Syrupal: An On-Chain Option Protocol with Order Book Matching Mechanism (DRAFT *)

Syrupal Team

info@syrupal.com

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Abstract

Syrupal Protocol is an innovative decentralized finance platform focused on options trading and structured financial products. The platform combines off-chain order book matching with on-chain transparent settlement to achieve a high-efficiency, low-cost trading model. Off-chain matching significantly boosts transaction speed and reduces gas fees, ensuring liquidity and minimizing slippage. On-chain transparent settlement, powered by blockchain technology, automates clearing processes to ensure transparency and traceability, eliminating the risk of price manipulation. With these two key features, Syrupal Protocol offers a decentralized trading environment that balances security and liquidity.

1 Introduction

With the rapid development of blockchain technology and crypto assets, decentralized finance (DeFi) is emerging as a frontier in financial innovation. Derivatives, as core instruments in the traditional financial system, are gradually integrating into this decentralized framework. Particularly in the highly volatile, 24/7 crypto market, derivatives—especially options—are attracting an increasing number of users and investors due to their risk-hedging and return-enhancing features. However, although options have achieved significant market size in traditional finance and centralized crypto exchanges (CEXs), the DeFi options market remains relatively small, primarily constrained by liquidity and the complexity of trading models.

Decentralized options trading platforms (DEX Options) aim to provide flexible, secure, and transparent options trading within a decentralized environment. Unlike centralized exchanges, DEX options platforms entrust users with full control over their assets, with smart contracts facilitating custody, order matching, and settlement processes, ensuring both the security and autonomy of user assets. These platforms also employ various innovative designs—such as automated market maker (AMM) models, central limit order books (CLOBs), and liquidity pools—to offer users a diversified trading experience with improved capital efficiency.

Additionally, the rapid adoption of Layer-2 solutions (e.g., Arbitrum, Optimism) has greatly enhanced the performance of decentralized options trading. These scaling solutions help DEX options platforms overcome speed and cost bottlenecks, making high-frequency trading and complex options strategies possible in a decentralized setting, further increasing the appeal of DEX options markets.

The decentralized options market not only offers advanced traders ample hedging and arbitrage opportunities but also opens the door for retail investors to achieve stable returns through structured products. In the future, as the market matures and technology advances, DEX options platforms are likely to play a more prominent role in the DeFi sector, driving a shift in the financial system from centralization to a more open, transparent, and inclusive decentralized network.

Over the past few years, the DeFi options market has grown rapidly to become an essential part of the DeFi ecosystem. Compared to traditional options markets, the DeFi options market is still in its early stages of development, yet it continues to attract a growing number of users and liquidity providers (LPs) due to its decentralized, transparent, and intermediary-free nature. Although the total value locked (TVL) in the DeFi options market is currently relatively small (around $100 million), its potential is vast, especially in terms of volatility management and risk hedging.

1.1 Market Characteristics

• Decentralization and Transparency: The DeFi options market eliminates dependence on traditional financial intermediaries (such as exchanges and market makers) by using smart contracts to automate and make transactions transparent.

• Liquidity Challenges: Due to the complexity and non-linear pricing nature of options, liquidity is more dispersed. Various strike prices, expiration dates, and option types lead to fragmented liquidity, impacting market depth and trading efficiency.

• Immature Economic Models: Many current DeFi options protocols are still exploring effective ways to incentivize liquidity providers and traders. Methods like funding rates, hedging strategies, and liquidity mining are under ongoing development and testing.

1.2 Challenges in the DeFi Options Market

• Fragmented Market: The diversity of options products (e.g., different strike prices, expiration dates, calls, and puts) leads to liquidity being dispersed across numerous pools, making large trades difficult to execute.

• Insufficient Incentives for Liquidity Providers (LPs): Currently, LPs in the options market face high risk exposure and complex hedging requirements. Existing economic incentives (e.g., trading fees or token rewards) may not be sufficient to attract enough liquidity.

• Complexity in Pricing and Hedging: Option pricing involves multiple factors (such as volatility and expiration time), imposing higher demands on LPs and traders. Additionally, hedging options positions in the DeFi environment often faces challenges related to capital efficiency and infrastructure limitations.

• Technical Limitations: Blockchain transaction speed and fees can limit the execution of high-frequency trading and complex derivatives pricing, leading to insufficient market liquidity or inaccurate pricing.

