Paystream V1 Whitepaper

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Abstract

Paystream V1 provides APY-optimized rates through matching lenders and borrowers with its P2P engine and introduces Leveraged Liquidity Provisioning (LLP), allowing users to borrow from Paystream's lending pool to enter amplified LP positions, while lenders earn interest from protocol-wide borrowing activity.

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1 Motivation

The decentralized finance (DeFi) landscape has grown significantly since the FTX crash on Solana. Still, existing protocols often lack flexibility in repayment options and fail to optimize lending rates for all participants.

Let's take the Kamino Protocol as an example:

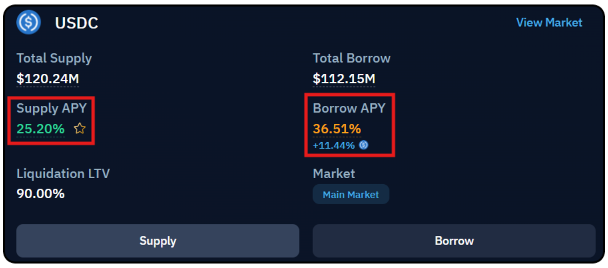

Figure 1: APY spread in app.kamino.finance

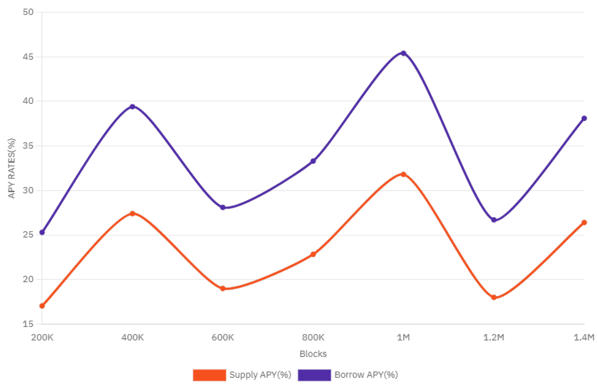

Figure 2: APY Spread of USDC on Kamino over 1.4M Solana Blocks.

The spread between APYs is intentional, as keeping utilization rates below 100% enables users to both withdraw current funds or borrow new funds at any time. This interesting property is sometimes referred to as the "liquidity" of the money market. The design choice of this "pool model" keeps suppliers and borrowers motivated whilst preserving the liquidity of positions.

However, this model has proven very inefficient as suppliers are not competing with each other. Moreover, one may also remark that rates are not decided by the offer and demand of the market but are biased by the borrowing rate curve and the Protocol reserve factor, chosen by the platform. Like here Kamino's supplying and borrowing rates are well documented:

$$B_t = B_F + \frac{B_C - B_F}{U_C - U_F}(U_t - U_F)$$

$$S_t = U_t \cdot B_t \cdot (1 - R_t)$$

Where:

- B_t: Current borrow interest rate

- B_C: Borrow interest rate at the ceiling utilization knot point
- B_F: Borrow interest rate at the floor utilization knot point
- U_t: Current utilization rate
- U_C: Utilization rate at the ceiling knot point
- U_F: Utilization rate at the floor knot point
- S_t: Current supply interest rate
- B_t: Current borrow interest rate
- R_t: Current reserve factor (protocol take rate)

Thus the spread is given by:

$$B_t - S_t = B_F + \frac{B_C - B_F}{U_C - U_F}(U_t - U_F) - U_t \cdot B_t \cdot (1 - R_t)$$

A natural idea would be to build some sort of order book to register every position in a P2P fashion.

The Paystream Protocol leverages the currently existing PLFs (Protocol-Level Frameworks), such as Margin-Fi and Kamino, to create an efficient yet liquid P2P market of supply and borrow positions with near-zero spread.

Users eventually get permanent positions with self-adjusting rates, being, at best, the exact rate that the matched borrower is paying, and at worst, the rate of the PLF that Paystream falls back on. Paystream can therefore be described as a liquidity pool optimizer, where both borrowers and suppliers benefit from improved rates while preserving the same guarantees and the same liquidity.

