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 option owner the right, but not the obligation to buy or sell the asset, at the defined exercise price to the underwriter. The underwriter earns an upfront premium for assuming the obligation.

Options give traders and investors a variety of financial strategies, but the primary use cases are placed 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 additional asset exposure make options one of the most popular tools for leverage.

2. **Hedging** - Almost opposite of speculation, options are used to hedge downside risk. For example, buying a put option effectively reduces the downside risk of spot holdings. Given crypto's high volatility, where three-sigma events happen 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 (i.e., 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 premium. In exchange, the investor misses out on the opportunity of the additional upside past the expiry price. One can automate option underwriting strategies to provide consistent low-risk cash flow on assets.

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Introducing Sigma Protocol

Sigma is the first DeFi protocol that 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 that allows users to mint options with the necessary underlying collateral. In addition, the protocol implements vault infrastructure to solve the problem of option liquidity fragmentation arising from multiple strike prices and expiry dates for any particular asset, along with an order book for decentralized peer-to-peer trading. Sigma controls the entire options stack from base primitive, open market system, and strategies built on top. This allows Sigma to build upon the financial Lego blocks within the Terra ecosystem and provide superfluid usage of underlying option assets. Collateral for minting options may generate yield through various strategies, from depositing UST into Anchor to running riskier and more complex farming and lending strategies. As a tease, UST deposited in the put vaults will not only receive native token incentives and generate a yield from option premiums, but the deposited UST will also accrue interest through Anchor.

Sigma further improves the options space by allowing options to be denominated in any Terra native coin and backed by the underlying spot CW20 asset (LUNA, ANC, mAssets, LP tokens, etc.), yielding a Terra-native decentralized options ecosystem for participants. With IBC and various bridges, Terra-native users can gain significant exposure to non-native assets on the Terra chain without the need for sufficient underlying spot liquidity.

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 purely relying on inflationary token rewards.**

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Protocol Mechanism

Sigma Options are smart contracts that hold the details about any 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

A call option represents the right to purchase a given asset at the specified strike price before the expiration date. In contrast, a put option represents the right to sell the asset at the specified strike price before the expiration date.

Call options are minted with the underlying asset as collateral and exercised through the denominating currency. On the other hand, put options are minted with the denominating currency 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 option at an equal rate. One token, the obligation-token, represents the right to reclaim the proceeds of the transaction. The other token, the exercisable-token, represents the right to exercise the option.

Traditional options strictly couple debtor and creditor of a single contract, meaning that whether an option has been exercised or not is binary. This is less conducive to the DeFi space, as it is preferable for all obligation-token holders to have equal outcomes, which would be challenging to capture in cases where only a fraction of an option's exercisable-tokens are exercised. Consequently, Sigma divides all assets owned by the contract into two collateral pools shared across all token holders: one for the denominating currency, and another for the underlying asset.

Sigma supports both American and European options, with an initial focus on European options in Vaults and American options on the CLOB.

Exercise & Settlement

If an option expires in the money, the user can exercise the option by providing both the exercisable-token and the funds required to purchase or sell the asset at the strike price.

Calls

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

Puts

A put option may only be exercised if the start time of the current block is before the expiration time and if the underlying asset's tokens are **less than or equal** to the strike price, as defined by the provided oracle. To exercise, the user must deposit tokens of the underlying asset and the exercisable-token itself. The exerciser will receive the number of coins equal to the strike price in the denominating currency in return.

Sigma options will initially be settled through physical delivery, meaning that if the option expires in the money, the option will be settled with the underlying asset rather than cash. European options differ from the American options described above in one way: they may only be exercised within a short window **after** the expiration time.

After expiry, once the options can no longer be exercised, holders of obligation-tokens can redeem them for their proportional shares of the two collateral pools. If no exercisable-tokens are exercised, the holder will simply reclaim their collateral. Otherwise, the holder will receive their proportional share of any remaining collateral and whichever asset was provided as payment upon exercising.

Market Efficiency Mechanism

Prior to the expiration time, a user can deposit one obligation-token and one exercisable-token and retrieve the underlying collateral in return. This means for a call they would receive one token of the underlying asset, and for a put they would receive coins equivalent to the strike price in the denominating currency. Through this mechanism, the market is incentivized to fairly price both the exercisable and obligation tokens. In the event that the tokens are underpriced, arbitrageurs can simply buy and burn the obligation and exercisable tokens to retrieve the collateral at a discount. Conversely, if the obligation and exercisable tokens are overpriced, arbitrageurs can 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 log-normal distribution to model spot price and 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, are insufficient for pricing options. While there have 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 provides 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.

