DeFi Digital Options

TwinOwls.io
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This paper introduces the concept of DeFi digital options, a decentralized alternative to traditional digital option contracts, and outlines the specifications of its implementation by TwinOwls.

Introduction

Digital options are a type of financial derivative in which the investor or trader speculates on the price fluctuations of an underlying asset within a predetermined time frame. They are also called "binary" options because there are only two possible outcomes at expiration: the option holder either gets a fixed payoff or nothing at all, depending on the outcome of a specific condition.

There are many types of digital options, yet we will confine ourselves with the most common version, that is, European-style cash-or-nothing high-low digital options. Below are the defining characteristics of a cash-or-nothing high-low European[1] digital option contract.

Underlying asset: Each option contract derives its value from an underlying asset, such as a stock, currency pair, commodity or index, whose price movement determines the outcome at expiration.

Expiration time: Each option contract has a specific expiration time, which determines when the option contract ends. Traders must make their predictions within a fixed timeframe, typically ranging from a few minutes to hours or days.

Strike price: In the context of digital options, the strike price represents the price level against which the price at expiration is compared. In European digital options, the

[1] It is important to note that the term "European" does not refer to where the options are traded, but rather to the specifics of how they can be exercised.

strike price is typically the price of the underlying asset at the time of issuance, that is, when the trade is entered.

Option type: High-low digital options come in two contract types; "call" and "put" options. A call option is said to expire "in-the-money" if the price at expiration is above the strike price, and a put option is said to expire "in-the-money" if the price at expiration is below the strike price. When an option expires in-the-money, its holder is entitled to receive the payout. Otherwise, the option is said to expire "out-of-the-money", in which case the holder gets nothing.

Payout percentage: In European digital options, this predetermined rate represents the fixed return on investment (ROI) that the option holder is entitled to receive on top of the initial stake if the option expires in-the-money.

Thus, European-style cash-or-nothing high-low digital options may well be considered as a structured yes/no proposition, where the option holder is essentially speculating on whether the price of an asset will increase or decrease within a specified period. If the prediction is correct, the option holder receives the predetermined payout. If the prediction is wrong, they lose the amount invested in the option, i.e., their initial stake.

Traditional digital options trading

Digital options provide investors with unique opportunities that can hardly be replicated by other financial instruments. First of all, they are straightforward and easy to understand. This is the reason why it is popular among less sophisticated investors, offering a betting-like experience in trading. Secondly, digital options present a fixed risk scenario. An investor knows precisely the maximum amount they can lose in a given time, regardless of the magnitude of the price movement, and without any calculation involving stop losses or margin requirements.

Apart from these, digital options also offer considerable strategic possibilities for sophisticated investors. Traders can make use of complex strategies involving multiple digital options, or combine them with other financial instruments in a wider investment portfolio. Lastly, by nature, they give the ability to profit from miniscule price movements in very short timeframes, which is nearly impossible in any other financial instrument due to intermediary fees, transaction costs, and financing rate and limitations.

To roughly estimate the potential of digital options, one could examine a volatile market such as BTCUSD. Over a 10-year span, from June 2013 to June 2023, its average absolute daily return can be calculated to be approximately 2.6%, based on data from CoinGecko. Consequently, a long/short or futures trader would need to employ around 30x leverage to match the potential return of binary options with 80% payout percentage. This is considering a relatively long 1-day expiration time. As the investment timeframe shortens, the potential returns from binaries becomes increasingly unparalleled, setting them apart from all other investment instruments.

Limitations

As with all traditional financial mechanisms, digital options trading suffers from lack of an autonomous regulatory oversight, such that, it cannot function properly without the full grip of financial authorities. Coupled with their relative simplicity, their exorbitant profit potential has brought in a notorious attraction to digital options as many fraudulent actors found the digital options market to be an easy target.