1.3 Innovations in the DeFi Options Market

The DeFi options market is leveraging various innovations to address these challenges, exploring new trading models and products to drive market development. Key innovation areas include:

1.3.1 Automated market makers (AMMs)

AMM are widely applied in the DeFi options market to provide liquidity and support trading. AMM applications can be broadly divided into two generations. First-Generation AMMs: For instance, the model used by Dopex only allows the purchase of options from the AMM, with LPs always acting as option sellers. This model is simple but faces issues of insufficient liquidity and risk concentration.Second-Generation AMMs: For example, Lyra V1 allows LPs to provide bidirectional liquidity (buying or selling options) and supports dynamic hedging strategies to improve capital efficiency. This model offers greater flexibility and risk management capabilities.

Utilizing Existing AMM Concentrated Liquidity Pools in the Panoptic Model: Panoptic uses Uniswap V3's concentrated liquidity pools as its foundation, borrowing AMM's existing liquidity to support options trading. This model addresses liquidity fragmentation and uses AMM's pricing curve to dynamically adjust option prices, enabling the options market to quickly attract liquidity and traders, enhancing capital efficiency.

1.3.2 Order Book Mechanism

The order book model, with its precise price discovery, high trading flexibility, and lower slippage, is gradually replacing AMMs as the preferred model for decentralized options trading protocols. This provides professional and institutional traders with a more transparent and efficient trading environment. Key participants in DeFi using order books include decentralized options platforms like Opyn and Aevo, which attract professional traders, institutional investors, and high-frequency traders seeking to profit in the decentralized finance market through precise order execution and complex strategies.

1.4 Advantages of Order Books over AMMs

1.4.1 Accurate Price Discovery and Transparency

• Order Book Model: In an order book model, all buy and sell orders are recorded on-chain in a public book. Participants can submit limit and market orders, with prices determined by supply and demand. The order book provides a clear price structure, displaying all bid and ask prices and quantities, achieving more accurate price discovery. This transparent mechanism better reflects true market supply and demand, particularly in highly volatile or uncertain market environments.

• AMM Model: By contrast, the AMM model uses an algorithm to determine prices based on asset ratios in the liquidity pool (such as the constant product formula). While simple and user-friendly, AMM pricing is less precise than order books, especially during market volatility, which may lead to unstable prices and high slippage.

1.4.2 Lower Slippage and Better Trading Costs

• Order Book Model: Since order books display the depth and price distribution of all buy and sell orders, traders can execute large trades at specific prices, reducing slippage, especially in high-liquidity markets. Lower slippage is crucial for large traders or those looking to execute trades at precise prices.

• AMM Model: In an AMM model, slippage depends on the depth of the liquidity pool and trade volume. If liquidity is insufficient, trades may significantly impact prices, causing high slippage, which can substantially increase costs for large trades.

1.4.3 Greater Flexibility and Customization

• Order Book Model: Order books allow for various order types, such as limit orders, market orders, and stop orders, offering traders higher flexibility and strategy customization. Traders can set specific price conditions for automatic order execution.

• AMM Model: AMMs generally support only immediate execution (similar to market orders) and lack complex order types, simplifying the trading process but providing less flexibility, which may not suit users needing precise control and complex trading strategies.

1.4.4 Reduced Impermanent Loss

• Order Book Model: LPs in an order book model don't bear the risk of impermanent loss as in AMMs. Impermanent loss in AMMs arises from price changes that cause LPs to lose potential gains during asset exchange. In the order book model, LPs are only exposed to market price volatility risk without concerns about additional losses due to changes within a liquidity pool.

• AMM Model: In AMMs, LPs can face impermanent loss during significant price fluctuations. When market prices deviate from the pool price, LPs incur losses, which can be substantial, especially in shallow liquidity pools.

1.4.5 Support for Large Trades without Market Impact

• Order Book Model: Order books support large trades without significantly impacting market prices, as they display the full depth of all bids and asks in the market. Traders can spread large orders across various price points, crucial for investors looking to maintain price stability during large trades.

• AMM Model: AMM pricing formulas mean that large trades can impact asset ratios within the pool, leading to increased slippage and market price instability, especially in smaller liquidity pools.

2. Project Overview

Syrupal Protocol is a decentralized finance (DeFi) platform specializing in options trading and structured financial products. By combining an efficient off-chain order book matching mechanism with transparent on-chain settlement, Syrupal introduces a new trading model aimed at enhancing market efficiency, transparency, and security.

