cSigma

Protocol Whitepaper

V1.0

www.csigma.finance

January 2024

Abstract

This document comprehensively covers all aspects of the protocol's implementation, providing a detailed and thorough examination of its design and functionality.

Contents

1. Introduction

The cSigma protocol connects borrowers and lenders with excess capital globally in a low-friction and high-transparency process. The protocol standarizes the critical steps of the lending process and provides infrastructure services such as handling capital movements, accounting, information symmetry, dashboards, etc. It empowers credit providers (underwriters, risk assessors) and pool managers (providing first loss capital) to originate the loans with their existing relationships with borrowers, plug in their underwriting and domain expertise into the protocol, and make loan pools available to lenders.

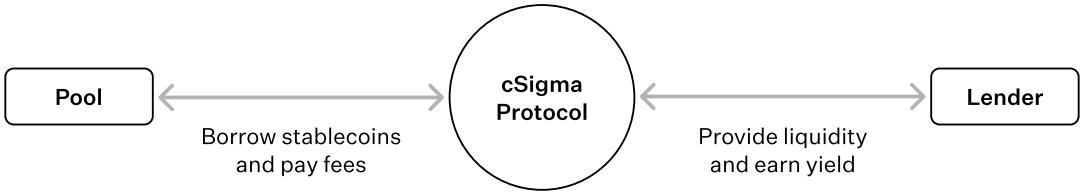

Figure 1: cSigma Protocol

cSigma provides crypto-uncorrelated yield generation opportunities worldwide in a transparent process to excess capital tokenized on the blockchain in the form of Stablecoins. Commercial lending is a complex process, and cSigma chooses to focus on two forms of commercial lending—Wholesale and Corporate Debt—to standarize the process and extend the protocol to end beneficiaries and consumers.

Overview

The protocol is built around five different roles. The first two, Lenders and SMB Borrowers, are the end beneficiaries of the protocol. The other three, Portfolio Manager, Pool Manager, and Credit Service Providers, are platform partners and provide different credit services in exchange for economic interests.

Pool Managers propose, build, and manage a debt pool. They define APR and repayment terms, provide first-loss capital, and fund and manage individual loans within the pool. The protocol requires them to publish underwriting details for each loans and times for each loan to provide full transparency to lenders.

SMB Borrowers apply to a specific pool. Pool Managers are primarily responsible for doing due diligence, underwriting, setting up loan terms and funding, and receiving loan repayments.

Portfolio Managers manage capital on behalf of lenders if Lenders want to delegate the capital deployment to specialists. They are responsible for assessing risks and constructing credit portfolios using Credit Pools on the platform that maximizes the yield for selected risks. In version 1, lenders act as their capital portfolio managers, whereas in future versions of the protocol, we expect third-party portfolio managers to take an active role.

Lenders provide capital to the pools. They are responsible for assessing the risks and reputation of pools, making investment decisions, and balancing diversification and yield. In a future version, they will be able to utilize the services of Portfolio Managers and delegate these responsibilities.

Credit Service Providers are independent service providers who will offer their expertise on the platform for a fee. The protocol plugs in 3rd party credit analysis risk management, and montoring services to decentralize key credit investment decisions. Part of the total economic value—a combination of origination fees and APR—will be provided to 3rd party credit and risk service providers.

2. Features and Functions

The cSigma protocol facilitates decentralized lending and borrowing, offering users the ability to supply liquidity to lending pools and earn interest as lenders. On the other hand, pool managers can access stablecoin-denominated private capital by providing first loss capital and paying protocol fees. This section explores the essential components that make these interactions seamless and secure within the cSigma ecosystem.

2.1 Core Protocol Services

Within the cSigma ecosystem, a Decentralized Autonomous Organization (DAO) assumes a central role in managing critical functions. The DAO is responsible for overseeing various roles, upholding platform integrity, and controlling essential parameters. These core protocol services and components include:

Role Management: The DAO efficiently manages and orchestrates the roles of participants within the ecosystem. This ensures that each role, from lenders to borrowers, operates harmoniously, fostering a dynamic and inclusive lending environment.

Platform Integrity: Upholding the integrity of the platform is paramount. The DAO implements measures to maintain transparency, trust, and fairness in all lending and borrowing activities, creating a secure and realiable ecosystem.

Paramenter Control: The DAO wields control over vital parameters that underpin the platform's operations. This includes configuring fee structure networks, rewards, and enforcing Anti-Money Laundering (AML) regulations. These parameters are thoughtfully managed to be aligned with the best interest of all ecosystem participants.

2.2 Roles

The cSigma protocol incorporates various roles to efficiently manage its diverse functionalities, ensuring a seamless and transparent lending and borrowing experience. Each role plays a vital part in maintaining the protocol's robustness and effectiveness.

The cSigma protocol revolves around five distinct roles, each serving a critical function within the ecosystem:
- Lender
- Portfolio Manager
- Pool Manager
- Borrower
- Credit Service Provider

2.2.1 Lender

Lenders are the pivotal capital providers within the cSigma ecosystem, each playing a central role in fueling the lending process. They provide capital to Pool Managers and contribute to overall success of the protocol. Some of the core responsibilities of Lenders include:

- **KYB Process:** Lenders are required to undergo a Know Your Business (KYB) process before they can deploy their capital. This crucial step enhances the security and legitimacy of the lending ecosystem.
- **Risk Assessment:** Lenders diligently assess risk and yield opportunities by evaluating the data and analysis provided by the protocol and its 3rd party service providers. This comprehensive evaluation process enables Lenders to make informed investment decisions.
- **Holding Period:** Lenders are subject to specific holding periods or "cool down" periods for capital withdrawals. This feature ensures the stability and integrity of the lending pools.

» **Yield Management:** Lenders have the flexibility to withdraw accumulated Annual Percentage Rate (APR) yields at any time or choose to reinvest them for compounded yield. This feature empowers Lenders to optimize their capital deployment strategies.

Examples of Lenders within the cSigma protocol encompass a diverse range of participants, including wealth managers, accredited investors, neo-banks, crypto brokers, and fund managers. Their collective engagement within the ecosystem contributes to the protocol's vibrancy and accessibility, fostering a dynamic and collaborative lending environment. The protocol takes on the responsibility of originating high quality credit pools, providing robust data and analysis, and helping lenders monitor risks in their pools.

2.2.2 Portfolio Manager

Portfolio Managers serve as esteemed credit service providers within the cSigma ecosystem, bringing their expertise in risk assessment, diversification strategies, and yield management to the forefront. Their role is crucial in ensuring the optimal deployment of capital while upholding fiduciary resposibilities towards Lenders. Key aspects of the Portfolio Managers' role include:

» **Expertise and Due Diligence:** Portfolio Managers undergo a rigorous due diligence process conducted by cSigma. They are required to publish their professional credentials and fee structures on the platform, enhancing transparency and trust within the ecosystem.
» **Fiduciary Responsibilities:** Portfolio Managers shoulder fiduciary responsibilities toward Lenders. This entials a commitment to prudently manage Lenders' capital, make well-informed investment decisions,, and uphold the highest standards of financial stewardship.

