RateX: A Protocol for Margin Yield Trading and Synthetic Yield-Bearing Asset

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1. Introduction

The rapid expansion of the crypto currency market, led by Decentralized Finance (DeFi), has revolutionized the financial sector. This transformation is highlighted by the significant increase in Total Value Locked (TVL) across major lending protocols and staking platforms, indicating a substantial inflow of capital into yield-generating assets. However, the market's dynamic nature introduces a major challenge for investors: The inherent volatility and uncertainty of these yields make it challenging for investors to accurately predict the potential returns throughout the entire investment period.

Interest rates for lending and borrowing, along with staking yields, often fluctuate unpredictably, making it difficult for investors to forecast their returns throughout the investment period. This unpredictability can lead to unexpected losses or reduced gains, posing a significant challenge in portfolio planning and management.

In addition to lending and borrowing rates and staking yields, other on-chain assets like Liquid Restaking Tokens (LRTs), LP Pool Tokens, and Point Rewards from projects can also generate income. These assets necessitate a robust marketplace for yield trading and hedging. Furthermore, incorporating real-world yield-generating assets into the on-chain environment and creating corresponding synthetic assets can greatly enrich the on-chain asset class, thereby expanding the crypto ecosystem.

To address these challenges, we have developed RateX, a decentralized platform for yield trading and the creation of synthetic yield-bearing assets. RateX provides an efficient marketplace that allows market participants to effectively manage their yield exposures. Our platform not only offers hedging opportunities but also supports speculation and arbitrage strategies across a wide range of yields in the crypto ecosystem, with the ultimate goal of improving the efficiency and risk management capabilities of the crypto asset market.

2. RateX Protocol

The RateX Protocol, stands out as a specialized platform designed for efficient yield trading and the minting of yield-bearing assets. Unlike conventional protocols that rely on yield stripping to obtain yield tokens (YT), RateX takes a unique approach. Through its Minting System, RateX generates synthetic YT, offering two significant advantages. Firstly, the available liquidity of YT isn't limited by the quantity of yield-bearing assets deposited, thereby significantly boosting capital efficiency. Secondly, RateX facilitates short-selling yield, enabling users to mint and sell YT. This considerably broadens trading strategies, opening up new opportunities for users.

Additionally, RateX boasts a powerful engine for minting synthetic yield-bearing assets. Users can mint a diverse range of assets, such as Liquid Restaking Tokens (LRTs), LP Pool Tokens, Point Rewards from web3 projects, and even assets tied to real-world yields. This innovation not only adds to the DeFi ecosystem with a broader selection of assets but also pushes the limits of financial innovation and accessibility in the decentralized finance realm."

To achieve these objectives, RateX Protocol incorporates six pivotal components:

- **Minting System:** This system takes tokens deposited by users as collateral to produce corresponding Standard Tokens (ST) and Yield Tokens (YT). After each yield settlement period concludes, the amounts of ST and YT are recalibrated to mirror the actual Annual Percentage Yield (APY) of the underlying asset accurately. This adjustment guarantees that the tokens consistently represent the accrued yield over time.
- **RateX AMM:** Tailored for yield trading, the RateX Automated Market Maker (AMM) is an optimized platform that effectively tackles the natural decline in the intrinsic value of Yield Tokens (YT) as they approach expiration. It ensures smooth pricing and liquidity for transactions based on yield, facilitating efficient market operations.
- **Decentralized Orderbook:** In addition to the AMM, the decentralized orderbook enables users to place limit orders, thereby augmenting liquidity and providing more diverse trading options.
- **Innovative Liquidity Provision Mechanism:** RateX introduces a mechanism for liquidity provision, offering users unprecedented customization and control. Participants can either contribute to a Universal Liquidity Pool, which supports automated market making, or tailor their own tick ranges and contribute to Specific Liquidity Pools, aligning with their individual market-making strategies. This dual approach allows users to fine-tune their liquidity contributions to match their strategic preferences and market outlook.

