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The HST Protocol: Evolving Hashrate Tokenization into a Collateralized Stablecoin

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Abstract: The HST Protocol is a decentralized stablecoin protocol on the Solana blockchain that introduces a novel DeFi primitive. It uses a tokenized representation of Bitcoin hashrate (BHRT) as collateral to mint a USD-pegged stablecoin (HST) via an over-collateralized debt position (CDP) model. This analysis examines the protocol's two-token architecture, CDP vault mechanics, and liquidation-based risk management, contrasting it with foundational "Stake-to-Mine" models.

Keywords: Decentralized Stablecoin, Blockchain, Stake-to-Mine, Bitcoin Hashrate, Liquidation, Collateralized Debt Position

I. INTRODUCTION

Bitcoin mining, while a foundational element of the network's security, has long been characterized by significant capital and liquidity challenges. Miners invest heavily in specialized, rapidly depreciating hardware yet face limited exit options, often relying on illiquid broker markets for infrequent sales. This illiquidity makes it difficult to hedge against the volatility of mining machine prices or to capitalize on price fluctuations. Furthermore, the high and constant operational costs, particularly for energy, create a persistent need for liquid capital (typically in fiat) to maintain operations. For external traders and investors, gaining exposure to mining—which can be viewed as a leveraged long option on Bitcoin —is often dissuaded by high transaction costs and a lack of standardized, accessible instruments.

A foundational solution to these problems emerged with the tokenization of mining power, exemplified by projects like the Bitcoin Standard Hashrate Token (BTCST). This model's objective is to "bring exchange-grade liquidity to Bitcoin mining". It achieves this by creating a token where each unit is collateralized by a standardized unit of Bitcoin mining power, such as 0.1 TH/s. The primary utility of this token is a "Stake-to-Mine" mechanism: holders can stake their tokens in a dApp to receive daily Bitcoin distributions that correspond to the mining power staked. This design successfully creates a liquid market for hashrate and, because its value is derived from the discounted cash flow of the underlying productive asset, the token itself performs as a leveraged Bitcoin token free from liquidation risk.

The HST Protocol represents a significant evolution of this concept, transitioning from a simple yield-bearing asset to a capital-efficient DeFi primitive built on the Solana blockchain. The HST protocol addresses a different, more advanced need. While first-generation tokens provide liquidity by allowing miners to sell their mining exposure (i.e., stake for BTC yield), the HST protocol allows miners to leverage their hashrate for USD-pegged liquidity without selling the underlying productive asset. This provides a direct tool for miners to hedge against volatility and finance their real-world operational costs (like energy bills) in a stable currency.

To achieve this, the protocol employs a two-token, Collateralized Debt Position (CDP) model. First, it provides a mechanism for miners to tokenize their hashrate into the Bitcoin Hashrate Reward Token (BHRT), an SPL token representing a verifiable legal and technical claim on future mining rewards. Second, it allows any user to lock this BHRT as collateral in a smart contract vault to mint the protocol's stablecoin, the Hashprice Standard Token (HST), which is pegged to the US Dollar. To ensure system solvency against the price volatility of the BHRT collateral, the protocol mandates a 150% over-collateralization ratio and enforces this through an incentivized liquidation mechanism. This architecture effectively bridges Bitcoin's proof-of-work infrastructure with the Solana DeFi ecosystem, creating a robust, decentralized stablecoin backed by a productive, real-world asset.

II. LITERATURE REVIEW

Foundational literature in this domain identifies a significant "impediment to participation in Bitcoin mining" : the "limited number of exit options" and profound market illiquidity. Miners traditionally have few avenues to "hedge against... the price fluctuation of mining machines". Existing solutions, like cloud mining, are often deemed "imperfect" due to a "lack of standardization", which prevents efficient markets from forming.

The primary solution proposed by this initial literature is the standardization and tokenization of mining power. In these first-generation models, a token is created that is "collateralized by" a specific, standardized unit of mining power, such as 0.1 TH/s. The token's core utility is derived from a "Stake-to-Mine" mechanism. Holders who "stake" their tokens are entitled to receive daily "Bitcoin distributions that correspond to the mining power staked". This token is defined as a leveraged Bitcoin token , with a value determinable by the "discounted cashflow" of the underlying mining power. A key feature of this model is its design to be "free from liquidation risk". This body of literature thus establishes tokenized hashrate as a liquid, yield-bearing asset designed to mirror the economics of mining.

