# SYNTHETIX LITEPAPER V1.2 (November 2019)

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## 01. ABSTRACT


Synthetix is a decentralised synthetic asset issuance protocol built on Ethereum. These synthetic assets are collateralized by the Synthetix Network Token (SNX) which when locked in the contract enables the issuance of synthetic assets (Synths). This pooled collateral model enables users to perform conversions between Synths directly with the smart contract, avoiding the need for counterparties. This mechanism solves the liquidity and slippage issues experienced by DEX's. Synthetix currently supports synthetic fiat currencies, cryptocurrencies (long and short) and commodities. SNX holders are incentivised to stake their tokens as they are paid a pro-rata portion of the fees generated through activity on Synthetix.Exchange, based on their contribution to the network. It is the right to participate in the network and capture fees generated from Synth exchanges, from which the value of the SNX token is derived.


## 02. SNX AS COLLATERAL

### How SNX backs Synths

All Synths are backed by SNX tokens. Synths are minted when SNX holders stake their SNX as collateral using Mintr, a decentralised application for interacting with the Synthetix contracts. Synths are currently backed by a 750% collateralisation ratio, although this may be raised or lowered in the future through community governance mechanisms. SNX stakers incur debt when they mint Synths, and to exit the system (i.e. unlock their SNX) they must pay back this debt by burning Synths.

### Why SNX holders stake

SNX holders are incentivised to stake their tokens and mint Synths in several ways. Firstly, there are exchange rewards. These are generated whenever someone exchanges one Synth to another (i.e. on Synthetix.Exchange). Each trade generates an exchange fee that is sent to a fee pool, available for SNX stakers to claim their proportion each week. This fee is between 10-100 bps (0.1% - 1%, though typically 0.3%), and will be displayed during any trade on Synthetix.Exchange. The other incentive for SNX holders

to stake/mint is SNX staking rewards, which comes from the protocol's inflationary monetary policy. From March 2019 to March 2024, the total SNX supply will increase from 100,000,000 to 245,312,500, with an annual reduction of the inflation rate. These SNX tokens are distributed to SNX stakers on a pro-rata basis provided their collateralisation ratio does not fall below the target threshold.

### Minting, burning, and the C-Ratio

The mechanisms above ensure SNX stakers are incentivised to maintain their Collateralisation Ratio (C-Ratio) at the optimal rate (currently 750%). This ensures Synths are backed by sufficient collateral to absorb large price shocks. If the value of SNX or Synths fluctuate, each staker's C-Ratio will fluctuate. If it falls below 750% (although there is a small buffer allowing for minor fluctuations), they will be unable to claim fees until they restore their ratio. They adjust their ratio by either minting Synths if their ratio is above 750%, or burning Synths if their ratio is below 750%.

### Stakers, debt, and pooled counterparties

SNX stakers incur a 'debt' when they mint Synths. This debt can increase or decrease independent of their original minted value, based on the exchange rates and supply of Synths within the network. For example, if 100% of the Synths in the system were synthetic Bitcoin (sBTC), which halved in price, the debt in the system would halve, and each staker's debt would also halve. This means in another scenario, where only half the Synths across the system were sBTC, and BTC doubled in price, the system's total debt—and each staker's debt—would increase by one quarter.

In this way, SNX stakers act as a pooled counterparty to all Synth exchanges; stakers take on the risk of the overall debt in the system. They have the option of hedging this risk by taking positions external to the system. By incurring this risk and enabling trading on Synthetix.Exchange stakers earn a right to fees generated by the system.

