OpusDigital: A Blockchain Option Protocol

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I. Abstract

OpusDigital (Opus) is a blockchain native fintech firm dedicated to democratizing the financial markets with its total solution for on-chain options trading and investing.

Following in the crypto industry's disruptive path, Opus is building an autonomous marketplace for minting, pricing, and trading option smart contracts. Decentralized, Opus simultaneously empowers and rewards its investing liquidity providers with the economic benefits of passive market making and its trading liquidity takers with access to option products and world class risk management solutions.

As money and markets truly enter the digital age, Opus is pushing past old boundaries and building new frontiers for the infinite game that technology plays best.

II. Introduction

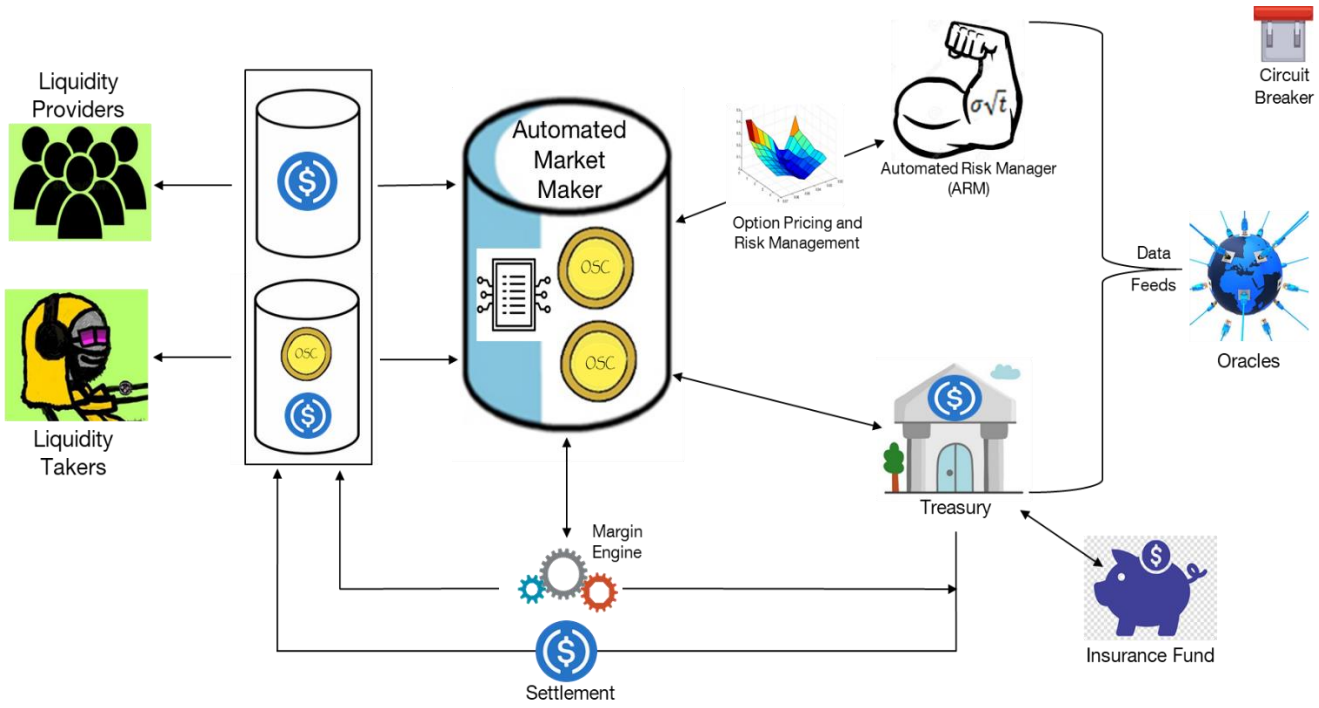
The derivative markets date back centuries and have grown to become a critically important part of a fully functioning, sustainable, and scalable financial system. A vital source of risk management and economic leverage, Opus knows the important role derivatives will play in the nascent crypto industry's ability to mature into a commercially viable and fully adopted financial marketplace.

Over the last several years, options trading volumes for cryptographic assets like BTC and ETH have grown exponentially on OTC, CeFi, and DeFi marketplaces. Consistent with crypto's blockchain DNA, Opus believes all financial markets - especially the derivative markets - should fully migrate on-chain where they can be made transparent, interoperable, and accessible for anyone, anywhere, and anytime.