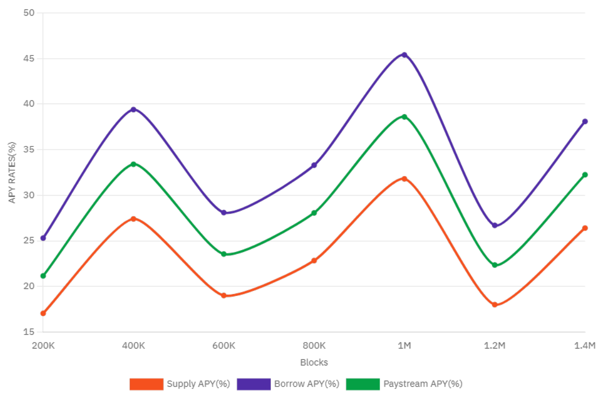

Figure 3: Kamino rates compared to the Paystream P2P APY on USDC over 1.4M Solana blocks

Although this architecture introduces fragmentation by associating liquidity with protocol-specific optimizers, it establishes a strong foundation for trust and risk isolation. Each optimizer operates independently, reducing systemic exposure to protocol-specific failures, oracle inconsistencies, or changes in collateral parameters. More importantly, this modular approach allows Paystream to adapt seamlessly to evolving DeFi infrastructure.

To unify fragmented liquidity and further optimize returns, Paystream introduces Leverage d Liquidity Provisioning (LLP). LLP enables users to borrow capital from the protocol and open leveraged positions in supported liquidity pools such as DLMM or DAMM V2. This mechanism absorbs idle capital into higher-yield opportunities and creates a flywheel where lenders earn protocol-wide interest while LP users amplify their returns using borrowed funds.

LLP serves as the scalability layer for Paystream. It connects isolated pools, abstracts protocol selection from the end user, and allows the system to dynamically allocate liquidity across integrated markets. As LLP matures, users no longer interact with individual optimizers. Instead, they experience a unified interface that routes capital based on yield potential, leverage appetite, and system health.

Paystream is therefore positioned not just as a lending protocol, but as a liquidity router, optimizer, and capital amplifier. The architecture is built to preserve trust, segment risk, and maximize efficiency across the entire lending and liquidity stack.

2 The Paystream Protocol

2.1 High-level description

Paystream combines APY-optimized lending with Leveraged Liquidity Provisioning(LLP) tailored for different types of users. Leveraging a peer-to-peer (P2P) matching engine, Paystream aligns borrower and lender requirements, ensuring competitive rates while maintaining liquidity through integrations with PLFs like Kamino and MarginFi. Users benefit from LLP, enabling them to open leveraged positions in different AMM strategies.

Now in this section it is assumed that the Paystream Protocol is only integrated with kamino and is then called Paylend-Kamino

From a user point of view, Paylend-kamino operates very similarly to Kamino: users can supply, withdraw, borrow and repay assets witht the same liquidity as Kamino. Liquidators can liquidate undercollateralized credit lines according to the same collateral factors and the same price oracles as Kamino. One should not experience any different from what they are used to, except that the rates are more interesting. Paylend-Kamino acts as a proxy between the user and Kamino. Let's take at how assets flow in this setting.

- **Supply:** The user supplies tokens to Paystream (Step 1). In the background, the protocol deposits these tokens into Kamino (Step 2) and generates KMNO tokens (Step 3). Paystream holds the KMNO tokens and uses them to manage incentives from the Kamino pool.

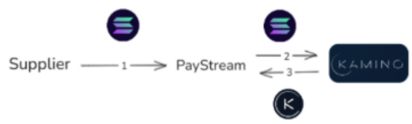

Figure 4: A supplier deposits liquidity to Paystream

- **Borrow:** The user first provides collateral, such as SOL tokens, with collateral factors determined by the underlying Protocol-Level Framework (PLF) like Kamino (Step 4), and triggers the borrow function (Step 5). In the background, the protocol performs the following steps:

  1. **Matching Engine Activation (Step 6):** The Paystream P2P matching engine attempts to match the borrower's request with available lender liquidity directly within the protocol.
  2. **Fallback to PLFs (Step 7):** If the required liquidity is not matched through P2P, the protocol allocates funds from Kamino's pool or similar PLFs.
  3. **Liquidity Transfer (Step 8):** Paystream moves liquidity directly from the matched lenders or PLFs into the borrower's wallet as the borrowed asset.