Due to the composability of Sigma's smart contracts, vault strategies will be able to provide significantly higher yields. For example, users depositing stablecoins (UST) into cash-covered put vaults will automatically have the UST accrue interest in Anchor, a Terra-native lending protocol. The ability to stack yields gives Sigma an immediate head start in attracting depositors.

Users in vaults can expect the following type of yield structure:

1. **Options Premiums** - Income received by underwriting and selling options through the auction process.

2. **$SIG Token Rewards** - $SIG token rewards for protocol participation. These tokens can be additionally staked to receive a portion of Sigma's revenues (cf. Section 6).

3. **Accruable Collateral Yield** - Collateral in vaults will be capable of earning additional yield prior to 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** - Digital/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/Misc.** - Cosmos IBC can be utilized to write options on/with Cosmos ecosystem tokens such as ATOM, OSMO, and JUNO. Other potential Terra-native uses of Sigma options include hedging against interest rate changes on Anchor/Mars/Edge Protocol yields.

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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.)

Sigma will focus on providing sustainable yields through various options strategies and vaults (see below) rather than using high inflationary token incentives. The majority of SIG rewards will be provided to users who are highly involved with the protocol. Additionally, SIG stakers will receive some portion of protocol revenues in the form of rewards. Governance will feature a mechanism 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 are collected when options are exercised or settled. Fees are baked into the option primitive and thus uniformly apply regardless if the settlements are made through the limit order book or through vault strategies. This structure is used to avoid taking fees from minters and liquidity providers in order to incentivize token creation and overall liquidity. Fees are accrued to xSIG stakers and will be paid out as-is or through buybacks.

2. **Vault Yield** - UST premiums and deposits used to underwrite put vaults are placed into Anchor Protocol, earning a fixed yield throughout the lifetime of the option. Upon launch, the collected yield will be provided to vault depositors. In the future, some portion of this yield will be diverted to xSIG stakers (relative to each staker's LIG boost).

3. **Vault Performance Fee** - A small performance fee will be charged for vault strategies which will be redirected to the treasury to seed an insurance fund.

4. **Staking** - xSIG staked for longer periods of time will proportionally increase the amount of SIG rewards received during option settlement (cf. below).

xSIG/LIG

To recieve benefit from the various methods of value accruel defined above, users must partake in the following locking mechanisms.

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 protocol's revenues will be used to buy back SIG and the other half will be completely converted to UST. xSIG holders will be eligible to collect both of these pro-rata their stake. Note that xSIG can be unstaked to reclaim the original SIG with a short unstaking period.

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

    - 1 staked xSIG generates 0.012 LIG per hour
    - Maximum LIG balance is capped at 100 times the xSIG staked
    - If **any** xSIG is unstaked, which can be done without a lockup, the user's entire LIG balance will reset to 0

    This implies that an individual user will reach their maximum cap in roughly 1 year, 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 protocol revenue disbursements). Users will have the following weighting scheme for determining rewards in vaults,

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

    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 48 and 24 months respectively. Not all investor tokens may be sold, and any remaining tokens will be held by the Foundation. The core team has solely targeted long-term minded 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).
- **Retroactive Rewards** will be a one-time event to wallets satisfying certain usership requirements in both the Terra ecosystem as well as within Sigma. The specific details will be announced in the future.
- **Settlement rewards** are tokens that will be distributed to those who settle options every week. These rewards will be disbursed across both vault and order book users. The protocol will target ~250K SIG per week in the first year to avoid unnecessary inflation, but this number will vary depending 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 put under governance's 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 allocated 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 a 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. Members on the team have helped design and build Mirror, Anchor, and Ozone Protocols and have a working experience with the core infrastructure of Terra. This, along with a strong understanding of Terra's economic design, gives the team a high level of experience with the ecosystem and Terra's core mission. As some of the earliest members of the Terra blockchain, Sigma will be able to be swiftly integrated with various other ecosystem projects.

The team is composed of graduates from 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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