With the CFTC warning investors against over-the-counter digital options ("Beware of Off-Exchange Binary Options Trades") and the SEC publishing an investor alert titled "Binary Options and Fraud", the digital options concept has become more and more attached to deception and illegitimate practices. An article by the FBI has summarized the three main points where the fraud comes into binary options:

> **Refusal to credit customer accounts or reimburse funds to customers.** This is usually done by canceling customers' withdrawal requests, … and sometimes even freezing accounts and accusing the customers themselves of fraud.
>
> **Identity theft.** Representatives of binary options websites may falsely claim that the government requires photocopies of [a customer's] credit card, passport, driver's license, utility bills, or other personal data … to steal [the customer's] identity.
>
> **Manipulation of trading software.** Some of these Internet trading platforms may be reconfiguring the algorithms … For example, if a customer has a winning trade, the expiration time is extended until the trade becomes a loss. ("Binary Options Fraud", ¶6)

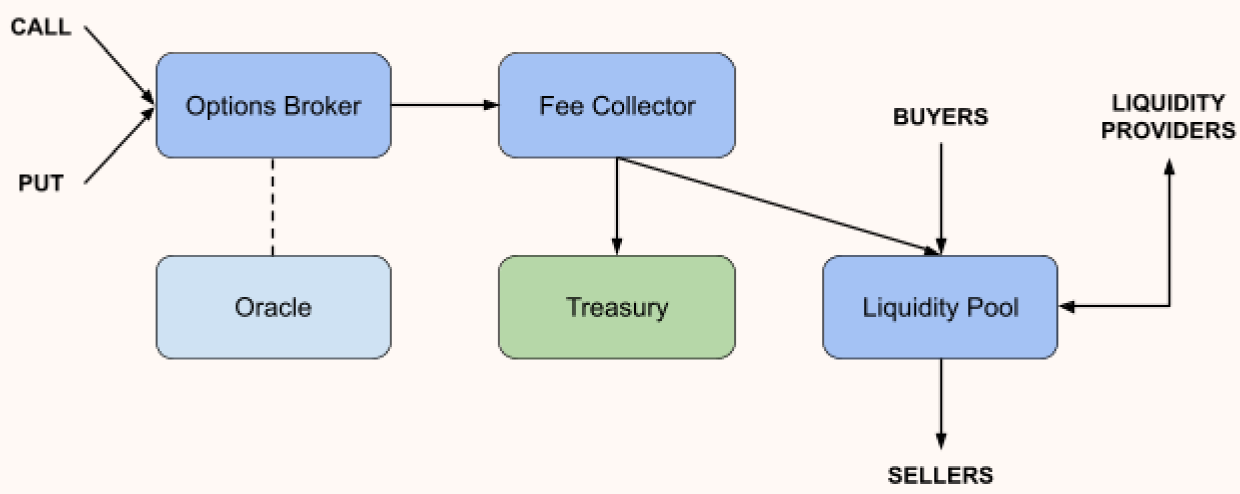
As a result, these points constitute the main limitations of the traditional mechanisms of issuing, trading and executing binaries in the absence of a regulated, centralized exchange and a clearing house for the processing of transactions.

DeFi digital options

There are two primary modes of trade execution for digital options: exchange-traded and over-the-counter. Introducing a third alternative utilizing the methods of decentralized finance (DeFi) can help overcome the limitations pertaining to traditional digital options trading even in the absence of a regulatory control.

Exchange-traded digital options are traded through the matching of orders that come from the participants of an exchange. In this model, traders buy and sell the option contracts from one another. The broker-dealer might act as a market maker, but it does so only by placing orders on the exchange just as any other trader does. In contrast, if the contracts are traded over-the-counter, the trades are typically between two parties without going through an exchange. The broker-dealer, in this case, directly acts as the counterparty to every trade.

DeFi digital options appear as the third alternative, in which case the trade execution is handled on a blockchain through smart contracts to attain the highest level of transparency in both the issuance and the exercise of option contracts, thereby eliminating the counterparty risk. This model combines the flexibility of the over-the-counter trades with the security and transparency of regulated exchanges.



The above diagram illustrates the movement of funds in a DeFi digital options setting. Options Broker is a smart contract that handles calls and puts that come from traders. It retrieves data from a blockchain oracle, and distributes payouts to the holders of the options that expire in-the-money. The system cuts a fee, either explicitly taken or hidden inside the spread. The fee is then automatically sent to another smart contract, Fee Collector, which accumulates the fees and distributes them either to a treasury account or to the Liquidity Pool (LP) periodically. In the former case, the transaction is a simple transfer of funds into one or multiple wallets; in the latter, the fees are used to purchase the platform's token.