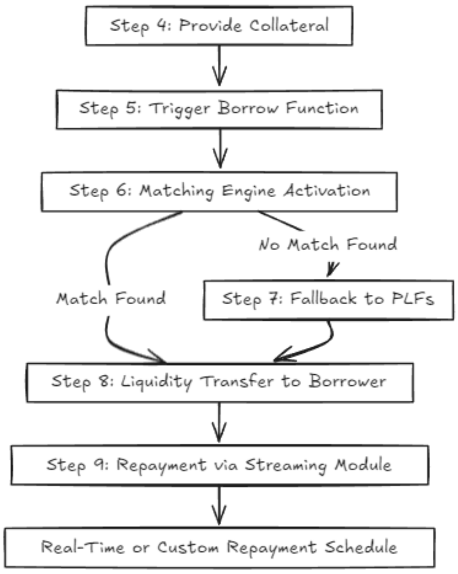

Figure 5: A borrower takes liquidity from Paystream

To extend capital efficiency beyond standard borrowing, Paystream introduces Leveraged Liquidity Provisioning (LLP). LLP enables users to borrow from the lending pool and deploy into leveraged LP strategies across supported venues such as DLMM and DAMM v2. LP initiators gain amplified exposure, while lenders earn yield on borrowed capital through continuous, per-block interest accrual.

For example, a borrower taking a 2× leveraged position by borrowing 1,000 USDC at a 15% borrow rate under Tier 2 will accrue debt based on their Borrower Liquidity Index (BLI):

$$\text{Debt}_t = 1000 \times \left(\frac{\text{BLI}_{\text{now}}}{\text{BLI}_{\text{entry}}}\right) \quad \text{e.g., if} \quad \frac{\text{BLI}_{\text{now}}}{\text{BLI}_{\text{entry}}} = 1.10, \quad \text{Debt}_t = 1100$$

If the LP position yields 18% over the same period, the initiator nets 80 USDC in profit after servicing the interest while holding only 50% of the capital upfront.

LLP acts as a unification layer for idle lender capital across fragmented PLF-based optimizers. It abstracts protocol-specific risk while enhancing systemic yield and capital deployment efficiency. All LLP positions are subject to real-time LTV monitoring and standardized liquidation logic, independent of the underlying optimizer.

Separately, Paystream's P2P engine enables direct lender-borrower matching at full utilization. Instead of facing a 25.2% supply APY and 36.5% borrow APY on Kamino, users matched via Paystream may both transact at a shared rate of approximately 30.7%, eliminating spread inefficiencies. This results in higher yield for lenders, lower cost for borrowers, and no idle capital—creating a self-reinforcing flywheel across all liquidity layers.

2.2 P2P Engine

Paystream is a hybrid interest rate mechanism that combines Peer-to-Peer (P2P) matching with fallback integration into Protocol-Level Frameworks (PLFs) like Kamino and MarginFi. It is designed such that, if a borrower or lender is unable to find a counterpart via the P2P mechanism, Paystream seamlessly falls back onto PLFs by allocating unmatched funds into their liquidity pools. Under this configuration, PLFs act as the supplier or borrower of last resort, ensuring users are at least as economically rewarded as they would be by directly using the PLFs.

2.2.1 Liquidity

One may ask how Paystream ensures full liquidity in specific scenarios, such as when a lender wants to exit a Peer-to-Peer (P2P) position where their capital is fully borrowed. The core principle is that in situations where a Paystream user cannot exit, the protocol seamlessly falls back to the underlying Protocol-Level Frameworks (PLFs), such as Kamino or MarginFi, ensuring liquidity and flexibility.

For example, instead of an underlying supply APY of 25.2% and borrow APY of 36.5% in Kamino's pool (USDC token), Paystream creates a win-win scenario where both supply and borrow APYs converge to near 30.7%. In this scenario, if a lender (Alice) wishes to withdraw her supplied USDC but the borrower (Bob) has not yet repaid the loan, Paystream borrows USDC from Kamino using Bob's collateral as security.

2.2.2 Liquidation Mechanism

Paystream has its own liquidation mechanisms, but directly copies the parameters of the underlying PLFs, such as Kamino or MarginFi. The protocol mechanically mirrors the same collateral factor, liquidation conditions, and price oracles fetched on-chain from the underlying PLF. In this way, the liquidation guarantees for Paystream users are the same as those on the underlying PLF.

It is important to note that Paystream's contract may sometimes have a borrow position on the underlying PLF. However, Paystream itself can only be liquidated if its aggregate position, which consists of all Paystream users' positions, becomes eligible for liquidation. To prevent this, Paystream ensures that users' positions are liquidated when necessary, maintaining the safety of Paystream's overall position in the PLF.

