Sigma

Options for Terrans

Sigma

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Background

Options are a class of financial derivative instruments where two parties contractually agree to transact an asset at a specific price before a future date. These derivatives give the owner of the option contract the right, but not the obligation to buy or sell an asset at the defined exercise price to the option underwriter. The underwriter earns an upfront premium for assuming the obligation.

The financial of options products is a complicated quantitative subject, but the use cases can be largely qualified into three categories: speculation, hedging, and cash flow generation.

1. **Speculation** - Options are an efficient way to increase leverage on one's portfolio with no liquidation risk. Additionally, relatively lower costs (compared to buying/selling the underlying asset) required for the additional asset exposure makes options one of the most favored tools for leverage.

2. **Hedging** - Almost completely opposite of speculation, options can be used to hedge downside risk. For example, buying a put option effectively reduces the downside risk of spot holdings. Given the crypto industry's high volatility where three sigma events seem to happen much more frequently than every 741 days, options present a great way to hedge tail risk arising from black swan events.

3. **Cash Flow Generation** - Selling options can generate additional cash flow (ie. increasing your yield on your assets). An investor who holds LUNA may decide to sell a low risk call option on their LUNA to earn the option premium. In exchange, the investor misses out on the opportunity of the additional upside past the expiry price. Additionally, Sigma will employ low-risk (~10Δ) automated options strategies to simplify the underwriting and cash flow generation process.

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Introducing Sigma Protocol

Sigma is the first DeFi protocol which enables the creation and usage of collateralized options on the Terra blockchain. Sigma empowers buyers to make leveraged directional bets on their favorite assets, while simultaneously providing sellers an opportunity to construct time-based hedging strategies.

Sigma consists of the basic financial primitive allowing users to mint new options by providing the necessary underlying collateral. In addition, the protocol implements vault infrastructure to solve the problem of option liquidity fragmentation arising from the multiple strike price and expiry dates for a given underlying asset.

Sigma protocol makes innovative improvements to the options space through allowing the options to be denominated in any Terra native coin, and backed by the underlying spot CW20 asset (LUNA, ANC, mAssets, etc) including LP tokens, yielding a Terra-native, fully decentralized ecosystem for participants. With IBC and various bridges, Terra-native users are able to gain exposure to non-native assets on the Terra chain without the worry of the underlying spot liquidity. Additionally, through superfluid usage, assets that are used as collateral for minting options will generate yield through strategies as basic as depositing UST into Anchor to running riskier and complex (farming, lending, etc) strategies. As an example, UST deposited in the put vaults will not only receive native token incentives and generate yield from the options premiums, but the deposited UST will also accrue interest (currently ~20%) through Anchor.

The act of selling volatility through options has provided sustainable sources of yield in traditional finance for years. **Sigma will unlock a vast array of high sustainable yielding strategies without the need to purely rely on inflationary token rewards.**

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Protocol Mechanism

Sigma Options are contracts which contain the configuration pertaining to a given option, as well as facilitate the minting, exercising, and settling of said options.

These contracts have **4 primary parameters**:

- the denominating currency/underlying asset pair
- whether the option is a call or a put
- the expiration date
- the strike price

To clarify, a call option represents the right to purchase a given asset at the specified strike price before the expiration date, whereas a put option represents the right to sell the asset at the specified strike price before the expiration date.

In the case of a call option, tokens will be minted with the underlying asset as collateral, and willt be exercised through the denominating currency, whereas put options are minted with the denominating currency used as collateral, and exercised with the underlying asset.

The Sigma Protocol employs a **dual-token system**, in which two separate CW-20 tokens are minted for each contract, at an equal rate. One token, the obligation-token, represents the right to either reclaim the collateral if the option is never exercised, or claim whichever asset was provided as payment upon exercising.

The other token, the exercisable-token, represents the right to exercise the option, and represents what we would consider an option in the TradFi context.

Sigma supports both American and European options, with an initial focus on European styled products to reduce complexity.

Exercise & Settlement

If an option expires in the money, user is required to provide both the exercisable-token as well as the funds to purchase the assets at strike price (call) or the asset to sell at the strike price in order to exercise the option. More specifically,

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Calls

A call option can only be exercised if the start time of the current block is before the expiration date set, and if the underlying asset's tokens are **greater than or equal** to the strike price, as defined by the provided oracle. In order to exercise, the user must pay the strike price in the denominating currency, as well as the exercisable-token itself, and they will receive a token of the underlying asset in return.

