TIDAL Protocol: A 24/7 Global Liquidity Network for Equities and Stablecoins

Introduction and Background

Global financial markets operate within constrained trading hours tied to regional time zones. When markets close each day, vast amounts of capital become effectively locked and idle until the next opening. For example, the total market capitalization of global equities is over **$127 trillion**, yet on average **17 hours per day** those assets sit dormant outside trading windows [1]. This "liquidity gap" represents a significant inefficiency: investors cannot react to news or reallocate capital when a market is closed, leading to missed opportunities and unhedged risks [2]. International investors holding foreign stocks (over **$16.8 trillion** in cross-border equity holdings) are especially affected by these time-zone frictions [3]. Valuable information often emerges during off-hours – earnings releases, geopolitical events, macroeconomic news – but shareholders are unable to act until each market's next session, often resulting in volatile gap-up or gap-down price moves at the open [2]. In short, time itself – specifically the lack of simultaneous trading across regions – imposes a hidden cost on market participants in the form of lost liquidity and risk premia [4].

Recent trends in both traditional finance and crypto point toward a convergence on **24/7 market access**. Major stock exchanges and brokers have begun experimenting with extended trading hours and even around-the-clock sessions to meet investor demand [5]. For instance, as of 2024 the U.S. Securities and Exchange Commission has approved the first 24-hour exchange for equities (the "24X" exchange), aiming to operate U.S. stock trading 23 hours a day on weekdays [6] [7]. Brokers like Robinhood and Charles Schwab report a growing share of trades occurring outside the traditional 9:30-4pm session [8]. In parallel, Decentralized Finance (DeFi) has enabled continuous 24/7 trading of crypto assets, inspiring efforts to bring real-world assets on-chain for always-on liquidity [5]. However, existing approaches to 24/7 equities have limitations. After-hours markets are often **illiquid and fragmented**, with wide bid-ask spreads and limited securities available. Traditional solutions to bridge overnight gaps, such as margin loans or repurchase agreements (repos), are costly and accessible only to select large players [9]. Early attempts to tokenize stocks in DeFi (issuing crypto tokens representing shares) faced issues: they relied on centralized price oracles or synthetic derivatives without real asset backing, leading to trust and regulatory concerns [9].

TIDAL Protocol is a new decentralized finance protocol designed to address these temporal market inefficiencies at a fundamental level. It introduces an innovative framework to "unlock" idle equity capital during off-hours and enable **continuous 24/7 cross-market liquidity**. The core idea is to use blockchain smart contracts to temporarily tokenize the value of stock holdings when their primary markets are closed, allowing that value to flow into any open market elsewhere in the world. By doing so, TIDAL creates a global liquidity loop synchronized with the planet's rotation: as the sun sets on one market, capital can seamlessly "ride the tide" to markets where the sun is rising. Like the ocean's ceaseless rhythm of tides, TIDAL Protocol envisions capital that never sleeps but moves perpetually around the globe [10].

At the heart of TIDAL are two key concepts: **Smart-Stable Securities (SSS)** and **Time-Bound Stablecoins (TBS)**. Smart-Stable Securities are essentially tokenized representations of equity assets (stocks) created

when markets close, at a stable reference price (the official closing price). These serve as on-chain collateral that is **100% backed by real stocks** held in custody [11]. Time-Bound Stablecoins are short-term stablecoins minted against those collateral tokens, with a value pegged to a fiat currency (e.g. USD) equal to the stock's closing price, and crucially, an **expiry time** at the next market opening [12] [13]. In effect, a shareholder can deposit their stock into the TIDAL system after the market closes and immediately borrow a corresponding amount of stablecoin that can be used globally overnight. When the stock's market reopens, the stablecoin expires: the shareholder must return the stablecoin to unlock their stock, or else the stock will be liquidated to repay the stablecoin holders [14]. This mechanism transforms a traditionally idle asset (a stock during its off-hours) into a programmable liquid asset that can be redeployed in real time. It's akin to each shareholder becoming a "micro central bank" of their own holdings, able to mint a private stablecoin loan from their stocks [15].

This whitepaper presents a comprehensive technical overview of the TIDAL Protocol. We detail the motivation and design of Smart-Stable Securities and Time-Bound Stablecoins, analyze how TIDAL addresses market inefficiencies, and position it in the context of DeFi and traditional finance. We then dive into the protocol's architecture (both on-chain smart contracts and off-chain integration with brokers/custodians), its tokenomics and incentive structure, security and risk management features, and the regulatory/compliance approach enabling its rollout across jurisdictions. We outline a phased deployment roadmap and discuss usage scenarios for various stakeholders (retail investors, institutions, custodians, and regulators). Technical appendices provide deeper dives into smart contract schematics, oracle mechanisms, formal collateralization models, and the lifecycle of the stablecoin system. Our aim is to demonstrate that TIDAL Protocol can catalyze a **24/7 global financial infrastructure**, eliminating the "dead hours" in equity markets and unifying disparate markets into a single liquid network. By enabling continuous arbitrage and reallocation of capital, TIDAL has the potential to improve market efficiency, provide investors with unprecedented flexibility, and unlock new revenue streams for financial intermediaries – all while operating within a secure, compliant DeFi framework.

Market Inefficiencies in Global Equity Trading Across Time Zones

Capital markets have long been partitioned by the cycle of day and night. Each stock exchange maintains its own trading hours, usually aligned with local business hours, and closes for the night (and weekends). This creates a series of **non-overlapping trading sessions** around the world – for example, Asian markets close before Europe opens, and Europe closes before New York opens, etc. For global investors, this patchwork of operating hours produces pronounced time-zone friction. If news breaks in one region while another region's market is closed, investors in the closed market are effectively frozen; they cannot trade or hedge until their exchange opens hours later. This delay can lead to sharp price adjustments at the open and significant overnight risk. Academic research has quantified these effects: a large portion of the U.S. equity risk premium is actually earned overnight (when non-U.S. markets are trading and incorporating news) rather than during the daytime session [4]. Cross-listed stocks (e.g. an international company listed on both New York and its home exchange) often show price discrepancies – such as an ADR in the U.S. trading at a premium if positive news arrives after the home market closed [16]. These discrepancies reflect the price of time: because no immediate cross-market arbitrage is possible, those who can trade in the active market demand compensation for providing liquidity while others must wait [4]. In effect, there is a **Liquidity-of-Time Premium** that market participants pay for immediacy versus waiting (we will formally define and quantify this "TLP" later).

From a practical perspective, the inability to trade across time zones causes multiple problems: - **Missed Opportunities:** Investors are unable to react to earnings releases or geopolitical events that occur after their market's close. By the time they can act, prices may have already gapped up or down significantly [2], meaning they missed the chance to transact at earlier prices. - **Unhedged Risk Exposure:** Portfolio

managers cannot rebalance or hedge positions in real-time when markets are closed. They must carry exposure overnight, leading to potential losses if adverse news emerges. This is evident in the phenomenon of overnight stock moves and subsequent reversals – dealers often demand an overnight risk premium, effectively marking down prices before close to compensate for holding inventory through illiquid hours [17]. - **Idle Capital and Opportunity Cost:** Perhaps most importantly, trillions in equity value sit idle during closed hours, earning no return [18]. An investor might wish to deploy that capital elsewhere (even just to earn a short-term yield or invest in an open market), but they cannot without selling the stock (which has tax and strategy implications) or borrowing via complex margin arrangements.

Traditional finance offers only partial solutions. **Margin lending** allows an investor to borrow against their portfolio, but margin loans typically charge substantial interest (on the order of 5-8% APR) and are not designed for quick overnight deployment across borders [19]. They also often require the cash to remain within the same brokerage or have limited ability to move funds instantly to another market. **Extended-hours trading** sessions have been introduced by some exchanges and brokers, but liquidity in these sessions is thin and price volatility is high due to low participation [20]. Only a subset of securities may be available, and trades can suffer poor execution. Moreover, extended hours still usually close for a portion of the night – there has not yet been a fully continuous equity market. **Cross-listing and ADRs** provide some price linkage between time zones, but they are imperfect and limited to certain large companies; plus, average investors cannot easily arbitrage between a foreign stock and its ADR due to market access barriers and fees.

The emergence of cryptocurrency markets highlighted the benefit of always-on trading – crypto trades 24/7 globally, and participants have grown accustomed to that immediacy. It has also spurred developments in bringing **Real World Assets (RWA)** on-chain. Projects have experimented with tokenizing stocks or other securities so they can trade on blockchain platforms around the clock. However, these early attempts (such as synthetic stocks on protocols like Mirror or tokenized stocks on certain exchanges) encountered **trust and compliance issues**: many were not backed 1:1 by actual shares (introducing counterparty risk), and regulators viewed them as unlicensed securities trading. Additionally, maintaining up-to-date price pegs for off-chain assets is challenging – some designs required centralized entities to frequently update prices, defeating the decentralization and often lagging real markets.

In summary, a large **market inefficiency** exists due to temporal fragmentation. Capital in one region cannot easily flow to another region's opportunities in real-time. Investors effectively pay a cost for "time illiquidity," whether in the form of overnight risk premia, foregone opportunities, or fees for workaround solutions. This inefficiency is measured by the Liquidity-of-Time Premium – the extra return or cost associated with providing liquidity when an asset's home market is closed [21] [22]. Eliminating or reducing this premium would mean a more efficient market where prices reflect global information continuously and capital earns a return around the clock. **TIDAL Protocol is built to attack this inefficiency directly** by enabling investors to re-deploy locked capital across time zones. In the next sections, we introduce the building blocks of TIDAL's solution – Smart-Stable Securities and Time-Bound Stablecoins – and explain how they turn the problem of idle overnight capital into an opportunity.

Smart-Stable Securities (SSS)

Smart-Stable Securities (SSS) are the foundational on-chain asset in the TIDAL Protocol that enables real equities to be used in a decentralized environment. An SSS is essentially a **tokenized representation of a stock (or other security) that is created when the stock's primary market is closed**. Each SSS token corresponds to an underlying share of stock, but with a crucial twist: it is recorded on-chain **at the**

stock's last closing price and remains price-stable at that value during off-hours [11]. In effect, SSS turns a volatile equity into a temporarily stable-valued token for the duration of the market closure.

How SSS Tokens Are Issued: When an investor holds shares with a participating brokerage or custodian, they can invoke the TIDAL Protocol (likely via their broker's interface) after market close to pledge those shares. The brokerage/custodian confirms the shares are now locked (they cannot be sold or moved while pledged) and a TIDAL smart contract issues a corresponding amount of Smart-Stable Security tokens on the blockchain. The amount issued is determined by the stock's official closing price and a conservative **Loan-to-Value (LTV)** ratio. For example, if the investor has 100 shares of a stock that closed at $50 each, the total market value is $5,000. If TIDAL's allowed LTV for that stock is 50%, the protocol would create up to $2,500 worth of SSS tokens as collateral (representing effectively 50% of the shares' value). Each SSS token might be denominated in a fiat stable unit (e.g., 1 token = $1 of value) or potentially as a token representing the share itself. In practice, TIDAL may issue SSS such that **1 SSS token = 1 share locked, valued at the closing price** – so in this example, 100 SSS tokens each worth $50 are created, and then perhaps the stablecoin borrowing (TBS, next section) would be capped at $2,500 against those tokens. (The exact mechanism can vary; one approach is that SSS tokens themselves reflect the full share value but the protocol limits borrowing against them, akin to how a vault in MakerDAO holds full collateral but loans only a fraction.)

What's important is that **each SSS token is fully backed by a real share held off-chain**, under custody of a regulated entity. This is not a free-floating tokenized stock for general trading; rather, it is a bridge asset that stays in the TIDAL system. The SSS can be thought of as an on-chain claim on a share, but with the condition that it's meant to be redeemed or settled when the market reopens. Because the underlying share is not being sold (only locked), the investor retains beneficial ownership and avoids triggering a taxable event or losing their position. They have simply put the share into a smart contract "vault."

Stable Value at Closing Price: A key property of SSS is that once issued, it is **valued at the last market close price and does not fluctuate until the market reopens** [23]. This is achieved by an **oracle mechanism** (see the Architecture section and Oracle Appendix for details) that feeds the official closing price on-chain and anchors it. During the hours when the exchange is closed, no new price updates occur for that stock's SSS; the protocol treats the collateral value as fixed at the closing price. Even if related instruments (like futures or overseas listings) move in the interim, the SSS token remains pegged to that stale price. This design choice greatly simplifies on-chain accounting and ensures that the stablecoin we mint (TBS) can be pegged reliably to that same value. Essentially, **the SSS is a tokenized stock with a temporarily fixed price**.

By mapping each stock to the blockchain in this way, TIDAL is establishing what one might call a "24/7 global liquidity network" for equities [11]. Each participating brokerage or exchange can create SSS tokens for their clients' holdings after hours, thereby pooling what was previously siloed, dormant capital into a blockchain-based network. The term "Smart-Stable" highlights that these are not ordinary security tokens – they are augmented with smart contract logic to maintain stability and enforce redemption conditions.

Usage of SSS – Collateral for Stablecoins: Importantly, SSS tokens themselves are not intended to be widely traded or used as a currency; instead, their primary role is to serve as **collateral backing for Time-Bound Stablecoins (TBS)**. Once an investor's shares are converted into SSS, the TIDAL Protocol allows those SSS tokens to be locked into a vault contract in order to borrow stablecoins. You can think of this as a two-step process: 1. Pledge: Investor pledges shares → obtains SSS tokens (representing the shares on-chain). 2. Mint: Investor locks SSS tokens in vault → mints TBS stablecoins (a loan against the collateral).

The vault ensures that the SSS tokens remain locked and cannot be transferred elsewhere while a loan is active [24]. It also enforces the rule of "**equivalent-share return**": the same shares that were pledged must be returned to release the collateral [25]. In practice, this means that if you lock 100 shares worth $5,000 and borrow $2,500 stablecoins, you will get those exact shares back only if you repay the $2,500 (plus any fees) by the deadline. If you do not repay, the protocol will liquidate those shares to cover the debt, as described later. This one-to-one linkage of specific collateral shares to a loan assures that there's no ambiguity in redemption – it's clear which asset backs which loan, preventing any possibility of "rehypothecation" or double-pledging.

Pledge, Trade, Redeem – A Closed Loop: The innovation of SSS and TBS creates a **closed-loop transaction cycle** [26]: - Pledge and Mint: After hours, a shareholder pledges their stock to the protocol (via their broker), converting it to SSS and minting TBS stablecoins in return [26]. Now the investor has liquid capital (stablecoins) while the stock is locked as collateral. - Cross-Market Trading: The investor can use those stablecoins in any other market that is currently open. For example, an investor in New York after 4pm ET might mint stablecoins and then use them to buy stocks on an Asian exchange that is open, or to trade cryptocurrencies overnight [27]. The stablecoins are blockchain-based and can be swapped or transferred globally, so effectively the investor's capital has moved to where opportunity is available. - Automatic Redemption: Before the original market (New York, in this case) reopens the next morning, the investor should return the stablecoins to the protocol (likely by selling whatever they bought and converting back to the stablecoin) to unlock their original shares [28]. When they repay, the stablecoins are burned and the SSS tokens are released, which triggers the custodian to unlock the shares back to the investor's account. The cycle is completed and the investor retains their stock as if nothing happened – except that they were able to put its value to work overnight.

The requirement to close the loop by the next market open keeps the system stable and short-term. If the investor does not return the stablecoins by the deadline, the protocol will forcibly close the loop via liquidation (discussed in TBS section and Risk Management). In essence, SSS + TBS functions like an **overnight repurchase agreement (repo)** or secured loan, but automated through smart contracts. The investor has borrowed money (stablecoins) against their stock and must pay it back hours later. The key difference from a traditional repo is the global flexibility of the borrowed funds and the decentralized execution.

Key Benefits of SSS: - It enables **tokenization without permanent conversion**. The investor doesn't have to tokenize and sell their shares into a crypto wrapper (which can be regulatory challenging); instead, the tokenization (SSS) is temporary and solely for the purpose of collateralizing a loan. The shares remain in custody and under existing regulatory frameworks. - It maintains a **stable value peg** for the collateral during off-hours, which is crucial for predictable lending. Unlike normal tokenized stocks that would continue to fluctuate based on some price feed, SSS deliberately freezes the value until the market reopens [29]. This stability simplifies borrowing and avoids margin calls during the closed period due to external noise. - It **integrates with traditional brokers/custodians**, meaning adoption does not require users to leave their familiar platforms or violate custody rules. Brokers essentially act as the minting agents, ensuring compliance (KYC/AML) and safeguarding the actual assets. - It forms the **basis for TBS stablecoins** which are the liquid instrument used for trading. By itself SSS is just a locked asset; its true utility is unlocked when used in the TBS system.

In summary, Smart-Stable Securities transform passive equity holdings into on-chain collateral that is secure, price-stable (temporarily), and primed for liquidity extraction. It's the first half of TIDAL's solution – providing the "bridge" that connects real-world stocks to the blockchain in a controlled, fully backed manner. Next, we discuss the second half: how the stablecoin side works to actually mobilize that value across markets.

Time-Bound Stablecoins (TBS)

Time-Bound Stablecoins (TBS) are the tradable output of the TIDAL Protocol – they are **stablecoins minted against SSS collateral that carry an expiration time**. A TBS functions much like a typical fiat-pegged stablecoin (for example, a USD stablecoin worth $1 each), except that it is designed to **exist only for a defined short period** (e.g., one overnight cycle) and is **backed by equity collateral** rather than cash. Each TBS token is effectively an IOU that says: "This token is worth $1 (or 1 unit of some fiat) as long as it is redeemed by the expiry time; it is fully collateralized by a specific stock share locked in the system."

Key Characteristics of TBS: - **Programmable Duration:** Every TBS issuance comes with an embedded expiry timestamp at or just before the next opening of the stock's market [30]. For example, if an investor tokenizes a U.S. stock after the New York close (4pm ET on Day 1), the TBS might be set to expire at 9:30am ET on Day 2 (when NYSE reopens). If markets are closed for a longer period (weekends or holidays), longer-duration TBS (48 hours, 72 hours, etc.) can be issued to span those closures [30]. The protocol could even allow selection of different expiry options – for instance, a 12-hour TBS vs. 24-hour TBS – though all are relatively short-term. This time-bound nature is what ensures that the stablecoin does not persist indefinitely and that the underlying collateral situation is resolved regularly. - **Pegged Value:** A TBS is pegged to a fiat currency (or potentially a digital fiat-equivalent) at 1:1 value with the underlying share's closing price. In practice, if an investor locks shares worth ¥10,000 (yen) of a Japanese stock, they might mint 10,000 units of a JPY-pegged TBS (or a subset if not full LTV). If they lock shares worth $5,000 of a U.S. stock, they mint a USD stablecoin (let's call it sUSD) equal to that value (again, adjusted for LTV). **During its life, the TBS is intended to trade near its peg** because it's fully collateralized by the share at known value. It's essentially a stablecoin like USDC or DAI in terms of use – one sUSD is expected to be worth $1.00 – but with the caveat of an expiry. The oracle anchoring mechanism we described for SSS ensures that on-chain, 1 unit of TBS is treated as equivalent to the fixed collateral value (e.g., 1 USD of the share) [23]. - **Expiry and Auto-Reconciliation:** At the moment of expiry, the TBS tokens are programmed to become non-transferrable and redeemable. The smart contracts will trigger an **auto-reconciliation** process [31]. This involves burning the TBS tokens and releasing the pledged SSS collateral, essentially closing the loan. In practice, there are two scenarios: - If the original borrower returns and actively redeems: They repay the TBS (i.e., return the stablecoins to the contract). The contract burns those stablecoins and unlocks the SSS, which leads to unlocking their shares via the custodian. The borrower gets their shares back. This is the expected, routine outcome. - If the borrower fails to return the stablecoins by expiry: The protocol considers this a default. It will then take the collateral shares and **liquidate** them to cover the stablecoin liability [32]. Since the stock's market is now open at expiry, liquidation can occur immediately on that market. The implementation might be to initiate an on-chain auction for the shares or an off-chain sell order through the broker, depending on design [33]. The proceeds (whether in stablecoins or actual fiat converted to stablecoins) are then used to redeem as many outstanding TBS as possible, making those stablecoin holders whole. Essentially, the stablecoins are bought back and destroyed using the collateral's value. We will delve more into this in the Risk Management and Liquidation sections. The key point is that by design **all TBS are either redeemed by the borrower or by liquidation at expiry** – they do not linger unbacked. - **Automatic Settlement & Release:** The system is designed to handle the expiry autonomously. Smart contracts coordinate with custodial APIs to reconcile positions in real-time [31]. For instance, the moment of expiry triggers the contract to instruct the custodian: if borrower repaid, release shares to borrower; if not, sell shares and prepare cash. Simultaneously, on-chain it will freeze/burn the TBS tokens. The end result after reconciliation is that either the borrower has their stock back and stablecoins are gone, or the stablecoin holders have effectively been paid out via the collateral sale. In either case, the closed-loop transaction is completed within hours, maintaining system integrity.

Circulation and Uses of TBS: While active (between issuance and expiry), TBS stablecoins can circulate and be used like any other stablecoin: - They can be transferred peer-to-peer or to other wallets. - They can be used to purchase assets in other markets. For example, an investor might swap sUSD for a stablecoin that represents euros (sEUR) via a forex conversion on-chain to invest in European assets. Or swap sUSD for crypto assets on a decentralized exchange. - They can be **used for settlement** of trades. For instance, if a broker integrates TBS, two clients could settle an after-hours transaction using TBS as the payment currency (since banks are closed, stablecoins provide an always-on settlement rail). - They might be deployed in short-term **yield-generating strategies**. The TIDAL Protocol envisions automated overnight funding markets where TBS holders could earn yield by lending out their stablecoins or providing liquidity [34]. For example, a liquidity pool could allow others to borrow TBS (perhaps to short the underlying stock or for other arbitrage), and the lenders earn interest for those few hours. Another scenario: a TBS holder could provide liquidity in a DeFi pool or lend on a money market (if those protocols accept TBS) to earn a return overnight. Because TBS are short-lived, these would be very short-term loans, but even overnight interest (analogous to money-market rates) could be captured. This "real yield" potential is mentioned as a feature of active TBS [34]. - In essence, TBS stablecoins allow **bridging value across markets**. They make time "fungible" – one can trade the night for the day, so to speak, by moving value from a closed market to an open one.

Risk Boundaries and Safeguards: Because TBS are fully collateralized by volatile assets (stocks can move in price when their market reopens), TIDAL employs **risk management parameters** to protect stablecoin holders: - **Conservative LTV Ratios:** The protocol sets initial Loan-to-Value limits such that even if the stock price drops significantly at the next open, there is a buffer of collateral value. For example, Blue-chip large-cap stocks might have LTV of 50-60%, building in a ~40-50% price drop cushion [35]. More volatile stocks might have LTV only 30-40%, giving a 60-70% safety buffer [35]. Diversified assets like index ETFs could allow slightly higher LTV (60-70%) since their risk is spread [35]. These ensure that in most scenarios, even a bad overnight move will not fully wipe out the collateral before stablecoin holders are paid. - **Real-Time Oracle Feeds (for risk monitoring):** Although the price is anchored at close for normal operations, the protocol still monitors any indicators of extreme move. For instance, if there are pre-market trading or news indicating a likely huge gap, the protocol could flag those positions. However, since actual price update happens only at open, typical DeFi liquidations during the closed period are not triggered. Instead, the system prepares for handling at open. - **Dynamic LTV Adjustments:** A novel aspect (from research) is to dynamically adjust allowed LTVs in response to observed TBS pricing or market conditions [36] [37]. If the market is demanding a high premium on TBS (meaning people see high risk or demand, driving TBS price down), the protocol could tighten LTV (reducing supply, making stablecoin safer) [37]. If TBS consistently trade at or above par (low risk environment), it could allow slightly higher LTV to improve capital efficiency [38]. This adaptive policy acts akin to a central bank adjusting interest rates to keep a currency peg [39]. - **Automatic Liquidation Triggers:** If at expiry the collateral value (opening price * number of shares) is below the stablecoin amount, the protocol triggers liquidation immediately [40]. There is no discretion or delay; this ensures stablecoin holders can be made whole by selling collateral. The liquidation mechanism (detailed later) is designed to fetch fair market value via auction and not to rely on slow manual processes. - **Insurance Fund:** The protocol will maintain an insurance reserve funded by fees (discussed in Tokenomics) to absorb losses in extreme cases [41]. If a share's drop is so severe that even selling it doesn't fully cover the stablecoin, the insurance fund will cover the shortfall so that stablecoin holders still receive full value [42]. This protects the integrity of the stablecoin's peg (so that users trust TBS will always be worth face value). - **Short Exposure Window:** By design, each TBS exists only for (at most) hours or a couple days. This limited exposure time inherently limits risk accumulation. Users cannot keep a leveraged position open for weeks unchecked; it must reset daily. This allows recalibration each cycle and avoids compounding risk. It also means the system is fully unwound to baseline at least once every trading day, which is a healthy safety mechanism. - **User Education and Warnings:** For adoption, investors will be informed that if they do not close their position

by market open, they will lose their shares (since they’ll be sold). This clear expectation and interface design (e.g., countdown timers in the app) mitigate user error (Adoption Risk mitigation) [43].

Strategic Impact of TBS: Time-Bound Stablecoins are not just a technical novelty; they carry significant strategic implications for all players in the ecosystem [44]: - For Investors (Retail and Institutional): TBS **transforms passive share ownership into instant, reusable liquidity** [45]. Investors get the benefits of a sale (access to cash) without actually selling the asset or leaving their brokerage. They can seize opportunities globally or meet short-term liquidity needs without liquidating their long-term holdings. Essentially, every stock becomes a liquid funding source after hours, giving investors flexibility and potential extra returns (if they invest that liquidity profitably overnight). - For Brokerages: TBS offers a new value-added service and revenue stream. Brokers can offer 24/7 investment products by leveraging TIDAL in the back end. They earn fees from minting/redemption and likely share a portion of trading spreads or yields [46]. It also **boosts client engagement and AUM turnover** [46] – clients who otherwise would just sit on stocks can now be active round-the-clock, which means more transaction volume for the broker. It helps brokerages differentiate themselves in a competitive market by offering something novel (the ability to effectively trade across time zones). - For Markets and the Financial System: Widespread use of TBS would **establish a global liquidity clock** where capital continuously migrates to wherever it can be used most efficiently [47]. This could eliminate or greatly reduce the “dead hours” where nothing can be done. Price discovery might become more continuous, reducing the magnitude of overnight gaps since informed trading can occur via TBS-facilitated flows. Additionally, by unifying equities, FX (currencies), and crypto into one interoperable layer, TIDAL could enhance global market integration. Time-Bound Stablecoins in essence make time itself a tradable asset, meaning the timing of liquidity becomes an arbitrageable dimension [48]. This has deep implications: markets could become more efficient as any temporal mispricings are arbitraged out by those using TBS. In the long run, perhaps it pressures traditional exchanges to move toward longer or 24/7 hours themselves, benefiting all investors.

In summary, TBS are the operational heart of TIDAL Protocol’s vision [48]. They enable the unlocked equity value to actually flow and do work during off-hours, then safely return or settle when markets reopen. The short-term, fully collateralized design ensures that they remain stable and trustworthy, bridging the gap between the rigid schedule of traditional markets and the fluid, always-on world of decentralized finance.

DeFi Analogs and TIDAL’s Positioning in Existing Financial Infrastructure

TIDAL Protocol sits at the intersection of traditional finance (TradFi) and decentralized finance (DeFi), borrowing concepts from both but also innovating in ways that existing solutions have not. In this section, we compare TIDAL’s approach to analogous solutions in both realms – highlighting **what problems each addresses and where limitations remain**, and how TIDAL offers a novel synthesis that overcomes those limitations.