In the initial version of the product, the Portfolio Manager role may not be available. However, as cSigma onboards more pools, we actively encourage qualified Credit Portfolio Managers and credit funds to participate in the cSigma ecosystem. Their involvement will further enrich the lending experience for all participants, reinforcing cSigma's commitment to excellence and innovation.

2.2.3 Pool Manager

Pool Managers play a pivotal role in the cSigma ecosystem by overseeing various aspects of the lending process, ensuring transparency and efficiency. Their multifaceted responsibilities include:

» **KYB Process:** Pool Managers are required to undergo a Know Your Business (KYC) process before they can create their pools. This crucial step enhances the security and legitimacy of the lending ecosystem.
» **Loan Approval and Management:** Pool Managers in most cases have ongoing lending business that lends to SMBs and want to borrow wholesale capital from lenders on the cSigma platform. Pool Managers originate the individual SMB borrowers, gather loan applications, underwrite the loans, issue the capital and manage the recovery of the capital. Pool Managers also commit first capital which typically absorbs more than 99% of the possible losses in the credit pool.
» **Pool Creation:** Pool Managers establish Debt Pool that have loans to individual SMB borrowers. These pools also offer diversification by deploying borrowed capital across hundreds of small SMB borrowers. These pools include a detailed loan portfolio profile, target yield, term, pool size, and specific conditions like lockup periods.
» **Funds Commitment:** Once the pool is set up, lenders can commit their funds to the pool.
» **Loan Vetting and Underwriting:** Pool Managers take on the crucial role of meticulously vetting each loan. They provide comprehensive underwriting, set Annual Percentage Rates (APR) for borrowers, and ensure that credit losses are minimal and significantly lower than the first loss capital.
» **Arbitrage Management:** Pool Managers have the freedom to manage the arbitrage rate between individual loans and the pool's yield target. This flexibility allows them to optimize returns for lenders while maintaining the pool's overall financial health.

» **Transparency:** All parameters and decisions made by Pool Managers, including underwriting scores, APR, loan approvals and rejections, deployed capital, and default statuses, are transparent and visible to all lenders and portfolio managers within the protocol. This transparency fosters trust and confidence among all participants.

Pool Managers, through their meticulous oversight and commitment to prudent lending practices, ensure that the cSigma ecosystem operates smoothly and efficiently, benefiting lenders, borrowers, and the overall lending community.

2.2.4 Borrower

Borrowers are the end beneficiaries of the cSigma ecosystem, seeking access to capital via the platform. Borrowers often have an existing relationship with a Pool Manager who lent capital to them before or after establishing the credit pool. The cSigma platform gains visibility into borrowers through the Pool Manager data feeds.

2.2.5 Credit Service Provider

Within the cSigma protocol, professionals and service providers can seamlessly integrate their expertise into the lending ecosystem. The protocol offers interfaces that allow these professionals to deploy their services for single or multiple pools. Some of the key services include:

» **Credit Analysis:** The cSigma protocol has established a credit analysis framework where each credit pool is rated from CCC to A, similar to publicly traded debt. The protocol has implemented first-party services in analyzing and rating the credit pools, while 3rd party providers are welcome to use the same raw data and rate credit quality with their own processes. Eventually, credit rating by multiple parties will create a robust decentralized process that increases lenders' confidence and reduces borrowing costs for Pool managers.
» **Risk Monitoring and Management:** The protocol offers independent risk monitoring services for debt pools. While the first-party service provides a foundational framework, others can plug in their expertise, particularly in various geographic regions or domains. These risk monitoring services perform critical functions, including:
  - Establishing transparency around the lending process managed by Pool Managers.
  - Continuous monitoring of a pool's actual performance in comparison to its target.
  - Vigilantly observing macroeconomic conditions and alerting lenders to any changes in the risk profile of a specific pool.
» **Underwriting Monitoring:** cSigma aims to standardize underwriting practices for each loan pool based on borrower characteristics. Independent underwriting monitoring services ensure that each pool adheres to its predetermined credit risk boundaries. This level of oversight enhances the integrity and risk management of the lending process.
» **Recovery Service:** In case of loan defaults, specialized recovery service providers step in to mitigate losses. These providers may purchase defaulted loans at a discount and subsequently work to recover them off-chain. The cSigma protocol collaborates with various recovery service providers across geographic regions, allocating economic interests to incentivize the highest possible recovery rates.

These protocol-integrated services uphold cSigma's commitment to transparency, risk management, and efficiency within the lending ecosystem. By providing a flexible framework for professionals to contribute their expertise, cSigma ensures a comprehensive and resilient lending experience for all participants.