Puts

A put option can only be exercised if the start time of the current block is before the expiration date set, and if the underlying asset's tokens are **less than or equal** to the strike price, as defined by the provided oracle. In order to exercise, the user must deposit a token of the underlying asset, as well as the exercisable-token itself, and they will receive an amount of coins equal to the strike price in the denominating currency in return.

Sigma options will be initially settle through physical delivery, meaning that if the option expires in the money, the option will be settled with the underlying asset rather than cash.

Following a short period after the expiration date, holders of obligation-tokens can deposit them and receive their proportional shares of the collateral pool and exercising deposits pool. If no tokens were exercised, then the entire payout will be from the collateral pool; if every token was exercised, then the entire payout will be from the exercising deposits pool. In many situations, it will be a blend of both.

Market Efficiency Mechanism

("No-Arbitrage Condition")

Prior to the expiration date, a user can deposit one obligation-token and one exercisable-token and retrieve the collateral in return. This means for a call they would receive one token of the underlying asset, and for a put they would receive strike price in the denominating currency. Through this mechanism, the market is incentivized to fairly price both the exercisable and obligation tokens, otherwise arbitrageurs can simply buy and burn the obligation and exercisable tokens to retrieve the retrieve collateral, or mint new tokens and sell both, until the prices re-converge.

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Options Trading

To price options, multiple inputs are required (spot price, underlying volatility, strike price, time to expiry, and risk-free interest rate). The Black-Scholes-Merton (BSM) uses a lognormal distribution to model spot price & outputs theoretical options prices. As the parameters vary on a trade by trade basis, simple bonding curve AMMs where pricing only varies as a function of the token reserve is insufficient for pricing options. While there has been many innovations made in the space to deal with some of these parameters, the current AMM models have the fundamental requirement that LPs are take-only sellers with no pricing power. Price discovery is reduced as liquidity provided gets arbitraged against, leading to bleeding returns.

As a result, Sigma provide a **limit order book where users will be able to post orders across various strike prices and expiries** as well as a **vault system where users can mint/sell options with predefined strike prices**. There is significant complexity to provide liquidity at various strikes and expiries, so Sigma will also have a user-friendly interface consisting of various vaults with fixed expiries and strikes. Users will be able to deposit the underlying asset directly into the vault strategies. The bids will be done through an auction, with the lots allocated to the buyer with the highest bid price. If any lots remain thereafter, the next highest bidder is able to purchase his/her desired quantity ad infinitum. In the future Sigma will expand vaults to include more complex strategies with various risk appetites.

Unlike various other options related protocols that utilize vaults, Sigma's vault strategies will be able to provide significantly higher yields for most vaults. As an example, users depositing stablecoin (UST) into a cash-covered put vault will automatically have the UST zapped into Anchor, which provides additional fixed stablecoin interest. Current rates for most vaults products are under 20% while Anchor yields hover around 20%. This gives Sigma an immediate head start in attracting liquidity versus other project participants.

Users in these vaults can essentially imagine the following type of yield structure:

1. **Options Premiums** - Income received by options contract sellers.

2. **$SIG Token Rewards** - $SIG token rewards for protocol participation. These tokens can be additionally staked to received a portion of the fees generated (cf. Section 6).

3. **Accruable Collateral Yield** - Collateral in the vaults will be able to earn additional yield before expiry. UST deposits that will be required for put vaults will be put into Anchor Earn to receive interest on the stablecoin. Call vaults with collaterals such as LunaX will allow users to retain their staking rewards as well as all airdrops accruable to staked LUNA.

Example. Luna Put Vault

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Secondary Use Cases

Given that Sigma options are highly composable and only require a valid oracle to be minted, interesting use cases arise. These include,

- **De-peg insurance** - Non-UST stablecoins may be bridged into Terra and used as collateral to mint UST put options. Users looking to hedge UST downward de-peg risk would be able to exercise these options and claim the underlying non-UST stablecoin. Granularity for the level of de-peg can be easily adjusted through the strike price.
- **Principal Protected Vaults** - Users will be able to deposit UST into Sigma, which will be passed into Anchor Protocol. The yields then can be routed into weekly vault strategies that can be chosen by the users. For calls, the UST yield will be used to purchase the underlying asset and deposited into the vault. For puts, the UST yield will be deposited into put vaults to underwrite the corresponding options. Thus the initial deposit made by users will always be protected, regardless if the options are exercised. All weekly cashflows generated by this strategy will be rolled over into the next week along with the base Anchor yield.
- **Prediction Markets** - Digitial/Binary options allow for participants to make bets on certain outcomes of an event that can be verified either through an oracle feed, contract parameter, or governance. A completely two-sided market can be formed on the orderbook with users buying or minting/selling these options, representing each side of the bet.
- **IBC Assets** - Other potential Terra-native uses of Sigma options include options on the Anchor/Mars/Edge Protocol yield rates for hedging interest rate changes as well as utilizing Cosmos IBC to write options on/with Cosmos ecosystem tokens just as ATOM.

