BTCStable: A Comprehensive Framework for a Bitcoin-Backed Stablecoin

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Abstract. This whitepaper introduces BTCS, a groundbreaking stablecoin operating on the Core network, designed to harness the inherent value and decentralization of Bitcoin (BTC). BTCS combines direct BTC backing with perpetual shorts and yield-generating assets, orchestrated by a dynamic collateralization ratio (DCR) to ensure robust stability and responsiveness to market dynamics.

Central to BTCS' architecture is the integration of a Reserve Value Monitoring (RVM) engine and a Stabilization Reserve Fund (SRF), which together facilitate real-time asset management and peg stabilization. By leveraging real-time DCR adjustments and sophisticated yield optimization strategies, BTCS is designed to extract stability from the world's largest cryptocurrency.

1. Overview

The expansion of a stablecoin sector insulated from centralized-issuer risk necessitates the creation of a stablecoin intimately connected with the ethos of blockchain finance. Such a protocol requires the creation of a stablecoin that is most closely tied to the cryptocurrency's leading asset, Bitcoin (BTC). This BTC stablecoin (BTCS) must balance the challenges of scalability, centralization, and efficiency, as highlighted by Tushar Jain of Multicoin Capital.[1] To accomplish this challenge, BTCS will be 100%+ collateralized by a dynamic basket of BTC and yield-generating assets such as LSTs, RWAS, or professionally managed derivatives positions. Downside BTC price action will be hedged via the utilization of on-chain BTC-USD perpetual contracts (perps).

2. High-level Architecture

The BTCS issuing process begins with KYC-approved users depositing BTC into the BTCS minting system. Upon deposition, the minter will receive one BTCS for each dollar that BTC is valued at in accordance with a decentralized oracle's pricing data, such as Chainlink, Pyth, SupraOracles, etc., minus any minting contract fees. From there, the BTCS can be permissionlessly traded, staked, lent, and issued to other chains in alignment with ERC-20 token standards and third-party protocol support. On the backend, the BTCS system oversees a dynamic basket of collateral and manages hedging strategies to ensure the stability and scalability of the protocol.

2.1 Collateralization

Collateralization mechanisms for stablecoins are measured on a spectrum of efficiency and stability. Highly collateralized stablecoins, such as those with a ratio of 2:1 collateral to stablecoin, are highly stable yet

[1] https://multicoin.capital/2021/09/02/solving-the-stablecoin-trilemma/

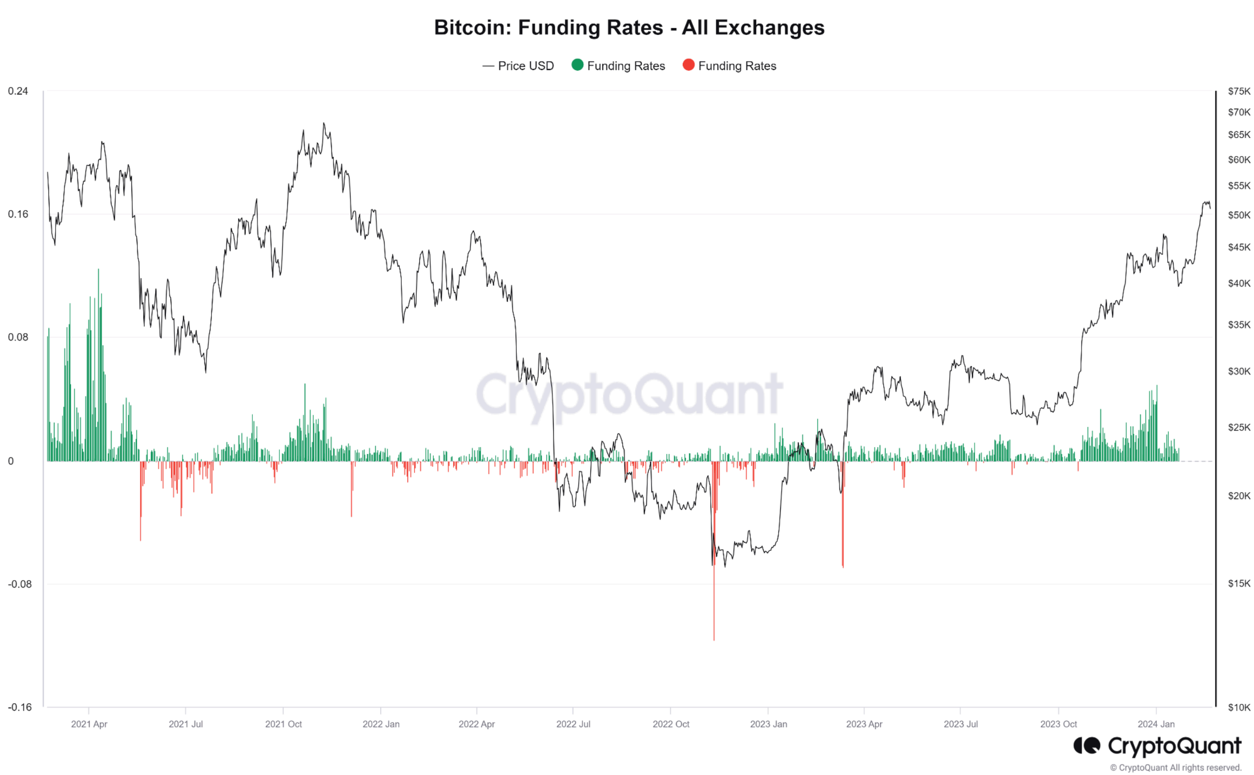
inefficient when it comes to capital utilization. Undercollateralized stablecoins, 0.5:1, can be considered highly efficient yet comparatively unstable. BTCS will maintain as close to 1:1 collateralization as possible, with a tendency towards over-collateralization. BTCS collateral will be divided across BTC held in reserve, BTC used for perp collateral, and yield-generating assets such as LSTs or STBT. The ratios will be informed by an actuarial analysis led by BTCS' risk management partner.