Recently, there has been a surge of decentralized option vaults (DOVs) creating access to the crypto options market. A novel source of option driven yields, DOVs gained immediate traction but quickly peaked as they are proving to be an inefficient option trading solution with a myriad pricing, structuring, and risk management limitations.

Developed, honed, and proven over 25 years on the frontline of TradFi trading, Opus has a better way to leverage the blockchain's power to bring simple market and trading access to the masses. Through a combination of smart contract driven AMM and ARM technologies, Opus codifies the process employed by TradFi market makers to mint, price, and trade options in a permissionless, trustless, and capital efficient manner.

OpusDigital Markets Ecosystem



III. Innovations

The Opus protocol implements the following key innovations:

1. Permissionless decentralized peer-to-pool option trading platform
2. Opus Users
3. OpusAMM
4. OpusARM
5. Option Smart Contract (OSC-01)
6. OpusTreasury
7. Insurance Fund
8. Liquidity Pool Units
9. Composability
10. Circuit breakers

This whitepaper will cover the above key innovations in detail.

1) Permissionless decentralized peer-to-pool option trading platform

Opus' marketplace creates a decentralized peer-to-pool option trading platform. This permissionless trading obviates KYC and AML documentation. All transactions are transparent and trustless as OpusAMM and OpusTreasury functions disintermediates trading and settlement risks for Opus users who retain full control over their private keys and ownership of their assets. Elimination of the traditional market maker role will lead to more competitive prices.

Opus Users

The protocol services two distinct user roles: Liquidity Providers (LP) and Liquidity Takers (LT). These users are either passive market makers or option traders.

A. Liquidity Providers

LPs are the financial backbone of the Opus ecosystem by providing the liquidity that powers the protocol. As an investing LP, stablecoins (ex. USDC) are deposited in an LP liquidity pool and returns are accrued through bid/offer spreads, LT transaction fees, and profitable management of the LP liquidity pool's aggregate position.

LPs will transfer USDC from their personal wallet to OpusTreasury where it will be used as collateral to fund LT trading. In return, LPs will receive liquidity pool units (LPU) which reflect their pool percentage ownership. The NAV of an LPU will be calculated by OpusTreasury and calculated as:

$$\text{LPU NAV} = (\text{Liquidity Pool Value}) / (\text{Total LPU Units})$$

LPs will be able to withdraw their liquidity at the end of day LPU NAV price payable T+1.

B. Liquidity Takers

1. Sellers

Opus' flexible margin calculator (OpusFlex) improves capital and trading efficiencies by allowing LTs to choose to sell options on bespoke margin terms. LTs will deposit margin collateral into their OpusTreasury account where it will be continuously marked to market and displayed in their respective LT account dashboards.

LT positions are auto-liquidated by OpusTreasury if a predetermined price level trades before additional capital is deposited. The onus is on the LT to track their margin collateral requirements. If the LT wants to avoid a close liquidation price level they can choose to deposit more collateral, a higher margin amount or both. The OpusFlex calculator will be available in LT's personal dashboard.

2. Buyers

Option buyers deposit full option premium for each option purchased into OpusTreasury. Long options are netted against short option positions to realize collateral management efficiency.

All option contracts are auto exercised by OpusTreasury and USDC settled.

2) OpusAMM

OpusAMM provides 24/7/365 option liquidity. Option premiums are calculated using the Garman Kohlhagen pricing model (GKPM) for European style options. The GKPM accounts for two interest rates to correct the Black-Scholes-Merton model's limiting assumption that borrowing and lending takes place at the same interest rate.

GKPM inputs are sourced via external oracles (ex. Chainlink) and the OpusARM:

Model inputs:

a) Spot/Forward Price
b) Maturity
c) Strike Price
d) Domestic Interest Rate (Rd)
e) Foreign Interest Rate (Rf)
f) Implied Volatility

Implied volatility price are adjusted by Opus' proprietary models and guided by the LP pool's positions. Similar to spot AMMs, volatility arbitrageurs are expected to aid in curve adjustment and LP position management by trading with Opus when its implied volatility prices are out of line with the broader market.