The subsequent evolution of this concept, represented by the HST Protocol's technical literature, shifts the focus from direct yield generation to capital efficiency and deep integration with the decentralized finance (DeFi) ecosystem. This protocol is explicitly designed to "bridge the gap between Bitcoin's proof-of-work infrastructure and the DeFi ecosystem on Solana". While it also tokenizes hashrate into the Bitcoin Hashrate Reward Token (BHRT), the onboarding mechanism is further formalized. Miners are onboarded "through a verifiable process" that includes an off-chain "legal agreement" represented on-chain by a "legal proof-of-commitment NFT".

The most significant divergence in the literature, however, is the implementation of a two-token system that utilizes a Collateralized Debt Position (CDP) model. Instead of a "Stake-to-Mine" function, the HST Protocol re-imagines the hashrate token (BHRT) as productive collateral. Users (miners or investors) can "lock their BHRT tokens" into a vault to open a CDP. This locked collateral enables them to mint an entirely new asset: the Hashprice Standard Token (HST), a stablecoin pegged 1:1 to the US Dollar. This mechanism provides miners with "instant liquidity" and a "tool to hedge" by borrowing a stable asset against their productive, yield-bearing hashrate.

This architectural shift introduces a different risk paradigm. To ensure the HST stablecoin remains solvent, the protocol mandates a 150% over-collateralization ratio. This directly contrasts with the "liquidation-free" nature of the earlier models. In the HST system, if the collateral value drops and the position falls below a 125% collateralization ratio, it becomes eligible for liquidation. Any user can act as a liquidator by repaying the position's HST debt, for which they are rewarded with the seized BHRT collateral plus a 5% penalty reward. This transition from a simple yield-generating instrument to a productive collateral asset used to mint stable liquidity marks a significant conceptual development in the application of tokenized hashrate.

III. METHODOLOGY

The HST Protocol is architected on the Solana blockchain, implemented in the Rust language and built using the Anchor framework. The methodology is designed to "ensure a clear separation of concerns" by dividing the system's logic into two distinct, modular smart contracts (or "programs" in Solana terminology). This dual-program architecture enhances security and modularity by isolating the asset-tokenization lifecycle from the stablecoin's risk-management logic.

The protocol's methodology relies on several key technologies: it uses the Metaplex standard for minting the "legal proof-of-commitment" NFTs, the Solana Token-2022 Program for its fungible tokens (BHRT and HST), and external oracles like Switchboard to provide the live price feeds necessary for managing collateralization ratios.

The system's operation and flow are defined by these two core programs, which interact to create a complete financial primitive.

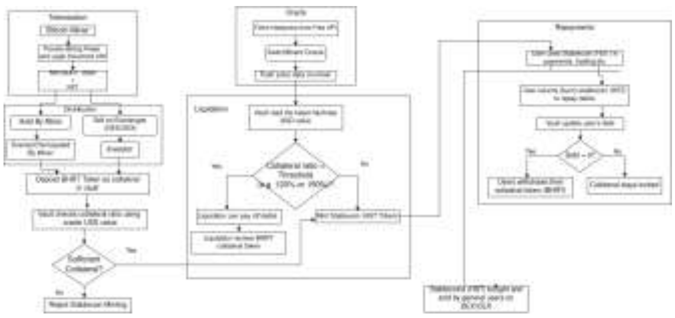

Figure 1: HST Protocol System Architecture Flow

3.1 Program 1: The BHRT Minter & AMM

The first program (ID: AbBt8CJq2PrE9WoDR5iSmJXxuFCGcs7PMKUuZKzVxFDD) is the foundational layer, managing the "entire lifecycle of the BHRT token." Its methodology covers the "supply side" of the ecosystem: onboarding real-world hashrate and transforming it into a liquid, on-chain asset.

This process follows four distinct phases:

Permissioned Onboarding: The methodology for onboarding miners is a multi-step, permissioned process. First, the protocol's administrative authority must explicitly whitelist a miner's public key using the approve_miners instruction. This functions as a gate to ensure only vetted participants can commit hashrate.

Legal Gating via NFT: Once approved, the onboard_miner_nft instruction is used. This mints a "legal proof-of-commitment NFT" that is unique to the miner. This NFT serves as an on-chain representation of the "off-chain legal agreement," linking the miner's wallet to a unique ID and the agreement's URI. This step ensures every BHRT is verifiably backed by a real-world commitment.

Hashrate Tokenization: With the NFT as a "key," the miner can then use the onboard_miner_mint instruction to mint BHRT tokens. The number of BHRT tokens minted is "proportional to the amount of hashrate they have committed" (e.g., 0.1 TH/s per BHRT). This is the core step that converts the miner's future, illiquid productive capacity into a present, liquid SPL token.