- **Margin Engine:** This component continuously monitors the Collateral Ratio (CR) of each trading position. If the CR dips below the Minimum Collateral Ratio (MCR), the Margin Engine initiates a liquidation process to protect against undercollateralized positions, ensuring the protocol's solvency.
- **Synthetic Asset Generator:** The Synthetic Asset Generator in RateX is a robust engine that efficiently produces synthetic assets derived from Yield Tokens (YT). Users can utilize this tool to create synthetic versions of a wide array of yield-bearing assets, thereby broadening their trading and investment opportunities significantly

3. Yield Tokenization and Minting System on RateX

3.1. Minting System

The minting system forms the foundation of RateX's efficient yield trading capabilities. Through this system, traders and liquidity providers have the ability to mint Yield Tokens (YT) and Standard Tokens (ST). In subsequent chapters, we will delve into the specifics of what YT and ST are, and how RateX leverages these tokens to facilitate Yield Trading. These tokens, YT and ST, serve as the fundamental components of the RateX ecosystem, upon which various functions such as yield trading, liquidity provision, and synthetic asset minting are constructed.

The minting system plays a pivotal role in facilitating the issuance of Yield Tokens (YT) and Standard Tokens (ST) within the RateX platform. This process occurs when users, whether they are traders or liquidity providers, supply sufficient collateral, enabling seamless and efficient yield trading on RateX.

For traders, upon depositing margin, they can mint Standard Tokens (ST) or Yield Tokens (YT) . This flexibility supports both long and short positions, providing traders with enhanced opportunities for profit.

For Liquidity Providers (LPs), RateX’s LP mechanism simplifies liquidity provision. LPs can supply liquidity with just a single token, which is then converted into ST and used as collateral to issue YT.

3.2. Tokenization Mechanisms in RateX and YT Calculations

To elaborate on the tokenization mechanism within RateX, we introduce three types of tokens:

- **Standard Token (ST):** ST is a rebasing yield-bearing token with specific underlying asset’s yield.
- **Yield Token (YT):** YT is time-decaying asset which entitles its holders of receiving the yield component of one Standard Token (ST) during each yield settlement period before the YT reaches maturity. This yield, distributed in the form of ST, represents the right to periodic income generated by the underlying asset.

- **Principal Token (PT):** PT conceptually represents the principal component of ST. At maturity, it's convertible to ST on a 1:1 basis. PT serves as an aid in calculations and clarifies our tokenization structure.

Firstly, we introduce the concept of *impliedRate*, which is similar to APY and exhibits the characteristics of compound interest, aligning with common practices on staking platforms. Regarding the price of PT P_{PT} in vToken, we have the following equation:

$$P_{PT} = \frac{1}{(1 + impliedRate)^t}$$

where *t* represents the term of the PT in years.

For the price of YT P_{YT}, we employ this formula:

$$P_{YT} = 1 - P_{PT}$$

Through some algebraic manipulations, we can derive the relationship between P_{YT} and *impliedRate*:

$$P_{YT} = 1 - \frac{1}{(1 + impliedRate)^t}$$

$$impliedRate = (\frac{1}{1 - P_{YT}})^{\frac{1}{t}} - 1$$

3.3. Yield Distribution Mechanism of ST and YT

Once the Annual Percentage Yield (APY) for a specific underlying asset over a particular yield settlement period is determined, RateX's Minting System springs into action to facilitate the corresponding accrual and distribution of earnings in the form of Standard Tokens (ST) and Yield Tokens (YT).

The process commences with the calculation of the accrued yield, precisely determined based on the APY and the duration of the settlement period. The formula for this calculation is as follows:

$$AccruedYield_i = (1 + APY_i)^{t_i} - 1$$

where t_i represents the duration of the settlement period in years.

Having obtained the accrued yield, the minting system proceeds with the yield distribution between the holders and issuers of ST and YT, adhering to the following rules:

Before Yield Distribution:

- YT Holders: *x* YT
- ST Holders: *y* ST

After Yield Distribution:

- YT Holders: x YT + $x \times AccruedYield_i$ ST
- ST Holders: $y \times (1 + AccruedYield_i)$ ST

For the issuers of YT and ST, the yield distribution process works in reverse, meaning their liabilities increase in proportion to the accrued yield, mirroring the increase in holdings for the holders.

From the above results, it can be seen that when holders possess the same amount of YT and ST, the yields they obtain are identical. By holding YT, traders have the potential to considerably elevate their capital efficiency and generate augmented returns. This mechanism ensures a fair and transparent distribution of earnings among all participants in the RateX ecosystem.

