Mulle
Structured Yield Vaults

Real-world carry and DeFi liquidity in one portfolio, split into a fixed-rate Senior and a levered Junior, on the chain you already use

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mulle

Abstract

Real-world assets now pay real yield on-chain. Tokenized US Treasuries passed USD 15.9 billion in September 2026 [4], Brazilian and Mexican government bills trade as tokens [2], and Brazilian card receivables pay a 10.8% annualized yield through Plume's nOPAL vault [9]. Two things keep most on-chain capital away from the higher of these yields. Most tokens offer a single risk profile, so a dollar saver who cannot carry a 20% swing in the Brazilian real, or a credit loss, has little to buy. And real-world assets exit slowly: issuers redeem in days, and on-chain pools are thin.

Mulle is a multichain structured yield protocol. Each market is a **Structured Yield Vault** with two books. The **Carry Book** holds real-world assets, such as government bonds and card receivables, and earns the yield. The **Liquidity Book** holds liquid DeFi positions that pay withdrawals quickly. A **Yield Router** places both books across chains and venues within the market's limits, and a waterfall splits the result into two tranches: a **Senior** tranche that is paid a fixed target rate first, and a **Junior** tranche that keeps everything above it and absorbs losses first.

Curators open markets and fix their terms at opening, including the assets, chains, tranche split, Senior rate rule and performance fee. A ledger chain records every request, price and approval, and users deposit and redeem on the chain they already use.

This paper describes the problem, the vault design, the protocol, three case studies (Brazilian federal bonds, Uzbek government bonds and Brazilian card receivables), the risks, the business model and the roadmap. In backtests on actual data, the card receivables market's Junior earned 17.7% a year after fees from nOPAL's launch to September 2026, against 11.0% for holding nOPAL, while its Senior was paid 8% throughout; the Brazilian bond market's Junior earned 17.2% a year before fees from January 2023, against 11.6% for the bond token alone.

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1. Background

1.1 Real-world yield is on-chain

Tokenization has moved well beyond US Treasuries, which passed USD 15.9 billion in September 2026 [4]. Issuers such as Etherfuse hold local-currency government bills with regulated custodians and issue tokens that track them, including Mexican CETES and Brazilian federal bonds [2]. Private credit has followed. Plume's Nest vault nOPAL holds BlackOpal's LiquidStone II fund, which buys Brazilian card receivables and hedges them to dollars; it held USD 122.2 million and had a 30-day annualized yield of 10.8% in October 2026 [9][10].

The highest yields sit in markets most investors cannot reach directly. Brazil's Selic rate has averaged about 10.8% a year since 2005. Uzbekistan's policy rate averaged between 13.8% and 15.4% in every year from 2020 to 2025, and reached 17% in March 2022 [16]. Brazil's domestic federal debt alone is R$ 8.94 trillion (about USD 1.73 trillion), of which non-residents hold 9.91% [1].

1.2 Tokenization solved access, not risk

A token backed by Brazilian government bonds earns Brazilian rates in reais. A dollar holder earns those rates minus whatever the real loses against the dollar. Rebuilt from the Selic rate and the official USD/BRL rate [6], a Selic-linked Brazilian government bond earned **9.94% a year in reais but 6.83% a year in dollars** from 2005 to 2026 (Section 6). In reais it never lost money in a calendar year. In dollars it lost money in 10 of 22 years, and fell 47% from peak to trough between 2011 and 2015.

A dollar saver looking at that record sees an asset with a 39% chance of losing money over any given year. A risk seeker sees an asset that returned 23.1% a year in dollars since the token launched in November 2024. They are looking at the same asset.

Private credit carries a different risk. Card receivables hedged to dollars carry little currency risk, but merchant defaults, originator failure and chargebacks fall on every holder, and the fund's loss record is short and not independently verified.

1.3 Tokenization did not solve liquidity

Real-world assets leave slowly. nOPAL redeems to USDC in up to four days [9]. Issuers buy and redeem at par only for verified counterparties [2]. Secondary markets are thin: the largest on-chain pool for the Brazilian bond token held about USD 120 thousand in October 2026, and a USD 10 thousand trade moved its price by about 15%. The token itself is spread across Stellar, Solana, Polygon and Base.

DeFi is the opposite. USDC lending vaults and short-dated Pendle principal tokens (PTs) exit in minutes, but the established ones pay 4–5% (Morpho USDC 4.2% and Pendle PT sUSDS 4.9% in October 2026, against a 3-month US Treasury bill that averaged 3.94% in September) [20][13][14]. A product that holds only real-world assets cannot pay withdrawals quickly. A product that holds only DeFi assets earns DeFi rates.

1.4 One token, one risk profile

Every tokenized asset today is a single class: one token, one price, one risk. Traditional finance solved this problem decades ago with **tranching**. Securitizations, collateralized loan obligations and structured notes all split one pool of assets into claims with different priority. The senior claim is paid first and carries less risk; the junior claim is paid last and carries more risk and more return.

On-chain structures have started to appear. Centrifuge runs real-world asset pools across chains with a hub-and-spoke design and several share classes [21], and Strata splits single assets such as nOPAL into senior and junior tokens [11]. To our knowledge, none of them blends real-world and DeFi assets in one tranched portfolio, routes that portfolio across chains for yield, or manages its liquidity for withdrawals. That is the gap Mulle fills.

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2. Problem

1. **One token, one risk profile.** Currency and credit risk land on every holder. Dollar savers, stablecoin holders and treasury managers want a predictable dollar return; risk takers want more carry than a Treasury bill pays. When a token comes in one class, both must buy the same token, so most of them buy neither.
2. **Real-world exits are slow.** Issuer redemptions take days and secondary markets are thin. A product built only on real-world assets cannot offer daily liquidity without selling at a discount.
3. **Yield and liquidity are scattered across chains.** The same asset lives on several chains with thin markets on each, DeFi rates differ by venue and chain, and cash held back for withdrawals earns little.
4. **Risk takers have little leverage on carry.** Outside a few single-asset tranching markets, investors who want emerging-market or credit yield can buy the token, but cannot take a larger exposure to its excess return without borrowing.
5. **Primary access is gated.** Issuers buy and redeem at par only for verified (KYC/KYB) counterparties. A product that serves many users must hold a verified relationship with the issuer and still give its own users simple on-chain access.

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3. Solution: Structured Yield Vaults

Mulle pools deposits into Structured Yield Vaults. Each vault does three things: it **blends** real-world and DeFi assets, **routes** them across chains and venues, and **tranches** the result into a Senior and a Junior claim.