2.3 Interaction

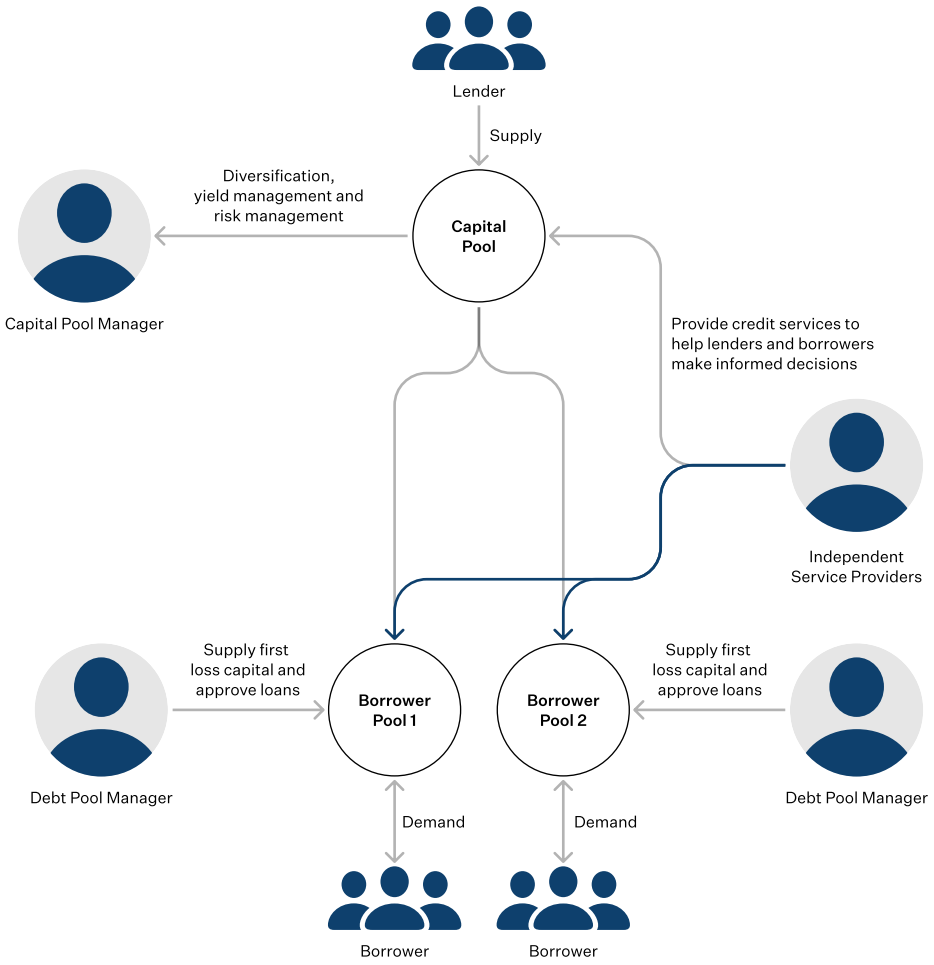

Figure 2: Roles and Interactions of the cSigma Protocol

In the cSigma lending ecosystem, five essential roles contribute to seamless capital allocation and lending processes. Lenders serve as primary capital providers, conducting KYB processes and assessing risks and yield opportunities. Portfolio Managers, experts in credit services, manage diversification and yield, with fiduciary responsibilities towards lenders. Pool Managers approve loans, provide initial capital, and oversee loan deployment and collection. Borrowers access capital, repay loans, and build credit scores. Lastly, Credit Service Providers offer specialized services including risk monitoring, underwriting oversight, and loan recovery, enhancing transparency and efficiency. These roles collaborate to create a trusted lending ecosystem.

3. Implementation and Architecture

3.1 High Level Technical Architecture

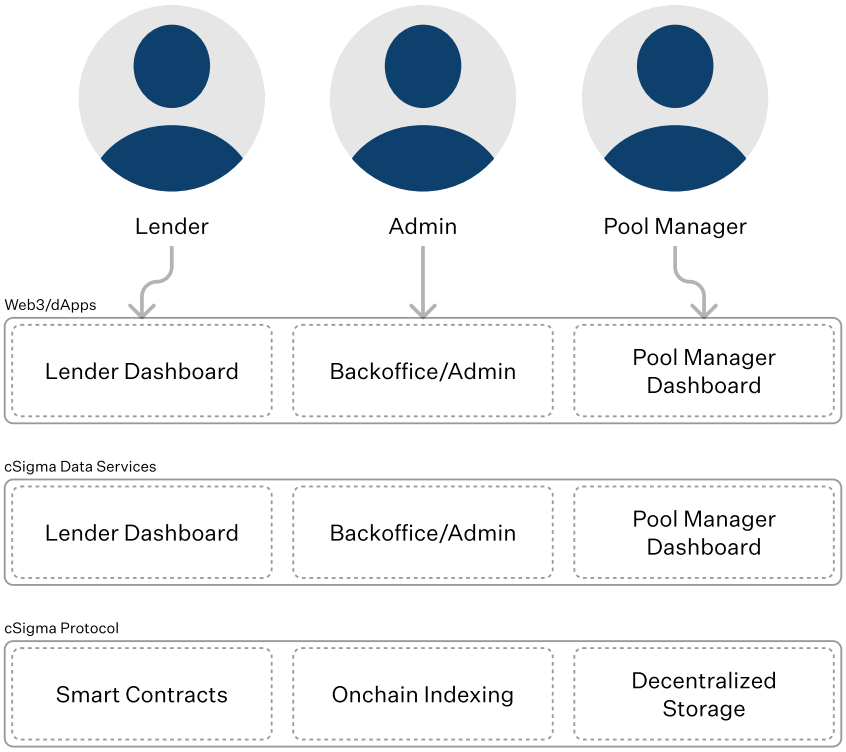

Figure 3: Technical Arquitecture of the cSigma Protocol

3.1.1 Client Applications

The cSigma client suite is comprised of the following:

» **Lender Client:** The Lender Client is for the Lender/Portfolio Manager to review available Credit Pools and construct a portfolio based on their risk profile and desired return. They can deposit, withdraw, and invest stablecoins in the application through the connection of their web3 wallet. There is also a dashboard for the users to see their exposure and expected returns at a glance.

» **Backoffice Client:** The Backoffice Client is where users with elevated permissions on the platform can perform essential management activities. All the actors in the cSigma system must be permissioned and this is the place where that happens along with any KYB or Multisig approvals.

» **Pool Manager Client:** The Pool Manager Client is the workhorse of the client apps. Here, the Pool Manager can load loan tapes and create Credit Pools with tailored returns and risk characteristics. They can also make coupon, maturity, and payoff payments from within the app using stablecoins. The dashboard enables Pool Managers to see their obligations and expected outflows at a glance.

3.1.2 Data Services

The cSigma Data Services suite is comprised of the following categories:

» **Application Services:** The Application Services layer is where the application data is served related to the various models in the system. Token-based authentication, GraphQL services, and RESTful services comprise the bulk of the

services that support the cSigma client and related providers.

- **Analytics Services:** The Analytics Services layer is where cSigma warehouses large amounts of data from various providers and creates actionable insights. This layer processes and transforms risk, market, borrower, lender, and institutional data to make it available to the application services and AI/ML layer.
- **AI/ML Services:** The AI/ML Services layer is where the magic within the cSigma platform happens. With the data-rich feeds from our providers, we can create portfolios for lenders, generate risk scores, suggest pricing, and so much more.

3.1.3 Protocol

The cSigma Protocol is comprised of the following modules:

- **Smart Contracts:** The Smart Contracts module is where all the onchain activity takes place. The smart contracts manage stablecoin payments between all participants in the system, as well as any staking and native token functions. The smart contracts store limited information about the participants that is not publicly identifiable and is used to reconcile onchain and offchain activity. The smart contracts also emit events that are indexed by our graph service, enabling easy and cost-effective storage of additional non-PII data. In addition to the offchain indexing service, the smart contracts also store the content hash of documents stored on IPFS as an additional cheap, decentralized, and flexible data storage mechanism.
- **Onchain Indexing:** The Onchain Indexing module is essentially a graph that listens to custom events on the smart contracts and indexes them in a database to allow retrieval through a GraphQL service layer. While the event data is stored onchain, not all nodes maintain this data since it can significantly increase the storage footprint. These events serve as an easy and cost-effective means of putting non-PII data onchain rather than storing it in the contract itself. The indexing service improves both front-end responsiveness and data availability.
- **Decentralized Storage:** The Decentralized Storage module is currently IPFS-based and meant to be a flexible means of storing additional attributes related to the models and transactions within the cSigma system. The content hash of the files is stored onchain and allows anyone to validate that the file content has not been tampered with. Attributes can be easily added and removed from the JSON file without affective some of the more immutable modules such as the Smart Contracts and Indexing.