Garman Kohlhagen Pricing Model

European vanilla option payoffs are calculated using spot at maturity (St) and the strike (K):

$$Payoff_{call} = max(S_T - K, 0)$$
$$Payoff_{put} = max(K - S_T, 0)$$

Option prices in CCY2 per CCY1 (i.e., CCY2 pips) terms:

$$Price_{call} = Se^{-rCCY1.T}N(d_1) - Ke^{-rCCY2.T}N(d_2)$$
$$Price_{put} = Ke^{-rCCY2.T}N(-d_2) - Se^{-rCCY1.T}N(-d_1)$$

where:

$$d_1 = \frac{\ln\left(\frac{S}{K}\right) + \left(rCCY2 - rCCY1 + \frac{\sigma^2}{2}\right).T}{\sigma\sqrt{T}}$$

$$d_2 = \frac{\ln\left(\frac{S}{K}\right) + \left(rCCY2 - rCCY1 - \frac{\sigma^2}{2}\right).T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}$$

and σ is the volatility of the spot log returns.

Volatility Curve Surface Construction

Implied volatility term surface calibration keeps option prices in line with the current market and trading conditions. Interpolation uses accumulated weighted daily variances between curve tenors. Weights reflect each individual day's value according to business days, non-business days, and important events. Holidays and weekends are substituted with a constant weight and inwards interpolation towards the 1d tenor and outwards interpolation is used:

The weighted daily variance:
Let $A(d) = vol(d)*vol(d)*d$ at day d

Then daily variance between days d(t) and d(t+1) is defined as:
$D(v) = [A(dt+1)-A(dt)]/[d(t+1)-dt]$

Weighted daily variance between days dt and d(t+1) is defined as:
Let $W(d) = \sum$(Wi be the weight accumulated till day d)

Then weighted daily variance between days dt and d(t+1) is defined as:
$dVw=[A(dt+1) – A(dt)] / [W(dt+1)-W(dt)]$

Now the interpolated A(d) is:
$A(d) = A(dt) + dVw * [W(d)-W(dt)]$

Yielding:
$Vol(d) = \sqrt{A(d)/d}$

On top of accumulated volatility interpolation, a smoother transition of weighted daily variance between tenors is volatility differentiable in time to the second order: $= A(dt+1) > A(dt)$

Forward Curve Construction

Yield curve and forward curve construction (i.e., cross currency yields) are needed to discount the base (ccy1) and term (ccy2) currencies. Interpolations are performed on continuously compounded zero coupon rates which are themselves calculated from given US deposit rates and forward points. These continuously compounded zero coupon rates are converted back into deposit rates and forward points.

Discount factors are calculated from the deposit rates according to the following formula:

$$DiscountFactor = 1 / (1+Depo*T)$$

3) OpusARM

OpusARM is an implied volatility curve calibration and risk management protocol. As LPs are in effect passive market makers, they will neither make prices nor risk manage the LP pool portfolios. Option prices will be sourced from the OpusAMM and risk management of the LPs positions will be managed by an off-chain protocol. Initially in our ecosystem, LP positions will be managed by the OpusARM which sits off-chain and works independently from the OpusAMM.

Using volatility oracle feeds, relative value volatility arbitrage, and algorithmic optimization, the OpusARM determines what volatility is worth and how and when to position across implied volatility surfaces to maximize LP portfolio risk/reward. Analogous to the efficient frontier in traditional portfolio management, the OpusARM works to keep the LP's portfolio on or above the efficient risk/reward ratio frontier. This proprietary volatility surface will be used by the OpusAMM to make option markets. It will also be used to determine the most efficient way to hedge the portfolio risks of the LPs.

We envision that in the future, LPs will be able to determine for themselves if they want to manage their own portfolios or if they want to use a third party and who that third party would be using token governance. In fact, one might envision a world where retail LPs will want that risk managed by the OpusARM, while a hedge fund might want to manage the risk by themselves off-chain

4) Option Smart Contract (OSC)

To allow for more options payoffs types and expiration logic a new token standard that can manage multiple options, store more data, and is gas efficient is needed.

New functions built in this standard will allow users to economize their gas fee spend, by optimizing purchases, sales and exercise of options in batches. This batching mechanism will also help in the "packaging" of options.

Existing structures, such as AMM exchanges or lending platforms will need to be updated to recognize this new standard if accepted by the market. With this, options with the same standard will be able to be exchanged in the secondary market.