***Example 1***

| | | Medio | Yan | Total Debt |
|---|---|---|---|---|
| Step 1 | Starting sUSD | 50,000 | 50,000 | **100,000** |
| Step 2 | sBTC<br>sUSD | 50,000 | <br>50,000 | **100,000** |
| Step 3 | sBTC<br>sUSD | 75,000 | <br>50,000 | **125,000** |
| Step 4 | Final<br>Debt Owed | 75,000<br>62,500 | 50,000<br>62,500 | **125,000** |
| | **Net Profit** | 12,500 | -12,500 | |

- **Step 1:** Medio & Yan both start with $50k sUSD. Combined this equates to a total network debt of $100k, with Medio and Yan each responsible for 50% of it.
- **Step 2:** Medio purchases sBTC with his $50k while Yan continues to hold sUSD.
- **Step 3:** The price of BTC rises +50% meaning that Medio's position is now worth $75k. That $25k of profit increases the total network debt to $125k.
- **Step 4:** Medio & Yan are still responsible for 50% of the total network debt, which now corresponds to each of them owing $62.5k. When the value of Medio's sBTC position is netted against his debt owed, it results in a $12.5k profit. Even though the value of Yan's position stayed flat at $50k, the amount of debt he owes increased by $12.5k resulting in an equivalent $12.5k loss.

***Example 2***

| | | Medio | Yan | Total Debt |
|---|---|---|---|---|
| Step 1 | Starting sUSD | 50,000 | 50,000 | **100,000** |
| Step 2 | sBTC<br>iBTC | 50,000 | <br>50,000 | **100,000** |
| Step 3 | sBTC<br>iBTC | 75,000 | <br>25,000 | **100,000** |
| Step 4 | Final<br>Debt Owed | 75,000<br>50,000 | 25,000<br>50,000 | **100,000** |
| | **Net Profit** | 25,000 | -25,000 | |

- **Step 1:** Medio & Yan both start with $50k sUSD. Combined this equates to a total network debt of $100k, with Medio and Yan each responsible for 50% of it.
- **Step 2:** Medio purchases sBTC with his $50k while Yan shorts Bitcoin by purchasing $50k of iBTC ("Inverse Bitcoin").
- **Step 3:** The price of BTC rises +50% meaning that Medio's long position is now worth $75k, while Yan's short position falls to $25k. The total debt stays flat at $100k.
- **Step 4:** Medio & Yan are each responsible for 50% of the total network debt, which still corresponds to each of them owing $50k. When the value of Medio's sBTC position is netted against his debt owed, it results in a $25k profit. For Yan, this equates to a $25k loss.

*Examples from Delphi Digital demonstrating how debt works in the Synthetix system .*

## 03. SYNTH PEGGING MECHANISM

The Synth peg is critical to a well functioning system, because traders require both liquidity and stability between a Synth/s and other cryptoassets to take profits from trading. Some Synths trade on the open market, so it is possible for them to fall below par with the assets they track. Incentives are required to ensure that deviations from the peg are minimal and that actors are motivated to correct them.
There are three methods to maintain the Synth peg:

1. Arbitrage: SNX stakers have created debt by minting Synths, so if the peg drops they can now profit by buying sUSD back below par and burning it to reduce their debt, which assumes a perfect 1:1 peg for sUSD and USD.
2. sETH liquidity pool on Uniswap: each week, a portion of the SNX added to the total supply through the inflationary monetary policy is distributed as reward to people providing sETH/ETH liquidity on Uniswap. This has incentivised liquidity providers to collectively create the largest liquidity pool on Uniswap (at time of writing), allowing traders to purchase Synths to start trading or sell Synths to take profits.
3. SNX arbitrage contract: We created a contract holding SNX that allows people to send ETH to it if the sETH/ETH rate on Uniswap falls below 99:100. Their ETH is then exchanged for SNX (via the sETH/ETH Uniswap pool) at par value. This essentially means that if the sETH ratio falls too low, people can use this contract to exchange ETH to SNX at a discounted rate. A portion of the weekly added SNX supply is sent to the contract for this purpose.

## 04. SYNTHETIX.EXCHANGE

**Why trade synthetic assets?**

Synthetic assets provide exposure to an asset without holding the underlying resource. This has a range of advantages, including reducing the friction when switching between different assets (e.g. from Apple shares to synthetic gold), expanding the accessibility of certain assets, and censorship resistance.