3.2 Key Aspects and Attributes

The cSigma lending ecosystem's architecture encompasses essential components to ensure a secure and efficient lending and borrowing environment. The Profile Registry mandates users to create unique profiles, issuing role-based ID for secure interactions with smart contracts. The ID Registry enforces Know Your Business (KYB) and Anti-Money Laundering (AML) compliance, safeguarding user data via onchain registry while upholding confidentiality. The Credit Service Registry acts as a centralized hub for credit service providers, necessitating registration for entities offering specialized services, promoting transparency, security, and efficiency.

The DAO governs crucial global parameters, including loan origination fees, KYB fees, APR, maximum pool size, maximum loan duration, and first loss capital requirements, ensuring transparency, adaptability, and sustainability. The protocol leverages an upgradeable proxy mechanism with a 'Diamond Proxy' architecture, allowing seamless upgrades and modular enhancements, ensuring the platform's long-term resilience and user-centric approach.

3.2.1 Profile Registry

Within the cSigma ecosystem, every user is required to create a unique profile. These profiles store essential information about individuals or entities, fostering trust and uniqueness on the platform. The Profile Registry serves as a digital signature of the user's identity and is indispensable when interacting with the protocol's smart contracts. Smart contracts rigorously enforce the association between Profile Registry and user wallets, enhancing security and accountability throughout the ecosystem.

3.2.2 ID Registry

The ID Registry plays a pivotal role in establishing trust, enhancing compliance, and mitigating fraud within the cSigma ecosystem. Borrowers and lenders are required to undergo a Know Your Customer (KYC) or Know Your Business (KYB) process. During this process, borrowers and lenders share the necessary information with the cSigma. Upon successful verification, the system updates the status in their respective registry, without disclosing any private information.

The protocol's smart contracts play a crucial role in upholding KYB and Anti-Money Laundering (AML) compliance by securely referencing data from this unique smart contract registry. This ensures a high level of security and transparency while maintaining the confidentiality of sensitive information, creating a robust and trustworthy lending and borrowing environment.

3.2.3 Credit Service Registry

The Credit Service Registry serves as the centralized hub for all credit service providers affiliated with the cSigma protocol. Any entity seeking to offer specialized services within the ecosystem must undergo registration here.

Likewise, entities providing risk monitoring services, including the issuance of periodic risk assessments, must also complete registration to access user fees and provide their valuable services. The Credit Service Registry acts as a gateway, ensuring that all service providers adhere to the protocol's standards and requirements, thereby enhancing transparency, security, and efficiency within the cSigma lending and borrowing ecosystem.

3.2.4 Protocol Parameters

The cSigma protocol entrusts the DAO with the governance and management of a diverse range of global parameters, each playing a vital role in shaping the lending business process. These parameters, under the careful supervision of the DAO, include:

- **Loan Origination Fee:** The fee associated with loan origination, serving as a crucial component of the lending process. The DAO sets and oversees this fee, ensuring it aligns with the platform's sustainability and user interests.
- **KYB Fee:** Parameters related to Know Your Business (KYB) processes, encompassing fees associated with identity verification. The DAO manages and configures these fees, maintaining compliance and enhancing security.
- **Max Pool Size:** The maximum size that a loan can attain, a parameter designed to maintain optimal diversification and mitigate risks.
- **Max Loan Duration:** Parameters governing the maximum duration for loans, ensuring alignment with borrower needs and platform dynamics.
- **First Loss Capital Requirements:** Parameters that dictate the level of first-loss capital necessary to safeguard the lending ecosystem against potential defaults.

These protocol parameters, diligently managed by the DAO, form the framework for the cSigma lending business process.

3.2.5 Smart Contract Registry

The cSigma protocol employs an advanced and robust mechanism for smart contract upgrades, ensuring flexibility and adaptability over time. Central to this approach is the utilization of an upgradeable proxy, with a specific emphasis on the 'Diamon Proxy' architecture.

The 'Diamond Proxy' is a modular and extensible framework in smart contract development. It allows the addition, replacement, or removal of specific components or facets of the protocol without disrupting its core functionality.

The facets are implemented in the diamond as follows:

» `OwnershipFacet`: Manages ownership and control of the protocol.
» `AccessControlFacet`: Manages roles and features for access control.
» `LenderFacet`: Handles lender onchain attributes.
» `PoolManagerFacet`: Handles pool manager onchain attributes.
» `CreditPoolFacet`: Handles credit pool onchain attributes.
» `PaymentFacet`: Manages payment information.
» `VaultFacet`: Safeguards and manages asset storage and transactions.
» `MetadataFacet`: Provides essential protocol information.
» `DiamondCutFacet`: Enables seamless upgradeability.
» `DiamondLoupeFacet`: Offers insights into Diamond statistics.