Off-Chain Order Book Matching: By handling order matching off-chain, Syrupal significantly boosts transaction speed and efficiency while reducing on-chain execution load. Compared to a purely on-chain order book, this approach manages higher order volumes and lowers gas fees per transaction, reducing trading costs for users. This efficient off-chain matching system also ensures liquidity depth when orders are matched, thereby reducing slippage and ensuring accuracy and fairness in trade execution.

On-Chain Transparent Settlement: All clearing operations rely entirely on blockchain technology, guaranteeing transparency and traceability for each transaction. This design eliminates risks of price manipulation or tampering, commonly known as "price pinning," which may occur in centralized systems. Smart contracts automatically handle the settlement and recording of all transactions, allowing users to view each step of the settlement process in real-time, thereby enhancing transparency and trust. Automated on-chain execution also removes the possibility of human intervention or fraud, ensuring a fair and transparent trading environment.

Contract Accounts: Syrupal uses a non-EOA (Externally Owned Account) structure, known as contract accounts, to simplify the user experience. Through this mechanism, once the initial deposit is made, users don't need to pay gas fees for each transaction individually. This feature significantly lowers trading costs and improves the overall user experience, particularly for frequent traders. Additionally, the contract account design provides more flexible asset management and trading operations, creating a seamless and convenient user experience.

3. Contract Architecture

3.1 PositionManager Contract

Options Pricing: PositionManager is the most critical contract within Syrupal, especially for options pricing. We use the Black-Scholes-Merton (BSM) formula to price options in real-time, enhancing pricing accuracy compared to non-standard options based on AMM pools. For specific formulas, refer to the BSM pricing section.Note that only short positions require margin; long positions do not.

3.1.1 Initial Margin

Required for opening short positions

Initial Margin for Short Call Options:

$$IM = \max\left[\left(0.2 - \frac{\text{OTM Amount}}{\text{Underlying Mark Price}}\right) \times \text{Spot Price}, \; 0.13 \times \text{Spot Price}\right] + \text{Mark Price of the Option} \tag{1}$$

where:

- OTM Amount is the out-of-the-money amount, equal to $\max(\text{Strike Price} - \text{Underlying Mark Price}, 0)$
- Spot Price is the spot price of the underlying asset.
- Mark Price of the Option is the mark price of the option.

Initial Margin for Short Put Options:

$$IM = \max\left[\max\left(0.2 \times \text{Spot Price} - \frac{\text{OTM Amount}}{\text{Underlying Mark Price}}, \right.\right. \\ \left.\left. 0.13 \times \text{Strike Price}\right), 0\right] + \text{Mark Price of the Option} \quad (2)$$

where:

- OTM Amount is the out-of-the-money amount, equal to $\max(\text{Underlying Mark Price} - \text{Strike Price}, 0)$.
- Strike Price is the strike price of the option.

3.1.2 Maintenance Margin

Required to sustain a position. Falling below this level triggers liquidation.

Maintenance Margin for Short Call Options:

$$MM = 0.1 \times \text{Spot Price} + \text{Mark Price of the Option} \quad (3)$$

Maintenance Margin for Short Put Options:

$$MM = 0.1 \times \min(\text{Index Price}, \text{Strike Price}) \\ + \text{Mark Price of the Option} \quad (4)$$

3.2 Liquidation

Trigger Condition: When a user's USDX balance falls below the Maintenance Margin (MM), the liquidation process is initiated.

Step1. Account Takeover: The platform takes control of the user's account, freezing operations that affect funds to ensure smooth liquidation.

Step2. Cancellation of Open Orders: All unfilled orders are canceled to reduce market impact.

Step3. Market Order Liquidation: Executes liquidation based on position type, prioritizing the highest-risk position.

Step4. Limit Order Auction: Positions not fully closed enter an auction, with prices adjusted gradually to attract bidders. The forced liquidation stops if any step brings the user's cash balance above the margin requirement; otherwise, the following steps proceed.

Step5. Insurance Fund Account Takeover: Any remaining position is transferred to the insurance fund account for auto-deleveraging.

Step6. Auto Deleveraging: An algorithm closes the position to protect the platform and counterparties.