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Governance & Tokenomics

Sigma Protocol will have its own token, SIG, which will facilitate votes on:

- Whitelisted assets
- Whitelisted currencies
- Whitelisted oracles
- Option contract creation
- Project features & evolution
- Fees (exercising fee, settling fee, etc.)

Unlike many other ecosystem projects, Sigma will focus on providing sustainable yields through user vaults (see below) rather than providing high inflationary token incentives. The majority of SIG rewards will come through settling obligations at expiry. Additionally, SIG stakers will be returned some fees via staking, and some via participating in polls. Governance will feature a vote escrow locking system that will allow users to lock their SIG in return for the ability to boost and re-direct additional yields (generated by Anchor) to specific vaults or options.

SIG Value Accrual

To align long-term incentives of SIG holders with the growth of the protocols, $SIG tokens will accrue value in the following manners:

1. **Settlement Fees** - Fees will be collected when options are exercised and settled and will be deducted from the payout. These fees will be applied uniformly regardless if the settlements are made through the limit order book or through the weekly vaults. This structure is used to avoid taking fees from minters and liquidity providers in order to incentivize token creation and overall liquidity. These fees are accrued to xSIG stakers and will be paid out as-is or through buybacks.

2. **Vault Yield** - UST deposited will be put into Anchor Protocol to earn a fixed yield during the life of the option. The original deposits and premiums will accrue Anchor yield and then withdrawn before option expiry to earn additional yield. The collected yield will be initially provided to vault depositors but will be split between the original vault depositors and xSIG stakers (factored in with each staker's LIG boost) in the next iteration of updates.

3. **Vault Performance Fee** - A small performance fee will be charged for vault strategies which will be redirected to the treasury, which serves various functions include vault insurance.

3. **Staking** - xSIG tokens locked for a longer period will be eligible to accrue a greater portion of the above yields than those locked for a shorter period. xSIG staked for longer periods of time will proportionally increase the amount of SIG rewards received during options settlement (cf. below).

xSIG/LIG

The primary user case of SIG tokens will be allowing stakers to receive a portion of the SIG mining rewards.

1. **SIG ↔ xSIG** - Users who stake SIG tokens into governance will receive xSIG, which accrues value in SIG as fees are collected. This is similar to how aUST accrues value in UST. You can think of xSIG as a way to calculate the fees (ie. revenues generated by the protocol when options are settled) owed to the user. Half of the fees will be used to buy back SIG and the other half will be completely converted to UST. xSIG users (ie. SIG stakers) will be eligible to collect both of these pro-rata their stake. Note that xSIG can be unstaked to receive back the original SIG plus any fees accrued during the period. There are no lockups or penalties for staking SIG or unstaking xSIG.

2. **xSIG ↔ LIG** - Users who have staked SIG are able to further stake their xSIG in exchange to earn LIG (locked SIG). LIG is a non-transferrable token with the following properties:

    - 1 staked xSIG generates 0.012 LIG every hour
    - Maximum LIG held with a deposit equals to 100 times xSIG staked for the deposit
    - xSIG can be immediately unstaked at any time. However, all LIG accrued will be immediately removed (ie. LIG balance will reset to 0) if any xSIG is unstaked.

    This implies that an individual user will reach their maximum cap at roughly 1 year staked, assuming no increases in xSIG staked. LIG will be used to determine the amount of SIG settlement rewards from participating in option vaults (not to be confused with xSIG staking rewards/fees) that will be distributed. As user will have the following weighting scheme for determining rewards,

$$w_0 = \sqrt{l_0 \times d_0}$$

    where l_o is the number of LIG deposited by the user, and d_o is the amount deposited in the vault. Then the percentage of rewards that an individual user is able to claim per epoch/week is determined pro-rata the weighted stake over the total sum of all weighted stakes. That is,

$$r_0 = \frac{w_0}{\sum_i w_i} r = \frac{l_0 d_0}{\sum_i l_i d_i} r$$

    where r is the total rewards allocated to a specific vault. Note that this requires the user to commit/deposit a certain amount of LIG before the beginning of each epoch/week. However, the LIG is not consumed, and users are free to withdraw or deposit more LIG for the next week.