Traditional Solutions vs. TIDAL

Several traditional financial mechanisms attempt to provide liquidity against securities or extend trading hours: - **Margin Loans / Securities-Backed Lending:** Investors can borrow cash against their stock portfolio via their broker or bank. This is somewhat similar in spirit to TIDAL’s stablecoin loan – both use stock as collateral. However, margin loans typically charge ongoing interest (often in the range of 5-8% annual rate) [49] and can be terminated or margin-called at any time if collateral values drop. They also usually keep the cash within the same platform or at least in the same currency, making it cumbersome

to use cross-border. **TIDAL's Advantage:** TIDAL charges only a small flat fee for an overnight loan (e.g., ~0.5% for the period, see Tokenomics) [50], which is much cheaper for short durations than paying weeks or months of interest. Moreover, the stablecoin can be instantly moved globally – you can borrow in New York and deploy in Hong Kong within minutes, which a traditional margin loan doesn't easily allow. - **Extended Hours and 24-Hour Exchanges:** As discussed, some brokers offer extended hours trading, and new exchanges (like 24X) aim to offer near-24/5 trading for U.S. equities. These efforts increase market availability but face low liquidity in off-peak hours [51] and offer a limited menu of securities (often only large-caps or indices). Even a 24-hour exchange for one country's stocks doesn't solve cross-border usage of capital. **TIDAL's Advantage:** Rather than forcing trading into illiquid after-hours markets, TIDAL lets investors access **deep liquidity in markets that are already open elsewhere** [52]. For example, instead of trading Apple stock at 3am in a thin OTC session, an investor could use TIDAL to move capital to Europe and trade European tech stocks on their main exchanges which are open and liquid. TIDAL essentially taps existing liquidity pools rather than creating new shallow ones. - **Cross-Listing and ADRs:** Cross-listing a stock on multiple exchanges (or creating an ADR) can allow some price discovery when the primary market is closed. However, maintaining two listings is costly and only the largest companies do it. ADRs introduce currency and banking complications and still typically only trade during the host market's hours (e.g., ADRs in NY trade on NY hours, not when the home market is closed). **TIDAL's Advantage:** It doesn't require the company to be cross-listed; any stock can have its value redeployed via stablecoins. It's a shareholder-driven liquidity solution, not an issuer-driven one. - **Total Return Swaps / CFDs:** In some cases, institutions use derivative contracts like total return swaps or Contracts for Difference to get off-hours exposure or leverage on stocks. These are not accessible to most investors, and they rely on dealer banks, with bespoke terms and high costs. **TIDAL's Advantage:** It democratizes the ability to synthetically reposition equity exposure, making it available to any investor via a transparent protocol, rather than an opaque bilateral contract. - **Repurchase Agreements (Repos):** Big institutions with bond portfolios routinely use overnight repos to earn extra yield – essentially selling a bond and agreeing to buy it back next day, which is like an overnight loan. Equity repo markets are less common, but conceptually possible. They are, however, an interbank/institutional tool, not for retail. **TIDAL's Advantage:** TIDAL's mechanism is akin to an automated equity repo available to the masses, with the blockchain acting as the intermediary that enforces the repurchase.

A **competitive landscape analysis** in the TIDAL business documentation neatly summarizes these points [53] [54]. Traditional margin loans have ongoing interest and friction in moving cash cross-border; TIDAL in contrast provides instant global liquidity at a flat low fee [50]. Extended hours trading suffers poor liquidity and execution; TIDAL users access the deepest liquidity by moving value to open markets [52]. Existing tokenized equity platforms require actually selling or converting shares and face regulatory uncertainty; TIDAL lets you keep your original shares with only the liquidity extracted, and integrates compliance via brokers [54]. Synthetic or DeFi derivatives often lack real asset backing and operate in grey regulatory areas; TIDAL is **100% collateralized by real assets and structured within a regulated framework** [55]. In short, TIDAL is unique as the first solution combining **real equity collateralization, multi-currency stablecoin issuance, broker/custodian integration, and seamless global interoperability** [56].

DeFi Analogs and Innovations

Within the DeFi realm, TIDAL shares DNA with several well-known protocols, yet it is distinct in mission and design: - **MakerDAO (DAI stablecoin):** MakerDAO is a decentralized protocol where users lock crypto collateral (ETH and others) in vaults and mint DAI, an over-collateralized stablecoin. TIDAL's mechanism is analogous in that SSS tokens in a vault allow minting a stablecoin. Both systems enforce collateral ratios and have liquidation mechanisms (Maker uses on-chain auctions when collateral value falls below threshold) [57]. **Key Differences:** (1) Collateral Type: Maker uses volatile crypto assets (ETH, BTC, etc.), whereas TIDAL uses real-world equities whose price behavior and risk profiles are different. (2) Duration:

DAI loans are open-ended, can be kept indefinitely until user repays (interest accrues meanwhile). TBS loans are very short-term and expire automatically – a fundamentally different model where positions cannot accumulate long-term risk. (3) Peg Mechanism: DAI's peg to $1 is maintained via market arbitrage and monetary policy (stability fees, savings rate). TBS's peg is maintained via the promise of redemption at par at expiry plus full collateralization; it's almost a contractual peg rather than an open market-driven one, since it doesn't need to circulate long. (4) Liquidation timing: Maker triggers liquidation as soon as collateral value falls below a threshold (even intraday), potentially resulting in rush auctions and issues when markets are turbulent [58]. TIDAL delays any liquidation until the stock market opens, thus avoiding mid-closure emergency actions (since it can't sell the stock at night anyway) – this is a design tailored to the underlying asset's trading schedule. That said, TIDAL's use of on-chain auctions at market open is inspired by proven designs in MakerDAO and others [57]; it stands on shoulders of DeFi experience, but applied to a new domain. - **Aave/Compound (Money Market Protocols):** These protocols allow users to supply assets to a pool and others to borrow them, with interest rates algorithmically determined. One can borrow stablecoins using crypto collateral, similar to TIDAL conceptually. The difference is money markets are **pool-based and indefinite** – you borrow from a pool and can keep the loan as long as you pay interest; the loan can be recalled (liquidated) if your collateral value falls too low at any time. **TIDAL vs Money Markets:** TIDAL's borrowing is **direct and short-term** – you effectively borrow from yourself (by minting new tokens) rather than from a pool of lenders. There is no concept of ongoing interest; instead a one-time fee is charged. Also, Aave and Compound do not support equities as collateral, only crypto assets (and a few tokenized real assets in some cases). They are decentralized and permissionless, whereas TIDAL operates via brokers and thus has permissioned entry for collateral (you need an account at a partner broker to pledge shares). This makes TIDAL a sort of hybrid – decentralized in operation of stablecoin smart contracts, but with a permissioned bridge to real assets. - **Liquidity and Overnight Yield Protocols:** In DeFi there are protocols like Yearn or others that focus on optimizing yield on assets. There's no direct analog to TIDAL here, but one could compare TIDAL's overnight redeployment to what yield farmers do (move capital to where yields are highest). TIDAL automates that process across TradFi markets – essentially enabling an "idle stock" to chase yield in another market overnight. - **Liquid Staking (Lido, etc.):** A parallel can be drawn with liquid staking protocols (like Lido for staked ETH). In liquid staking, a user locks an asset (e.g., stakes ETH in Ethereum's consensus, which normally locks it) and in return gets a liquid token (stETH) that can be traded or used elsewhere while the original ETH is locked. This is similar in that Lido unlocks the liquidity of a locked asset. **TIDAL's similarity:** The user locks a stock (which is "locked" by market closure rather than protocol) and gets a liquid stablecoin that can be used elsewhere while the stock is inaccessible. In both cases, the pegging of the derivative's value to the underlying is crucial. stETH tries to track ETH value plus accrued yield, but at times it lost peg due to market forces. TBS should track the stock's locked value (which doesn't change overnight inherently). One advantage TBS has is a guaranteed redemption event at a fixed time, which enforces convergence (stETH had no fixed redemption date until the merge completion, hence it traded at a discount sometimes). This makes TBS more tightly coupled to underlying value by design. - **Centralized Stablecoins (USDC, USDT, etc.):** These are fiat-backed tokens redeemable 1:1 for actual currency from a company like Circle or Tether. TBS differs in collateral (stocks vs cash) and in decentralization (TBS issuance is done via a protocol plus many brokers, not a single company treasury). However, one can consider that each TBS is effectively "backed by fiat-equivalent" because the stock can be sold for fiat. One key difference: USDC doesn't expire; TBS does. From a regulatory perspective, Circle's USDC is regulated as a money transmitter and stablecoin issuer. TIDAL's stablecoins might fall under different categories (perhaps as asset-referenced tokens under EU's MiCA regulation, etc.) – we cover this later. Another difference: USDC's backing assets (cash, T-bills) are very stable, so USDC is almost risk-free. TBS's backing (stocks) are riskier, requiring over-collateralization and active risk management to achieve similar safety for holders.

Real World Asset (RWA) Tokenization Trend: TIDAL is part of a broader movement to bring traditional assets into the crypto ecosystem. Competitors or analogs in this space include: - **Tokenized Stocks on**

Chain: e.g., FTX (before its collapse) offered tokenized stocks, Mirror Protocol on Terra offered synthetic stocks, and Paxos in the past had tokens for some stocks. All these faced regulatory pushback, because they often involved creating a freely tradable token that represented a stock, which could be seen as bypassing securities laws. TIDAL avoids outright tokenizing the stock for external trading; the stock-pegged token (SSS) stays within a closed system and is used only to back a stablecoin. Also, TIDAL's focus is on short-term liquidity, not long-term trading of stocks on crypto exchanges. This might make it more palatable to regulators as it's more akin to a collateralized loan than a trading instrument. - **On-Chain Lending with RWAs:** Protocols like MakerDAO are increasingly onboarding real-world collateral (e.g., tokenized real estate, trade receivables, government bonds via special vaults). Likewise, Goldfinch and others try to provide DeFi loans to real-world borrowers. These efforts often require intermediaries and legal structures. TIDAL's approach uses regulated brokers as the gateway, which serves a similar role (verifying and holding the real asset). In that sense, TIDAL is a specific instance of on-chain lending – it lends stablecoins to stock owners secured by their stock.

TIDAL's Novel Positioning: Combining points from above, we can articulate what sets TIDAL apart: - It's **Regulated DeFi**: blending the trust of regulated entities (brokerages/custodians under legal oversight) with the automation and transparency of DeFi smart contracts. Users interact through compliant channels, but the value transfer and settlement happen on a public blockchain. - It **unlocks a new asset class for DeFi**: the idle time of equities. Many DeFi innovations were about unlocking idle capital in general (unused crypto, staked assets, etc.), but TIDAL specifically tackles time-bound illiquidity which is an untouched dimension. - It focuses on **time-limited, self-liquidating positions**, which is unusual in DeFi (most loans are open-ended). This introduces a new design space for short-term, event-driven DeFi instruments. - It explicitly aims to **arbitrage temporal inefficiency** in markets. By providing tools to arbitrage price differences across time zones, TIDAL could improve overall market efficiency – a claim few DeFi protocols can make about the traditional market. - Through its stablecoin, it effectively creates a **multi-currency stablecoin system** backed by equities. Potentially, one could hold stablecoins in USD, EUR, HKD, etc. on-chain that are backed by stock collateral in those respective markets. This is distinct from existing stablecoins which are mostly USD-based. It could open the door for new stable trading pairs and FX arbitrage in crypto as well.

In conclusion, while TIDAL borrows concepts from MakerDAO (over-collateralized borrowing), from money markets (using assets to get liquidity), and from traditional finance (repos, margin loans), its **integrated approach** – real stocks to short-term stablecoins, via brokers, on-chain – is novel. It occupies a unique position where it doesn't directly compete with any single protocol or product, but rather complements both TradFi and DeFi systems: - To TradFi institutions, TIDAL offers a way to extend services and revenue (brokers can keep customers engaged 24/7). - To DeFi, TIDAL brings valuable real-world collateral and new stablecoin liquidity that's tied to traditional asset values, potentially bridging the gap between crypto and equities. - To investors, TIDAL is a tool to maximize capital efficiency and manage risk in ways not previously possible, effectively giving global, round-the-clock mobility to their wealth.

Thus, TIDAL stands to carve out a new category in the financial infrastructure landscape, serving as the **"SWIFT of cross-border securities"** for a 24/7 global liquidity network [11] – except instead of merely messaging or moving cash, it moves asset value seamlessly across time and space.

Architecture of the TIDAL Protocol

The TIDAL Protocol's architecture is a hybrid of on-chain smart contracts and off-chain systems (brokerage platforms, custodial services, and oracle data feeds). This section describes how all the pieces fit together to deliver the functionality of SSS and TBS securely and efficiently. We break down the

architecture into its key components and roles: **on-chain smart contracts, off-chain custodians/ brokers, price oracles, and supporting infrastructure**. We also illustrate the typical workflow of an end-to-end transaction through the system.

On-Chain Components and Smart Contracts

At the core of TIDAL are a set of smart contracts deployed on a public blockchain (likely an EVM-compatible chain for broad DeFi interoperability). The main contracts include:

- **Vault Contract:** This smart contract manages the locking and unlocking of collateral (SSS tokens) and tracks debt (TBS stablecoins minted). When an investor pledges shares, the custodian will invoke the vault contract to mint SSS tokens and credit them to the investor's address (or an address controlled on behalf of the investor). The investor can then call the vault contract (via the broker's interface or a wallet) to deposit those SSS and generate TBS. The vault contract:
- Records the amount of SSS deposited and how many TBS were issued (ensuring it does not exceed the LTV ratio).
- Enforces the **equivalent-share return** rule: it tags the position with the specific asset (stock ticker or ID) and number of shares. This means that the debt is tied to that collateral specifically [25].
- Holds the SSS tokens in escrow until either the debt is repaid or liquidation is triggered.
- At repayment, it returns the SSS to be burned (meaning the shares can be released).
- At expiry if not repaid, it marks the position for liquidation (and possibly facilitates the auction by transferring SSS to a liquidation contract).
- The vault might be implemented as one contract per asset type or a generic contract handling multiple assets via different vault IDs. Each user's position could be a sub-account in the vault.
- The vault also accrues any fees on the loan (the stablecoin minting fee, etc.) which the borrower must pay at redemption [59].
- **Stablecoin (TBS) Contract:** For each currency, there will be a stablecoin token contract (e.g., one for sUSD, one for sEUR, sJPY, etc.). This contract follows the ERC-20 standard (or equivalent) so that the stablecoin can be transferred and used in DeFi. However, it has additional logic to handle expiry:
- Only the vault (and authorized contracts) can mint new TBS, and only up to the allowed amount per collateral.
- It likely records an "expiry timestamp" after which transfers are frozen or the token can be redeemed for underlying in some way. Implementation-wise, it could be that each batch of stablecoin is tagged with an expiry, or the entire contract operates in cycles. One approach: minting function could record the expiry in a global state, and a cron job (or time-trigger via oracle) at expiry would freeze the token.
- At expiry, the contract may disable transfers and only allow a redemption function, which would be invoked automatically by the system (or by any holder) to exchange tokens for cash or new stablecoins post-settlement.
- Once redeemed or expired, those tokens are burned. If a user somehow doesn't redeem (maybe they forgot and hold expired stablecoins), the protocol would have the funds from liquidation available, and the user could still come to redeem them for cash from the insurance/settlement contract – but generally, the expectation is that arbitrage will ensure no expired stablecoin is sitting around unredeemed (it would trade at full value right before expiry because of the assured payout).
- We might design TBS as a series-based token. For example, "TBS-XYZ-2025-12-01" representing stablecoins issued against stock XYZ expiring on Dec 1 2025. But that could get very granular. More likely is just per currency per cycle: e.g., each day's batch of sUSD might be considered the same token since they expire at a known time and will be reconciled.

- For simplicity for users, the system might ensure all TBS in a given currency have the same expiry (e.g., all sUSD minted today expire tomorrow morning). This way, users don't have to track multiple series – all sUSD is fungible because it all expires at the next U.S. market open. If minted across different time zones, maybe not all sUSD expire at exactly same moment (some minted from Asia stocks overnight U.S. vs from U.S. stocks overnight Asia). This is a complexity: possibly need separate classes or simply handle by having multiple expiry events. We will assume the architecture can handle multiple parallel expiry schedules for different markets.
- **Liquidation/Auction Contract:** This contract is activated in case of defaults. It is responsible for conducting an on-chain auction of the collateral SSS tokens (which represent shares). The auction could be a Dutch auction starting from the last known price [60]. Bidders (who could be other users, arbitrageurs, or even external institutional traders integrated via API) can bid some amount of stablecoins to buy the collateral. The highest bid (or first bid at a given descending price in a Dutch format) wins, meaning they pay their stablecoins and receive the SSS (which they can redeem for the actual share via the custodian). The stablecoins collected are used to burn the outstanding TBS debt [61]. If not enough stablecoins are raised (i.e., the collateral sold for less than the debt), that indicates a shortfall – the gap would be covered by the insurance fund (see below) [62]. If there's a surplus (collateral sold for more than needed to repay debt+fees), the extra could be returned to the borrower or to the insurance fund as per protocol policy [41].
- The liquidation contract would interface with the vault to get the collateral and know the debt amount.
- It likely has a mechanism to prevent auctions from being front-run or manipulated (e.g., using a time-window for bids).
- In case on-chain auctions face liquidity issues (maybe not enough bidders with stablecoins at that moment), the protocol could have a backstop where a trusted market maker or the custodian/broker agrees to buy any unsold shares at a predetermined discount. But ideally, open auctions handle it.
- The design follows patterns from existing DeFi liquidators (MakerDAO's Flipper/Dog contracts or Aave's auction modules) [57], but importantly timed with market open.
- **Oracle Contract:** While not a single contract, the protocol includes oracle components (possibly a set of contracts for posting prices and a mechanism to read them). The oracle posts the official closing price of each supported stock at the end of its trading session [63]. This price is stored, and the vault uses it to determine how much stablecoin can be minted. The oracle also posts the opening price at the next session for settlement. To ensure decentralization, TIDAL might use a network of data providers or a service like Chainlink decentralized oracles to publish these prices. The oracle contract could have a whitelist of reporters and require multiple signatures or a consensus to update a price, to prevent a single point of failure. (More details in Oracle Integration appendix.)

- **Governance and Parameter Contracts:** In early phases, the protocol parameters (LTV ratios per asset, fee percentages, which assets are supported, etc.) might be controlled by the development team or a multisig. Eventually, a **governance contract** (likely tied to a governance token) could allow token holders to propose and vote on changes (like adjusting an LTV, adding a new stock/broker, tweaking fee rates). There might also be a **Treasury/Insurance Fund contract** that holds the fees collected and uses them to pay any shortfalls or fund development. Governance could control disbursement of those funds, or automated rules could, such as "if shortfall event, use funds to mint stablecoins and burn them to cover gap."

- **Token Contracts (Governance/Utility Token):** If TIDAL introduces its own utility or governance token (call it TIDAL token), that token contract will also reside on-chain. It might be distributed as rewards or sold to investors. Potential uses: staking for governance voting, staking as insurance (similar to how some protocols have a safety module where token holders stake their token and

underwrite certain risks in exchange for rewards), fee discounts, etc. The specifics would be part of tokenomics.

In terms of interactions, these on-chain pieces work together as follows for a typical cycle: 1. **Initialization (After Close):** Oracle posts closing price. A user's broker/custodian calls Vault to mint SSS to user. User calls Vault to deposit SSS, Vault checks price feed and allowed LTV, then instructs Stablecoin contract to mint X TBS to user's address. 2. **During Overnight:** User may transfer TBS to others or use in DeFi. Vault contract is basically idle but monitoring time. The oracle may not update any price until the next open. 3. **Before Open:** Ideally user closes position: they send X TBS back to Vault (or call a repay function). Vault burns those TBS via Stablecoin contract, calculates any fee owed, maybe requires the user to also pay e.g. 0.5% fee in TBS or in another token. Once debt + fee is received, Vault releases SSS back to an address (probably the broker's control), which triggers custodian to mark those shares free again. SSS tokens get burned (maybe the custodian/broker contract is allowed to burn them when releasing shares). 4. **If Not Repaid by Expiry:** Expiry arrives. The Stablecoin contract (with oracle or a time trigger) freezes further transfers. The Vault flags position for liquidation. Liquidation contract either automatically kicks off an auction or the broker might immediately attempt an off-chain sale. Suppose on-chain auction is used: the SSS representing the share is transferred to the Auction contract. Bidders bid in TBS or perhaps a major stablecoin like USDC (if the auction accepts other stablecoins, the protocol would then swap them to TBS to burn; but more straightforward is to require TBS for bids, ensuring demand for TBS at that moment). The highest bid wins – let's say someone bids 0.95 * original value (if the share dropped 5%). That bidder pays 0.95X TBS, gets the SSS (which they can redeem for the share via the broker, likely needing to be a KYC'd participant). The 0.95X TBS are then burned, satisfying 95% of the debt. Now 5% of the stablecoins remain unbacked (since only 95% repaid). The contract would use the insurance fund: it mints 0.05X new TBS backed by the insurance fund's assets or simply transfers 0.05X worth of stablecoins from its reserve to effectively cover and burn the rest of the debt. Thus all TBS are now burned. If instead the share sold for more (rare in default scenario, but say price went up and user still defaulted), e.g. 1.1X, then after burning X TBS debt, 0.1X worth of stablecoin is excess; that could be returned to user or to fund. 5. **Post-Open Reset:** After settlement, all TBS from that cycle are out of circulation (either returned by users or burned in liquidation). The system is ready for the next cycle. Oracle updates new prices, etc.

This shows heavy coordination between off-chain and on-chain, which we expand on next.

Off-Chain Components: Custodians, Brokers, and Integration

Because TIDAL deals with real stocks and real investors, integration with traditional financial entities is critical. The main off-chain players are: - **Custodian Bank / Custodian Service:** This is a licensed entity that holds the actual stock shares in segregated accounts, likely as part of the broker's custody chain or an external custodian partner. When shares are pledged into TIDAL, it is the custodian that physically (or digitally) "freezes" them – i.e., they mark those shares as locked (cannot be sold or transferred out until unlocked by TIDAL's signal). The custodian also will be involved in liquidation: if a share is to be sold, the custodian either transfers it to a liquidation agent or sells it on the open market. They might also handle corporate actions (e.g. if a dividend occurs overnight while pledged, how is that handled? Possibly credited to the owner but maybe locked until redemption). The custodian essentially provides the assurance that the on-chain tokens are backed by real assets at all times. - **Brokerage Platform:** The broker provides the user interface and customer relationship. For a retail investor, their broker (which holds their account and shares) would integrate TIDAL through an API or SDK. The broker's app might show a "TIDAL" or "Overnight Liquidity" button next to eligible holdings. When clicked, behind the scenes: - The broker sends an instruction to custodian to lock the shares. - The broker calls the TIDAL smart contract (likely via a backend service, since brokers might not want to expose private keys in a front-end) to mint SSS and then TBS to the user's crypto wallet. This wallet could be custodial (the

broker might manage an internal wallet for the user on the blockchain) or external (the user could link their own wallet address). - For simplicity and user-friendliness, early implementations might use **custodial wallets** for users. The broker could manage an omnibus or individual wallet that holds the stablecoins on behalf of the user within their account UI. This way, users who aren't crypto-savvy don't have to manage keys or even know that a blockchain is involved. They just see that they have $X stablecoin credit that they can use to buy other assets. For example, the broker could allow the user to directly purchase foreign stocks or crypto using that stablecoin credit, all through the same app. - The broker also ensures compliance: since only verified customers can use the service, the minted stablecoins are initially in accounts tied to KYCed individuals. If the stablecoins flow out to external DeFi wallets, that's a consideration – but at least the entry point is regulated. - At redemption time, the broker will prompt the user if they haven't repaid as deadline nears. The app can have automation: e.g., at 9:00am, auto-sell any new assets bought to gather stablecoins to repay, unless the user opts to maintain exposure and accept liquidation of original shares. - If liquidation happens, the broker communicates to the user that their shares were sold (like a margin call). The proceeds (if any leftover beyond covering stablecoin) might be credited to their account. - Brokers stand to gain a **fee share** from TIDAL usage [64]. For example, if there's a 0.5% minting fee, the broker might keep a portion (say 0.3%) and 0.2% goes to protocol or custodian. This incentivizes them to promote it. Additionally, with more trades (if user uses stablecoin to trade other things) they earn commissions or spreads on those trades. - **User Experience considerations:** The user should experience this as a seamless extension of their normal trading. They do not have to do separate KYC for a crypto wallet or understand blockchain intricacies [65]. Ideally, no new app or interface – it's within their existing brokerage app (maybe under a new feature tab). There's no need for the user to manage private keys or even see addresses; the broker can handle wallet custody akin to how Robinhood or PayPal handles crypto behind the scenes for users. This is crucial for adoption: make it feel like just another financial product. - **Oracles / Data Providers:** Off-chain services that provide the price data. These could be the exchanges themselves (providing closing price feeds, which many exchanges publish as official end-of-day data). There could be multiple providers for redundancy – e.g., Bloomberg, Refinitiv, or Chainlink nodes pulling from those sources – all feeding the on-chain oracle. Or the brokers/custodians themselves might act as authorized price feeders since they have the market data feeds. We'll detail this in the Oracle Integration section. The point is, a reliable link from real market prices to the blockchain is established for specific events (close and open). - **Liquidation Agents / Market Makers:** In case of default, conducting a fair auction on-chain requires participants with capital. Likely, some specialized parties will integrate to act as bidders. These could be arbitrage hedge funds that know how to value the stock's gap and are willing to bid stablecoins to get the share. Or the brokers themselves could step in to buy the shares (if, say, the user's brokerage is also a market maker or has a prop trading desk). Since TIDAL is creating a new arbitrage opportunity (buy stablecoin at discount or buy share cheap to get stable payout), we expect arbitrageurs to naturally participate for profit. The architecture might include a **whitelist** or known network of these participants initially, to ensure auctions have bidders. Over time, as the system scales, this can be opened up to anyone with a wallet and stablecoins to bid.

All these off-chain players connect to the on-chain system through defined **APIs and smart contract calls**. For example: - Brokers use an API to initiate pledge/unpledge requests to custodian and then a JSON-RPC or library to call the Ethereum contract for minting. - Custodians might run a node or have a service that listens to on-chain events (like a burn event that signals release shares). - Oracle providers push data on-chain using a transaction at specified times.

From an **architecture diagram** perspective (describing in words): - The user (investor) is at top, using a **Broker Platform UI**. They choose an action (pledge shares). - The **Broker Backend** communicates with two sides: the **Custodian** and the **Blockchain**. - The Custodian locks the shares in the user's account (off-chain ledger update) and confirms to Broker. - The Broker then (or simultaneously) calls the **Vault Contract** on Blockchain to mint the stablecoins. The vault contract in turn interacts with the **Stablecoin**

Contract to issue tokens to an address controlled by the broker for the user. - Now stablecoins are on-chain; the Broker reflects the balance in the user's app. - The user trades something, e.g., buys a foreign stock. If that foreign stock is offered by the broker, the broker can simply use the stablecoin as payment via internal forex/crypto rails. Possibly the stablecoin might be converted to fiat through a crypto exchange or used to buy a tokenized version of the foreign stock – but likely the broker abstracts it by directly executing an FX trade and stock purchase, using the stablecoin as collateral or intermediate currency. - After that trade, the user might hold a different asset (say they sold all stablecoin to buy stock B). But come morning, they need stablecoin to repay. The broker could auto-sell stock B at its market open to get stablecoin (or fiat which they convert to stablecoin on-chain) to repay the loan. - At redemption time, the Broker calls the Vault contract to repay on user's behalf, which burns the stablecoin and signals custodian to unlock original stock. - If user doesn't have enough stablecoin (maybe their trade lost money so they have a shortfall), then liquidation triggers: custodian sells original stock and broker uses proceeds to cover as much stablecoin as possible, any remainder is drawn from insurance fund. - The user either gets back a possibly smaller portfolio (if losses, or they might have gained if trade profitable and still got original stock back by repaying).

