HFC Platform project

White Paper Frameworks

HFC COIN

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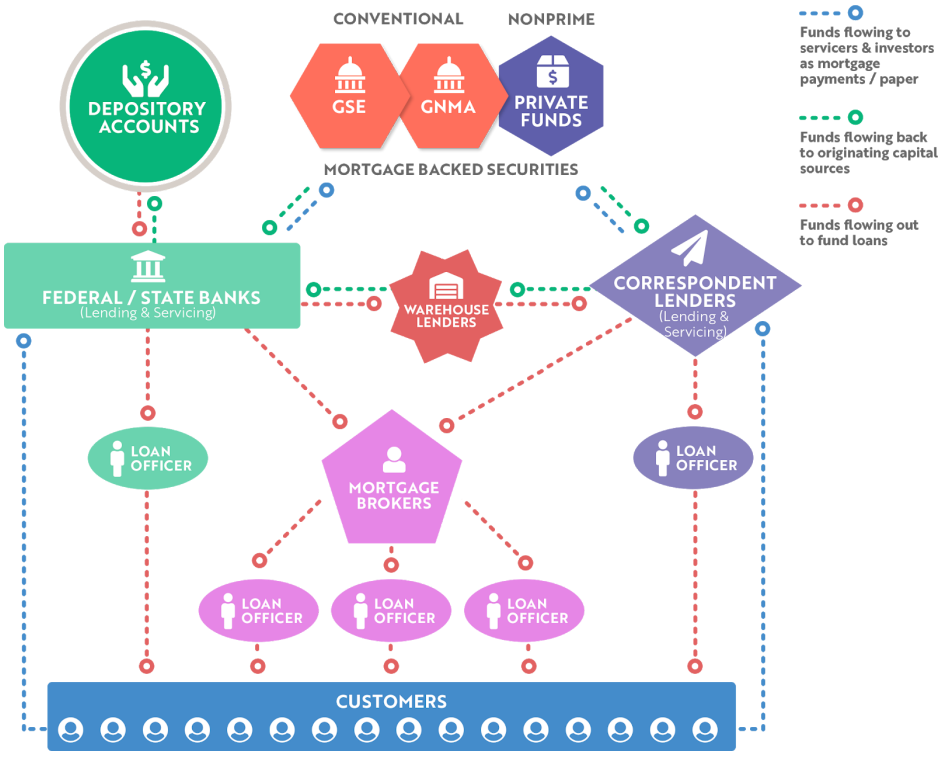
HFC Blockchain Platform Overview

Purpose and Key Markets

The HFC blockchain and artificial intelligence platform is a tokenization solution designed to reduce the costs and inefficiencies of the mortgage process while providing transparency and innovation in Mortgage Backed Securities (MBS). The financial crisis of 2008 revealed major flaws in the mortgage industry. The HFC blockchain platform will bring trust, transparency and profitability to all stakeholders in the mortgage process through the tokenizing and collateralizing of mortgages using artificial intelligence and blockchain technology.

Figure 1. Structure of mortgage lending in traditional economy



The mortgage industry is plagued by various issues:

- Regulation - more than ten Federal agencies oversee the industry leading to higher costs to comply with their requirements. These expenses are passed over to customers.
- Unnecessary intermediaries - a typical retail mortgage will be touched by over 11 different people from origination to closing.
- Illegible contracts with vague descriptions of rights and ownership transfer limitations.
- Slow decision-making.
- Exorbitant fees and charges.

Other organizations and institutions have begun to address these challenges. However, they are hindered from being truly innovative because of legacy costs associated with the retail mortgage process which consists of brick and mortar branches and human resources. Also, the MBS markets are currently outside of their scope.

The HFC platform will eliminate such legacy costs by creating the AI Loan Officer. As a result, the savings will be passed on to customers and investors, increasing market share and driving value for HFC Coin owners.

Derivatives are pure abstractions of financial assets in risk-based economy and one of the most complex financial products that are combining high-risk mortgages with low-risk mortgages to mitigate losses and increase returns on investment. But decisions are made without notifying mortgage holders or properly transferring ownership.

Decomposition of mortgage backed securities is a complex process with obligations that require the agreement of numerous stakeholders. Another issue is that those derivatives are not widely available through traditional investment methods such as stock exchanges. This effectively prohibits the average investor from participating in mortgage backed securities markets.

The mortgage industry can be transformed by digital tools that uphold the rights of all the stakeholders in the mortgage process: the lender, the investors and the customer. The HFC platform will deploy an artificial intelligence and blockchain solution to introduce

transparency to the MBS market with the appropriate level of confidentiality and privacy.

With advanced cryptography to protect privacy, blockchain enables a complete and verifiable history of events related to the creation and transfer of any security or asset with a dedicated token. To ensure public access to the mortgage market and to remain compliant with KYC/AML regulations the HFC platform uses a combination of public and consortium Ethereum blockchains. This hybrid model allows for the complete digitalization of the Mortgage Backed Securities market.

The key goals of the HFC blockchain platform for the customers are:

- Reduce the costs associated with mortgage lending and pass the cost savings on to customers
- Create the fastest and most efficient mortgage application process for consumers
- Provide traceability and transparency for Customers as their mortgages transfer into the Secondary / Mortgage Backed Securities market
- Respect the rights of mortgage customers while their mortgages are collateralized with other mortgages in a Mortgage Backed Security

Together with that HFC goals for the Investors are:

- Open access to Mortgage Backed Securities markets for a wider investment community
- Decentralize Mortgage Backed Securities markets
- Ease the process of MBS decomposition and conventional mortgage creation
- Secure rights and enforce obligations of all stakeholders in the mortgage process
- Integrate out-of-exchanges market of derivatives into one secured, blockchain based platform

A critical element to achieving these goals is the tokenization of lending agreements. HFC will be the first comprehensive solution for tokenizing mortgages and performing business operations using smart contracts. The HFC platform will integrate both public and private Ethereum tokens.

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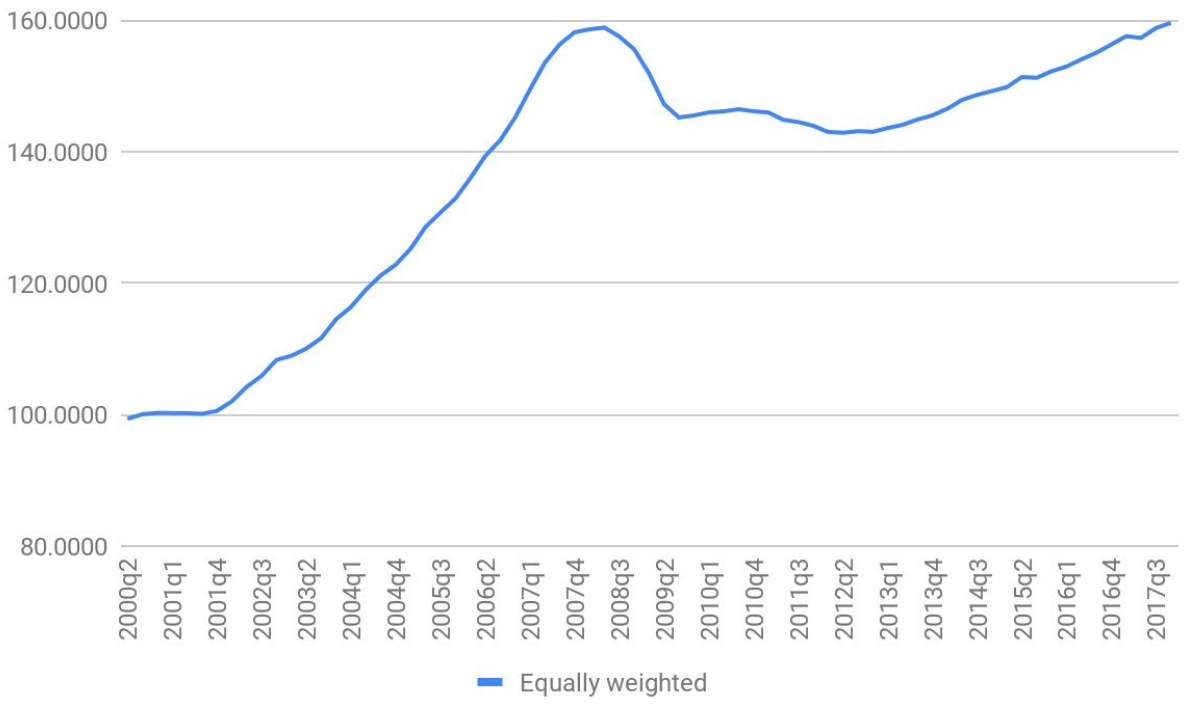
Market Analysis

The US is the largest mortgage market and is saturated with financial instruments. The HFC platform can help with the tokenization of new and existing derivatives in order to revitalize the market with blockchain technology through application of new technology tools.