5) OpusTreasury

OpusTreasury is the custodian for LP deposits, LT margin collateral, and the insurance fund's escrow account and serves to:

a) Ensures LT aggregate position risk is in balance with LP pool's aggregate liquidity,
b) Work with the margin and liquidation engine (MLE) to manage LT's margin collateral requirements and liquidations,
c) Manages expiration cash settlement procedures,
d) Maintains real time position and mark-to-market updates on the LP's and LT's dashboards,
e) Collect a percentage of LP fees for the insurance fund esrow account

Each option traded by the LT community creates a corresponding change in LP collateral available and is monitored by OpusTreasury to guarantee cash settlement liquidity for each open option position.

The amount of liquidity in an aggregate LP pool will be tracked using three storage variables:

a. Total Liquidity
b. Total Notional Value
c. Total Locked Liquidity

The Total Liquidity variable tracks the total amount of liquidity deposited by LPs for a given asset. The amount deposited by each user will be tracked using UserLiquidity(userAddress)

The Total Notional Value variable will track the amount of maximum liquidity that is capable of being transacted for a given pool.

The Total Locked Liquidity variable will track the amount of the Total Notional Value variable that is being used by LTs. This liquidity needs to be locked because it is backing current open positions of the LTs.

The liquidity deposited for each LP account will be tracked using three storage variables:

a. User Liquidity (userAddress)
b. User Notional Value (userAddress)
c. User Locked Liquidity (userAddress)

The amount for each LT account will be reported using User Notional Value (userAddress) where the function requires the list of positions as an input.

The amount of Locked Liquidity for each user account will also be computed using the User Locked Liquidity (UserAddress).

Note: Since LP pools will carry large option inventories, it's computationally difficult to manipulate an array of positions if it were stored in smart contracts. It's simpler to require the protocol to supply the position list off-chain and have the smart contract loop through the provided list to check that the number of positions matches the option balance.

Custody, Expiration and Settlement, and Margining Solutions

Custody

Ensuring protocol security is of the highest importance. To this end, annual smart contract security audits will be conducted and multisig technologies employed. Opus will also collaborate with advanced self-custody solutions and offer bounties for security vulnerabilities identified by any third parties.

Expiration and Settlement:

OSC expiration will be managed by OpusTreasury. OSCs are European style, exercised at maturity, and USDC cash settled. OSCs are auto-exercised using OpusTreasury calculated fixings equal to the average price during the 15 minute period between 7:45 AM and 8:00 AM UTC. LT and LP positions and cash balances settlement will clear immediately and be reflected in their respective dashboards.

Margining

The selling of under-collateralized options creates risks for LPs since they are lending their liquidity to option sellers who may lose their capital if the LT has not posted sufficient collateral to cover their position margin requirement.

Margin collateral is managed on a portfolio level enabling LTs to deploy their capital more efficiently. When a LT enters a trade, OpusTreasury will query their collateral to ensure that sufficient margin is available to enter the trade. As an LT's position changes, OpusTreasury updates and nets accordingly. As positions are settled, profits and losses will be swept back into collateral.

OpusTreasury's MLE secures the LPs by liquidating positions and removing risks of unrecoverable LT losses.

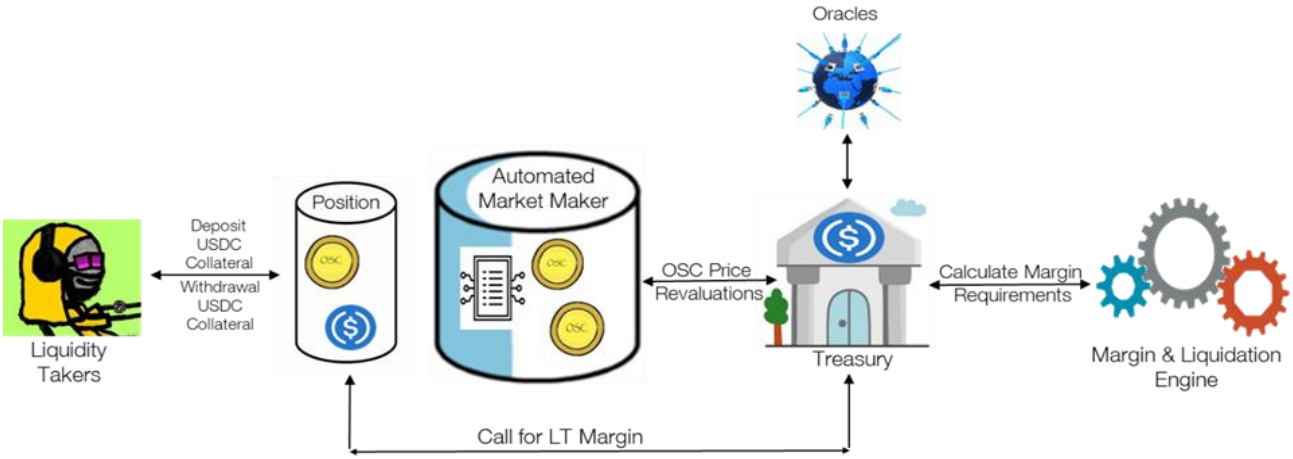
Margin requirements will be set as follows:

For Long Positions: ***min(100% * mark price, 10% of spot)***

For Short Call Positions: ***max((20% - OTM Amount/spot)*spot), 12.5%* spot)***

For Short Put Positions: ***min(max((20% - OTM Amount/spot)*spot,12.5%*spot), 50% of strike)***

Opus reserves the right to change margin requirements higher or lower as market conditions warrant.



6) Insurance Fund

Although the MLE is in place to protect LPs from LT losses, Opus will add another layer of protection via an insurance fund to cover cases of unrecoverable LT losses. OpusTreasury manages the insurance fund and will escrow a percentage of the LP management fees paid to Opus. The state of the insurance fund will be continuously disclosed and fully transparent to all LPs via their personal dashboard. If the insurance fund is depleted, LT losses will be socialized by the LPs while the fund is replenished. The insurance fund will initially contain no funds and will increase over time as LP management fees are released.

7) Liquidity Pool Units (LPU)

LPUs will represent a pro rata share ownership of each liquidity pool. LPUs NAV is calculated by OpusTreasury and reflects the total value the pool's positions at 8:00 AM UTC:

$$\text{LPU NAV} = (\text{Liquidity Pool Value}) / (\text{Total LPU Units})$$

LPUs will be self-custodied and can theoretically be traded at other AMMs and used as collateral in lending platforms.

8) Composability

OSCs are a new tokenization standard and will allow for the eventual trading of options away from Opus' DEX. This composability when achieved will allow for greater growth of the ecosystem.

9) Circuit Breaker

Market security and stability are Opus' first priority. Consequently, Opus needs to be able to halt trading, stop withdrawals, liquidations, or settlements from occurring at any time it deems non-market related risks place the DEX at risk.

To this end, "circuit breaker" timeouts will be used to slow or completely stop trading. During a circuit breaker halt, Opus can override oracle feeds, pricing parameters, and all internal controls it deems needed to maintain Opus' operational integrity. A circuit breaker will be automatically used if mechanical failure occurs or if there are any significant bugs, oracle risks, or a perceived or real threat or occurrence of theft or cyberattack. The circuit breaker length will be dictated by mitigation of the event that led to the circuit breaker being used. Resumption of trading will occur when all issues are resolved. Settlement or early settlement will occur if the DEX is expected to be down for an extended period of time. Early settlement will use AMM determined prices and funds will be available to be withdrawn on trading's resumption.

Opus will use all customary media channels to communicate and make announcements on issues and current operational status as needed.

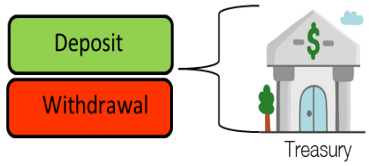
IV. User Interface Examples

1) Liquidity Provider Dashboard

OpusTreasury manages LP community and individual LP account activity and displays it in a dashboard format on the OpusMarket's website. Account activity includes trades, deposits, withdrawals, exercises, expirations, and cash settlements. The sources of returns for LPs are market making returns and ARM profitability. The LPs performance is proportional to the number and the time LPUs are held. Historical pool activity will be posted. Deposits are credited immediately and withdrawals are made on a T+1 basis.