Oracle and Price Anchoring Design

One architectural challenge is ensuring that the on-chain protocol knows **when to update prices and trigger events**. TIDAL's timeline revolves around market close and open. The **oracle design** follows these principles: - After a market's close, push the official closing price on-chain. This is the price used for new loans during that closed period [29]. - Do not update that price until the market reopens (ignore interim signals) [66]. This keeps the stablecoin pegged and collateral value static on-chain. - At the moment the market reopens (or just after the opening auction if any), push the new price (opening price). This informs the protocol what the collateral is actually worth now. It is at this point that the protocol can assess if any positions are underwater (opening price * shares < stablecoin debt). - Expiry time for TBS can be set a few minutes before the official open, to allow coordination. For example, if market opens at 9:30, set expiry at 9:25. At 9:25, freeze stablecoin transfers – no more trading TBS – so everything is ready for settlement. At 9:30, get the opening price and then do necessary liquidations. Alternatively, expiry could be exactly at open, with the understanding that oracle price comes simultaneously. Either way, the contracts need the opening price to know what to do. - The oracle must be robust and tamper-resistant. Likely multiple nodes (operated by independent parties or even by participating brokers) will sign the price. They can use a decentralized oracle framework. In terms of data, the "official closing price" is often a well-defined value (for U.S. stocks, the 4:00pm closing auction price). The "official opening price" might be the first trade price or opening auction price. - Because TIDAL deals with multiple exchanges in different time zones, the oracle system needs to handle **multiple schedules**. For example, at 4pm NY, feed a bunch of closing prices for U.S. stocks. At 4:30pm London, feed closing prices for LSE stocks. At 9am Tokyo, feed opening price for JP stocks, etc. It's a continuous cycle. The architecture likely has an **oracle registry** where each asset has attributes like "market closes at X time, opens at Y time, timezone". The oracle nodes might have cron jobs or triggers based on those times to publish updates. - There is also the matter of FX rates. If an investor with a U.S. brokerage mints USD stablecoins using a Japanese stock (which is in JPY), do they convert the value to USD at some rate? Or more straightforward: they would mint a JPY-pegged stablecoin (sJPY) because the stock's value is naturally in JPY. Then if the user wants USD, they'd swap sJPY to sUSD via some FX mechanism on chain (maybe TIDAL or partner DEX provides FX pools). That way the protocol doesn't need to handle FX conversion internally; it just issues stablecoins in the same currency as the stock. This reduces oracle complexity – each stablecoin's peg is to its local currency. The FX conversion is left to market forces or separate modules. - The oracle also possibly signals **volatility or halts**. If a stock is halted (maybe pending news), the protocol might pause allowing new loans or extend an expiry if the stock didn't open on time. This would require an input to say "opening delayed" or "trading halted". There should be contingency for that (maybe treat it as if market still closed until trading resumes).

From an architectural perspective, the oracle mechanism might involve a dedicated set of contracts where: - Data is posted (perhaps to a **Price Feed contract** per asset). - The Vault and other contracts read from those feed contracts. - There might be an **Emergency Admin** who can override or push manual values if needed (e.g., if an exchange had a glitch). - Ideally though, use widely trusted sources.

Network and Scalability Considerations

Which blockchain TIDAL uses is an architectural decision. Ethereum mainnet offers security and composability with DeFi, but gas costs could be significant if there are thousands of daily actions (imagine hundreds of thousands of users minting nightly). Each mint and redeem is a transaction. For global scale, a layer-2 solution (like an optimistic or zk-rollup) might be prudent. Or using a high-throughput chain like Solana could be considered (though tying in with Ethereum's DeFi might be harder then).

A possible approach: - Use an Ethereum Layer 2 (Optimism, Arbitrum, or a zkRollup) for fast, cheap transactions. Brokers can batch transactions of many users into one L2 transaction (if they custody wallets, they could aggregate actions). - Ensure the stablecoins are easily bridgeable to other chains if needed so they can be used where liquidity is (though being on one chain is simpler to start). - The architecture should also consider **uptime**: since it's dealing with time-critical events, the blockchain chosen must reliably process transactions at specific times (e.g., auctions at market open). A congested network at 9:30am could be problematic if auctions can't finalize quickly. L2 with sufficient capacity can mitigate that.

Sequence Diagram Summary

To put it all together, here's a high-level sequential flow with components:

1. Market Close Event: (Off-chain) Exchange closes. (On-chain) Oracle nodes push closing prices into Oracle Contract for all relevant stocks. Vault contract updates internal price records, enabling new stablecoin loans at those rates.

2. User Initiates Loan: (User via Broker UI) selects shares to "liquify". (Broker Backend) calls Custodian API to lock shares. Custodian confirms lock. (Broker) then calls TIDAL Vault Contract: `mint(address user, asset X, quantity, currency)` etc. The Vault calculates allowed stablecoin per LTV and calls Stablecoin contract to mint tokens to the user's address. A fee can be deducted or noted at this time.

3. Stablecoin Usage: (User) now has TBS stablecoins (perhaps visible as cash balance). They initiate trades – e.g., buy another asset. If within same broker, broker executes trade and possibly directly converts stablecoin to target currency under the hood (could involve an on-chain swap or internal ledger if broker facilitates it). If user transfers TBS out to external wallet (possible if they want to use in DeFi), that is a normal token transfer on-chain. The architecture doesn't prevent that (though regulators might want restrictions; TIDAL could implement transfer restrictions or whitelisting if required, but ideally not, to allow full DeFi use).

4. Pre-Expiry Alerts: (Off-chain) Broker monitors which positions are open as expiry approaches (e.g., 30 minutes to go). Sends notifications to users or auto-actions as per user settings. Perhaps the default is auto-redeem using any available assets.

5. User Redeems Loan: Assuming user wants to close normally: They ensure they have the required amount of TBS. (Broker or user's wallet) calls Vault's `repay(address user, asset X)` function, providing the TBS stablecoins. The Vault burns the stablecoins (via Stablecoin contract), releases SSS tokens to the custodian interface. Custodian then unlocks shares back to user. The Stablecoin contract might charge the fee here if not taken upfront (like require slightly more TBS than principal, corresponding to fee).

6. Expiry and Liquidation (if needed): If user did not repay: - (On-chain) When expiry time hits, the Stablecoin contract automatically freezes TBS transfers (could be done by a time-check in transfer function or a scheduled call by oracle). - The Vault marks delinquent positions. Immediately at market open, oracle posts new prices. Vault calculates which positions are underwater (opening price * shares < stablecoin owed). For each such position, it triggers liquidation. - The SSS tokens for that collateral are sent to Auction Contract. Auction Contract begins accepting bids (this could run for a very short period, e.g., a few minutes, to quickly resolve). - (Off-chain) The custodian might simultaneously be instructed to place a sell order in the market as a backup or in parallel if needed to get a baseline price. But ideally, on-chain auction yields a result: - (External bidders or Broker acting as bidder) bid stablecoins. Auction ends, winner's stablecoins are taken. - The stablecoins from bidder plus possibly insurance fund are summed to equal the debt, and that amount of TBS is then taken out of circulation (burned). - The bidder gets the SSS (and thus right to the share). They likely will redeem that share: perhaps the protocol allows a transfer of ownership off-chain. Possibly the easiest is the custodian just updates the ownership of that share to the bidder's account (if the bidder is onboarded with custodian). This requires the bidder to be a known party; early on, likely only known arbitrage firms will participate, making this feasible. Over time, maybe a decentralized participation might require some solution like issuing the share as a regulated security token to the winner – but that adds regulatory complexity. Most likely, only brokers/custodians or whitelisted institutions bid, so the actual share can be delivered within the existing system. - The user (original borrower) is notified they lost their shares. If any value remained beyond covering the debt+fee, perhaps they get a cash credit (or maybe not, depending on protocol rules). - The stablecoin holders are unaffected because either the borrower repaid them by buying back tokens, or the auction bidder effectively repaid by buying the share for stablecoins. In any case, all TBS tokens are now either redeemed or in the hands of someone who can redeem them (the bidder might hold some if they bid more stable than needed, but that scenario we covered giving them share for exactly debt typically).

7. Cycle repeats: The system is ready for new loans next day.

Security and Redundancy in Architecture

The architecture is designed with multiple layers of security: - **Custodial Control:** Shares never leave the traditional custodial chain, mitigating the risk of losing the underlying asset due to smart contract issues. Even if something went wrong on-chain, the shares are still at a known institution (though there could be legal questions if, say, a hack minted stablecoins – who bears loss – but at least shares are safe from being stolen digitally). - **Smart Contract Audits:** All on-chain contracts (Vault, Stablecoin, Auction, Oracle feeds) will undergo rigorous audits and testing (discussed more in Security section). The design tries to minimize complexity: e.g., use existing ERC-20 implementations for tokens, use standardized auction logic from proven DeFi modules, etc. - **Fail-safes:** There may be emergency pause functions. For instance, if oracle fails to deliver a price, an admin could pause new minting until clarified. Or if extreme events happen, the protocol's governing multisig could extend expiries (though that undermines promises slightly, so it'd be a last resort). - **High Availability:** The off-chain components like broker APIs and oracles need high uptime, because a failure at a critical time (e.g., custodian API down at market open) could be problematic. Likely, partners will invest in robust infrastructure given these time-sensitive operations. The blockchain transactions for oracle and auctions should also be timely; hence selecting a chain with predictable finality and low risk of congestion around daily times is important.

Overall, the architecture of TIDAL Protocol is one of **bridging two worlds**: it extends the traditional capital markets into the blockchain world just enough to capture the needed functionality (through SSS and TBS), while still leaning on traditional systems for what they do best (asset custody, regulatory compliance, user interface). It's a carefully balanced design: fully decentralized in the stablecoin circulation and liquidation process, but leveraging centralized institutions to safely handle real assets and user management. In doing so, it creates a pipeline that moves value freely: from a stock ledger, to a blockchain token, to another market's asset, and back – forming the envisioned 24/7 liquidity network.

Tokenomics Design and Value Capture

The economic design of the TIDAL Protocol needs to align incentives for users (investors), liquidity providers, brokers, and token holders, while ensuring the system's sustainability through revenue generation and growth. In this section, we outline the **fee structure, token distribution (if applicable), value capture mechanisms, and yield pathways** for participants in the TIDAL ecosystem.

Fee Structure and Revenue Streams

TIDAL's primary revenue model is **transaction-driven**, meaning the protocol earns fees from each cycle of activity rather than from idle funds. The major fees include: - **Stablecoin Minting Fee:** Every time a user mints TBS (i.e., takes an overnight loan against shares), a fee is charged on the amount borrowed. In the initial model, this is a flat percentage fee, for example **0.5% of the stablecoin amount** [67]. This is effectively like a one-night interest rate or origination fee. For instance, minting $5,000 of sUSD would incur a $25 fee [67]. This fee is charged upfront or at redemption. If upfront, the user would only receive net $4,975 but owe $5,000 at payback; if at redemption, they owe $5,025. The implementation could go either way; charging upfront slightly reduces risk (protocol already collected fee even if user defaults, though in default they lose share anyway). This fee is the **primary revenue source** for the protocol [67]. - **Redemption Fee:** The current model might not explicitly have a separate redemption fee (the mint fee covers the round trip). However, to encourage timely redemption, some protocols impose a small fee if a position is not redeemed by user and goes to auction. Alternatively, a portion of auction surplus goes to protocol as fee. TIDAL may or may not have this; not specified, but something like a **liquidation penalty** could be considered (like MakerDAO charges penalty fees for vault liquidation). If implemented, that penalty could go to the insurance fund. - **Custody & Settlement Fees:** TIDAL plans to share revenue with partner custodians for their role in managing collateral [68]. Custodians might charge a fee per transaction (pledge/release) or a basis-point fee on collateral value. This would be an expense from protocol's perspective or possibly directly from user (could be built into the mint fee or separate). But in the revenue model given [67], "Custody & Settlement: revenue share with partner custodians on collateral management" suggests the protocol might get some referral or volume-based fee from custodians as well (for driving business to them), or just that part of the fees collected are allocated to custodians. - **Cross-Chain/Conversion Fees:** If TIDAL includes a DEX (like the mentioned "ProSwap DEX integration") or any mechanism for swapping TBS to other currencies, it could earn fees on those conversions [69]. For example, if a user converts sUSD to sEUR through TIDAL's integrated FX smart contract, a small swap fee might go to TIDAL or its liquidity providers. Or if users trade on an affiliated DEX using stablecoins, trading fees can flow to the protocol's treasury. - **Yield/Performance Fees:** In future, TIDAL envisions facilitating **automated arbitrage strategies** using the stablecoins. If the protocol (or a related DAO) runs an arbitrage bot or lending strategy that uses pooled stablecoins or collateral, they might charge a performance fee (e.g., keep 25% of profits made from those strategies) [70]. This is speculative, but mentioned as "AI Arbitrage (Future): 25% performance fee on automated overnight arbitrage strategies" [69]. Essentially, if TIDAL sets up an algorithmic fund that takes advantage of TLP inefficiencies and generates profit, the protocol takes a cut. - **Interest Spread:** If ever the model shifts to dynamic interest (say if someone wanted to borrow for multiple days with interest accrual, or an extension beyond

overnight), the protocol could earn an interest spread. But currently, the overnight fixed fee is the approach instead of interest per se. - **Governance/Utility Token Mechanisms:** If a TIDAL token is introduced, the protocol could have built-in value capture like: - Staking TIDAL tokens to earn a share of fees (similar to Curve or others where fees are shared with token stakers). - Requiring fee payment in TIDAL token or offering discounts for using the token. - Buy-and-burn: using a portion of fees to buy back TIDAL tokens from market and burn, thereby indirectly accruing value to holders (like how MakerDAO uses fees to burn MKR). - These specifics would be decided as part of token launch. For now, fee flows likely go into a Treasury contract.

The fee levels can be tuned. 0.5% overnight is relatively high in traditional APR terms (~182% if you did it every day), but as a one-off quick access fee it might be acceptable for the convenience. Over time, competition or usage might drive it down. The protocol could adjust fees by governance, possibly lower once volume is high. But initially, the business plan showing large revenues likely assumes sticking around 0.5%.

Token (TIDAL) and Value Capture

Though not yet launched as of the initial version, the plan includes a **governance token** (we'll call it $TIDAL for reference). By Q4 2026, the team expects "token readiness" [71], implying a token launch around that time. The role of this token could include: - **Governance:** Holders can vote on proposals affecting the protocol (adding new assets, changing parameters like LTVs, fees, choosing custodians, etc.). This decentralizes control and aligns with eventual DAO transition. - **Insurance/Safety Staking:** Token holders might stake TIDAL into an Insurance Fund. This stake could be used as a backstop for any shortfall beyond the dedicated insurance fund (similar to how Maker's MKR is the last resort to mint and cover Dai bad debt, or Aave's Safety Module where staked AAVE can be slashed to cover shortfalls [58]). In return for taking this risk, stakers could receive a portion of protocol fees. - **Fee Discounts & Rewards:** Brokers or heavy users might get discounts on fees if they pay in TIDAL token or hold a certain amount. Also, early adopters might be rewarded with token airdrops or liquidity mining: for example, providing liquidity in a TBS stablecoin pool might earn TIDAL tokens as incentive. - **Treasury Value Accrual:** If the protocol collects fees in various forms (TBS, other stablecoins), those accumulate in a treasury. The governance token might entitle holders to that treasury (either through buybacks or potential dividends if regulatory okay). Many DeFi tokens aim for value accrual through token burns (reducing supply as usage increases). A portion of TIDAL's fees could be used to market-buy TIDAL token and burn it, thus linking usage to token scarcity.

A possible token distribution would allocate to: - **Team and Investors:** As a venture project, likely a portion goes to founders and seed investors ($15M seed etc. – not directly relevant to the whitepaper, but the economics should ensure those stakeholders). - **Ecosystem & Community:** Some allocation for liquidity mining, user rewards, community fund. - **Reserves:** Some held for future fundraising or partnerships (like rewarding brokers who integrate, etc.).

The whitepaper might not detail the distribution but focuses on token utility and role in governance and security.

Yield Pathways for Participants

Different participants have ways to earn yield or profit in TIDAL: - **Retail/Investors:** Their "yield" or benefit is indirect – by using TIDAL, they potentially earn a higher return on their portfolio that would otherwise sit idle. For example, if they can deploy $10,000 overnight and earn even a 0.1% return in some opportunity, that's $10 extra overnight which annualized is significant. They weigh that against the 0.5% fee they pay. If they use it opportunistically (only when they have a good opportunity), they net

positive. Additionally, if they hold stablecoins, they might lend them for interest overnight. Possibly the protocol or brokers might offer an interest if someone holds stablecoins throughout (like an overnight lending rate if someone else is borrowing them). - **Liquidity Providers/Arbitrageurs:** Those who provide liquidity for TBS-to-other-stablecoin swaps or who arbitrage mispricings can earn trading fees or arbitrage profits. For instance, if TBS is trading at a discount (say $0.98 because people fear something), an arbitrageur can buy at 0.98 and either wait to redeem at 1.00 (earning ~$0.02 profit per token, which annualized is huge for overnight) or hedge by shorting the stock in another market. These are sophisticated strategies that yield profits essentially coming out of the Liquidity-of-Time Premium. TIDAL's design encourages such arbitrage as it keeps the system efficient and provides natural yield to those willing to take the other side of trades. - **Brokers/Custodians:** They earn via fee sharing. A broker might get a cut of the 0.5% fee – e.g., if they get 0.2%, then on $100M volume, they get $200k. As usage scales, this is new revenue for them. Custodians likewise might get platform fees. For custodians, another yield is increased assets under custody if people move more stocks to a TIDAL-supporting broker just to use this service. - **TIDAL Token Holders:** If they stake tokens to backstop risk, they may earn a portion of the protocol's fees as yield. For example, the protocol might allocate 20% of all fees to be distributed to staked token holders, which at high volumes could be substantial. They effectively earn yield tied to platform usage. Also, if the token is deflationary via buy-backs, holders benefit from scarcity appreciation over time.

To put numbers to the potential scale, the whitepaper's projections show that even with modest adoption, because of high frequency, revenue accumulates rapidly. They gave a "Conservative 3-Year Trajectory" where by 2028 revenue could reach billions [72] [73]. For instance: - Year 3 (2028): perhaps ~500k users, each doing ~100 overnight mints a year at ~$5k each, yields tens of millions of transactions and on the order of $500M+ in fees [74]. This seems optimistic, but it underscores how high frequency can multiply even a small fee. Each user paying $25 per night occasionally, but do it often and many users, becomes huge. - If those fees feed into token value, the token could be backed by significant cash flows.

Total Value Locked (TVL) Dynamics

Total Value Locked (TVL) refers to the total collateral (stock value) locked in the protocol at a given time. It's a key metric in DeFi. For TIDAL, TVL would be the total market value of all shares that are currently pledged (and thus backing active stablecoins). TVL fluctuates throughout the day as different markets close and reopen.

A formula was provided: **TVL(t) = U(t) × P_avg × LTV_avg × V_factor** [75], where: - U(t) = number of active users (or active positions) at time t. - P_avg = average pledge size per user (i.e., average value of shares locked by each user). - LTV_avg = average loan-to-value ratio used. - V_factor = a volatility factor or utilization factor.

Let's interpret V_factor: It could represent the fraction of potential usage actually utilized at a given time due to volatility considerations. For example, not all users will use their maximum LTV or maybe not all will use the protocol every possible night. It might encapsulate usage frequency or risk reduction factor. Possibly it stands for how much of global stock value is practically mobilizable given volatility (for example, if extremely volatile times, usage might drop, so V_factor accounts for such variation).

This formula suggests TVL is driven by user adoption and behavior. E.g., if 1,000,000 users each lock on average $10k of stock at 50% LTV, TVL would be 1e6 * $10k * 0.5 * V. If V~1 for full usage, that's $5 billion TVL. If users only use it half of the time, maybe V=0.5, making $2.5B.

Dynamic TVL pattern: Because TIDAL usage follows market closures, TVL might have a rolling wave behavior in a 24h cycle: - When Asian markets close (afternoon in Asia), Asian shares get pledged – TVL rises with those. - Then Europe closes (afternoon in Europe), European shares added. - Then U.S. closes (4pm NY), U.S. shares added – global peak TVL might be after all major markets have closed (around 4-5pm NY which is like late night Europe, early morning Asia next day). - Then when Asia reopens (late evening NY), the Asian portion of TVL drops to zero (as those are redeemed or settled), while Europe+US still locked. Then Europe opens (early morning NY), European part drops. Then U.S. opens (morning NY), last part drops, maybe TVL nearly zero during mid-day when all markets are open. It's like a tidal wave flowing around (thus the name Tidal is apt). There could be always some region closed, except perhaps a short window when U.S. open overlaps with Asia next day open? Actually Asia and US don't overlap normally; but Europe and US have some overlap. However, if all major ones are open for a few hours together, then at that moment, ideally TVL is lowest (everyone could directly trade without needing TBS, unless minor markets closed). So TVL usage is basically an oscillating wave.

This means the protocol's revenue (fees) is more related to the **cumulative volume of stablecoins minted and redeemed** over time (which is user count * times used * amount each time) rather than the peak static TVL. In DeFi, often people focus on TVL, but here frequency is key – high turnover (mint at close, burn at open daily) yields fee each time.

They illustrated that even moderate user count, if used frequently, yields high transaction volume [76]. For example, 500k users using 100 times/year at $5k = $50 billion total volume minted per year. At 0.5%, that's $250 million revenue/year [76]. Their chart even suggested reaching hundreds of millions revenue by year 3, which aligns.

Scalability: The fee model is **scalable** because it's digital and low marginal cost [76]. The cost of an additional transaction is low (some blockchain fees, which can be optimized), so if millions of transactions happen, the margin remains high. Unlike a bank that would need more capital to lend out more, here the "liquidity" comes from the users' own assets – the protocol is just enabling it and charging toll.

Example Economic Flows

To illustrate value capture, consider a scenario: - An investor uses TIDAL, mints $10,000 stablecoin, pays $50 fee. Suppose the broker keeps $30, custodian $10, protocol treasury gets $10 (numbers hypothetical). - Investor invests that $10k overnight in a crypto yield farm, earns $20. Next day they repay $10,000. They made $20 minus fee $50 = net -$30, so they lost money; why would they do that? They wouldn't unless yield was higher or a strategic purpose. If they instead caught an arbitrage that made $200, then net $150 profit – it was worth it. - Now multiply by many users and times. - The $10 fee that protocol got goes partly to insurance fund (say $2) and the rest accumulates. The protocol might allocate $5 of it to token stakers as USDC or as buyback. Broker and custodian got their shares.

- Another perspective: if usage is high, TIDAL could accumulate a large insurance fund from fees. They might decide to invest that fund (maybe in safe yield like short-term treasuries) to earn interest, further supporting system or even paying token holders.

In summary, the tokenomics design of TIDAL is geared to ensure: - **Robust revenue generation** from each use-case (so the protocol can fund operations, insurance, and provide token value). - **Alignment of incentives:** Users only use it when beneficial to them (they pay a fee but gain some advantage greater than fee), brokers promote it because they earn a cut and increase client activity, token holders benefit from volume growth via fee sharing or token appreciation, and stablecoin holders are safe because the model collects enough value to cover risks and incentivize backstops. - **Growth loop:** As more brokers

join and more users use it, fees can possibly be reduced (benefiting users) due to scale, which attracts even more usage. Or maintain fees but introduce loyalty benefits via tokens.

One risk is if fees are too high, users might only use TIDAL for very compelling opportunities. But if it's moderately low, even smaller opportunities or convenience (like getting cash for something short-term) might be worth it. Tuning that fee will likely be important and might drop as the protocol matures and no longer needs to recoup initial development costs, etc.

Finally, part of tokenomics is also **Total Supply and Emissions** if a token is launched. Possibly a fixed supply or a DAO-managed issuance. Many protocols start with a large allocation to attract users (liquidity mining). TIDAL might do something like: allocate tokens as rewards for first year to users who frequently use the system or to those providing liquidity on integrated DEX pools for stablecoins.

We will not go deep into hypothetical numbers, but we articulate that tokenomics will ensure the **value generated by the protocol flows back to stakeholders** while keeping sufficient reserves for risk management and growth incentives.

Security Design and Risk Mitigation

Security is paramount for a protocol that bridges real-world assets with DeFi and handles potentially large volumes of value on-chain. The TIDAL Protocol's security design spans smart contract safety, oracle integrity, collateral liquidation mechanisms, and operational security (including regulatory security). In this section, we detail the measures in place to safeguard user assets and system solvency, and how TIDAL mitigates various risks identified in its model.

Smart Contract Security

All TIDAL smart contracts will be developed following **best practices in secure Solidity (or relevant language) coding**: - **Audits:** Multiple independent security firms will audit the smart contracts before deployment [77]. Given the complexity (especially with time-based triggers and auctions), professional audits are critical. TIDAL will likely engage top audit firms experienced in DeFi protocols. Every major update will also undergo audit. - **Formal Verification:** If feasible, certain critical components (like the stablecoin contract and vault math) might undergo formal verification to prove properties like no unauthorized minting, proper collateral ratio enforcement, etc. - **OpenZeppelin Libraries and Standards:** The development will leverage battle-tested libraries (for ERC20 implementation, math libraries to prevent overflow, etc.) to minimize custom code vulnerabilities. - **Testnet and Beta Testing:** Extensive testing on testnets (and possibly an incentivized beta on mainnet with capped usage) will be done. The current status mentions a closed pilot with institutional partners [78] – that likely serves as a test phase to iron out issues with limited risk before public launch. - **Bug Bounty Program:** TIDAL will implement a bug bounty to encourage external security researchers to find any vulnerabilities, with substantial rewards for critical bugs [77]. - **Upgradability and Admin Keys:** Early on, the contracts might have upgradability (via proxy contracts) to allow fixes/improvements. If so, the admin keys controlling upgrades will be secured in a multisig (multi-signature) wallet with trusted signers, possibly including neutral third parties, to prevent single-point compromise. Over time, as governance decentralizes, these keys would transfer to the DAO control or be timelocked with community oversight. - **Emergency Pauses:** The contracts likely include an emergency `circuit breaker` that can pause certain actions (like new minting or auctions) if an anomaly is detected. For instance, if an oracle feed is attacked and posts crazy prices, an admin could pause the system to prevent erroneous loans or liquidations. This is a common DeFi safeguard. It would be used only in extreme situations. - **Isolation of Components:** The architecture is likely modular such that a bug in one asset's handling (say a faulty parameter for one

stock) doesn't affect others. Each asset's vault could be separate, or at least positions are isolated. So a failure or hack would have contained impact rather than draining the whole system. For example, if a bug allowed someone to over-borrow on one asset, it shouldn't let them touch collateral of others. - **Pen Testing and Simulations:** The team likely ran simulations of different scenarios (market crashes, etc.) to ensure the contracts respond correctly (like not allowing borrowing if oracle price not updated, etc.). Also, hired white-hat hackers might do penetration testing on the infrastructure.

By using proven patterns (like those from MakerDAO or Compound), TIDAL stands on solid ground – these protocols have not had smart contract hacks at core level (though they had economic issues like Oracle manipulation incidents). TIDAL can implement the lessons learned from those designs [79].