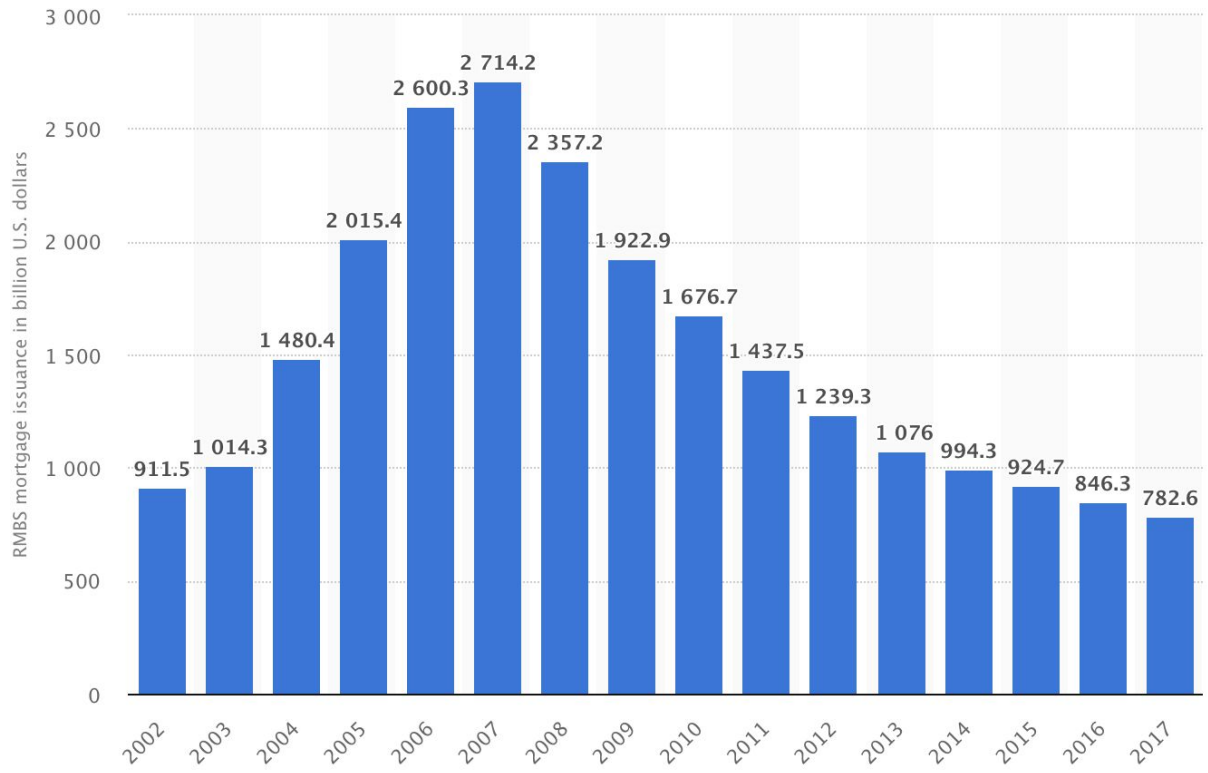
The global mortgage market is growing in value and the house price index is growing according to the International Monetary Fund.

Figure 2. Global House Price Index[1] dynamics



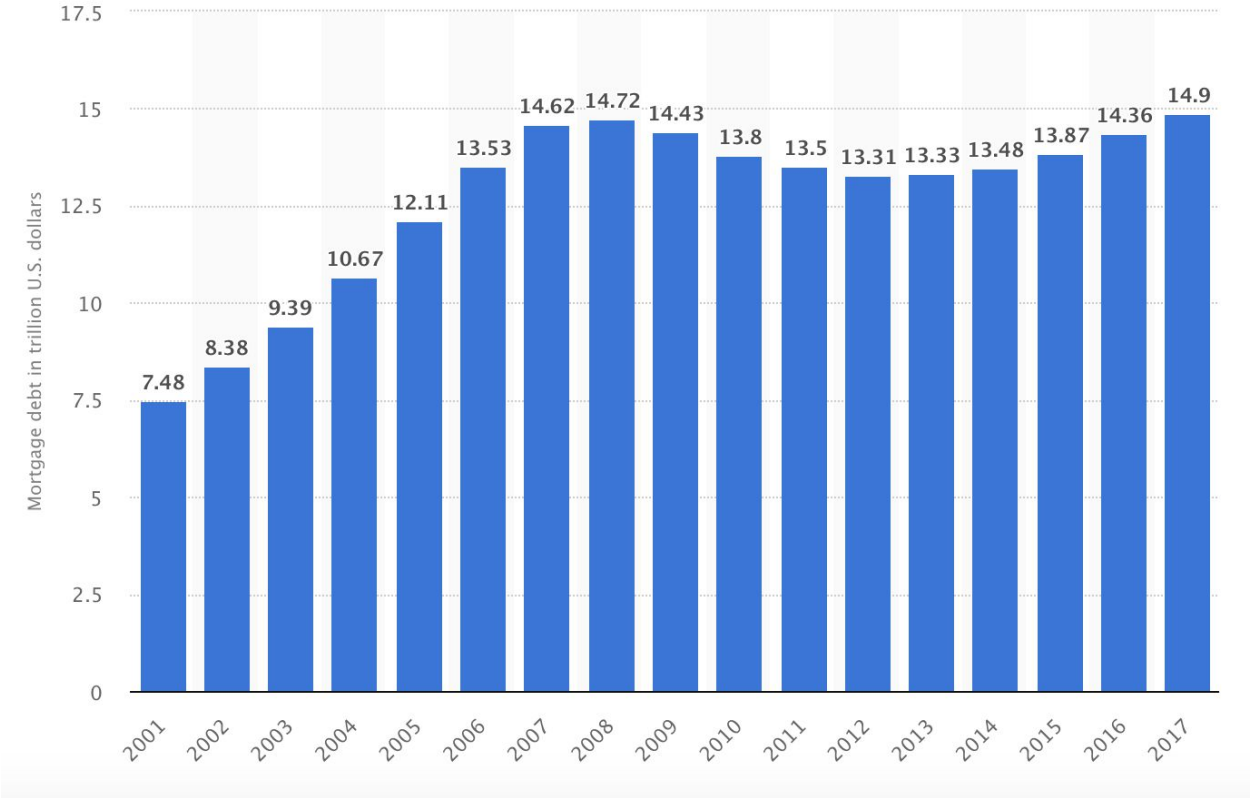
[1] Global House Price Index indicate real price changes on residential estate around the world in comparison to basic year and weighted on Purchasing Power Parity and nominal GDP growth in included to index countries.

Figure 3. Residential mortgage backed security issuance in the United States from 2002 to 2017 (in billion U.S. dollars)



In 2017, MBS totaled $782.6 bn. There is a reason for the decrease in value of MBS and it is a specter haunting the market. According to Bloomberg, more that 40% of newly issued MBS come from unaffiliated mortgage companies (UMC). This reveals a strong need for transparency and a solid rationale for HFC Coins.

Figure 4. Value of mortgage debt outstanding in the United States from 2001 to 2017 (in trillion U.S. dollars)



The total outstanding mortgage debt in 2017 was $14.9 trillion. Those debts are prolonged with CDOs.

Collateralized debt providers have up to $364 billion in revenue (according to IBIS statistics) with a projected growth of 5% annually till 2025. To prevent volatility, the supply of tokens should have inflation mechanisms.