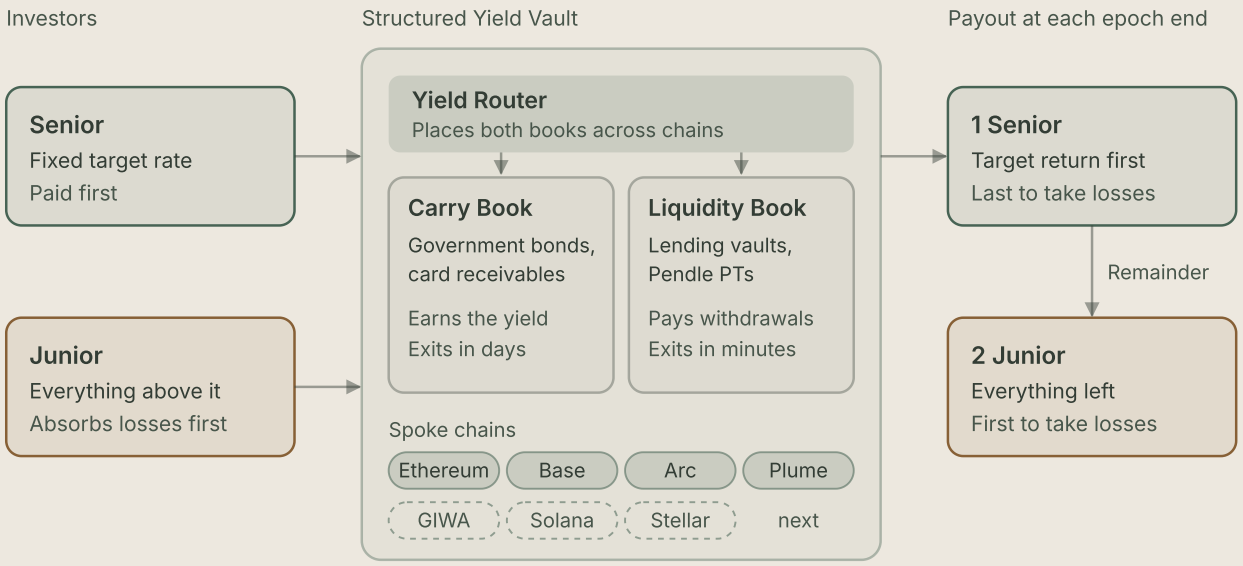


Figure 1. A Structured Yield Vault. Investors choose a tranche; the Router places capital in the two books across chains; at each epoch end the waterfall pays the Senior target first and the Junior everything left.

3.1 Blend: the Carry Book and the Liquidity Book

	Carry Book	Liquidity Book
Holds	Real-world assets: government bonds, card receivables, other private credit	Liquid DeFi positions: USDC lending vaults, short-dated Pendle PTs, tokenized Treasuries with on-chain liquidity
Job	Earns the yield	Pays withdrawals and holds dollar value
Typical yield	10–15% a year, in local currency or hedged to USD	4–8% a year in USD
Exit time	Days, through the issuer or the fund	Minutes to hours
Share of the vault	Typically 70–90%	Typically 10–30%

Each market sets a target share for each book. The Liquidity Book is sized to the withdrawals the market expects in an epoch, so most withdrawals are paid without selling the Carry Book. Its dollar assets also keep their value when the Carry Book's currency falls, which narrows losses before they reach either tranche.

3.2 Route: the Yield Router

The Yield Router decides where each book's capital sits. It moves the Liquidity Book to the best yield across venues and chains, keeps enough of it on the chains where withdrawals arrive, and buys Carry Book assets on whichever chain offers par access or the deepest market. Every move stays inside limits the market sets at opening (Section 5.6).

3.3 Tranche: Senior and Junior

	Senior	Junior
Return	A USD target rate r set by the market's rule (6% and 8% in this paper's cases)	Everything the vault earns above what the Senior is owed
Priority	Paid first	Paid last
Losses	Touched only after the Junior is exhausted	Absorbs losses first
Who it fits	Dollar savers, stablecoin holders, treasuries	Investors seeking emerging-market or credit carry with leverage

3.4 The waterfall

Let V be the vault's value, α the Senior share of capital, r the Senior target rate as an annual yield, and T the Senior's target value. The target grows at r, and at every NAV round the Senior is worth the smaller of its target and the vault, while the Junior is worth the rest:

$$T_{t+\Delta} = T_t\,(1+r)^{\Delta/\text{year}} \qquad S = \min(T,\,V) \qquad J = V - S$$

Because the target keeps growing during a shortfall, the Senior is made whole from later gains before the Junior earns anything. Over one period in which the vault returns g and the Senior starts at αV:

$$R_S = \min\left(r,\;\frac{1+g}{\alpha} - 1\right) \qquad R_J = \max\left(\frac{g-\alpha r}{1-\alpha},\;-100\%\right)$$

For periods shorter than a year, r is replaced by the period rate $(1+r)^{\Delta/\text{year}} - 1$. Four numbers describe any split; the table uses the configurations of the three case studies:

Metric	Formula	A: 55:45, 6%	B: 60:40, 8%	C: 80:20, 8%
Vault return at which the Junior breaks even	αr	3.3%	4.8%	6.4%
Junior leverage on excess return	$1/(1-\alpha)$	2.2×	2.5×	5.0×
Vault return below which the Senior misses its target	$\alpha(1+r)-1$	−41.7%	−35.2%	−13.6%
Vault return below which the Senior loses principal	$\alpha - 1$	−45.0%	−40.0%	−20.0%

Splits are Senior : Junior. Vault returns are over one year and include the vault's yield.

The Senior is not guaranteed. It earns less than its target when the vault's return falls below the third row, and loses principal below the fourth. Each market chooses α so that both points sit beyond the worst one-year loss its assets have shown, counting the Liquidity Book's stable dollar value.

3.5 Senior rate rules

Each market sets its Senior rate rule at opening. Two forms are supported:

- **Fixed, with a step-down.** The rate is fixed (8% in Case C). If the vault's trailing 30-day yield is below a floor (9.0% in Case C) on the first day of a month, that month's rate becomes the vault yield minus 1 percentage point, rounded down to 0.25%, and new Senior deposits pause until the yield recovers. At an 80:20 split this keeps the Junior at least 5 points above the Senior, before losses, at each monthly reset.
- **Benchmark-linked.** The rate follows a benchmark plus a spread inside a band and is fixed for each epoch. In Case A it is the 3-month US Treasury bill plus 2 points, rounded to the nearest 0.25% and kept between 5% and 7%.

Each rule comes with a launch test: new Senior capital is accepted only while the carry left for the Junior is wide enough. In Case A the asset must yield at least 4 points more than the Senior rate; in Case C the vault must yield at least 9.0%.

3.6 Coverage rules

- The Senior can be at most k times the Junior, where $k = \alpha/(1-\alpha)$ at the target split (1.22 in Case A, 4 in Case C). Senior deposits above the cap are refunded.
- A Junior withdrawal that would push the Senior above the cap waits until coverage allows. Markets with long epochs open Junior withdrawals only at epoch ends.
- If losses shrink the Junior, Senior capital above the cap is returned at the next epoch end.
- No new Senior capital is accepted while the Senior is below its target value.

3.7 Why tranche instead of hedge

Hedging removes currency risk but also removes most of the carry. Locking the real with forwards costs roughly the gap between Brazilian and US interest rates, about 9.4 percentage points in October 2026, which would leave a holder of the Brazilian bond token about 1.9% a year in dollars, less than a Treasury bill. Tranching keeps the carry and moves the currency swing to the investors who want it: the Junior takes the swing with leverage, and the Senior receives a fixed dollar rate as long as the swing stays inside the Junior's cushion. Where the currency is already hedged at the source, as in nOPAL, the same structure moves credit risk instead.

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4. Markets and curators

4.1 Markets

A market is one Structured Yield Vault: its two books, its two tranches and its rules. Each market deploys a Senior vault and a Junior vault on every deposit chain and records its definition, prices and requests on the ledger chain. Each market's assets and losses are kept separate. Markets still share the contracts, the ledger chain, the messaging layer and the keepers, and may use the same venues.

4.2 Terms fixed at opening

A market's terms are set when it opens, including its performance fee. Changes after opening are limited so that holders always know what they bought:

Term	What it sets	Example (Case C)	After opening
Carry Book	Assets and target weights	nOPAL 90%	Weights move only within bands; new assets follow the notice period
Liquidity Book	Venues and minimum size	Morpho USDC vault 10%	As above
Chains	Deposit chains and asset chains	Deposits on Ethereum and Arc; nOPAL on Plume	New chains follow the notice period
Split and Senior cap	α and k	80 : 20; Senior at most 4× Junior	The cap can be lowered at any time; raising it follows the notice period
Senior rate rule	Fixed with step-down, or benchmark-linked	8% fixed; steps down below a 9.0% vault yield	Changes apply from the next epoch, after notice
Performance fee	Share of Junior gains above the high-water mark, 0–20%	10%	Can be lowered, never raised
Management fee	Optional annual fee on vault assets, paid out of the Junior's residual	None	Can be lowered, never raised

Term	What it sets	Example (Case C)	After opening
Eligibility	KYC-gated, or open with wallet screening	Open to non-US persons, as on Plume Nest	Fixed
Epoch	Settlement frequency and cutoff	24 hours, 00:00 UTC	Follows the notice period
Limits	Vault size; per-asset, per-venue and per-chain caps	Vault at most 5× Junior TVL; nOPAL at most 20% of its TVL	Can be lowered at any time
Price sources	Feed and deviation bounds for each asset	nOPAL NAV posted daily at the cutoff	Follows the notice period
Minimum deposit	Smallest request accepted	10 USDC	Follows the notice period

The notice period is always longer than the market's slowest withdrawal path, so holders who disagree with a change can leave before it applies; Junior exits remain subject to the coverage rules.