3.2.2 Flow of funds

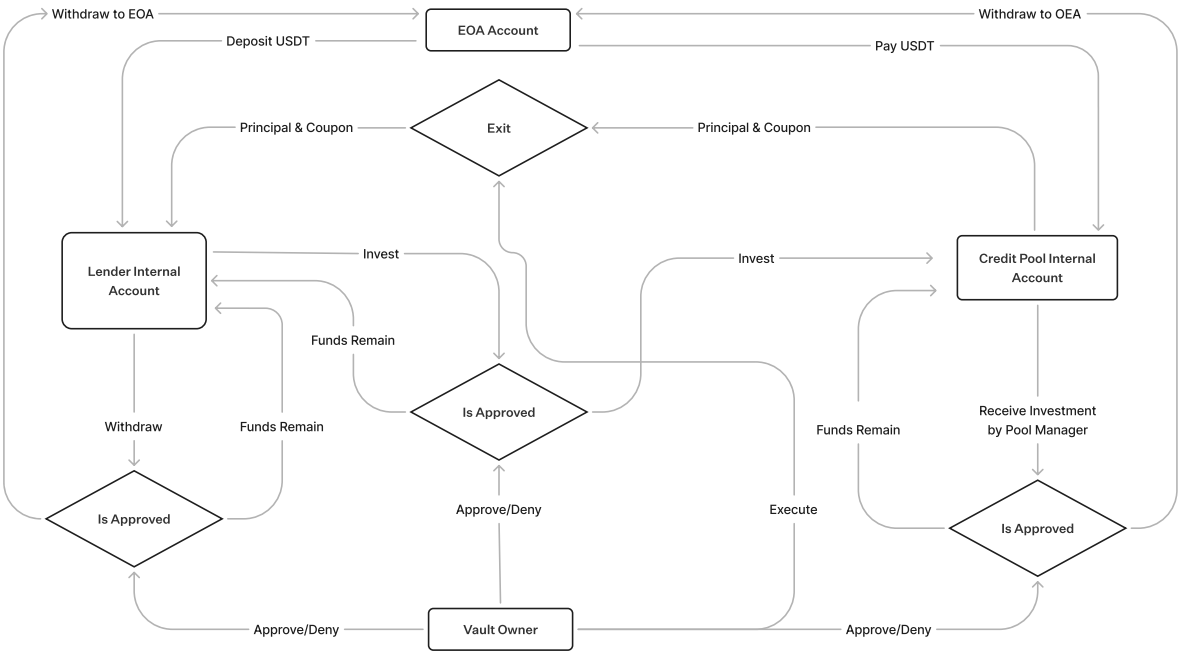

Figure 4: Flow of funds in the cSigma Protocol

» **Deposit:** Lenders inititate deposits in USDT or USDC from their EOA (Externally Owned Account) into their internal account within the platform.
» **Invest:** Lenders then invest these deposited stablecoin funds from their internal account into the internal account of their chosen credit pool.
» **Receive Investment:** The Pool Manager subsequently receives or withdraws the stablecoin funds from their credit pool's internal account into their own EOA.
» **Pay:** In managing the credit pool, the pool manager may pay or return stablecoins from their EOA to the credit pool's internal account.
» **Exit:** Upon completing the lending cycle, administrators settle stablecoin funds from the credit pool's internal account back to the lender's internal accounts within the platform.
» **Withdraw:** Finally, lenders have the option to withdraw stablecoin funds from their internal account to their own external EOA as needed.

3.4 Hybrid Data Handling

The cSigma Protocol's Hybrid Data Handling architecture is designed to combine the advantages of on-chain and off-chain storage. The protocol ensures user privacy while promoting trust in the system through transparency via its data handling mechanism. This means that some data is stored on the blockchain and IPFS, while other data is stored in an encrypted cloud.

3.4.1 Data Storage Strategies

» **Private Data:** Private data, such as personal identifiable information (PII), is stored in the encrypted cloud. This data is not accessible to the public. The cSigma Protocol uses an encrypted cloud storage provider, such as Amazon Web Services (AWS) to store private data.
» **Public Data:** Public data, such as financial transactions, is stored both on-chain and in IPFS. On-chain storage is expensive and inflexible, but it provides a high degree of security. IPFS is a decentralized file storage system that allows for immutable data storage. This means that data stored in IPFS cannot be modified or deleted.

3.4.2 Data Storage Architecture

» **On-chain Data:** On-chain storage is utilized for public data, which needs to be fully transparent and immutable. However, on-chain storage comes with certain drawbacks such as high cost and inflexibility. To mitigate these limitations, the cSigma Protocol selectively stores only specific and essential data models on-chain, including:
  - Country, KYB, onboard date, user's wallet address
  - Borrowing amount, inception time, credit ratings, expiry time of pool
  - Payment types and payment history
  - Vault balance
» **JSON Storage on IPFS:** The cSigma Protocol uses the InterPlanetary File System (IPFS) to store certain public data because it is more flexible and scalable than on-chain storage. IPFS offers flexibility and a degree of immutability, making it suitable for storing non-sensitive data.

  When a data model is stored in IPFS, its contents are hashed, and the hash is stored on-chain. Users can verify that the JSON content has not been altered by ashing the JSON and comparing the resultant hash with the IPFS hash.

  cSigma stores on IPFS some of the data models such as accrued interest, last KYB check, invested principal, and subscribed amount.
» **cSigma Private Database:** Everything other than the on-chain data and IPFS data is stored in the cSigma Private Database. The data is encrypted at both rest and during transmission, ensuring unauthorized users cannot access it.

3.4.3 User Privacy and Transparency

» **Encryption and Cloud Storage:** Private data, which is sensitive and must remain inaccessible to the public, is stored in encrypted cloud storage. This ensures that no private data is available to any unauthorized individuals or entities. The use of encryption techniques provides an additional layer of security.
» **Immutable and Verifiable Data:** To maintain transparency and trust, the cSigma Protocol ensures that public data remains immutable and verifiable. The JSON contents stored on IPFS are hashed, and the has value is stored on the blockchain. This enables users to verify that the JSON data has not been modified by comparing the on-chain hash with the hash of the JSON content.

3.4.4 Advantages of Hybrid Data Storage

» **Enhanced Privacy:** By storing sensitive data in encrypted cloud storage, the cSigma Protocol ensures that private information remains confidential and inaccessible to unauthorized parties.
» Cost and Flexibility: Utilizing a hybrid approach allows the cSigma Protocol to leverage the benefits of both on-chain and off-chain storage mechanisms. On-chain storage is used sparingly for public data, reducing costs and ensuring immutability. Off-chain storage on IPFS provides flexibility and scalability.
» Verifiable Data Integrity: By storing hashed content on the blockchain, the cSigma Protocol enables users to verify the integrity of public data. This trust-building feature ensures that the system remains transparent and reliable.
» Scalability and Security: IPFS is a scalable, secure and flexible data storage solution. This allows the cSigma Protocol to handle large amounts of public data which are encrypted and cannot be modified or deleted.

In summary, the cSigma Protocol's approach to data handling embraces a hybrid paradigm, prioritizing user privacy, transparency, and data integrity. Through careful integration of on-chain and off-chain storage, users can trust the system's immutability while maintaining confidence in the privacy and security of their data.

4. Governance

The cSigma Protocol embraces community-driven governance through a robust DAO. Initially, cSigma oversees the DAO's functions via a multi-signature wallet, ensuring a seamless transition. This DAO carries significant responsibilities, including smart contract updates for adaptability, token approval to diversify assets, parameter configuration for optimal performance, and credit service provider management. It also handles reward distribution, intervenes in emergencies and compliance matters, and maintains a kill switch for extreme situations. This approach transparency, security, and long-term ecosystem success.

Version 2 of the Protocol

Version 2 of the cSigma Protocol marks a significant milestone with the introduction of the cSigma Utility Token (SIGMA) within the DAO governance framework. This new token, held by many stakeholders, wields the power to make critical decisions that shape the protocol's trajectory. These decisions encompass crucial elements including admitting new borrowers, configuring fees, defining first-loss provisions, selecting service providers, and endorsing fresh stablecoin currencies on the platform.

The cSigma Utility Token enhances community involvement and influence, solidifying the protocol's commitment to decentralized, community-driven governance. This flexible governance structure allows tokenholders to adapt token requirements and incentives as the platform evolves.

5. Lending Process and Capital Flow

The cSigma Protocol embraces community-driven governance through a robust DAO. Initially, cSigma oversees the DAO's functions via a multi-signature wallet, ensuring a seamless transition. This DAO carries significant responsibilities, including smart contract updates for adaptability, token approval to diversify assets, parameter configuration for optimal performance, and credit service provider management. It also handles reward distribution, intervenes in emergencies and compliance matters, and maintains a kill switch for extreme situations. This approach transparency, security, and long-term ecosystem success.