2.2 Hedging Strategies

BTCS downside price risk exists when the dollar value of BTC drops. If left uncontrolled, this price drop could lead to undercollateralization and potential depegging. To limit this risk, BTCS will initially short BTC-USD via on-chain perpetual swaps at 1x leverage. With this strategy, as the value of BTC decreases, the value of the short position will increase, effectively creating a delta-neutral hedging position. With such a position, BTCS can maintain collateralization levels and support the peg. A basket of separate yield-generating assets will better support portfolio growth, improving collateralization or the circulating supply of BTCS on Core. The following subsections will discuss the prevailing risks of using perps for BTCS risk control and for their mitigation strategies.

2.2.1 Funding Rate Risk

While shorting BTC, BTCS runs the risk of backwardation if the BTC spot price exceeds futures prices. In such a scenario, BTCS would have to pay longs at the market-determined funding rates. A three-year analysis of BTC margined funding rates demonstrates a high favorability toward contango in both the duration and magnitude of rates. This means that positive markets are more common, and BTCS is likely to be funded over time. It would be unwise, however, to rely solely on past funding rate behavior to indicate future performance. As such, BTCS will utilize yield from yield-generating assets to offset the costs of funding rates in negative



markets. Excess yield will be utilized to increase collateralization of shorts, held in reserve for funding rate payments, or accumulate additional BTC for reserves.

2.2.2 Basis Risk

The second risk factor when employing perpetual swaps is basis risk, which refers to the divergence in the value of the perpetual swap from the underlying asset, in this case, BTC. Consider BTCS opens a short position in BTC perpetual swaps with 1 BTC valued at $40,000, establishing the notional value of the short at $40,000. If the spot price of BTC rises to $41,000 but the perpetual swap's price only advances to $40,500, rather than the expected $41,000, BTCS encounters basis risk.

Basis risk directly impacts the profit and loss of BTCS' hedging strategy. Ideally, if the perp price matched the spot price movement perfectly, the profit from the short position would negate the increase in the spot value of BTC, resulting in a neutral outcome. Yet, with the perp price lagging at $40,500, the short position only yields a $500 gain, not the $1,000 needed to counterbalance the spot market's rise fully. Consequently, BTCS faces an unmitigated exposure of $500. Several options exist to offset this incomplete hedge. The first is to wait until perp and spot prices converge before closing the position. Alternatively, BTCS can utilize yield from the yield generating positions to offset losses for a position that must be closed immediately. However, the core mechanism for mitigating basis risk is holding a pre-determined amount of BTC in reserve to fulfill redeeming demand. In doing so, perp positions would not have to be unwound, and basis risk is wholly avoided.