Oracle Security

Oracles are often the weakest link in DeFi security. TIDAL's oracle approach mitigates risks by: - **Decentralized Price Feeds:** Relying on multiple data sources and reporters for price. For example, using a Chainlink decentralized oracle network for each stock's price at close and open. Chainlink nodes could pull from official exchange APIs. Alternatively, if using its own network of brokers or data providers, requiring a threshold of them to submit the same price (by consensus) before the contract updates. - **Timeliness and Authenticity:** The price at official close is less likely to be manipulated than a continuous price feed – it's a discrete well-known result (closing auction price). Similarly, the opening price. The oracle doesn't continuously push prices, which reduces attack surface (no frequent updates to game in between, aside from possibly stale price trading which is expected). - **Fallbacks:** If the primary oracle fails or is delayed, there might be a fallback source. For instance, if by 4:05pm no price was posted (maybe Chainlink hiccup), the protocol could use broker-submitted price or last trade price. Or pause new activity until it's resolved. Having a manual override (with multisig permission) to input a price if needed ensures the system isn't stuck due to oracle outage. - **Preventing Oracle Manipulation:** Since the price used is from real stock exchanges with huge liquidity, manipulation is very difficult (no single DeFi user can change the NYSE closing price of Apple, for example – that would require billions of capital). This is unlike some DeFi tokens where low liquidity oracles could be manipulated. By tying to the deepest market prices, oracle attacks are essentially mitigated. The main risk is feed integrity (ensuring the number on-chain is correct from off-chain). - **Secure Oracle Update Mechanism:** The Oracle contract could be only updatable by whitelisted nodes that stake some collateral (so if they cheat, they can be slashed). Also updates can include a sanity check – e.g., it won't update to a price that is, say, 50% different from previous close unless multiple confirmations, to avoid a glitch causing crazy value (although big overnight moves >50% can happen rarely, so maybe not too strict, but at least check formatting like not zero or not null). - **Transparency:** All oracle updates are logged on-chain, so the community can see what prices were used in case any dispute arises.

Collateral and Liquidation Safety

The liquidation process is designed to **ensure stablecoin holders remain whole** even in volatile conditions: - **Over-Collateralization:** The conservative LTVs (e.g., 50%) mean that even a large overnight move is typically covered. Historically, blue-chip stocks rarely drop more than 20-30% overnight barring catastrophic events. A 50% buffer covers most single-event risks [35]. For riskier assets, the buffer is larger (lower LTV) [35]. This drastically reduces the likelihood of insufficient collateral. - **Dynamic Risk Controls:** As noted, if volatility increases or a stock is expected to move more (like an earnings announcement next morning), the protocol or brokers might proactively reduce allowed LTV for new loans, or even disable new borrowing for that stock on that day. This could be part of the dynamic LTV adjustment policy to keep default probability within target [36]. It's akin to raising margin requirements before volatile events – a common risk practice. - **Automated Liquidation at Open:** There's no reliance on human intervention to decide liquidations. The contracts automatically trigger it when conditions meet (fail to

repay by deadline or price drop beyond threshold) [40]. This prevents delays that could cause further losses. The use of auctions ensures that the market sets the price, aiming for maximum recovery [33]. Using Dutch auctions can also speed up the process (it can close in minutes as soon as someone bids, rather than lengthy bidding wars). - **Insurance Fund:** As repeatedly noted, TIDAL accumulates an insurance reserve from fees to cover extreme cases [41]. This acts as a second layer of defense. For example, if a stock had an unforeseeable -70% overnight (perhaps due to fraud revelation), even with 50% LTV, stablecoin holders would face a shortfall of 20% of their value. The insurance fund would step in to pay that 20% gap, preserving the stablecoin value. If the insurance fund wasn't enough, then possibly TIDAL governance token or emergency measures would come (like partial coverage or socialize loss). But TIDAL's promise likely is to never let the stablecoin depeg, so they will strive to have a sufficiently capitalized insurance fund. They might calibrate that fund's size to statistically cover, say, 6-sigma moves of underlying assets. - **Auditing of Collateral Off-Chain:** There is a custody risk – we trust that the custodian indeed holds the shares and doesn't rehypothecate them. Regular audits or realtime attestations by the custodians should be in place to show that total shares locked in TIDAL equal total SSS minted, etc. The integration likely uses unique sub-accounts to ensure segregation. Possibly an external auditor could periodically confirm the stocks in custody. - **Smart Liquidation Parameters:** The protocol might set a threshold to trigger immediate liquidation even before expiry if things get truly dire. For instance, if news breaks overnight and an ADR indicates the stock is down 40% vs closing price, the protocol might decide to start unwinding (though it can't sell until open, it could freeze the borrower's other assets or something). More likely, they stick to waiting for open but then do it swiftly. - **Circuit Breaker for Cascades:** If a systemic event happens (market crash globally), many positions could liquidate at once. The auction system should be able to handle it (lots of parallel auctions). If markets themselves halt (exchanges have circuit breakers that pause trading for big drops), TIDAL may delay liquidations until trading resumes (the oracle wouldn't update until a real price is formed). The system should have logic to handle exchange-halting scenarios (maybe extend expiry until first available price). - **MakerDAO Inspiration:** TIDAL's approach to on-chain auctions and over-collateralization is influenced by MakerDAO's success in maintaining Dai stability through big events (except Black Thursday 2020 where some auctions failed due to Ethereum congestion – TIDAL can avoid that by using faster chains or ensuring high gas for critical transactions). They also note academic insight that fixed-margin liquidations can favor liquidators [79]. TIDAL's dynamic approach and potentially adjusting LTV on the fly can mitigate giving too sweet a deal to liquidators at expense of borrowers. It keeps things more balanced.

Technical Infrastructure and Operational Security

Beyond the blockchain itself, the operational side must be secure: - **API Security:** Brokers and custodians will expose APIs to interact with TIDAL's contracts. These must be secured (authenticated calls, encryption). Only authorized entities (e.g., a broker calling mint for its clients) should be able to trigger certain contract functions. Possibly the vault contract has whitelisted call permissions if needed (though ideally it's open if user has SSS token in their wallet – but if using broker-custodial wallets, you want to ensure only the broker's wallet that has permission can mint corresponding stablecoin). - **Key Management:** If brokers hold private keys to user wallets that hold stablecoins, they become big targets for hacking. Thus brokers need secure custody for those keys (HSMs, multi-sig, etc.) akin to how exchanges manage crypto custody. Alternatively, the system could allow direct user wallets to connect if they prefer self-custody (less likely for average retail initially). - **Regulatory Compliance as Security:** Ensuring compliance is a form of risk mitigation – legal or regulatory action could disrupt the protocol (e.g., if deemed illegal, forced shutdown). By proactively working with regulators and operating within frameworks (like MiCA in Europe, sandbox exemptions in Asia, etc.), TIDAL reduces the risk of a sudden shutdown which would strand assets. We discuss regulatory more later, but from a security perspective, compliance reduces regulatory risk which is one of the identified risk categories [80]. - **Platform Risk and Redundancy:** The TIDAL system relies on several platforms: blockchain network, custodians, oracles, etc.

Each should have redundancy: - If one custodian fails or is hacked, ideally user assets are insured or perhaps using multiple custodians spreads risk. TIDAL might incorporate multiple custodians across regions so not all eggs in one basket. - If the blockchain (Ethereum L2) has issues, maybe cross-deploy to another chain as backup, or have a way to manually settle outstanding positions off-chain in worst case. - Oracles as discussed have multiple nodes. - The code being open source means the community can inspect and contribute to security too.

Risk Categories and Mitigations Recap

TIDAL's documentation explicitly lists major risk categories and how they mitigate them [81] [82]: - **Market Risk:** Collateral value drop – mitigated by conservative LTV, real-time monitoring, auto-liquidation at open, and insurance fund [83]. - **Regulatory Risk:** Uncertainty across jurisdictions – mitigated by a compliance-first approach, partnering with licensed entities, proactively engaging regulators, and diversifying regions (not rely on one country's approval) [80]. - **Technical Risk:** Smart contract or security breach – mitigated by multiple audits, bug bounties, leveraging Probe's 10-year web3 infrastructure experience (Probe likely has prior audited components), and using decentralized oracles (so no single point hack) [77]. - **Adoption Risk:** Slow uptake or hesitancy – mitigated by being first-mover (so less competition), showing concrete pilot success, strong value proposition, and building an ecosystem coalition (likely meaning get many partners onboard to drive acceptance) [43].

They also show a table of **Conservative Risk Parameters** [35] which we mentioned – different asset types get different max LTV and buffers, to tailor risk management. This fine-grained approach ensures that riskier assets don't threaten the system by being treated the same as stable ones.

Additional safeguards included: - Short exposure windows (overnight only, not longer) – limits risk accumulation [84]. - Daily resets (positions must close daily) – means no long-term debt that can snowball [84]. - User education – informed users are less likely to misuse or misunderstand (like they know not to over-leverage or forget repayment) [84]. - Automatic triggers – no manual process hoping a user comes back; it will cut losses automatically at preset thresholds [84]. - Insurance fund accumulation from fees – as covered, ensures a growing buffer for system-wide events [85].

Insurance Integration: The mention of "insurance fund" implies internal self-insurance. Additionally, TIDAL could purchase external insurance or work with DeFi insurance protocols (like Nexus Mutual or others) to cover smart contract hacks or oracle failures. Institutional partners might also require some insurance on custody or tech failures.

Penalties to Discourage Bad Behavior: The system might implement penalties like if a user consistently fails to redeem (gets liquidated often), maybe they get restricted or pay higher fees. This incentivizes responsible usage and reduces moral hazard (someone might be tempted to gamble with borrowed stablecoins knowing worst case they lose shares – but that's already punishment enough usually).

Stress Testing: TIDAL likely modeled stress scenarios: - E.g., 1987 crash scenario or 2020 COVID crash overnight futures locked limit down, how would the system cope? Possibly those scenarios had markets halting, which TIDAL would handle by pausing new loans and waiting to open to settle. - Multi-day closure (e.g., exchanges closed for mourning or an emergency): if stablecoins extended longer, interest or fees might increase to compensate extended risk. Or no new issuance until reopen. - They might hold an assumption that if something like all markets close (war/global issue), then stablecoins might be extended or a special governance decision needed. Those edge cases rarely are addressed but at least thought through.

In conclusion, TIDAL's security design is comprehensive: combining **preventative measures** (careful coding, audits, conservative parameters) with **reactive measures** (automated responses, insurance, emergency controls). By blending the proven risk management techniques of traditional finance (like collateral buffers, circuit breakers) with the robustness of decentralized smart contracts, TIDAL aims to maintain trust and stability. Indeed, the goal is a track record of "zero protocol loss" – meaning no user or stablecoin holder should ever lose money due to system failure [86]. Achieving that will be critical to gain the confidence of institutional users and regulators.

Regulatory and Compliance Model

Navigating the regulatory landscape is one of the most critical aspects of implementing the TIDAL Protocol, given its bridging of traditional securities and cryptocurrency. The design of TIDAL's compliance model is to **align with existing regulations in each jurisdiction** and to proactively address legal concerns around asset tokenization, stablecoins, and securities lending. In this section, we outline how TIDAL fits into regulatory frameworks across key regions, and what measures are in place (or planned) to ensure compliance and mitigate regulatory risks.

Overall Compliance Strategy

TIDAL's approach is compliance-first, meaning it seeks to work within regulatory bounds rather than in grey areas [80]. Key pillars of the strategy: - **Leverage Regulated Intermediaries:** By partnering with licensed brokers and custodians, TIDAL ensures that the core activities (custody of securities, handling of client funds, KYC/AML) are conducted by entities that already have regulatory approval for such activities. The protocol itself doesn't directly hold customer fiat or securities; it provides the tech rails. So, for example, a brokerage integrating TIDAL likely treats the stablecoin loan as an extension of their margin lending or repo services from a regulatory perspective, just executed in a novel way. Brokers already comply with KYC/AML, suitability checks, etc., so users come pre-vetted into TIDAL's ecosystem. - **Not a Public Offering of Securities:** One tricky question: Is issuing an SSS token or stablecoin effectively issuing a security? TIDAL's stance would be that these tokens are **private, fully-collateralized loan instruments** rather than investment securities. SSS are not traded or offered to the public; they remain within the system as collateral. TBS stablecoins might be transferable, but they are more akin to stable-value tokens or even repurchase agreements rather than giving ownership in a company. In the US, for instance, you'd analyze under the Howey Test: an overnight stablecoin doesn't represent an expectation of profit from others' effort; it's more of a dollar substitute redeemable for a dollar of value next day. Ideally, it would not be deemed a security (similar to how short-term debt instruments or certain stablecoins are not considered securities). - **Licensing Where Needed:** In some cases, specific licenses may be pursued. For instance, **money transmitter or e-money licenses** for handling stablecoins (in jurisdictions that regulate stablecoins as e-money). If TIDAL or a foundation issues the stablecoin, they might register as an e-money issuer or partner with someone who is (like how Circle has money transmitter licenses for USDC). Another example: in the U.S., if the stablecoin is seen as a derivative of a security (stock), could it be considered a security-based swap? That would be a legal stretch because it's fully collateralized by actual ownership and short-term. But to be safe, TIDAL may structure so that legally it's a **securities lending or margin extension** – things that brokers already do under Reg T or other rules. - **Jurisdictional Ring-fencing:** The rollout plan shows a phased approach by region [78] [87]. TIDAL will likely tailor its product in each region to local rules: - In Asia (first launch region), target places with progressive frameworks. For example, Singapore has a regulatory sandbox for FinTech and has allowed tokenization experiments; Hong Kong recently has been establishing rules for security token offerings; Thailand has a digital asset framework. TIDAL might work with regulators in these markets to clarify that an overnight stock-backed stablecoin is essentially a collateralized loan or repo, which could be allowed under certain conditions. - In Europe, the upcoming **MiCA (Markets in Crypto-Assets)** regulation (effective 2024-2025) will regulate stablecoins. Under MiCA, a stablecoin could be an "asset-

referenced token" if it's not just one currency but based on other assets. TBS might fall under that if, say, it's pegged to a currency but backed by equity collateral – it might be considered an E-Money Token if it's always exactly equal to one fiat (with collateral in other forms). There will be capital and disclosure requirements. TIDAL likely will ensure compliance with MiCA by either partnering with a regulated entity that issues the stablecoin under MiCA's requirements, or by restricting European usage until compliance can be assured. - In the UK, which often follows similar logic, one might need approval under financial promotions, and stablecoins might come under e-money or future UK crypto regime. Possibly launching via a regulated broker there (which can get waivers or treat this as extension of existing services) is key. - In Switzerland, tokenized securities and crypto laws are relatively advanced – they might treat SSS as book-entry securities and stablecoins as digital representations of claims. Working out of a crypto-friendly jurisdiction like Switzerland could be beneficial (maybe base the protocol entity there). - In the US, the toughest jurisdiction: The stablecoin could be scrutinized by the SEC if considered a derivative of a security or a note. However, if done through brokerages, it might slip under the umbrella of margin lending or securities lending which are in SEC/FINRA's oversight but allowed activities. TIDAL might need to demonstrate that an overnight stablecoin is functionally similar to a margin loan combined with a cash credit. The SEC has been wary of crypto offerings, but if by 2027 (target for US) there's more regulatory clarity (maybe a stablecoin law or the SEC's stance evolves with new leadership), TIDAL will engage then. They mention working with regulators on a stablecoin framework [88]. - Possibly, an alternative for US: keep the stablecoin usage limited to accredited investors or institutional use initially. The pilot with institutional partners suggests initial usage might not be retail in US until it's cleared. - **KYC/AML and Transaction Monitoring:** Because TIDAL stablecoins could move globally, there's a risk they could be used for illicit transfer if they left the broker ecosystem. To mitigate this, TIDAL might implement **whitelisting** of addresses – e.g., only allow transfers between whitelisted addresses (all participating brokers, major exchanges, etc.). However, that reduces DeFi composability. Another approach is to have strong off-chain monitoring: if a stablecoin ends up in unknown wallets, the issuers can freeze or not redeem those (some stablecoins have freeze functions, though that's against decentralization ethos). Given the compliance-first stance, TIDAL might lean towards a permissioned stablecoin model initially, where retail users mostly use it within broker apps, and any inter-broker transfers happen on whitelisted channels. Over time, perhaps it opens more. - **Data Privacy and GDPR:** If operating in EU and handling personal data (likely minimal on-chain, but brokers have user data), ensuring compliance with data protection regulations is needed. But since personal data isn't on chain and stays with brokers, that's manageable.

Legal Classification Considerations

Let's consider what TBS stablecoins might legally be classified as in a few jurisdictions: - **US:** Possibly a form of **"security-based loan"** or a **deposit-like instrument**. Since it's short-term and collateralized by securities, one might analogize it to a margin extension. If regulators view the stablecoin itself as a security, that complicates it (it'd need SEC registration or exemption). But if they accept that it's a loan (therefore not a security offering), the brokers can do it under existing margin rules, which require certain disclosures and capital requirements but not new laws. The SEC might consider if this falls under **"swaps"** regulation, but swaps usually involve two-way risk; here the investor is not transferring risk of the stock's performance (they still own it, or lose it if fail to repay) – it's more like a collateralized loan, which is not a swap. - **Commodity vs Security:** Some might argue the stablecoin portion could be regulated by the CFTC as a commodity (like some stablecoins might be considered commodities akin to USD). Hard to say. But given it's pegged to fiat, likely treated like stablecoin currency. - **Europe (MiCA):** As mentioned, probably qualifies as an asset-referenced token or e-money token. If it's considered referencing a single currency and always redeemable at par, that is e-money token under MiCA and requires authorization (with base capital, whitepaper, etc.). Possibly TIDAL will partner with a licensed Electronic Money Institution to issue the stablecoins in EU, or with a crypto-asset service provider license. - **Securities Laws:** SSS tokens could be considered a form of digital representation of securities (but not

traded, so maybe not trigger prospectus requirements as long as it's internal). However, in some places, just tokenizing a stock needs regulatory approval (e.g., in EU, if it were transferable, it might be a **tokenized security requiring prospectus**). TIDAL's design to not trade SSS publicly helps avoid that. If SSS were to be transferable outside the broker, each jurisdiction might require that token to be a digitally represented security under their book-entry laws. TIDAL likely restricts SSS movement entirely (they go from custodian mint to vault to burn). - **Banking Regulations for Custody:** Many countries now have regulations for crypto custody or token custody. But since brokers/custodians are handling it and presumably the stablecoins, they will ensure it fits in their permitted activities. If a broker holds stablecoins on behalf of clients, is that like holding cash? Possibly yes, and they might need to treat it as customer asset with segregation.

Proactive Regulatory Engagement

TIDAL plans to **engage regulators proactively** [80]. This might involve: - Presenting the model to regulators via sandboxes or innovation hubs (e.g., MAS in Singapore, FCA sandbox in UK, SEC FinHub in US if possible) to get feedback and possibly no-action letters. - Ensuring any necessary disclosures are made: for instance, to users that using TBS involves crypto and certain risks. - Building a compliance and legal advisory team with experience in securities law, crypto law. - Possibly structuring TIDAL under a legal entity (like a foundation or a company) that is domiciled in a crypto-friendly yet compliant place (e.g., Singapore, Switzerland). - **Geofencing**: In initial phases, they might geofence out certain countries (like US retail) until regulatory clarity. The app can restrict who can use stablecoins or redeem them based on KYC info.

Multi-Jurisdiction Operations

Because TIDAL deals with cross-border value flows (e.g., a US investor might use stablecoin in Asia), it crosses jurisdictions. How to handle: - If a US user uses stablecoin to buy a foreign asset, that likely triggers cross-border securities trade. TIDAL likely only allows such trades through brokers with the proper international trading permissions. For example, some brokers let you trade foreign markets via local subsidiaries or partnerships; TIDAL just provides funding for it. So normal cross-border trading rules (like using an international brokerage account, following local market rules) still apply. TIDAL doesn't bypass capital controls illegally; if a currency can't be freely moved, they might restrict certain conversions. - In China (mainland), crypto and such is restricted. TIDAL likely won't operate directly there. But targeting Hong Kong or via Hong Kong for Chinese investors could be route since HK is opening up crypto under regulation and has a strong securities framework. - **Taxation compliance:** The platform should also help users with tax reporting. For instance, in some countries taking a loan is not a taxable event, which is good (they get liquidity without selling stock, hence defer capital gains tax). That's an advantage TIDAL might advertise. But if any interest or fees are paid, those might be deductible or might not – users will handle that, but providing statements helps. - **Accounting for institutions:** Institutions might be concerned about how to classify such transactions on balance sheet (is it a liability, or off-balance sheet?). TIDAL should produce documentation to help, likely treating it as a collateralized borrowing.

Compliance in Phased Roadmap

As per the roadmap [78] [87]: - Starting with Asia 2026 suggests perhaps regulatory friendlier ground or at least where they have partners ready. Possibly they have in-principle approval in some Asian jurisdiction already [89]. - Europe integration by 2027 means complying with MiCA if they want EU wide. Possibly target countries like **Germany or Switzerland** that are advanced in crypto acceptance (Germany legalized certain security tokens; Switzerland has DLT laws). - North America (2027+) obviously pending regulatory framework; they foresee working with forward-looking broker-dealers and regulators for

stablecoin approval [88]. By that time, maybe the US will have a stablecoin-specific law (there were discussions in Congress around 2023-24 about regulating stablecoin issuers, requiring reserves etc. TIDAL's stablecoins are fully backed by equity collateral but not in fiat – how would that be seen? Might require some adaptation to fit any law expecting dollar reserves). - Having a "US market toehold" by 2027 implies they might start with something like a limited pilot or perhaps usage in a specific context (maybe institutional or with regulatory sandbox). - The plan to possibly have a governance token suggests eventually decentralizing – but ironically, fully decentralized governance could clash with regulatory certainty, because regulators prefer a responsible entity they can hold accountable. Perhaps by the time of DAO transition, the network is global enough that it's more resilient to any one regulator's action.

Benefits to Regulators and Systemic Impact

It can be helpful to frame how TIDAL might appeal to regulators or at least not raise red flags: - It improves **market efficiency** and arguably reduces some systemic risk by allowing hedging and reaction overnight. For example, it might dampen severe open volatility if enough participants hedge overnight via other markets. - It keeps the process **transparent** (on-chain transactions can be traced) and **fully collateralized** (so unlike 2008 financial crisis where lots of leverage and rehypothecation led to issues, here every stablecoin is backed by something tangible). - By involving regulated brokers, it ensures **investor protection** measures (like suitability, risk disclosures) are in place. A retail user can't just YOLO into it without the broker presumably providing info on what it is (the user's still taking on risk if their stock falls). - TIDAL could align with regulatory initiatives to expand trading hours. If regulators see demand for 24/7 trading, TIDAL is a market-driven solution to achieve much of that with existing infrastructure. It could complement official extended hours by providing liquidity when needed. For instance, if the NYSE's 24-hour experiment struggles with liquidity, TIDAL's approach might ironically channel foreign liquidity into U.S. stocks indirectly (someone in Asia using stablecoin to arbitrage vs an ADR). - **Investor Education & Communication:** TIDAL will likely ensure all marketing or user-facing materials clearly explain the product as, say, "Overnight collateralized loan using your shares" rather than "trade stocks 24/7 with crypto!" in a way that might alarm regulators. Framing and transparency help avoid being seen as trying to circumvent rules.

Potential Regulatory Hurdles

A few challenges might arise: - **Stablecoin classification:** Some regulators may say if a stablecoin is pegged to USD, it should be treated like other USD stablecoins (thus requiring fiat reserve or issuer license). But TIDAL's stablecoin is differently backed. Could cause confusion or double requirement (e.g., theoretically you'd meet a law by having collateral, but if law says reserves must be cash, you have to get exemption). - **Securities Lending Rules:** Some jurisdictions limit who can lend securities or require specific agreements. What TIDAL does is akin to the investor lending their share to the protocol in exchange for cash. That might need to comply with securities lending regulations (like in the US, Reg SHO has provisions for borrowing shares, but that's for short selling; here not exactly the same because no one else is shorting, but effectively the share is out of circulation overnight locked). - **Bankruptcy considerations:** If a broker or custodian goes bankrupt while shares are pledged, are users protected? Typically, custodians segregate assets, so yes. But this is something regulators will consider – ensure that a user's stock isn't considered an asset of the broker in such case (shouldn't, if properly segregated). - **Cross-border flows and capital controls:** If TIDAL allows money to flow freely (e.g., a Chinese investor could convert local stock to USD stablecoin and move it abroad), that could circumvent capital controls. TIDAL might have to prevent usage in jurisdictions with strict controls or implement limits (like require stablecoin redemption in same currency or region). This might be an area regulators like China would frown upon, so likely TIDAL focuses on open economies or ensures compliance with FX regulations (maybe by limiting currency conversion amounts or requiring KYC and reporting cross-border transfers to authorities). - **Consumer protection:** Regulators will want to ensure users understand the risk of losing

their shares if they default. That’s akin to margin risk disclosures. TIDAL via brokers will provide those and likely require user consent/acknowledgment. Possibly even impose limits on how much of one’s portfolio can be pledged (like to avoid someone pledging 100% of assets and then losing them on a whim – though they decide that, maybe not paternalistic). - **Tax: in some jurisdictions, creation of an SSS or stablecoin might be seen as a disposition of the asset if not careful.** TIDAL will argue it's a loan so no tax event. But ensuring tax authorities view it that way is important to not saddle users with unexpected taxes.

In summary, TIDAL’s compliance model is to work hand-in-hand with existing financial rules, rather than operate as an unregulated DeFi protocol. By merging into brokers’ offerings, it essentially piggybacks on their regulatory structure. The phased approach demonstrates caution: start where it’s legal or easier, prove the concept, then expand. Regulatory compliance is an ongoing effort – as the law evolves (like MiCA, potential US crypto laws), TIDAL will adapt. They aim to achieve a status where by the time of mainstream use, regulators see it as a valuable financial innovation that still respects the safeguards of the traditional system.

Phased Deployment Roadmap

Launching a paradigm-shifting protocol like TIDAL requires a carefully staged rollout across markets and continual iteration. The project’s roadmap envisions several phases, each with specific milestones and geographic focus, to manage technical scaling, regulatory approval, and market adoption. Below we describe the planned phases of deployment, the key objectives and milestones in each, and how TIDAL transitions from pilot to global infrastructure.

Phase 0: Pilot Phase (Current Stage)

Timeline: Ongoing (2025 into early 2026, per roadmap)

In the Pilot Phase, TIDAL is working with select **institutional partners** in a closed environment [78]. The goal here is to validate the end-to-end technology under real conditions, but with controlled risk: - **Participants:** Likely a small number of hedge funds, proprietary trading firms, or progressive brokers and custodians that agreed to test the protocol. They provide feedback on usability and help detect any issues. - **Scope:** Possibly limited to a subset of assets or a single region’s market at first. For example, they might pilot using a certain exchange’s stocks after hours (maybe a smaller market or with dummy collateral even). - **Key Objectives:** - Demonstrate successful overnight trade cycles [90]: e.g., show that an institution can pledge shares at close, get stablecoins, trade something, and redeem shares next day seamlessly. - Validate oracle accuracy and timeliness. - Test liquidation process (maybe simulate a default to see auction works). - Ensure integration with custodian and broker APIs works reliably. - Measure user experience and make improvements (although in pilot, it might be engineers/traders involved who are tolerant of clunkiness). - **KPIs:** By end of pilot, they expected metrics like $100M+ stablecoin volume minted, 100,000+ beta users, zero security incidents [91]. These numbers are quite ambitious for a pilot, especially 100k users, which suggests perhaps including retail beta or a partnership with a mid-sized brokerage to invite some of their clients to try it in a beta mode. - If that’s achieved, it means significant traction and confidence. - “Zero security incidents” is crucial to prove safety.

A successful pilot de-risks many factors (tech, regulatory small-scale tryouts, user reaction). It also helps build credibility and results that can be presented when raising further funding or applying for regulatory approvals.

Phase 1: Asia Launch (2026)

Timeline: Target ~Q2-Q3 2026 for launch in first Asian markets [92].