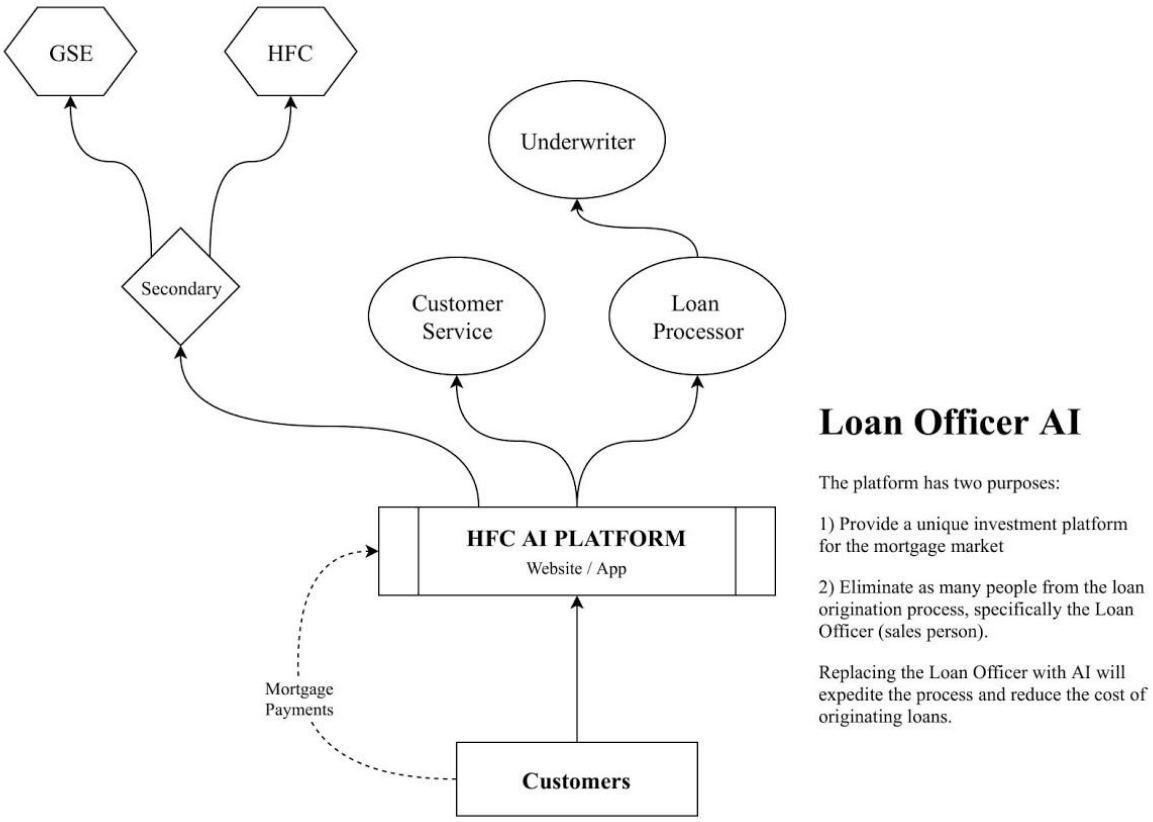
Business Model

The HFC blockchain platform is a comprehensive system based on a hybrid model of public and consortium blockchains and off-chain

non-distributed systems. The hybrid platform will automate financial operations related to mortgages for customers, investors, institutions and the lender..

The main objective of the platform is to establish simple communication and operation channels for all stakeholders with minimal transactional costs. The system relies on a web-based point of entry accompanied with an AI Loan Officer and enhanced with machine learning for scoring.

Figure 5. HFC off-chain AI/ML system place in business model



HFC off-chain elements will include web and application interfaces to provide a single point of entrance for Customers. At this stage the AI Loan Officer and Machine Learning software is used to simplify the creation of agreements, scoring of customers, prediction of applicable mortgage products and prediction of required documentation. This will

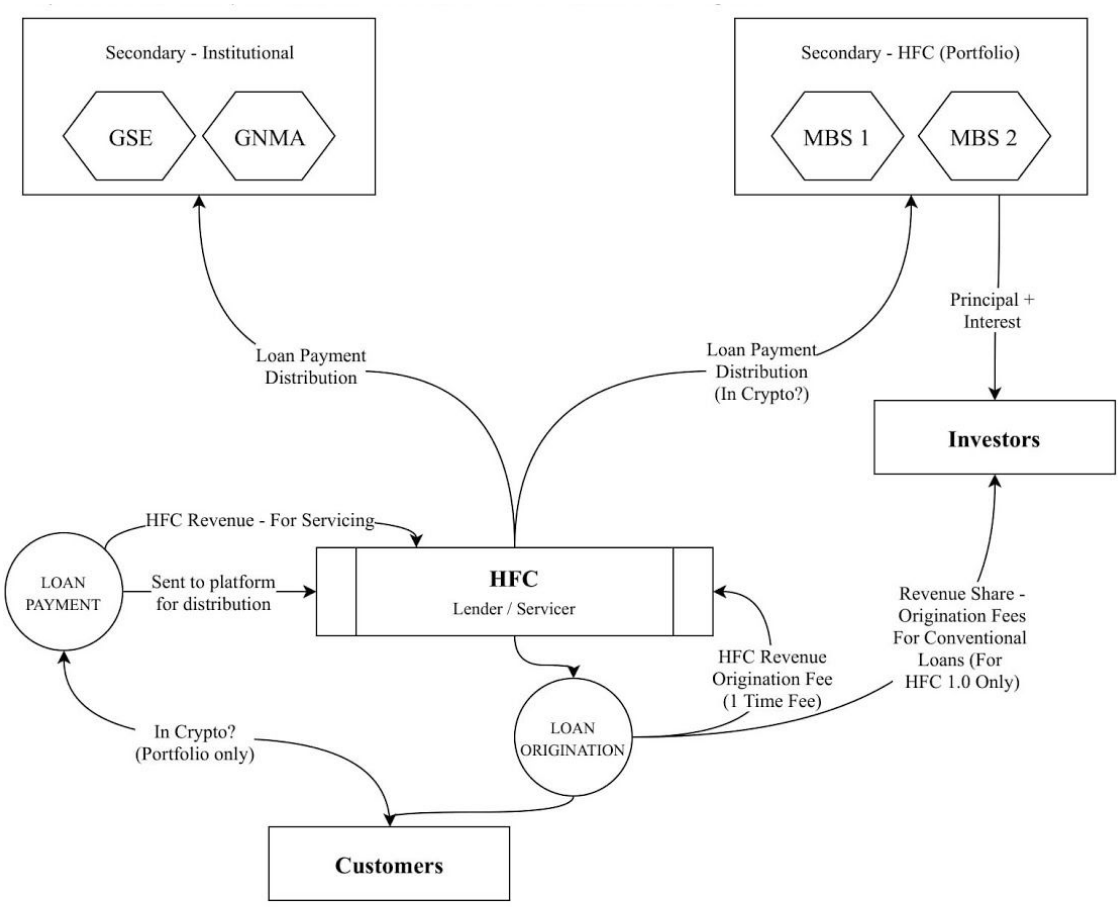
reduce mortgage pre-approval time to only a few minutes and provide key data required for the future tokenization of mortgages. The data is also used for customer support services as well as loan processing and underwriting.

After a mortgage is closed, HFC receives revenue from the origination and servicing of mortgages. Regardless of the type and destination of the mortgage (conventional, GSE, portfolio, etc.), the mortgage is tokenized.. To provide transparency, traceability and security to this process, the HFC platform relies on a hybrid system of public and consortium chains.

As customers close a new mortrgage, HFC will receive a one-time fee called an origination fee. All HFC Coin's Holders will receive a reward (in crypto or fiat) from every mortgage originated on the HFC platform, regardless of the type and secondary destination of the mortgage.

