# YggChain - White Paper

*A Price-Stable Cryptocurrency for Everyday Transaction.*

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## Abstract

"*One of the main problems with Bitcoin for ordinary users is that, while the network may be a great way of sending payments, (...) Bitcoin the currency is a very volatile means of storing value.*" -- Vitalik Buterin on The Search for a Stable Cryptocurrency.

Price volatility and scalability keep hindering all cryptocurrencies to be widely adapted, far from the level of everyday transaction. Stability of value is one of the 5 must-have properties of money, and the lack of a proper scaling solution are the reasons why transaction throughput is extremely limited and the fee is getting higher and higher everyday. Until these curses are lifted, cryptocurrency will forever stuck in the basement of blockchain technology. And lifting those curses, is no other than YggChain's purpose: to stabilize the currency price and to scale the network for everyone, everyday and every transactions.

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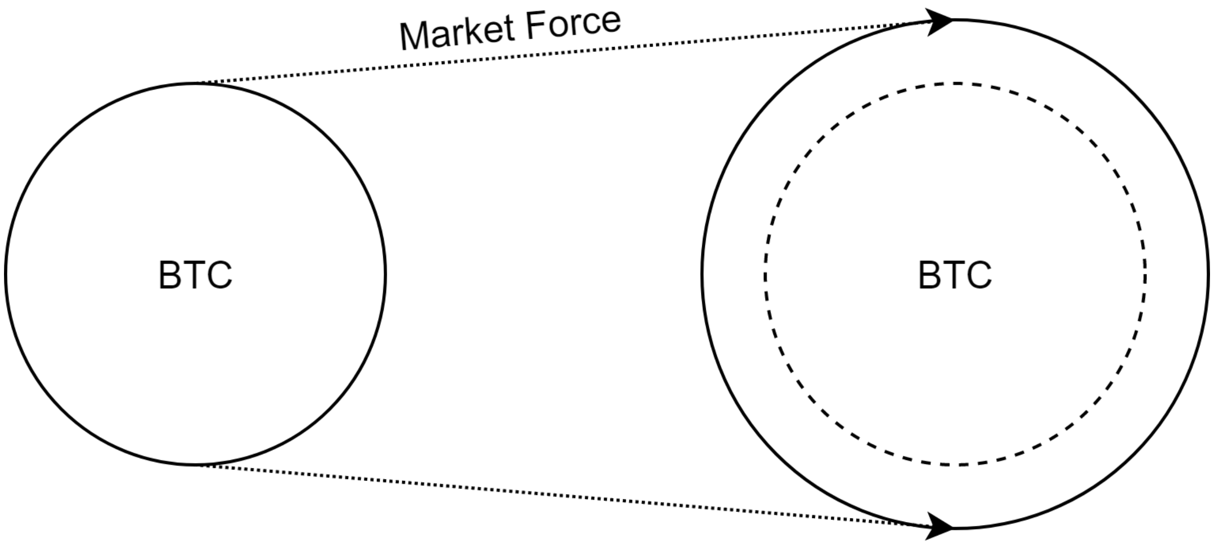
# Introduction

YDR is a price-stable cryptocurrency for everyday usage, from paying for a beer to billions dollar business transaction without worrying about losing its value every other seconds. Powered by YggChain - a public, permissionless blockchain with instant confirmation and Staking Service Network, where many kinds of decentralized service are built and served. Beneath all, Yggdrasil - an economic-driven sharding protocol scales the blockchain to any level of adaptation, remove all the network bottleneck for an unlimited transaction throughput, and the lowest transaction fee ever possible.

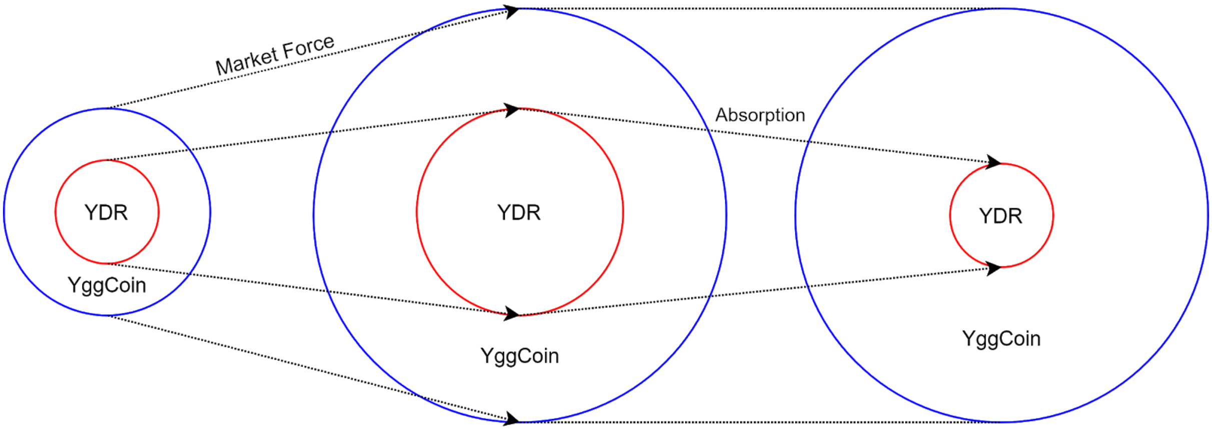
# Economic

How can the market price of a free-floating asset can be stabilized? Robert Sams' paper proposes a solution to use another asset to absorb all the price volatility of the stabilized token.

In a fixed or deterministic supply currencies (gold, stock, Bitcoin, etc.), token price is completely driven by the market force. When the market is demanding or declining, the market price of each currency unit is increasing or decreasing with the same rate.



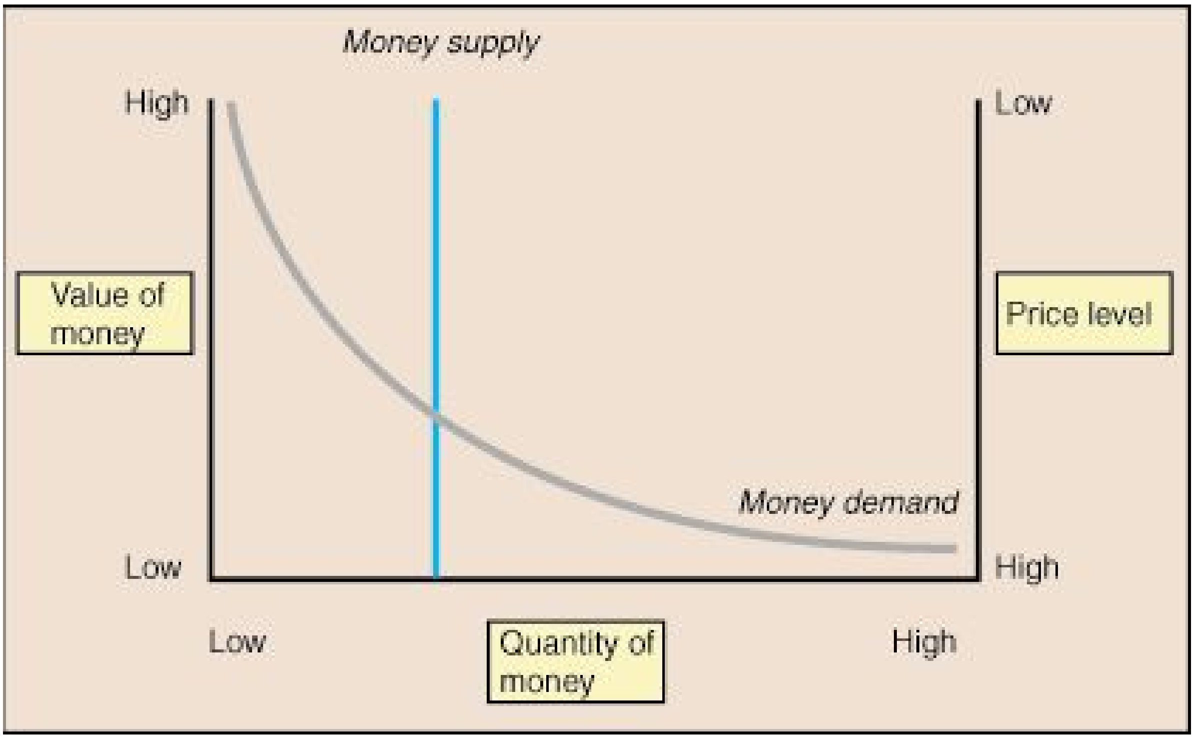
In YggChain - an elastic supply currency, there's a dedicated token (YggCoin) to absorb all the price volatility of the main price-stable token - YDR.



When the market is demanding, both YDR and YggCoin price will be increased, but the internal mechanism of YggChain will push the price of YggCoin even higher to lower YDR price back to the previous value, effectively stabilizes the YDR price around a desirable value. The same mechanism will work in revert when the market is declining.