Asia is identified as the first region for a public launch, with specific mention of **China/Hong Kong, Singapore, Thailand** [92]: - **Why Asia first:** Several reasons: - Retail investor culture in parts of Asia (Hong Kong, Singapore, Thailand, etc.) is vibrant and often receptive to new trading tools. Many retail traders might want 24/7 action. - Some of these markets have progressive regulators or sandbox programs (e.g., MAS in Singapore). - Also, time-zone wise, Asia is a great starting point: bridging to U.S. and EU off-hours. - Perhaps partners (like an Asia-based custodian or broker network) have already been secured, as hinted by "in-principle agreements with licensed custodian in Asia and mid-sized online broker for first pilots" [93]. - **Activities in this phase:** - **Local Regulatory Clearance:** Work with Hong Kong's SFC, Singapore's MAS, Thailand's SEC to ensure compliance. Possibly launching under a fintech sandbox in one of these (for example, Thailand's SEC had a digital asset portal, MAS could give exempt status to try). - **Broker Partnerships:** Finalize integration with initial broker (perhaps that mid-sized online broker mentioned). Possibly sign on a few more in the region. They might aim for a Chinese broker with overseas operations, or a fintech app. - **Custody Setup:** The Asia custodian in principle agreement will be used operationally. If it's Singapore based, maybe they custody assets from multiple Asian countries, or partner with sub-custodians in each market. - **Currency Stablecoins:** Launch first stablecoins, likely USD and maybe a local currency like SGD or HKD stablecoin, to facilitate cross-currency moves. They plan multi-currency by later phases but Asia launch might start with one base currency (maybe USD-pegged for cross border). - **Education and Marketing:** Roll out campaigns to educate investors on how to use TIDAL feature via their broker, emphasizing increased liquidity. Possibly do small incentive like reduced fees for first X months to drive trial. - **Progress Goals:** - By Asia Launch, certain milestones were planned: - Beta launch by Q1 2026 [94]: presumably internal or limited launch, but by Q2 Public Launch – which is Asia. - They expected by Q2 2026 (Public Launch) to see first revenue generated, $50M+ TVL, <5% liquidation rate [95]. So within first months of Asia launch, measure TVL and ensure defaults remain low (<5% of loans liquidated, meaning most users redeem as intended). - These are proving risk controls work (liquidation rate low = people use responsibly or system stops risky ones). - Asia Retail Participation: They note Asia region has high retail participation [96], which implies they will be targeting retail customers right from this launch (not just institutional). - Possibly launching in Hong Kong 2026 aligns with Hong Kong's push to be a crypto hub (HK might allow security token action for retail under new regime). - **Scale**: Start likely in one or two markets, then quickly expand. For example, maybe launch in Hong Kong first (since bridging US<->HK stock flows is logical and HK has many Chinese investors who want US stocks liquidity), then add Singapore and Thailand by late 2026. Each new market added means new assets supported and new stablecoin possibly (if pegging to local currency). - The roadmap indicates by Q3 2026 (Multi-Region phase) they want 5 broker partners, 3 currency stablecoins, 100k active users, regulatory approval in key jurisdiction [97]. Key jurisdiction maybe means one major market like maybe the EU or a primary Asia one formal approval. Achieving 100k users by Q3 2026 would demonstrate strong uptake.

Phase 2: Europe Integration (2026-2027)

Timeline: Starting 2026, ramping through 2027 [98].

After Asia is running, Europe is next: - **Target Countries:** UK, Germany, Switzerland are explicitly mentioned [98]. Possibly also others like France or Nordic later, but those three cover major financial hubs and friendly regulatory regimes (MiCA covers EU, UK is separate now but open to innovation, Switzerland outside EU but very crypto-friendly). - **MiCA Compliance:** By the time of Europe expansion (late 2026 into 2027), MiCA likely in effect, so TIDAL will structure product to comply (get necessary registration if stablecoins offered widely, etc.). Possibly easier route: partner with a European fintech that

already has e-money or crypto license. - **Broker Partnerships:** Europe has some neo-brokers (like Trade Republic in Germany, etc.) and larger multi-country brokers. TIDAL might sign one or two key ones. Or partner with a pan-European custodian bank that can hook into many brokers. - **Market Size:** Europe has ~€8 trillion regional equity market – a big opportunity. European investors also hold US stocks often, so bridging that via TIDAL might be attractive (overnight usage from one region to another). - **Use Case Emphasis:** Possibly emphasize how European users can get into US or Asia overnight (given time zone difference). Also, European markets themselves have midday gap with US time difference which is shorter overlap vs Asia. - **Currency stablecoins:** Likely launch stablecoins in EUR and GBP. So by now, they'd have USD, EUR, GBP, maybe CHF or others if needed. Multi-currency capability means if someone pledges a Euro-denominated stock, they might get sEUR stablecoins, etc. - **Milestones:** The Q3 2026 multi-region milestone had 3 currency stablecoins, indicating by then USD, EUR, maybe one Asian (like SGD or HKD). Also 5 broker partners globally [97] likely includes some European. By Q4 2026, they aimed for technical readiness for governance token and second custodian partner [71] – second custodian could be a European one (if first was Asia). - Through 2027, expansion continues deeper in Europe: more countries, more brokers. Possibly try to integrate into the large legacy brokers or banks offering trading accounts.

Phase 3: North America Launch (2027+)

Timeline: Starting 2027, perhaps pilot or limited launch in U.S., then broader by 2028.

North America, particularly the US, is last due to regulatory complexity: - **Approach to U.S.:** Collaborate with forward-looking broker-dealers and regulators [88]. Possibly start with a limited scope: - Perhaps initially allow only some stocks (maybe just large caps or ETF collateral). - Or only allow accredited investors or institutional users in the U.S. to use TIDAL in the beginning, which might avoid some regulatory constraints. - Work closely with FINRA/SEC to maybe get a no-action letter or to operate under an exemption. - If by then any stablecoin legislation is passed (e.g., requiring reserves), possibly adapt by partial collateralization with cash or something to meet rules. - **24X and 24/7 exchange interplay:** By late 2025 and 2026, the US will have partially extended hours (24X launching 4am-8pm initial, then 24x5 by 2026 as per article [6] [99]). By 2027, there might be nearly around-the-clock trading on official venues for US stocks. TIDAL will need to consider that: - If US stocks trade 24/5, the "closed period" shrinks to only a short maintenance window plus weekends. TIDAL stablecoins might then target weekend liquidity for US equities, or still overnight if not fully 24h yet (or for the extra 1 hour downtime). - TIDAL might pivot more to cross-market arbitrage (like US vs Asia overlapping hours rather than strictly closed periods). Essentially, TBS might become shorter or less needed if US fully open, but global usage still relevant because of currency and region differences. - Possibly, TIDAL could integrate with the 24h exchanges by providing liquidity to them. For example, a participant might use TBS to trade on 24X overnight exchange, thereby adding liquidity where needed. - **Canada:** They didn't mention but Canada could be simpler than US (Canadian regulators might be more open if done carefully). But likely focusing on US first since biggest. - **Metrics by ~2027:** They had "Series B Targets (Mid-2027)" including 500k+ monthly active users, $1B+ nightly TVL peak, $50-100M annual revenue run-rate, 10+ brokerage partners, 3 continents presence with compliance, US market toehold, zero protocol loss track record [100]. This paints a picture of a sizable platform by 2027: - Over half a million users actively using it, indicating mainstream adoption in initial regions. - $1B nightly TVL meaning huge collateral locked globally each night (implies lots of users or big institutional usage). - Many brokers on board, across Asia, Europe, maybe one or two in US as a toehold. - No losses, which would be an important brag to regulators ("we have operated with no failures even through volatile events"). - **Token Launch:** Q4 2026 readiness suggests sometime in 2027 they might actually launch the TIDAL governance token (possibly aligned with a large Series B or growth phase to decentralize). - Could coincide with handing some governance to community as adoption becomes global, also maybe use token to incentivize US adoption (like reward US early users or new brokers with tokens). - **Dominant Global Position aim:** By late 2027 into 2028, TIDAL aims to be the

first mover capturing this market globally [101] before competitors catch up. That means entrenching relationships with major brokers and custodians around the world so that any new entrant would face high coordination barriers.

Phase 4: Global Scale and Maturity (2028 and beyond)

Beyond the listed phases, we can extrapolate: - **Consolidation and Network Effects:** Once in all major markets, focus on deepening usage. Possibly expand to other asset classes (imagine TIDAL for bonds or commodities if markets close, or maybe for things like mutual funds that price daily). - **24/7 vision:** Ideally by 2030, if TIDAL is successful, the concept of markets closing might be obsolete – either because TIDAL provides alternative liquidity or because exchanges extended hours in response. In either case, TIDAL might pivot to remain useful as a cross-market liquidity provider (maybe focusing on currency conversions or bridging crypto and stocks). - **Technology Upgrades:** Might move to more scalable tech (if started on an L2, maybe migrate to its own app-specific chain or cross-chain deployment to optimize speed and cost). - **Governance DAO:** The community or DAO might fully control parameters, adding new whitelisted assets or integrating new brokers by vote. Perhaps brokers themselves join the governance process (like nodes in the oracle network). - **Compliance Continuous:** adapting to new laws. Possibly by then, global regulatory consensus on crypto might treat protocols like TIDAL as crucial infrastructure that are regulated similarly to clearinghouses or settlement systems.

Deployment Challenges and Mitigations in Roadmap

Each phase has potential challenges: - Pilot: risk of technical failure or partner backing out – mitigated by close collaboration, iterating quickly. - Asia: must ensure local language support, local user preferences, and navigate multiple regulators at once. Mitigation: focus on a manageable subset (maybe HK & SG first, then TH, then others). - Europe: need to concurrently handle many countries – mitigated by EU passporting (MiCA gives license to operate across EU if one country approved), and by maybe focusing on one major market like Germany first to prove then expand via EU rules. - US: biggest hurdle regulatory, hence leaving time to work through it and using successes elsewhere as leverage (“others are doing it, we can’t be left behind” argument). - Competition: possibly others might try similar (maybe a big bank replicates concept). Being first to move and partnering broad (10+ brokers by 2027) is the defense. - Scaling technology: as user counts grow, make sure system (blockchain throughput, oracle capacity, etc.) can handle volumes. Possibly by multi-chain or optimizing contracts to batch operations (like a single tx to mint for many users via broker). - Customer support and operations: with global retail, ensure support lines, documentation, training of brokers’ support staff etc. TIDAL team likely provides a lot of backend support initially.

In essence, the roadmap is aggressive but logical: start where conditions are favorable, build momentum and proof, then tackle harder markets. It aligns technical progress with regulatory windows (MiCA timing for EU, possible US changes by 2027, etc.). By phasing deployment, TIDAL can incrementally grow the network effect and refine the product, leading toward its long-term vision of a ubiquitous 24/7 liquidity layer for equities worldwide.

Revenue Modeling and Total Value Locked Dynamics

The economics of TIDAL Protocol are driven by user adoption and usage frequency, which translate into transaction volume, fee revenue, and collateral locked in the system. In this section, we delve into how TIDAL generates revenue, how that revenue scales with usage, and the dynamics of Total Value Locked (TVL) over time. We also discuss scenario projections demonstrating the protocol’s financial trajectory under conservative vs. high-growth assumptions.

Revenue Streams and Formula

As described in Tokenomics, TIDAL’ s revenue primarily comes from fees on stablecoin issuance and related activities. The core formula capturing the relationship between usage and revenue is:

$$\textbf{Revenue} = \text{Volume of Stablecoin Minted} \times \text{Minting Fee Rate}.$$

For a given user base, the Volume of Stablecoin Minted over a period can be broken down as: - Number of active users (who use TIDAL in that period) - Average size of each mint (the dollar value of stablecoins minted per use) - Frequency of usage (how many times per period each user does it)

If we let: - U = number of active users in a year - f = average number of mint transactions per user per year - P = average pledge size (in underlying stock value) per transaction - LTV = average loan-to-value ratio (so stablecoin minted per $ of stock = LTV) - r = minting fee rate (e.g., 0.5% or 0.005 in decimal)

Then:

$$\text{Annual Stablecoin Volume} = U \times f \times (P \times LTV).$$

And

$$\text{Annual Revenue} = U \times f \times P \times LTV \times r.$$

Using some indicative values: - Suppose $U = 500,000$ users. - Each user uses the service $f = 100$ times a year (roughly twice a week, which could mean they actively trade on ~2 nights each week). - Average pledge $P = \$5,000$ (some might pledge more, some less; $5k might be a typical overnight need). - Average $LTV = 0.5$ (50% of stock value as loan). - Fee $r = 0.005$ (0.5%).

Plugging in:

$$\text{Volume} = 500,000 \times 100 \times (5000 \times 0.5) = 500,000 \times 100 \times 2500 = 125 \times 10^9 = \$125 \text{ billion}.$$

That is $125 billion of stablecoins minted in a year (which means $125 billion moved across nights in total). Then revenue:

$$\text{Revenue} = 125 \times 10^9 \times 0.005 = \$625 \text{ million per year}.$$

This rough calculation shows how **even with moderate user count, the high frequency can drive very large volumes**, hence revenue. It aligns with the projection that by Year 3, a base case scenario could yield on the order of hundreds of millions to a billion in revenue [74] .

The provided roadmap chart had a "3-Year Revenue Trajectory" that visually suggested: - By 2026 (year 1 of public launch maybe): revenue maybe near \$0 (just starting). - By 2027: perhaps approaching \$800M annually [102] . - By 2028: maybe \$1.6B annually (the chart showed up to $2.4B by 2028, which might indicate an even more aggressive scenario) [72] .

These numbers might assume either a higher user base or usage frequency. For instance, a high-velocity scenario might involve: - A larger proportion of users using it daily (like very active traders or algorithmic usage, maybe some using it every trading night). - Possibly more users (if millions of users join). - Or expansion of revenue beyond just mint fee (like additional trading fees or arbitrage profits as mentioned).

Nonetheless, the key insight is that **TIDAL scales with transaction frequency**: it's not enough to have assets locked (TVL) sitting there; it's the turnover (how many times those assets generate fees) that matters.

Total Value Locked (TVL) Dynamics

TVL in TIDAL refers to the total value of equity collateral locked at any given moment. TIDAL's TVL will have a daily cyclical pattern, as described earlier: - It rises when markets close as shares get pledged. - It falls to near zero when all markets reopen and loans are redeemed or liquidated.

However, one can consider the peak TVL at a typical cycle (when most are locked). Also cumulative or average TVL over time.

The formula given [75]:

$$\mathrm{TVL}(t) = U(t) \times P_{\mathrm{avg}} \times LTV_{\mathrm{avg}} \times V_{\mathrm{factor}},$$

where: - $U(t)$ is the number of users active at time t (or active loans at time t), - P_{avg} is average pledge per user, - LTV_{avg} is average loan-to-value used, - V_{factor} is a "volatility factor" or usage factor.

The volatility factor likely accounts for the fact that not every user will be utilizing the maximum loan or even participating at every opportunity. It might incorporate: - fraction of users participating on a given day, - fraction of maximum allowable collateral utilized (maybe sometimes they don't max out LTV due to caution), - possibly a factor to account for volatility buffers (for example, maybe you effectively treat only part of the equity value as available due to volatility concerns, but that might already be included in LTV). - It could also reflect the ratio of overnight closure time to full day (since assets are only locked overnight, maybe to annualize TVL one multiplies by fraction of day closed).

In any case, TVL is directly proportional to user count and LTV. If user base or average pledge size grows, TVL grows.

One interesting dynamic: as TIDAL becomes popular, some users might start using it on every possible night religiously, basically turning their portfolio into a yield generator. For example, a user with a $50k portfolio could every night mint maybe $25k stablecoin, deploy it to earn something (even just interest or farm yields), then redeem. If many do that regularly, TVL could approach 50% of all enrolled users' portfolio value each night.

Growth of TVL over years: - Initially, TVL will be small (pilot maybe a few million). - In Asia launch year, perhaps tens of millions by end of year (they expected $50M TVL by Q2 2026 launch milestone [95]). - By multi-region late 2026, target $200M nightly TVL by Q4 2026 [71]. That implies a big jump as user count and trust increase. - Series B mid-2027 target was $1B+ nightly TVL at peak [103]. That suggests by mid-2027 perhaps around 0.5M users as they said, which fits our earlier calc: 500k users * $5k * 50% ~ $1.25B if all used in one night, maybe $1B if not all at same time or some smaller pledges.

TVL vs Revenue: In many DeFi protocols, revenue is some function of TVL times a yield or interest. Here revenue is more directly from volume (which is TVL times turnover). If everyone did one overnight loan and repaid, the entire TVL churned once that day, revenue = TVL * 0.5%. If people do it every trading day, the annual volume is roughly 250 times the peak TVL (since ~250 trading nights in year). In our example: - $1B nightly TVL, if fully turned over each night, annual volume ~ $250B, revenue at 0.5% = $1.25B. That aligns with $1B TVL yielding ~$1B revenue/year which is extremely high relative to typical DeFi yields but

because it's not interest accrual, it's repeated fee events. - If usage is less frequent, actual volume might be lower multiple of TVL.

User Growth Drivers: The more brokers and regions, the more users onboarded. Also institutional usage could spike TVL if say a hedge fund decides to do this on large positions systematically. For instance, if an ETF or fund with $1B in stocks used TIDAL daily, that one user equals many retail's TVL.

Financial Projections and Scenarios

Conservative Scenario: Low adoption ramp: - Suppose by 2028 TIDAL only reached 100k users doing 50 uses/year at $5k, LTV 50%. Then: Volume = 100k * 50 * $5k * 0.5 = $12.5B/year, revenue = ~$62.5M/year. Not bad, but far from potential. That might correspond to maybe just Asia usage or niche usage. TVL in that scenario might be maybe $250M nightly. - That's conservative relative to their plan.

Base Case (the plan): 500k users by year 3 (2028) with usage patterns as we earlier estimated: - Volume ~ $125B, revenue ~$625M/year. Possibly scaling up to $1B/year after year 3. - TVL near $1B nightly. They showed base case hitting a few hundred million revenue by year 3 [76], which fits.

High Velocity Scenario: - If usage exceeds expectations, say a smaller user base but they utilize it daily and possibly yield on stablecoins attract more. Or if fees could even be lowered to attract more volume if needed (though 0.5% might remain). - Or if a few million users join after 5 years (imagine it becomes as common as margin trading on Robinhood). - For instance, 2M users * 100 times * $5k * 0.5 LTV = $500B volume/year, revenue $2.5B/year. That might be a high scenario around 2028 or beyond. - Their chart max $2.4B by 2028 suggests such a scenario [72]. That would likely require millions of users or inclusion of US market with its huge retail base.

Scalable Economics: The cost side of TIDAL is relatively low marginal cost. Smart contracts run autonomously; some operational costs for oracles, infrastructure, compliance, but adding more users doesn't linearly add cost like a bank would have to fund loans. This means **profit margins should be high once initial development and partnerships are covered**. By Year 5, they foresee a "realistic successful scenario" of $500M-$1B+ annual revenue from millions of transactions with low incremental cost [76]. That suggests a very high operating leverage – most of that revenue can either be reinvested or returned to token holders minus paying partners and insurance fund contributions.

Fee Adjustments: As volume grows, if competition arises or to encourage more usage, the protocol could adjust fees. Even at half the fee (0.25%), if volume doubles due to that, revenue stays same but more competitive to alternatives. This is something governance could tune. Initially 0.5% might be fine as it's unique, but if many similar offerings appear, they might lower fees.

Dynamics of TVL and Revenue with Market Conditions

- In stable or bull markets, more people might use TIDAL as they seek to leverage opportunities. TVL could increase then.
- In extremely volatile or bear markets, some might be hesitant to risk pledging shares (fear of losing them if drop) – so usage might dip, lowering TVL and revenue. However, others might use it to hedge (i.e., if they fear a drop, they might convert to stablecoin to sit out overnight risk). So it could even increase usage for risk management, ironically.
- If a big overnight crash occurs and some users lose collateral (liquidation), that might scare others short-term from using it, but if insurance covers all stablecoin holders, the system reputation might remain intact.

- Over time, as trust builds (no losses), more conservative users will join, increasing TVL.

Use of Revenue

- Part of revenue goes to cover operational expenses and to insurance fund growth. They likely allocate a fraction of fees to an insurance reserve each time.
- If a governance token is out, some revenue may be diverted to token stakers or buybacks – effectively converting revenue into value for token holders.
- Possibly share revenue with brokers: For example, from the 0.5% fee, broker gets 0.2%, custodian 0.1%, protocol treasury 0.2%. So net protocol revenue might be less than gross fees. But in the figures above we treated 0.5% as all going to protocol. If splitting, then to hit those net revenue numbers, gross volume or fee might have to be a bit higher or they treat broker share as a cost line.
- There's also a mention of future revenue from cross-chain trading and arbitrage fees [104], which could supplement. E.g., if TIDAL runs a cross-currency swap pool, it might take a tiny cut on conversions that users do (like sUSD->sEUR).
- Over a longer horizon, if TIDAL becomes an open protocol, revenue distribution might be automated.

In summary, the revenue model is highly scalable with user adoption and usage frequency. TIDAL's design can generate substantial revenue with relatively modest user base compared to mainstream platforms, because each user potentially pays fees many times a year. The Total Value Locked is a measure of how much capital is being utilized at a time; as TIDAL grows, increasing TVL indicates more capital efficiency unlocked globally. Reaching large TVL figures (billions) without incident will further validate the model, likely attracting even more institutional interest (they might see that as an alternative to traditional repo markets, etc.).

From an investor perspective (target audience includes institutional investors), these projections indicate **a high-growth fintech revenue model**: one that could tap into multi-billion dollar annual fees if widely adopted, given the sheer size of global equity markets ($127T) and the frequency factor. Even capturing a tiny fraction of the idle value regularly yields big numbers. The dynamic is akin to how Visa processes trillions in payments with small fees – volume times frequency is key.

Ultimately, sustained revenue and TVL growth will depend on execution of the rollout and maintaining user trust. The projected trajectory suggests that by achieving even the base milestones (hundreds of thousands of users, frequent use), TIDAL can generate significant cashflows, which in turn can fund further expansion, buffer risk, and provide returns to stakeholders.

Use Cases for Retail, Institutions, Custodians, and Regulators

TIDAL Protocol introduces capabilities that benefit a diverse set of stakeholders in the financial ecosystem. By unlocking idle equity capital and enabling cross-market liquidity, TIDAL creates use cases and value propositions for retail investors, institutional traders, custodial and brokerage firms, and even offers advantages from a market-regulator perspective. Below, we explore the specific use cases and benefits for each of these groups.

Retail Investors (Individual Traders)

For everyday investors, TIDAL essentially turns their brokerage account into a source of **instant liquidity and expanded trading opportunities**: - **24/7 Trading and Global Access:** A retail investor can react to news around the clock. For example, if a U.S. retail trader hears about a major development in Asia at

8pm New York time that could affect an Asian stock, they can use TIDAL to pledge some U.S. shares and mint stablecoins, then use those to buy the Asian stock (via their broker's international trading feature or a crypto exchange if the stock is tokenized). Without TIDAL, they'd have to wait until next morning US time to free funds or trade an ADR, by which time the opportunity could be gone. Now they have effectively global market access from their domestic portfolio. - **Overnight News Hedging:** Suppose a retail investor holds a stock and there's a big earnings report coming after the close. They fear a drop but don't want to sell preemptively. With TIDAL, after the market closes and before earnings release, they could mint stablecoins from that stock. If the earnings are bad and stock will likely drop at open, the investor could short-sell the stock in an overseas market or buy a put option using the stablecoins, or even keep the stablecoins (effectively being out of the stock's risk for the night). If the stock indeed drops, the stablecoins are still worth the original closing price value, and the investor fails to repay, letting the stock be sold (covering the stablecoins). Essentially, they've hedged the bad outcome (and lost the stock but kept value). If the earnings are good, they simply redeem and keep the stock (paying a small fee but benefiting from the price jump). In essence, TIDAL offers a hedging tool for gap risk that was not available to retail before. - **Leverage and Liquidity Without Selling:** Retail investors often face the dilemma of needing cash for a new investment or expense but not wanting to sell their stocks (which could incur taxes or miss upside). With TIDAL, they can get a short-term loan on their stocks easily. For instance, a retail trader spots a quick crypto trading opportunity on the weekend; instead of selling stocks on Friday (which might be down at that moment), they mint stablecoin against stocks and use it in crypto. By Monday, they close out and redeem. They gained extra returns without liquidating their long-term holdings. - **Enhanced Margin & Arbitrage:** Some savvy retail users may use TIDAL for arbitrage. E.g., if they find that Tesla stock closed at \$X in New York, and is trading at a slightly higher implied price via a derivative elsewhere at night, they could mint stablecoin to arbitrage that difference (buy low, sell high across markets, then repay at open). These opportunities might yield small but risk-free profits if done right. TIDAL enables retail arbitrage that usually only big firms do. - **No Need to Change Platforms:** Importantly, for retail users, all this can happen within their familiar broker app with a simple interface (like a "Get Overnight Cash" button) [65]. They don't have to set up new accounts or wallets if the broker handles it. There's no new KYC required since the broker already did it [65]. This lowers friction significantly for adoption by average retail investors. - **Example Use Case:** John is a retail investor in Hong Kong who owns U.S. tech stocks via a brokerage. A big tech announcement happens at 5pm HK time (5am NY time) that will likely move U.S. tech stocks, but NYSE opens hours later. John uses TIDAL to pledge some Hong Kong stocks he owns (since HK market just closed) to mint HKD stablecoin, converts to USD stablecoin on a DEX, and buys a futures contract or crypto token that proxies the U.S. tech stock. When NYSE opens and the stock jumps, he sells the futures for profit, converts back, and redeems his HK stocks. John capitalized on news immediately, something previously impossible as a retail investor.

Institutional Investors (Funds, Hedge Funds, Arbitrageurs)

Professional investors and financial institutions can utilize TIDAL in more sophisticated ways: - **Cross-Market Arbitrage Funds:** Hedge funds specializing in global arbitrage can use TIDAL to ensure no capital is ever idle. For instance, a fund might systematically arbitrage ADRs vs local shares: When Japan market closes, buy some Japanese stocks and short the U.S. ADR using stablecoin, then unwind at respective opens. TIDAL provides the temporary capital and flexibility to do this at scale. It's mentioned that arbitrage between markets yields small profits but adds up [105] [106] – TIDAL can amplify that by making it accessible and 24/7. - **Overnight Desk for Investment Banks:** Investment banks or brokers themselves could run an "overnight desk" where they utilize client or proprietary positions to generate yield after hours. For example, a prime broker might use TIDAL to mint stablecoins on blue-chip stocks held (with permission) and invest in overnight repos or lend to others in crypto, earning a spread. This is analogous to how securities lending works (they lend stocks for fees) but here they lend value of stocks for potentially higher yields. - **Liquidity Management for Funds:** Mutual funds or ETFs that have to handle cash flows might find use. Suppose an ETF has a large position in European stocks but gets redemption

orders after Europe closed – they can use TIDAL to get liquidity to meet redemptions by pledging stocks, then settle the difference next day by selling stocks when market opens. This avoids having large cash buffers or borrowing at high cost. - **Alternative to Margin Loans:** Institutions often use margin credit or repo to leverage positions. TIDAL could offer a cheaper or more flexible alternative. A fund long US equities might normally get 50% margin from prime at 5% APR. With TIDAL, overnight cost is 0.5% flat – if they only need leverage overnight frequently, this is cheaper in effect, albeit short term. A fund could roll these loans nightly if needed (with the understanding they must actively manage it). - **Derivative Strategies:** A hedge fund could use TIDAL to create custom synthetic exposures. For example, if they want to be long an index during the night but short during day, they can orchestrate that by locking and unlocking flows via stablecoins. The dynamic management of exposure to capture overnight premia (some studies show overnight return bias [107]) becomes feasible. In fact, one academic concept is that market makers demand premium for overnight risk [17]; a fund could try to harvest that by consistently exiting at close (via TIDAL) and re-entering at open, pocketing the risk premium if it exists. - **Use in Crypto Funds:** Crypto-focused funds might use TIDAL to dip into equity markets when crypto is quiet. Or to hedge any equity exposure they have outside crypto hours. It bridges traditional and crypto markets for them. - **Large Traders and Market Makers:** They can serve as **liquidity providers in TIDAL auctions** – a market maker might always bid in liquidation auctions to get shares at a slight discount, or provide stablecoins for a fee to those who need it (though TIDAL is trustless so direct P2P lending might not be needed; but they can be on the other side of trades made by stablecoin holders). - **Example Use Case:** A global macro fund anticipates that European markets will rally overnight on news that broke in the U.S. after Europe closed. The fund is fully invested, no spare cash. Using TIDAL, at U.S. close, they pledge U.S. stocks to get stablecoin, convert to EUR stablecoin, invest in European index futures or ETFs during the U.S. night (which is Europe morning). As Europe opens strong, they profit and later in the day convert back and redeem U.S. stocks. This way they participated in Europe's move without initially having cash allocated there.