Compensation Mechanism: If the insurance fund account's balance cannot cover counterparty profits, the USDX contract will mint additional USDX to cover the gap (Inflation Loss).

3.3 SubAccount

As with many derivatives trading systems, we employ a SubAccount mechanism to manage user assets. A single EVM address can create multiple SubAccounts, each with isolated assets. The PositionManager contract, inheriting from the ERC721 contract, makes each SubAccount an independent ERC721 token.

3.4 USDX Contract

Stablecoin Support: The USDX contract acts as a stablecoin system within the Syrupal platform, pegged 1:1 to USDC, supporting deposits and withdrawals in USDC.

Token Management: When a user deposits USDC, the contract mints USDX; when a user withdraws USDC, the corresponding USDX is burned, ensuring fund stability within the system.

3.5 Insurance Fund Contract

Protocol Fee Management: Manages platform protocol fees, including maker fee, taker fee, and open interest fee.

Liquidation Fund Support: Takes over and manages user positions upon liquidation.

Auto Deleveraging: Processes high-risk positions in the insurance fund account, prioritizing them through algorithms to protect platform and user interests.

3.6 Oracle Module

Since existing Oracle providers (like Chainlink) cannot deliver forward price and volatility (SVI) data, we use real-time data from Blockscholes to supply our oracle contract.

Oracle Types: Spot price,Forward price and Volatility data As data is key to options pricing, spot price, forward price and SVI data for different expiries are crucial for accurate margin calculations.

3.7 Gas Fee Optimization using Transient Storage

Pricing options via smart contracts consumes a significant amount of gas. For example, if a user holds multiple positions, the contract traverses each option position upon every new position, calculating the latest margin based on current oracle data, which increases gas consumption as the number of positions grows.

To save gas, we leverage the EVM's newly supported transient storage opcode:

- We use transient storage reentrancy locks.

- For options with the same expiry but different strike prices, the oracle data required is the same, so we fetch it only once via transient storage, avoiding repeated oracle calls.

- In batch trades, if multiple users trade the same option (e.g., split orders), the mark price should be identical. We use transient storage to retrieve the same mark price without recalculating the BSM price.

4. Pricing Model

In the DeFi options market, the pricing model is one of the core tools for constructing options contracts. The Black 76 model, a variant of the Black-Scholes model, is specifically designed for pricing futures options. Since the underlying assets in DeFi options are often futures or other financial derivatives, the Black 76 model has found widespread application in this field.

4.1 Fundamentals and Formula of the Black 76 Model

$$C = e^{-rT} \left[F \cdot N(d_1) - K \cdot N(d_2) \right]$$

where:

- F is the forward price of the underlying asset,
- K is the strike price,
- T is the time to maturity,
- r is the risk-free interest rate,
- $N(\cdot)$ is the cumulative distribution function of the standard normal distribution,
- σ is the volatility of the underlying asset.

The main difference between the Black 76 model and the Black-Scholes model is that the Black 76 model is specifically designed to price options on futures rather than on spot assets. The Black 76 model assumes that the underlying asset is a futures contract, so it does not require consideration of dividends paid by the underlying asset when pricing. This makes the model particularly well-suited for assets that do not pay dividends or other holding returns, such as cryptocurrencies.

Using these formulas, the Black 76 model can calculate the theoretical price of an option. This model offers distinct advantages over the Black-Scholes model when handling futures options, making its application especially relevant in the DeFi market.

4.2 Advantages of the Black 76 Model

Compared to the Black-Scholes model, the Black 76 model offers significant advantages in pricing forward start options, where the price of the underlying asset is determined at a specific future time rather than at the time of option creation, as with standard options. This type of option is commonly found in long-term investment and derivatives strategies.

When using the Black-Scholes model to price forward start options, the future price of the underlying asset must be predicted, which can introduce additional uncertainty and errors. However, the Black 76 model directly uses the futures price, as it already reflects the market's expectations of the future price of the underlying asset. In this way, the Black 76 model can more accurately capture the value of forward start options without requiring extensive assumptions about the future movement of spot prices.

4.3 Application of the Black 76 Model in the DeFi Market

One of the defining characteristics of the DeFi market is transparency and real-time data. In traditional financial markets, options pricing often relies on complex market data, including various fees, interest rates, and holding costs. In contrast, the public and transparent nature of on-chain data in DeFi allows the Black 76 model to easily access key data like futures prices and volatility, thereby enabling real-time options pricing.