4.3 Curators

A curator designs and runs a market. It picks the assets and venues, sets the terms above, writes the Router policy and publishes a monthly report on holdings, yields and withdrawals. Mulle curates the first markets. Third-party curators, such as asset managers and DeFi risk curators, can open markets after a listing review and within protocol-wide limits on chains, adapters and leverage. A market's fees go to its curator, and the protocol keeps a share (Section 10.2).

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5. Protocol design

5.1 Architecture

Mulle separates where users are from where the books are kept.

- **Spoke chains** hold the user vaults, the adapters and the assets. Users deposit and redeem on the chain they already use. A spoke can also be an asset spoke that holds adapters only, as Plume does for nOPAL. Mainnet spokes at launch are Ethereum, Base, Arc and Plume; GIWA, Solana and Stellar follow.
- **A ledger chain (hub)** records every request, valuation, price and approval, and holds no assets. It runs on Bifrost, whose runtime includes tranche-specific modules (pallets) that store market definitions, tranche prices, investment requests and approvals as native chain state, so any auditor or indexer can rebuild a market's history from the chain alone.
- **Messages** between hub and spokes travel over CCCP, Bifrost's cross-chain message layer.
- **Assets** move directly between spokes, over Circle's Cross-Chain Transfer Protocol (CCTP), which burns USDC on one chain and mints it on another, where a chain supports it [7], and over the asset's canonical bridge otherwise. Assets never route through the hub.

5.2 Vaults and shares

Each spoke holds two vaults per market, one per tranche. The vaults follow the asynchronous vault standard (ERC-7540 on EVM chains [8]; equivalent programs on Solana and contracts on Stellar):

1. A user requests a deposit or redemption. Funds or shares move into escrow.
2. The request waits for the next settlement round, where it is approved at that round's price.
3. The user claims shares (for a deposit) or USDC (for a redemption).

In KYC-gated markets, shares are restricted tokens: a transfer succeeds only between verified holders, enforced by a hook in the token itself (ERC-1404 on EVM; transfer hooks or authorization flags on Solana and Stellar). In open markets, shares transfer freely and wallets are screened at deposit and redemption.

5.3 Rounds

Mulle runs two kinds of rounds:

	NAV round	Settlement round
Frequency	Frequent (for example hourly)	At each epoch end (for example daily at 00:00 UTC)
Collects every spoke's valuation	Yes	Yes
Runs the waterfall and records tranche prices on the hub	Yes	Yes
Approves pending deposits and redemptions	No	Yes

A round has three legs. In **Collect**, the hub asks every spoke for its valuation. In **Response**, each spoke values its adapters and reports its net asset value; when the last spoke reports, the hub runs the waterfall and fixes the tranche prices. In **Finalize** (settlement rounds only), the hub approves pending requests at those prices and sends each spoke its approvals and any asset movements.

Every leg is split into numbered chunks, so a round scales with the number of requests and adapters without hitting any single transaction's gas limit. Each chunk can be retried on its own, and a chunk applied twice has no further effect. On testnet, a single round has settled 100 requests in ten chunks, with the hub side completing in 132 seconds. A settlement round re-collects valuations immediately before approving, so requests are never approved at a stale price. Keepers trigger rounds on schedule; the permissionless steps of a round can also be called by any address, so a keeper outage delays settlement but never moves assets.

5.4 Deposits

A settlement round approves pending deposits at that round's price. The deposit chain first tops up its Liquidity Book to target; the Router sends the rest to Carry Book adapters and to other spokes, directly over CCTP. Senior deposits that would push the Senior above its cap are refunded.

5.5 Withdrawals: the Redemption Ladder

Withdrawals draw on the fastest money first:

1. **The Liquidity Book on the redeeming chain.**
2. **The Liquidity Book on other chains**, moved over CCTP.
3. **The Carry Book**, redeemed through the issuer or the asset's own exit (up to four days for nOPAL).

A settlement round approves only redemptions whose funds have already arrived on the redeeming chain; the rest wait for the next round, first in, first out. Users can claim the moment their approval lands, because the money is already there. While a Senior redemption waits on the Carry Book, it stops accruing the Senior rate from the request epoch but still bears any loss recognized before payout, so waiting never pays better than leaving. The Router then refills the Liquidity Book toward its target from Carry Book cash flows and new deposits.

5.6 The Yield Router

The Router turns a market's limits into allocations. At each NAV round it reads, for every eligible venue on every chain:

- net yield: the base yield plus a haircut share of token rewards, since rewards can stop or lose value;
- withdrawable liquidity and utilization;

- the market's share of the venue;
- the cost and time of moving capital there (gas, CCTP, slippage);
- the health of the venue's price feed.

It then sets target allocations that maximize the vault's expected net yield within the market's constraints:

Constraint	Example
Book targets and bands	Liquidity Book at least 10% of the vault
Liquidity floor	The Liquidity Book covers at least one epoch's expected withdrawals
Venue and protocol caps	At most 20% of a venue's deposits; at most 20% of the vault in one DeFi protocol
Venue health	No lending market above 95% utilization; the position at most one third of the venue's free liquidity
Chain caps	A maximum share of the vault on each chain

The Router moves capital only when the gain pays for the move:

> $$\Delta y \cdot x \cdot h \; > \; c + m$$

where Δy is the yield gain, x the amount moved, h the holding horizon, c the cost of the move and m a safety margin. When a venue breaks a health rule, the Router exits it at the next round to the next eligible venue, or to idle USDC. The curator sets the policy, a keeper executes it, the vault contracts reject any move outside the policy, and every move is recorded on the hub.

5.7 Adapters

An adapter is a contract that holds part of a market's assets in a yield source and reports its value. Mulle supports four kinds:

- **On-chain adapters** deposit into lending markets, Pendle PTs, DEX pools or tokenized bonds with on-chain liquidity, and report value directly.
- **Vault adapters** deposit into another vault, such as Plume Nest's nOPAL, and follow its subscription and redemption schedule.
- **Keeper adapters** handle sources that require a verified counterparty, such as an issuer's primary market. The adapter records a request; a keeper operated by Mulle's verified entity executes it with the issuer (for example buying a stablebond at par for USDC) and returns the result to the adapter.
- **Leverage adapters** loop a Carry Book asset on a lending market: they post the asset as collateral, borrow USDC and buy more of it. They keep the loan-to-value inside a band, deleverage automatically when the position's health falls below a threshold, and unwind when the borrow rate approaches the asset's yield.

An adapter reports value only for assets it actually holds.

5.8 Prices and NAV

Each asset has a price source set at opening: an on-chain exchange rate (such as an ERC-4626 share price), an issuer price or NAV posted by a keeper, or an oracle. Two safeguards apply to every source. A price that moves more than the market's bound in one round is rejected until a second source confirms it, and a price older than the market's staleness limit pauses settlement for that market. Either way, no request is approved at a doubtful price.

A market's NAV is the sum of every spoke's assets minus what it owes, plus USDC in transit between spokes; each spoke reports what it has sent and received on each route (Appendix A).