4. Yield Trading on RateX

4.1. Hybrid Trading Matching Engine

To enhance liquidity depth and trading efficiency, RateX has introduced a Hybrid Trading Matching Engine. This innovative engine seamlessly integrates two primary components: the Automated Market Maker (AMM) and the Decentralized Limit Order Book (DLOB).

AMM for Constant Liquidity

The RateX AMM serves as a continuous source of liquidity for traders, ensuring that market orders can be swiftly filled. Built on the x×y=k constant product formula, it provides traders with the necessary liquidity, especially during volatile market conditions.

DLOB for Limit Orders and Expanded Liquidity

Complementing the AMM, RateX's Decentralized Order Book (DLOB) offers an additional layer of liquidity and order matching. This on-chain order book allows users to place limit orders, specifying their desired price and quantity. By introducing the DLOB, RateX not only expands liquidity depth but also enhances trading flexibility.

Hybrid Matching Process

The core of RateX's trading system lies in its Hybrid Trading Matching Engine. This engine intelligently calculates the optimal execution path for each incoming market order. It assesses whether to fulfill the order entirely via the Automated Market Maker (AMM), the Decentralized Limit Order Book (DLOB), or a strategic combination of both. This hybrid approach ensures efficient order matching, reduces slippage, and maximizes trading efficiency,

ultimately providing traders with a smooth and seamless trading experience.

4.2. RateX AMM

As previously mentioned, RateX transforms yield trading into trades involving YT and ST. For simplicity, we illustrate our mechanism using the constant product curve x × y = k. In the RateX AMM context, x represents the YT quantity in the AMM, while y represents the ST quantity. The price of YT, denoted as P_{YT} and expressed in ST, is determined as follows:

$$P_{YT} = \frac{y}{x}$$

For instance, when a trader intends to execute a long yield trade, two primary steps occur (conversely for a short yield trade):

1) M ST are borrowed from the RateX Protocol.

2) These borrowed m ST are then swapped for n YT through the AMM.

To calculate the specific value of m, we utilize a set of formulas:

$$k = x \times y$$

$$x' = x - n$$

$$y' = \frac{k}{x'} = \frac{k}{x - n}$$

$$m = y' - y$$

Given the unique characteristics of Yield Tokens (YT), RateX has developed a distinctive AMM mechanism with key features:

1) Traders can deposit margin to mint Standard Tokens (ST) or Yield Tokens (YT), and exchange one for the other, enabling them to take long or short positions on the yield.

2) After the Annual Percentage Yield (APY) of a specific underlying asset is established over a yield settlement period, the AMM automatically adjusts to mirror the decreased intrinsic value of YT, while preserving the same implied yield.

3) Recognizing that yields typically vary within a narrow range, applying a uniform liquidity distribution along the entire x × y = k curve could lead to inefficiency and increased slippage. Inspired by Uniswap v3, RateX allows Liquidity Providers (LPs) to allocate liquidity within specific yield ranges, thereby enhancing LP

efficiency and offering a wider range of strategic options.

4.3. Decentralized Orderbook

Inspired by Drift's design principles, the RateX Protocol introduces a decentralized order book (DLOB) as a pivotal component of its liquidity mechanism. This DLOB not only provides a robust source of liquidity but also enables traders to leverage order types beyond basic market orders, significantly facilitating more effective and versatile trading strategies and objectives.

Users place limit orders directly on the block chain. A network of Keeper Bots then efficiently organizes these on-chain limit orders into an off-chain order book. This process involves categorizing the orders based on their age (from oldest to newest) and size (from largest to smallest).

Each Keeper maintains its independent view of the order book, embodying the decentralized ethos. They continuously monitor incoming orders, assess AMM liquidity, and stay updated on oracle prices. Whenever a limit order's trigger condition is met, the Keeper promptly executes it against the AMM. Additionally, if the conditions align, Keepers facilitate matches between taker orders and resting limit orders.

The decentralized order book serves as a reservoir of "resting" liquidity. Orders remain active within the orderbook until a taker executes them or until market conditions permit their fulfillment against the AMM.