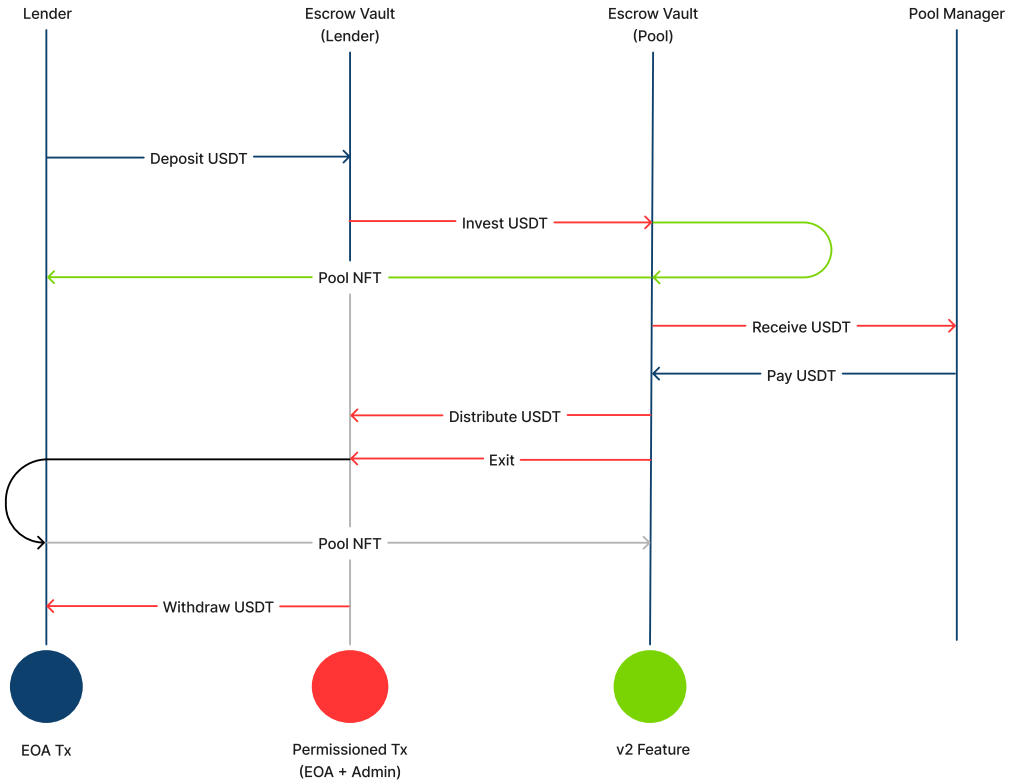

Figure 5: Lending process and capital of the cSigma Protocol

5.1 Yield Management

5.1.1 APR Setting Mechanism

The cSigma Protocol employs a systematic approach to determine Annual Percentage Rates (APR), ensuring fairness, transparency, and alignment with risk management practices.

The APR suggested by the protocol is a combination of prevailing yields for similar quality debt and country, counterparty, and illiquidity premiums suitable for the credit pool. This APR setting mechanism involves the following key steps:

- **Credit Quality Analysis:** cSigma decentralizes the credit quality analysis, where multiple credit experts can take the same raw data (loan book, financials, etc.) provided by the Pool Manager and rate the credit pool from CCC to AA credit quality, using rating industry standards and their established rating analysis process which needs to be transparent in the protocol. Regardless of the industry or type of credit, each pool should be rated on the same credit quality scale (CCC to AAA) that is widely understood and accepted.
- **Market Conditions:** The protocol constantly updates the data points about prevailing debt market conditions such

as U.S. treasury yields, yields of publicly traded corborate debt, yield spreads between credit quality ratings, etc. The protocol overlays marker conditions on the credit quality to calculate the APR.

» **Prevailing Risk Premiums:** Each borrower is levied a different country risk premium based on its country of operations and different counterparty risk premiums based on the size of the borrower, track record of the lending business, and regulatory framework of the operations. Risk premiums are added to calculate the total suggested APR by the protocol.

The Pool Manager can set an APR within 15% of the one suggested by the protocol, for example, if the suggested APR is 10%, the Pool Manager can set the pool APR between 8.5% and 11.5%. By adhering to this APR setting mechanism, the cSigma Protocol maintains a balanced approach to interest rates, promoting fairness and predictability within the lending ecosystem while accomodating international variations in lending practices.

5.1.2 Loan Traces and Yield Distribution

In later versions of the cSigma Protocol, each loan pool will issue two distinct types of Pool Tokens, categorized as Senior and Junior. These tokens represent varying levels of risk and return for participants. Specifically:

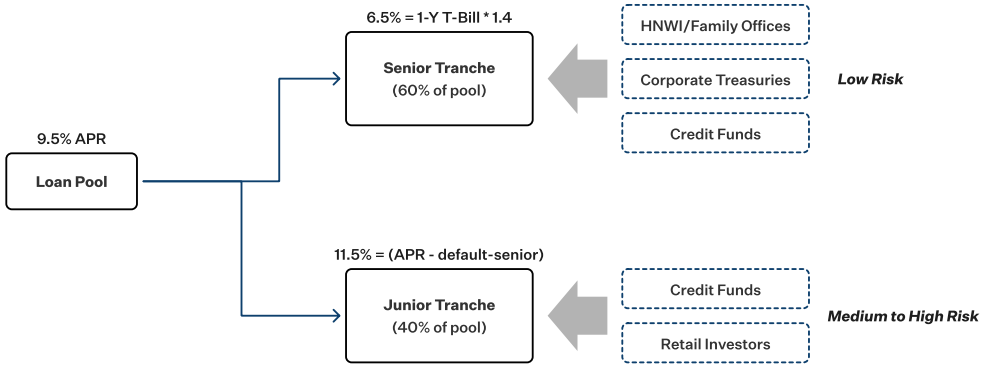

Figure 6: Loan Traces and Yield Distribution of the cSigma Protocol

» **Senior Tranche:** Approximately 40% to 50% of the total capital constitutes the Senior Tranche. This tranche offers a yield that closely mirrors the prevailing yield of "A" rated assets. This blend ensures a competitive return for participants in this tranche.

» **Junior Tranche:** The remaining capital and yield, net of possible default loss, belongs to the Junior Tranche. The protocol places significant confidence in the credit quality associated with the junior tranches, considering the presence of first-loss capital. Junior tranche holders realize a yield that is comparable to lower credit quality yield in the market without necessarily taking similar default risk.

Yield Distribution

» The Junior Tranche receives the remainder of the yield generated by the loan pool monthly. This distribution mechanism promotes regular and predictable income stream for participants in this tranche.