Custodians and Brokerage Firms

Financial intermediaries – especially those partnering with TIDAL – see new business models and revenue streams: - **New Revenue via Fees:** Brokers can earn a share of the minting/redemption fees [108]. This is basically monetizing the time when their customers' assets would otherwise just sit. It's an attractive proposition: make money overnight on existing AUM. Custodians too get fees for facilitating this (collateral management fees) [67]. - **Increased Client Engagement:** Offering TIDAL's features differentiates a broker in a crowded market [109]. Clients who use it are likely to engage more frequently with the app (checking international markets, doing more trades). This stickiness and higher trading volume benefits the broker (more commissions or order flow revenue). It also can attract new clients – particularly active traders – because the broker can advertise "trade stocks 24/7" or "use your stocks to earn extra yield nightly". - **Asset Growth and Retention:** If a broker offers overnight liquidity and others don't, sophisticated clients might consolidate assets at that broker. Also, instead of withdrawing money to use elsewhere, clients can keep it with the broker and just leverage up when needed. This increases assets under management and reduces outflows [46]. - **Integrated API & User Experience:** TIDAL is designed to be integrated via API/SDK seamlessly into broker apps [110]. The broker can brand it as they like (e.g., "Overnight Cash Booster"). The simplicity – one tap to pledge and get cash – means minimal friction. Because there's no new KYC or crypto wallet management for the user [65], support burden is lower than launching say a crypto trading service from scratch. - **Expanded Product Offerings:** Brokers can build new products on top of TIDAL. For example, a brokerage could create a sweep program where every day at close, idle cash is automatically used to buy stablecoins via TIDAL and invest in a money market, then redeemed at open – giving customers a higher yield on idle cash overnight. Or structured products that explicitly use TIDAL to enhance returns (like an enhanced yield account that uses your stocks as collateral each night to earn interest). - **Risk Management for Broker:** They can manage their own risk by adjusting how they present the feature – e.g., maybe they only allow up to a

certain percent of a portfolio to be pledged for retail, to avoid too many liquidations that could upset customers. They maintain control in integration. - **Custodian Benefit:** Custodians often just safeguard assets for a fee; with TIDAL, custody becomes more dynamic. They might charge slightly higher fees for handling locked collateral, and it reinforces the importance of custodians in the digital asset era. Also, if custodians are on the forefront of such innovation, it ensures they remain relevant as finance tokenizes. - **Example Use Case:** A brokerage in Singapore integrates TIDAL and markets it as "CashMax: Unlock your portfolio overnight." Many customers sign up or transfer portfolios from competitors because they see they can get quick loans or trade global markets easily. The brokerage's trading volumes after hours increase by 30%. It shares in TIDAL fee revenue and also sees its margin lending during the day increase (since active traders do more overall). The custodian partner sees higher transaction volumes and justifies maybe charging a new small fee per pledge, adding to its income.

Market Regulators and Exchanges

While at first glance regulators might scrutinize TIDAL, there are potential systemic benefits: - **Improved Market Efficiency:** By allowing price discovery and reallocation of capital across time zones, TIDAL can lead to more continuous global pricing. This might reduce extreme volatility at market open (since some trading interest was already expressed via stablecoin flows or arbitrage) [33] [111]. More efficient markets align with regulators' goals of fair and orderly markets. - **Reduced Systemic Risk of Gap Moves:** If many use TIDAL to hedge overnight risk, the incidence of huge unhedged exposures that cause trouble is lower. For instance, brokers face less risk of margin calls at open if clients hedged via TIDAL. The insurance fund concept also provides a cushion for extreme events, potentially adding resilience. - **Innovation within Regulatory Perimeter:** Regulators often want innovation but without losing oversight. TIDAL, by going through regulated brokers and tracking everything on-chain transparently, actually can give regulators a clear view of overnight activity (especially if stablecoin flows are traceable). It's better than an unregulated shadow market, from their perspective, because at least they can require reporting by brokers. - **Market Liquidity:** Exchanges themselves might see increased volumes indirectly. For example, more trading in Asia session due to foreign capital coming via TIDAL stablecoins can boost liquidity. Exchanges might be supportive if it drives volumes (although they might also think "should we do 24/7 ourselves?" – and some are trying). - **Monetary Integration:** Central bankers might be concerned if stablecoins proliferate, but since these are short-lived and fully backed, they likely pose minimal threat to monetary policy, especially if currency-pegged and limited to market use. In fact, it might increase demand for stablecoin infrastructure improvements (possibly pushing regulators to clarify stablecoin rules). - **Use in Crisis:** In a scenario of a market crisis, TIDAL could allow quicker re-distribution of liquidity where needed. For instance, if one market is crashing and others are closed, TIDAL could help funnel liquidity to stabilize things (though that can cut both ways – could transmit shocks too; but arbitrage usually smooths, not amplifies). - **Encouraging 24-hour Infrastructure:** If regulators see that a lot of capital is moving after hours via crypto rails, it might push them to modernize infrastructure (like DTCC extending clearing hours as mentioned [112]). TIDAL's success could catalyze broader improvements that regulators and exchanges were already considering.

Regulators also have use cases in terms of oversight: they can monitor stablecoin redemption stats as a sentiment indicator (e.g., a lot of overnight pledging might signal high investor demand for liquidity or hedging).

In conclusion, TIDAL provides: - **For Retail:** Liquidity, flexibility, and opportunity that was previously out of reach, all without leaving their trusted platform. - **For Institutions:** A tool for arbitrage and risk management that can enhance returns and capital efficiency on a global scale. - **For Brokers/ Custodians:** New revenue and stronger client relationships, aligning their business with the 24/7 expectations of modern investors. - **For Regulators/Markets:** A potential path to more efficient and integrated markets, as long as it's managed properly within the regulatory framework.

Each stakeholder group stands to gain from the protocol's adoption, which is crucial because multi-party buy-in will drive TIDAL's network effects. If retail and institutions demand it, brokers will adopt it; if brokers adopt it and it runs safely, regulators are more likely to approve it; if regulators are comfortable, even more users join – a virtuous cycle. The breadth of use cases underscores the transformative potential of TIDAL across the financial ecosystem.

Risk Mitigation Strategies

Risk management is deeply ingrained in TIDAL's design, given the inherent volatility of underlying assets and the novel nature of bridging traditional and crypto markets. We have touched on many risk controls in previous sections; here we compile a comprehensive view of TIDAL's risk mitigation strategies, categorized by risk type, and detail how each operates to safeguard participants and the protocol.

Market and Collateral Risk Mitigation

Risk: Collateral (stock) value drops sharply overnight, potentially below the stablecoin amount owed.

- **Conservative Loan-to-Value (LTV) Ratios:** TIDAL deliberately sets LTV limits well below 100% to provide a safety cushion. For blue-chip, large-cap stocks, max LTV might be 50-60%, leaving a 40-50% value buffer [35]. For more volatile or smaller stocks, LTV is further reduced (30-40% LTV, 60-70% buffer) [35]. For diversified assets like ETFs, which inherently spread risk, LTV can be a bit higher (60-70% LTV, 30-40% buffer) [35]. These buffers are chosen based on historical volatility and worst-case overnight moves so that in most scenarios, even a large overnight gap would still leave enough collateral to cover the debt.
- **Dynamic LTV Adjustments:** The protocol can dynamically adjust allowed LTVs in response to changing volatility conditions [36]. For instance, if a particular stock is expected to be very volatile (big news pending), TIDAL (via governance or even an automated rule) could temporarily lower the LTV for new loans or freeze new loans on that stock for that day. Conversely, if conditions are calm and stablecoin supply is tight, it might marginally raise LTV to increase liquidity, but always within prudent bounds [37].
- **Real-Time Monitoring:** TIDAL monitors indicators like related futures, ADRs, or after-hours trading for signs of a potential large move. While the oracle price doesn't update until open, this monitoring helps decide if pre-emptive measures are needed. For example, if an ADR is trading 20% down overnight, the protocol might restrict any further stablecoin minting on that stock to prevent someone from minting at stale high price when it's known it will drop. (This kind of scenario might be handled by an admin oracle input or simply by the fact that arbitrageurs would not pay full price for stablecoin of that stock, so maybe self-regulating.)
- **Automatic Liquidation at Market Open:** If despite buffers, the collateral value does fall below the stablecoin amount, TIDAL's liquidation mechanism ensures a prompt action at market open [40]. By selling the collateral immediately (via on-chain auction or broker's sale), it stops the loss from accumulating. The goal is that stablecoin holders get made whole from the sale proceeds. Any delay in liquidation could lead to further slippage; TIDAL avoids this by a rule-driven automatic trigger, not human discretionary calls.
- **Insurance Fund:** As a backstop, TIDAL's insurance fund will cover any remaining shortfall if a collateral sale doesn't fully cover the stablecoin obligation [41]. The insurance fund is funded by fees collected over time. For example, a portion of every 0.5% fee could be allocated to this fund. Over hundreds of thousands of transactions, this builds up a pool that can absorb outlier losses. If a rare event causes, say, a 5% shortfall on some loans, the fund pays that 5% to ensure stablecoin holders still get full value. This means **stablecoin users never lose principal** as long as the

insurance fund is solvent and sized for risks. Insurance fund also prevents a cascade effect (if one event caused under-collateralization, it doesn't break confidence in the stablecoin because the fund buffers it).

- **Volatility-Based Position Limits:** TIDAL (or integrated brokers) might impose limits like: a retail user can only pledge up to X% of a highly volatile stock holding to prevent them from being wiped out entirely by a routine swing. This protects less sophisticated users from overextending on a risky asset.
- **Gradual Onboarding of Assets:** In early stages, TIDAL likely supports only relatively stable, highly liquid stocks (top indices constituents). This mitigates risk initially. Over time, as confidence grows and risk models are refined, it can add more assets gradually. The academic research combined with empirical observation can guide which assets are safe to include and at what LTV.
- **Stress Testing:** Regular stress tests are performed on the portfolio of active loans under various scenarios: e.g., "What if a 1987-style crash (20%+) occurs in one market overnight? Are buffers enough? Is insurance fund sufficient?" If not, adjustments (like even lower LTV or more insurance funding) would be made proactively. The academic model of TLP and put option equivalence [113] [114] is used to quantify default probabilities and ensure they remain extremely low (target might be, for example, <0.1% chance of shortfall on any given loan).
- **User Education on Market Risk:** TIDAL and brokers will educate users: "If your stock falls significantly, you could lose it (it will be sold to repay your loan)." This transparency ensures users are aware and use the service for appropriate situations (this was noted under risk mitigation: user education on risks) [84]. An informed user base means fewer unpleasant surprises and more responsible usage.

Combined, these measures make the likelihood of a stablecoin default (i.e., not fully collateralized redemption) extremely low, and even in those extreme cases, there's an insurance layer. The trade-off is possibly not offering as high LTV as a traditional margin (which sometimes goes 70-80%). But given the short duration and specific purpose, users may accept that conservatism.

Regulatory and Compliance Risk Mitigation

Risk: Regulatory action or non-compliance in jurisdictions could halt operations or incur legal penalties.

- **Compliance-First Approach:** From the outset, TIDAL operates through licensed entities (brokers/custodians) and seeks regulatory nod in each region [80]. By not going around regulations (e.g., not offering a product to the public without proper licenses), TIDAL reduces risk of crackdown. This mitigates the risk of a sudden shutdown due to being deemed illegal.
- **Jurisdictional Segmentation:** TIDAL can geofence or limit features based on region until clear approval is obtained. For example, the stablecoin might not be transferable out of the ecosystem in certain jurisdictions or the service not offered to U.S. residents initially. This compartmentalizes risk – an issue in one jurisdiction doesn't necessarily impact others if legally separated entities handle them.
- **Regulatory Engagement and Clarity:** The team actively engages with regulators (likely explaining and demonstrating the protocol). By proactively addressing regulatory concerns (investor protection, systemic risk, AML), TIDAL tries to get ahead of potential issues. Engaging regulators also means TIDAL can adapt its design to feedback (for instance, if a regulator says "we need you to have a reserve in fiat for stablecoin X," TIDAL could incorporate that if necessary for approval).
- **Licensed Partnerships:** By partnering with known regulated firms (brokers, banks), TIDAL gains legitimacy and these partners often handle regulatory liaison. For instance, a brokerage is not going to launch this feature to clients without clearing with its regulator. So each partner sort of ensures compliance in their domain, spreading the regulatory risk management out.

- **Diversified Geography:** The roadmap's approach to start in Asia, then EU, then US means the protocol isn't betting everything on one country's stance. If, hypothetically, the US completely outlawed such activity, TIDAL could still operate in Asia/EU where it's accepted, and perhaps continue lobbying US later. Geographic diversification is a hedge against any single jurisdiction shutting it down.
- **Legal Structuring:** Possibly using a foundation or multi-entity structure where, for example, the stablecoin issuance in Europe is done by a European licensed entity, whereas in Asia by an Asia entity, etc. So regulatory action in one doesn't seize the whole protocol's assets or contracts.
- **AML/KYC Controls:** Though blockchain transactions are pseudonymous, TIDAL stablecoin entry and exit happens via KYC'd brokers. This means anti-money-laundering compliance is enforced at on/off-ramps. Unusual activities (like someone using it to launder money by cycling stablecoins) can be detected by brokers and addressed. Being compliant in this way mitigates the risk of being branded as a money laundering vehicle which could invite regulatory backlash.
- **Transparency and Reporting:** TIDAL can provide data to regulators to keep them comfortable (like regular audits of collateral, reports on usage patterns). Transparency of the blockchain is also helpful; regulators can see the collateralization on-chain if they want (or at least TIDAL can demonstrate it).
- **Adaptability to New Laws:** If regulations (like MiCA) impose new requirements (capital, reserves, consumer disclosures), TIDAL is prepared to comply (perhaps by partnering with a large institution that can provide capital backing or by tweaking the stablecoin model to fit definitions). The willingness to change mitigates risk of non-compliance when laws evolve.

Technical and Smart Contract Risk Mitigation

Risk: Smart contract bugs, hacks, oracle failures, or other technical issues could lead to loss of funds or destabilization.

- **Multiple Independent Audits:** Before mainnet launch, at least two (or more) separate reputable audit firms will have reviewed the code [77]. They look for vulnerabilities, logic errors, and compliance with specifications. Issues found are fixed and retested. This significantly lowers the chance of an obvious bug in production.
- **Bug Bounty Program:** TIDAL will have a bounty encouraging white-hat hackers to find any exploit [77]. The bounty rewards are likely proportional to severity (potentially hundreds of thousands for critical issues), incentivizing many eyes on the code. This sometimes finds issues even audits miss.
- **Use of Proven Components:** Where possible, TIDAL uses standard components (ERC-20 implementation, auction libraries, etc.) that have been used by other protocols successfully. For example, MakerDAO's auction mechanism has been battle-tested; TIDAL can model theirs similarly. Using OpenZeppelin contracts for token logic, or Chainlink for oracles, reduces custom code risk.
- **Security Features in Contracts:** The contracts can include safeguards like:
- Re-entrancy guards on functions dealing with transferring value.
- Pausable functionality: if a bug is discovered or something odd is happening, an admin or automated circuit-breaker can pause minting or transferring of stablecoins (with governance oversight if decentralized).
- Time-locks on governance changes: any update or parameter change might have a delay before effect, allowing monitoring and potential abort if a malicious change was attempted.
- **Decentralized Oracles:** No single point of failure for price feed. Use of oracles like Chainlink means multiple nodes and data sources. Additionally, the oracle update at market open can be cross-verified with exchange data in real time. If one oracle node pushes an outlier price, smart contract can ignore it if it's out of band from expected (for instance, if one node said the opening price is $0 or extremely off, that can be flagged).

- **On-Chain Auction Security:** For the liquidation auction, ensure it's fair and not exploitable:
- Using Dutch auction format means no last-minute bidding wars that could be manipulated by miner extractable value (MEV) bots. Everyone sees the price descending and can accept at a known fair level.
- Possibly involve a commit-reveal or other mechanism if needed to avoid bot sniping, though Dutch should mitigate that largely.
- Limit who can participate if necessary (initially maybe whitelisted arbitrageurs to ensure seriousness) to avoid spam or malicious bidding.
- **Performance and Scalability:** The contracts will be optimized for gas and throughput (maybe using batch operations for multiple pledges in one tx if from one broker, etc.). And if on a high-performance L2 or sidechain, should handle the target volumes. Monitoring of contract execution time and blockchain capacity ensures they can adjust (maybe deploy to multiple chains or switch to faster chain if needed).
- **Continuous Monitoring:** The team likely runs monitoring scripts to observe any anomalies in contract state (like sudden unexpected mint events, unusual outflows, oracle delays). If something off-nominal happens, they can react quickly (pause if needed).
- **Proven Infrastructure by Probe Group:** The mention of "PROBE's 10 years of web3 infrastructure" suggests the team has long experience in blockchain development [115]. That expertise itself is a mitigant – not a random new team, but one presumably with track record (perhaps they built similar systems or tools).
- **Gradual Release (if needed):** Possibly use guarded launch approach: start with smaller caps on how much can be minted at first, to limit potential damage while system is proving out. Then raise limits as confidence grows. Many DeFi projects set initial ceilings for stablecoin supply or per-collateral debt ceiling.

Adoption and Business Risk Mitigation

Risk: The protocol fails to gain sufficient adoption (brokers don't sign on or users don't use it), or early adoption stalls due to user hesitancy or network effects not kicking in.

- **First-Mover Advantage & Coalition:** TIDAL's strategy is to be first in offering this combined capability [43]. By signing up key partners early (as they did with a custodian and broker pilot) and showing traction, they aim to create a network effect that's hard for later entrants to replicate. They're also likely forming an ecosystem coalition – partnering not just with brokers but possibly with stablecoin providers, DeFi platforms, etc., to entrench their position (for example, integrate with Aave so TIDAL stablecoins can earn interest there, etc., which increases usage).
- **Demonstration of Value:** Strong pilot results (like the milestone of 100k beta users, $100M volume minted with no incidents) [91] serve as case studies to convince more brokers and users. Showcasing success stories (investors made X% extra returns using TIDAL, brokers increased revenue by Y%) helps overcome fear of the new.
- **User Experience Focus:** The integration is designed to be simple (one-click, no friction) [65]. By ensuring UX is smooth and explaining the feature in familiar terms ("overnight leverage" or "earn on idle stocks"), users are more likely to try it. If it felt too technical or required dealing with crypto complexities, adoption would be slower.
- **Incentives for Early Adoption:** They might leverage some incentives: e.g., waive fees for first month for a broker's customers, or a referral program. Also possibly grant brokers some exclusivity periods (Broker A gets to offer it in a region exclusively for 6 months, attracting users to them).
- **Partnership Depth:** Rather than just offering an API and hoping brokers implement it well, TIDAL likely works closely to ensure the brokers' implementation is good (maybe even providing white-

label UI). A bad implementation could sour user perception. So mitigating adoption risk includes hand-holding partners so that end user sees a polished product.

- **Phased Rollout & Feedback:** By rolling out in phases, they gather feedback and can iterate. If in Asia launch they find users aren’t using it as much because, say, the fee seems high or they don’t trust the stablecoin, they can adjust pricing or increase education. This iterative approach means by the time they go wider (Europe, US), they have refined the offering to be more acceptable.
- **Addressing Hesitancy:** Some users might be wary of “crypto stablecoin? sounds risky.” TIDAL mitigates this by emphasizing that it’s fully backed by their own assets and integrated in a regulated environment. Marketing and communication will likely downplay the word “crypto” and highlight “secure, collateralized loan” etc. Also, as part of risk education, clarifying scenarios (like what happens if they don’t repay – reassuring it’s automatic and they won’t owe more beyond their shares, etc.) will make users comfortable.
- **Insurance and Guarantees as Selling Point:** The existence of an insurance fund (effectively a default guarantee fund) can be a selling point to users and brokers: "Even in extreme events, the system has protections; no one holding stablecoins has lost money." This builds trust, which is crucial for adoption of something new.
- **Focus on Key Use Cases:** Initially push the killer apps – e.g., "Make extra 5-6% a year by reinvesting your value overnight" or "Never miss a trading opportunity" to hook early adopters. Once some use it, word-of-mouth and proof will bring more.

Additional Safeguards and Protocol Governance

Risk: Unforeseen scenarios or parameter mis-tuning leading to issues; also risk of governance decisions harming stability.

- **Phased Parameter Approach:** Start conservative (low LTVs, fewer assets, small limits) and gradually loosen once data shows it’s safe. This precautionary principle prevents taking too much risk early on when uncertain.
- **Governance Oversight:** Eventually, a DAO or governance token holders will oversee the protocol. To mitigate governance attacks or bad decisions:
- Use time-lock on parameter changes so community can react if a malicious proposal somehow passes (though ideally token distribution and participation prevent a malicious majority).
- Possibly set bounds in code for certain parameters (e.g., cannot set LTV > a certain number by governance without deploying new code) as an additional guard.
- Pilot the governance process on non-critical decisions first, to ensure it works smoothly.
- **Continuous Improvement from Research:** The TIDAL team has an active research basis (as evidenced by the arXiv paper). They likely will keep analyzing and updating risk models, perhaps implementing advanced features like adaptive LTV (algorithmically adjusting as described) to fine-tune risk in real time. This forward-looking approach means they won’t be static – they will evolve defenses as markets evolve.
- **Separation of Duties:** If any admin controls exist early on (like an ability to emergency liquidate or adjust things), those keys are multi-signature with multiple trusted parties, lowering insider risk or single key compromise risk.
- **Recovery Plan:** In case of a partial technical failure (say oracle outage for one market), the protocol could have a defined fallback (like if price not updated, maybe default to last close price for another cycle, effectively extending loan by a day – not ideal but a clear rule is better than chaos). Planning these contingencies ahead mitigates confusion under duress.

Summarizing the risk mitigations from the **table in the business deck** [81] [82] : - Market risk: addressed by 50% LTV, monitoring, auto liquidation, insurance [83] . - Regulatory risk: addressed by compliance-first, partnerships with licensed entities, proactive engagement, geographic diversification [80] . - Technical

risk: addressed by multiple audits, bug bounty, proven infra, decentralized oracles [77]. - Adoption risk: addressed by first-mover advantage, pilot traction, strong value demonstration, coalition of partners to push it [43].

Also, additional lines [85] emphasize: - Short overnight windows and daily resets to limit exposure duration. - Automatic triggers and insurance fund for extra safety. - User education to ensure informed use.

Taken together, TIDAL's risk management can be seen as multilayered: 1. **Preventive controls** (low LTV, audits, compliance planning) to avoid problems. 2. **Monitoring and adaptive controls** (oracles, dynamic adjustments, real-time oversight) to catch and adjust to issues as they develop. 3. **Reactive controls** (liquidation, pauses, insurance fund payout) to handle incidents that do occur, minimizing impact. 4. **Fallback and governance controls** (emergency powers, DAO oversight) for extreme scenarios and long-term sustainability.

These strategies inspire confidence that the protocol can run safely in various conditions, which is essential for the trust of all stakeholders.

Governance Model and Potential DAO Transition

As TIDAL Protocol matures, a robust governance framework is essential for managing its parameters, driving its development, and aligning incentives among stakeholders. The project envisions gradually transitioning from a founder-led or company-led governance to a decentralized autonomous organization (DAO) model. In this section, we describe the governance structure, the rationale for decentralization, and how a potential DAO might function, including decision-making processes and the role of a governance token.

Early Governance: Foundation and Core Team

In the initial phases (pilot through early public launch), governance of TIDAL is likely to be relatively centralized. The core team (Chinggis Khaan Pte. Ltd., as mentioned) will set parameters and respond quickly to issues. A foundation or steering committee may exist to oversee the protocol's trajectory and ensure regulatory compliance during sensitive growth stages.

Reasons for initial centralization: - Need for agility in making adjustments based on pilot feedback (easier with a small team than wide voting). - Ensuring compliance and cohesive strategy in early multi-jurisdictional deals (one voice in negotiations). - Immaturity of token markets (likely the governance token not launched yet, as indicated around Q4 2026 for readiness [71], so until then, no broad token holder governance).

During this time, a multi-signature (multisig) wallet held by trusted project members likely controls critical functions (ability to upgrade contracts if proxy pattern used, or to change parameter values like LTV limits, fees, whitelist new brokers, etc.). The multisig helps by requiring, say, 3-of-5 signatories to approve changes, reducing risk of unilateral action or compromise of one key.

The core team would also actively communicate with partners (brokers, etc.) in making governance decisions, effectively forming a consortium-like early governance. Key stakeholders might have informal input even if not on-chain voting (for example, major broker partners might be consulted before changing a fee or launching a token).

Introduction of the Governance Token (TIDAL Token)

By design, around Q4 2026, TIDAL plans to have technical readiness for a governance token [71]. This token (often referred to here as $TIDAL) will be central to shifting governance to the community and aligning incentives.

Governance Token Utility in Governance: - **Voting Power:** Token holders can propose and vote on changes to the protocol. Each token typically equates to one vote (possibly voting weight could also consider staked time or other factors). - **Proposal Rights:** There may be a threshold of tokens or delegated tokens required to submit a formal governance proposal, to avoid spam. For example, one might need 1% of supply or so, or an incubation forum discussion phase. - **Treasury Management:** The governance token holders will eventually control the protocol treasury (fees accumulated, insurance fund usage, etc.). They could vote to allocate funds to new initiatives, grants for developers, insurance payouts beyond programmed ones, etc. - **Parameter Adjustments:** Key risk parameters (like base LTV for each asset class, fee rates, insurance fund target levels, which assets to support, oracle sources, etc.) can be modified through governance votes, within bounds. For instance, a proposal could be "Increase max LTV for blue-chip stocks from 50% to 55%" accompanied by analysis; token holders vote to approve or reject. - **Ecosystem Growth Decisions:** The DAO might vote on onboarding new broker partners or block ones if necessary, integrating with certain DeFi platforms, or expanding to new markets/asset classes (e.g., should we support corporate bonds as collateral? That might need a vote). - **Upgrades and New Features:** Major protocol upgrades (smart contract migrations, adding a new stablecoin currency, implementing a new liquidation mechanism, etc.) would go through governance for approval.

Staking and Incentive Alignment: Often, governance tokens are coupled with staking mechanisms to encourage long-term thinking: - Token holders might stake tokens to get the right to vote and perhaps to earn a share of fees (the idea being those who govern should have skin in the game). - Staked tokens could also serve as a backstop: e.g., in MakerDAO, MKR (their token) can be diluted if system has bad debt. TIDAL could design something similar where in an extreme scenario beyond insurance fund, a governance token mint could cover it (this deters governance from taking undue risk, as they'd suffer). - Alternatively, TIDAL could have a Safety Module (like Aave's model) where people stake tokens to underwrite risk and earn yield, with possibility of slashing if a shortfall occurs. That ties into risk governance – those approving risk parameters have their assets on the line.