5.9 Compliance

- **Eligibility is set per market.** In KYC-gated markets every investor is verified before their address is allowed in. The hub records eligibility and propagates it to every spoke's vault hook, so one verification covers every chain. Markets that hold bond tokens offered under Regulation S exclude US persons at this step.
- **Open markets follow the policy of their underlying venue.** Case C follows Plume Nest: no KYC, US persons and restricted jurisdictions excluded, and depositing wallets screened for anti-money-laundering risk [9].
- **Markets inherit their asset's legal structure.** Senior and Junior shares are claims on the market's vault, and the vault holds its Carry Book asset on the terms the issuer sets for every holder, so a market is never open to investors its asset excludes. Each market's terms set out the full chain of entities behind its asset, as Section 8.2 does for the first market.
- **Issuer relationship.** Mulle's operating entity completes the issuer's business verification (KYB) and operates the keeper wallets that trade with the issuer, so the issuer's records show a verified counterparty for every primary-market trade.

5.10 Security and governance

- Valuation (hub) and vault managers (spokes) are upgradeable diamonds owned by a multisig. Upgrades and parameter changes pass through a timelock and are tested on a fork of the live chain before they go out. Signers, threshold and timelock length are published before mainnet.
- Every state-changing function emits an event, and an external monitor runs 24 accounting and liveness rules against the chain.
- Internal reviews of the contracts are complete; an external audit of the mainnet contracts is planned before launch.

6. Case study A — Brazilian federal bonds

6.1 The asset

Brazil's domestic federal debt is R$ 8.94 trillion (August 2026). Non-residents hold 9.91% of it, and 3.83 million individuals hold R$ 272 billion through the government's retail program [1]. A tokenized Brazilian bond already exists: Etherfuse's TESOURO stablebond, backed by Brazilian federal bonds held at B3. It holds fixed-rate federal bills, accrues interest into its price, launched in November 2024, and posts a customer rate of 11.55% a year [2]. The quote sits below the Selic target rate of 13.75% in October 2026 [6] because fixed-rate bills price in the rate cuts the market expects, and because of the issuer's spread.

6.2 Record since the token launched

Period	Return in BRL	Real against USD	Return in USD
2024, from 26 November	+0.96%	−6.35%	−5.46%
2025	+13.70%	+12.54%	+27.96%
2026, to 6 October	+9.97%	+10.72%	+21.76%
Cumulative	+26.23%	+16.68%	+47.29%
Annualized	**13.34%**		**23.14%**

BRL returns from the token's daily price [2]; the real's move uses the central bank's PTAX rate on the same dates [6], so in every row (1 + BRL return) × (1 + real's move) = 1 + USD return, computed from unrounded data.

Over this period the token earned about 0.75 percentage points a year less than the Selic rate. The dollar column adds the real's move: it fell 6.4% in the last five weeks of 2024, then rose 12.5% in 2025 and 10.7% in 2026 to date.

6.3 Twenty-two years, rebuilt

To see the full cycle, we rebuilt the token from 2005 using the daily Selic rate minus the 0.75-point spread, converted to dollars at the central bank's official rate (PTAX) [6]. Over the token's own life the rebuilt series returned 47.22% in dollars against the token's 47.29%, and 26.17% in reais against 26.23%. The series tracks the Selic rate; because the token holds fixed-rate bills, a sharp rise in Brazilian rates can cost it more than the series shows.

2005–2026	BRL	USD
Annualized return	9.94%	6.83%
Losing calendar years	0 of 22	10 of 22
Worst calendar year	+1.98% (2020)	−22.49% (2015)
Maximum drawdown	—	−47.0% (Jul 2011 to Sep 2015)
Chance of losing money over one year	—	39.0%

Every large dollar loss came from a fall in the real: 2008, 2015, 2020 and 2024. The long-run dollar return of 6.83% also sets a ceiling on the Senior rate. At a Senior rate of 7–8%, the Junior on this bond alone would have earned less than the Senior over a full cycle. Even with the rate rule and launch test below, the Junior's full-cycle return only about matches the Senior's (Section 6.6), so the product relies on today's wide carry, a thick Junior and a dollar Liquidity Book, and takes new Senior capital only while that carry lasts.

6.4 Product design

Term	Setting
Carry Book	TESOURO, 70% (11.55% a year in BRL)
Liquidity Book	Pendle PTs, 20% (sUSDS 4.88% and sUSDe 5.04%, fixed, 1–2 month maturities) and Morpho USDC vaults, 10% (Steakhouse 4.15%, Gauntlet Prime 4.33%)
Split	Senior 55%, Junior 45%; Senior at most 1.22× Junior
Senior rate	3-month US Treasury bill plus 2 points, rounded to the nearest 0.25%, between 5% and 7%, fixed for each epoch; 6% today
Launch test	TESOURO yields at least 4 points more than the Senior rate (5.55 points today)
Epoch and withdrawals	3 months; withdrawals at epoch ends, Junior locked within an epoch
Venue limits	At most 20% of the vault in one DeFi protocol and 20% of a PT market's liquidity; no lending market above 95% utilization
Eligibility	KYC-gated; US persons excluded
Performance fee	Set at opening; at most about 4.5%, so that the Junior's average stays ahead of holding TESOURO alone

The dollar assets earn about 4.7% blended, less than the Senior's 6%, so they cost the Junior some return. In exchange they keep their value when the real falls, which protects the Senior. Each 10 points of dollar assets lowers the Junior's average return by about 0.8 points and its worst-year loss by about 8 points:

TESOURO share	Fall in the real at which the Senior first misses its target	Junior average	Junior worst year	Junior exposure to the real
100%	−47.5%	+11.1%	−77.9%	2.22×
90%	−52.2%	+10.3%	−69.8%	2.00×
80%	−58.0%	+9.5%	−61.7%	1.78×
70% (chosen)	**−65.4%**	**+8.7%**	**−53.6%**	**1.56×**
60%	−75.4%	+7.9%	−45.5%	1.33×

Senior 55% at 6%; dollar assets split two parts PTs to one part Morpho. Results apply October 7, 2026 yields to every one-year path of the real since January 2000.

At 70% the Junior's worst year stays within a 55% loss, so it can carry on into the next epoch, and its average, before fees, still beats holding TESOURO alone (+8.3%). At 60% it no longer does, and the Junior has no reason to invest.

6.5 Results

Applying October 7, 2026 yields to all 310 one-year paths of the real in monthly data since January 2000:

	Senior	Junior	TESOURO alone
Average one-year return in USD	6.0%	+8.7%	+8.3%
Median	6.0%	+9.7%	—
Worst path (Sep 2014 to Sep 2015, real −38.6%)	6.0%	−53.6%	−31.8%
Paths where the Senior target was missed	0 of 310	—	—

The Senior is paid in full unless the real falls more than 65.4% in a year. The Junior breaks even when the real falls 7.6% in a year, and it carries 1.56 times TESOURO's currency exposure (70% held against a 45% Junior). At today's yield, TESOURO alone lost money on 34% of these paths; the 39% in Section 1.2 uses historical rates since 2005.

6.6 Backtest with actual rates

The same vault was run on actual monthly Selic rates, exchange rates and USDC lending rates from January 2023, in 3-month epochs. At each epoch the Senior rate was reset by the rule in Section 6.4, and the launch test closed the Senior whenever TESOURO's yield, taken as the trailing Selic rate less 1.5 points, was less than 4 points above that rate. While the Senior was closed, the Junior held the whole portfolio without leverage. Returns in USD:

Year	Senior	Junior	TESOURO alone	Real against USD
2023	6.50–7.00%, paid in full	+24.4%	+20.0%	+7.8%
2024	Closed by the launch test	−8.5%	−14.6%	−21.8%
2025	Closed in Q1, then 5.75–6.25%, paid in full	+30.6%	+26.8%	+12.5%
2026, to September	5.50–5.75%, paid in full	+22.1%	+16.1%	+6.2%
Cumulative		+81.5%	+50.8%	+0.7%
Annualized		**17.2%**	**11.6%**	

Junior before the performance fee. TESOURO alone is modeled as inside the vault, without the vault's trading costs (Appendix C).