## The Quantity Theory of Money

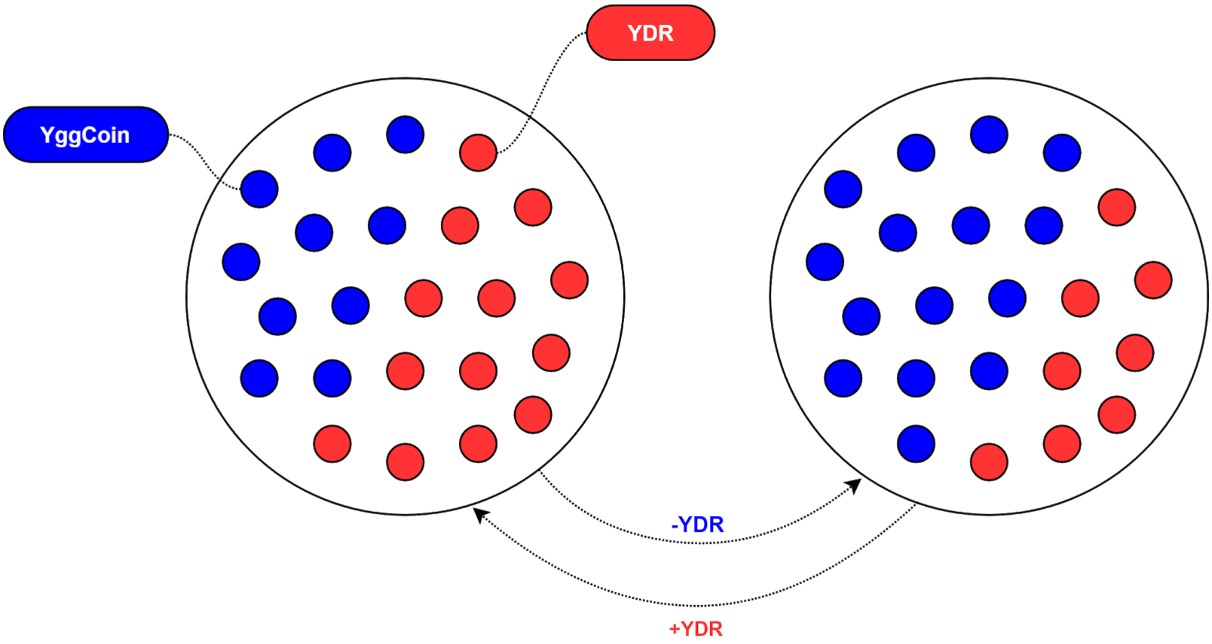
In monetary economics, the Quantity theory of money states that the general price level of goods and services is directly proportional to the amount of money in circulation, or money supply.



YggChain leverages this theory to stabilizing the price of its currency - YDR.

1. At time t(0), there is **N(YDR)** number of YDR, each worth 1.00 XDR.
2. By time t(1), each YDR has increased in value by 10% to be worth of 1.10 XDR.

3. Now, if somehow, we can increase the circulating supply of YDR by 10%, its price will be decreased to 1.00 XDR, since the market now has 10% more supply for the same demand. This process is called **10% expansion**.
4. At time t(2), each YDR has decreased in value by 5% to be worth 0.95 XDR.
5. If we can decrease the circulating supply of YDR by 5%, the price will be increased to 1.00 XDR, since the market now has 5% less supply for the same demand. This process is called **5% contraction**.



The supply of YDR is changed by converting them from and to another token, called YggCoin. YggCoin supply is also changing along with YDR supply in revert direction, effectively swings the price of YggCoin up and down to absorb YDR's price volatility.

## Stablecoin Protocol

### Two-tokens system

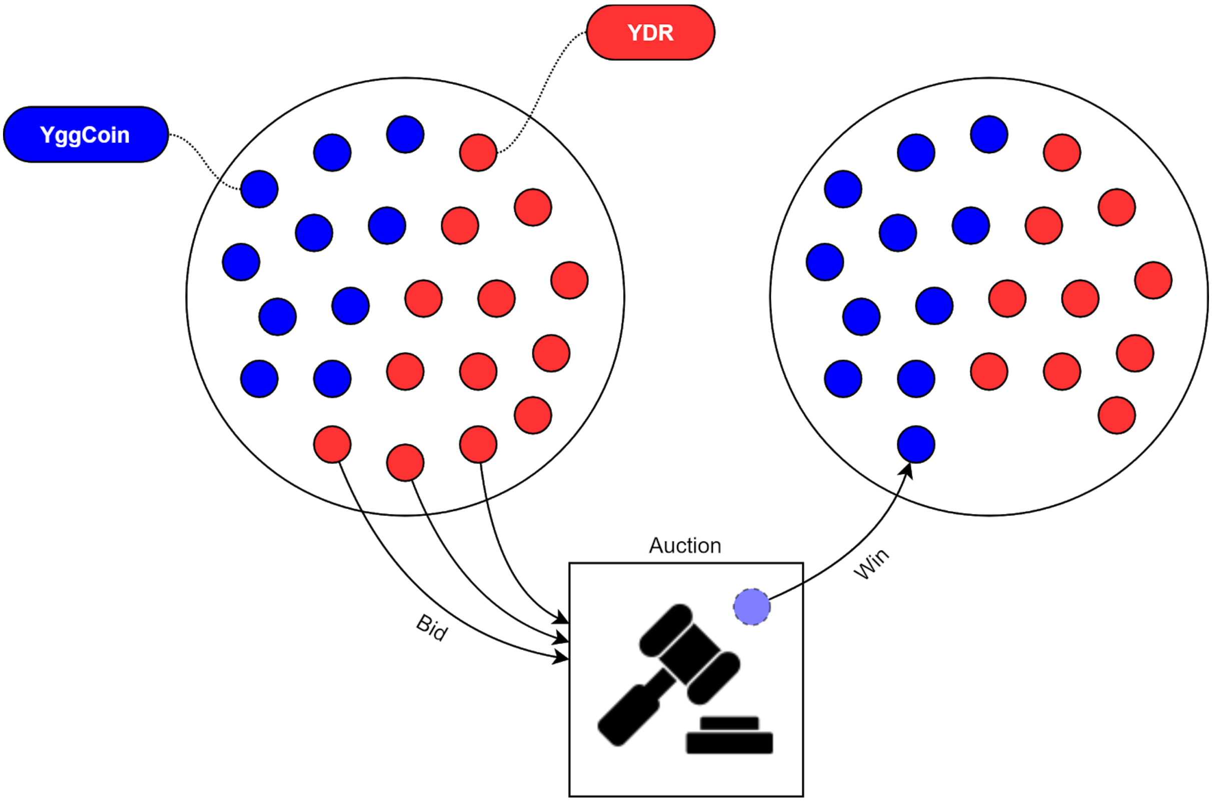
The YggChain Stablecoin Protocol consists of 2 types of token:

- YggCoin (YGC) - represents the value that is contributed to the network from outside (by capital investment, mining or providing service to the network). The holder of YggCoin take the role of stock/shares holder, which they bear the responsibility to maintain and stabilize the network; they are rewarded with transaction fee, exchange fee and all the capital value gain when the network grows. Obviously, like any other investment, their risk is losing capital value when the network shrinks.
- YDR (YggChain Drawing Right) - represents the service provided by the network. The holders of YDR take the role of customer, for currency service YggChain provides. Their benefit will be protected by the protocol with the highest priority.

To keep the price of YDR stable, the following process is continuously repeated:

1. YDR price is fed from the outside, or calculated using internal values of the network. (See Exchange Rate Feed)
2. If the YDR price is **c%** higher than **1.00 XRD**, an **c% contraction** is taken place in the next phase.
3. If the YDR price is **x%** lower than **1.00 XRD**, an **x% expansion** is taken place in the next phase.

The conversion between YggCoin and YDR is the main mechanism for YggChain stablecoin economic.



## Expansion

In the event of **x% expansion**, when there is total **N(YDR)** of YDR in circulation, a total of **X = N(YDR) * x%** is created (out of thin air) and sold in an off-chain public auction (see YggAuction) for YggCoin. The price of YDR/YggCoin is completely market driven, which is usually a little less than the current market price, effectively drive the market price of YggCoin higher. The YggCoin used to buy auctioned YDR, will be destroyed, taken out of circulation.

The auction ends with new transactions included in the chain. The result are:

- The total supply of YDR is increased by **x%**, thus decrease its price by **x%** to exactly **1.00 XDR**. Newly created YDR is given to the highest bidders of the auction.
- The total supply of YggCoin is decreased, thus increase its price, benefits all current YggCoin holders. The highest bidders will be the most benefit, because not only they

have their remains YggCoin price increased, they also sold their YggCoin for a higher price than the market through the auction of the newly created YDR.

How much percent of YggCoin will be sold? [TODO: insert math proof here]

$$\boxed{\%N_{YggCoin} = \%N_{YDR} \times MC_{YDR} \,/\, MC_{YggCoin}}$$

### Contraction

Contraction process is exactly the opposite of Expansion.

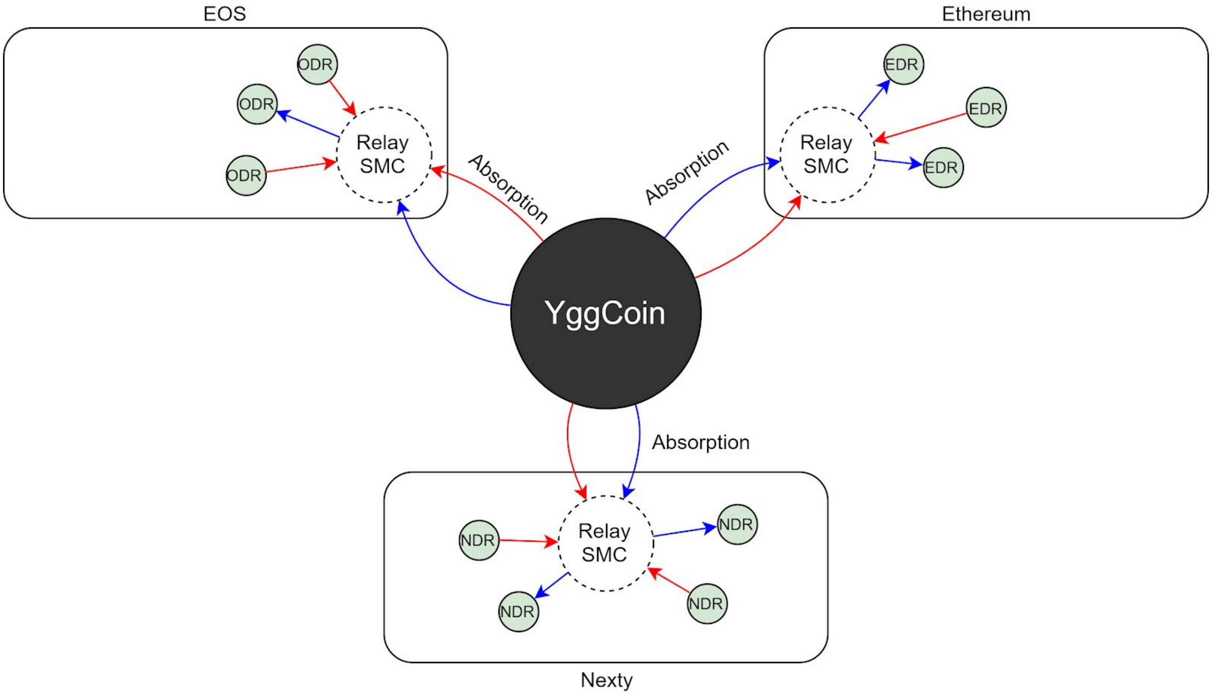
In the event of **c% contraction**, when there is total **N(YDR)** of YDR in circulation, a total of **C = N(YDR) * c%** is needed to be taken out of the circulation. New YggCoin is created (out of thin air) and sold in IggAuction, enough to cover all total **C** number of YDR. The price of YggCoin is obviously market driven, which is usually a little less than the current market price, effectively drive the market price of YggCoin a little lower. The YDR used to buy auctioned YggCoin, will be destroyed, taken out of circulation.