4.4. Order Types

Market Orders

Central to the trading functionality of RateX are Market Orders, which are executed immediately at the current market price. These orders tap into liquidity from both the Automated Market Makers (AMM) and the Decentralized Orderbook, utilizing our hybrid matching engine. This dual-sourcing method guarantees that traders obtain the most favorable prices for their instantaneous trades.

Limit Orders

RateX acknowledges the need for precision and control in trading by incorporating Limit Orders into its Decentralized Orderbook. Preferred by many traders, Limit Orders enable the setting of specific buy or sell prices, granting traders enhanced control over their transactions by ensuring that orders are executed only at their predetermined prices. Although Automated Market Makers (AMMs) typically lack native support for Limit Orders, RateX overcomes this limitation by integrating a familiar trading experience that accommodates these orders.

Stop Market Orders

For traders seeking automation based on specific price conditions, RateX offers Stop Market Orders. These orders are triggered when the market price reaches a predefined level, either above or below the current price. This feature is invaluable for those wanting to automatically enter the market at key price points.

TP/SL Orders (Take Profit/Stop Loss)

TP/SL Orders provide traders with an additional layer of risk management. With these orders, traders can preset profit and loss levels for their trades. Once the market price hits these preset levels, the orders are automatically executed. This helps traders lock in profits or minimize losses, depending on market movements.

4.5. Example on Yield Trading

Let's illustrate the trading process with a practical example. Consider a scenario where the YT has a remaining term of 91 days, and the AMM currently holds 10,000 YT and 100 ST. From this, we can calculate the price of YT in terms of ST as follows:

$$P_{YT} = \frac{y}{x} = 0.01$$

Using the conversion formula between P_{YT} and the *impliedRate*, we can deduce that the current market *impliedRate* is 4.11%:

$$impliedRate = \left(\frac{1}{1 - P_{YT}}\right)^{\frac{1}{T}} - 1 = \left(\frac{1}{1 - 0.01}\right)^{\frac{365}{91}} - 1 = 4.11\%$$

Now, imagine a trader who wishes to execute a long trade of 50 YT. Here's how the process unfolds:

$$k = x \times y = 100 * 10{,}000 = 1{,}000{,}000$$

$$x' = x - n = 10{,}000 - 50 = 9{,}950$$

$$y' = \frac{k}{x'} = \frac{k}{x - n} = \frac{1{,}000{,}000}{9{,}950} = 100.5025$$

$$m = y' - y = 100.5025 - 100 = 0.5025$$

The trader's average entry price, expressed in terms of YT price and the *impliedRate*, is:

$$P_{YT} = \frac{0.5025}{50} = 0.01005$$

$$impliedRate = \left(\frac{1}{1 - P_{YT}}\right)^{\frac{1}{T}} - 1 = \left(\frac{1}{1 - 0.01005}\right)^{\frac{365}{91}} - 1 = 4.135\%$$

After the trade is completed, the current price of YT and the *impliedRate* are:

$$P_{YT} = \frac{y'}{x'} = \frac{100.5025}{9950} = 0.010101$$

$$impliedRate = (\frac{1}{1 - P_{YT}})^{\frac{1}{T}} - 1 = \left(\frac{1}{1 - 0.010101}\right)^{\frac{365}{91}} - 1 = 4.156\%$$

5. Liquidity Provision Mechanism

5.1. Structure of LP Positions

For each Yield Token (YT) and its corresponding Liquidity Pool, it is crucial to understand that there are two primary types of tokens involved: those deposited into the Liquidity Pool, referred to as $Token_{pool}$, and those used for calculating and distributing yields, denoted as $Token_{base}$.

As an illustration, consider the YT of mSOL, which represents the Liquid Staking Token (LST) of the Marinade Staking Pool on Solana. In this case, the Liquidity Pool consists of mSOL tokens ($Token_{pool}$), while the yields are settled in SOL tokens ($Token_{base}$).