The Senior was open in 10 of the 15 epochs and received its rate in each. The launch test closed it from January 2024 to March 2025, after Selic cuts left less than 4 points of carry over the Senior rate. In 2024 the real then fell 21.8%, and the Junior, unlevered and 30% in dollars, lost 8.5% against 14.6% for TESOURO alone. Held at a fixed 6% with no launch test, the same Junior would have lost 24.5% in 2024 and gained 62.5% over the period instead of 81.5%. The real ended the period where it started, so the Junior's lead over TESOURO alone came from carry, not from the currency.

Longer windows are less kind. Run the same way from January 2000, the Senior was closed in 39 of 107 epochs and never missed its rate, and the Junior earned 5.7% a year, with a maximum drawdown of −65%, against 6.2% for TESOURO alone (−47%). In the last five years of high rates and a steady real it earned 14.1% a year against 12.1%. The Junior is a bet on today's carry and a steady real, and it is offered as one.

6.7 Getting the asset

The token's on-chain markets are thin: the largest on-chain pool held about USD 120 thousand in October 2026, and a USD 10 thousand trade moved its price by about 15%. Scale requires the issuer's primary market, at par, through Mulle's verified entity and a keeper adapter (Section 5.7); on-chain pools serve small rebalancing trades. Pendle PT markets hold about USD 3–5 million each, so under the 20%-of-liquidity rule a 20% PT share fits vaults up to about USD 6–10 million; larger vaults hold the rest in Morpho vaults or direct sUSDS deposits.

7. Case study B — Uzbek government bonds with a USD yield sleeve

7.1 The asset

Uzbekistan's policy rate averaged between 13.8% and 15.4% in every year from 2020 to 2025 [16], and foreign demand for its local-currency debt is proven: the April 2026 international som bond drew about 50 foreign investors and orders four times its size, pricing at 12.25%. Som-denominated international bonds outstanding reach about USD 1.8 billion [3].

7.2 Dollar returns, 2020–2025

Buying a one-year government bond each January at that year's average policy rate, used here as a proxy for the bond yield, and converting back to dollars the next January:

Year	Policy rate (annual average)	USD/UZS change	Som vs USD	USD return
2020	14.98%	+10.20%	−9.26%	+4.34%
2021	14.00%	+3.44%	−3.33%	+10.21%
2022	15.37%	+3.58%	−3.46%	+11.38%
2023	14.21%	+9.92%	−9.02%	+3.90%
2024	13.79%	+4.71%	−4.50%	+8.66%
2025	13.89%	−6.93%	+7.45%	+22.37%
Average	**14.37%**			**10.14%**

USD return = (1 + rate) ÷ (1 + USD/UZS change) − 1, computed from unrounded data.

A Senior at 8% with a 60:40 split would have been paid in full every year, even in the weakest (+3.90%). Six annual observations are a small sample, and they miss the 2017 devaluation, so the stress test below adds it.

7.3 Mixing in USD yield

Crypto futures funding yield, the source behind Ethena's sUSDe [17], was high in the years the som fell: its correlation with Uzbek bond returns was −0.43 from 2020 to 2025. Six observations cannot establish a hedge, so the sleeve is treated as diversification, with risks of its own: funding can turn negative. Mixing the two still narrows the swing:

Mix	Average	Lowest year	Junior average (60:40)	Junior losing years (60:40)
Bonds 100	10.14%	3.90%	13.4%	2 of 6
Bonds 70 · Funding 30	10.44%	5.43%	14.1%	0 of 6

Now repeat the September 2017 one-day devaluation (som −48%), assuming a 12.5% bond yield that year and a 10% loss on the USD sleeve. The vault returns −32% with the mix and −41.5% with bonds alone. At 60:40 the Senior is paid in full with the mix and loses 2.5% with bonds alone; at 70:30 it would lose 2.9% and 16.4%. That is why the base case uses 60:40.

7.4 Product

Recommended base case: Senior 8%, split 60:40, a Carry Book of 70% Uzbek government bonds and a Liquidity Book of 30% USD yield sources, with part of it kept in venues that exit within an epoch to fund withdrawals. On 2020–2025 data its Junior averaged 14.1% with no losing year, and its Senior survives a repeat of 2017. The market opens once an issuer offers tokenized som government bonds with primary-market access for Mulle's verified entity; the testnet runs on mirrored Central Asian bonds (Section 11). Convertibility of the som and withholding tax on interest are confirmed with the issuer before launch.

8. Case study C — Brazilian card receivables (nOPAL)

8.1 The asset

BlackOpal's LiquidStone II fund buys future credit card receivables from Brazilian merchants at a discount, and the discount is the yield. Purchases are true sales registered in the Central Bank of Brazil's C3 registry; ownership is locked at the CERC receivables registry and checked against it by an independent third party; and collections settle through Visa and Mastercard [10]. The fund holds the receivables in a Brazilian FIDC, keeps a separate on-chain liquid sleeve of daily-redeemable instruments, and hedges to dollars with non-deliverable forwards; its stated target is 12% a year in USD [10]. Nest names Superstate's USCC, a market-neutral crypto basis strategy, as the fund's liquidity tool [9], and fund listings describe a roughly even split between USCC and the receivables, with a target of 14% or more [23][24]. nOPAL, Plume Nest's vault for the fund, had a 30-day annualized yield of 10.8% on October 14, 2026, held USD 122.2 million, and redeems to USDC in up to four days [9].

Because the receivables are hedged at the source, the risk to tranche here is credit and operating risk: merchant defaults, originator failure, chargebacks and hedge costs, plus the basis strategy's own risks for whatever share of the fund it holds.

8.2 Legal structure

The market reaches the receivables through a chain of entities, each with its own law, rules and eligible investors. From the bottom up:

Layer	Entity and jurisdiction	Regulation and protections	Holders, exit and fees
Receivables	Card receivables of Brazilian merchants, held in a Brazilian receivables fund (FIDC). BlackOpal operates through BlackOpal Finance Ltda. (Porto Alegre) and BlackOpal Labs, Inc. (Delaware)	FIDCs are regulated by Brazil's securities regulator (CVM). Bought by true sale and owned outright; registered in the C3 registry; ownership locked at CERC and verified by an independent third party; collected through Visa and Mastercard [10]	Held for LiquidStone II; short-dated, repaid as card payments settle
Fund	BlackOpal Onchain Private Credit Fund I Ltd. SAC, The Bahamas (registration no. 212939B); fund manager Opal Capital Ltd.; administrator Agio; auditor HLB Acme Advisors	Professional fund under the Investment Funds Act, 2019, supervised by the Securities Commission of The Bahamas; a segregated accounts company, which ring-fences each account's assets from the others'; hedged to USD with NDFs [10][23][24]	Non-US professional investors, permissioned; minimum 10,000 USDC; shares are the OALS2T token on Enzyme Onyx; redemption at NAV in 1–5 business days; 1% management and 30% performance fees
Vault	nOPAL, issued by Nest DAO LLC (Plume Vaults), Republic of the Marshall Islands	Listed as non-regulated [23]; Nest's terms cite an RMI international investment business licence, Marshall Islands law and ICC arbitration seated in the British Virgin Islands [9]; about 96% in LiquidStone II, the rest in Nest's treasury vault and liquid assets for flows	Non-US investors, no KYC; redeems to USDC in up to four days; no vault fees
Mulle market	**Structured Yield Vault on Ethereum and Arc: 90% in nOPAL on Plume (Carry Book), 10% in a DeFi USDC vault (Liquidity Book)**	**Senior and Junior shares are claims on the vault's assets under the market's terms, not on Nest or the fund**	**No broader than nOPAL: non-US persons, restricted jurisdictions excluded, wallets screened; daily epochs; 10% of Junior gains above the high-water mark**

From public listings and the sponsors' own materials, October 2026 [9][10][23][24]. Sources disagree in places: one listing gives the fund token's domicile as Bermuda, one lists redemption as weekly rather than daily, and Plume's announcement calls nOPAL a vault issued by BlackOpal Finance rather than Nest. The offering documents govern; Mulle confirms these points, the fund's current allocation and Nest's terms for smart-contract holders with BlackOpal and Plume before the market opens.