The auction ends with new transactions included in the chain. The result are:

- The total supply of YDR is decreased by **c%**, thus increase its price by **c%** to exactly **1.00 XDR**. Newly created YggCoin is given to the highest bidders of the auction.
- The total supply of YggCoin is increased, thus decrease its price, hurting all current YggCoin holders. The highest bidders lose the least, because despite they have their remains YggCoin price decreased, they can buy some new YggCoin with a lower price than the market through the auction.

## Cross-Chain ERC20 Token Absorption

[TODO]


EOS
Ethereum
ODR
ODR
ODR
Relay SMC
Absorption
Absorption
EDR
EDR
EDR
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YggCoin
Absorption
Relay SMC
NDR
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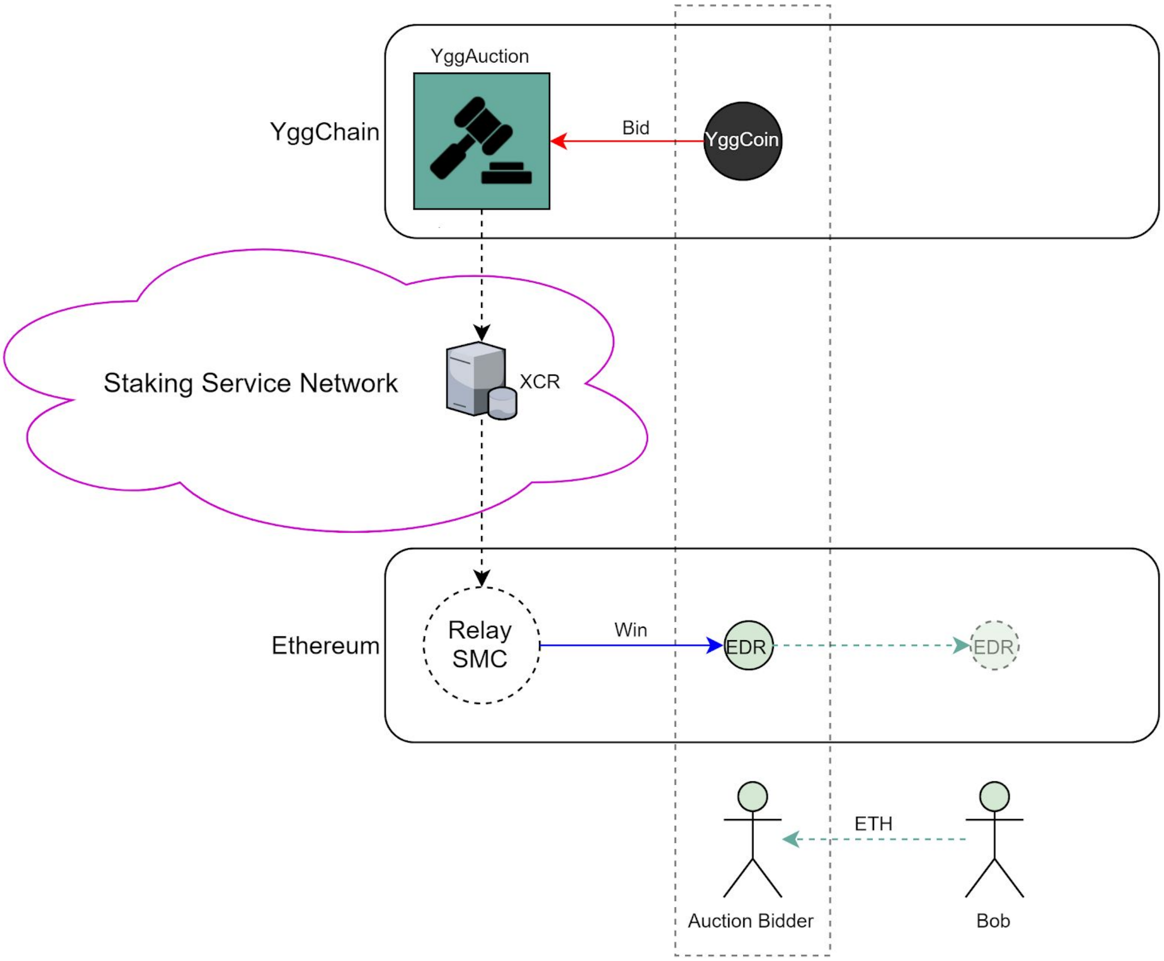
Nexty

[TODO]


YggAuction
YggChain
Bid
YggCoin
Staking Service Network
XCR
Ethereum
Relay SMC
Win
EDR
EDR
ETH
Auction Bidder
Bob

## Unit of Currency

YDR will always be pegged to the most stable currency of human (and aliens that we known of), which currently is XDR, a basket of fiat money.

In the future, YDR might eventually be no longer pegged to fiat money basket, but something else, be it a market basket (CPI) or anything considered having the most stable purchasing power by humanity (and alienity).

In the event of YDR unit change, the price of YDR will not be affected, only the unit reference is changed.

E.g.

| | |
|---|---|
| Before | YDR = XDR |
| Unit change event | Pegged unit will be changed from XDR to EUR.<br>Exchange rate at the event: 1 XDR = 1.18151 EUR. |
| After | YDR = 1.18151 EUR.<br>The protocol will now stabilize the YDR price to 1.18151 EUR instead of 1 XDR, until the next unit change event in the future. |

Because the YggChain itself does not have to know about its reference unit and exchange ratio, the system is not affected. The only affected parts are price feeding oracle services, where they feed the data to the system using the percentage of YDR itself, not of the reference unit.

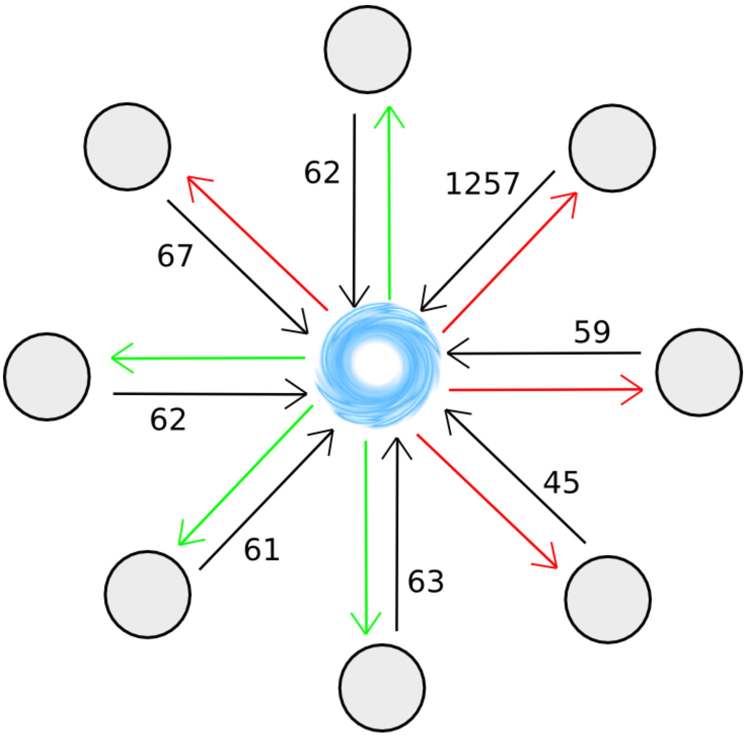
E.g.

After the YDR switch to EUR with the exchange rate of 1.18151, at 1 point of time, where YDR price is dropped to 1.1696949 EUR, oracles will feed the value of 0.99 (1.1696949/1.18151) to the system, represent the 1% price drop, and trigger an **1% contraction** event.

## Exchange Rate Feed

For a blockchain to have knowledge of the exchange rate of its own crypto tokens, there are two solutions: exogenous (the price is fed from outside of the network) and endogenous (the price is measured using internal variables inside the network).

YggChain initially uses an exogenous method, which have the price fed from all oracles using SchellingCoin data feed scheme.



SchellingCoin: A Minimal-Trust Universal Data Feed

This introduces a certain degree of centralization, (in which the source for price is fed from multiple centralized exchange services), but currently is inevitable due to the lack of a complete endogenous method.

An endogenous solution is being researched and developed by YggChain team, since it requires more data collected by the the network itself in the public performance. YggChain price evaluation will eventually switch to its endogenous method, once the research is completed and fully tested.