Token Distribution Breakdown

The total supply of SIG is 1,000,000,000 (one billion) and will be emitted over four years.

Category	% of Total Supply	Genesis	Year 1	Year 2	Year 3	Year 4	Year 5
Team	17% (170)	0	0	42.5	42.5	42.5	42.5
Foundation	15% (150)	6	36	36	36	36	0
Strategic Partners	3.5% (35)	0	0	17.5	17.5	0	0
Investors	10% (100)	0	0	25	25	25	25
Community Launch	7.5% (75)	75	0	0	0	0	0
Retroactive Rewards	3% (30)	0	30	0	0	0	0
Settlement Rewards	30% (300)	0	75	75	75	75	0
Protocol Treasury	14% (140)	20	40	40	40	0	0
Cumulative Supply	100% (1000)						

Numbers are denominated in millions (1,000,000) and the final distribution is subject to minor change.

- **Team tokens** will be subject to a 1 year cliff and linearly vested over 4 years. They are earmarked for both the current core team as well as future employees. Ensuring that interests are aligned for future collaborators will be a key factor for the continued success of Sigma, so we have set aside a large portion of the team tokens for future builders. New team members will be subjected to similar vesting schedules starting from their date of employment.
- **Investor tokens & Strategic Partner tokens** will be subject to a 1 year cliff and vest every month over 24 or 48 months respectively. Not all investor tokens may be sold, and any remaining tokens will be held by the Foundation. The core team has solely targetted investors and partners who will be able to continuously provide value in the form of product, protocol liquidity, and operational expertise.
- **Foundation tokens** will be held under multi-sig by the founding team. These tokens are solely used to provide additional incentives for vaults with partner protocol projects and occasionally fund operational costs. 6 million tokens will be distributed at genesis to support initial operations at launch (initial liquidity setting, vault market making, foundation partnerships), and 3 million will be vested monthly. As an example, co-tokens utilized to incentivize vaults using partner project collaterals will be executed from the foundation supply.
- **Community Launch** tokens will be available to community members to receive through Sigma's TGE via a LBP (Liquidity Bootstrapping Pool).
- **Retroative Rewards** will be a one-time event to wallets satisfying certain usership requirements in both the Terra ecosystem as well as within Sigma Protocol. The specific details will be announced in the future.
- **Settlement rewards** are tokens that will be distributed to those who settle options every week. They come in the form of rewards given to settlements on the order book as well as settlements in the vaults. The protocol will target ~250K SIG per week in the first year to avoid unnecessary inflation, but this number will vary depend on the number of active order book contracts and vaults. In the beginning, the tokens will be under multi-sig so that the rewards can be quickly adjusted depending on the number of initially supported assets for collateral. After the protocol's launch and stabilization, the rewards will be handed over to governance control. However, all decisions with regards to inflation will always go through a governance vote.
    - **Order Book Rewards** will be distributed weekly with token rewards allocate evenly across all of the top contracts by total supply for the corresponding week. Only users who settle or exercise the options will be eligible for the rewards pro-rata to their share of the corresponding contract pool.
    - **Vault Rewards** will also be distributed weekly with the rewards allocated evenly across a fixed number of vaults. If there are less than the total maximum number of vaults, the remaining rewards are returned to the vault rewards contract to be used in the next cycle ad infinitum.
- **Protocol Treasury tokens** are earmarked for bootstrapping the growth of Sigma through farming programs, community partnerships, and incentivizing individual stakeholders in the ecosystem to contribute to the protocol. Acting as the community pool, the majority of the tokens will be effectively locked but will be initially held under multi-sig to allow for effective deployment of funds for strategic initiatives.

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Team Experience

The Sigma Protocol founding team is entirely composed of current and former Terraform Labs employees, who were on the founding team of Mirror Protocol, have working experience with the core infrastructure of Terra, and have full understanding of Terra's economic design. This gives the team a high level of experience with the ecosystem, and a strong understanding of Terra's core mission. As some of the earliest members of the Terra ecosystem, Sigma will be able to be swiftly integrated into various other ecosystem projects.

The team are graduates of Princeton University, University of Pennsylvania, and top business schools in Canada. Prior to diving into the Terra ecosystem, the team members have worked as traders, researchers, and developers in some of the top quantitative funds in the world as well as SWEs at multiple FAANG+ companies. This provides the team with strong familiarity with managing complex financial instruments and understanding of existing Web3 projects/narratives.

Three sigmas above the rest

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