Three points follow for the market's investors. Their claim runs through every layer: the vault holds nOPAL, Nest holds the fund's shares, and the receivables sit in the FIDC, so a failure or dispute at any layer reaches them, and regulation differs by layer: the fund and the FIDC are regulated funds, while nOPAL is listed as non-regulated. The protections that matter most to the Senior sit at the bottom of the chain, in the true sale, the registries and the segregated account, which keep the receivables away from the originator's creditors and from the fund's other accounts. And every return in this section is measured from nOPAL's price, so it is already net of whatever the fund and Nest charge nOPAL's holdings.

8.3 Product design

Term	Setting
Carry Book	nOPAL, 90% (10.8%)
Liquidity Book	Morpho's Pendle Ecosystem High Yield USDC vault, curated by Armitage by Wintermute [12], 10%; modeled at 7.5%, the middle of the team's 7–8% estimate (Section 8.6)
Vault yield	10.47%
Split	Senior 80%, Junior 20%; Senior at most 4× Junior
Senior rate	8% fixed; if the trailing 30-day vault yield is below 9.0% on the first day of a month, that month's rate is the vault yield minus 1 point, rounded down to 0.25%, and new Senior deposits pause
Epoch	24 hours, cutoff 00:00 UTC (09:00 KST); first epoch date to be announced
Withdrawals	At the next epoch end when the Liquidity Book covers them, otherwise within 3–5 days
Fees	10% of Junior gains above the high-water mark; none on the Senior
Eligibility	As Plume Nest: no KYC; US persons and restricted jurisdictions excluded; wallets screened
Chains	Deposits on Ethereum and Arc; nOPAL on Plume; Liquidity Book on Ethereum
Limits	Vault at most 5× Junior TVL; nOPAL holding at most 20% of nOPAL's TVL; Liquidity Book at most 20% of the Morpho vault's deposits
Prices	nOPAL NAV posted on-chain daily at the cutoff
Minimum deposit	10 USDC

8.4 Returns and stress

Annual figures at today's vault yield, before the Junior's fee unless stated. Pool losses are a share of the vault over one year:

Metric	Value
Senior return	8.0%
Junior return before losses	20.4% (18.3% after fee)
Pool loss at which the Junior breaks even	4.1%
Pool loss through which the Senior is paid in full	24.1%
Pool loss through which the Senior keeps its principal	30.5%
Junior return at a 10% pool loss	−29.7%
Junior return if the vault yield falls to 9%	13.0%
Junior return if the Liquidity Book earns its 7-day rate (6.06%)	19.6%

The split trades Senior capacity against the loss the Senior can absorb:

Senior : Junior	Junior return	Junior breakeven loss	Senior paid in full through	Senior per Junior dollar	Coverage
75 : 25	17.9%	4.5%	29.5%	3.0×	133%
80 : 20 (this market)	**20.4%**	**4.1%**	**24.1%**	**4.0×**	**125%**
85 : 15	24.5%	3.7%	18.7%	5.7×	118%
90 : 10	32.7%	3.3%	13.3%	9.0×	111%

Every row uses a 10.47% vault yield and an 8% Senior rate, before the Junior's fee. Coverage is total capital divided by Senior capital.

The Junior is thicker than in comparable products. The fund's loss record is short and not independently verified, the tail risks (originator failure, fraud, a hedge counterparty) arrive as single events rather than gradual losses, and Strata's nOPAL market allows coverage down to 107.5%, a Junior of about 7% [11]. At 125%, this market absorbs a much larger event while the Junior still earns about twice the vault yield.

8.5 Backtest: the Junior against nOPAL

nOPAL launched on October 30, 2025, so the backtest starts there and runs to September 30, 2026, with 90% of the vault in nOPAL and 10% in the Liquidity Book, the split held at 80:20, and the Senior rate tested each month under the rule in Section 8.3. The Liquidity Book earns the actual average USDC lending rate on Morpho and Aave, a conservative stand-in because the Wintermute vault opened only in October 2026. Annualized returns:

Period	nOPAL alone	Senior	Junior before fee	Junior after fee	Junior lead over nOPAL
Nov–Dec 2025	10.92%	8.00%	20.57%	18.35%	+7.4 points
Q1 2026	10.92%	8.00%	19.06%	17.02%	+6.1 points
Q2 2026	11.37%	8.00%	21.34%	19.04%	+7.7 points
Q3 2026	10.77%	8.00%	18.66%	16.66%	+5.9 points
Whole period	**11.00%**	**8.00%**	**19.85%**	**17.71%**	**+6.7 points**



Figure 2. Growth of USD 100 in the Case C market from nOPAL's launch to September 30, 2026, against holding nOPAL alone. The Junior is shown after its 10% fee.

After its fee the Junior earned 17.7% a year, 1.6 times nOPAL's 11.0%, and led nOPAL in each of the 11 months; its weakest month, July 2026, still annualized 15.4%. The Senior received 8% throughout: the vault's lowest monthly yield, 9.8% in July, stayed clear of the 9.0% step-down trigger. With the Liquidity Book at the modeled 7.5%, the Junior would have earned 19.5% after its fee.

The period tests the arithmetic, not the downside: nOPAL had no losing month, so the Junior's cushion was never used, and Section 8.4 sets out what losses would do. If nOPAL's yield falls instead, the step-down rule keeps the Junior ahead of it:

nOPAL yield	Vault yield	Senior rate	Junior after fee	Junior lead over nOPAL
8.0%	7.95%	6.75%	11.5%	+3.5 points
9.0%	8.85%	7.75%	11.9%	+2.9 points
10.0%	9.75%	8.00%	15.1%	+5.1 points
10.8% (today)	**10.47%**	**8.00%**	**18.3%**	**+7.5 points**
12.0%	11.55%	8.00%	23.2%	+11.2 points

Liquidity Book at 7.5%; no losses. Below a 9.0% vault yield the Senior rate is the vault yield minus 1 point, rounded down to 0.25%. The lead is smallest, about 2.5 points, at a vault yield of exactly 9.0%. nOPAL's price comes from published observations after launch and is compounded at a constant rate between them (Appendix C), so month-to-month moves are smoothed.

8.6 The Liquidity Book in practice

On October 15, 2026, the Morpho vault held USD 9.57 million and kept no idle USDC: 98% sat in one market lending against PT-reUSD (91.5% liquidation loan-to-value, maturing December 10, 2026), which was 88–90% utilized and had USD 13–15 million of free liquidity shared by 11 suppliers. USD 9.44 million of the vault could be withdrawn at once. Its 9.44% headline yield included 2.86% in PENDLE rewards, and its 7-day APY was 6.06% [12]. The vault launched on October 6, 2026, and its curator has not filed a risk disclosure.

The Router's rules are built for exactly this. The Liquidity Book stays below 20% of the Morpho vault's deposits, counting its own, which is about USD 2.4 million today, which caps this market near USD 24 million until the venue grows or a second venue is added. PENDLE rewards count only at a haircut, and the Liquidity Book moves to idle USDC if the lending market's free liquidity falls below three times its position.

8.7 A looped variant

A second market can hold nOPAL through a leverage adapter on Plume. At leverage λ, asset yield y and borrow rate b, the looped yield is $y + (\lambda - 1)(y - b)$. For illustration, at 2× leverage and a 7% borrow rate, a 10.8% yield becomes 14.6% before costs. Losses scale the same way: a 10% fall in nOPAL becomes about a 20% loss of equity, so a looped market needs a thicker Junior and higher coverage than Case C.