2.2.3 On-chain Liquidity Constraints

BTCStable is built on Core, a BTC-powered EVM blockchain network leveraging Satoshi Plus consensus. As a newly emerging ecosystem, one evident risk is market fragmentation, where the on-chain perp volume operates out of alignment with prevailing market conditions. With BTCS supplying consistent short volume on the ecosystem, there could come a point where funding rates do not match larger, centralized venues. As a result, BTCS may end up funding longs when most of the market is positive. BTCS can diversify through multiple on-chain trading venues to mitigate this risk and open deals with institutional traders to shift BTC liquidity through more optimal routes. Given RBL's network of enterprise connections, numerous partners can be chosen to control portfolio strategy and handle BTC custody. These institutional investment firms would interface with trusted BTCS custodians to generate yield for BTCS in a risk-controlled manner. Using a DeCeFi strategy prioritizes the utilization of decentralized venues for stable downside risk management without sacrificing the long-term scalability of BTCS.

3. Peg Management Mechanisms

With collateralization details and downside risk vectors covered, we will now focus our discussion on the peg management of BTCS. The BTCS system will utilize two main algorithms to ensure proper peg management: Dynamic Collateralization Ratio adjustments and Stabilization Reserve Fund deployments. We will examine each in detail.

3.1 Collateralization Ratio

A stablecoin's collateralization ratio (CR) refers to the ratio of deposited collateral to the number of coins minted. A collateralization ratio of 1.1 would mean that for every $1 in BTCS, $1.10 in BTC or other assets is held in reserve. Peg management is a continuous process that defines the necessary collateralization ratio based on BTC prices, supply, and variable rates. Selecting a fixed CR would be simple, yet would invariably lead to inefficiencies across time. For example, if the CR is held at 1.1, for periods of low volatility, ~10% of the collateral would be held back when the supply of BTCS could safely be raised by ~10%. The same scenario holds for opposite market conditions. For periods of high volatility, too little collateral may be held in reserve for the number of minted BTCS.

3.1.1 Dynamic Collateralization Ratio

In order to maintain efficiency in both calm and volatile market conditions, BTCS will utilize a dynamic collateralization ratio (DCR), algorithmically adjusting the amount of collateral necessary to maintain a healthy peg.

BTCS' DCR can be generalized as the following equation

$$DCR = CR + (VF \cdot VI) + (PF \cdot PD)$$

where CR is the base collateralization ratio, VF is the volatility factor, VI is the volatility index, PF is the price factor, and PD is the price deviation. Since we always want full collateralization for BTCS *trending towards over-collateralization,* the CR would be set to 1 or some constant close to 1. The collateralization of a BTC-backed stablecoin must always be proactively calculated in alignment with the historical volatility of BTC itself. Collateralization calculations are a dynamic balance between external pricing factors and internal risk management. The ideal outcome will maximize efficiency while minimizing undercollateralization and potential depegging risks.

3.1.2 Volatility Factor

BTCS' volatility factor is a coefficient that determines how the DCR is adjusted in response to changes in BTC price volatility. A high VF means that the DCR adapts more conservatively to changes in volatility over time, compensating with a higher overall DCR. Maintaining a low VF will keep sensitivity to volatility lower, thereby allowing for less collateralization and greater circulating BTCS. This constant will be determined based on a multi-period volatility analysis to create a baseline for BTC volatility within certain timeframes. From the start, the VF will be higher to manage risk and decrease across time as the Core markets mature and DCR algorithms are adapted.

3.1.2 Volatility Index

The volatility index quantifies BTC's aggregate volatility as the standard deviation of simple return within preset windows. We calculate the daily return as

$$R_t = \left(\frac{Price_t - Price_{t-1}}{Price_{t-1}}\right) \cdot 100\%$$

and the standard deviation as

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(R_i - \overline{R})^2}$$

where N is the number of days, R is the daily return on day *i,* and $\overline{R}$ is the average return over that period as $\frac{1}{N}\sum_{i=1}^{N} R_i$. With this equation, the DCR can dynamically adapt to a range of volatilities, either purely historical or via adaptive modeling. To understand the applicability of these equations, let's lay out an example of how the DCR will dynamically adapt to volatility measurements for BTCS.