**Advantages of Synthetix.Exchange**

Trading on Synthetix.Exchange provides many advantages over centralised exchanges and order book based DEX's. The lack of an order book means all trades are executed against the contract, known as P2C (peer-to-contract) trading. Assets are assigned an exchange rate through price feeds supplied by an oracle, and can be converted using the Synthetix.Exchange dApp. This provides infinite liquidity up to the total amount of collateral in the system, zero slippage, and permissionless on-chain trading.

**How Synths work**

Synths are synthetic assets that track the price of the underlying asset. They allow holders to gain exposure on Ethereum to various asset classes without holding the underlying assets themselves or trusting a custodian. Synths are backed by the Synthetix Network Token (SNX), which is staked as collateral at a ratio of 750%.

**The current Synths**

There are currently four categories of Synths available: fiat currencies, commodities, cryptocurrencies, and inverse cryptocurrencies. Our fiat Synths include sUSD, sEUR, sKRW, and many more; our commodity Synths include synthetic gold and synthetic silver, both measured per ounce; our cryptocurrencies include sBTC, sETH, and sBNB, with more to come; and our Inverse Synths inversely track the price of those available cryptocurrencies, meaning that when BTC's price decreases, iBTC's price increases.

## 05. SYSTEM ARCHITECTURE

**Minting Synths ( diagram )**

An SNX holder can mint Synths by locking their SNX as collateral via the Synthetix smart contract. The steps involved when an SNX holder mints are:

1. The Synthetix contract checks that the SNX staker can mint Synths against their SNX, which requires their Collateralisation Ratio to be above 750%.
2. Their debt is added to the Debt Register. The debt is the amount of the new Synth value minted, and is stored in XDR's (Synthetix Drawing Rights). XDR uses a basket of currencies to stabilise the value of the debt, similarly to the IMF's Special Drawing Right (SDR). These currency prices are pushed on-chain via the price oracle.
3. With the debt assigned to the staker, the Synthetix contract instructs the individual Synth contract to issue the new amount. It adds it to its total supply and assigns the newly minted Synths to the user's wallet.

If the price of SNX increases, an equivalent portion of a staker's SNX is automatically unlocked as collateral. For example, if a user locks $100 of SNX as collateral, and the value of SNX doubles, then half of their SNX (total value: $200) is locked and the other half is unlocked. If they wish, that extra unlocked SNX can then be staked to mint more Synths.

**Exchanges ( diagram )**

The steps involved for the smart contracts to process a Synth exchange (from sUSD to sBTC in this example) are below:

1. Burn the source Synth (sUSD), which involves reducing that wallet address's sUSD balance and updating the total supply of sUSD.
2. Establish the conversion amount (i.e. the exchange rate, based on the price of each currency).
3. Charge an exchange fee, which is currently 0.3% of the converted amount, and send the fee as XDR to the fee pool, where it can be claimed by SNX stakers.
4. The remaining 99.7% is issued by the destination Synth (sBTC) contract and the wallet address balance is updated.
5. The sBTC total supply is updated.

No counterparty is required to exchange, as the system converts the debt from one Synth to another. Hence no order books or order matching is required, resulting in infinite liquidity between Synths. No debt change is required to be recorded against the debt pool either, as the same value is burned from the source Synth and minted from the destination Synth.

**Claiming fees ( diagram )**

When Synths are exchanged through the Synthetix contract, a 0.3% fee is extracted and sent to the fee pool as XDR to be claimed by SNX stakers. When claiming fees (also called Synth exchange rewards) a staker also claims their SNX staking rewards, which reward them with extra SNX for staking the SNX they currently have. The smart contracts' process once a staker requests to claim their fees is as follows:

1. The fee pool checks whether there are fees currently available and whether the staker is eligible to receive fees.
2. The amount of fees in sUSD is issued and the equivalent amount of XDR in the fee pool is burned. The balance of the staker's wallet address and the balance of the fee pool are updated.
3. Additionally, a pro-rata amount of escrowed SNX is assigned to the wallet address from the SNX staking rewards contract.