9. Risks

Risk	What it means	How Mulle handles it
Currency	Local-currency assets lose dollar value when the currency falls (Cases A and B)	The Junior absorbs it first; splits sized to the worst historical paths; dollar Liquidity Book; the Senior cap is rechecked each epoch against a sharp fall in the currency
Credit and originator	Merchant defaults, originator failure or chargebacks reduce collections, and default records may be self-reported (Case C)	The Junior absorbs it first; in Case C the Senior is paid in full through annual pool losses of 24.1%
Layered structure	In Case C a claim runs through the market's vault, Nest (Marshall Islands), a Bahamas professional fund and a Brazilian FIDC (Section 8.2). A failure, dispute or change of terms at any layer delays or impairs it, under different laws and forums	nOPAL holding at most 20% of its TVL; offering documents and Nest's terms reviewed before launch; eligibility no broader than nOPAL's; the Liquidity Book pays exits while a layer is slow

Risk	What it means	How Mulle handles it
Fund strategy	The fund can change its mix. Listings describe about half of LiquidStone II in a crypto basis strategy, whose risks are funding rates, exchanges and custodians rather than Brazilian credit	Allocation tracked through the fund's reports; a material change triggers a review of the split, the Senior rate and the market's limits
Sovereign credit	The issuing government fails to pay	Rated sovereign issuers only; per-country limits
Issuer and custody	The token's issuer or custodian fails, or controls KYC wallets, redemption routes and upgrade keys	Regulated custody and published reserve attestations preferred; redemption terms agreed with each issuer before launch; issuers diversified as markets grow
Carry Book liquidity	Redemptions take days and may take longer under stress	Redemption Ladder; Liquidity Book sized to expected withdrawals; Junior withdrawals limited by coverage; payouts wait for the Carry Book in a delay
Base yield decline	Local rate cuts, lower receivable discounts or fading rewards reduce the vault's yield. If the Selic rate fell to 12% by the end of 2027, as surveyed economists expected in October 2026, TESOURO would yield about 10%, about 4 points over a 6% Senior	Senior rate rules step down and launch tests pause new Senior capital (Section 3.5)
Liquidity Book venues	Lending pools can reach full utilization, and curated vaults can concentrate on one collateral. After the KelpDAO exploit in April 2026, Aave stablecoin pools were fully utilized and withdrawals stalled [18]; the Stream Finance collapse in November 2025 left lending markets with about USD 285 million of exposure [19]	Per-venue and per-protocol caps; exit above 95% utilization or when free liquidity falls below three times the position; reward haircuts
Leverage	Looped positions face liquidation and borrow-rate spikes	Loan-to-value bands, automatic deleveraging, a borrow-rate stop, thicker Junior
Stablecoins	USDC or a yield-bearing dollar token loses its peg	Venue and asset caps; USDC as the settlement asset
Prices and NAV	A wrong or late price misprices deposits and withdrawals	Deviation bounds, staleness limits and a settlement pause; second-source confirmation
Smart contracts	A bug in Mulle or in a dependency	External audit before launch, fork-tested and timelocked upgrades, multisig ownership, chunk-level retries and idempotency, monitoring
Cross-chain	A message or transfer is delayed or lost	Every leg retryable; transfers in transit counted in NAV; no asset ever routes through the hub
Regulation	Rules on tokenized securities and pooled products change, and a market may be treated as a collective investment scheme	Legal review for each market; KYC/KYB where required; US persons excluded where the underlying requires it
Convertibility and tax	Capital controls or withholding taxes reduce dollar returns (Case B)	Confirmed with the issuer before the market opens
Model	Results rely on reconstructed series, monthly data and short samples; TESOURO holds fixed-rate bills, which can lose more than modeled if Brazilian rates jump	Results presented as ranges; stress tests beyond the historical record
Operations	Keepers stop	Settlement pauses and assets stay put; anyone can call the permissionless steps

10. Market and business model

10.1 Reference markets

Market	Size	Source
Brazil domestic federal debt	R$ 8.94tn ≈ USD 1.73tn	Tesouro Nacional, Aug 2026 [1]
— held by non-residents (9.91%)	≈ USD 171bn	[1]
— Brazil retail program (Tesouro Direto)	R$ 272bn ≈ USD 52bn, 3.83m investors	[1]
Uzbek som international bonds outstanding	≈ USD 1.8bn	[3]
Tokenized US Treasuries	USD 15.9bn	RWA.xyz, Sep 2026 [4]
Stablecoins	USD 310.7bn	DefiLlama, Oct 2026 [5]
nOPAL (Plume Nest)	USD 122.2m	Nest, Oct 2026 [9]

USD figures at USD/BRL 5.18 (31 August 2026). Market size is a reference point, not money available to invest.

10.2 Fees

Fees are set for each market at opening (Section 4.2) and come out of the Junior's share; fees never reduce the Senior's target.

- **Performance fee** f_p: a share of Junior gains above the high-water mark, between 0% and 20%. It can be lowered after opening but never raised.
- **Management fee** f_m, optional: an annual fee on vault assets.
- **Protocol share** s: Mulle keeps all fees in the markets it curates and a share of fees in third-party markets, for example 20%.

Across markets i, with assets A_i and annual Junior gain above the high-water mark G_i:

$$\text{Revenue} = \sum_i s_i \left[A_i \, f_{m,i} + A_i \, (1 - \alpha_i) \, G_i \, f_{p,i} \right]$$

With a 10% performance fee and no management fee, the terms of Case C, the fee comes to about 0.41% of assets a year in Case C and 0.56% in Case B, using each case's average Junior return. Case A can carry only about a 4.5% fee before its Junior falls behind holding TESOURO alone, which comes to about 0.18% of assets. These are approximate: a high-water mark lowers fees after losing years, while fees charged period by period on uneven returns can come out higher than a fee on the average.

Assets under management	Performance fees (about 0.4%)	With a 0.5% management fee
USD 25m	USD 0.10m	USD 0.21m
USD 100m	USD 0.40m	USD 0.85m
USD 250m	USD 1.00m	USD 2.13m
USD 1bn	USD 4.00m	USD 8.50m

Annual fees in Mulle-curated markets; at a 20% protocol share, third-party markets would bring a fifth of these amounts. A management fee also trims the performance fee, because it comes out of Junior gains; the last column includes that effect at a 10% performance fee. Fee levels are illustrative; each market sets its own.

10.3 Capture scenarios

Share captured	Stablecoins (USD 310.7bn)	Tokenized Treasuries (USD 15.9bn)
0.01%	USD 31m	USD 1.6m
0.05%	USD 155m	USD 8.0m
0.10%	USD 311m	USD 15.9m

These markets overlap and are not additive.

11. Roadmap

11.1 Implementation status

Item	Status
Testnet markets	Eight live across Ethereum Sepolia, Base Sepolia, BSC testnet, Robinhood Chain testnet, GIWA Sepolia and the Bifrost testbed
Chunked settlement	Live on testnet; a 100-request round settled in ten chunks
Yield sources on testnet	Mock lending pools, mirrored asset baskets, Central Asian bond mirrors, escrow lending
Mainnet design	Ledger-only hub, CCTP between spokes, separate NAV and settlement rounds
Ecosystem	Mulle is in Phase 3 of GASOK [15], Dunamu's program for builders on GIWA, the Layer 2 from Upbit's operator

11.2 Next

Phase	Milestones
1	Arc and Plume testnet spokes with the nOPAL vault adapter and the Morpho adapter; external audit; mainnet hub and spokes on Ethereum, Base, Arc and Plume; first market: Brazilian card receivables (Case C)
2	Keeper adapter for an issuer's primary market; Solana and Stellar spokes; Brazilian federal bonds market (Case A); GIWA spoke
3	Third-party curators; leverage adapters and a looped nOPAL market; Uzbek market once an issuer is available

12. Conclusion

Tokenization put real-world yield one transaction away from anyone with a wallet. It did not make that yield suitable for most of those people: it left currency and credit risk exactly where they were, and it left real-world assets slow to sell. Mulle finishes the job. Each Structured Yield Vault blends real-world carry with DeFi liquidity so withdrawals do not wait on the slowest asset, routes capital across chains to where it earns most within clear limits, and splits the result between investors who want a fixed dollar rate and investors who want to be paid for taking the risk. Every price and approval is recorded on a public ledger, and each investor stays on the chain they already use.

