementation costs, decentralized network topology, and long-term sustainable energy costs, Lynx provides a viable building platform for technical application designers.

To further our goal of application development, the Lynx testnet environment currently supports HPoW Rules 1, 2, and 3 for short-term research and development. This free open source environment exists to encourage developers to test their ideas and build new applications on the Lynx network.⁷⁰

For free testnet coins, please contact: info@getlynx.io.

⁷⁰ The testnet environment is fully supported but comes with the risk of being expunged fully without notice.



References

“51% Attack, Majority Hashrate Attack.” *Bitcoin.org*.
<https://bitcoin.org/en/glossary/51-percent-attack>

“Bitcoin Difficulty.” *Bitcoin Wisdom*. <https://bitcoinwisdom.com/bitcoin/difficulty>

“Bitcoin Mining.” *Investopedia*.
<https://www.investopedia.com/terms/b/bitcoin-mining.asp>

Brown, Mike. “Bitcoin’s Energy Consumption is Killing the Planet but There is a Solution.” *Inverse*. December 12, 2017.
<https://www.inverse.com/article/39138-bitcoin-energy-consumption>

Bustillos, Maria. “Inside the Fight Over Bitcoin’s Future.” *The New Yorker*. August 25, 2015.
<https://www.newyorker.com/business/currency/inside-the-fight-over-bitcoins-future>

“Can Non-Techies Mine Lynx?” *GetLynxio*.
<https://getlynx.io/can-non-techies-mine-lynx-crypto/>

Chester, Jonathan. “The Battle For Bitcoin: What You Need To Know About Bitcoin And Bitcoin Cash.” *Forbes*. November 17, 2017.
<https://www.forbes.com/sites/jonathanchester/2017/11/27/the-battle-for-bitcoin-what-you-need-to-know-about-bitcoin-and-bitcoin-cash/#115b9dc6331f>

“Database.” *Wikipedia*. <https://en.wikipedia.org/wiki/Database>

Digiconomist. <https://digiconomist.net>.

“Double Spending.” *Investopedia*.
<https://www.investopedia.com/terms/d/doublespending.asp>

“Global Bitcoin Nodes Distribution.” *Bitnodes*. <https://bitnodes.earn.com>

“GNU Bash.” GNU Operating System. <https://www.gnu.org/software/bash/>



“Gresham’s Law.” *Merriam Webster*.

<https://www.merriam-webster.com/dictionary/Gresham's%20law>

Hankin, Aaron. “Here’s How Much it Costs to Mine a Single Bitcoin in Your Country.”

Marketwatch. May 11, 2018

<https://www.marketwatch.com/story/heres-how-much-it-costs-to-mine-a-single-bitcoin-in-your-country-2018-03-06>

Irfan, Umair.

- “Bitcoin’s Price Spikes is Driving an Extraordinary Surge in Energy Use.” *Vox*. December 7, 2017.
<https://www.vox.com/energy-and-environment/2017/12/2/16724786/bitcoin-mining-energy-electricity>
- “Bitcoin’s Price Dropped but it’s Still Devouring an Obscene Amount of Energy. *Vox*. Feb 6, 2018.
<https://www.vox.com/energy-and-environment/2018/1/18/16901422/bitcoin-price-crash-energy-emissions>

“Kittehcoin.” *Github*. <https://github.com/kittehcoin/kittehcoin>

“Kittehcoin launched! Come get some MEOW now. U haz it! DOGE sad.” *Bitcointalk*.

December 24, 2013. <https://bitcointalk.org/index.php?topic=383068.0>

Klitzke, Evan. “Bitcoin Transaction Malleability.” July 20, 2017.

<https://eklitzke.org/bitcoin-transaction-malleability>

Koomey, Jonathan. “Blog.” <http://www.koomey.com/post/171808646518>

“Lynx Node Builder.” *Github*. <https://github.com/getlynx/LynxCI>

Madrigal, Alexis. “Bitcoin Mining Turns Money into Profit.” *The Atlantic*. May 12, 2018

<https://www.theatlantic.com/technology/archive/2018/03/bitcoin-mining-arbitrages-cheap-electricity-into-money/555416/>

Miles, Kathryn. “Bitcoin is eating Quebec.” *MIT Technology Review*. April 11, 2018.

<https://www.technologyreview.com/s/610786/bitcoin-is-eating-quebec/>



“Moore’s Law.” *Merriam Webster Dictionary*.

<https://www.merriam-webster.com/dictionary/Moore's%20law>

Palmer, Jackson. “My Joke Cryptocurrency Hit \$2 Billion and Something Is Very Wrong.”

Motherboard. Jan 11, 2018.

https://motherboard.vice.com/en_us/article/9kng57/dogecoin-my-joke-cryptocurrency-hit-2-billion-jackson-palmer-opinion

Nielsen, Jakob. “Nielsen’s Law.” *Nielsen Norman Group*. April 5, 1998.

<https://www.nngroup.com/articles/law-of-bandwidth/>

Oberhaus, Daniel “Cryptocurrency Miners Are Sabotaging Blockchains for Their Personal Gain.” *Motherboard*. May 25, 2018.

https://motherboard.vice.com/en_us/article/a3a38e/what-is-a-51-percent-attack-silicon-valley-bitcoin-gold-verge-monacoin-cryptocurrency

“Programming Merit Badge.” *Boy Scouts of America*. 2017.

<http://usscouts.org/mb/worksheets/Programming.pdf>

“Proof of Work.” *Bitcoin Wiki*. https://en.bitcoin.it/wiki/Proof_of_work

Pruvot, Tanguy. “CPUMiner-Multi.” GitHub. <https://github.com/tpruvot/cpuminer-multi>

Roberts, Paul. “This is What Happens When Bitcoin Miners Take Over Your Town.” *Politico*. March/April 2018.

https://www.politico.com/magazine/story/2018/03/09/bitcoin-mining-energy-prices-small-town-feature-217230?utm_source=digg&utm_medium=email

Rogers, Adam. “The Hard Math Behind Bitcoin’s Global Warming Problem.” *Wired*.

December 15, 2017. <https://www.wired.com/story/bitcoin-global-warming/>

Verma, Sid. “Bitcoin’s Exorbitant Energy Costs May Prove to Be Biggest Risk.” *Bloomberg*. November 9, 2017.

<https://www.bloomberg.com/news/articles/2017-11-09/bitcoin-s-exorbitant-energy-cost-s-may-prove-to-be-biggest-risk>



“What can an attacker with 51% of hash power do?” *Stack Exchange*.

<https://bitcoin.stackexchange.com/questions/658/what-can-an-attacker-with-51-of-hash-power-do>

“What is DigiShield & How it Works to Retarget Difficulty.” *Bitcoin Forum*. March 22, 2014.

<https://bitcointalk.org/index.php?topic=526721.0>

<http://www.koomey.com/post/171808646518>

<https://digiconomist.net>