The LP can be arranged in many ways, but for simplicity it can be assumed that the automated market maker (AMM) that it powers works on a constant-product basis (cf. "Uniswap Math"). Under the basic pricing model used by Uniswap v1 and v2, each purchase increases the token's price by a factor of $[1 + \Delta x(1 - \varphi)/x]^2$ where

Δx is the amount of funds used to purchase the corresponding token,
x is the amount of funds that were inside the LP prior to the purchase, and
φ is the LP fee (e.g., 0.003 for 0.3%).

In this case, $\varphi\Delta x$ is the LP fee that goes to Liquidity Providers, and the platform increases the value of its token by the factor specified above as a result of buying back $y\Delta x/(x + \Delta x)$ tokens, where y is the amount of tokens that were inside the LP prior to the purchase.

Statistical considerations on the spot-strike digital options

DeFi digital options can be issued in two ways based on how the strike price is determined. In spot-strike digital options, the strike price is taken as the spot price at which time the option contract is issued and entered into. Therefore, the price at expiry is compared to the price at the start of the trader's position. As traders buy calls and puts at different times during the trading window, each trader's entry price becomes their unique strike price. The premiums from out-of-the-money options provide capital for in-the-money payouts, but since this may be insufficient, the Options Broker needs to act as a dealer. As the dealer, it maintains sufficient capital reserves to cover potential payouts and manage the risk of imbalanced positions in their options book. The following calculations show some statistical properties of the trader profitability and the capital requirements of such an Options Broker-Dealer (OBD).

As financial markets are widely assumed to follow a form of geometric Brownian motion (P. Wilmott, *Derivatives*, p. 53), the profitability for both the OBD and traders may as well be assumed to derive their statistical properties thereat. Simply shown as a stochastic differential equation, it reads as

$$dS/S = \mu dt + \sigma dW \qquad \text{where}$$

S is the price,
μ is the drift (represents the expected return),
σ is the volatility (standard deviation of returns) of the asset, and
W is a standard Wiener process (continuous-time random walk).

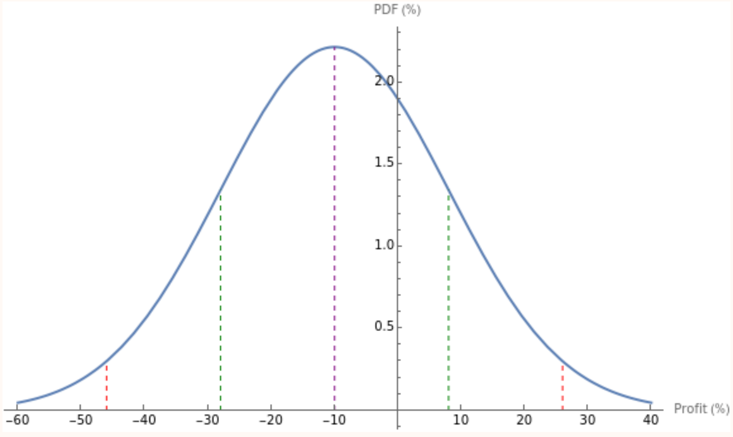
Discretizing it using the Euler-Maruyama method yields

$$\Delta S/S = \mu \Delta t + \sigma \varepsilon \sqrt{\Delta t} \qquad \text{where}$$

ε is a standard normal random variable (i.e., from a $N(0, 1)$ distribution).

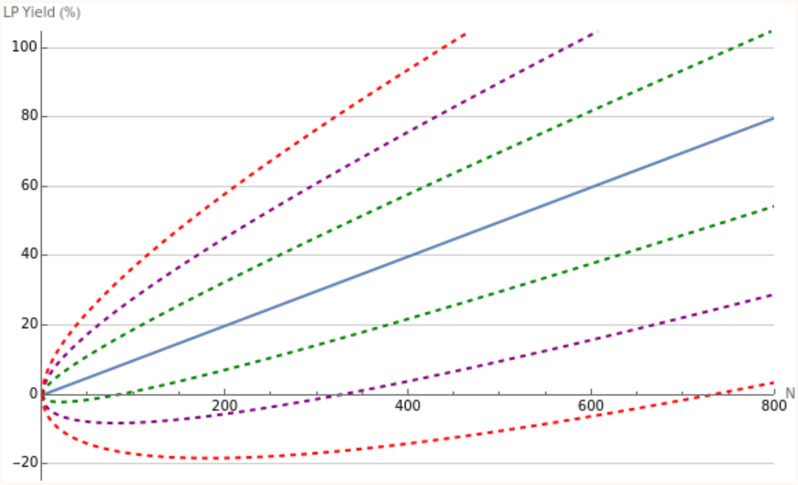
Thus, if we limit ourselves with intraday time frames—which may heuristically be accepted as "short enough"—the effect of the drift term will be negligible compared to the effect of the stochastic term, as Δt approaches to zero more quickly than $\sqrt{\Delta t}$ for small values.