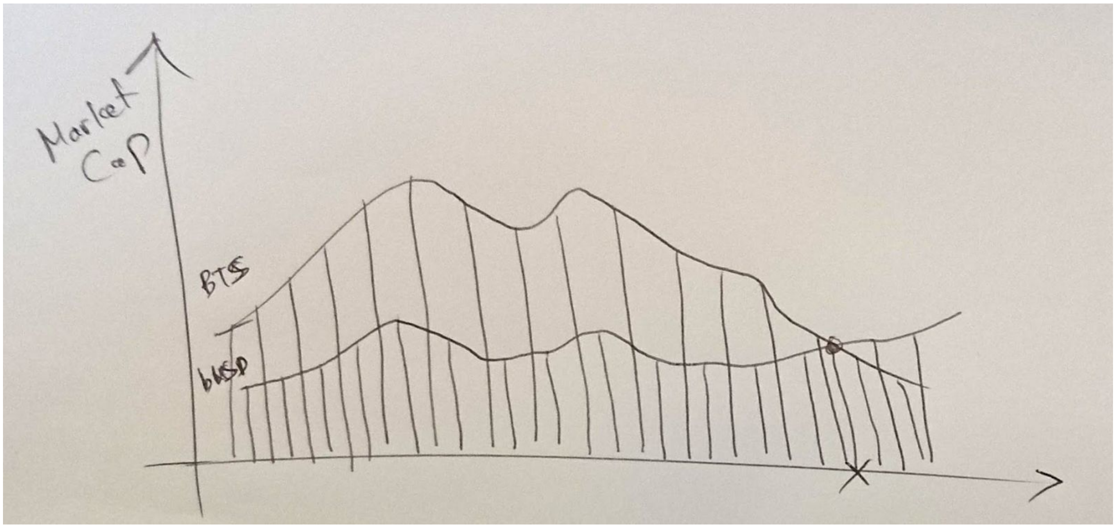
## Black Swan Event

What happen when when the coin price drop too low? This is the most frequently asked question for every collateral stablecoin projects, and such event does happen to them every once in a while. YggChain is not a collateral stablecoin, but an elastic supply stablecoin. That doesn’t mean it is immune to all black swan events, it means that the chance are extremely unlikely, and how the system handle it is much more elegant.

Collateral stablecoin, is essentially a collateral loans system, where you lock your asset (BTS, ETH) up into a contract, to borrow money (BitUSD, DAI) from people who need a stable-price asset. The problem is that, the borrowers always have 2 choices:

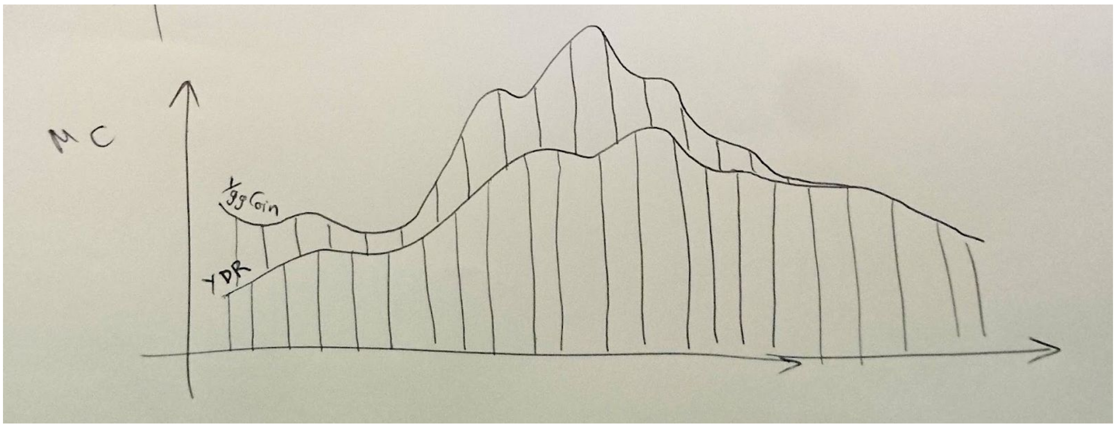
- to repay the debt (BitUSD, DAI) and get their locked up asset (BTS, ETH) back, or
- to abandon their collateral asset, and run away with their debt.

To repay or not to repay? That is the question any rational borrowers can easily answer, it depends on “*Which is worth more?*” or to be precise, “*Which will be worth more?*”



This is a mock up chart of BTS and BitUSD (unstacked). The system is healthy when the market cap of collateralized BTS is much higher than the market cap of borrowed BitUSD. BitShare requires borrowers to over-collateralize their BTS with at least 200% value of borrowed BitUSD, (MakerDAO requires 150%.) The system will break when the BTS price (along with its market cap) is dropped by 50%, (and ETH by 34%.) That the point where their locked up asset is no longer worth more than the debt they owe.

In YggChain, there is no loan nor debt, no borrower nor lender; nobody owes anyone anything. No one has such easy choice to abandon an asset for the other. YggCoin is used to absorb the price volatility of YDR, not collateralized it.



This is a mock up chart of YggCoin and YDR market cap (stacked). All the circulating YggCoin is used to stabilize YDR price, and as long as the YggCoin market cap is not zero, the YDR price can be stabilized.

To recap, BitShare stablecoin will be unstable when the price of BitShare is quickly dropped by 50%, same with MakerDAO when ETH price dropped by 34%. While YDR price is unstablizable only when YggCoin lost all of its value, a.k.a. 100% price drop.

No financial system, traditional or digital, can assume that it is unaffected by or immune to Black Swan Events, but some system is more robust against them than others. The Quantity Theory of Money is well researched by economists and the elastic supply mechanism is what all fiat money now are made of. Thus, we believe YggChain's stablecoin will be the last one to fall, if any critical crisis ever happens to the blockchain ecosystem, or specifically stablecoins.

# Consensus

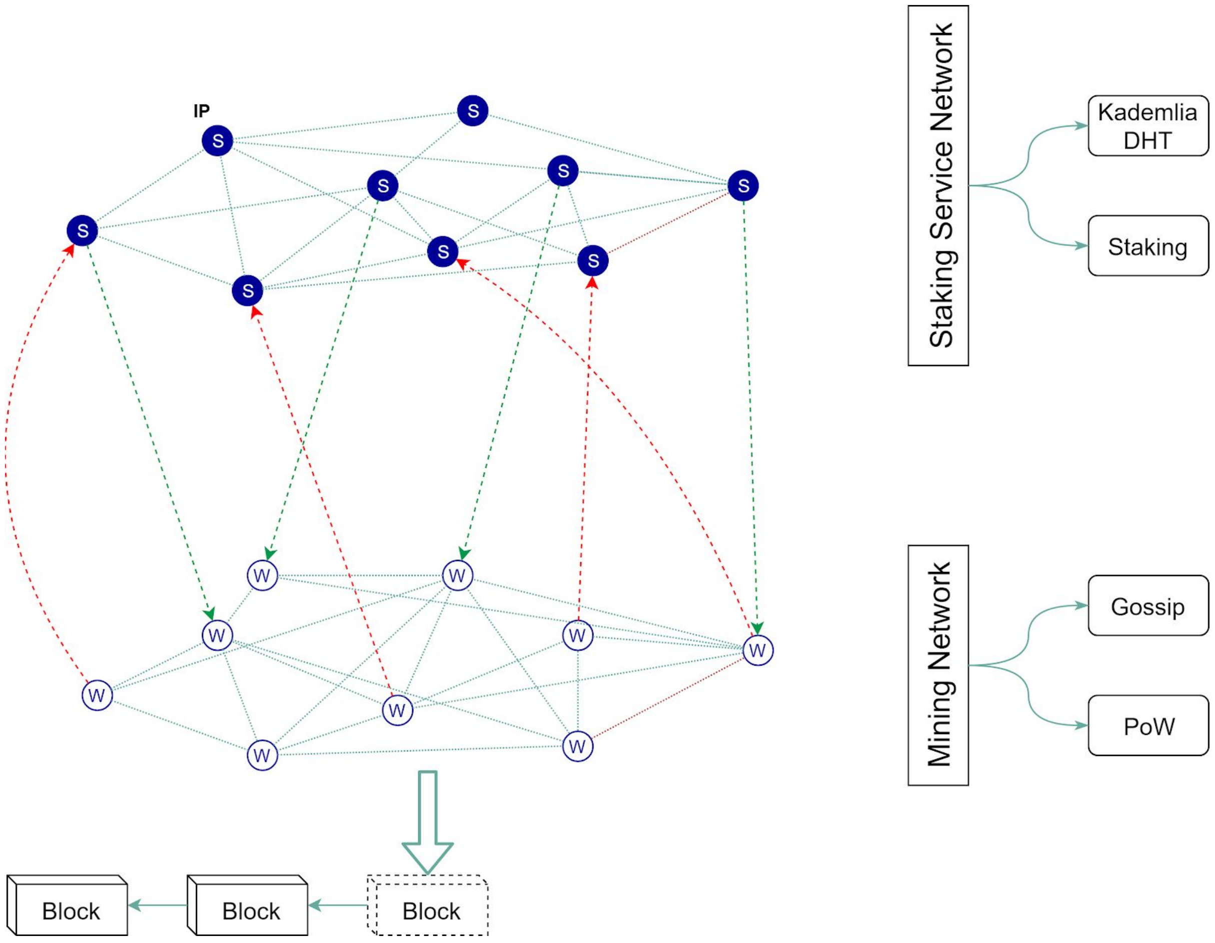
There are a lot of consensus algorithms is being developed in the blockchain world, only one is well tested by time until now - the Proof of Work. YggChain's consensus at it core, is PoW, and to provide more desirable features, a Staking Service Network is implemented as the second layer, and some of the service drastically improves the consensus properties. Most notable type of Staking Service is Validator, along with PoW, introducing the Lock & Block protocol - the main consensus of YggChain.

## Staking Service Network

Staking Service Network (SSN) is a second layer network built on top of the Proof of Work layer of a public blockchain, to provide many services that is not possible or inefficient to be implemented in the consensus layer. Those services include (but are not limited to):

- Interactive Services:
    - Input Locking
    - Coin Mixing
- Oracle Service
- Cross-chain Relay Service
- Price Matching Services:
    - Market Order
    - Auction

Full technical paper of the SSN is located at yggchain.github.io/ssn.pdf, this section only discusses about how the SSN is implemented for YggChain.



Staking Service Network (SSN) is an essential part of YggChain, which anyone holding YggCoin can join and serve the network for 40% of block reward. YggChain currently has the following types of Staking Service:

- Input Locking Service: lock the transaction input to provide consistency and instant confirmation for the network.
- Oracle: feed data from outside of the network.
- Market: process the market order, including the YggAuction.
- Cross-chain Relay: relay states from and carry actions to other ledgers.