With smart contract technology, the Black 76 model can be programmed into DeFi platforms, automating the pricing, settlement, and execution processes for options. This automation not only enhances trading efficiency but also reduces the risk of human error and ensures fair pricing. For DeFi platforms, the Black 76 model is an effective way to respond to high market volatility and to meet the unique characteristics of crypto assets.

Furthermore, the Black 76 model performs exceptionally well in handling the highly volatile assets typically found in the DeFi market. Because the DeFi market is often highly volatile, the Black 76 model can adjust volatility parameters in real time, ensuring that option prices consistently reflect the latest market conditions. This provides a more reliable and trustworthy pricing mechanism for investors participating in DeFi options trading.

5. Margin Requirements

In DeFi options trading, the margin system is essential for ensuring the stable operation of the market. Margin is divided into Initial Margin (IM) and Maintenance Margin (MM), which are required to ensure that traders have sufficient funds to withstand potential market risks during both position opening and holding periods.

5.1 Calculation of Initial Margin

Initial Margin is the upfront capital that a trader must provide when creating an options position to ensure they can cover potential losses resulting from fluctuations in the option price. Below are the formulas for calculating the Initial Margin for selling call options and put options:

Initial Margin for Short Call Options:

$$IM = \max\left[\left(0.2 - \frac{\text{OTM Amount}}{\text{Underlying Mark Price}}\right) \times \text{Spot Price}, \right. \\ \left. 0.13 \times \text{Spot Price}\right] + \text{Mark Price of the Option} \quad (5)$$

where:

- OTM Amount is the out-of-the-money amount, equal to $\max(\text{Strike Price} - \text{Underlying Mark Price}, 0)$
- Spot Price is the spot price of the underlying asset.
- Mark Price of the Option is the mark price of the option.

The first part of this formula considers the option's out-of-the-money (OTM) level. Since OTM options have a lower probability of being exercised, the required Initial Margin is also relatively lower. To calculate the moneyness level, first determine OTM amount, then divide it by the underlying asset's mark price to obtain a standardized OTM measure. This value is used to adjust the Initial Margin rate, resulting in the final margin amount as the adjusted rate multiplied by the spot price, plus the option's mark price.

Initial Margin for Short Put Options:

$$IM = \max\left[\max\left(0.2 \times \text{Spot Price} - \frac{\text{OTM Amount}}{\text{Underlying Mark Price}}, \right.\right. \\ \left.\left. 0.13 \times \text{Strike Price}\right), 0\right] + \text{Mark Price of the Option} \quad (6)$$

where:

- OTM Amount is the out-of-the-money amount, equal to $\max(\text{Underlying Mark Price} - \text{Strike Price}, 0)$.
- Strike Price is the strike price of the option.

For short put options, the margin calculation places special emphasis on the risk of a significant decline in the underlying asset's price. To prevent margin shortfalls in the event of a market downturn, the formula typically sets a lower limit at 13 percent of the strike price. This ensures that traders maintain sufficient margin even under adverse market conditions.

5.2 Calculation of Maintenance Margin

Maintenance Margin is the minimum capital level that must be maintained during the holding period to allow the trader to withstand fluctuations in the underlying asset price. The Maintenance Margin is calculated mainly based on the spot or strike price of the underlying asset. Below are the formulas for calculating the Maintenance Margin for short call and put options:

Maintenance Margin for Short Call Options:

$$MM = 0.1 \times \text{Spot Price} + \text{Mark Price of the Option} \quad (7)$$

In this formula, the primary component of Maintenance Margin is 10 percent of the spot price, plus the option's mark price. This means that as the spot price rises, the risk of a short call option increases, requiring more margin to sustain the position.

Maintenance Margin for Short Put Options:

$$\begin{aligned} MM = 0.1 \times \min(\text{Index Price}, \text{Strike Price}) \\ + \text{Mark Price of the Option} \end{aligned} \quad (8)$$

For short put options, the Maintenance Margin calculation uses the smaller of the spot price and the strike price. When the market declines, the spot price typically falls below the strike price, so selecting the smaller value ensures that the Maintenance Margin aligns with market risk.