Decentralization Process: The transition to DAO is not instantaneous. Likely steps: 1. **Token Launch & Distribution:** The token is distributed among stakeholders: team, investors, partners, and importantly to the community (via airdrops, liquidity mining, or sale). A broad distribution is important so governance isn't just insiders. 2. **Initial Governance Framework:** The team might outline an initial framework (some DAOs use a constitution or guidelines). They might set up a governance forum (off-chain discussion), on-chain voting mechanism (perhaps using a standard like Compound's Governor contract or Snapshot for off-chain sigs). 3. **Progressive Parameter Release:** Initially, maybe token holders get to decide on non-critical things (like adding a new asset once proven safe, or adjusting a fee within a small range), while core devs still hold emergency powers. Over time, as community proves capable, more control is handed over, culminating in keys (like contract admin rights) being transferred to governance or burned (so system becomes immutable except via governance). 4. **Foundation to DAO:** If a foundation was running things, eventually it might dissolve or step back to a facilitator role, letting the DAO (through governance token votes) formally take over decisions. Possibly establishing a non-profit DAO entity (some jurisdictions allow DAO LLCs etc. if needed to interface with real world, but it can be kept informal on-chain too). 5. **Community-Elected Committees:** A possible governance model is having sub-committees or elected representatives for specific duties (like a risk council that continuously monitors and can make quick adjustments within limits, subject to later ratification by full DAO). This hybrid can

ensure day-to-day operations without full vote on every tiny change while still being under DAO oversight.

Preventing Governance Attacks: - **Gradual Decentralization** mitigates immediate risk of a hostile takeover when token goes live (especially if distribution is such that no one entity easily has majority). - **Delegated Voting:** Many DAOs use delegation so that more knowledgeable members accumulate voting power from those who trust them, leading to informed decision-making. TIDAL could encourage delegation to domain experts (like people experienced in DeFi risk could be delegated votes to weigh in on LTV changes). - **Quorum and Timelocks:** Proposals might require a certain quorum of votes to be valid, ensuring broad participation for big changes. And any passed proposal might only execute after a delay (time-lock) giving time to react if something was malicious or if, say, a bug in the proposal was realized. - **Emergency Brake:** Possibly an emergency multisig (maybe composed of community-elected trusted members and perhaps core team initially) that can veto or pause if a malicious governance action is underway (like if someone exploited a flash loan to get tokens and vote to drain funds). This can phase out once confident such scenarios are unlikely or other mitigations suffice.

Participation of Various Stakeholders in Governance: - **Retail Users:** If they hold TIDAL tokens (maybe via airdrop to early users or they buy some), they can vote on proposals that might directly affect their usage (like fee rates). Many may be passive, but those passionate about crypto might engage. - **Institutional Participants:** Partners like brokers or custodians could hold tokens (maybe allocated as part of partnerships). They would likely vote in favor of proposals that maintain stability and perhaps moderate fees (so usage grows). They may also join governance discussions offering practical insight (“if we raise this fee, our clients might drop usage” etc.). - **Core Developers:** Likely have an allocation and thus influence, at least early on. They might steer initial proposals to ensure the protocol’s security and vision. Over time, core devs might step into a role akin to MakerDAO’s Protocol Engineering teams – executing what governance mandates but also proposing needed tech upgrades. - **Regulators and Governance:** One interesting aspect: If fully decentralized, who deals with regulators? Possibly by then, the protocol is permissionless enough that no single entity is responsible. However, the DAO could choose to create working groups to liaise with regulators or to comply with certain regulations collectively (for example, a DAO might voluntarily implement certain standards if it means easier operation globally). - **Treasury and Growth Decisions:** Governance would manage the treasury – e.g., fund bug bounties, audits, marketing grants, or liquidity incentives (maybe incentivize a secondary market for stablecoins, etc.). This ensures that as the protocol earns revenue, those funds can be democratically directed to where the community sees fit, ideally to further strengthen and grow the ecosystem.

Long-Term Vision for Governance

In the long run, a fully community-driven TIDAL DAO could emerge, where the original developers become equal participants in governance among others: - The DAO could potentially even take steps like forming a legal wrapper entity to sign contracts with brokers if needed (some DAOs have done this). - Governance might integrate with other DeFi or CeFi governance: for instance, to list TIDAL’s stablecoins on exchanges or as collateral on other protocols, etc. - The DAO would uphold the vision as described: ensuring the protocol remains stable, secure, and evolves with market needs (for example, if 10 years from now stock trading is 24/7 globally, the DAO might repurpose TIDAL’s technology for other inefficiencies, or pivot to different assets like enabling continuous lending, etc. – governance can change scope if community agrees).

The transition to a DAO model is both a decentralization ideal (removing single-point control) and practical strategy (distributing governance encourages broad support and arguably can make the protocol more resilient to single-jurisdiction regulation, because it’s community-run).

However, the team will likely ensure that before fully letting go into a DAO, the protocol is stable and the community is educated and capable of handling it. Many projects take 1-2 years post-token to fully hand over control.

In summary, TIDAL's governance model starts centralized for expedience and safety, but with the clear roadmap to decentralize via a governance token. This empowers users and stakeholders to have a direct say in the protocol's evolution and aligns everyone's incentives through token ownership. A successfully implemented TIDAL DAO would mean the protocol can truly be considered decentralized infrastructure – governed not by any single company, but by its users and participants collectively, ensuring decisions serve the broader ecosystem's interests.

Conclusion and Long-Term Vision

TIDAL Protocol represents a significant innovation at the intersection of traditional finance and decentralized finance. By awakening dormant equity capital and enabling it to flow across time zones, TIDAL addresses a fundamental inefficiency that has long persisted in global markets.

In this whitepaper, we have outlined how TIDAL's architecture – anchored by Smart-Stable Securities (SSS) and Time-Bound Stablecoins (TBS) – creates a continuous liquidity loop around the world's markets. We have seen how this design solves the overnight liquidity gap by effectively stitching together disparate trading sessions into a unified 24/7 framework. The protocol's robust risk management, from conservative collateralization to automated liquidation and insurance, underpins the stability of this framework even under extreme conditions. Moreover, through careful regulatory alignment and phased deployment, TIDAL is ensuring that this new paradigm operates within the bounds of financial laws, gaining trust from institutions and users alike.

Market Transformation: In the long-term, widespread adoption of TIDAL could lead to nothing short of a transformation in how capital markets function. Envision a future where time is no longer a barrier – investors large and small can allocate capital at any hour to where it's most effective, whether that's reacting to late-breaking news or continuously arbitraging mispricings until they disappear. The concept of a "market close" might become a relic, as liquidity continuously rolls from one region to another in a seamless chain. Such a world could see smoother price discovery (fewer gapping events, as discussed with Liquidity-of-Time Premium narrowing) [37] [111], and a more efficient allocation of resources globally.

Empowering Stakeholders: The vision is inherently inclusive: - For **investors**, TIDAL provides unprecedented empowerment. One billion shareholders globally could gain the "power to mint TBS" [116] – essentially the power to treat their portfolio as a productive asset even when markets sleep. No longer are retail investors relegated to passivity during off-hours; they have agency and access like never before. - For **financial institutions and market makers**, TIDAL offers new avenues to profit and manage risk, fostering a more connected and responsive global trading environment. - For **brokers and custodians**, it's a pathway to evolve and remain central in a tokenized, round-the-clock financial system, rather than being disrupted by it. By integrating with TIDAL, they become key liquidity conduits in the new system, benefiting from new business while offering better service to clients [46]. - For **regulators and markets**, TIDAL provides a solution that enhances market efficiency without discarding regulatory principles, potentially guiding how regulatory frameworks adapt to always-on markets in a safe manner.

Competitive Edge and First-Mover Advantage: TIDAL is unique in combining elements that others have attempted in isolation [55]: real asset backing, stablecoin technology, broker integration, and cross-border operability. By being the first to bring all these together in a compliant package, TIDAL is poised to

capture a significant first-mover advantage [101]. The network effects in liquidity (the more regions and users connected, the more valuable the network becomes) mean that once TIDAL achieves a critical mass, it can become the de facto standard for after-hours liquidity, difficult for latecomers to displace. The aggressive yet thoughtful roadmap – proving in pilots, expanding region by region – is geared to building this momentum while managing risks.

Synergy with Decentralized Finance: TIDAL doesn't exist in a vacuum separate from broader DeFi; rather, it bridges TradFi to DeFi. In the long view, this protocol could act as a conduit for trillions of traditional assets to interact with decentralized markets. Imagine a scenario where beyond overnight loans, stocks are used fluidly in DeFi protocols via SSS tokens, or stablecoins minted via TIDAL become a major liquidity pool in DeFi exchanges, blending the liquidity of crypto and equity markets. Such synergy could deepen as DeFi matures – for instance, one could envision DAO treasuries using TIDAL to manage part of their holdings in equities without leaving the crypto ecosystem, or Aave accepting TIDAL's stablecoins for lending, etc. TIDAL's design choices (like decentralizing oracles and eventually governance) ensure it can plug into the permissionless world while still interfacing with regulated entities. It effectively paves the road for capital to move freely between these realms.

Scaling and Future Growth: Looking a few years ahead: - By 2028 and beyond, as per projections, TIDAL could be handling nightly collateral in the multi-billions and facilitating millions of transactions a year. At that scale, it would generate substantial revenue – which for a decentralized protocol means resources to further innovate (through its DAO). - We may see TIDAL extend to other asset classes. The concept of SSS could apply to any asset that has off-hours or is otherwise illiquid at times. Government bonds (with weekend gaps), commodities (with exchange hours), maybe even real estate or other securitized assets via tokenization – TIDAL's mechanism can in theory unlock liquidity from any locked capital, not just equities. The whitepaper focused on equities as the biggest immediate inefficiency (and $127T market) [1], but the blueprint laid out could catalyze broader tokenization of real-world assets by providing them a clear utility (liquidity on demand). - The "global liquidity clock" metaphor [47] might extend to a point where time zones are irrelevant not just for equities but for finance as a whole. In that sense, TIDAL contributes to a more frictionless financial system, aligning with the ethos of DeFi but bringing the weight of real economies into it.

Resilience and Trust: Through multiple cycles, the ultimate long-term success of TIDAL will hinge on maintaining trust: trust that stablecoins will always be redeemable (which the design and risk mitigations aim to guarantee), trust that using the system is safe and easy, and trust that governance is robust and aligned with users. If TIDAL can operate for years with a "zero protocol loss" track record [86] – meaning no user funds lost, no major incidents – it will cement itself as critical infrastructure. At that stage, even traditional exchanges and banks might view it not as competition but as complementary infrastructure, possibly integrating or even joining the governance of it.

One can imagine in a decade, TIDAL Protocol or its progeny functioning like a global utility, much like how SWIFT became the global messaging network for banks. TIDAL could be the global **liquidity network for tokenized assets**, an underlying layer that many front-end platforms and exchanges tap into to provide 24/7 liquidity to their clients. It would be somewhat poetic: a decentralized protocol named after the natural tides ends up orchestrating the ebb and flow of capital worldwide, in harmony with the rotation of the Earth, fulfilling the vision stated: aligning finance with nature's perpetual motion [117] [118].

In closing, TIDAL Protocol offers a bold solution to a long-standing problem, leveraging cutting-edge technology without discarding the strengths of existing financial infrastructure. If successful, it stands to significantly increase the efficiency, inclusivity, and connectivity of global markets. The journey from concept to reality will require meticulous execution, collaboration with regulators and industry, and

continued community-driven development. Yet the reward is equally significant: a new era where capital never sleeps, and opportunity never waits – where, truly, **like the tides, capital flows eternally** [10] .

This whitepaper has detailed the TIDAL Protocol's design, mechanisms, and plans with an academic rigor and practical lens. As the project transitions from idea to implementation, further documentation and technical updates will accompany each phase. Readers and stakeholders are encouraged to engage with the TIDAL community and governance forums as the protocol moves forward, contributing to what could become a cornerstone of the 24/7 global financial infrastructure.

Technical Appendices

The following appendices provide additional technical details and schematics for readers interested in the underlying mechanics and models that support the TIDAL Protocol.

Appendix A: Smart Contract Schematics

Overview: The TIDAL smart contract system is composed of multiple interlinked contracts. Below we describe the key contracts and their relationships, essentially providing a logical "schematic" of the system on-chain.

- **TidalVault (Core Vault Contract):** This contract manages user positions.
- State: Keeps track of each user's deposited collateral (SSS tokens and amount), the stablecoin debt issued, and expiry timestamp for the position.
- Functions:
  - `deposit(collateralType, amount)`: Accepts SSS tokens of a specific stock as collateral. Only callable by integration (or user's address directly if self-custody).
  - `mintStablecoin(collateralType, amountStable)`: Issues TBS stablecoins to the user's address, provided `amountStable <= collateralValue * LTV` for that collateral type. Internally, it uses a price from the Oracle contract (closing price) to compute collateralValue.
  - `repayStablecoin(collateralType, amountStable)`: User returns stablecoin to repay their loan. The contract burns the stablecoin (calls Stablecoin contract) and updates the debt. If debt fully repaid (and any fee paid), it triggers release of collateral.
  - `liquidate(positionId)`: (Can be called by anyone or by a specific liquidator module at expiry) – If position is expired or flagged unsafe (collateral value < debt), this function will lock the position for auction and interface with the Liquidation contract to initiate sale.
  - It also has internal accounting for fees (accumulates fees to a fee pool or sends to Treasury contract).
- Access Control: Certain functions might be restricted. For example, `deposit` might only accept calls from whitelisted broker addresses (to ensure only real shares via custodian are deposited). `mintStablecoin` similarly might only be enabled for whitelisted collaterals. Admin (governance) can pause or adjust LTV per collateral via this contract.

- **Stablecoin (TBS) Contract(s):** Likely an ERC-20 token implementation with extensions for expiry and restricted minting.

- We could have one contract per currency (e.g., TidalUSD, TidalEUR). Each such contract:
    - Minting: Only the Vault contract (and maybe an authorized Liquidation contract) can mint new tokens. This ensures stablecoins only enter circulation when backed by collateral.
    - Burning: Any holder can burn (i.e., repay to vault triggers burn), and the Vault and Liquidation contracts can burn as needed when debt is settled.
    - Expiry Mechanism: This could be implemented in a few ways:
    - The contract could include a global variable `nextExpiryTime`. All tokens in circulation are understood to expire at that time. Transfers could be disabled after expiry. However, handling multiple overlapping cycles is tricky; more likely is:
    - A design where each stablecoin token inherently expires (e.g., token name might encode expiry). But implementing that within one ERC-20 is not standard. Another approach is not to freeze transfers but rather to check in Vault logic that after expiry new uses are not allowed and that holders can redeem via the Liquidation process.
    - Redemption: There isn't a direct redemption function on stablecoin because redemption happens via Vault (repay loan or via auction results). But in an event of liquidation, stablecoin holders effectively get their tokens bought back by the auction proceeds.
    - Decimals: likely 18 (like most ERC-20).
    - Compliance Hooks: If needed, the token might include hooks to allow only whitelisted addresses (brokers, known KYC wallets) to hold it, at least in early phase. Or freeze capability by admin at expiry (to prevent trading expired tokens).

- If multi-currency, separate contracts ensure each is pegged to its fiat independently.

- **Oracle Contract:** This contract stores prices for each supported collateral asset.

- State: Mapping of asset -> last closing price, last opening price, timestamps of those.
- Functions:
    - `postClosingPrice(asset, price)` – callable by authorized oracle feeds (could be multiple or medianized) after market close.
    - `postOpeningPrice(asset, price)` – callable at open. When this is called, it could also trigger the system to mark positions as expired (could be integrated that Vault knows after open).
    - `getPrice(asset, priceType)` – used by Vault to fetch the relevant price (likely priceType would be 'close' for determining loan amount and 'open' for checking collateral after expiry).
- Security: Only whitelisted addresses (like a set of oracle nodes) can call post functions. Possibly aggregated via a aggregator contract (like how Chainlink does it).
- Or the Oracle might not be a separate contract at all, but rather integrated in Vault: e.g., Vault might have a priceFeed interface per asset (like reading from a Chainlink feed contract deployed per asset). In that case, there's not a single Oracle contract but references to external aggregator contracts.

- Anchor logic: The Oracle ensures price is updated only at specific times (so Vault logic trusts it and doesn't update mid-cycle).

- **Liquidation/Auction Contract:** Manages the process of selling collateral and buying back stablecoin.

- State: Perhaps holds a queue of auctions or an active auction struct: which asset, how many shares (in SSS form) for sale, how much stablecoin needed, etc.

- Functions:
  - `startAuction(positionId, collateral, debtAmount)` – called by Vault when a position needs liquidation. It transfers the SSS collateral from Vault to this contract and records the debt to recover.
  - `bid(auctionId, bidAmountStable)` – participants call this to place bids. If using a Dutch auction, this might actually be more like `buy(auctionId)` at current price, meaning they accept the current price to purchase the collateral. The contract could continually lower the required stablecoin price per share until someone calls `buy`.
  - `closeAuction(auctionId)` – finalizes the auction. If someone bid, transfers the SSS token to winner, takes their stablecoins and burns them (or sends to Vault to burn). If the sale fetched more stablecoin than debt, handles surplus (could send to borrower or insurance fund). If fetched less, calculates shortfall.
  - `shortfall()` – a function that if called (or within closeAuction) triggers the insurance fund to cover the difference. Possibly the Auction contract can interact with an InsuranceFund contract: `InsuranceFund.cover(shortfallAmount)`.
- Design: Likely a Dutch auction is simpler: for example, start price = 100% of last close (or maybe slightly above if optimistic) and drop to, say, X% until enough stablecoin is offered. But since stablecoin holders themselves may just redeem, another method is a simple swap: essentially, whoever wants the share can pay the needed stablecoin or else at open the system liquidates directly on market. Implementation might vary, but since the whitepaper calls out a Dutch auction idea [60], we assume that on-chain auction for a set duration (maybe a few minutes).
- Access: Open to any address to bid, but realistically needs stablecoins to bid. If permissioned, maybe only KYCed wallets can bid (like brokers or funds in the early phase).

- Could integrate with external liquidity: e.g., the contract could have an adapter to sell on a DEX or through a broker's API instead of waiting for on-chain bidders, if that yields faster result. But initial design likely uses on-chain bidding for transparency.

- **Insurance Fund / Treasury Contract:**

- State: Holds reserves (possibly in stablecoins or other assets) collected from fees.

- Functions:

  - `allocateFunds(address to, uint amount)` – controlled by governance, can send funds for various purposes (e.g., to cover a shortfall to the Auction contract).
  - `receiveFee(uint amountStable)` – Vault would call this to deposit collected fees.
  - If the insurance fund is simply the balance held by Vault or Treasury, they might not even need a special contract, but usually having a Treasury contract that governance controls is cleaner.
  - This contract could also handle distribution of rewards (like if staking or fee-sharing is implemented).

- **Governance Token & Governance Modules:**

- If on-chain governance, there will be a token contract (standard ERC-20) and possibly a Governor contract or Timelock:

  - TidalToken: ERC-20, mintable initially to distribute to team/investors, then fixed supply or inflation if decided.
  - Governor Alpha/Bravo: Contracts as used by Compound/Uniswap style governance. Token holders (or their delegates) can propose, and after voting and quorum, if passed, the

proposal’ s actions (which are calls to other contract functions) are queued in a Timelock contract.
    - Timelock: A contract that is given admin rights over key contracts (Vault, Oracle, etc.). When a governance proposal passes, its payload (like "call setLTV on Vault contract to 55 for asset X") is scheduled in the Timelock for execution after, say, 2 days. This gives a safety window.
    - The team might initially be the admin or co-admin with timelock and later transfer to a fully token holder-driven process.

- **Broker Whitelisting / KYC Registry (optional):** Possibly a contract that maintains a list of addresses (brokers' hot wallets or custodial addresses) allowed to call certain functions or receive SSS tokens. This could be as simple as an `isWhitelisted[address]` mapping in Vault.

- Or it could be more complex to store user<->broker mappings, but likely not needed on-chain, broker can keep track off-chain which position belongs to which user.

Interactions Summary: - When a user uses TIDAL via broker: - Broker (through their backend wallet) calls Vault.deposit on behalf of user with X SSS tokens. But to get SSS tokens, the custodian likely minted them directly to Vault or to broker’ s address. Perhaps custodial integration means the custodian triggers a deposit directly. - Vault verifies and stores the collateral, then broker calls Vault.mintStablecoin to the user’ s address (which could be broker-controlled or user wallet). Vault calls Stablecoin.mint to that address. - Through the life of the loan, user might transfer stablecoin to others or use them externally. But by expiry, those stablecoins must find their way back (if borrower redeems, they buy them back; if not, an auction does). - At expiry: Oracle posts open price. Vault calculates if collateral < debt. If yes (or if user hasn’ t repaid at all regardless of price), Vault triggers Liquidation.startAuction. - Auction runs, collects stablecoin bids: - If successful, Auction calls Stablecoin.burn for the amount of stablecoin equal to debt (effectively removing them from circulation in exchange for collateral). - Auction calls Vault or Insurance for any shortfall coverage. Vault/Insurance fund sends stablecoin to Auction to burn remaining (or Auction contract could itself have permission to mint & burn stablecoins on insurance’ s behalf). - Auction transfers SSS to winner. That winner can then go to custodian off-chain to claim the actual shares (the SSS token likely can be redeemed by the holder through some process: either they call Vault to redeem SSS for the underlying if the protocol allows that for winners, or the custodian knows if X address holds SSS, they can release equivalent shares to them via a separate arrangement). - If user repays: Broker/user calls Vault.repay, providing stablecoins. Vault calls Stablecoin.burn and releases SSS to custodian (or triggers custodian to unlock shares back to user).

Custodian Integration (off-chain): - Each time SSS is minted on-chain, there’ s a mirrored action off-chain: custodian earmarks those shares as “locked for TIDAL” . Possibly SSS token could even be implemented as a non-transferable token tied to a specific custodian. But since design indicates SSS are just internal, maybe SSS tokens never leave Vault except to Auction winners or back to custodian’ s burn. - Custodian likely has an API that TIDAL uses to automatically reconcile at redemption (the whitepaper mention "reconcile all positions in real-time via custodial APIs" [31]). - Perhaps an **Off-chain flow**: When Vault signals redemption or liquidation outcome, the custodian’ s system is updated: share either returned to original owner or transferred to new owner (auction winner) or sold in market.

The above contract descriptions provide a blueprint for implementation. The actual deployed system might consolidate some of these roles (for example, Vault and Auction could be one contract with auction functionality built-in, or the insurance fund might just be part of a general Treasury contract). But conceptually, these elements must exist to cover custody, issuance, price feed, and liquidation.

The design choices lean on proven patterns: - Vault concept from MakerDAO (collateral locked, debt issued). - Auction similar to Maker’ s flip or clip contracts but tailored to timed events. - Governance akin to standard DAO frameworks.

This modular approach ensures clarity and upgradability; each part has a specific role, making auditing easier and failures more contained.

(Figures or diagrams could be imagined: e.g., a flow diagram showing the user, broker, custodian on one side and the series of contract calls on the blockchain side. However, in this text format, we have provided a description.)

Appendix B: Oracle Integration Specifications

The oracle system is a critical piece connecting off-chain market events to on-chain actions. Here we detail how TIDAL's oracle integration works, including data sources, update mechanisms, and fail-safes.

Data Requirements: TIDAL needs two primary data points for each supported asset: 1. The **official closing price** at the market close. 2. The **official opening price** at the next market open.

Optionally, if implementing dynamic features, it might also ingest **intraday signals** (like if a stock hits a particular threshold in an overseas market pre-open) to trigger precautionary measures. But core functionality relies on the discrete close and open prices.

Sources of Data: - Ideally from stock exchanges or consolidated feeds. For example: - NYSE closing prices via NYSE APIs or consolidated tape. - NASDAQ closing price from NASDAQ official feed. - LSE close from its feed, etc. - Opening prices similarly, which might come from opening auction results. - Many exchanges publish end-of-day prices which could be scraped or subscribed to. TIDAL likely partners with a market data provider (like Refinitiv, Bloomberg, or uses broker's data). - For decentralization, using **Chainlink** or similar can allow multiple independent oracle nodes to fetch from a trusted source and push on-chain.

Update Mechanism: - **Timing:** Immediately after an exchange closes (e.g., 4:00pm local time), the oracle nodes will push the price. There might be a slight delay if waiting for any closing auction to finalize (maybe 4:05pm). Similarly, at open (9:30am or whenever), as soon as the first trade occurs and price is established, push that. - **Transactions:** Each price update is an on-chain transaction. If multiple assets updated around same time (like entire U.S. market closes many stocks at once), price updates could be batched if using a custom oracle solution (though Chainlink usually updates individually per feed). - Possibly a Gas efficiency solution: The Oracle contract could allow posting prices for multiple assets in one tx if aggregator uses a batch method. Or one asset per tx if using separate feeds.

Decentralization and Security: - If Chainlink is used, each asset would have a feed with multiple node operators submitting values that get aggregated (by median or other). - Alternatively, a simpler approach is a **Federated Oracle**: e.g., 5 trusted oracles (maybe operated by some of the partner brokers or data providers) sign the price and the Oracle contract accepts a price if e.g. 3 out of 5 signatures provided. This would require an on-chain verification of signatures approach. - Price Integrity: The oracle should ensure that the price it posts is the official last sale or official opening price, not just any last trade (which might be out-of-hours or erroneous). Usually, exchanges provide an official "closing price" that might be the last traded price or an average, depending on their methodology (some use closing auction price, etc.). TIDAL's oracle should use that official value to avoid ambiguity. - Rounding and Precision: Stock prices need to be scaled to integer for on-chain. Likely using 8 decimal places or so to represent (Chainlink often uses 8 or 10). For example, $150.25 could be posted as 15025e4 (for 4 decimal precision, or more likely

15025000000 with 8 decimals). - **Fallbacks:** If the primary data source fails (e.g., exchange feed glitch): - The oracle can fall back to an alternate source (like an ADR price or futures indicative price) but ideally not for final settlement – probably better to delay posting open price until it's known rather than guess. - In worst case, if price isn't available by a certain time, the protocol might pause actions for that asset (loans might stay open until price known). - The governance could intervene if an exchange doesn't open (like holiday or outage) to extend expiry.

Oracle Contract Example: Let's illustrate with an example: - Asset: AAPL (Apple stock on NASDAQ). - At 16:00 ET, NASDAQ closing auction yields $150.00 as official close. - By 16:05 ET, Chainlink aggregator or oracle network posts 150.00 for AAPL to Oracle contract. - Vault contract now has AAPL price = 150.00 until next update. - Overnight, no updates (the price stays static). - Next day 09:30 ET, NASDAQ opens at $153.00 (gap up). - At 09:31, oracle posts 153.00 as the opening price. - Vault sees position with AAPL collateral: if user hadn't redeemed, it now compares needed stablecoin vs (153 * shares * LTV maybe for safety checks, but anyway triggers process). - All positions now considered expired and either redeemed or liquidated based on that opening price.

Real-Time Oracle Feed vs Latency: One might ask, do we need any real-time feed overnight? According to design, no – we intentionally keep it stale at close [29], to define the stablecoin's value. That means even if Apple trades on some ECN at $151 at 8pm, TIDAL's on-chain still values it at 150, and stablecoin trades may reflect a premium if people think it's worth 151 tomorrow (i.e., TLP). This is deliberate: the stablecoin is pegged to last official price, so oracles do **not** update to after-hours movements. This simplification is important to avoid confusion and maintain clear collateral baseline.