Under this random walk assumption, then, the OBD and trader profitability depends entirely on the payout percentage (denoted as P), the number of positions (N) and the trade amount per each position (C). The trader profitability is consequently a normal distribution with $\mu = CN\frac{P-1}{2}$ and $\sigma = C\sqrt{N}\frac{P+1}{2}$. To visualize it, let us consider a group of traders risking 4% of their initial tradable balance in each option trade and enter into 25 such positions (i.e., $C = 4\%$ and $N = 25$). Given the payout percentage is 80%, the resulting profitability distribution is shown below.



Despite being heavily dependent on the assumed trader behavior, the graph still conveys the basic idea. With these numbers, the CDF at $x = 0$ yields approximately 0.71, meaning that around 71% of the traders are in an aggregate loss. As is also seen that only about 2.5% of the traders are able to make a significant profit (i.e., above 2σ or 26%), the results are not too far from existing statistics on general trader profitability (e.g., cf. ESMA, "Decision 2019/679", L 114/28; H. Nikolovska, "Day Trading Statistics").

As for the growth of the OBD, it is straightforward to see that the traders' loss is the the OBD's profit, and vice versa. Hence, the OBD size itself will follow a geometric Brownian motion where $\mu = CN\frac{1-P}{2}$ and $\sigma = C\sqrt{N}\frac{1+P}{2}$. Let us assume the traders purchase options whose trade amount corresponds to 1% of the OBD's initial size (i.e., $C = 1\%$), and visualize the yield as a function of N, given the payout percentage is 80%.



The dashed lines show 1, 2 and 3 sigmas above and below the expected path. At the 3σ-level, the OBD's loss may reach up to 20%, and offsetting the loss might come as late as at $N = 729$ (i.e., when the total turnover reaches 7.29 times the initial OBD size).

The maximum loss at the n^{th} sigma level is found more generally as $\frac{Cn^2}{8}\frac{(P+1)^2}{1-P}$, after a simple derivation based on the μ and σ values given above. This result may be utilized to calculate the OBD's capital requirement with respect to the upper limit of a single call or put. To adhere to 6-sigma standards, with 80% payouts, the OBD should have about 100 times the upper limit (i.e., $C = 1\%$), and recovery occurs at $N = 2916$, i.e., when the cummulative turnover reaches about 29 times the initial size of the OBD.

Forward-strike digital options

The second and more convenient way of determining the strike price is by fixing it at a specific time. In this way, a group of option contracts have the same strike price and the same expiration time. If the strike price is a price from the past, it means that the current price information will give the trader an unfair advantage, because by the time of the trader's entry, the market would have already moved in one of the directions, skewing the odds of winning. This is indeed common with American-style digital options, where the market's position with respect to the strike price is discounted in the price of the option contract, typically calculated by the Black-Scholes options pricing model. As a result, the broker doesn't have to act also as the dealer, and the premiums from out-of-the-money options provide the entire capital for in-the-money payouts.

There is yet another way of achieving the same result, one which does not involve varying contract pricing but varying payout percentages instead. In the forward-strike model, the strike price is taken at an agreed future time. Therefore, the pricing is fixed but the payout percentage varies. To explain, assume that the time is 10:00 now, and the options will be issued at 10:05, where the expiration time is 10:10. As the Options Broker provides no capital to start with, it will be a zero-sum game between call and put buyers. That is to say, the payout for the calls is determined by the aggregate stake of the puts, and vice versa. By 10:00, there is still 5 minutes for all traders to place their positions, and this means that altough the time window for the digital option's life is fixed between 10:05 and 10:10, the amount of calls and puts that would be given until 10:05 will determine the payout percentage for both sides. If there is sufficient participation in the protocol, this model would yield similar results for the trader profitability, but removes the statistical element for the Options Broker, leaving its gains always equal to the expected value by way of a fixed fee percentage.