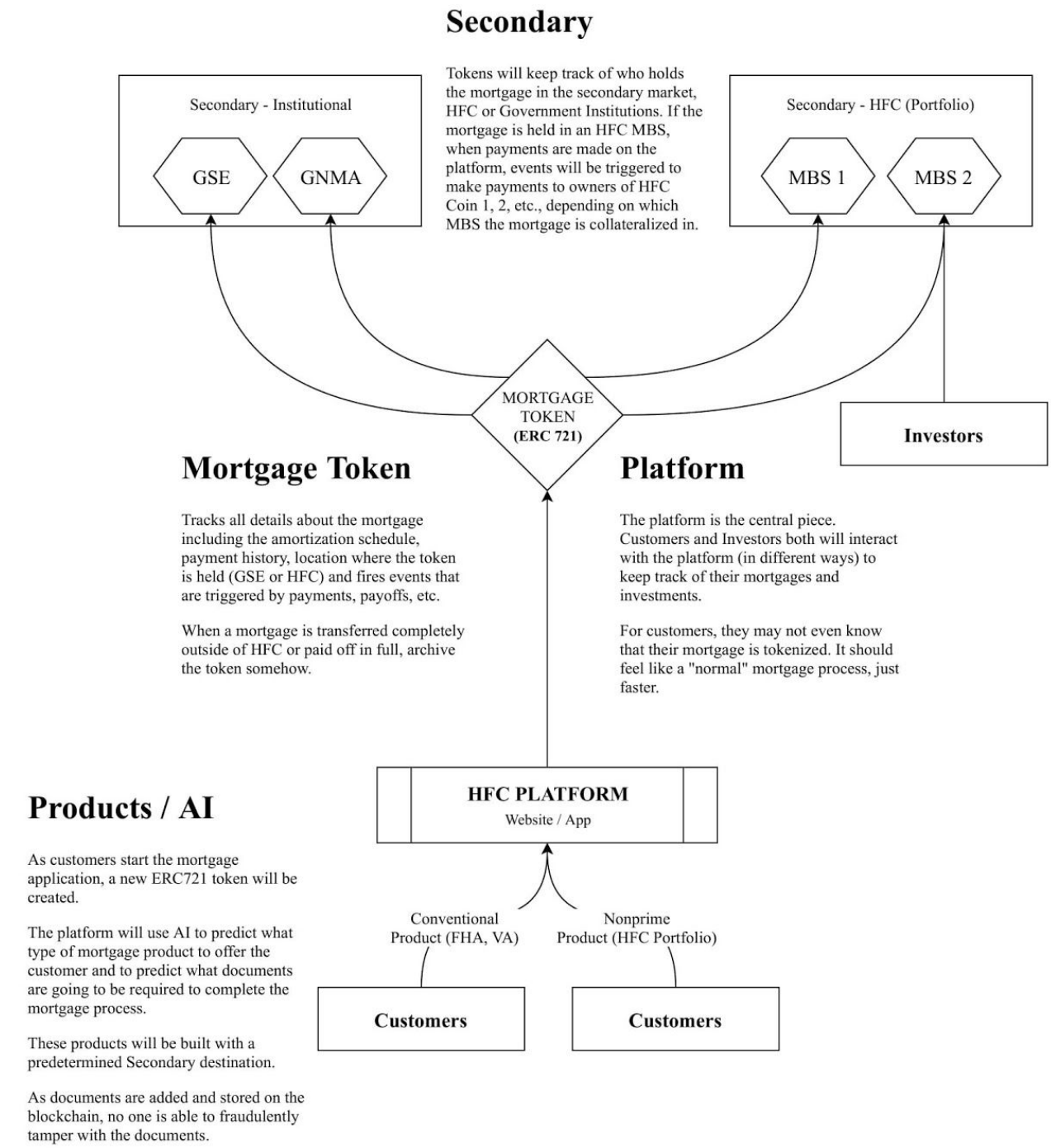
As customers make monthly payments on mortgages , HFC will generate revenue through servicing fees. Servicing fees are applied to all mortgages, regardless of where they are held in the secondary markets. Payments are automatically distributed to investors in the secondary markets including investors on the HFC platform.

Figure 6. HFC platform blockchain-based system place in business revenue stream



HFC as the Lender/Servicer in this process is using its blockchain platform to provide trust in the process of mortgage provisioning, investing, return distribution and government control. To facilitate this, HFC relies on two major types of tokens to store the required data in the blockchain platform.

Figure 7. HFC Platform token flow place in business processes



Consortium chain does not allow direct communication with Ethereum Mainnet and does not allow distribution of sidechain tokens through public exchanges. To ensure market penetration and ease of access for investors, HFC Coin on public Ethereum Mainnet will be used as an entry point to the platform and a key public asset. With this approach, HFC relies on its token flow process consisting of public token balances and cross-balances transactions inside consortium chain.

Figure 8. Token flow process of public and consortium based tokens

https://docs.google.com/presentation/d/16Sz5vyU1SsjZYR23qpqT5TBQSjuWcz1os3fuctrwb0k/edit#slide=id.g3db61a6a52_0_0

The entire token flow process consists of 2 elements: HFC Coin and sidechain tokens.

HFC Coin flow:

1. HFC Coins are available on public exchanges and must be purchased by investors to begin the investment process.
2. All invested HFC Coins are contributed to the HFC Smart Contract on Ethereum Mainnet.
3. HFC Coins are used to obtain fiat currency from public exchanges to source mortgages.
4. Sidechain tokens are used to activate blockchain system transactions to introduce transparency and trust in the MBS investment process.

Because HFC Coins allow investment in MBSs based on USD parity, the market price of HFC Coin is not limited by the potential amount of investments in MBSs.

To ensure this process, the HFC platform uses public Ethereum MainNet and Quorum for consortium chain with Proof-of-Stake consensus behind it.

Blockchain Architecture

Key Types of Roles

The HFC blockchain platform is a multi-stakeholder system dedicated to managing complex mortgage and derivatives related operations. In comparison to traditional financial markets, this solution avoids arbitration roles in the process with distributed and transparent technology. The platform does not fully eliminate arbitration roles, but transforms their responsibilities and obligations. Examples of these roles include loan processors, underwriters and compliance officers.

Platform roles are digital instances inside the platform and define permissions regarding operations with tokenized assets.

The key roles are:

- **Customer**

  The Customer is an individual applying for a real mortgage and a signed agreement that will be tokenized. The Customer begins the application process and the system starts building information to store in the blockchain while analyzing the Customer's inputs using the AI Loan Officer/ML to predict applicable mortgage products and required documents. When the Customer finishes the application, the system creates an ERC721 token that contains the mortgage object data. Customers only have access to mortgage agreements in which they are a party and have rights to their information.

  Once a mortgage is closed, the Customer can only make payments to the mortgage. The Customer will never need to directly interact with the ERC721 object that represents their mortgage. When a payment is made, the system automatically triggers the events for the ERC721 token.

- **Investor**

  The Investor uses HFC ERC20[2] in-platform tokens to invest in ERC721 tokens. The Investor receives tokens equal to their percentage of ownership in the collateralized ERC721 mortgages created by the platform. The Lender uses the funds invested by the Investor to fund mortgages. As mortgage payments are made to the Lender, a smart contract distributes principal and interest payments back to Investors that own a part of that particular mortgage.

  The Investor will have to use tokens (HFC Coin) to represent their stake in the collateralized mortgages. Investors will have to be on-boarded and whitelisted through KYC/AML compliance. Investors are able to buy or sell their stake in collateralized/conventional mortgages within the platform via fiat or crypto currencies. For this, investors have no need to deal with public exchanges, as the HFC arranges everything inside the platform.

  The Investor can inspect the underlying mortgages of a mortgage backed security (MBS) according to permissions to determine the risk associated with their stake in the MBS. The Investor can buy or sell their stake in each MBS.

- **Lender / Servicer / Platform provider**

  The lender is the HFC platform itself which gathers all the required documents for a mortgage. HFC will be a licensed lender in the regions where it operates and will be fully compliant with mortgage laws and regulations. Once a mortgage is approved and closed, the Lender sends the borrowed funds collected from Investors to the closing agency for distribution to third

[2] Those token will have a platform value according HFC economic consensus over it. To avoid issues with in-platform Gas fees that are used to protect the system from DDoS attacks and inconsistent smart contracts, consortium Ethereum (Quorum) native currency (Ether) is off-use and distributed to users freely to allow the creation of Gas fees for transactions. For this reason the platform has to launch ERC721 tokens and ERC20 tokens, with no value and used only for the protection of the system.

parties. After closing, the Lender services the mortgage, accepts mortgage payments from the Customer and distributes payments to Investors. The Lender is a consortium of all arbitration parties that are part of the Lender's process for generating a mortgage e.g. loan officers, account executives, loan processors, underwriters, compliance officers, etc.