When a LP contributes to RateX, the Minting System generates a corresponding amount of ST based on the deposited $Token_{pool}$ quantity and its exchange rate relative to $Token_{base}$. The formula for determining the amount of ST minted is as follows:

$$Amount_{ST\_Minted} = Amount_{Token\_pool} \times ExchangeRate$$

The newly minted Standard Tokens (ST) are recorded in the LP Reserve. Following this, based on the prevailing Active Ratio (AR) and the yield range set by the Liquidity Provider (LP), an equivalent amount of Yield Tokens (YT) is minted. These YT are then paired with a corresponding quantity of ST and integrated into the Automated Market Maker (AMM). This AMM, comprising YT and ST pairs, supports active trading and sustains liquidity.

The surplus ST remains in the LP Reserve, which plays a pivotal role in covering the yield payments for the minted YT. Essentially, the LP Reserve, holding only ST, guarantees the settlement of yield commitments to YT holders.

In summary, the structure of an LP position consists of:

- **AMM:** Composed of YT and ST pairs, facilitating trading and maintaining liquidity.
- **LP Reserve:** Consisting of ST, responsible for covering yield payments for the minted YT.

5.2. Liquidity Provision with Tick Ranges

The traditional AMM model, based on the constant product formula x × y = k, presents significant challenges in liquidity provision. In these systems, liquidity provided by LPs is uniformly distributed across the entire pricing curve. However, this approach fails to account for the reality that interest rates typically fluctuate within narrower ranges. As a result, a substantial portion of liquidity remains unutilized, leading to increased transaction slippage. Furthermore, it restricts LPs' ability to strategically target specific interest rate ranges with their liquidity.

To overcome these limitations, we have drawn inspiration from Uniswap v3 and tailored its approach to the unique requirements of interest rate swaps. Our design allows LPs to selectively provide liquidity within yield ranges. This innovation not only improves capital efficiency and reduces slippage but also enables LPs to implement more personalized market-making strategies. By targeting specific yield intervals, LPs can align their liquidity provision with their risk appetites and market expectations more effectively.

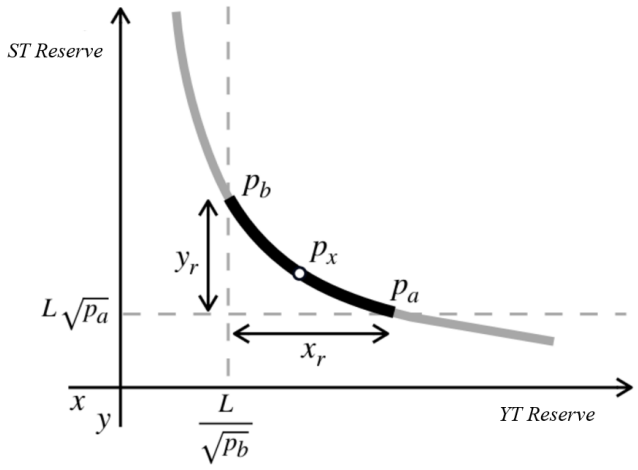
Specifically, when an LP contributes liquidity, their chosen yield-based market-making range is converted into a corresponding price range for YT, denoted as [p_a, p_b]. In alignment with the Uniswap v3 framework, our system involves three key variables: x represents the quantity of YT in the AMM, y represents the quantity of ST, and L signifies the liquidity contributed by the LP. The relevant formulas are as follows:

$$\mathrm{x} \times \mathrm{y} = \mathrm{k}; \mathrm{k} = L^2$$

$$\mathrm{x} = x_{real} + x_{virtual} = x_{real} + \frac{L}{\sqrt{P_b}}$$

$$\mathrm{y} = y_{real} + y_{virtual} = y_{real} + L\sqrt{P_a}$$

$$\left(x_{real} + \frac{L}{\sqrt{P_b}}\right)\left(y_{real} + L\sqrt{P_a}\right) = L^2$$



Within our framework, the Active Ratio (AR) plays a crucial role in determining the proportion of an LP's contributed liquidity that will be transferred into the AMM. Within the market-making price range [p_a, p_b], when the market price reaches the upper bound p_b, the quantity of ST y attains its maximum value y_{max}, calculated as the liquidity provided multiplied by the AR. The liquidity L in Ratex is determined using the following formula:

$$L = \frac{y_{max}}{\sqrt{P_b} - \sqrt{P_a}} = \frac{LP \times AR}{\sqrt{P_b} - \sqrt{P_a}}$$