### Staking Reward

The block reward is distributed as below:

- 50% for Proof of Work miners,
- 40% for SSN nodes selected for the locks,
- 10% for development subsidy,

All staking coin is bunt at a constant rate, from Start Staking Signal to Stop Staking Signal, whether the node is selected to serve or not. The initial burning rate is 0.01% per block, and this value is subject to change in the development process. This burning rate is compensated by additional reward for the SSN nodes that serving the block.

Each SSN nodes selected and have their service signature in the block will be rewarded from the staking reward and burning stake, pro-rata. The reward is not distributed on new block mined, but on withdrawing request. Each staking node balance is calculated locally on every full nodes, and only put on-chain when a staking node submits a Staking Reward Withdraw Transaction.

$$r_i = \frac{n_i}{n} \times (R \times 40\% + S \times 0.01\%)$$

$r_i$ = staking reward for node i
$n_i$ = number of node i's signatures in the block
n = total number of all node signatures in the block
R = total block reward (for both PoW and PoS and development subsidy)
S = total stake of running staking service network

As with coinbase transaction for mining rewards, staking reward can only be spent after 146 blocks from the last staking signature. Staking YggCoin is also locked for 146 blocks after the last served block. This provides a time window for any double-spend victim to submit the conflicting signatures so the cheating SSN nodes can be punished. To unlock the staking YggCoin, SSN nodes would need to stop serving for a whole day (146 blocks), before the coin can be spent.

## Staking Transactions and Signals

The success rate of Input Locking process is directly proportional with the availability of Staking Validators Nodes. To increase this rate along with the availability of the service, one of the most effective strategy is to punish the offline Validator nodes by burning their stake. This is done by burning all staking YggCoin, and compensate the active nodes by increasing the reward (see Staking Reward).

Staking transactions and signals are also designed to be very compact and efficient, so SSN nodes can actively staking in and out of the system as their nodes go on and off.

### Staking Transaction (STx)

To start collateralizing YggCoin for SSN, node sends an STx to lock their coin into a special UTXO. This UTXO cannot be spent before 146 blocks from the last block it serves. STx is only submitted once for a while, and takes regular transaction fee.

There is no need for an reverse transaction to unlock the stake, owner of the staked UTXO can spend it after 146 blocks from the last block it serves. The output UTXO will have the value different than the original one, because of the burning and rewarding stake accumulated while the node is serving.

$$s' = s - s \times 0.01\% \times N_{active\ block} + \sum_{b}^{N_{serving\ block}} r_b$$

s' = output stake
s = original input stake
$N_{\text{active block}}$ = number of blocks that the SSN was active
$N_{\text{serving block}}$ = number of blocks that the SSN has served
$r_b$ = staking reward in block b

Active blocks are all the blocks between a Start and Stop Staking Signal, inclusively.

Serving blocks are all the blocks that contain at least one serving signature of the SSN node. Those blocks set obviously are a subset of the active blocks set.

#### Start and Stop Staking Signals

Start Staking Signal and Stop Staking Signal are two special transactions to signal the network that a SSN node is go on and off. These two signals only take up to 2 bytes each in the block. Additionally, all signals in the block takes a single aggregated BLS signature.

### Transaction Overriding

As mentioned in the Staking Service Network technical paper, YggChain uses on-chain transaction overriding mechanism, allowing transactions have different finality on the chain.

The following list provides different transaction types of YggChain and their finality:

- Locked Transaction (LTx): highest finality, instant confirmation, pledged by it's ILS nodes. Cannot be double-spent without ILS nodes being punished, the stake of cheating nodes will be used to pay the victims, up to full transaction value.
- Unlockable Transaction (ULTx): transaction with input so large, no ILS node in the network can lock it. Medium finality, same level with Bitcoin transaction, no different.
- Open Transaction (OTx): low finality, requires at least 2 confirmations before its output can be spent. OTx can be overridden by a conflicting LTx before its 3th confirmation, effectively nullify it.
- Cross-chain and cross-shard Transaction (XTx): very low finality, can be overridden when the counterparty chain/shard get reverted. XTx has to wait for several confirmations before its output can be spent.

## Centralization-Resistant Proof of Work

For maximum decentralization, YggChain use Programmatic Proof-of-Work, an improvement of Ethash to be even more resistant to ASIC devices.

# Scalability

In order to be the currency of everyday transaction, YggChain should scale to any level of adaptation. Scalability is the biggest issue with Bitcoin, Ethereum and all other blockchains. A lot of research and development is ongoing with this issue, most notable projects including:

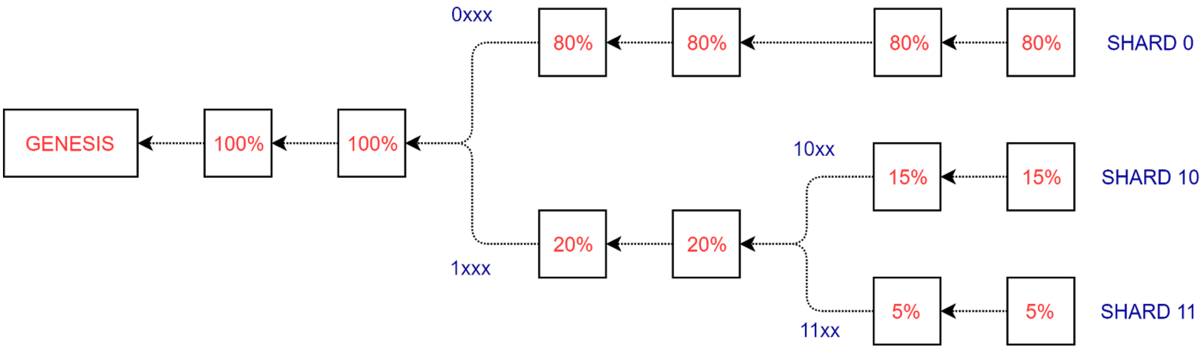
- State Sharding for Ethereum's PoS Consensus by Vitalik.
- Load Balancing of Zilliqa. (They call it 'Transaction Sharding', but it conflicts with the original meaning of database sharding.)

They are all advanced and promising, with their own challenges. YggChain comes with its own Sharding mechanism: Yggdrasil - an economic driven blockchain sharding protocol.

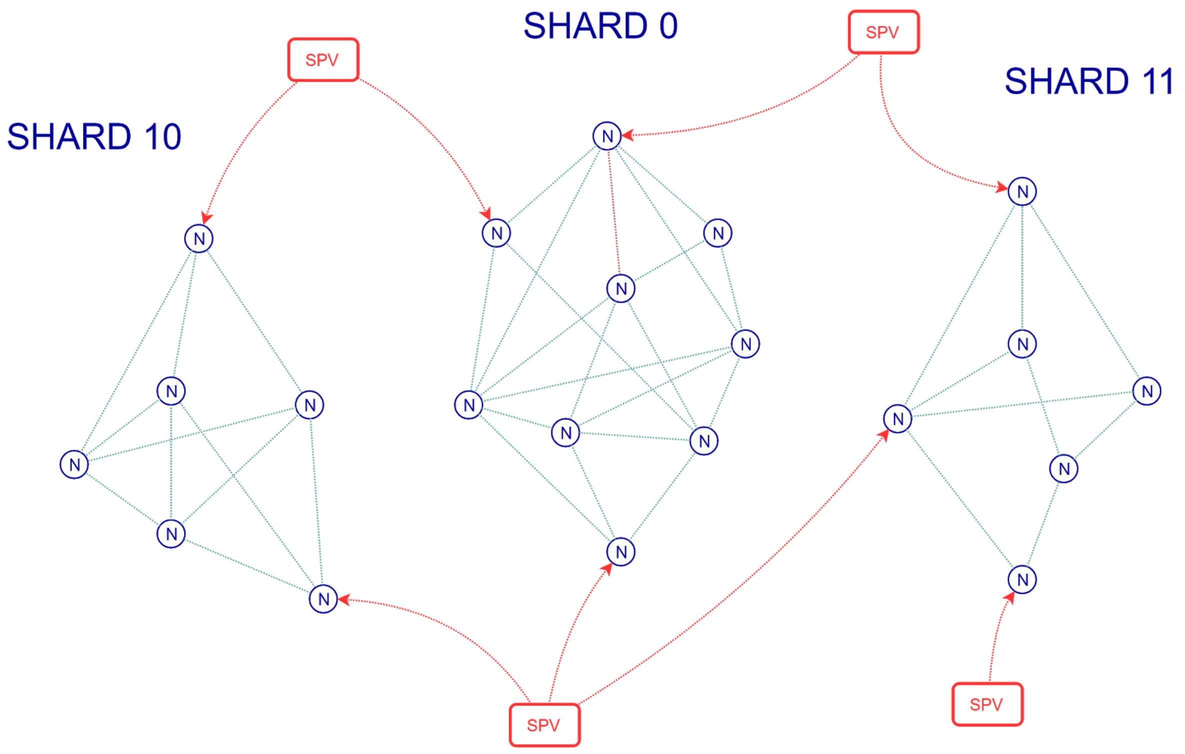
## Horizontal Scale: Yggdrasil Sharding Protocol

Yggdrasil shards the YggChain by splitting it into 2 side-chains called high shard and low shard with the following properties:

- Transaction throughputs should be equal between two shards.
- All the transactions with higher value reside in the high shard, the rest stays in the low shard.
- Tokens can be transferred between shards, with normal transaction fee. This will keep the token price the same in all shards.
- Full-client only works on 1 shard at a time. But SPVs and wallets connect to full-clients of as many shards as necessary.
- The block mining reward, difficulty and Service Node requirements will be split proportional with total value of each shard's transaction set. The total block reward of all shards is always 1.00 YggCoin.



The chain will eventually grow into a tree, where each branch (or shard) independently works on a subset of UTXO from its transactions. Each address can have UTXOs in many shards. This removes the responsibility of managing shards off the network, to the user and client softwares which have the best incentive to secure their own money. See Security for wallet shard management.