2.2.3 Supply and Borrow Balances: onPool vs inP2P

In Paystream, the supply balance and borrowing are each split into two variables: onPool and inP2P. This reflects whether the user's liquidity or borrow request has been matched with a counterpart in the Peer-to-Peer (P2P) market, where they benefit from the P2P APY, or if the supply/borrow position is in the underlying Protocol-Level Framework (PLF) like Kamino.

For the **onPool** case, when the user's liquidity has been supplied or borrowed on Kamino, Paystream directly tracks the user's deposit or borrow position within the Kamino pool. In this case, the user's balance and generated yield are based on the rewards provided by Kamino's liquidity pool.

In the **inP2P** case, Paystream uses a mechanism inspired by current liquidity protocols. Paystream introduces a unit called 'p2pIndex', whose underlying value grows over time. This unit is used to describe the "on Paystream" debt (both for suppliers and borrowers). The value of the debt is linked to the token's unit by the variable `p2pIndex`, according to the following formula:

$$\text{valueInUnderlying} = \text{valueInP2PUnit} \times \text{p2pIndex}$$

The `p2pIndex` is updated based on the mid-rate yield per block via an internal function, which is called each time a user calls a function that requires the conversion to this unit. Note that the complexity remains constant.

Example: Assume 1 SOL = 100 p2pSOL (representing the deposit amount in Kamino). Alice supplies 1 SOL to Paystream, so her supply balance becomes:

- onPool: 1 SOL (deposited in Kamino)
- inP2P: 0 p2pSOL

Now Bob borrows 1 SOL. At this moment, 1 SOL = 100 p2pSOL. Alice's supply balance becomes:

- onPool: 0 SOL (Kamino pool)
- inP2P: 100 p2pSOL

Note that Bob shares the same numbers for his borrowing balance. A year later, if the mid-rate remains 1.4%, the price of p2pSOL should be approximately 1 SOL = 98.6 p2pSOL.

Market Imbalance: In current PLFs, there is a great imbalance between the volume of loanable funds compared to the volume of demand, which is intentional since liquidity pools need more suppliers than borrowers to function. This is not the case with Paystream, which can handle more borrowers than suppliers and still remain fully liquid.

Moreover, in Paystream, the imbalance is not necessarily in favor of suppliers since the rates may be different. The imbalance is highly dependent on market conditions and thus on the P2P APY itself. The P2P APY in the example above is an arbitrary choice and should be flexible to reflect supply and demand. For example, the P2P APY could be adjusted closer to the supply APY of the PLF instead of being positioned in the middle to attract more borrowers.

Without needing to build a complete competitive interest rate market, Paystream introduces flexibility by updating the P2P APY according to market conditions, ensuring optimal balance between supply and demand.

2.2.4 P2P Positions and Matching Engine in Paystream

P2P positions on Paystream benefit from a 100% utilization rate, meaning there is as much supply as borrow demand. This is a key difference from other pool-based Protocol-Level Frameworks (PLFs), where there is often more loanable liquidity than borrow demand, leading to low utilization rates in their pools and consequently, creating the APY spread.

In Paystream, there is often an imbalance between supply and demand. For example, one might expect n units of suppliers attempting to match k units of borrowers, with $n > k$ (or vice versa). The protocol needs to select k suppliers to benefit from the P2P APY, while the remaining $n - k$ suppliers will be placed into the underlying PLF, such as Kamino. The module responsible for choosing and matching the k suppliers is referred to as the $matchingengine$.

There are several ways to design a matching engine:

- Maximize matched volumes.
- Minimize gas usage and avoid small leftover amounts (dust).
- A passive user or contract should be able to benefit from Paystream simply by supplying or borrowing.
- The use of Paystream should benefit as many users as possible.

It might seem that efficiency is gained at the advantage of a small group of matched suppliers, but this is not the case. The issue lies in the current DeFi interest rate market, which disincentivizes borrowing demand. With Paystream, more borrowers are attracted, and the entire cash-flow market grows. Additionally, as described in Section 2.3, the P2P APY will self-adjust according to supply and demand, attracting even more users.

One might worry that this matching engine requires looping over all users, making it inefficient and non-scalable with blockchain constraints. The Paystream algorithm does iterate through users; however, the gas cost for matching is chosen by the DAO, which sets how many matches are done for each user. When there is insufficient gas for matching, the algorithm falls back to the PLF for the remaining liquidity. This ensures the full scalability of Paystream while maintaining efficiency.