5.3 Application of Margin Calculation in the DeFi Market

In the DeFi market, margin calculation methods differ from those in traditional finance. Due to the transparency and real-time nature of the DeFi market, on-chain data is publicly accessible and easy to retrieve, making margin calculations more dynamic and accurate. By leveraging smart contracts, margin calculations can be automatically executed on-chain, reducing human intervention and improving trading efficiency. We have optimized Deribit's margin calculation logic to better adapt to the unique requirements of the crypto market in a DeFi environment. Deribit's method is highly flexible and precise, performing exceptionally well in high-volatility markets. These characteristics are equally essential in the DeFi market, and using a similar approach can effectively help platforms manage risk.

For the DeFi options market, implementing the above margin calculation methods can effectively mitigate risks and protect the interests of traders and the platform. In high-volatility environments, dynamically adjusting the margin rate allows the platform to respond quickly to market changes, preventing systemic risks caused by sharp price swings. Additionally, the transparency of margin calculations increases market trust, encouraging more users to participate in DeFi options trading.

6. Liquidation Mechanism

In the DeFi options market, the liquidation mechanism is essential for ensuring the stable operation of the market. It plays a critical role in mitigating risks caused by market volatility and employs a series of optimizations and innovations to make the liquidation process more efficient and fair. This section highlights the unique advantages of our liquidation mechanism in the DeFi options market.

6.1 Precise Trigger Conditions and Risk Control

Our liquidation mechanism employs stringent trigger conditions to ensure that the liquidation process is promptly initiated when a user's margin balance falls below the required level to maintain their positions. This approach effectively prevents accounts from entering a negative balance state. The specific trigger condition is as follows:

$$\text{Trigger Condition:} \quad \frac{MM}{\text{Margin Balance}} \geq 100\%$$

This setup ensures that the system can respond quickly when the user's financial situation deteriorates to a critical level, avoiding further losses. Compared to other systems that may adopt looser standards, this condition makes our liquidation mechanism more robust.

6.2 Efficient Liquidation Process

Our liquidation process is optimized to ensure efficient execution, even in volatile market environments. The specific steps include:

Step 1. Account Takeover
Upon reaching the liquidation trigger, the platform immediately takes control of the user's account, freezing all operations affecting funds (except deposits) to ensure that the user cannot interfere with the liquidation process. This measure guarantees the smooth execution of liquidation.

Step 2. Cancellation of Open Orders
The platform cancels all of the user's unfilled orders to prevent them from influencing market pricing during the liquidation process. For partially filled orders, only the unfilled portion is canceled, reducing unnecessary market impact.

Step 3. Market Order Liquidation
The system automatically executes market order liquidation based on position type (long or short). Our algorithm prioritizes the liquidation of the highest-risk positions to quickly restore the user's account to a safe state.

Step 4. Limit Order Auction

For positions that cannot be fully liquidated, the platform uses a limit order auction approach, gradually adjusting auction prices (e.g inflation coefficients and discount rates) to attract bidders. This method prevents positions from being excessively discounted, ensuring the preservation of the user's asset value.

Step 5. Insurance Fund Account Takeover and Auto Deleveraging
If the auction fails to complete the liquidation, the insurance fund account will take over the remaining positions and further reduce market risk through an auto-deleveraging mechanism (ADL). This multi-layered protection ensures the platform's stability, even in extreme market conditions.

6.3 Improved Auction Liquidation Mechanism

In the DeFi market, the traditional external liquidator auction mechanism faces issues such as insufficient liquidity and information asymmetry. To address these issues, we have innovated the following:

- Limit Order Auction with Inflation Control: Our system periodically posts limit orders on the order book, adjusting auction prices via inflation coefficients. This approach ensures a gradual adjustment in position prices, avoiding the excessive price drops that may occur in Dutch auctions.

- Lower Auction Barriers to Attract More Participants: We simplify the auction process, reducing technical requirements so that more external users can easily participate. This initiative not only increases market liquidity but also enhances the fairness of the auction liquidation process.

6.4 User-Friendly Liquidation Fee Structure

In the liquidation process, we have implemented a reasonable fee structure to protect the platform's interests while minimizing the burden on users:

- Moderate Liquidation Fees: We charge a certain percentage of liquidation fees and adjust them flexibly based on the user's cash balance. This design avoids excessive fee pressure and encourages users to maintain a focus on risk management through the fee structure.

- Innovative Insurance Fund Replenishment Mechanism: When the insurance fund is required during liquidation, we use an innovative replenishment mechanism to ensure that the fund pool is promptly replenished when it falls below the safety threshold, maintaining the overall stability of the system.