If the Customer defaults on the mortgage, the Lender will foreclose and will then own the property attached to the mortgage. The Lender will make efforts to recoup the principal for the Investors by selling the property. Once it is sold, the proceeds will be paid back to the Investors as a lump payment. Results are stored in blockchain as a hash value.

Platform Architecture Outline

HFC provides users with a unique ability to use, trade and invest with fungible tokens (namely ERC20 standard tokens) on public Ethereum Mainnet.

The main idea behind this is that users can invest into other in-platform non-fungible tokens and receive returns on investments by redeeming HFC Coins. To fund rewards, HFC lends capital for mortgages and tokenizes those mortgage agreements inside the platform. This keeps the token price as stable as the valuation of mortgages or derivatives of them. Moreover, the mortgages and derivatives generate additional revenue which is distributed between the investors in two ways:

- Revenue from mortgages leads to an increased price of public HFC Coins on the market.
- Revenue from mortgages and derivatives are distributed through mapping of HFC Coins owners, while tokens are a value storage, while tokens could be used by investors to re-invest in new rounds of MBS.

This approach requires the launch of a full cycle of MBS/CDO creation from mortgage tokenization to the creation of a blockchain-based market for collateralized investment instruments without the need of cross-institution closed connections. This introduces transparency for collateralized investment tools and traceability down to the particular owner of a mortgage/asset.

Figure 9. Overall description of the HFC Platform architecture

https://docs.google.com/presentation/d/16Sz5vyU1SsjZYR23qpqT5TBQSjuWcz1os3fuctrwb0k/edit#slide=id.g3c5a75b95d_1_0

Operational flow:

1. Customer decides to obtain a mortgage through the HFC Platform that requires registration with KYC/AML and a dedicated decentralized Application (DApp) on the platform back-end. This allows for the creation of a customer digital footprint in blockchain and enables them to interact with blockchain.
2. DApp communicates with Quorum through Gateway node that ensures synchronization and equalization of balances on both platform elements
3. HFC as the Lender deploys a Smart Contract in the Quorum environment by creating ERC721 tokens that includes mortgage agreements related data in it (tokenized them) that are collateralized in tokenized MBS - CMP token in the ERC721 standard.
4. Investor creates claim to obtain a CMP ERC721 token (share of it)
5. Inside the HFC platform Smart Contracts are deployed with the following features:
    a. Mapping of ERC721 token (Collateralized Mortgage Product - CMP) with investors in it,
    b. Locking of investors' ERC20 tokens,
    c. Receiving Lenders transfers to Smart Contract to reflect the Customer's principal and interest payments,
    d. Releasing returns from principal and interest payments to investors,
    e. Informing gateway to release public ERC20 tokens to investors
    f. Receiving confirmation of made payments

6. Platform establishes channel with Oracle node that executes exchange operations when investors want to receive returns in either crypto or fiat currencies.

Public Ethereum blockchain

HFC has extensive experience with mortgage and derivatives markets. This allows HFC to choose to invest with minimal risks and maximum profitability. When an investment is executed by the HFC blockchain, all documentation is stored in HFC data storage and the hash value of this data is stored with a HFC Coin transaction in Ethereum Mainnet, so it is impossible to change or obtain this data without the permission of all stakeholders. Each user who invests to the HFC Quorum platform receives an equivalent amount of internal ERC20 tokens. Investors have the right to mortgage or derivative returns depending on the amount of investment (crypto or/and fiat) at exchange rate on the moment of investments.

If investors want to receive confirmation regarding and mortgage object they send a request to the data storage by using their DApp. HFC Coins can be traded on crypto exchanges because HFC Coin is a public token and allows p2p payments as well. Moreover, HFC Coin is stable as it is backed-up with mortgage agreements, making it very attractive as a holding instrument.

To provide security and transparency to the whole process, HFC Coin uses Ethereum Mainnet as the main platform for the first stage.

Figure 10. Stage 1 - Public token architecture description

https://docs.google.com/presentation/d/16Sz5vyU1SsjZYR23qpqT5TBQSjuWcz1os3fuctrwb0k/edit#slide=id.p

Operational flow:

- Investor invests in HFC Coin during token sale event (TGE).
- Smart Contract in Ethereum Mainnet sends HFC Coins to Investor's wallet.
- HFC receives all needed documentation for mortgage(s).
- HFC creates mortgages and starts tokenization process.
- Platform sends data to HFC Data Storage and also stores hash data of documents on Ethereum Mainnet.
- If Investor wants to verify mortgage objects in hashed agreements, they send a request for the data to data storage. After verification of signatures, the investor receive access to documents.
- Data storage sends mutable data to Investor with verification of digital signatures.

It is critical to arrange a proofing mechanism behind hashes. For this purpose all parties of lending/mortgage/derivative agreement must sign with digital signatures that are based on the same private key that control the user balance in Ethereum blockchain. As Ethereum uses the same elliptic curve for cryptography as Bitcoin, a digital signature based on it is compliant with digital signature security requirements and is valid in most countries.

Process of verification is as follows:

1. Lending/mortgage agreement is concluded in traditional form as a legal document in digital form.
2. Parties to agreement sign it with digital signatures based on their private key.
3. Signed document is stored in off-chain storage and parties of agreement obtain hash provided by back-end of platform.
4. Hash is included in metadata of HFC coin transaction in Mainnet from customer to lender (HFC platform) where both of them provide their signatures for the transaction.
5. Hash is made available in public blockchain but access to mutable form of agreement is granted only if the transaction from

previous step contains the hash in the metadata of the signatures included in agreement.

This approach brings the following advantages to HFC investors:

- **Proof of mortgage back-up.** This keeps token price stable on the crypto market.
- **Coin price tied to the amount of tokenized mortgages and MBS.** This is the basis of the token economics.
-

Quorum Consortium Sidechain

HFC provides to its users a unique opportunity to invest into mortgage and mortgage backed securities by using crypto and fiat funds without the need of third parties for arbitration and hidden fees.

This feature is available on Ethereum Mainnet, but for the reduction of transaction fees and to respect compliance requirements, HFC is developing this platform as a sidechain to Ethereum Mainnet by developing Quorum[3] sidechain. It reduces transaction costs due to an agreement between nodes that they support HFC's platform with Gas fees for transaction/Smart Contract execution in prices defined between HFC and all nodes. As a result, operational costs are optimized. Furthermore, it provides higher speed to the system as nodes serve only the HFC platform's operations and is not stressed with overflow by other tokens launched on Ethereum Mainnet.

For mortgage tokenization and collateralization, the platform uses ERC721 tokens that allow for the mortgage agreement description and price influencing factors to be stored inside the blockchain token and set the price in HFC coins. As for securities, ERC721 can be filled with other ERC721 tokens but with a new value based on the derivative price formula.

[3] Quorum is a framework for the development of Ethereum consortium sidechain introduced by JP Morgan (www.jpmorgan.com/global/Quorum) to ease the process of enterprise scale Ethereum development.

ERC721 tokens include an Owner_ID and token transaction parties, which implements security, tracking and transparency.

Mortgage deals are arranged with smart contracts that contain ERC721 and accept fiat as payment (principal and interest payments). Smart Contracts have timestamps regarding locking of ownership of the ERC721 token, until the Customer not return certain amount of ERC20 under lending procedure.

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During this stage, HFC smart contracts will include different ERC721 tokens representing mortgages into the one ERC721 token.

Figure 11. Stage 2 - HFC Platform's operational workflow

https://docs.google.com/presentation/d/16Sz5vyU1SsjZYR23qpqT5TBQSjuWcz1os3fuctrwb0k/edit#slide=id.g3bc959697e_0_23

Operational flow:

1. Customer decides to obtain mortgage lending for object via HFC Coin platform.
2. Customer and Lender sign mortgage agreement, which is stored in off-chain storage, while the Lender puts the hash of the agreement in a ERC721 token with a value equal to the full principal and interest payments
3. Customer makes payments and the Lender converts payment into ERC20 tokens the HFC Quorum, that are transferring to the Smart Contract that holds ERC721 token.