2.2.5 Rewards and inverted spreads

There are rare incidents where a token APY spread gets inverted i.e. $APYborrow < APYsupply$,

In this scenario Paystream guarantees at least the liquidity-inflated APY but it will be less likely to have a strictly better APY.

Paystream operates under the following regime:

- APY Spread Not Inverted: Paystream moves supply and borrowing positions in and out of Kamino to maximize APYs(Most likely scenario)
- APY Spread Inverted:Paystream and user can swap Earned rewards from $Paystream$ token, incentivizing users by providing abonus.

Thus, in every scenario, Paystream users are better off by using the platform, as it efficiently optimizes APYs through P2P matching without relying on additional rewards or external incentive mechanisms.

2.3 LLP

While the peer-to-peer engine effectively eliminates APY spread and idle capital inefficiencies, it introduces structural challenges around risk and liquidity fragmentation. Specifically, reliance on protocol-level frameworks (PLFs) such as Kamino or MarginFi introduces two key concerns: the potential failure or censorship of fallback protocols, and fragmented liquidation logic across isolated optimizers. For example, a Kamino-optimized position cannot be liquidated through a MarginFi-based engine, leading to siloed risk domains and inconsistent solvency enforcement.

To address these limitations and unify liquidity across isolated PLFs, Paystream introduces Leveraged Liquidity Provisioning (LLP). LLP allows borrowers to access leverage by drawing from a shared pool of lender-supplied capital, which is deployed into supported AMM strategies like DAMM and DAMM v2. This creates a capital-efficient path to deploy yield strategies without relying on isolated fallback layers.

LLP revolves around two principal actors. LLP-lenders deposit assets into the LLP pool, enabling capital availability for leveraged borrowing. LP-initiators borrow from this pool to enter amplified liquidity positions. This structure consolidates risk, standardizes liquidation logic across positions, and enables system-wide rebalancing and deleveraging irrespective of the underlying PLF.

The following sections detail the mechanics, roles, and interactions that define LLP as a trust-minimized, composable liquidity layer.

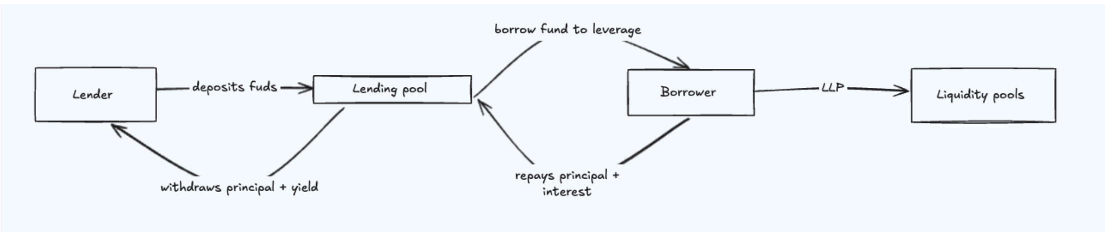

Figure 6: LLP system overview

2.3.1 LLP-lenders

LLP-lenders are the foundational liquidity providers within the Paystream protocol. By depositing base assets such as SOL or USDC into the leveraged lending pool, they enable borrowers to access leverage for capital-efficient liquidity provisioning. These deposits fuel all downstream strategies and borrowing activity within LLP.

Capital supplied to the pool accrues interest based on real-time utilization, governed by a protocol-defined maximum utilization ratio. This design ensures that there is always sufficient available liquidity to support new borrowing demand and protect against withdrawal constraints.

Yield distribution is handled proportionally across all active lenders according to their share in the pool. As borrowers repay their positions, interest is streamed back to lenders, compounding per block and enabling continuous, on-chain earnings. The mechanism ensures full transparency and responsiveness to borrowing demand while maintaining lender flexibility for withdrawals under safe utilization thresholds.

LLP-lenders remain entirely passive, yet participate in the yield generated by both P2P-matched loans and leveraged LP strategies executed by borrowers. This positions them as the capital engine behind Paystream's composable yield infrastructure.