## Sharding Strategy

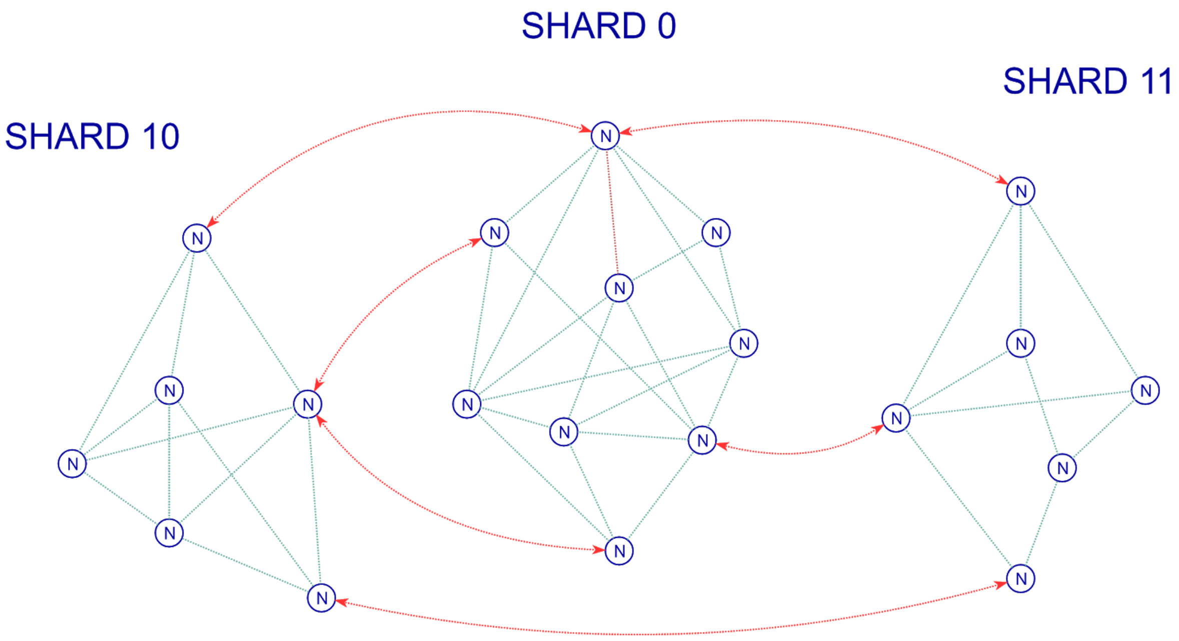
To protect the benefit of both user, Service Nodes and Miners, a shard is split only when a specific threshold of block saturation is reached. Splitting too frequent will create too many unsaturated shards, with transaction fee too low to properly incentive the Service Nodes network. Splitting too infrequent will result in oversaturated shards with transaction fee too high and drive the user always.

A shard is fully saturated when all the blocks in an epoch (1 whole calendar week) reach maximum block size. Only transactions with non-zero fee count. A shard will be split when it reaches 90% saturation. (This threshold is subject to change in the development process.)

## Cross-shard Communication

Once split, (even though it's technically possible,) shards (or branches) will never be merged. Most of everyday transactions does not require communication between shards, but occasionally some does. Cross-shard communication is performed by one full-client opening a connection to another full-client of a different shard. This connection will provide the state of transactions from other shard, so full-client can perform the following cross-shard operations:

- Cross-shard transfer.
- Cross-shard 2-ways transactions, or swap.



In a non-finality consensus, all states of confirmation can be reverted. YggChain's Lock & Block consensus is PoS/PoW hybrid, which is non-finality, a locked or blocked transactions can always be reverted when the longest chain has a conflict detected. When a cross-shard operation conflict is detected, transactions from higher order shard takes priority, and the conflicted transactions from lower order shard will be reverted, no matter how long the reverted chain is.

In a pure PoW system, reverting a long chain might sounds really bad, but with the Lock & Block protocol, only the double-spent transactions would be affected on the event of chain reversal. Non-conflicted transactions in a reverted block will return to locked state, and will eventually be included in one of the next blocks.

## Security

The security of Yggdrasil sharding protocol rely on its economic-driven property. After a shard split, transaction throughput should be equal between the 2 new shards. Let's say, the high shard has 80% of original shard's YDR value, and the low shard got 20%. The new high shard will have the following properties:

- 80% of YDR value.
- 80% of YggCoin value.
- 80% of mining reward.
- 80% of mining difficulty.
- 80% of Service Node requirements.

The low shard obviously has everything at 20%. This will naturally split the mining power and Service Node network at exactly the same percentage (80/20), because anything else is economically inefficient for all participants. [TODO: insert math proof here]

This resource split mechanism makes sure that high value transactions are protected by more mining power and stakes. (Transactions worth of 80,000 XDR should be 4 times more secure than 20,000 XDR transactions.) This efficiently protects the network from 51% attack and shard-hopping attack, which are major challenges of sharding in public blockchain.

In pure-technical sharding schemes, transactions are usually split randomly, while mining power and minting stake is split evenly between shards. This allows high value transactions can occur in all shards, while the security level of each shard is divided. Yggdrasil keeps all the high value transactions in one shard, with higher security, while letting all low value transactions in the other shard, with less security. Any adversary attempts to attack on either shards, should face the same cost versus benefit problem. It's easier to attack the lower shard, but also less worthy.

The protocol itself does not force the transaction value limit on each shard. Users can still receive transactions with high value on low shard (for lower fee or for bad intention). But doing so, they risk their own money getting double-spent or reverted. It is user's responsibility to only accept high value payment in high order shard, and reject ones in low order shard. Every wallet applications should perform this check, and alert its user when there's such a suspicious incoming transaction.

#### Centralization-Proofness

Sharding (along with ASICS-resistant algorithm) also prevents the centralization of control over the network. By splitting the mining reward and Service Node requirements, more participants can join the network to provide their service. Miner with less powerful rig can mine in lower shard, for smaller, but steadier price. The same with Service Node requirements, owning even a small amount of YggCoin can still allow one to run a Service Node in low order shard.

### Vertical Scale: Block Pruning

## Compare To Other Projects

### Economic

#### Non-Stable Coins

Along with other stablecoins, YggChain solves the volatility of the cryptocurrency price, to attract usage from regular everyday users. While non-stable coins still serve their own purpose, whether as an investment asset or distributed computing fee, they have been proved that not suitable for everyday exchange transactions.

##### Cryptocurrencies

Bitcoin and other altcoins are excellent as investment assets, like gold or stock. But with the volatility of their price, they can never be able to replace fiat money, which is what stablecoins like YggChain trying to be.

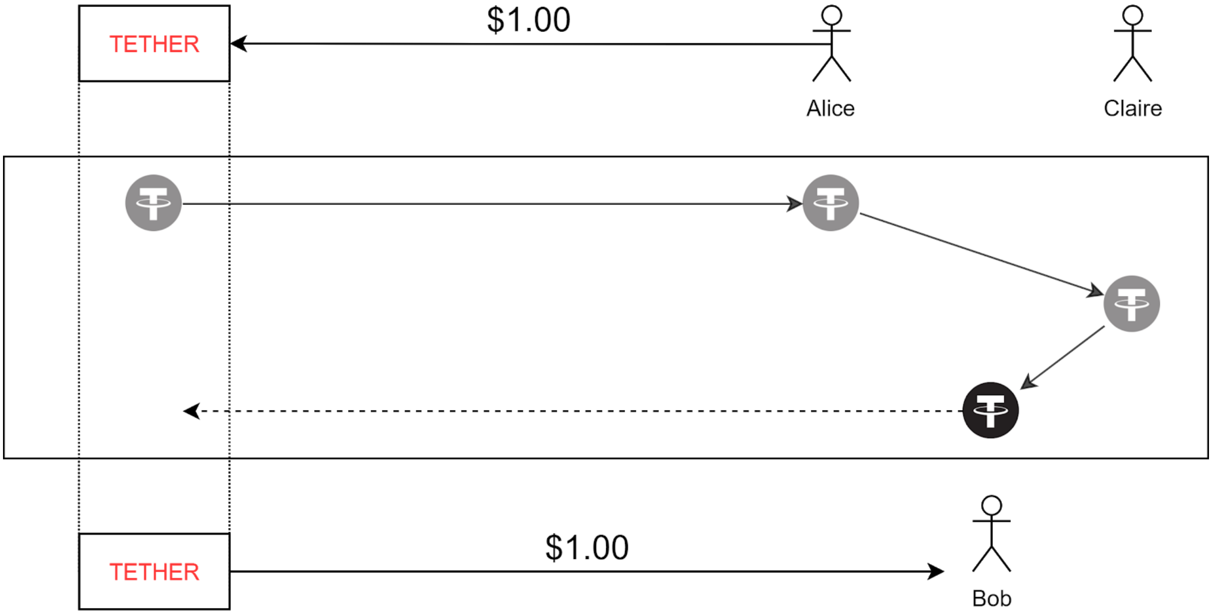
### Distributed Computing Platforms

Ethereum and other smart contract platforms run distributed applications, often for a fee. This fee serves as a mean to prevent DOS attack and an incentive for nodes to run the platform. The service these platform provides are not cryptocurrency, but computing power, so the volatility of the fee is not much of a problem.

## Stable Coins

### Centralized IOU Issuance

Tether and Digix issue IOUs, promise to hold assets in a bank account or vault and issues tokens that represent a claim on the underlying assets. The digital token has value because it represents a claim on another asset with some defined value.