4. HFC smart contract receives data regarding mortgage objects and fills ERC721 token related to the Customer.
5. HFC Smart Contract includes MBSs from different ERC721 tokens into one ERC721. This leads to a change in the collateralized ERC721 token value, which uses the MBS approach to estimate collateralized debt value and returns. This data is defined in the token and is visible to investors.
6. When the initial mortgage is fulfilled, the Lender run the process of collateralized token decomposition to extract the mortgage ERC721 and annihilate it.
7. Ownership over documents is transferred from the Lender to the Customer and stored in data storage and hashed in Ethereum blockchain to provide proof of the transfer.

As Quorum itself was developed prior to the introduction of EIP721 to Ethereum, the HFC development team is using Quorum and Ethereum open source approaches to import ERC721 standard libraries from the related EIP directly with the Quorum framework after sidechain deployment. This ensures the security of the sidechain by avoiding references to libraries of Ethereum MainNet Solidity.

Hybrid Model Communication Elements

The HFC platform uses a combination of public and consortium Ethereum chains in a hybrid model. The platform arranges the communication process of those systems for the following purposes:

1. Allows ERC20 HFC Coin to exist on Ethereum Mainnet to incentivize investors with a token that has value on private markets and/or public exchanges.
2. Reduce Gas fees for operations with ERC20 and ERC721 tokens inside the platform via consortium Ethereum.
3. Allow the Lender to perform in-platform accounting with ERC20 Quorum token token without constraints of limited supply and

prevent any price fluctuations caused by in-platform token flow or need of a fork to extend the platform in the future.
4. Remove operational cost constraints for mortgage backed securities and conventional mortgage development.

Figure 12. Public and Quorum communication architecture

https://docs.google.com/presentation/d/16Sz5vyU1SsjZYR23qpqT5TBQSjuWcz1os3fuctrwb0k/edit#slide=id.g3d1c81e631_0_15

Operational flow:

1. Investors interact through DApps (wallets) with the system but deal only with an ERC20 token, called HFC Coin, on a public network or make direct payments that are processed through payment gateway of Quorum.
2. Investors can freely transact public tokens (HFC Coin) between each other on Ethereum Mainnet with Gas fees payable by them.
3. Investors can also exchange public tokens (HFC Coin) on exchanges that list it with the same transactions fees in Gas.
4. Specialized Gateway in Quorum will obtain user public Ethereum wallet addresses and read the amount of ERC20 public tokens (HFC Coin) or amount of paid sum at rate settled by HFC platform for consortium token. These gateways will be used also for equalization of balances on public blockchain in reverse.
5. Oracle node allows uploading of platform data in the quazi-blockchain environment, where off-chain operations will be actively monitored with Quorum for events related to token transfer, while all other activities will be fully centralized and off-chain operated.

6. To ensure token economics, Gateway node will listen to Platform wallet. With this activity, Gateway allows mirroring off-platform transactions with public ERC20 token balances.

7. DApp will be available for investors inside the HFC platform, which is connected with off-chain data and allows investors to perform activities within a described solution. Investors will use ERC721 and ERC20 consortium tokens for operation in Smart Contracts related to mortgage tokenization or collateralized tokens.

8. All DApp's inside the platform communicate with off-chain data through the Oracle node (or nodes), as this is the only way to provide required data to them.

9. Gateway will listen to Quorum wallets and collect data about current account balances of ERC20 and value of ERC721 Quorum tokens.

10. Data from Gateway will be transmitted to Platform wallet and activate event of an ERC20 public token transfer (HFC Coin) in 1-to-1 parity of current value of ERC20 Quorum token.

11. If an Investor accepts the transaction in Quorum to receive HFC Coins, Platform wallet releases ERC20 public token (HFC Coin) that equalizes balances of publicly tradable tokens to Investor public address.

Summary of user processes:

- An Investor or a Customer make payments to platform wallet or account.
- An Investor makes transactions within platform with tokens to buy/sell share in ERC721 tokens.
- Platform wallet releases public tokens to the Investor in amount indicated in their in-platform balances.

At the moment of Quorum deployment, the platform is equipped with the following technical tools:

- Front-end of HFC Platform for off-chain elements - Java (**Jdk1.8.x/Jre1.8.x** open source Java libraries - robust, secure and platform independent; **Java script** for UI libraries to design the front-end components), **Django** (administration of front-end), **Web3.js** (communication with Ethereum blockchain/sidechain and Smart Contracts);
- Databases - **MongoDB/RocksDB** (databases management), **Apache Kafka** (databases and other systems communication).
- Agreements off-chain storage - **MongoDB/RocksDB** (databases management), **Apache Kafka** (databases and other systems communication).
- Back-end of off-chain elements - **Spring** (support development stack at each level whether security, messaging, data handling), **Hibernate** (ORM tool to map java classes to Database tables).
- Communication with 3rd party provider systems - **JSON RESTful API, Docker.**
- Every communication channel that is used within the platform (between nodes, data storage, users dApp, etc.) is encrypted and secured by SSL/TLS certificates establish fully encrypted channels within on/off-chain infrastructures.

As the HFC platform use Gateway and Ethereum at its core, with selected tools it will be possible to easily integrate any other project related to tokenization of mortgages based on Ethereum. It will require integration of the mortgage data collection and verification processes but there is no need to make changes to existing ERC20 tokens.

Gateway allows for the integration of mortgage tokenization platforms based on other types of blockchain (e.g. Bitcoin or PoW consensus algorithms) but to operate with tokens on them an Oracle node is required in both blockchains. With the development of the Plasma

project, this requirement could be dismissed sometime in the future but at the current level of integration it must be kept.

With this approach, the HFC platform aims to create a unified platform for operations with CMP rather than just tokenization of mortgages. It extends market coverage and integrates fragmented efforts. Under this umbrella it is possible also to integrate other asset backed tokens that comply with HFC platform requirements and enable the creation of collateralized derivatives whether CMP or CDO (for example real estate, gold or security backed tokens could be transformed in collateralized derivatives under the same logic as CMP).

Quorum Consensus Motivation

Quorum allows for the introduction of various consensuses behind its platform. Despite the ability of Proof-of-Work (PoW) consensus to provide higher security in public blockchains, the HFC platform will never be a large scale network in terms on nodes. This raises concerns about whether PoW will be strong enough to protect the sidechain, especially if taking into consideration that the value of each ERC721 token could be higher than the cost of equipment necessary to obtain more than 51% of the sidechain computational power needed to attack the system.

To protect the sidechain from a 51% attack by consortium members, the HFC team decided to rely on Quorum native Proof-of-Stake (PoS) consensus - QuorumChain. This allows for an increased cost of node attacks in average sized networks with high value tokens. With PoS, nodes must put real value at stake for the right to verify its share of transactions. This is implemented as a reserve system in the current financial market.

Amount of required stakes will grow with time on a weekly basis based on the average value of minted ERC721 tokens. As the stake cannot be more than the discounted value of node revenues in the network, probability formulas with appropriate AI scoring will be applied. All consortium members and node holders must agree on staking value growth.

Formula of staking growth:

$$Stake = (\sum_{0}^{n} ERC721_n \div n) \times R,\ R < 1$$

$$Stake_m \div \sum_{1}^{m} Stake_m < 1/3$$

Where n - number of tokenized mortgages, m - number of stakers (nodes) within Quorum, $ERC721_n$ - value of an ERC721 token, R - risk of node misbehaviour based on AI/ML scoring model.

HFC platform requires at minimum 3 stakers, as each share of node could not be more than ⅓ of network value.

Staking will be done in Quorum version of Ether and not related to operational ERC20 tokens.

Smart Contracts

The HFC platform can deal with both mortgage tokenization and MBS operations. Smart Contracts are deployed inside HFC Quorum to arrange the processes.