Automated Liquidity and Exit: To ensure BHRT has immediate utility and price discovery, the program includes a "built-in AMM" (Automated Market Maker) for a BHRT/USDT trading pair. Instructions such as amm_initialize, amm_deposit, amm_withdraw, and amm_swap facilitate this decentralized liquidity pool. Finally, the program provides a methodology for miners to exit the system. A miner can use the revoke_miner_participation instruction to end their commitment, which involves returning their BHRT tokens to the protocol to be burned, thereby "unlocking" their hashrate.

3.2 Program 2: The HST Stablecoin Vault

The second program (ID: CCLDZoaXu8EchMrVdVHokdyhBUGgHWBVguMibawESYJj) implements the protocol's core utility: the Collateralized Debt Position (CDP) model for the HST stablecoin. This program manages the "demand side" of the ecosystem, allowing users to leverage their BHRT.

The methodology for managing the stablecoin follows four key processes:

Vault Initialization: The methodology for the stablecoin vault begins with the initialize_config_and_vault instruction. This one-time setup function establishes the global configuration, creates the HST mint authority, and initializes the collateral vault's Program Derived Address (PDA), preparing the contract to receive collateral and mint HST.

CDP Creation and Minting: A user (either a miner or investor) locks their BHRT collateral in the vault using the open_position instruction. This action opens a new CDP, and the user mints (borrows) HST stablecoins. This process is strictly governed by a 150% over-collateralization ratio, meaning a user must deposit at least $1.50 worth of BHRT for every $1.00 of HST they wish to mint. The value of BHRT is determined by the external Switchboard price feed.

Debt Settlement and Collateral Retrieval: The user's debt position remains open as long as it is solvent. To reclaim their BHRT collateral, the user must repay their HST debt using the position_debt_settlement instruction. The protocol then "burns the repaid stablecoins," reducing the total supply of HST and returning the corresponding BHRT collateral to the user.

Decentralized Solvency and Liquidation: The protocol's primary risk-management methodology is an incentivized, decentralized liquidation mechanism. If the value of a user's BHRT collateral drops and their collateralization ratio falls below a 125% threshold, their position becomes "eligible for liquidation." At this point, "any user" can act as a "liquidator" by executing the liquidate instruction. The liquidator repays the under-collateralized HST debt and, as a reward, receives the seized BHRT collateral plus a 5% penalty reward. This creates a strong financial incentive for the community to actively monitor protocol health and prevent the system from becoming insolvent.

IV. RESULT

The application of the dual-program methodology results in a comprehensive, two-token decentralized financial ecosystem. This system successfully bridges the real-world productive capacity of Bitcoin's proof-of-work infrastructure with the liquid, composable DeFi environment of the Solana blockchain. The results of this architecture manifest in the creation of two novel, symbiotic assets and a self-regulating, economically-incentivized risk management framework.

4.1 Result 1: A Verifiable and Liquid Hashrate-Backed Asset (BHRT)

The primary result of the first program is the creation of the Bitcoin Hashrate Reward Token (BHRT). This asset transforms the abstract, illiquid concept of hashrate into a tangible, liquid, and—most importantly—verifiable on-chain primitive.

Verifiable and High-Integrity Collateral: The protocol's methodology for onboarding miners, which is gated by a "legal proof-of-commitment NFT", results in an asset with exceptionally high trust and transparency. This NFT serves as an on-chain, verifiable link to an off-chain "legal agreement". The result is that BHRT is not merely a synthetic token; it is a "verifiable claim on the future Bitcoin mining rewards", giving it intrinsic value and making it suitable as high-quality collateral.

Immediate Miner Liquidity and Price Discovery: The "built-in AMM" functionality for a BHRT/USDT pair directly solves the core problem of hashrate illiquidity. The result is an immediate, on-chain market where miners can gain "immediate capital" for their newly minted BHRT. This AMM also provides a crucial secondary result: constant, permissionless price discovery. This market-determined price is essential for the second program's vault to accurately assess collateral value.

A New DeFi Collateral Primitive: The ecosystem gains a new, "productive, real-world asset" for use as collateral. Unlike many volatile crypto-assets (like ETH or SOL) or non-productive stablecoins, BHRT is backed by a claim on the future productive capacity of the Bitcoin network. This introduces a novel, yield-bearing collateral type to the Solana DeFi ecosystem.

4.2 Result 2: A Capital-Efficient, Asset-Backed Stablecoin (HST)

The second program's CDP vault mechanism results in the Hashprice Standard Token (HST), a decentralized stablecoin pegged 1:1 to the US Dollar. The properties of this stablecoin are a direct result of its innovative backing and issuance model.