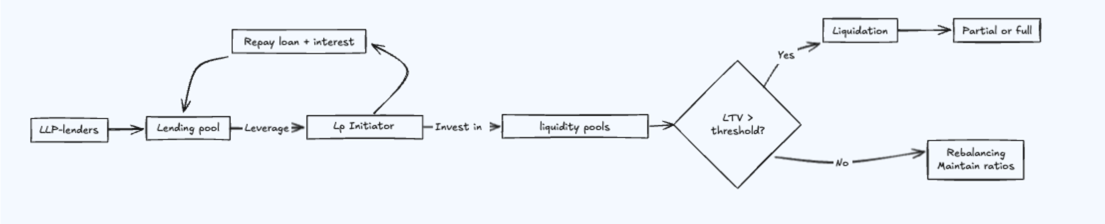

Figure 7: $LLPlenders$

2.3.2 LP-intiators

LP-initiators are borrowers within the Paystream LLP system who utilize lender-supplied capital to open leveraged liquidity positions in supported AMM strategies. By combining their own collateral with borrowed assets, initiators gain amplified exposure to fee-generating liquidity pools while maintaining custody and control over their position structure.

Initiators begin by selecting a supported strategy and entering a leveraged position. Their deposited assets are automatically routed and balanced into the chosen LP bins, either via manual strategy deployment or auto-trading using wallet mirroring. Before execution, tokens are swapped as necessary to align with the target pool requirements.

Each position is subject to ongoing Loan-to-Value (LTV) monitoring. Initiators are responsible for maintaining a healthy margin to avoid liquidation. They may optionally enable rebalancing to maintain optimal token ratios and reduce impermanent loss risk, or they can manage their positions manually for more custom execution.

As market conditions evolve, the initiator's position dynamically accrues debt according to the relevant borrower liquidity index. Yield generated by the position accrues to lenders, while initiators benefit from amplified LP fees and trading volume. If LTV breaches defined thresholds, partial or full liquidation is triggered, protecting lender capital and enforcing systemic solvency.

LP-initiators act as active capital deployers, converting passive lender liquidity into productive, yield-generating exposure across multiple AMM venues and strategies.

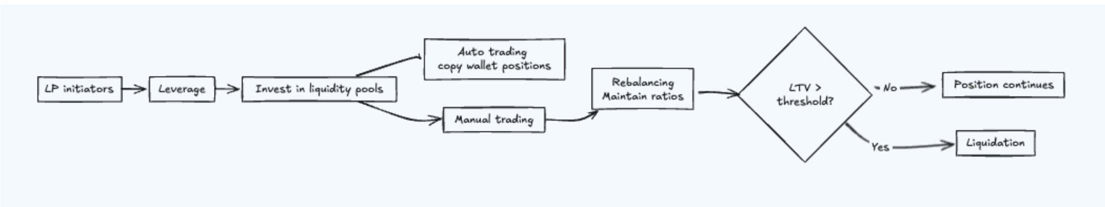

Figure 8: $LPinitiator$

2.3.3 Liquidation Mechanism for LLP

The LLP liquidation framework is designed to preserve capital efficiency while maintaining solvency guarantees for lenders and systemic health across the protocol. It incorporates three key layers: real-time LTV tracking, partial liquidation per borrower, and system-wide deleveraging during liquidity stress events.

Loan-to-Value (LTV) and BLI-Based Debt Accrual : Each LLP position is continuously evaluated via a Loan-to-Value (LTV) ratio, defined as:

$$\text{LTV} = \frac{\text{Debt}}{\text{Position Value}} \quad \text{where} \quad \text{Debt} = \text{Principal} \times \left(\frac{\text{BLI}_{\text{now},k}}{\text{BLI}_{\text{entry},k}}\right)$$

Borrower debt compounds block-by-block using the Borrower Liquidity Index (BLI), which reflects the cumulative interest growth within each leverage tier. Every borrower is assigned a tier (k) based on their risk profile, and the BLI update follows:

$$\text{BLI}_{k,t} = \text{BLI}_{k,t-1} \times (1 + \text{borrowRate}_k \times \Delta t)$$

The borrower's interest liability is settled at repayment time based on the difference between entry and exit index values. A snapshot of $\text{BLI}_{\text{entry},k}$ is taken each time a borrower opens or extends a leveraged position.

Partial Liquidation (Borrower-Level Risk Management) : If a borrower's LTV breaches the partial liquidation threshold (e.g., 85%), a portion of the position is liquidated to reduce debt exposure and bring LTV back to a safer range (e.g., 75%). This partial unwind preserves remaining capital, allows recovery opportunities, and prevents immediate full liquidation.