VI (%)	VF	DCR Adjustment Formula	DCR (%)
2	0.5	150 + (0.5 * 2)	151
4	0.5	150 + (0.5 * 4)	152
6	0.5	150 + (0.5 * 6)	153
8	0.5	150 + (0.5 * 8)	154
10	0.5	150 + (0.5 * 10)	155

In this example, BTC has a volatility index range of 2-10%, a volatility factor constant of 0.5, and a base collateralization ratio of 150%. The resultant DCR, sans pricing data, is between 1.51 and 1.55 collateralization. As volatility increases, the collateralization demands for BTCS dynamically increase. Over time, as the models are improved, the volatility factor decreases or becomes a function of the volatility index itself. The DCR update cadence will be determined via historical analysis of BTC price combined with a comprehensive risk strategy.

3.1.3 Price Factor

Similar to VF, the pricing factor is a constant for adjusting the DCR equation's sensitivity to BTC price divergence from a selected moving average. The higher the PF, the more sensitive BTCS will be to underlying BTC collateral price divergence. A lower PF means that trends away from the moving average will not have a response that is as highly sensitive. Unlike VF, PF examines the actual price of BTC at a certain point and not the rate of change of price across time. The PF will be calculated by examining the aggregate price function as a collection and weighting of moving averages. This will be analyzed against historical BTC price data to parameterize a range and distribution of statistical divergence. From there, we will establish risk management goals and select an appropriate PF.

3.1.4 Price Deviation

We define PD as the quantitative measurement of the difference between the current BTC market price and an exponential moving average (EMA) of BTC's price. The EMA was chosen due to its weighting of more recent data points in updating the EMA total. A case could be made for a simple moving average given the several years-long market cycles BTC moves through; however, given the narrative-driven nature of crypto markets, we thought it poignant to guard against less predictable, irrational price behavior. The EMA is not so reactive as to be unable to smooth out unsustained price spikes, making it our ideal choice for the PD input of the DCR.

The EMA formula is

$$EMA = (P \cdot k) + (EMA_{previous} \cdot (1 - k))$$

where P is the price today, k is the smoothing factor expressed as $\frac{2}{Period+1}$ and period is the EMA interval, and $EMA_{previous}$ is the EMA from the pervious interval (e.g. yesterday). This equation will provide the DCR formula with a reference EMA to calculate the PD. The next step is to calculate BTC price divergence from the EMA. The PD will be expressed in terms of the EMA as follows

$$PD = -\left(\frac{P_{current} - EMA}{EMA}\right) \cdot 100\%$$

The PD formula is made negative such that when the price negatively diverges from EMA (BTC price decreases), more collateral is required. When the price positively diverges from the EMA, less collateral is required. Let's review an example of how the DCR is impacted by BTC price action.

PD (%)	PF	Base CR (%)	DCR Adjustment Formula	Resulting DCR (%)
-5	0.05	150	150 + (5 × 0.05)	150.25
-2	0.05	150	150 + (2 × 0.05)	150.10
0	0.05	150	150 + (0 × 0.05)	150
2	0.05	150	150 + (-2 × 0.05)	149.90
5	0.05	150	150 + (-5 × 0.05)	149.75

This example shows a range of price deviations between -5 % and 5%, a price factor constant of 0.05, and a base CR of 150%. As the BTC price drops, the DCR increases. As the BTC price increases, the need for collateral decreases, and the DCR decreases. Brought together, the base collateral ratio, volatility measurements, and price divergence inputs constitute a dynamically adjusted, weighted peg management algorithm for BTCS. This DCR will inform system requirements for peg management and directly inform the subsequent stabilization reserve fund (SRF) algorithm.

3.2 Stabilization Reserve Fund

The DCR is an important facet of the overall BTCS peg management system. It intakes BTC price and volatility information to continuously determine a market-appropriate collateralization requirement for BTCS. Actively controlling the peg, however, requires a separate system. This is where the stabilization reserve fund (SRF) is applied. The SRF is a capital deployment and allocation mechanism that assists with stabilizing the BTCS peg by purchasing BTCS off of the open market to reduce supply and restore the peg. The system will monitor collateralization levels, market rates, and allocate resources as necessary to maintain the required DCR. The SRF will also deploy reserve assets to manage periods of high redemption properly. BTCS aims to minimize internal capital velocity (e.g. selling LSTs for BTC) to increase capital efficiency while ensuring enough “cash on hand” to proactively manage the various BTCS redemption requests.