Figure 13. Smart Contracts connection at HFC Quorum

https://docs.google.com/presentation/d/16Sz5vyU1SsjZYR23qpqT5TBQSjuWcz1os3fuctrwb0k/edit#slide=id.g3a3a6b1a9f_0_2

Operational flow:

1. Customers obtain a mortgage from HFC. Mortgage agreements are executed with physical signatures and converted to digital form signed by the Lender (HFC) and Customer. Lender provides funding to customer in fiat currency
2. Mortgage agreement is hashed and stored inside the ERC721 token with digital signature of Customer and contains Lender public address as Owner_ID of the token. The ERC721 token price with mortgage inside is defined as the mortgage price with the amount of agreed returns and represented in ERC20 tokens of Ethereum Quorum in parity of 1-to-1 with USD for ease of accounting.
3. Customers provide payment to Lender in fiat. Lender mints tokens in Quorum and transfers them to smart contract to collect principal and interest payments for accounting purposes. This continues until Customer pays entire sum of mortgage agreement.
4. Mortgage smart contract mint ERC721 tokens with tokenized mortgages that are locking inside the Collateralization smart contract. That creates opportunity to issue a new ERC721 token that represents MBS for investing in it and connected with tokenized mortgages.
5. Investors invest in MBS with HFC Coin that can be obtained from public exchanges and/or from HFC directly.
6. Quorum Oracle node tracks all contributions of HFC to Investment smart contract in Ethereum Mainnet and immediately releases Quorum ERC20 tokens with Investment smart contract in

permissioned chain with address of investors to map rewards. Investment smart contract in consortium maps investors' addresses with selected MBS inside Collateralization smart contract

7. Collateralization smart contract provides information on return on investments for each MBS to Reward smart contract. Reward smart contract obtains investors' address mapping from consortium Investment Smart Contract and collects required amount of paid mortgages principal and interest from Redemption smart contract.
8. This data with consortium Oracle node is transmitted to Investment smart contract in Ethereum Mainnet to release returns to investors.
9. When mortgage is paid off, Redemption smart contract transmits event to Mortgage smart contract that changes the Owner_ID of ERC721 token with mortgage inside from Lenders public address to customer public address. As a result, mortgage is treated as not valid and ERC721 token includes signed hash of confirmation that mortgage is closed. This data is stored inside blockchain. It also triggers decomposition process of MBS to exclude tokenized mortgage from collateralized token.
10. In case of mortgage default, Default smart contract creates required amount of consortium ERC20 token to close mortgage for other smart contracts and provide new distributions of reward for investors with time stamp on amount of potential tokens that will be provided after object realization.
11. In case of closed mortgage agreement (paid off or defaulted), Mortgage smart contract changes Owner_ID to Customer or annihilates ERC721 token to withdraw default from system to obtain tokens from object realization.

Mortgage Smart Contract

Figure 14. Mortgage tokenization Smart Contract flow

https://docs.google.com/presentation/d/16Sz5vyU1SsjZYR23qpqT5TBQSjuWcz1os3fuctrwb0k/edit#slide=id.g3d1c81e631_0_75

Operational flow:

1. Lender and Customer create a general mortgage agreement and physically sign it. It is then created in digital form and signed with Lender and Customer by their private digital signatures to create tokenized agreement.
2. Agreement is hashed and signed with customer signature once more. Unhashed agreement is stored in off-chain data storage and accessed only with private signature of customer and ERC721 Owner_ID.
3. Hashed agreement with signature is used to create ERC721 token with this data inside along with Lender public address as Owner_ID. Value of token defined as mortgage value of principal and interest in USD/HFC Coin parity (depending on agreement).

This process allows for a tokenization process for mortgage agreements and introduces base ERC721 tokens for MBS creation.

Collateralization Smart Contract

Figure 15. Collateralization Smart Contract flow

https://docs.google.com/presentation/d/16Sz5vyU1SsjZYR23qpqT5TBQSjuWcz1os3fuctrwb0k/edit#slide=id.g3d1c81e631_0_112

Collateralization smart contracts work by locking ERC721 tokens that are tokenized mortgages in one Smart Contract and then minting new ERC721 token that represents MBS of Lender and connects with investment and reward contracts.

Consortium Investment Smart Contract

Figure 15. Investment Smart Contract flow

https://docs.google.com/presentation/d/16Sz5vyU1SsjZYR23qpqT5TBQSjuWcz1os3fuctrwb0k/edit#slide=id.g3d43bf61f5_0_101

Consortium investment Smart Contracts are basically mapping contracts used to collect information on investor contributions. These Smart Contracts have an oraclization feature that collects investors' addresses and contributions used for MBS investments.

HFC Coin is used for investments and returns on investments tracking with enforcement of public Ethereum Mainnet. Quorum ERC20 token is used only for accounting purposes and for managing operations with MBS in form of ERC721.

Redemption and default Smart Contracts are used only to store statements. Customer payments are tokenized with ERC20 tokens and passed through a Redemption Smart Contract that stores the history of payments. ERC20 tokens are transferred from HFC wallets to Reward smart contracts through Redemption smart contracts. This minimizes the number of listen and call functions.

Default smart contracts hold a certain amount of consortium ERC20 tokens in reserve, which must be enough to initiate decomposition of MBS for a defaulted mortgage and inform investors of changes in principal and interest distribution. This contract only listens to Redemption smart contracts and used for call functions inside Investments smart contracts.

Reward Smart Contract

As an additional feature that is proposed to HFC platform's users is a reward and bonuses system. It will provide motivation to users to utilize the platform, which will increase the value of HFC on the market as well as its HFC Coin price.

This feature is provided by a special HFC Reward smart contract that is placed on HFC Ethereum Quorum. The HFC Reward Smart Contract is developed with predefined conditions in it and its role is to listen to user activities through a HFC Operational smart contract by verifying data with HFC Data storage in a decentralized manner. When the predefined conditions are met by the user, the HFC Reward smart contract catches this activity and pings HFC Operational Smart Contract to reward users.

There are several possible types of rewards:

- **Operational Activities -** By dealing with the platform (mortgage, investment, MBS trading, etc) users will be rewarded with HFC Coins which will provide further motivation to execute such deals
- **Referral programs -** When a deal is successfully executed within the HFC platform, users will be able to share such information with friends, family and the whole community as well. When someone else comes to the HFC platform by using this referral link and makes a purchase, both users will receive HFC coins that can be used for a discount with the next purchase, etc. One more way to utilise this bonus is its monetization. Users will be able to trade HFC coins on crypto exchanges or use for p2p transactions.

Figure 16. Description of the HFC Reward Smart Contract

https://docs.google.com/presentation/d/16Sz5vyU1SsjZYR23qpqT5TBQSjuWcz1os3fuctrwb0k/edit#slide=id.g3d1c81e631_0_116

Operational flow:

1. User connects to the HFC platform via DApp.

2. HFC Reward Smart Contract listens to the HFC data storage and Operational SC regarding how many interactions with the platform were obtained by the User.
3. Based on predefined conditions in HFC Reward SC, it sends requests to the HFC Operational Smart Contract.
4. HFC Operational Smart Contract sends request for reward to the platform's wallet (it could be ERC20 tokens as a reward or some subscription discounts, etc.)
5. Platform's wallet sends ERC20 tokens as a reward to the User's wallet.
6. User receives notification of received token via DApp.

Public Ethereum Smart Contracts

Figure 17. Smart Contracts flow in Mainnet

https://docs.google.com/presentation/d/16Sz5vyU1SsjZYR23qpqT5TBQSjuWcz1os3fuctrwb0k/edit#slide=id.g3d43bf61f5_0_156

To activate investments in MBS and source mortgages agreements, HFC issues HFC Coins on public Ethereum Mainnet. This allow to activate the logic behind Investment Smart Contracts is as follows in Quorum sidechain:

1. HFC platform uses available HFC Coins to distribute within market and receive fiat currencies to source mortgages and activate their tokenization process. Fiat currencies are provided to customers who can in the future make mortgage payments in fiat payments to the Lender.
2. Lending Smart Contract in public Ethereum Mainnet is used to track amount of sold HFC Coins for sourcing of mortgages and provide additional comfort for token investors.
3. Investment Smart Contract is a management tools for investors that allows them to choose in which MBS they want to invest (when several MBSs are launched) for portfolio development. Each MBS

will have its own Investment Smart Contract address at Mainnet for appropriate mapping of returns distribution.

4. HFC wires (or sends ETH/BTC transaction from its wallet) to distribute returns to investors from its bank account and obtain HFC coins from Investment Smart Contracts. New investors can join by purchasing HFC Coins from public exchanges or directly from HFC platform.

From a platform point of view, it will use the same internal tokens that are related to investors' wallets. This allows for an accounting system for investors at each serial issue of CMP.