To avoid unnecessary capital loss, partial liquidation is calculated precisely. The liquidation volume is determined such that 80% of the outstanding debt is covered:

$$\text{Liquidation Volume} = 0.8 \times \text{Debt}$$

This process can only trigger once per cycle, tracked via the state flag `has_been_partially_liquidat` Once the LTV drops below the safe threshold (e.g., 70%), the flag resets.

Partial liquidation currently applies only to blue-chip or mid-cap pools to ensure execution reliability and sufficient liquidity depth.

Full Liquidation : If the borrower's LTV continues rising beyond the full liquidation threshold (e.g., 90%) and the position has already undergone partial liquidation, the remaining position is fully closed. This ensures complete principal recovery for lenders. Borrowers may restore solvency by adding collateral before reaching this threshold.

Trigger Conditions.

- LTV $\geq$ partial_threshold and has_been_partially_liquidated = false $\rightarrow$ Trigger partial liquidation and set flag.
- LTV $\geq$ full_threshold and has_been_partially_liquidated = true $\rightarrow$ Trigger full liquidation.
- LTV $<$ safe_threshold $\rightarrow$ Reset flag and re-enable partial liquidation eligibility.

Deleveraging (Protocol-Level Risk Control) : In cases of elevated systemic risk—such as lending pool utilization exceeding a critical threshold (e.g., 95%), Paystream enforces proportional deleveraging across all open LLP positions. This ensures lender withdrawal liquidity and reduces aggregate leverage in the system.

The excess borrowed amount is calculated as:

$$\Delta B = B - U_{\text{target}} \cdot D$$

Where: B is the total borrowed amount, D is total deposited capital from lenders, U_{target} is the protocol's safe utilization target (e.g., 90%).

Each borrower i repays a share proportional to their current debt:

$$\text{Liquidation}_i = \text{Debt}_i \times \left(\frac{\Delta B}{B}\right) \quad \Rightarrow \quad \text{Debt}_{i,\text{new}} = \text{Debt}_i - \text{Liquidation}_i$$

Deleveraging is applied uniformly and programmatically to maintain fairness, ensure exit liquidity for lenders, and stabilize pool-level metrics under stress conditions.

3 Use Cases

3.0.1 Aggregators

Aggregators such as Earnpark and Lulo actively scan lending markets to identify optimal rates for capital deployment. Paystream offers a compelling edge in this landscape by structurally eliminating the traditional APY spread through its peer-to-peer matching engine and dynamic fallback architecture. As a result, liquidity aggregators are naturally incentivized to route funds toward Paystream, ensuring capital is always deployed where it is most efficiently utilized.

3.0.2 Strategists

Yield strategy protocols like Asgard frequently employ platforms such as Kamino and MarginFi for structured financial products. By leveraging Paylend-Kamino or Paylend-MarginFi, these strategists can access higher yields without introducing additional market risk. Moreover, Paystream's Leveraged Liquidity Provisioning (LLP) enables active LPs to construct customized leveraged positions tailored to specific risk-return profiles. Over time, this enhances the aggregate return of the $LLPpool$, reinforcing its utility as a yield-maximizing layer.

3.0.3 Individuals

Retail users, including independent investors and freelancers, can engage with Paystream to either borrow capital or lend idle assets at competitive rates. Lenders benefit from enhanced returns through efficient P2P matching, while borrowers gain access to liquidity without the inefficiencies typically seen in peer-to-pool models. The protocol's modular architecture accommodates both passive capital providers and advanced users seeking optimized capital strategies.

3.0.4 Stablecoins

Decentralized stablecoin issuers often rely on collateral deployment strategies to generate yield while maintaining full liquidity for redemptions. Paystream enhances these strategies by integrating with protocol-level frameworks such as Kamino, allowing stable collateral to remain productive without compromising solvency. When combined with LLP, stablecoin protocols can amplify returns on idle reserves by participating in leveraged LP strategies, all while retaining the flexibility required to maintain peg stability and meet redemption demand.

4 Conclusion

Paystream introduces a capital-efficient, modular alternative to traditional lending protocols by combining peer-to-peer matching, protocol-level fallback optimizers, and leveraged liquidity provisioning. This architecture eliminates APY spreads, routes idle funds into productive strategies, and isolates systemic risk through protocol segmentation. As DeFi continues to mature, Paystream is positioned to become a foundational yield engine, enabling scalable and composable lending for protocols, strategists, and individuals alike.

5 Acknowledgements

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References

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