6.5 Transparency and Fairness in the Liquidation Process

A prominent advantage of our liquidation mechanism is its high level of transparency and fairness. Through public limit order auctions and automated execution processes, users and bidders can clearly understand each step in the liquidation process. This transparency enhances the confidence of market participants and sets a standard of fair trading for the entire DeFi community.

Our liquidation mechanism offers significant advantages in the DeFi options market. Through precise trigger conditions, an efficient execution process, an improved auction liquidation mechanism, a user-friendly fee structure, and transparent and fair operations, we provide robust risk management for users while contributing to the healthy development of the DeFi ecosystem. Our goal is to ensure that the platform operates steadily under all market conditions, providing users with a secure, efficient, and fair trading environment.

7. Risk Management

In DeFi options trading, risk management is essential to ensure platform stability and the security of user assets. We have developed a comprehensive and efficient risk management system by combining an advanced margin mechanism, a liquidation mechanism, and the unique characteristics of on-chain options trading in DeFi. Below is an overview of this system.

7.1 Dynamic Margin Mechanism

Our margin mechanism is designed to handle the high volatility of crypto markets, ensuring that users can effectively manage risk under various market conditions. This system includes two main components: Initial Margin (IM) and Maintenance Margin (MM).

• Initial Margin (IM): At the time of opening a position, the system dynamically calculates the required margin based on the option's out-of-the-money level, the market price of the underlying asset, and volatility. This mechanism ensures users have sufficient capital buffer to mitigate potential risks due to market fluctuations.

• Maintenance Margin (MM): During the holding period, the system continuously monitors market conditions and dynamically adjusts the Maintenance Margin based on changes in the underlying asset's price. When a user's margin balance falls below the Maintenance Margin, the system triggers the liquidation mechanism to keep risks under control.

With this dynamic margin mechanism, we can promptly adjust margin requirements during market fluctuations, ensuring platform stability and reducing the risk of users' positions being liquidated.

7.2 On-Chain Transparency and Automated Execution

In the DeFi environment, we have implemented a highly transparent on-chain options trading system, where all trading and risk management operations are executed automatically via smart contracts and recorded on the blockchain. This transparency and automation offer several advantages:

• Real-Time Monitoring and Dynamic Adjustment: Smart contracts monitor market data and user positions in real-time, dynamically adjusting margin requirements and liquidation strategies according to the latest market conditions. This ensures that risk management measures respond quickly to market changes.

• Public and Transparent Settlement and Margin Information: All user margin statuses, settlement operations, and liquidation processes are publicly recorded on-chain, preventing information asymmetry and enhancing user confidence.

7.3 Improved Auction-Based Liquidation Mechanism

In a decentralized environment, our liquidation mechanism also incorporates an innovative auction-based liquidation approach to maximize the value of user assets.

• Limit Order Auction with Inflation Control: During liquidation, we handle positions through limit order auctions, adjusting auction prices incrementally using inflation coefficients. This avoids the risk of undervaluing positions that may occur in traditional Dutch auctions, ensuring gradual price adjustments that protect user interests.

• Lowering Participation Barriers to Increase Market Participation: To improve market liquidity, we have lowered the technical barriers for auction participation, attracting more external liquidators to bid. This not only enhances market fairness but also strengthens system stability.

Our DeFi on-chain options trading platform integrates an advanced margin mechanism, an efficient liquidation process, a transparent on-chain trading system, an improved auction-based liquidation mechanism, and a decentralized insurance fund to form a comprehensive and robust risk management system. This system not only ensures market stability and the security of user assets but also provides users with an efficient, fair, and transparent trading environment. Through this system, we can effectively manage risks in highly volatile crypto markets, ensuring the long-term stability of the platform.

8. Off-Chain Risk Management

In DeFi options trading, while most trading and management processes are automated on-chain, some critical risk management measures still need to be handled off-chain to ensure system stability and efficiency. Off-chain risk management mainly focuses on managing the Greek letters of positions, controlling trading volume, managing deposits and withdrawals, and maintaining liquidity in contract trading.

8.1 Management of Greeks

In off-chain financial risk management, Greek letters (such as Delta, Gamma, Vega, etc.) are essential as they measure the sensitivity of option positions to various market factors. These operations are typically performed off-chain by a dedicated risk management team or algorithmic systems to ensure position exposures remain within manageable levels.