The values of real reserves x_{real} and y_{real} depend on the current market price p_x. When $p_a \leq p_x \leq p_b$:

$$x_{real} = \left(\frac{1}{\sqrt{P_x}} - \frac{1}{\sqrt{P_b}}\right) L$$

$$y_{real} = \left(\sqrt{P_x} - \sqrt{P_a}\right) L$$

When $p_x < p_a$:

$$x_{real} = 0$$

$$y_{real} = y_{max} = LP \times AR$$

When $p_b < p_x$:

$$x_{real} = \left(\frac{1}{\sqrt{P_a}} - \frac{1}{\sqrt{P_b}}\right) \mathrm{L}$$

$$y_{real} = 0$$

5.3. Yield Distribution and Pegging Mechanism of LP

After each yield settlement period, the LP position undergoes an update process to maintain the balance between the AMM and the Reserve. This process follows a specific sequence:

1) The minting system adjusts the amounts of ST and YT based on the actual APY to reflect the yields earned. This adjustment applies to the assets within both the AMM and the LP Reserve.

2) Using the YT price at the end of the yield settlement period, the implied rate for YT is derived. Based on this implied rate and the updated term, the current price P_x and the upper and lower bound prices P_a and P_b for YT are calculated.

3) Applying the formulas introduced in the previous section, the appropriate amount of ST is determined to match the quantity of YT in the AMM within the new price range and bounds. Any discrepancies are adjusted from the AMM to the Reserve.

4) The system computes the equivalent amount of $\text{Token}_{\text{base}}$ that can be converted from the $\text{Token}_{\text{pool}}$ deposited

in the Liquidity Pool, utilizing the latest exchange rate. Ideally, this amount should match the total market value of all Liquidity Provider (LP) positions plus the profit and loss (PnL) of all traders. In case of any discrepancy, the quantity of Standard Tokens (ST) in the Reserve is proportionally adjusted according to each LP's share in the Liquidity Pool. This adjustment ensures that the quantity of ST is in line with the corresponding amount of $Token_{base}$, preserving a 1:1 peg between ST and $Token_{base}$.

5.4. Universal Liquidity Pool (ULP) and Specific Liquidity Pool (SLP)

In the RateX ecosystem, certain underlying assets like mSOL on Marinade feature multiple contracts, each with different expiration dates, yet are rooted in the same underlying asset. To manage liquidity efficiently across these various contracts while catering to the diverse preferences of Liquidity Providers (LPs), RateX has introduced the Universal Liquidity Pool (ULP) and Specific Liquidity Pool (SLP) mechanisms.

The Universal Liquidity Pool acts as a consolidated source of liquidity for a specific underlying asset, amalgamating liquidity from all trade types related to that asset. This allows for the smooth transfer of funds across different contracts. When LPs contribute to the ULP for a certain asset, RateX distributes their funds across all associated contracts, adjusting these allocations in response to live liquidity demands to optimize capital efficiency.

Conversely, the Specific Liquidity Pool is designed for a particular trade variety or contract, often identified by its unique expiration date. LPs seeking a more targeted liquidity provision strategy can opt for the SLP, where they can define their preferred tick range. This choice grants LPs detailed control and precision in their market-making activities.

By offering both ULP and SLP options, RateX elevates the liquidity provision experience for LPs, enabling them to strike an optimal balance between breadth and depth in their capital deployment. Whether they prioritize broad exposure or targeted opportunities, LPs can leverage our protocol to align their liquidity strategies with their unique risk appetites and objectives.

6. Margin Engine and Insurance Fund

6.1. Collateral and Margin

Utilizing the RateX Margin Engine, traders can trade the yield component of the underlying asset at multiples

significantly higher than their initial margin deposit, sometimes by hundreds of times. The robustness and efficiency of the collateral and margin management system are crucial to maintaining the operational efficacy and stability of RateX. This setup allows traders to leverage their positions extensively, magnifying both potential returns and risks, while the platform ensures a secure and stable trading environment through meticulous margin and collateral oversight.

In RateX, each trade position is comprised of three main components: Asset, Liability, and Margin. Depending on their trading or position direction, traders hold either YT or ST as Assets. Liabilities, on the other hand, represent the ST or YT issued by the traders in exchange for the asset tokens. The Margin, consisting of deposited tokens, alongside the assets, functions as collateral for the trade position.

