iModX

White Paper for the International Model Exchange from its Consortium Members

IMODX'S MISSION IS TO "UBERIZE" GLOBAL MODEL AND DATA INFRASTRUCTURE AND EMPOWER ALL KEY STAKEHOLDERS OF MODEL ECOSYSTEM

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1. AN INTRODUCTION TO IMODX

This document outlines our plans for a new **permissioned blockchain** - a commoditized model, data, and a smart contract platform - that together aims to create a new opportunity for democratization and efficient creation, validation, application and monetization of models and data.

1.1. PROBLEM STATEMENT

Exponential growth in computing power and resources and increased access to data has allowed organizations to apply models for quantification, inference, prediction and decision-making based on their intended purposes and functionality across all industries. As a result, skillful applications of data and models have become clear competitive advantages for firms in the digital era. New businesses, such as Google, Uber, Lyft, Airbnb, and many other big data processing companies, have emerged and are disrupting existing well-established businesses as they gain massive competitive advantages by leveraging sophisticated model and data applications. Advanced modeling techniques have truly become the 21st century "oil" powering innovation and growth that are driving market differentiated strategic imperatives.

For financial institutions and data processing companies, models and data are considered as strategic assets driving business objectives, which if mismanaged, can end up as liabilities for the firms. The emerging industry and regulatory standards for managing complex models and data, while necessary, have created an enormous burden on companies in terms of time, costs and resources. While various data pools and proliferation of accessible APIs (Application Programming Interfaces), IP and MAC addresses are forming a global data sharing infrastructure, thus bring down the cost of data processing, access to broader models still remains a purview and domain of the few given their proprietary nature. These costs can be decreased exponentially

and access to sophisticated models increased dramatically, thus, creating an opportunity to democratize and commoditize the model ecosystem.

The cost of those solutions and corresponding model risk management, just in regulated financial institutions, is in multibillion-dollar range. An army of specialized, highly paid qualified quants[1] with PhD and Master Degrees in hard sciences manually develop, validate, control, monitor, and audit thousands of models and model-based software solutions. Because of the proprietary nature of models and prevailing regulatory requirements, the same software packages, sold for instance to ten different banks, would undergo a heavy manual testing, initial and ongoing validation, and audit separately at each of the banks. In-house developed and third-party software solutions are currently built without APIs for embedded models and data feeds that prevents automation of model monitoring and risk management.

For all key stakeholders (model users, developers, validators, internal/external auditors, and industry regulators), the fragmented model ecosystem looks like a pre-Uber global taxi industry. In the past, the taxi owners were privileged businesses because of a possession of a limited number of expensive taxi licenses. They could keep high cost of taxi rides in a "taxi owners' market". Millions of qualified pre-Uber car owners could not provide taxi services and convert their cars from "cost centers" to "profit centers" by taxing on a part- or full-time basis. There was no legal framework and, the most important, the infrastructure was not in place to support "Ubering" drivers in finding clients and offering dynamically priced taxi services. Uber and Lyft have effectively democratized the taxi business by engaging millions of existing drivers and disrupting the traditional taxi business model. The similar democratization processes are happening in the office rental space business (Regus and WeWork versus traditional office space owners) and hospitality business (Airbnb and VRBO versus traditional hotel chains).

[1] Quants are the professionals who apply quantitative expertise and skills in their dealing with models. Those activities include, but not limited to, model development, validation, usage and performance monitoring, regulatory review and audit.

The current model ecosystem that underpins the global Financial Services Industry[2] is dominated by large vertically integrated companies (e.g., IBM, Fiserv, FIS, SAS Institute, etc.) occupying more than 50% of the market share of the $27B in software license, maintenance and subscription revenues. In addition to software license and maintenance, the financial institutions spend billions of dollars on an in-house army of specialized quants, who are engaged in the predominantly manual processes associated with models and third-party software packages (i.e. model development, validation, control, monitoring, audit, reporting, etc.).

The application of **Artificial Intelligence (AI) and Machine Learning (ML)** for model ecosystem is very limited at the current stage because of its outdated infrastructure and lack of accessible big datasets. Practically all financial institutions treat the proprietary data as sensitive without sharing it with industry pools. There is no a reliable mechanism in the marketplace, which would allow market participants to share anonymized, disguised, or "synthetic[3]" proprietary data in pools. Such pools with big data are required to form the knowledge-base and train AI and ML algorithms.

Distributed Ledger Technology (i.e. Blockchain) and digital assets have a number of unique properties that could address some of the endemic problems of accessibility, trustworthiness, transparency, and underlying cost of the current model and data ecosystems. These include the following:

i. **commoditization of models**, that decreases the cost of models and their maintenance by means of their broad usage, metering, and certification;

[2] Financial Services Industry consists of credit, lending, insurance, asset management, hedge funds and securities institutions that buy hedge fund administration, core banking, cash, treasury, payment, valuation, risk management and supply chain finance solutions, investment management systems, securities transaction and online trading technology, mortgage, loan origination and processing solutions, teller transaction and loan processing, automated loan decisioning, analytical science analysis, workflow management, and sales and service solutions, financials, HR, and procurement.