Community Dashboard	
BTC Liquidity Pool	
Pool NAV (USDC)	102,500,209
LPU (NAV)	18.18
LPU (#)	5,638,075
APY	15.25%
APY (last 30 days)	2.25%
LPs (#)	3,520
Pool Utilization	76.7%
ETH Liquidity Pool	
Pool NAV (USDC)	214,710,209
LPUs (NAV)	12.09
LPUs (#)	17,759,322
APY	28.76%
APY (Last 30 days)	2.66%
LPs (#)	10,127
Pool Utilization	56.1%

LP Dashboard	
BTC Liquidity Pool	
Balance (USDC)	305,102
LPU (NAV)	18.18
LPUs (#)	16,782
APY (ITD)	12.62%
APY (last 30 days)	2.25%
Pool Ownership	0.30%
Pool Time	272 Days
ETH Liquidity Pool	
Balance (USDC)	105,102
LPU (NAV)	12.09
LPUs (#)	8693
APY (ITD)	62.12%
APY (last 30 days)	3.15%
Pool Ownership	0.05%
Pool Time	172 Days



Pool Activity

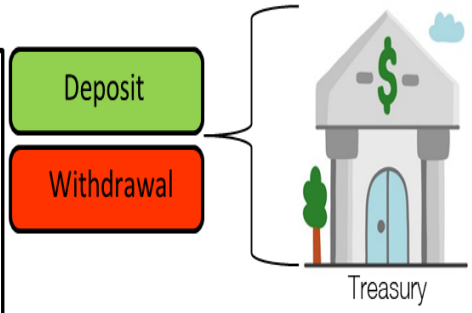
Trade Date	Trade Time	Contract	B/S	Amount	Maturity	Strike	P/C	Premium (USDC)	Polyscan
26-May-22	16:05:03	BTC.USDC.20220608.31500.C	S	10	8-Jun-22	31500	C	175,035.25	
27-May-22	17:05:03	BTC.USDC.20220809.33500.C	B	6	9-Aug-22	33500	C	66,036.35	
28-May-22	18:05:03	ETH.USDC.20220910.2750.P	B	35	10-Sep-22	2750	P	115,037.12	
29-May-22	19:05:03	ETH.USDC.20221105.2650.P	S	105	5-Nov-22	2650	P	235,038.05	
31-May-22	20:05:03	BTC.USDC.20221212.28500.P	S	5	12-Dec-22	28500	P	50,039.10	

2) Liquidity Taker Dashboard

OpusTreasury manages all LT account activity and displays it in a dashboard format. Account activity includes trades, deposits, withdrawals, exercises, expirations, and cash settlements. Open positions reflected on the open position blotter and will be revalued continuously. Liquidation levels will be reflected in real time on the LTs statement.

Daily Statement (USDC)

Beginning Balance	39071.09
Current Months Activity	39071.09
Ending Balance	39071.09
Net Option Premium	27,775.61
Options Market Value	9150.21
Account Value at Market	32766.58CR
Initial Margin Required	27,767.00
Maintenance Margin Required	25,242.00
Margin Excess/Deficit	12,623.19CR
Liquidation Levels	
BTC	$31,700
ETH	$ ----