When assessing risk, the most critical factor is the CR (Collateral Ratio). The formula to calculate CR is as follows:

$$CR = \frac{Asset\ Value + Deposited\ Margin}{Liability\ Value}$$

CR operates within two predefined threshold values:

- **Initial Collateral Ratio (ICR):** This threshold establishes the minimum collateral ratio necessary to initiate a position. The ICR guarantees that traders commence their trades with an adequate collateral buffer to absorb potential losses, thereby preserving the solvency of the transaction.
- **Maintenance Collateral Ratio (MCR):** This threshold determines the minimum collateral ratio that must be sustained to prevent liquidation. If the CR dips below the MCR, a liquidation process is initiated to mitigate further losses and uphold the stability of the trading platform. Serving as a safety net, the MCR affords traders the opportunity to readjust their positions or augment their collateral to steer clear of liquidation.

6.2. Margin Type

RateX offers two margin modes for traders to choose from: Isolated Margin and Cross Margin. These modes cater to different risk management strategies and trading preferences.

Isolated Margin:

In the Isolated Margin mode, a trader's losses are strictly limited to the initial margin specifically allocated to a given trading position. This margin functions as a designated collateral solely for that position, while any unallocated funds remain segregated and are not automatically drawn upon to cover potential losses. Essentially, this mode ensures that only the pre-set margin is exposed to risk, thus providing traders with enhanced control

over their risk exposure. Nonetheless, traders retain the option to manually increase the margin on a position if they desire additional protection against liquidation during periods of market volatility.

Cross Margin:

The Cross Margin mode on RateX adopts a comprehensive approach to collateral management. In this mode, the entire available balance is dynamically allocated across multiple positions within a single Cross Margin trading account. This allows the system to automatically reallocate margins to support positions experiencing losses, thus eliminating the need for manual margin adjustments. This mode provides traders with a safety net, as it utilizes the collective balance to prevent liquidation events. However, it's crucial to note that while Cross Margin can reduce the immediate risk of liquidation, when liquidation is triggered, traders may lose their entire deposited margin.

6.3. Liquidations

Isolated Margin:

For a trading position under the Isolated Margin mode, the initial liquidation price, denoted as P_{liq}, is determined using the following formulae:

- for a FLOATER (long YT):

$$P_{liq.} = \frac{Amount_{ST} \times MCR - Deposted\ Margin}{Amount_{YT}}$$

- for a FIXER (short YT):

$$P_{liq.} = \frac{Amount_{ST} + Deposted\ Margin}{Amount_{YT} \times MCR}$$

Once the accrued yield over the most recent yield settlement period is calculated, the minting system updates the position's $Amount_{ST}$ according to this formula:

$$Amount_{ST\_NEW} = Amount_{ST\_OLD} + (Amount_{ST\_OLD} - Amount_{YT}) \times AccuredYield$$

Subsequently, the liquidation price is adjusted based on the updated Amount_ST by recalculating $Price_{liq}$ using the formulae introduced earlier. When the 15-minute TWAP (Time-Weighted Average Price) falls below the liquidation price for a FLOATER position or rises above the liquidation price for a FIXER position, liquidation will be triggered for the position.

Cross Margin:

For positions under the Cross Margin mode, the CR of a Cross Margin account is computed using the following

formula:

$$CR = \frac{\sum Asset\ Value + \sum Deposited\ Margin}{\sum Liability\ Value}$$

Once the CR of a Cross Margin account dips below the Minimum Credit Risk (MCR), liquidation will be triggered for all positions within the account.

When liquidation is triggered, the assets, liabilities, and margins associated with the position (in Isolated Margin mode) or all positions (in Cross Margin mode) are transferred from the trader to the liquidator. Subsequently, the liquidators automatically execute market orders to sell YT (for FLOATER) or buy YT (for FIXER) to eliminate the YT exposure. After the transaction is completed, any remaining value from the deposited margin is retained by the liquidator as an incentive for participating in the liquidation process. If the deposited margin is insufficient to cover the losses incurred during the closing of the YT position, the liquidator bears the responsibility for those losses.