[3] Synthetic data is produced by an algorithm that is trained to study the available empirical distribution and create new distributions with similar features. The synthetic datasets cannot be linked to a particular portfolio or client that allows to resolve the issue of sharing sensitive data.

ii. **commercialization of data sets**, that allows financial institutions to rent their proprietary synthetic data on a disguised basis in pools, which can be used for advanced AI and ML model development and validation;

iii. **open access,** that democratizes the model ecosystem for thousands of independent quants and quantitative boutiques (model supply side), and enables their trustless connection with model end-users (model demand side) and data providers (data supply side) on a common platform;

iv. **lower-cost and entry barriers** for model and software end-users are achieved through the enablement of payments per model use or subscription (SaaS, PaaS) rather than required hefty up-front fees for purchasing software license and ongoing maintenance;

v. **fair and timely compensation** of model/solution developers, validators, and auditors is secured by smart contracts and cross border payments made with utility tokens;

vi. **security** through cryptography, which protects the privacy of shared data, know-how of models and solutions, and integrity of tokens used as a means of payments within iModX;

vii. **lower model risk exposures**, which are contained through the enablement of advanced model risk management, application of AI and ML techniques, deep hedging, and transparency in model usage within an enterprise, and across industries and jurisdictions;

viii. **distributed governance**, which ensures that no a single entity would control the model ecosystem; and

ix. **harmonization of regulatory requirements** and supervision, which is achieved through regulatory access to information about underlying data, models and their global usage, including performance monitoring.

Blockchain-based systems are reaching mainstream adoption in the digital era. Several projects have aimed to alter the existing ecosystems by successfully lowering their barriers and improving regulatory compliance. We believe that collaborating and innovating with the financial services industry, regulators, data scientists and quants across a variety of industries, is the way to ensure that a sustainable, secure, and trusted framework underpins this new iModX based model marketplace. Our proposed approach can facilitate a giant leap forward toward a lower-cost, accessible, and secure use of models and data by the financial services industry.

1.2. THE OPPORTUNITY

As we embark on this journey, we think it is important to share our beliefs to align the community and ecosystem we intend to spark around this initiative:

A. We believe that **democratization** of data and model ecosystems will create immense economic opportunity and wider adoption of models across the industries.

B. We believe that a global model ecosystem should have a **common marketplace** with a fair price discovery mechanism for models, proprietary data sets, and software solutions.

C. We believe that many more qualified professionals, smaller financial institutions should have a **low barrier access** to the model marketplace to democratize model ecosystem and release capital in the financial services industry.

D. We believe that the existing wall dividing leading edge **academic research** and models used in the real world should be broken that academics could easily convert their algorithms **into the industrial quality models** and put them for sale in the marketplace.

E. We believe that all key stakeholders of the model and data marketplace should have a right to establish a **self-regulated platform** that is compliant with the evolving industry regulations.

F. We believe that key stakeholders of the model/data marketplace will increasingly trust **decentralized forms of governance** on a blockchain.

G. We believe that global utility tokens and financial infrastructure should be designed and governed to **minimize cost and time** to transfer funds from model users to developers on the model/data marketplace.

H. We believe that the financial services industry and the quants community have a responsibility to help **advance adoption of models**, support secure sharing of data, and continuously uphold the integrity of the model ecosystem.

1.3. OUR VALUE PROPOSITION

The fragmented global model ecosystem is ripe for disruption. The financial services industry truly needs a reliable model and data exchange or a marketplace which can provide access to development environment and low cost, transparent and competitive models and software solutions. The solutions will be built with the use of data pools and Artificial Intelligence and Machine Learning techniques. Standalone proprietary datasets are inherently limited by whatever variables are available. But when those data are linked to some other data in a pool, new vistas will be opened up by AI and ML.

For financial engineers and statisticians, building software solutions with models on a blockchain should be simple and intuitive. It could be done in a similar manner as architects develop blueprints in AutoCAD by assembling standardized elements and components into sophisticated and customized construction designs. Standardization of model formats, application of Integrated Model Development Environment (IMDE), APIs and registration of models on a blockchain will decrease cost, eliminate process duplications/bias, and enhance security of models. A newly developed object-based visual programming software - Model Blockchain Studio IMDE - will become a critical component of the iModX platform and take its place among other existing IDEs, such as Visual Studio, R-Studio, Python Studio, C++ IDE, etc., which are widely used for building models and software solutions these days. New model innovation on a blockchain and additional trustless entrants to the model marketplace will enable the lowering of barriers to access and cost of capital for the entire financial services industry and facilitate frictionless payments from users of models and data to their developers and providers by means of utility tokens.