Fees are allocated based on the proportion of debt each staker has issued. For example, if a staker has issued 1,000 sUSD in debt, the debt pool is 10,000 sUSD, and 100 in fees are generated in a fee period, this staker is entitled to 10 sUSD because their debt represents 10% of the debt pool. The same proportional distribution mechanism is used for SNX staking rewards.

**Burning debt ( diagram )**

When an SNX staker wants to exit the system or reduce their debt and unlock staked SNX, they must pay back their debt. At its simplest: a staker mints 10 sUSD by locking SNX as collateral, and must burn 10 sUSD to unlock it. But if the debt pool fluctuates (and therefore their individual debt fluctuates) while they are staked, they may need to burn more or less debt than they minted. The process for reducing debt to zero is as follows:

1. The Synthetix contract determines their debt balance and removes them from the Debt Register.
2. The required amount of sUSD is burned, and total supply of sUSD is updated along with the sUSD balance in the user's wallet.
3. Their SNX balance becomes transferrable.

**The debt pool**

The system tracks the debt pool (as well as each individual staker's debt) each time an SNX holder mints or burns Synths. It does this by updating the Cumulative Debt Delta Ratio. This measures the SNX staker's proportion of the debt pool at the time they last minted or burned, as well as the debt change caused by other stakers entering or leaving the system. The system uses this information to determine the individual debt of each staker at any time in the future, without having to actually record the changing debt of each individual staker.

Updating the Cumulative Debt Delta Ratio on the Debt Register allows the system to track every user's % of the debt. It calculates the % change the new debt introduces against the debt pool using the formula below and appends it to the Debt Register:

$$New\ Debt\ Minted\ (\ Total\ Existing\ Debt\ +\ New\ Debt)$$

The staker's last mint/burn action is then recorded in the Debt Register within their issuance data and the relative index number at which this action happened. The detail recorded is the percentage of the debt pool they represent, which is calculated by this formula:

$$User\ debt\ percentage\ =(New\ Debt\ +\ Existing\ Debt)\ (Previous\ Debt\ Pool\ +\ New\ Debt)$$

The Debt Register holds the Cumulative Debt Delta Ratio, which is the product of the calculation above, and the relative time (index) the debt was added, so that it can be used to calculate any user's % of the debt pool at any index in the future based on the % shift in the debt pool their last mint/burn caused.

We recalculate the debt pool by summing the number of tokens in each Synth contract multiplied by the current exchange rates, each time new debt is issued/burned:

$$totalDebtIssued = totalIssuedSynths("XDR")$$

This enables the calculation of the current debt pool, and is included in the updated Cumulative Debt Delta Ratio so that we know at each Debt Register entry the size of the debt (in Synths).

When a staker pays back their debt (i.e. by burning the Synths they minted) to unlock their SNX collateral the system updates the Cumulative Debt Delta based on the % shift in the amount of debt to be burned against the total value of the system's debt after the reduction in debt.

This is the inverse calculation from when a user mints new debt:

$$user's\ new\ debt\ percentage = (existing\ debt - debt\ to\ be\ burned)\ (debt\ pool - debt\ to\ be\ burned)$$

This is the formula for calculating the updated Cumulative Debt Delta:

$$delta = debt\ to\ be\ burned\ (debt\ pool - debt\ to\ be\ burned)$$

If a staker burns all their debt, their issuance data in the Debt Register will be set to 0 and they will no longer be part of the debt pool.

### The oracle

The value of all synthetic assets in the Synthetix system are currently determined by an oracle that pushes price feeds on-chain (here). It uses an algorithm with a variety of sources to form an aggregate value for each asset. It is currently operated by the Synthetix team, but there are plans to decentralise it in the future.