3.2.1 SRF Funding

Funding for SRF operations will be generated from various sources:

1. A portion of raised funds will be allocated for reserve capital to be deployed by the SRF
2. Funding rates for BTC shorts will be pooled into the SRF
3. Interest from yield generating reserve assets will be allocated to the SRF
4. Any arbitrage profits made from open-market peg management
5. Low-risk, high liquidity asset deployment returns will be allocated to the SRF such as depositing BTC into lending protocols, yield systems, or via external lending agreements.

All of the above funds will first go to the SRF and be allocated to reserves or perps as necessitated by the global state of BTCS collateral. The SRF will intake the DCF, short position information (leverage, collateralization, funding rates, etc.), BTCS market health (peg, liquidity, etc.), reserve value and yield generation, and redemption/minting volume to algorithmically allocate and withdraw capital in alignment with BTCS' prevailing risk management strategy.

3.2.2 Operational Strategies

In order for BTCS to maintain a healthy peg, especially preceding high-volume, open-market, and organic arbitrage, the SRF must ensure that the on-chain price of BTCS is as close to $1 as possible. For periods where BTCS is less than $1, the fund will deploy capital to purchase BTCS at below-collateralized rates. As BTCS reaches $1, the purchasing stops, and the SRF halts capital deployment. When the price exceeds $1, the purchased BTCS can be sold on the open market for a profit, adding to the reserves and creating healthy downward pressure on the market value. This cycle will be continued indefinitely, creating bands of high pressure above and below $1 while continuously adding to the SRF. As the quantity of BTCS in circulation increases, the SRF will increase its peg management profitability until competition from third-party arbitragers eats away at the returns and the necessity for active peg management decreases. At that point, the threshold for SRF asset deployment will be loosened to higher deviations, and the process will continue.

During periods of high redemption, the SRF can allocate reserves away from certain assets, such as yield-generating assets, towards BTC to meet the high demand. Once demand slows down, the portfolio can be restructured to favor yield-generating assets again and continue growing SRF reserves.

3.2.3 Risk Management

To ensure the stable, sustainable growth of the BTCS ecosystem, a comprehensive risk management strategy must be enacted across all portfolio areas. The prevailing risks for well-audited stablecoins are market risk and credit risk. Market risk is mitigated using 1x leverages shorts on the underlying collateral. Because there is no leverage, the position is covered when the BTC spot price increases due to collateral growth and when the price decreases due to the swap price increase. Management of the underlying shorts is necessary when funding rates turn negative, as discussed in section 2.2.1 (red bars). The SRF will maintain capital in reserve to cover funding rates on BTC swaps. Maximizing yield is another market risk, as opportunity cost exists for the types of assets that BTCS utilizes in reserve. A balance must be struck between yield, liquidity, and underlying risk of the asset. A market-wide analysis of Core will inform this to determine the ideal yield-generating opportunities in concert with BTCS' risk management partner.

If BTCS uses third parties for shorting, a credit risk exists for the deposits allocated to centralized entities. If they collapse (i.e. FTX) then the BTC held in reserve is essentially lost. This risk will be minimized by using reputable venues, regular reporting, and diversifying across several hedging facilities.

Technological risk arises due to smart contract bugs which thorough, regular audits will offset. Technological management of the off-chain SRF system, including DCF calculation, will be geographically distributed across various servers. BTCS will leverage multiparty compute key sharding for wallet management, ensuring no external party can abuse BTCS infrastructure. BTCS will undergo regular stress testing, with public reports, to validate the security and stability of BTCS in the face of unlikely black swan events. Because BTCS aims to initially leverage on-chain hedging and yield facilities, deposits will be fully auditable and aggregated into a monthly report to demonstrate the proof of reserve matches the target DCF. All of the above-mentioned risk areas will be led, in concert, with a professional risk management partner.

3.3 KYC Control

No globally accepted framework exists for cryptocurrency regulation, although certain multi-national standards are beginning to emerge. To limit access to BTCS' services for sanctioned entities and regulatorily grey capital markets, BTCS will employ on-chain, zero-knowledge KYC checks on BTCS minters. This will be done via the Quadrata Passport, a non-transferable NFT that allows checking of user information such as KYC/AML status and country of residence in a GDPR-compliant manner. By doing so, BTCS checks that the wallet holding that passport is owned by individuals from approved domiciles. At minting, the smart contract will query a minter's passport to see if they are from an approved or blocked nation. If it is the former, the minting process is allowed, if not, then that individual will not be able to mint BTCS.