6.4. Insurance Fund

In RateX, the Insurance Fund plays a crucial role as the primary liquidator, responsible for managing risk and protecting users from socialized losses. When a trading position's collateral ratio (CR) dips below the minimum collateral ratio (MCR), the Insurance Fund promptly steps in to take control of the affected position and facilitate its liquidation. This proactive measure serves to prevent widespread financial losses among the RateX user community.

To fulfill its obligations, the Insurance Fund relies on two primary sources of income: Firstly, a predetermined portion of the trading fees generated from all transactions within RateX is systematically allocated to the Insurance Fund. Secondly, any residual value remaining from the margins after the liquidation process is also transferred to bolster the Fund's resources.

7. Minting Synthetic Assets

Beyond the natively supported leveraged YT trading, RateX offers the capability to mint a wide range of synthetic assets through a feature known as Flash Mint, further enriching the RateX ecosystem. These synthetic assets primarily fall into two categories: Synthetic Principal Tokens (PT) and Synthetic Assets with specific yields.

7.1 Synthetic Principal Tokens (PT)

Unlike YT, which corresponds to the yield component of the underlying asset, Principal Tokens (PT) specifically represent the principal portion of that asset. Upon maturity, PT can be seamlessly converted into the underlying

asset at a 1:1 ratio. However, it's evident that prior to the maturity date, PT would naturally trade at a discount, reflecting the asset's time value. This discount can be quantified using the Annual Percentage Yield (APY). The formula expressing this relationship is as follows:

$$P_{PT} = \frac{1}{(1 + APY)^t}$$

In this formula, P_{PT} signifies the price of PT, while t signifies the time in years.

Within the RateX ecosystem, the Flash Mint process of synthesizing PT unfolds as follows:

1) Users initiate the process by depositing the tokens they wish to convert into the protocol. In response, the minting system generates ST equivalent in value to the deposited tokens.

2) Next, users borrow x ST from the protocol. The specific value of x is precisely determined through a set of calculations. Currently, in the market, selling $1+x$ YT (Yield Tokens) via a market order would yield the required x ST.

3) Users then proceed to sell $1+x$ YT at the prevailing market price, using the subsequent proceeds to repay the x ST borrowed from the protocol. Once this transaction is complete, all assets held by the users have been successfully converted into PT (Principal Tokens).

7.2 Synthetic Assets with Specific Yields

Thanks to the remarkable scalability of RateX, we have the capability to combine YT corresponding to any underlying yield traded on RateX with PT of the same maturity through Flash Mint. This powerful combination allows us to mint synthetic assets that offer specific yields. For instance, we can create synthetic assets tied to the US CPI, synthetic assets linked to rental income, or even synthetic assets associated with the points rewards from projects. By synthesizing assets in this manner, we significantly broaden the range of on-chain assets, further fueling the growth and diversity of the on-chain ecosystem.

8. Governance

To foster decentralization and communal involvement, RateX's governance structure aims to transfer key decision-making authority, including protocol parameter adjustments, from central entities to a Decentralized Autonomous Organization (DAO) comprised of committed token holders. This shift empowers those directly involved in the platform’s success to make equitable judgements via transparent voting processes, minimizing potential conflicts

of interest. Additionally, automated execution and public ledger documentation via smart contracts promote just and efficient governance, fortifying both safety and dependability within the system.

9. Conclusion

The RateX Protocol is tailored for efficient yield trading and the minting of yield-bearing assets. RateX offers optimized functionality specifically geared towards yield trading, facilitating seamless transactions with minimal slippage. What sets RateX apart is its unique approach to yield token generation through its Minting System, which produces synthetic Yield Tokens (YT) without the limitations imposed by traditional yield stripping methods. This not only enhances capital efficiency but also enables short-selling yield, thereby broadening trading strategies and opening up new avenues for users. Furthermore, RateX's robust engine for minting synthetic assets allows users to create a wide array of customized assets, enriching the DeFi ecosystem and pushing the boundaries of financial innovation. The protocol's six pivotal components, including the Minting System, RateX AMM, Decentralized Orderbook, Innovative Liquidity Provision Mechanism, Margin Engine, and Synthetic Asset Generator, work in harmony to deliver a comprehensive and efficient trading experience.