» In the unfortunate event of a loan default, the first loss is absorbed firstly by the Pool Manager's first loss capital and subsequently by the Junior Tranche. If the recovered loan amount falls short of covering both the first loss and the Junior Tranche, the Senior Tranche assumes the net loss.

This structured approach to loan tranches and yield management ensures a balanced risk-reward profile for participants within the cSigma Protocol. It empowers users to make informed investments while promoting resilience and stability within the lending ecosystem.

5.1.3 Collection and Distribution

The cSigma Protocol facilitates a streamlined process for the collection and distribution of interest payments, ensuring efficiency and fairness for all participants. This process encompasses the key elements discussed below.

5.1.4 Transparency

Transparency is at the core of the cSigma Protocol, ensuring that participants have access to comprehensive yield information and fostering collaborative yield management. This commitment to transparency empowers capital providers or Lenders to actively participate in refining yield management strategies. cSigma achieves this by making all yield information available at the individual loan level through the Lender dashboard. This emphasis on transparency and collaborative yield management underscores cSigma's dedication to creating a lending ecosystem that is not only secure and efficient but also responsive to the needs and insights of its community. It fosters a sense of ownership and participation among all stakeholders, ultimately benefiting the entire ecosystem.

5.1.5 Default and Recovery

The cSigma Protocol operates with a robust default and recovery system to maintain the integrity of its lending ecosystem. Each borrower is expected to pledge significant first-loss capital that is maintained in a highly liquid form in the balance sheet and covers the vast majority of the losses. cSigma signs up escrow and debt recovery service providers to recover the due balance should there be an event of default. This specialist entity focuses on recovering both principal and outstanding balances, ensuring an efficient and effective fund retrieval process. This meticulous approach demonstrates cSigma's commitment to risk mitigation and participant protection while preserving ecosystem health.

5.2 Risk Management and Monitoring

At cSigma, trust from Lenders is paramount, and it's achieved through a comprehensive risk management and monitoring framework. Pool Managers oversee the unique risks associated with individual loans, while the cSigma Protocol takes on the responsibility of monitoring macro-level risks. This ensures that credit pools consistenly operate within predetermined credit boundaries. This dual approach underscores cSigma's commitment to maintaining a secure and reliable lending ecosystem, instilling confidence among its valued Lenders.

5.2.1 Risk Management

At cSigma, risk management serves as a critical pillar with three core objectives. Firstly, it establishes a standarized framework to meticulously capture the nuances of the Pool Managers' lending processes. Secondly, it rigorously evaluates macro-level risks within loan pools and promptly notifies both lenders and pool managers, fostering a proactive risk mitigation approach. Lastly, it delineates the risk boundaries essential for the seamless operation of the Credit Pools. This multifaceted approach to risk management underscores cSigma's commitment to maintaining a secure and efficient lending ecosystem, providing confidence to all stakeholders.

Over time, the insights generated by the Risk Management module become integral to lenders' portfolio construction. This optimization process maximizes yields while adjusting for default probabilities through the following formula:

$$w_1(y_1 - p_1) + w_2(y_2 - p_2)$$

Here, *'y'* is the target yield of the credit pool, and *'p'* signifies the weight of default probability. Furthermore, risk management ensures that the credit pool's risk-adjusted yields remain competitive with yields from risk-free sovereign debt, providing attractive returns for participants.

5.2.2 Pool Manager Due Diligence

cSigma takes substantial strides in fostering transparency within its lending ecosystem, an essential factor in building trust among participants.

cSigma and its service providers vet the borrowers on multiple dimensions: (a) tenure and track record of their loan book funded by the cSigma lender network, (b) quarterly detailed financials of the borrower to validate their strength compared to credit pool size, (c) keep track of the borrower's business to ensure that they have undisputed business practices, (d) only high quality borrowers with a strong balance sheet, established track record, and operating in a jurisdiction with well developed legal and regulatory frameworks for credit management, etc.

The cSigma Protocol places specific requirements on Pool Managers to share in-depth insights into their Underwriting System. This encompasses the divulgence of factors utilized in the Underwriting (UW) model and the determination of relative importance assigned to each factor in arriving at the net UW score, among other critical components. Moreover, Pool Managers are encouraged to showcase the real-world effectiveness of their UW models through holdout data samples, providing tangible evidence of their model's reliability.

cSigma actively supports Pool Managers in this endeavor by providing interfaces for the exposure of UW and pricing framework details, underscoring its commitment to accountability and equitable lending practices.

Data Pipe: Each Pool Manager is required to implement a data pipe through which it can send loan data almost daily or at least weekly, and financials at least once a month. The Protocol's access to the raw borrower data at much higher frequency enables superior risk management enforced by multiple decentralized processes.

5.2.3 Credit Pool Quality

cSigma only allows credit assets that can be systematically analyzed by the Data and Machine Learning services without any human biases. cSigma Protocol's design the outline of the credit quality framework and third party service providers are welcome to implement the services that consume the borrower data and and give a credit rating quality.

Currently, every credit asset on the platform should be rated on a scale from CCC to AA (highest rating possible) based on the default likelihood and datasets of the borrowers, industry, and the loan product being funded. The graded credit quality should be comparable to publicly traded credit, giving lenders the ability to compare and decide. Third-party service providers who provide credit quality analysis should expose their methodology and underlying data transparently on the platform.

The protocol's aim is to build decentralized credit rating infrastructure on blockchain optimized for private credit that can potentially rival established industry rating companies. Credit rating by multiple experts within the protocol's ecosystem will increase credit assessment robustness and yield stability.

Optimal First Loss Capital: Each borrower is required to pledge the first loss capital that covers the vast majority (over 99.5%) of potential losses based on the historical information. Higher first loss capital will improve the overall credit quality of the pool, attracting more lenders and cheaper capital. The borrower is required to maintain the first loss capital in highly liquid near-cash assets.

5.2.4 Pricing the Credit Pool

The cSigma Protocol introduces a scientific framework to price the credit pool based on the prevailing market conditions and the underlying credit quality of the credit pool. A very high-level outline of the credit pricing framework is as below:

$$SY = PY + CRP_1 + CRP_2 + IP + O$$

Where,
SY = Suggested yield
PY = Prevailing yield of similar credit quality of publicly traded corporate debt
CRP_1 = Counterparty risk premium
CRP_2 = Country risk premium
IP = Illiquid premium
O = Other idiosyncratic risk premium

The protocol will onboard multiple third-party credit pricing experts on the platform with their own methodology and datasets, made transparent, and make the necessary data available in a privacy-protected fashion. The protocol accumulates multiple prices from decentralized parties and presents the range, median, and average to lenders to make an optimal decision.