4. Technological Architecture

By nature of the varied, complex calculations associated with managing BTCS' perp positions, open market price, and reserves, BTCS will operate via a hybrid on-off-chain architecture. In the following subsections, we will outline the minting functions, reserve and yield management functions, and perpetual short health monitoring systems.

4.1 BTCS Management

BTCS will be minted at a 1:1 ratio of BTC USD price to BTCS plus or minus any DRC and smart contract fees. The system is not intended to generate revenue on minting or redeeming, but via yield generation through reserve deployment. The minting and redemption processes are straightforward and explained in the following diagrams

4.1.1 Minting and Redeeming

It should be noted that the reserve top-up process refers to the SRF's fund management algorithm. BTC that is not kept as cash on hand will be pulled from the reserve to redeem the BTCS or unwound from on-chain perp positions. A technical risk exists when using on-chain oracles, as the market price for BTC may experience flash changes that are not communicated on-chain in time. Solutions for this include waiting a certain amount of time before confirming the withdrawal of BTC. Another option is to leverage an in-house oracle with faster refresh rates. The best option will be decided during testing.

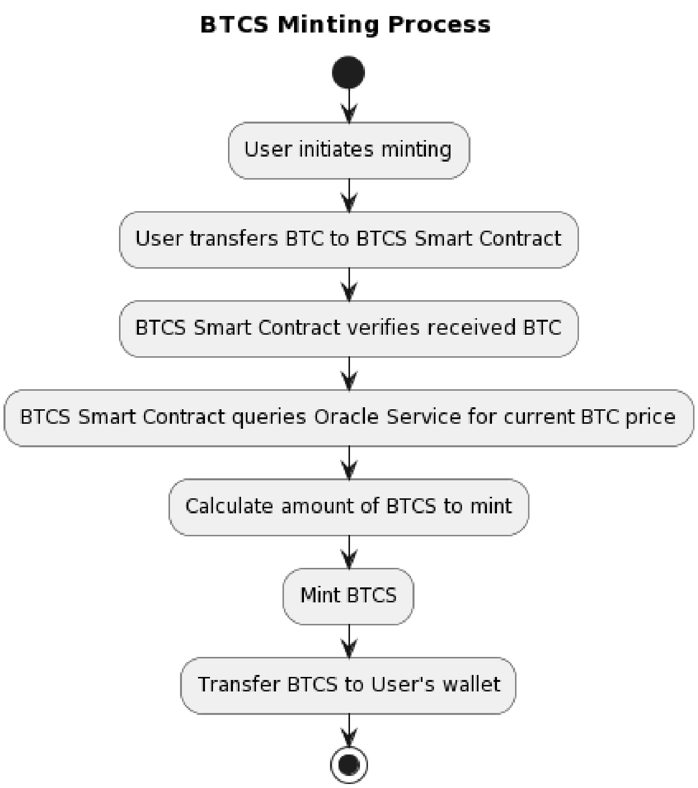
4.2 Reserves Control

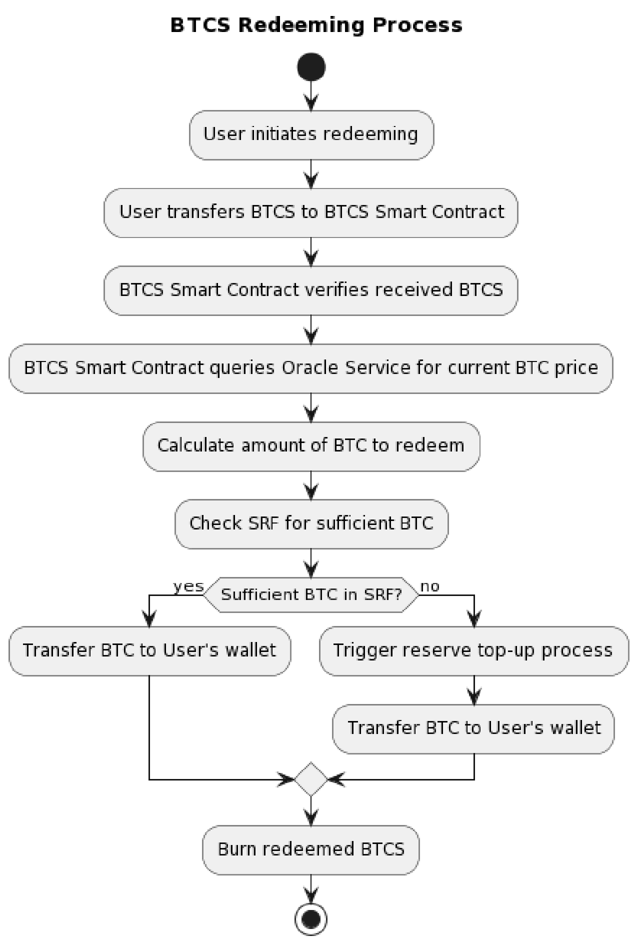
Reserves refer to the capital utilized to back the value of BTCS on the open market. They will be controlled through two disparate yet unified strategies. The first will monitor the price fluctuations of non-yield bearing reserve assets (BTC) and the future returns of yield-bearing assets (LSTs, T-bills, etc.).