A decentralized digital options trading protocol would eliminate the problems associated with traditional mechanisms of digital options trading by providing the ultimate level of transparency together with the programmatic guarantee that the options expiring in-the-money will actually yield the payoff. Furthermore, it would also engender the privacy features inherent in permissionless blockchains. As a result, utilization of smart contracts could elevate the digital options market to a level which even the most rigorous regulations cannot replicate.

Below is a table comparing the main characteristics of the three modes of trade execution for digital options.

Criteria	Exchange-traded	Over-the-counter	DeFi
Source of Liquidity	Exchange participants	Broker-dealer network	Exchange participants
Degree of Decentralization	Centralized	Centralized	Decentralized
Trust Model	Trust in regulated exchanges and clearing houses	Trust in individual broker-dealers	Trustless, based on transparent smart contracts
Permission Level	Permissioned – Requires brokerage account, approval, KYC/AML checks	Varies – Typically accessible to all, may require approval process	Permissionless – Open to anyone with blockchain access
Regulatory Oversight	Regulated – Subject to financial authority Rules	Varies – depends on jurisdiction	Varies – Often falls into regulatory gray areas
Transparency	High – Prices, volume, and trade data are publicly available	Varies – Some information may not be publicly disclosed	High – All transactions are recorded on the blockchain
Access to Exotic Options[2]	Varies – Mostly standard contracts	High – Contracts can be tailored to specific needs	High – Flexibility in contract creation with smart contracts
Speed of Transactions	Fast – Trades are executed rapidly on exchanges	Varies – Depending on agreement between parties	Fast – Limited by network congestion and smart contract interaction

[2] This paper is limited to European-style cash-or-nothing high-low digital options, which are considered to be exotic derivatives. There are yet further types of exotic options such as barrier options or lookback options (cf. J. C. Hull, *Options, Futures, and Other Derivatives*, Chapter 26), for whose execution and liquidity structures, too, blockchain technology may provide better alternatives.

TwinOwls' implementation

Notwithstanding the general considerations on DeFi digital options, the specifics regarding the LP and other elements and features are dependent on how the general idea is implemented. At TwinOwls, we have developed a unique system for the trading of forward-strike DeFi digital options which involves its own token issued as a jetton on The Open Network (TON) blockchain, and a reward scheme around it.

The TwinOwls platform is currently under active development, and the ensuing descriptions do not aim to establish any implied terms as the majority of the details are subject to change. That being said, the following provides an overview of TwinOwls' primary features, reflecting our current vision for the platform.

The TwinOwls mini app

As the digital options concept hinges on the simplicity of its trading mechanism, we wanted to double it down with the ease of access Telegram's mini app ecosystem provides (cf. *TwinOwls Blog*, "What are Telegram Mini Apps, and Why Do They Matter?"). Hence, TwinOwls comes as a hyper-casual no-download application that run inside Telegram, in other words, as a Telegram mini app. The user interface is designed to be straightforward and intuitive, while reserving room for further developments of advanced functionalities such as trading signals and copy trading.

The core functionalities of the mini app is fully developed, and a new UI is recently released, currently active on TON mainnet, reachable at Telegram with the handle @TwinOwls_bot. In order to start trading digital options, all one has to do is to start a conversation with the bot, launch the mini app, and connect their TON wallet with it using Telegram's built-in features.

Tokenomics of OWLZ

The TwinOwls Token (OWLZ) is a fixed-supply 'jetton'[3] that will be issued on TON blockchain. It will be tied to the fees generated by the Options Broker smart contract, such that, **100% of the fees will be distributed to the token holders**. Then, the company will get its portion only insofar as it holds the tokens. In this way, the token holder interest and the company's interest are perfectly aligned, because all fees must pass through the tokenomic system before becoming company revenue.

The token distribution will be as follows:

Company reserve	— 600k tokens
Public sale	— 250k tokens
Strategic allocations	— 100k tokens
LP reserve	— 50k tokens
TOTAL SUPPLY	— 1 million OWLZ

Company reserve is the portion of the tokens held by the company. As this portion constitutes 60% of the supply, it follows that 40% of the revenue will translate into buying pressure for the token through the AMM, as described above on page 5.