Token Economics

Token Specifications

ERC20 Tokens on Public Ethereum - HFC coin

The ERC20 tokens on public Ethereum Mainnet are used for the following purposes:

1. Public ICO for fundraising,
2. Listing on public exchanges,
3. Direct transactions between users outside HFC platform,
4. Access to HFC platform,
5. Burn of redeemed tokens of investors.

The key features of token economics are:

1. Initial distribution of token with ICO,
2. Token price reduction with fees payable in ETH,
3. Stable price of HFC Coin.

When new ERC20 tokens on public Ethereum are introduced, holders of HFC Coins from previous rounds who don't want to redeem them are allowed to swap old tokens for new ones. Prior to the TGE, old tokens will be delisted from exchanges that limited their turnover to only redemption or swapping on the HFC platform.

ERC721 Token on Quorum

ERC721 Tokens on Private Ethereum Chain are used for the following purposes:

1. Storing documentation on mortgage objects.
2. Storing unique User's ID (Owner_ID) in the ERC721 token's metadata so that it will be impossible to sell and move mortgage ownership to another user without the owners' involvement.

3. Storing value of mortgage objects which define the appropriate amount of ERC20 tokens on Ethereum Mainnet.

The key features of token economics are:

1. Unlimited deployment of ERC721 tokens with no additional fees.
2. Zero fees for running ERC721 tokens within Quorum. Gas fees will be on ETH wallet on Consortium to protect Smart Contracts from DDoS attacks.

ERC721 tokens on Ethereum Quorum will be used for the following purposes:

1. For each platform User who invests, a particular ERC721 token will be assigned.
2. The value of the ERC721 token is in equivalent ERC20 HFC Coins and depends on the mortgage object.
3. User can sell mortgage object (ERC721 token) at any time on the HFC platform (on Quorum).

This type of token will also incur Gas fees. However, HFC can set up the fee to zero for transaction execution as it is allowed by Quorum as one of its features.

ERC721 tokens will allow HFC to deploy as many tokens as needed. When a token is sold and there is no need of it, HFC could burn it by erasing the metadata in the ERC721 token and then to assign its account number to the last minted ERC721 token. This will result in the burning of the sold ERC721 token.

After that, HFC assigns to the User a new ERC721 token.

ERC20 Token on Quorum

ERC20 tokens on Quorum are used for the following purposes:

1. Accounting of investments and returns on balances for equalization of balances in HFC coins,
2. Direct transactions between users inside HFC platform,
3. Management of CMP/conventional mortgages and mortgage investment flow inside platform.

The key features of token economics are:

1. Distribution based on public Ethereum balances,
2. Token price is zero,
3. Transactions fees are zero,
4. Automation of processes related to CMP creation and decomposition.

ICO Economics and Specifications

ICO will contain only ERC20 HFC coins in Ethereum Mainnet.

Token type	ERC20
Fees	Gas of Ethereum
Access	Public
Max supply	65,000,000
ICO supply with vesting	52,000,000
Team reserve for vesting	6,500,000
Vesting period	3 years
Accepted contributions	ETH - yes
	BTC - yes (LTC, …?)
	Fiat (USD) -

Distribution of tokens from Token Generation Event:

HFC COIN

HFC Coin - Token Distribution		
Founding Team	6,500,000.00	10%
Reserve for 3 year vesting	6,500,000.00	10%
Referral bonuses	6,500,000.00	10%
Token sale	45,500,000.00	70%
Total	**65,000,000.00**	**100%**
ICO funds		
Hard Cap	$40,000,000	
Soft Cap	$4,000,000	

Distribution of ICO token supply:

HFC Coin - Sale Stages				
Stage	**Tokens**	**Discount**	**Dates**	**Price**
Early/Seed stage	2,275,000.00			
Stage 1	2,275,000.00	30%	TBD	$0.70
Stage 2	4,550,000.00	25%	TBD	$0.75
Stage 3	4,550,000.00	20%	TBD	$0.80
Stage 4	4,550,000.00	10%	TBD	$0.90
Public Sale	27,300,000.00	0%	TBD	$1.00

Distribution of funds received from ICO:

HFC Coin - Funds Allocation	
Operations	10%
Legal	5%
Marketing	20%
Technology R&D	10%
Mortgage Lending	50%

Reserves	5%
Total	100%

Additional estimations for token economics evaluation: https://docs.google.com/spreadsheets/d/14ykUfN2XG9_g43vXF1WAnjArnn2rGNIXb9HCj_lkmjY/edit#gid=0

Project Timeline

Stage 1. HFC Coins TGE starts on [date]:

1. Deployment of TGE Smart Contract at Ethereum Mainnet,
2. HFC Coins market distribution process,
3. Post-TGE marketing campaign,
4. Listing on public exchanges.

Stage 2. HFC Platform Proof-Of-Concept and initial tokenization process:

1. HFC Platform test-net with Ethereum Consortium chain under Proof-of-Authority consensus,
2. Tokenization of initial financed mortgages,
3. Solidity Smart Contracts for TGE of ERC721 and ERC20 tokens within consortium chains,
4. Public testing of Smart Contracts and security audit,
5. HFC Platform front-end and back-end finalization.

Stage 3. HFC Platform deployment with Quorum:

1. Setup of nodes to launch Quorum Chain consensus,
2. Initial testing of nodes overflow and stress testing,
3. Migration of EIP721 standard to Quorum,
4. Migration of Smart Contracts from PoC to Quorum,
5. Ethereum Mainnet addresses implementation to Quorum,
6. Gateway maintenance and full scale deployment.

Stage 4. Full scale HFC Platform launch:

1. Collateralization Smart Contract deployment
2. MetaMask and Infura JSON APIs and custom wallet deployment
3. Launch of first CMP ERC721 token for collateral investment
4. First round of reward distribution

Stage 5. Scaling of HFC Platform:

1. SDKs for tokenized asset integration to HFC platform for collateralization,
2. New rounds of CMP creation,
3. Distribution of licences for mortgage tokenization service vendors,
4. Scaling of nodes amount within platform consortium agreement,

5. Payment gateways for integration of new payment methods for investors,
6. Integration of public Ethereum Smart Contracts with 0x, Bancor and Graphene to ease process of dealing with decentralized exchanges.

Team and Advisors

Bryan Stone

CEO, HFC Coin
Bryan Stone is an experienced entrepreneur with more than 17 years of experience in the financial services and mortgage industry. After maintaining a successful mortgage branch through the mortgage crisis of 2008, Bryan founded his own mortgage brokerage, Stone Home Loans, in 2012.

James Lopez

CTO, HFC Coin
James Lopez is a multidisciplinary software developer, technology enthusiast and entrepreneur. James has over 15 years of experience in full stack development, software project management and database architecture.

Ott Sathngam

Senior Software Architect / Engineer
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Ott has worked as an electrical and software engineer for more than three decades. His extensive work product spans multiple industries and disciplines. He has been lead engineer on multiple defense contracts and has also worked as software architect / engineer on several private sector projects.

Advisor to add to documentation/website:

David Drake
Founder, LDJ Capital
David Drake is Founder and Chairman at LDJ Capital, a multi-family office which deals in worldwide funds accessing over trillions in assets and maintains over 50+ global directors and family office partners. LDJ Capital has holdings in Victoria Partners, a 500 family

office network based in London; LDJ Real Estate Group; and The Soho Loft Media Group.

Alan Johnson
Advisor, Founder at LoanXEngine
Alan Johnson has spent his career at the forefront of loan origination technology and software. Alan is an expert in loan origination automation and has created software that combines the essential services of lead management, product pricing and eligibility, and customer relationship management workflow into a single, easy to use platform.

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Grant Gulovson
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Grant is a licensed U.S.-based intellectual property attorney with over 15 years' experience in a wide variety of different practice areas. He started investing in Bitcoin in 2013, and is the legal advisor to several blockchain startups. Grant only works with projects that he believes in and that are sophisticated enough to recognize how important it is to have legal counsel that understands the law, the technology and the marketplace.

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Ihor Pidruchny

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An experienced technology manager and adviser in blockchain. Ihor has been involved in many blockchain projects and ICOs as well as technical development projects located in Silicon Valley.

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Disclaimers