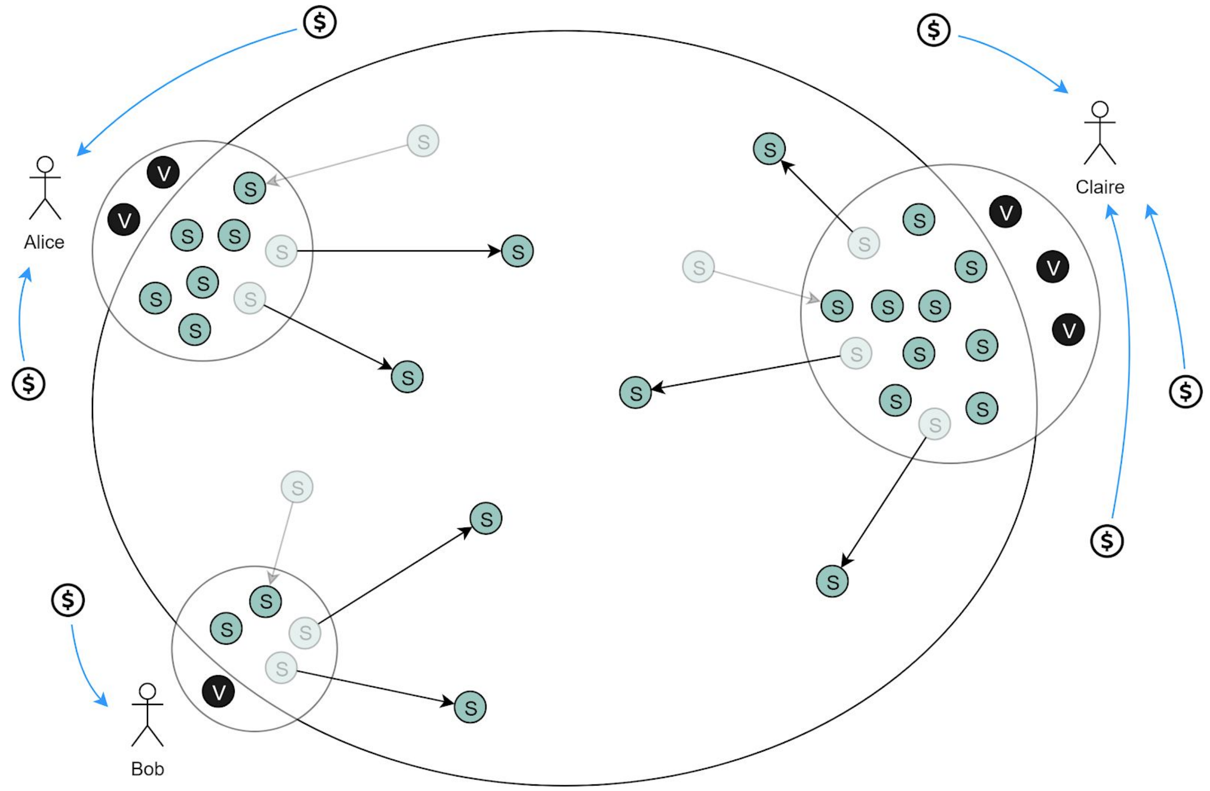


There are 2 main problems of this model:

- It is centralized and it requires trust in the issuing party - that they actually own the assets being represented and that they are willing to honor the IOUs. This model imposes serious counterparty risk on holders of the token. Tether is the canonical example given the serious concerns that the public has about their solvency and legitimacy.
- It is backed by non-crypto currencies, hence depends on those currencies, which make it never be able to replace them. In fact, their purpose is never to replace fiat money, nor provide an everyday-use currency. Their best use is to (short-termly) replace fiat money with crypto asset for convenient crypto trading.

### Decentralized Collateral Backed

Bitshares, MakerDAO and the likes try to solve the centralized problem of Tether by decentralize the collateral holder agents. This approach allows users to create stablecoins by locking up collateral in excess of the amount of stablecoins created, either by its own on-chain crypto token (called shares) or by other existing token on sidechains.



The first major problem, of course, is that the collateral backing the stablecoin is often a volatile crypto-asset such as  BTS or ETH. If the value of this asset drops too quickly, the stablecoins issued could become undercollateralized, then the best strategy for the issuer is to abandon the locked crypto-asset, and keep the money previously exchanged for issued stablecoins for their own benefit. By doing so, the whole stablecoins system would be flushed down to a spiral of death. For this reason, most of the projects using this model require that the stablecoins be overcollateralized enough to protect against sharp price movements. While this can provide some degree of certainty, there always exists the possibility of a black swan event that causes collateral prices to drop so quick that the stablecoins are undercollateralized.

The second one, is its economy (or rather monetary) efficiency. For each value of stablecoins in circulation, requires at least double of that value in collateral asset need to be locked up. Often, it’s much more than double to be overcollateralized enough to protect against sharp price movements, and anything less than double, is playing margin again the stablecoins holders. This provides a banking service, where the bank need to keep gold in reserve with double the value the money in circulation. In reality, most countries worldwide adopts fractional-reserve banking, in which only a fraction of bank deposits are backed by actual cash-on-hand and are available for withdrawal. This allow central bank to expand credit and money supply beyond the amount of the underlying reserves of base money originally created by it. The fraction is about 1% to 30% depend on the country regulation; the more stable the economic is, the smaller fraction it is required. Overcollateralization might sounds attractive for short-term loaner and borrower (just like with Tether), but in the long term, this is a huge limitation, which prevent this model to replace the current fiat money.

## Seigniorage Shares

Stablecoins based on Seigniorage Shares paper follow another principle, the core idea is to using another token (called *vol-coin* by Vitalik and *share* by most projects) to absorb the volatility of the stablecoin, but each project comes with different approaches. This section will discuss how each of them is different from YggChain.

### Basis (former Basecoin)

How YggChain is different than Basis (more detail analytic below):

- Diverted from Seigniorage Shares paper, Basis adds the 3rd token (Bond) to absorb all the risky volatility for Basis, while keeping the Share token safe and even more rewarded. Basis bond have expiration date making it is the most risky investment, thus defeat the contraction purpose of the token. Basis bond is even set a price limit, which goes against the free market rule, it likes forbid everyone to trade BTC with the price lower than a specific value, like $5k! YggChain otherwise, sticks close to the Seigniorage Shares paper with 2 tokens dynamic, using the YggCoin token alone to absorb all price volatility (both risk and reward) of YDR.
- In expansion process, Basis (along with Fragments and Carbon) distributes new stablecoins to each of token holders, pro-rata. This has 3 main problems:
    - Sleeper Supply: the new coins supply is distributed to all shareholders, whether they want them or not. [TODO: insert data statistic here] Most of the holders keep their shares for long or short term investment, they usually not active when the expansion occur; new coins distributed to them stays inactive in their wallet for sometimes, effectively not in circulation yet. Those new coins then fail their immediate purpose, to provide supply for the market, but instead stays inactive for indefinite time, and then become active later, tipping the balance to the other side of the market force. While the sleeper coins are still sleeping, coin demand are still present, new expansion will happen, causing more sleeper coins. This unwanted effect prevents the market to quickly stabilize the price, and creating more volatility of its own, even black swan event from its own mechanism.
    - Fragmented and dust: beside the top holders, small shareholders will get very small portions of the token, which is unusable due to the network fee.
    - Technical inefficiency: all shareholders will have 1 transaction when the expansion occur, which is half of the time. This will put an ernomost strain to the network, with transactions not directly serving the end users.

YggCoin, otherwise using off-chain auction protocol (named YggAuction) to sell the newly created YDR (stablecoin) for YggCoin. This has the following advantages over pro-rata distribution:

  - Active Expansion Supply: newly created YDR is given to the active shareholders, who participated and won the auction. New active token is essential to provide supply to the current stablecoins demanding network.
  - No fragment, no dust.
  - Technical Efficiency: YggAuction is a fast, fair and cheat-proof off-chain auction protocol, will be the main way for YggChain's YDR contraction and expansion.

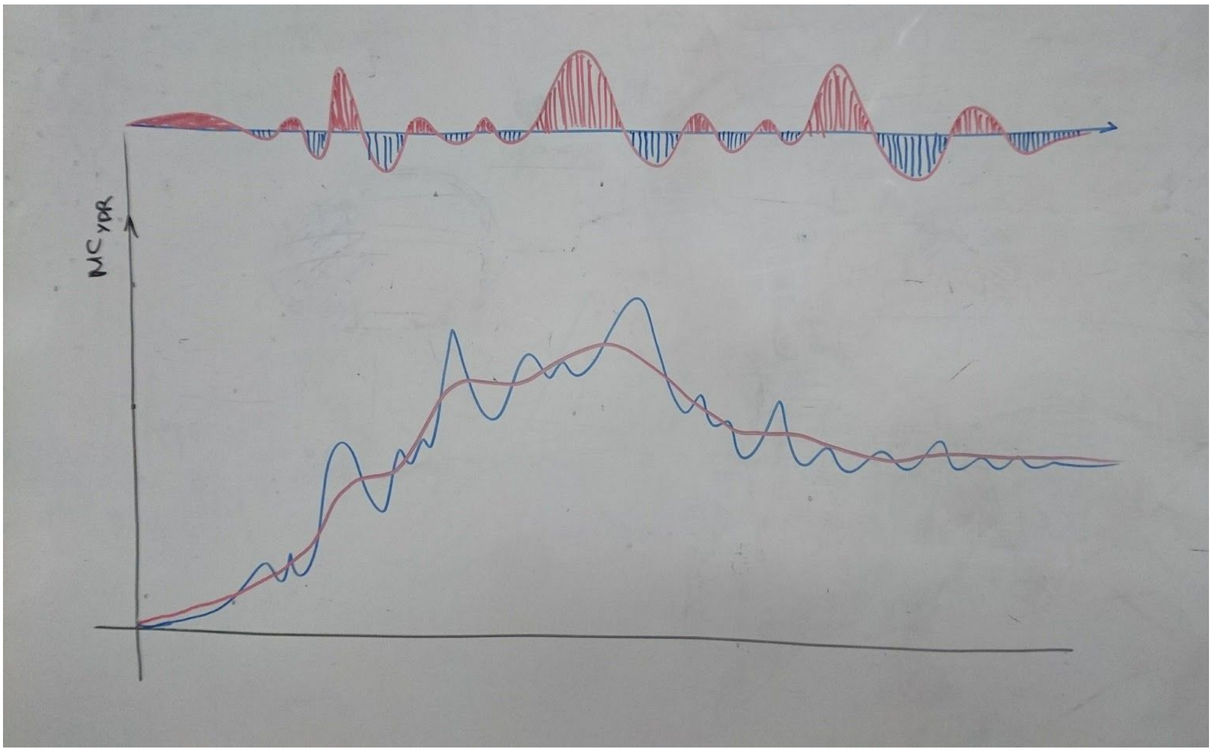
### *Detail Analytic of Basis*

The idea of Basis is rather strange, instead of using the Share token to absorb the price volatility, a third token called Bond is used for that purpose.