4.2.1 Reserve Value Monitoring Engine

The purpose of the reserve value monitoring engine (RVM) is to ensure that sufficient reserve assets exist to back the quantity of circulating BTCS, as defined by the DCR smart contracts. Properly managing reserves will necessitate the combined analysis of on-chain assets and off-chain dynamics utilizing a hybrid approach. The following diagram outlines the RVM Engine.

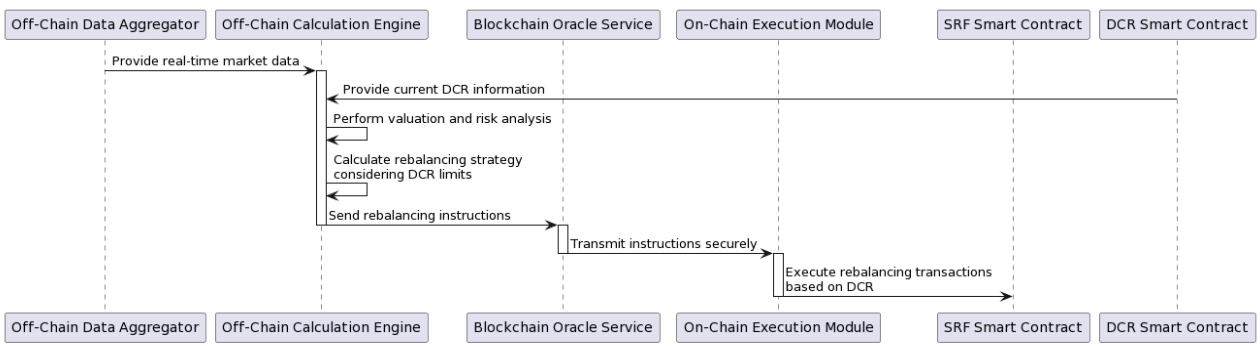
The process begins with the engine taking off-chain data such as BTC prices from CEXs, risk analytics on assets held in reserve, and any other broad market data deemed influential for the BTCS SRF strategy. These inputs are weighted and combined with the DCR and then sent on-chain to execute the reserve rebalancing transactions if necessary. The output of this engine is a continually monitored SRF strategy that ensures collateralization in alignment with the DCR requirements.





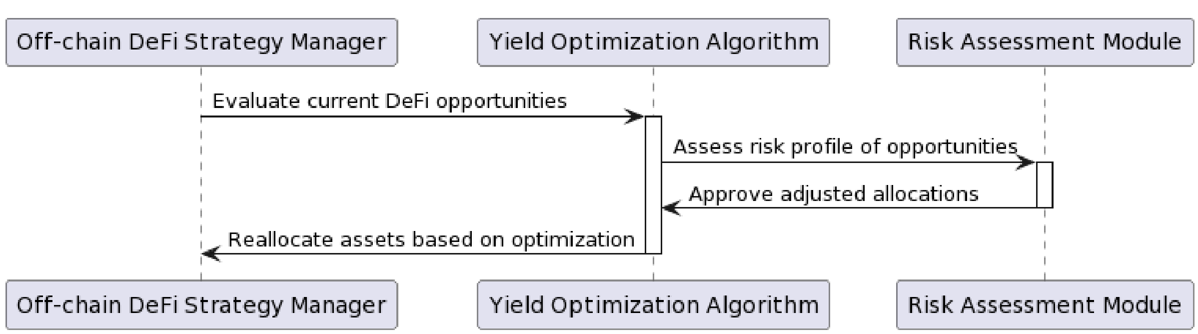
4.2.2 Yield Generation Strategies

While a majority of BTCS reserves will be held in BTC, either on-hand (neutral) or as perp collateral (downside protection), a portion of reserves will be managed as yield-generating strategies (upside interest). These can be allocated across any number of positions within the Core ecosystem such as LSTs, cToken equivalents, RWAs, or even distributed into yield strategies. The specific breakdown and allocation must be decided prior to launch given the composition of Core's ecosystem at the time. At a high level; however, the yield generation strategy for BTCS will utilize an off-chain strategy manager that optimizes yield within a risk module and sends the results to the RVM engine. From there, the engine will decide how much reserves can be allocated to yield-generating activities in alignment with DCR requirements.