• Delta Management: By monitoring and adjusting Delta values in real-time, we ensure that the overall portfolio exposure aligns with market volatility, effectively managing the impact of underlying asset price fluctuations on the portfolio.

• Gamma Management: When market volatility changes, Gamma management ensures that Delta changes do not cause a sharp increase in portfolio risk. The off-chain system regularly rebalances positions to keep Gamma within a reasonable range, thus reducing potential risks from significant market fluctuations.

• Vega Management: The off-chain management system continuously monitors and adjusts the Vega of positions, especially when changes in expected market volatility occur. This helps the platform handle increases or decreases in volatility affecting option prices, ensuring stable platform operations.

By managing these Greeks off-chain, we can respond promptly to market changes, keeping the platform's overall risk within target levels and minimizing the impact of sudden market events on system stability.

8.2 Trading Volume Management

Managing trading volume off-chain is also a crucial risk control measure, particularly under extreme market conditions:

• Large Transaction Monitoring (Future Release): The off-chain system monitors large transactions in the market in real-time to prevent single large trades from excessively impacting market prices. If unusual large trades are detected, the system can take off-chain measures, such as notifying liquidity providers or adjusting market liquidity supply to cushion sharp market fluctuations.

• Liquidity Provider Coordination: The off-chain system works closely with liquidity providers to ensure sufficient liquidity can be mobilized to maintain market stability when trading volume surges or declines. This cooperation is enforced through off-chain agreements and contract execution, ensuring consistent liquidity during market highs and lows. With these off-chain volume management measures, the platform can quickly respond to market fluctuations or surges in trading volume, ensuring order and trading efficiency in the market.

8.3 Deposit and Withdrawal Management

The management of fund flows, particularly deposits and withdrawals, is critical in off-chain risk management:

• Monitoring of Large Fund Movements: The off-chain system monitors large deposits and withdrawals to prevent rapid fund flows from adversely impacting market prices and liquidity. For large withdrawal requests, the off-chain management system may employ phased processing or delayed execution to prevent liquidity shocks.

• Margin Level Adjustment: Based on deposit and withdrawal activity, the off-chain system dynamically adjusts user margin levels. If a large withdrawal is detected that may cause a margin shortfall, the system will preemptively issue a margin call or directly limit the withdrawal to keep user positions within a safe risk range.

Through effective off-chain management of fund flows, the platform can maintain a healthy circulation of funds, prevent market instability due to rapid inflows or outflows, and ensure the safety of user positions.

8.4 Liquidity Management in Contract Trading

Liquidity management for contract trading primarily focuses on the following areas:

• Liquidity Provider Management: The off-chain system collaborates with liquidity providers through agreements to ensure adequate buy and sell orders are available to support market trading during periods of market volatility. Off-chain management can adjust liquidity provider incentives to attract more liquidity, especially when needed.

• Emergency Liquidity Allocation: During sudden market events, the off-chain system can quickly allocate liquidity resources to prevent liquidity from drying up. Through pre-defined emergency measures, such as issuing an urgent call to liquidity providers, the platform can rapidly restore normal liquidity levels in the market.

• Liquidity Risk Assessment: The off-chain system periodically assesses liquidity risk based on market transaction data and feedback from liquidity providers, adjusting liquidity management strategies accordingly. This assessment helps preemptively identify potential liquidity crises and formulate appropriate response plans.

These off-chain liquidity management measures ensure that the platform can maintain sufficient liquidity under various market conditions, guaranteeing smooth trading and market stability.

Conclusion

Syrupal focuses on creating a more efficient trading experience by combining off-chain order book matching with on-chain transparent settlement. Our innovative off-chain matching mechanism enhances trading speed and reduces gas costs, while on-chain settlement ensures transparency and security in all transactions. The core contract design of Syrupal includes the PositionManager contract, which utilizes real-time pricing based on the Black-Scholes-Merton model to improve option pricing accuracy. Additionally, we have designed a non-EOA contract account structure to streamline the user experience, allowing users to avoid gas fees on each transaction after their initial deposit. In terms of risk management, our liquidation and dynamic margin mechanisms ensure stable market operations, while an insurance fund account addresses liquidation needs in extreme situations, providing users with an efficient and secure DeFi options trading platform.