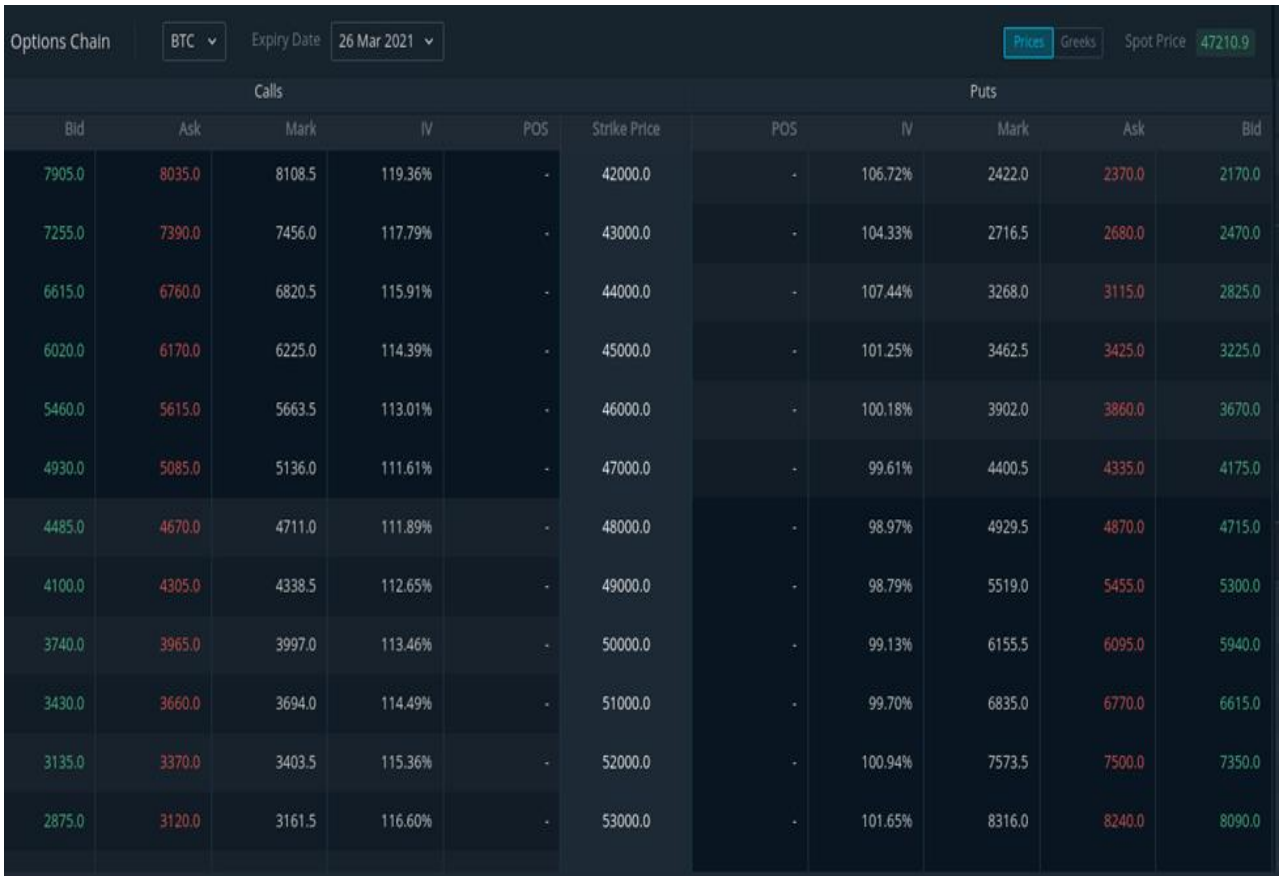


Open Position

Asset	B/S	Amount	Maturity	Strike	C/P
BTC	B	100	27-Apr-22	42000	C
BTC	S	50	04-May-22	44000	C
BTC	S	150	18-May-22	34000	P
ETH	B	700	29-Apr-22	3350	C

3) OSC Pricing Chain Interface (OPCI)

The AMM will mint preset OSC call and put price chains which are displayed on the OSC Price Chain Interface (OPCI). The number of OSC maturities and strike prices will be algorithmically determined according to open interest both internally and at external exchanges, bespoke LT minting decisions, and underlying market volatility. New chains will be added as others expire. Prices will be updated continuously.



Calls						Puts				
Bid	Ask	Mark	IV	POS	Strike Price	POS	IV	Mark	Ask	Bid
7905.0	8035.0	8108.5	119.36%	-	42000.0	-	106.72%	2422.0	2370.0	2170.0
7255.0	7390.0	7456.0	117.79%	-	43000.0	-	104.33%	2716.5	2680.0	2470.0
6615.0	6760.0	6820.5	115.91%	-	44000.0	-	107.44%	3268.0	3115.0	2825.0
6020.0	6170.0	6225.0	114.39%	-	45000.0	-	101.25%	3462.5	3425.0	3225.0
5460.0	5615.0	5663.5	113.01%	-	46000.0	-	100.18%	3902.0	3860.0	3670.0
4930.0	5085.0	5136.0	111.61%	-	47000.0	-	99.61%	4400.5	4335.0	4175.0
4485.0	4670.0	4711.0	111.89%	-	48000.0	-	98.97%	4929.5	4870.0	4715.0
4100.0	4305.0	4338.5	112.65%	-	49000.0	-	98.79%	5519.0	5455.0	5300.0
3740.0	3965.0	3997.0	113.46%	-	50000.0	-	99.13%	6155.5	6095.0	5940.0
3430.0	3660.0	3694.0	114.49%	-	51000.0	-	99.70%	6835.0	6770.0	6615.0
3135.0	3370.0	3403.5	115.36%	-	52000.0	-	100.94%	7573.5	7500.0	7350.0
2875.0	3120.0	3161.5	116.60%	-	53000.0	-	101.65%	8316.0	8240.0	8090.0

4) OSC Pricing and Minting Calculator (OPMC)

The OMPC is AMM driven and will be accessed from the OPCI page and be used by LTs to price and mint OSCs whether trading preset OSCs or creating their own.