4.3 Perp Monitoring

As discussed in section 2.2.3 perp strategies will mainly be deployed through institutional trading firms that manage risk and return on the position. Section 3.2.3 discusses this strategy alongside other risk mitigation techniques. At BTCS' release, a large percentage of the reserves would need to be collateralized as 1x leverage shorts to hold a high DCR and limit downside risk, but as the market demand for BTCS normalizes, the hedging strategy can be unwound, and higher-yield strategies can be deployed. This will generate higher yields to offset operational costs and can be deployed to BTCS minters. The state of BTCS's perps will be factored into the RVM engine to determine which excess capital needs are left to meet redemption demand and peg management and which remaining tokens can be swapped into yield-generating assets. This diversified management system will allow hedged downside price protection, in-market peg stabilization, and secure yield generation.



5. Governance

Numerous protocol factors will be governed by on-chain voting processes. The initial protocol deployment will have BTCS act as the governance token providing rights to contribute to protocol decisions. We are still working through utility and risk assessments of the governance structures to determine if a secondary protocol token will be meaningfully beneficial for overall BTCS governance. Criteria that will ideally be controlled via governance include

1) Collateral investment strategies
2) Risk management strategies
3) Protocol management
4) Marketing and community initiatives
5) Peg management
6) Collateralization criteria
7) Future direction of the protocol

To launch in the safest way possible, the BTCS protocol will not initially open governance until sufficient experiential data and a healthy, engaged community are created within this ecosystem. With that said, continued progress toward complete decentralization is the core focus.

6. Future Development

While the value of BTCS is meant to be unchanging over time, the underlying technology and strategies will not. Several areas of improvement will reveal themselves post-deployment to improve the security, scalability, and decentralization of BTCS. One of the first areas of improvement will be adaptive DCR management leveraging machine learning algorithms to create dynamic, responsive collateralization ratios. The present algorithms shall be sufficient to meet market demand, yet areas for improved yield via more efficient collateralization will likely open over time. A second area of future development will be innovations in perp hedging strategies. The example shared earlier in this paper demonstrates simple protection mechanisms that are comparatively low risk. Expanded reserves and stabilized markets will invariably result in an opportunity for securely dehedging to increase leverage or yield holdings. By doing so, increased reserve growth can be initiated while still holding to the optimal level of risk control. Increased decentralization is another area of improvement that will need to be explored. DAOs are notorious for suffering from lethargy, difficult-to-track malicious proposals, and more. Ensuring that decentralization can proliferate without a resultant upswing in inefficiencies will be paramount

7. Conclusion

BTCS is a novel, hybrid BTC-backed stablecoin launching on the Core network. By combining "cash-on-hand" BTC reserves, perpetual shorts, and yield-bearing assets, BTCS is architected to maintain sufficient backing in alignment with an overollateralized-focused, dynamic collateralization ratio. Reserves are algorithmically sorted into yield-bearing reserves and held-BTC by the reserve value monitoring engine. Portfolio reports from institutional partners on hedging positions will feed into the engine and determine the internal distribution of BTCS reserves. This dynamic asset management strategy balances collateralization and peg management risks with positive yield opportunities via the deployment of unallocated capital. By doing so, BTCS is kept both efficient and risk-controlled.

Growth and adoption of BTCS will be driven through extensive partnerships with ecosystem protocols, engagement with retail users, and integration into centralized venues. Focusing on advanced mathematical modeling, AI-based risk management, and a dynamic, hybrid reserve system combined aims to keep BTCS more efficient and secure than other stablecoin initiatives.

We invite the community, stakeholders, and potential collaborators to join us on this journey of building BTCS. Your engagement and feedback are invaluable as we strive to refine our models and seize new opportunities. Together, we can ensure that BTCS remains at the cutting edge of stability, security, and scalability in the evolving landscape of BTC-backed cryptocurrency.