5.2.4 Risk Boundaries of the Loan Pool

In a collaborative effort between cSigma and Pool Managers, the risk boundaries of the loan pool are defined, serving as a foundational framework for approving individual loans. These risk boundaries rely on six critical parameters:

- Mapping of Underwriting (UW) scores to distinct credit quality tiers and setting a minimum credit quality threshold for loans.
- Percentage exposure to individual loans within the pool, ensuring prudent risk distribution.
- Calculating the weighted default risk, emphasizing the collective risk agreement.
- Establishing minimum pricing benchmarks for various credit tiers, including CCC, BBB, and BB, ensuring consistency in pricing.
- Assessing the duration risk, accounting for variations in loan durations.
- Calculating the total weighted duration of loans using the formula $W_1D_1 + W_2D_2 + \ldots$, where W represents the loan weight and D signifies the loan duration.

This comprehensive approach ensures the precision and alignment of risk boundaries, ultimately contributing to the prudent management of the loan pool and the equitable setting of APRs for the benefit of all participants.

Borrowers in the growth stage may not have the entire institutional-grade risk management proposed by the protocol, but will evolve to realize it over time.

5.2.5 Risk Monitoring

cSigma's Risk Monitoring system is multifaceted, data/ML-driven, and designed to serve several key objectives. It keeps a watchful eye on macroeconomic conditions, assessing their impact on credit pool. This allows cSigma to adapt to changing economic landscapes, maintaining the ecosystem's resilience. Furthermore, it provides transparency into shifting credit risks within credit pools, empowering stakeholders to make informed decisions about loan renewals. The cSigma Protocol relies heavily on systematic monitoring to reduce errors and biases.

The system ensures that newly issued loans adhere to agred credit boundaries, upholding lending quality. It also computes the aggregate risk profile of loan pools weekly, considering factors such as default risk, duration, target yield, and credit

quality. This data-driven approach enhances risk assessment and management, contributing to the platform's overall stability.

Risk Monitoring captures essential metrics for each newly approved loan, such as UW scores, credit quality tranches, APRs, and origination fees. These metrics remain dynamic as loans are approved, ensuring the credit pool's risk profile remains current. The system actively monitors macro and beta risks while Pool Managers evaluate idiosyncratic borrower-specific risks.

Covenant Monitoring: The protocol expects that loan agreements between the Pool Manager and the lender will have defined covenants that monitor defaults, financial health of the borrower, and the liquidity of the borrower. Once the Pool Manager registers those covenants with the protocol at the time of setting up the credit pool, the protocol and its third-party partners monitor and enforce those covenants.

The end objective of Risk Monitoring is to relieve lenders from the burdensome and costly activity of private credit investing, and to improve robustness and reduce credit losses.

5.3 Protocol Global Parameters

The cSigma Protocol implements a flexible fee structure that is subject to adjustments through DAO voting. These fees are designed to maintain the efficiency and fairness of the lending process.

These fee structures and parameters are subject to governance by the DAO, allowing for adaptability and alignment with the evolving needs of the lending ecosystem.

6. Roadmap

The cSigma Protocol follows a strategic roadmap to continuously enhance its capabilities and cater to the evolving needs of the lending and borrowing ecosystem. In this journey, the protocol has transitioned from its initial Version 1, to a more robust and feature-rich Version 2, introducing the cSigma Utility Token. Looking ahead, Version 3 is on the horizon, bringing forth integrations with ZK-proof identity layers, medium-duation credit pools, staking of the cSigma Utility Token, and a decentralized validation system. This roadmap reflects the protocol's commitment to innovation, decentralization, and ensuring a vibrant and transparent lending ecosystem for all participants.

Version 1 Overview

cSigma unites global borrowers and lenders, simplifying lending with transparency. It standarizes processes, empowering credit providers and pool sponsors. The protocol generates crypto-uncorrelated yields in stablecoins, focusing on wholesale debt where pool managers act as intermediaries borrowing from lenders and lending to SMBs in well-defined credit products (such as invoice factoring, cash advances, etc.). In Version 1, a DAO logic is employed via a multi-sig wallet.

Version 2 Overview

In this evolution, the cSigma Protocol unveils significant advancements. Lenders now receive position receipts, representing their stakes in pools. These positions can be traded among KYB-verified lenders. Automated portfolio construction simplifies lending choices. The protocol now supports multiple stablecoins and is decentralizing core services. The introduction of the cSigma Utility Token brings greater decentralization, and a DAO Governance system that empowers the community. The protocol embraces DAO governance for community-driven decision-making. These advancements collectively foster a more dynamic, versatile, and inclusing lending ecosystem.

Version 3 Overview

The protocol integrates with ZK-proof identity layers, facilitating robust KYB with identity credentials. It supports medium-term credit pools, offers staking rewards for cSigma tokenholders, introduces protocol validators for decentralized fund movement approvals, and enhances the protocol's resilience and versatility. These developments represent a commitment to innovation, security, and decentralization in cSigma's lending ecosystem.

6.1 Product Roadmap Timeline

2023

- Launch of cSigma Platform for fiat and stablecoin lenders on Ethereum
- Onboarding on Institutional Borrowers and Lenders
- Streamline standardized loan agreements and KYC/KYB processes
- Establish strategic investor and partner relationships

2024

- cSigma governance token launch
- cSigma DAO creation
- Launch on other Layer 1 networks (Algorand, XRP, BSC)
- Facilitate trading of tokenized debt positions within app
- Simplified AI/ML portfolio creation and management for lenders

2025

- Integrate ZK Proofs into cSigma Identity Registry
- Launch on Solana
- Implement cSigma token staking mechanism
- Integrate additional assets for lending (ETH, BTC, etc.)
- Integrate AI/ML pool creation for pool managers

7. Summary

The cSigma Protocol is a promising new platform that could revolutionize the way lending and borrowing is done on the blockchain. It offers several advantages over traditional lending platforms, including increased transparency and efficiency, reduced risk, and increased access to capital. The protocol is still in its early stages of development, but it aims to become a major player in the decentralized finance (DeFi) space across all of Layer 1, bringing the highest risk-adjusted yields to asset holders.

Here are some of the key takeaways from the cSigma Protocol:

- The protocol is built on the Ethereum blockchain and uses smart contracts to facilitate the lending and borrowing process.
- cSigma is positioning itself as a hybrid platform that utilizes the best of traditional and decentralized technologies. This strategy allows cSigma to democratize lending—making it transparent, accessible, and open to a wider range of participants.
- The protocol is governed by a DAO, which is made up of all the participants in the protocol.

Here are some of the potential benefits of the cSigma Protocol:

- **Borrowers:** Access to capital from a wider range of investors, including those who may not be able to obtain loans from traditional banks or face unsustainable APRs.
- **Lenders:** Higher yields on capital through investment in carefully vetted and managed loan pools.
- **Market Efficiency:** Improved lending market accessibility and efficiency for all participants.