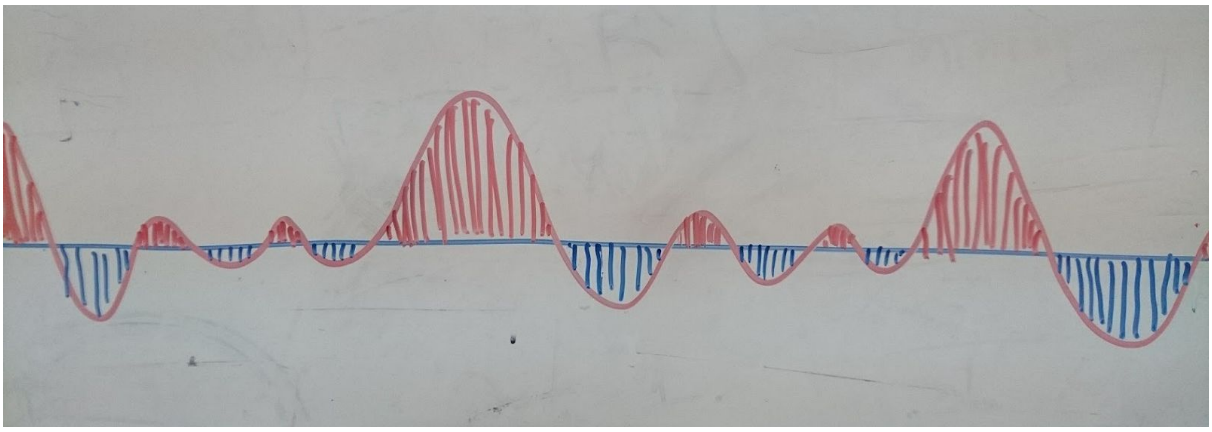
There is one important note here, that although sharing the same name, Basis' Bond is very different with financial bond.

- Financial bond has maturity date, where the bond issuer (government or corporation) is required to repay bond holder. This feature makes financial bond is one of the safest investment, which is important for the money contraction and expansion role.
- On the other hand, Basis' bond does not have maturity date, but expired date instead, where it is disappeared into thin air, making it is one of the riskiest investment.

This feature of Basis shifts all the risky volatility to its Bond token, while keeping all the rewarding volatility to it Share token. When the market interest is increasing, all the new Basis token is distributed to Share token holder, pro-rata; and when the market interest is decreasing for a long time, without recovering quick enough (like after the all-high hype), all the Bond will be expired, take away all the investment in vain.

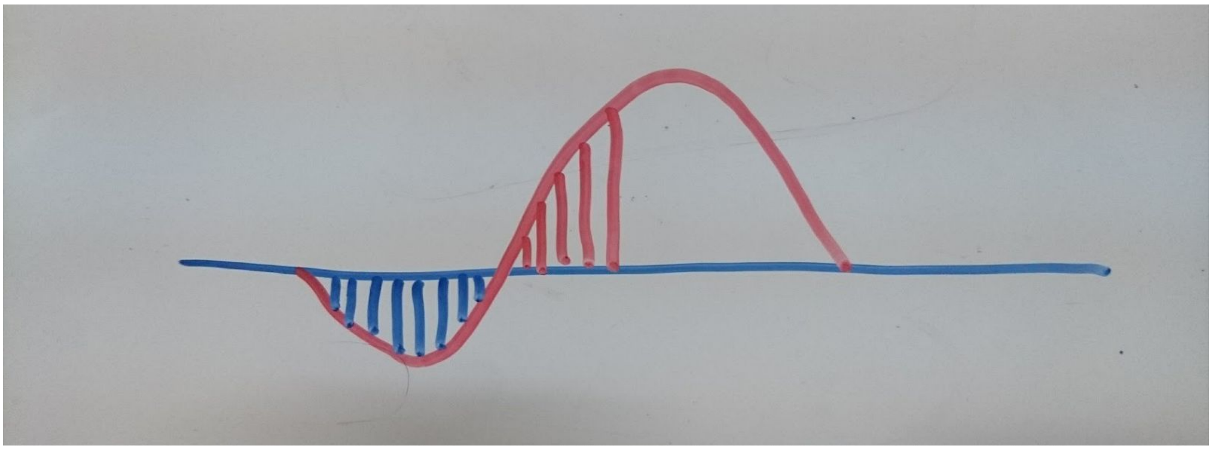


Red graph is the demanding market capacity and blue one is the current market cap of Basis token. The current MC always swings around the demanding MC as the price of the token is stabilized. When the red graph is above the blue one, the market is expanding (because demand is higher than supply), and vice versa. Straightening the current market cap, we have the demanding market cap graph:

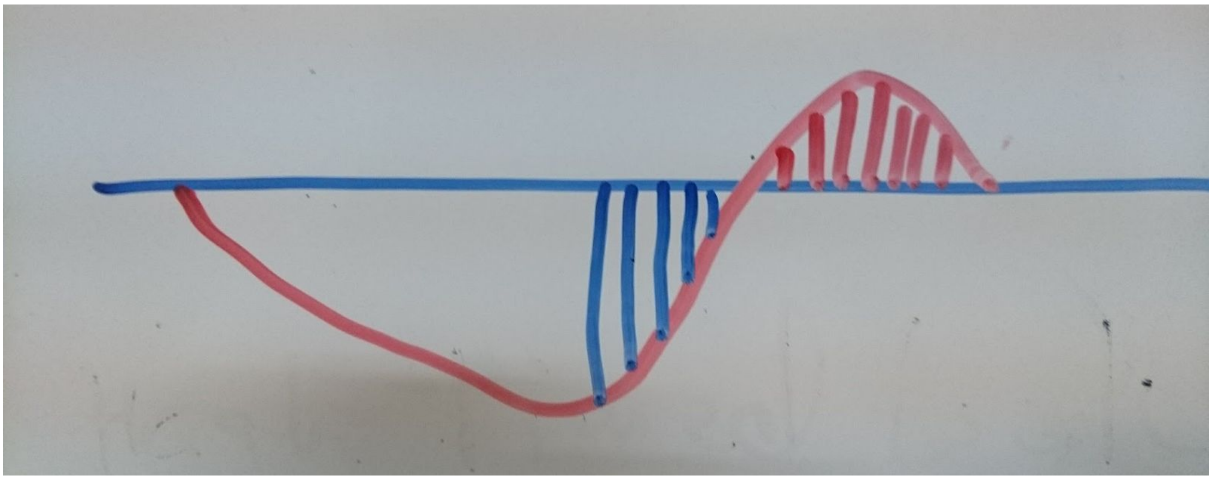


Red area is the total value of token expansion, and blue area is the total value of token contraction.

In a time window (equal bound expiration) where the expansion is larger than contraction value (the market is overall expanding), all the contracted value (blue) is repaid by a part of expansion (stripped red). The rest of the expansion value (empty red) will be distributed to the Share's holder, pro-rata. This makes the Share token a low risk - high reward asset.



And in a time window (bound expiration) where the expansion is smaller than contraction value (the market is overall contracting), only a part of contracted value (blue) is repaid by the expansion (red). The rest of the contraction value (empty blue) will be lost because of bond expiration. This make the Bond token an extremely high risk asset.



Because the risk is high, the reward should be also high, otherwise, buyer could just invest in Share instead, which is already low risk - high reward by definition. Firstly, Basis' bond is always repaid in 1.00 Basis (or 1.00 USD), so the bond price (driven by the market force) should be very low for the risk-worthy reward. Secondly, to prevent spiral of death causing by black swan events, Basis set the lower price limit for Bond in auction. That makes things worse, it likes setting the lower limit for Bitcoin or stock price, when the market force drives the price down lower than the limit, no one can buy bond with a price lower than the limit; but no one would buy anything higher than its expected value, so no bound can be sold at that moment. That is where the purpose of bond (to contract stablecoins supply) is failed.

### Fragments

Fragments project is another take on the Seigniorage Shares paper, also using bond token, but with the following distinctions:

- Using ETH as the Reserve Collateral Asset instead of its own (share) token. This makes the currency depends on the ETH, which has its own pros and cons, but not independent nonetheless. The main problem of using side token is, there's no incentive to hold them for reserve. Fragments development team could hold reserving ETH to bootstrap their project, but after a wider adoption, market cap of Fragments would be increased to the point where the volatility can no longer be absorbed by a single party's capital. Then, the stablecoin will solely rely on the secondary mechanism - bond.

- Fragments' bond is designed to be a secondary stabilizing mechanism (after ETH reserve), but (as described above) it will eventually be the main mechanism once the system is well adopted. Currently, there is not much detail of bond in the Fragment document.

How YggChain is different from Fragments:

- Fragment's expansion mechanism distributes newly created Fragments to all Fragment holders, pro-rata. This increase the total value in each user wallet, because there's no token to absorb the positive volatility; Bond only absorb the expansion of previously contraction. [TODO: insert diagram here] This benefits the early users of the Fragments stable-coins, while take away the reward of high-risk bond trader. This approach is exactly what Seigniorage Shares paper tell us not to do, in section "How not to distribute $\Delta$i" of the paper. YggChain otherwise, clearly separates high-risk-high-reward YggCoin and no-risk-no-reward stablecoin (YDR) for their intended users.
- Fragments share the same problems of distribution new token pro-rata as Basis (see above).

### Carbon

Of all the Seigniorage Shares stablecoins, Carbon is different from YggChain the least.
Those different includes:

- Distribution new tokens pro-rata: see above for problems.
- Powered by Hedera Hashgraph, a permissioned DLT, and not a blockchain. YggChain otherwise, is an public permissionless blockchain, where everyone can join to use, trade, develop and even fork their own project if they no longer agree with our development direction. We believe public permissionless blockchain project will lead to the ultimate future of cryptocurrency of free world.