Unprecedented Capital Efficiency for Miners: The most significant result for the protocol's target users—miners—is the ability to unlock capital without liquidating their underlying productive asset. A miner, who has constant, real-world operational costs (like energy) that must be paid in fiat, is typically forced to sell their mined Bitcoin. The HST protocol provides a "tool to hedge" this volatility. The miner can lock their BHRT, mint stable HST to pay for expenses, and later repay the stablecoin debt to reclaim their BHRT. This fundamentally improves their cash flow management and allows them to retain their long-term exposure to mining.

Robust, Decentralized Backing: The HST stablecoin is "backed by a decentralized portfolio of BHRT tokens". This means its value is not reliant on fiat in a bank account (a centralized point of failure) or on purely algorithmic mechanisms (which can be fragile). Its value is secured by the productive economic activity of the Bitcoin network, creating a uniquely robust "asset-backed" stablecoin.

Programmatic Stability: The stability of the HST peg is a direct result of the "150% collateralization ratio". This high ratio creates a significant buffer designed to "absorb the price volatility of BHRT". The result is a system where every $1.00 of HST in circulation is backed by at least $1.50 of verifiably productive collateral, giving the market strong confidence in the peg.

4.3 Result 3: A Decentralized and Incentivized Risk Management System

The liquidation mechanism established by the protocol results in a self-regulating, trustless, and robust system for maintaining "protocol safety" and solvency.

Decentralized and Autonomous Solvency: The system does not rely on a central entity, committee, or manual intervention to manage risk. Instead, it outsources solvency monitoring to the open market. The "125%" collateralization ratio acts as an immutable, on-chain trigger, automatically flagging any position that becomes a "risk" to the protocol.

A Financially-Incentivized Guardian Network: The protocol's key risk-management result is its elegant incentive structure. "Any user" is empowered to act as a liquidator. By repaying the HST debt of an under-collateralized position, the liquidator receives the seized BHRT collateral at a discount, equivalent to a "5% penalty reward". This creates a "strong financial incentive for the community to keep the protocol solvent". The result is a decentralized, self-correcting loop where profit-seeking actors are economically rewarded for actively removing bad debt, thus continuously securing the HST peg and the health of the entire ecosystem.

V. CONCLUSION

The HST Protocol presents a significant and sophisticated evolution in the tokenization of real-world assets, directly addressing the foundational problem of illiquidity and capital inefficiency within the Bitcoin mining industry. While first-generation "Stake-to-Mine" models successfully created a liquid market for mining yield, the HST Protocol's architecture re-imagines tokenized hashrate as a productive financial instrument for "instant liquidity" and hedging.

By implementing a modular, dual-program architecture on the Solana blockchain, the protocol achieves a clear separation of concerns that enhances both security and functionality. The first program (BHRT Minter) successfully transforms the illiquid, off-chain "legal agreement" of a miner's hashrate into a high-integrity, liquid, and "verifiable" on-chain asset: the BHRT. The inclusion of a "legal proof-of-commitment NFT" as a minting gate is a novel methodology that ensures all BHRT tokens are verifiably backed by real-world productive capacity.

The second program (HST Stablecoin Vault) provides the system's core utility. By treating BHRT as productive collateral within a "Collateralized Debt Position" (CDP) model, the protocol allows miners to mint the HST stablecoin. This is the protocol's most significant contribution: it provides miners with a tool to manage their cash flow and "hedge against future reward volatility" in a stable, USD-pegged asset. Miners are no longer forced to sell their core productive asset (their hashrate claim) or their mined Bitcoin to pay for real-world, USD-denominated operational costs like energy.

Furthermore, the protocol's stability is not left to chance. The "150% over-collateralization ratio" provides a substantial buffer against the volatility of the BHRT collateral. The "125% liquidation threshold" and "5% penalty reward" create a "strong financial incentive" for a decentralized network of liquidators to "keep the protocol solvent." This results in a self-regulating, "protocol-safe" ecosystem where risk is managed autonomously by market participants.

In conclusion, the HST Protocol successfully designs a symbiotic ecosystem. It creates a new, asset-backed stablecoin (HST) for the DeFi market, which is in turn secured by a new, productive collateral type (BHRT). For miners, it provides an essential financial tool, transforming them from simple producers into capital-efficient managers of their own productive assets. This model serves as a powerful blueprint for how other "real-world assets" can be verifiably tokenized and integrated into the decentralized financial system.

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