## 06. CURRENT RISKS AND RISK MITIGATION STRATEGIES

### Current risks

There are several risks in the current architecture, as Synthetix is still an experimental system and complex systems require both empirical observations and theoretical analysis. Empirical observation and theoretical analysis ensure the mechanism design aligns incentives for all players.

One risk involves the debt SNX holders issue when they stake their SNX and mint Synths. As previously explained, this debt can fluctuate due to exchange rate shifts within the system. This means that to exit the system and unlock their staked SNX, they may need to burn more Synths than they originally minted.

Most people in the cryptocurrency space are aware of this risk, but the prices of most cryptoassets are highly correlated to Bitcoin and/or Ethereum. This means it's possible for major price fluctuations in the SNX token to occur for reasons that have little to do with SNX or the Synthetix system.

Finally, there are a number of aspects of the system that are currently centralised. This decision has been made to ensure efficient implementation of the project. One example of centralisation is the use of proxy contracts across much of the architecture. This is to ensure the system can be upgraded easily but confers a level of control to the engineering team which requires trust from users. While these aspects will be phased out over time, it is important to understand the risks inherent in the current system architecture.

### Risk mitigation strategies

As a decentralised protocol, the Synthetix team is committed to decentralisation and censorship resistance — this will be a gradual process as the system matures. This includes crucial areas such as our price feeds. We have previously announced a partnership with Chainlink, a provider of decentralised oracle solutions, and have already completed an integration on Kovan Testnet.

Another important area is governance, we have recently initiated regular community governance calls to ensure the project's goals are aligned with the community. Another aspect of this process is a move to a formal change management process, we have introduced SIPs (Synthetix Improvement Proposals) to allow the community to introduce change requests and to ensure that any changes to the system are well understood and considered by all stakeholders.

## 07. FUTURE FUNCTIONALITY

### Additional Synths

There are many different kinds of Synths that can be added to the system to provide greater utility to Synthetix.Exchange. These include leveraged assets that are not available on other platforms as well as indices like the S&P500 and equities like AAPL and TSLA.

### Synthetic positions

We expect to launch the ability for traders to take synthetic positions on Synthetix.Exchange in the near future. Many aspects of this functionality are yet to be finalised, but it's expected it will use a self balancing mechanism similar to the Uniswap auto market maker algorithm, where the total open interest of each position and therefore the risk to SNX stakers is capped and borrow rates are adjusted based on the current open interest. The system will also encourage traders to balance the risk in the system by paying a percentage of the fees to traders who rebalance positions, though this feature will not be in the initial release. There are already a number of derivatives trading platforms for cryptoassets, but they are all limited by counterparty liquidity. The unique design of the Synthetix system means it may be able to capture market share in this area, similarly to how Binance captured market share by listing more cryptoassets than most other centralised exchanges.

### ETH as collateral

Several people within the Synthetix community have requested Ether be added as a form of collateral, claiming it will help make the system more robust. We are currently looking at implementing a unique mechanism that allows people to stake ETH as collateral without destabilising the system by affecting the SNX value.

### Lending

There is a growing DeFi (decentralised finance) movement on Ethereum that Synthetix is a part of and fully supports, and non-custodial lending is a crucial part of this ecosystem. For this reason, Synthetix plans to integrate with open-source lending protocols to provide sUSD lending, allowing users to borrow Synths to trade on Synthetix.Exchange. This will be an exciting new method for attracting users to the platform.

## 08. CONCLUSION

Synthetix has already delivered one of the most complex and useful protocols built on Ethereum to date. But the potential for censorship-resistant synthetic assets is still largely untapped. Further improvements to the mechanism as well as functional upgrades and new Synths will vastly increase the utility of the platform. Movement to a decentralised governance process will also reduce systemic risk and increase the long term viability of the project.