Public sale tokens are offered to early supporters. 20% of the funds raised from the presale will constitute the starting LP balance, the initial liquidity for launching the AMM. The remaining portion will be deployed to fund the business operations to ensure the platform's smooth launch, continuous development, marketing initiatives, compliance with legal regulations, and other essential aspects that contribute to the growth and sustainability of the TwinOwls mini app.

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[3] Jettons are user-defined tokens on TON blockchain. They are the equivalent of ERC-20 tokens on Ethereum (cf. *TON Documentation*, "Jetton Processing").

Strategic allocations will be used for strategic and marketing partnerships, community rewards, incentives, or to fund development projects that align with TwinOwls' mission and goals.

LP reserve constitutes the tokens to initiate a market for OWLZ vs. TON using an established AMM protocol on TON blockchain. OWLZ tokens will appreciate value through direct buy orders in this market as the platform generates profits.

OWLZ token is primarily intended as a reward token to those who provide liquidity to TwinOwls, and the token holders may further be rewarded upon each profit distribution, which is based on the diagram above on page 4. In order not to increase the volatility, the company may put in place several measures to distribute profits to high-stake token holders, such as issuing an airdrop. For example, it will distribute its own portion to itself by direct transfers to the Treasury wallet instead of creating multiple orders in the AMM and disturbing the market.

Evaluating the buying pressure for OWLZ generated through the Fee Collector smart contract's buy orders[4] is a relatively easy task because the forward-pricing model doesn't leave a stochastic component in Fee Collector's growth over time. Indeed, the accumulated fees is directly tied to the platform's aggregate turnover. Assuming a 10% fee, which corresponds to an 80% payout percentage if the total stakes in calls equals to that of puts, the collected fees will be 10% of the turnover.

Let us now examine a scenario that starts with zero daily turnover, as it would, and goes up to $50k linearly in 12 months where the first 2 months are with no activity, which may serve as a realistic starting point for our calculations considering the current market potential in TON ecosystem (cf. DEX Screener, "TON"). In this scenario, the buying pressure created by the buyback program for OWLZ is projected to reach $300k in the first year and grow by $180k in each subsequent quarter, which may be interpreted as an expected annualized return of about $720k after attaining a level of product/market fit at $50k daily turnover. On the basis of the assumption of linear growth, and by fixing the top daily turnover at $50k, the quarter-on-quarter growth of the buying pressure for OWLZ is found to be as follows.

[4] This process might be handled manually at the beginning, but the goal is to implement an on-chain automation for it.

Quarter	Average daily turnover (USD)	Quarterly buying pressure (USD)
1	833	3,000
2	12,500	45,000
3	27,500	100,000
4	42,500	153,000
5+	50,000	180,000

How the buying pressure for OWLZ, generated through the platform's profits, will be reflected in the AMM depends on the trader behavior and the thickness of market. Thus, we will be content with having laid out the basic working of the OWLZ token and refrain from making assumptions about how the market will be shaped around it in the actual AMM.

Further prospects & concluding remarks

We have chosen to take on the lean methodology and decide our direction predominantly on the basis of user feedback, so the most assured projection we could make now is to develop systematic ways to capture user feedback and obtain data so as to align our resources with the needs of the community and the existing market potential. With that being said, possible development directions include

- enriching the platform with copy trading and auto-trading venues,
- adding markets other than BTCUSD and time frames other than 10 minutes,
- developing an automated mechanism for profit distribution,
- developing a dynamic payout percentage system depending on the market trend and in a way to reward OWLZ token holders,
- expanding to other blockchains, and even launching our own.

Having emerged as a new type of investment instrument, cryptocurrencies have also made available new ways for financial engineering. Most notably, staking, lending, and liquidity mining protocols have demonstrated novel alternatives to traditional financing and interest mechanisms, yet novelty pays off only when the following three qualities are met.

1. **Soundness of the value proposition:** Proposed benefits and underlying value must address a real problem and align with market needs.
2. **Robustness of the theoretical framework:** Foundational concepts and methodologies must provide stability, reliability and resilience against various market conditions.
3. **Sustainability of the model:** Working dynamics must exhibit long-term viability, ensuring that they can continue to function and provide value well into the future.

We believe that our approach to DeFi digital options as presented here displays adherence to all three key criteria, and we look forward to demonstrating how our commitment to providing value for the cryptocurrency community translates into tangible benefits for our users.

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