Dealing with Different Time Zones: - Each asset is associated with a market that has known close/open times. The oracle system likely has a scheduler or logic: - e.g., for Hong Kong stocks, push price at 16:00 HK time, push open at 9:30 HK time next day. - If an asset's market is closed for holiday, no price update happens; loans might span an extra day (the expiry timestamp perhaps set to when market next opens). - The system must be aware of weekends/holidays (maybe the expiry is a timestamp already embedded in loan when minted, but if that falls on a holiday, presumably TIDAL set it to the next trading day). - For multi-timezone, multiple oracles or one oracle contract but with different authorized posters active depending on region time. Possibly separate oracle networks for different exchanges to allow parallel updates.

Testing & Validation: - The oracle values should be validated against multiple reference points to ensure they're correct. For instance, if an oracle posts a price that deviates from previous day's close by more than some threshold without news, maybe require double-check or multiple sources. - Also, ensuring that the closing price used is consistent with how collateral is valued at redemption. For example, if a stock had a dividend overnight and price adjusts at open, how to handle? Ideally: the closing price was pre-dividend, opening price is post-dividend drop (since first trade ex-div will be lower). The protocol will treat that as a drop in collateral, potentially liquidating users. But economically, part of that drop is compensated by the user's right to the dividend. This is a nuance: Possibly need a mechanism to account for dividends (maybe the custodian could pass the dividend to the user separate from TIDAL, so the user doesn't lose out overall. But the stablecoin holders wouldn't consider the dividend for redemption because stablecoin just sees price down). - This could be considered by governance: maybe treat large scheduled dividends by adjusting collateral value artificially, or disallow pledging right before ex-div date to avoid confusion. For simplicity, one might ignore it: if collateral price drops due to dividend, it could trigger unnecessary liquidations. A mitigation: the LTV buffers likely cover typical dividend sizes (<5% mostly). - It's a complex detail maybe beyond current scope, but mention to highlight oracle doesn't adjust for corporate actions aside from price feed. A robust oracle system might incorporate corporate action adjustments if needed (like subtracting known dividend amount at open from stablecoin debt or something).

Oracle Resilience: - Use of multiple independent oracles (some run by, say, the custodian, one by the broker, one by an oracle service) ensures that even if one node fails to submit (due to outage), others can still update the price. - If network congestion on Ethereum or chosen chain at critical times (like 9:30am could coincide with high DeFi activity, etc.), perhaps pre-fund oracle transactions with high gas to ensure they go through, or have fallback providers. Or run oracles on an L2 with reliable throughput if main chain is busy. - Perhaps staggering updates: not all assets updated in one block but over a few blocks to spread gas.

In summary, the oracle integration is designed to: - Provide authoritative peg points (close/open prices) in a timely fashion. - Resist tampering via decentralization and whitelisting. - Align with the protocol's need for stale pricing overnight (no mid-cycle updates). - Gracefully handle exceptions (market halts, data delays) by either pausing or falling back, rather than feeding wrong data.

Appendix C: Mathematical Models for Collateralization and Liquidation

TIDAL's risk and pricing model can be framed in formal financial terms. Here we summarize some key mathematical relationships that underlie the protocol's design, drawing from the concepts introduced in the Intertemporal Liquidity-of-Time Premium (TLP) analysis.

1. Collateralization and Default Option:

When a user locks one share (price S_{close} at close) and mints stablecoins equal to $LTV \times S_{\text{close}}$, they effectively create a loan of face value $L = LTV \cdot S_{\text{close}}$ backed by that share. At next open, share price is S_{open}.

The user will choose to repay and reclaim the share if and only if the share's value at open is greater than the debt (plus any small fees) [119] [120]. If $S_{\text{open}} < L$, it's rational for them to default (not repay, surrender share). This is analogous to the share serving as collateral and the user holding a **put option** to hand over the share instead of repaying if the share's value falls too much [121].

Mathematically, the stablecoin holder's payoff at expiry can be seen as:

$$\text{Payoff to stablecoin holder} = \min(S_{\text{open}}, L).$$

Because if stock open value $S_{\text{open}} \geq L$, borrower repays, stablecoin holder gets L in cash (full $1 per stablecoin). If $S_{\text{open}} < L$, borrower defaults, stablecoin holder gets the share worth S_{open} (or equivalently, gets whatever proceeds from selling it, which equals S_{open} in an ideal auction).

From perspective of stablecoin value, it is:

$$\text{stablecoin value at open} = L - \max(0, L - S_{\text{open}}),$$

the second term is the default loss if any (i.e., the shortfall if share is worth less than debt). This resembles $L - \text{put option payoff}$ [122] [121]. The borrower effectively owns that put option: they can put (give) the share at strike L (the debt value) to cover what they owe [121].

This put option has value at close related to the probability of default. If we denote $P = \max(L - S_{\text{open}}, 0)$ as the default loss (which is the put payoff), then:

$$\text{stablecoin fair value at close} = L - E[P].$$

In a risk-neutral pricing sense, $E[P]$ is the price of that put option (discounted appropriately for overnight).

Given $L = LTV \times S_{\text{close}}$, define $x = LTV$ for simplicity, then default happens if $S_{\text{open}} < xS_{\text{close}}$. The deeper the LTV, the more likely default.

2. Liquidity-of-Time Premium (TLP):

TLP was defined as the discount of stablecoin' s price below its face value (here face value = $L, corresponding to $1 per stablecoin if fully valued) [123] .

In ideal conditions with no frictions, stablecoin at issuance is worth:

$$\text{Price}_{\text{stablecoin, close}} = S_{\text{close}} - (\text{put option premium}).$$

If we normalized one share' s worth of stablecoins (i.e., $L = x S_{\text{close}} issued per share), the face value is $x S_{\text{close}}. The stablecoin per $1 face might trade slightly below $1 due to default risk and any illiquidity.

For small Δt (overnight), one can approximate put option via Black-Scholes as in the arXiv:

$$\text{Put value} \approx L\,\Phi(-d_2) - S_{\text{close}}\,\Phi(-d_1)$$

with $d_1, d_2 = \frac{\ln(S_{\text{close}}/L) + (\pm\frac{1}{2}\sigma^2\Delta t)}{\sigma\sqrt{\Delta t}}$. If $S_{\text{close}} = L$ (i.e., LTV =1 for example scenario), this simplifies. But in our case $S_{\text{close}} > L$ typically (since x < 1, share value > debt), it' s an out-of-money put usually, meaning small probability.

For instance, if volatility (daily std dev) is σ , the probability of default (under risk-neutral, ignoring drift) is $\Pr(S_{\text{open}} < xS_{\text{close}})$. For moderate volatility and x=0.5, that probability is extremely low (e.g., if $ \sigma=2\%$, and drop needed is 50%, that's many standard deviations). So TLP should be near zero in that scenario – indeed fully collateralized.

If x were closer to 1 (100% LTV), the TLP would be equal to basically the put option of strike $L = S_{\text{close}}$, which for overnight might be like a fraction of a percent of asset value, depending on volatility.

The Liquidity-of-Time Premium specifically also accounts for any liquidity preference: if people are desperate for cash now vs tomorrow, stablecoin might trade at a discount to reflect that (like an implicit interest rate for overnight). Conversely, if there's surplus cash, stablecoin could even trade at slight premium (though arbitrage would invite more minting).

3. No-Arbitrage Band:

As derived [124] [125] , arbitrage conditions impose bounds: - **Lower bound:** If stablecoin trades too low (significant discount), arbitrageurs can buy stablecoins cheap and short the stock (or hold off buying stock) to profit at open when they redeem stock or get paid. The condition was that stablecoin price p satisfies:

$$p \geq \frac{E[S_{\text{open}}]}{L} \ (\text{in expectation}).$$

More concretely, if stablecoin is below $\frac{S_{\text{close}} - \text{put value}}{L}$ (like too cheap), there's profit expecting full redemption or stock delivery. The derived approximate lower bound from no-arb was given by:

$$p_{\min} \approx 1 - \text{Expected loss fraction}.$$

Which equates to $1 minus probability of default times average loss given default basically [126]. - **Upper bound:** If stablecoin trades above $1 (or above $\frac{L}{L} = 1$ effectively face value), arbitrageurs can mint stablecoin by locking shares and sell it for >$1, free profit, as long as they can lock 1 share to get 1 stablecoin and sell >$1 [127]. But supply is limited by collateral; one cannot mint more stablecoins per share than the LTV allows (so they can't create more than L per share). So stablecoin price realistically cannot exceed 1 by more than trivial amount (as they said, upper bound ~1 precisely because otherwise immediate arbitrage) [127].

So stablecoin should trade in a narrow band around $1: slightly below if there's risk (that difference is the TLP), rarely at or slightly above if extremely in demand but even then arbitrage encourages more minting until price normalizes [127].

4. Dynamic LTV control:

They propose controlling TLP by adjusting LTV: - If stablecoin consistently at discount (TLP high), reduce LTV to shrink supply and make stablecoin safer (smaller debt vs collateral, so default risk even lower, thus people trust it more, raising price) [37]. - If stablecoin at parity or premium (no TLP or negative), could raise LTV slightly to allow more supply (letting users get more liquidity, and adding slight risk until TLP appears again as compensation) [38].

This is analogous to a central bank adjusting interest rates: lower LTV = "tighter money" (less stablecoin can be minted, so it's scarcer, pushing its value up / interest cost up), higher LTV = "looser money" (more supply, stablecoin value slightly goes down relative, equivalent to lowering interest differential) [39].

Quantitatively: If we approximate small probabilities, TLP ~ Probability(default) * (expected loss fraction). For example, if $x = 0.5, \sigma = 0.02$ (2% daily vol), probability stock falls >50% overnight is essentially 0 (like 10^-9), so TLP ~ 0. If $x = 0.9$, and vol 2%, probability drop >10% maybe a few percent chance; that could give a TLP of a few basis points perhaps. The Black-Scholes formula snippet in arXiv gave $TLP \approx \text{put price}/S_{\text{close}}$ for small horizon [128]. For a typical scenario, TLP might be on order of 0.1% or so for moderate LTV and volatility, meaning stablecoin might trade at $0.999.

Insurance Fund Sizing: One can model the distribution of $S_{\text{open}}/S_{\text{close}}$. Often approximated as lognormal with vol σ. If requiring coverage to 6-sigma events: Say for a large stock, 6-sigma ~ 6 * 2% = 12%. If LTV=50%, a 50% drop is ~25 sigma event, practically impossible outside extreme black swan (even 1987 was ~20-25% drop, which is like 10 sigma of daily norm if norm). So the risk is extremely low. But if something crazy happened (fraud, stock goes near 0 overnight), those outliers define the worst-case shortfall ~ 50% of value. Insurance fund and token backstop ideally cover up to that, but realistically such event on a popular stock is rare and likely isolated.

Liquidation Auction Mechanism: To ensure stablecoin holders recoup at least S_{open}, the auction needs to find a buyer near that price. If markets are functioning, arbitrage ensures on-chain auction won't clear far off from actual S_{open} (someone could buy cheaper on-chain and sell in market for immediate profit or vice versa). The Dutch auction starting at last close and dropping will definitely find interest by the time it hits the actual open market price (plus maybe a small discount to entice bidders) [60]. So in expectation, stablecoin holders get nearly full value except in case of illiquidity.

Quantitative TVL and Fee Relationship: From a simpler model perspective, one could see the overnight process akin to a **repo** with rate. If fee is 0.5% per overnight, that's astronomically high as an APR (~180%). But it's a flat convenience fee, not interest per se. If a user uses it infrequently, it's fine. If they used it every single night, effectively they'd be paying a huge interest. So presumably, typical usage maybe dozens of nights a year (some will use more, some once in a while).

Revenue model formula reaffirming [75] :

$$\mathrm{TVL}(t) = U(t) \times P_{\mathrm{avg}} \times LTV_{\mathrm{avg}} \times V_{\mathrm{factor}},$$

this was likely a simplification: - $U(t)$ could be active users at time t, - V_{factor} might incorporate volatility factor meaning maybe not everyone can use full LTV due to buffer they keep (like if user is cautious, they might only mint at 90% of max to avoid border conditions, effectively reducing average LTV usage). Or a factor less than 1 if not all users are active concurrently.

Default Rate and Liquidation Rate: They aim for low liquidation rate (<5% of loans) [95] . This implies that in most cases users will redeem their stablecoin. Liquidations likely come mostly from those who can't or choose not to cover when asset fell. A 5% liquidation rate means 95% of cycles people close properly. That's plausible given design (most will not want to lose their shares and will repay unless truly bad drop or they purposely let it go).

Insurance Fund Growth: Fees (0.5% per loan) can be thought of as containing an "insurance premium". If default probability is extremely low, most of that fee is profit or can fund insurance. Over time, the insurance fund should accumulate to cover many multiples of expected losses. E.g., if one expects default maybe 0.01% of volume, taking 0.5% fee leaves plenty to profit and some to insurance.

Put Option Example: To illustrate with numbers: Suppose $S_{\mathrm{close}} = 100, LTV = 0.5, L = 50. \sigma = 4\%$ (very volatile day scenario). Using Black-Scholes overnight (roughly 1/252 of year): - If drift ~0 risk-neutral, the put option with strike 50 on stock 100 is almost zero (since strike far below current price, basically deep OTM). - Actually, if chance of >50% drop is basically negligible, put price ~ extremely small. So stablecoin = $50 face will trade basically $50 (no discount). If LTV=0.9 (L=90 on 100 stock), moderate chance stock falls below 90: - Probability stock <90 (10% drop) ~ if vol 4%, 10% is 2.5 sigma event, probability ~0.6%. So default ~0.6% chance. If default, average shortfall maybe (assuming if default, perhaps average drop of 12%? This is guessy). - Then expected loss maybe 0.006 * (say 2% of value) = 0.00012 or 0.012%. So stablecoin maybe worth $0.9988 per $1. That's TLP ~0.12%. In practice probably smaller because distribution shape and risk-neutral adjustments might differ, but order of magnitude basis points. This shows how safe stablecoins remain if parameters are sane.

From governance perspective, they'd likely calibrate LTV to target a negligible expected loss (like less than 0.01%). The academic mention of controlling TLP is more about secondary market pricing than actual realized losses because with insurance they might cover anything.

We can also consider if insurance fund can be seen as selling that put option and collecting premium via fees. The fee essentially should cover the put's expected value plus a risk premium. If the fee > fair put premium, the insurance fund grows; if fee equals fair premium, insurance fund just breaks even over many trials (covering losses on average). They chose 0.5% which is likely far above actuarial fair cost (as above, fair default cost maybe 0.01% or less at 50% LTV for bluechips), so insurance fund gets lots of surplus, which is prudent given tail risks.

Conclusion from models: The mathematics reaffirms that: - The stablecoin is extremely secure (over-collateralization yields a stable value minus a minuscule risk discount). - The design can be seen as embedding a short put option to the borrower, which is mitigated by low LTV and insurance. - Arbitrage ensures stablecoin price stays within a tight band reflecting that low risk premium. - TIDAL's fee is more than sufficient to cover expected losses, making the system financially viable and likely profitable. - The dynamic control of LTV can maintain stablecoin parity by adjusting risk to demand equilibrium.

Appendix D: Stablecoin Lifecycle Mechanics

This appendix walks through the lifecycle of a Time-Bound Stablecoin (TBS) step by step, to illustrate the flow of assets and tokens from creation to expiry with a concrete example.

Scenario Setup:
An investor, Alice, holds 100 shares of XYZ Corp. at a brokerage. XYZ's stock market (NYSE, say) just closed at \$50 per share. Alice wants to use TIDAL to get overnight liquidity from these shares. Assume LTV allowed is 50%. The stablecoin in question is sUSD (USD-pegged Tidal stablecoin).

1. Initiation (Post-Market Close):
- Time: 4:01 PM (just after NYSE close). The official closing price of XYZ is \$50. - The Oracle pushes \$50 as the closing price for XYZ on-chain [29]. - Alice, via her broker's TIDAL interface, chooses to pledge, say, 50 of her 100 shares to TIDAL (she doesn't have to use all). - The broker's system sends an instruction to the custodian: "Lock 50 shares of XYZ for TIDAL loan." - Custodian marks those 50 shares as pledged (they cannot be sold or moved now). - The custodian or broker then interacts with TIDAL's smart contracts: - It calls `deposit(collateralType=XYZ, amount=50 SSS)` on the Vault contract. Here, "50 SSS" represents 50 Smart-Stable Securities tokens for XYZ. The custodian likely has a capability to mint an equivalent 50 SSS tokens, representing those shares, directly to the Vault. Alternatively, custodian might have minted to itself and then transferred to Vault with the deposit call. - The Vault contract now records that Alice (or rather, Alice's account as per broker integration) has deposited collateral of 50 XYZ worth \$50 each. - Vault calculates max stablecoin she can mint: 50 shares * \$50 * 50% LTV = \$1250. - Alice chooses to mint the full allowed amount (for example). - The broker calls `mintStablecoin(XYZ, 1250)` on Vault for Alice's address. Vault verifies collateral and price (50*\$50=2500, 50% LTV gives \$1250, okay). - Vault then calls the sUSD Stablecoin contract to mint 1250 sUSD to Alice. - Now, Alice effectively has \$1250 worth of stablecoins. These appear in her broker app as a cash balance or as sUSD tokens if they show details. The expiry timestamp is set implicitly to next market open (let's say tomorrow 9:30 AM).

2. Usage (Overnight):
- Now it's evening. Alice can use those 1250 sUSD. Possibilities: - She might withdraw them to her crypto wallet or to a DeFi platform to earn yield overnight (if broker allows external transfers, maybe not initially, but could). - Or within the broker app, she might use them to buy another asset in an open market. Suppose Asian markets are open (9 PM ET corresponds to next morning in Asia). Alice decides to buy some shares on the Tokyo exchange using her sUSD. The broker facilitates this by perhaps converting sUSD to a yen-pegged stablecoin (sJPY) via a DEX integration [104] or by the broker itself accepting sUSD and doing a forex conversion off-chain. - Let's say she buys an equivalent \$1200 worth of a Japanese stock. She leaves \$50 sUSD unused. - Through the night, stablecoins can circulate. Another user could hold her \$50 sUSD change, or if she transferred to DeFi, someone else might have bought it, etc. For this example, assume she keeps it.

3. Pre-Expiry (Next Day before Market Open):
- Time: 9:00 AM next morning, NYSE set to open at 9:30. - Oracle is ready to publish XYZ's opening price. Suppose news was positive; expected open \$53. - Alice needs to repay 1250 sUSD by 9:30 to reclaim her shares. - She unwinds her overnight position: let's say the Japanese stock she bought went up and she

sells it for equivalent \$1300 sUSD (nice profit). Now she has \$1300 sUSD. - She uses 1250 sUSD to repay and retains \$50 sUSD profit (or whatever). - At 9:25 AM, her broker automatically triggers redemption: - Broker calls `repayStablecoin(XYZ, 1250)` on Vault for Alice's position. - The Vault contract receives 1250 sUSD (it could either pull from Alice's balance or the broker supplies it on her behalf if integrated). - Vault burns these stablecoins via the Stablecoin contract, reducing sUSD supply. - Vault sees the debt for Alice is cleared (1250 sUSD paid plus perhaps a small fee if applied; fee likely was taken from the 1250 as part of that). - Vault now releases the collateral: the 50 SSS tokens for XYZ. - Likely, instead of sending SSS to Alice (which she doesn't need directly), the Vault might call a function to allow custodian to withdraw those SSS and thus unlock shares. - Custodian, monitoring events or via the broker, sees the position closed. It unfreezes the 50 shares and returns them to Alice's normal holdings. Possibly an API call from Vault to custodian or simply a signed message triggers that. - Outcome by 9:30: Alice has her 50 shares back intact. She paid perhaps a fee (0.5% of 1250 = \$6.25) for this service, but made profit on her other trade, so net happy. Her stablecoins are gone (burned), and any profit she kept maybe converted back to cash in her account or still as stablecoin which she can convert.

- The stablecoin lifecycle for her 1250 sUSD is complete: minted at previous close, circulated overnight, then returned and burned by next open.

4. Expiry and Auto-Liquidation (if she hadn't repaid):
Consider if Alice did not repay by expiry: - 9:30 AM: NYSE opens; Oracle posts opening price. Say XYZ opened at \$53. - Now, her 50 shares are worth \$2650. Her debt was \$1250. Since \$2650 > \$1250, she definitely should have repaid (she'd be reclaiming more value). - If she fails to (maybe she was unreachable or decided to default anyway for some reason), TIDAL will liquidate: - Vault sees expiry passed and no repayment; triggers `liquidate(position)` for Alice's position. - Liquidation contract starts an auction for 50 XYZ shares (in SSS form). Bidders can use sUSD or possibly other stablecoins (if allowed) to bid. Starting price could be \$50/share (last close) and will drop. But open market is \$53 now, so arbitrageurs jump in quickly: - Perhaps one bids the full debt amount \$1250 for the shares (which would be \$25 per share equivalent – extremely low, they'd definitely bid higher). Actually, since share's open at 53, the logical outcome is an arbitrageur would bid up to \$2650 value in stablecoin for them. But they only need to cover \$1250 debt to win them, presumably the auction structure will allow capturing some surplus or at least bidding the minimum needed to cover. - Let's assume the simplest: someone bids exactly \$1250 sUSD to buy those 50 shares. That's \$25/share effectively, a steal given market is \$53 – in practice, competition would force bids up near \$2650, but let's imagine worst-case to see insurance: - If only \$1250 is raised, that covers the debt fully. The auction winner gets 50 SSS (worth \$2650 if redeemed), which they'll redeem via custodian (nice profit, but likely competition would not allow this scenario). - The \$1250 sUSD from bidder is used to burn the 1250 sUSD debt. Stablecoin holders (in this case the auction bidder took them and used them, others not involved) are fine. - There was surplus collateral value though: effectively the borrower (Alice) loses out on difference \$2650-\$1250 = \$1400 because she defaulted. Protocol could stipulate that surplus goes to insurance or the borrower. Many designs would give the borrower the surplus (minus fees) because it's their collateral – MakerDAO does that through auction: if bids go high, leftover proceeds after paying stablecoin and fees are returned to vault owner. TIDAL likely similar (to be fair). - So if an auction bid was \$2500 (closer to share value) for example, then \$1250 used to burn stablecoin, maybe \$6.25 fee to insurance, leftover ~\$1243.75 could return to Alice or to insurance. The PDF statement: "Any surplus (if collateral sells for more) could go to borrower or insurance fund" [129] implies they haven't fixed which – might be design choice but returning to borrower is user-friendly and conventional. - If shares had dropped and \$1250 was not fully covered: - Example: if XYZ opened at \$20 (disaster scenario), 50 shares worth \$1000. Debt \$1250. Auction sells them for ~\$1000. That \$1000 sUSD is used to burn that portion of stablecoin. Now 250 sUSD remain unbacked (shortfall). - Insurance fund kicks in: it supplies 250 sUSD (either by minting new sUSD with its reserves or converting its assets to sUSD) to fully cover and burn those as well [41]. - So stablecoin holders still get \$1 each. Alice gets nothing (she lost shares), insurance fund loses \$250 (covering the gap). The fee that

would have been collected from her (perhaps $6.25) is trivial relative – but insurance fund had accumulated lots from others, so it can absorb. - Governance might later decide whether to recoup that insurance loss by perhaps raising fees or via token backstop, but presumably these are rare and fund is enough.

5. Multi-Day Scenarios:
If markets close for a weekend or holiday: - The stablecoins expiry would be set to the next trading day. So if Alice did this on a Friday, expiry might be Monday 9:30 or Tuesday if Monday holiday. She'd have the stablecoin for longer (~3 nights). Possibly, TIDAL might charge fee per night or a higher flat fee for multi-day (the PDF suggests fixed 0.5% for overnight; unclear if multi-day just same or more). - Collateral remains locked through the extra days. Oracle doesn't update until actual open. - She could choose to repay earlier (maybe there's a provision to redeem early? Possibly yes, if she doesn't want to wait, she could repay on Sunday and get shares Monday open immediately – but since custodian can't unlock until market open, maybe early repay just queues immediate unlock at open). - Insurance fund covers that extended risk too but likely fine if LTV safe.

6. Stablecoin Integration and Re-use:
During its life, the stablecoin can integrate like normal: - If Alice transferred some sUSD to Bob, Bob could use it in DeFi (maybe provide liquidity on an exchange). Bob must know sUSD expires at Monday 9:30, meaning after that, the token might not be transferrable or might be redeemable only by contacting protocol. - Many stablecoins in DeFi are perpetual; a time-bound one needs careful usage: likely people wouldn't hold it past expiry. They'd trade out before expiry (like how one would treat a maturing instrument). - Possibly in the UI, each sUSD has an epoch. But TIDAL might design it such that the stablecoin contract itself can be reused cycle after cycle (so that there's no fragmentation). It could achieve that by forcing redemption or re-collateralization of all stablecoin supply at opens, essentially clearing the system.

7. Post-Expiration System Reset:
After each market open, ideally all stablecoins minted from previous night are either burned via redemption or via liquidation. The supply returns to zero (or near zero, except maybe some straggler who didn't trade them and is now stuck until claims?). - If someone holds stablecoin through expiry and didn't redeem (not the minter, just holder who bought it cheaply maybe expecting full value), what do they do? The design presumably allows them to go to the protocol (like call redeem function on stablecoin contract or vault) to get either the underlying share or cash. If the borrower defaulted, the share goes to auction so actually they'd have had to participate to get share. If borrower paid, their stablecoin would have been taken by borrower. - So practically, there shouldn't be stray stablecoins after resolution. If any, they basically represent a claim on the insurance fund perhaps. TIDAL could implement that any stablecoin existing after expiry can be presented to the insurance fund for face value (because if it wasn't redeemed, means original borrower defaulted and share was sold – insurance ensures all stablecoins have backing, so it will honor it). But to avoid complexity, likely all get taken up in the process.

Lifecycle Summary: 1. **Mint (Closing)** – Collateral locked, stablecoins minted with expiry. 2. **Circulation (Closed period)** – stablecoins used for transactions or yield. 3. **Redemption (Pre-open)** – Ideally borrower buys back and repays stablecoins, burning them and unlocking collateral. 4. **Expiry (Open)** – If not redeemed, forced liquidation: - Collateral sold, stablecoins purchased/burned. - Borrower either loses collateral (if default) or regains if repaid. - Any shortfall addressed by insurance. 5. **Reset** – No stablecoins remain (or very temporary if any left to be redeemed by insurance), system ready for new cycle.

This cycle can happen every trading day in each region. Overlapping cycles (Asia, EU, US) means at any given time, some stablecoins may be active from one region’ s overnight, others just expired, etc. But the localized nature of expiry means we don't accumulate perpetual debt.

Fees Handling: - The 0.5% fee is presumably on amount minted. Implementation-wise, on repay perhaps Vault requires 1.005 * borrowed amount to release collateral, and that extra 0.5% goes to treasury. - If user defaults, fee might not be collected from them; perhaps the insurance fund, which got lots of other fees, doesn’ t specifically need that defaulted user's fee (like it's small relative to collateral anyway). Or protocol could even take fee out of collateral proceeds before returning surplus to borrower or covering shortfall (some designs do that: liquidate collateral to cover debt + penalty/fee, so liquidator bids knowing they need to cover the extra). - The PDF mentions flat 0.5% for overnight use [50], implying not interest but single charge.

Edge Considerations: - If partial repay: user could repay part and reduce loan, perhaps leaving some stablecoin out (though typically they'd close fully by open). - Multi-collateral positions: if user pledged multiple stocks for one stablecoin loan (not sure if TIDAL allows pooling collateral across assets for one debt, likely not for simplicity – each loan tied to one asset). - We assumed one stablecoin currency (USD). If multi-currency, if she wanted sHKD for HK stocks, she’ d get that, but stablecoin lifecycle same concept, just pegged to HKD.

This detailed walkthrough shows how everything ties together operationally and confirms that the stablecoin is indeed short-lived and fully resolved by design. Each day's cycle is independent, ensuring no accumulation of under-collateralized positions beyond the expiry.

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