The same structure works for any yield-bearing asset that pays well on average but is volatile or slow in dollars. Brazilian federal bonds, Uzbek government bonds and Brazilian card receivables are the first three.

Appendix A. Formulas

Name	Formula
Senior target	$T_{t+\Delta} = T_t\,(1+r)^{\Delta/\text{year}}$
Tranche values	$S = \min(T, V), \quad J = V - S$
Senior return over one period	$R_S = \min\left(r,\ \dfrac{1+g}{\alpha} - 1\right)$
Junior return over one period	$R_J = \max\left(\dfrac{g - \alpha r}{1-\alpha},\ -100\%\right)$
Junior breakeven vault return	αr
Junior leverage on excess return	$1/(1-\alpha)$
Senior misses its target below	$g = \alpha(1+r) - 1$
Senior loses principal below	$g = \alpha - 1$
Junior in loss terms (vault yield B, annual pool loss L)	$R_J = \dfrac{B - L - \alpha r}{1-\alpha}$; breakeven at $L = B - \alpha r$
Senior in loss terms	Paid in full while $L \le (1-\alpha) + B - \alpha r$; principal intact while $L \le 1 + B - \alpha$
Senior cap	$S \le k\,J, \quad k = \alpha/(1-\alpha)$
Market NAV	$\sum_c (\text{adapters}_c + \text{cash}_c - \text{owed}_c - \text{pending}_c) + \sum_{s\to t} (\text{sent}_{s\to t} - \text{received}_{s\to t})$
Router move test	$\Delta y \cdot x \cdot h > c + m$
Looped yield	$y + (\lambda - 1)(y - b)$, with λ the leverage and b the borrow rate
Revenue	$\sum_i s_i\,[A_i f_{m,i} + A_i(1-\alpha_i) G_i f_{p,i}]$

Rates are annual yields; for periods shorter than a year, replace r with $(1+r)^{\Delta/\text{year}} - 1$. g is the vault's return over the period, including its yield; pending deposits are excluded from NAV until approved.

Appendix B. Market term sheets

Term	A — Brazilian federal bonds	B — Uzbek government bonds	C — Brazilian card receivables
Carry Book	TESOURO 70%	Uzbek government bonds 70%	nOPAL 90%
Liquidity Book	Pendle PTs 20%, Morpho USDC 10%	USD yield sources 30%	Morpho USDC vault 10%
Split; Senior cap	55 : 45; 1.22×	60 : 40; 1.5×	80 : 20; 4×
Senior rate	T-bill + 2 points, 5–7%; 6% today	8%	8% fixed; step-down below a 9.0% vault yield
Launch test	Asset yield ≥ Senior rate + 4 points	Set at opening	Vault yield ≥ 9.0%
Epoch	3 months	Set at opening	24 hours
Withdrawals	At epoch ends	Set at opening	Next epoch, or 3–5 days
Performance fee	At most about 4.5%	Set at opening	10% above the high-water mark
Eligibility	KYC; US persons excluded	KYC; US persons excluded	No KYC, as Plume Nest; US persons excluded

Term	A — Brazilian federal bonds	B — Uzbek government bonds	C — Brazilian card receivables
Legal chain	Etherfuse stablebond backed by federal bonds held at B3	Set by the issuer	nOPAL (Nest, Marshall Islands) → LiquidStone II (Bahamas professional fund) → Brazilian FIDC
Chains	Issuer's primary-market chain for assets; deposit chains set at opening	Set at opening	Deposits on Ethereum and Arc; nOPAL on Plume
Status	Phase 2	Design case	Phase 1

Appendix C. Constants and data

Constant	Value	Source
Brazil domestic federal debt (DPMFi), Aug 2026	R$ 8,944.48bn	[1]
Non-resident share	9.91%	[1]
Tesouro Direto stock / active investors	R$ 271.99bn / 3,832,453	[1]
USD/BRL (PTAX), 31 Aug 2026	5.1816	[6]
TESOURO spread to Selic, Nov 2024 – Oct 2026	0.75 points a year	[2], [6]
TESOURO record, 26 Nov 2024 – 6 Oct 2026	BRL +26.23%; PTAX 5.7990 → 4.9698; USD +47.29%	[2], [6]
Selic (daily); USD/BRL (daily)	BCB series 11; BCB series 1	[6]
Case A yields, 7 Oct 2026	TESOURO 11.55%; PT sUSDS 4.88%, PT sUSDe 5.04%; Morpho Steakhouse 4.15%, Gauntlet Prime 4.33%; 3-month T-bill 3.94% (September average); Selic 13.75%	[2], [13], [20], [22], [14], [6]
Case A paths	310 one-year paths of USD/BRL in monthly data since January 2000; TESOURO trading cost 0.2%	[6]
Uzbek policy rate and som rate, 2020–2025	Annual average policy rate; official som rate each January	[16]
Funding yield, 2020–2025	Ethena documentation, sUSDe (DefiLlama), Binance funding	[17], [5]
Case C inputs, 14–15 Oct 2026	nOPAL 10.8% (30-day), USD 122.2m; Morpho vault 9.44% instant including 2.86% PENDLE, 6.06% over 7 days, USD 9.57m deposits	[9], [12]
nOPAL prices for the backtest	1.00 at launch, 30 Oct 2025 (assumed); 1.05423 on 4 May, 1.06858 on 18 Jun, 1.07612 on 11 Jul and 1.07769 on 18 Jul 2026; 1.1053 on 15 Oct 2026, up 0.87% over 30 days	[25], [23]

Method notes. The Brazilian series in Section 6.3 compounds the daily Selic rate, subtracts the issuer spread pro rata over 252 business days, and divides by the daily USD/BRL rate; its loss frequency uses every one-year window between January 2005 and October 2026. Sections 6.4–6.5 apply October 7, 2026 yields to each one-year path of the real in monthly data since January 2000, with the Senior at today's 6%. Section 6.6 runs 3-month epochs on actual data: TESOURO earns each month's Selic minus a more conservative 1.5 points and converts at actual exchange rates; Morpho earns actual Morpho and Aave USDC rates from October 2021 (the T-bill plus 0.26 points before that) and the PTs that rate plus 0.8 points; the Senior rate follows the rule in Section 6.4; the launch test compares the trailing three-month Selic rate less 1.5 points with that rate; TESOURO trades cost 0.2%. Case C figures in Section 8.4 are annual, at the October 2026 vault yield, with losses as a share of the vault over one year. The Section 8.5 backtest compounds nOPAL's price at a constant rate between the observations above, pays the Liquidity Book each month's average Morpho and Aave USDC rate, holds the split at 80:20 and charges the Junior 10% of gains above the high-water mark. Taxes and other trading costs are excluded unless stated.

Disclaimer

This document is for information only. It is not an offer or solicitation to buy or sell any security or token, and it is not investment, legal or tax advice. Historical, reconstructed and modeled returns do not predict future returns. Senior returns are targets, not guarantees, and either tranche can lose money. Market terms, fees and supported chains described here are illustrative and may change before launch. Mulle markets may not be available in every jurisdiction and are not offered to US persons where the underlying assets restrict them.

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