Now it is the time to create a new kind of a model marketplace with the foundation built on the blockchain technology. The mission for iModX is a global model platform and financial infrastructure that empower thousands of quants, data scientists and smaller firms as well as decrease the application cost of model and software solutions at large financial institutions. iModX is made up of two interoperable blockchains respectively connected with repositories of models, data, and reserve assets that will work together to create a more inclusive model ecosystem:

1. **Model Blockchain** represents a secure, scalable, and reliable **private permissioned blockchain** governed by the iModX Consortium tasked with evolving the model ecosystem

   - Linked to a **repository of proprietary data sets, standardized models** and software solutions, which are managed within the **integrated model development environment (IMDE)**

2. **Payment Blockchain** enables a **payment system with utility tokens** which are fully backed by a basket of reserve assets

   - Linked to an **independent custody** that holds a basket of reserve assets consisting of fiat, cryptocurrencies and gold, which is designed to give stability to the intrinsic value of the tokens.

Blockchains are described as either permissioned or permissionless in relation to the ability to participate as a validator node. In a "permissioned blockchain," access is granted to run a validator node. In a "permissionless blockchain," anyone who meets the technical requirements can run a validator node. In that sense, iModX will operate as a **Permissioned Blockchain Platform for the Enterprise** implemented in Hyperledger Fabric[4].

To ensure that iModX is truly transparent and it always operates in the best interest of its stakeholders, the iModX network will be kept permissioned and governed by a Consortium comprised of key stakeholders and node validators (i.e. "forgers"). The goal is to implement a proven solution that can deliver the scale, security and flexibility needed to support thousands of stakeholders and transactions across the globe through a permissioned network.

Essential to the spirit of this new model and data marketplace, the iModX Blockchains will be open to qualified and registered stakeholders. Quants community of developers, model validators, data scientists, auditors, and regulators as well as business users can use the iModX network, build products/models and solutions on top of it, and add value through their services. Qualified access ensures low barriers to entry and innovation, and it encourages healthy competition that benefits the wide

[4] According to the Forbes' Blockchain 50 list, the Hyperledger Fabric and Ethereum are the most popular blockchain technologies used by the world's biggest companies that are actively working on blockchain projects.

range of stakeholders. This is foundational to the goal of building more inclusive democratized model and data marketplace.

The benefit of using a distributed ledger for models and proprietary data rather than a centralized database is that there is no single point of failure, which decreases the odds that a network is hacked or information is lost. In addition to that, there is not a single entity that owns the blockchain data stored on the network. This means that nobody outside of the circle of iModX stakeholders could monetize that data or use it in a way that the Consortium does not approve of.

Adequate tooling is essential to the job model developers, validators and solution architects, especially if said stakeholders want do their work effectively and efficiently on iModX platform. Our analysis indicates that the developer tooling currently available for the blockchain ecosystems is in its infancy. To create attractive and efficient model and data marketplace, the iModX team will be engaged with the quants community for enhancing the existing **blockchain tooling**:

i. An **IMDE - Integrated Model Development Environment** as an enhanced version of the **Blockchain Composer** tool that has good linters and all the necessary plug-ins for an effective model solution and smart contract development, as well as blockchain analysis.

ii. A **build tool and compiler** that is well-documented and easy to use.

iii. A **deployment tool** that is user friendly and complaint with the existing model deployment regulations.

iv. **Technical documentation** for iModX APIs, frameworks and IMDE that is accessible for all registered stakeholders.

v. **Testing frameworks** that offer various options for experimentation around testing model-based solutions on the cloud. It is also critical for smart contracts that might be moving significant amounts of utility tokens on the blockchain throughout the entire life of widely used models.

vi. **Debugging and Logging tools** should be capable of doing a similar type of work on the blockchain as in the web development today (i.e. being able to step through code line by line using a debugger).

vii. **Independent validation of models** where validated models would have certified model validation report prepared in accordance with the industry validation standards.

viii. **Tools for Auditing Security, Existence and Ownership of Digital Assets on the Blockchain.** Key stakeholders and security experts will be engaged to create advanced or adapt existing tools and services to help thoroughly audit smart contracts and digital assets held on the blockchain and in custody.

ix. **iModX Block explorers** will enable serious chain analytics in a similar manner as Etherscan, Blockchain.info, Blockexplorer, or Blockcypher do for Ethereum and Bitcoin. The analytics capability of iModX and availability of data about usage and performance of models would serve as a foundation for prudent model risk management at the enterprise level and systemwide with the application of AI and ML techniques.

All the activities on the **Model Blockchain** will be supported by the iModX payment system that is based on a separate private and permissioned **Payment Blockchain** with the use of **iModX currency** in the form of utility tokens. Because it is intended to serve iModX stakeholders globally, the **Hyperledger Fabric** software that implements the iModX Payment Blockchain will require an operating system, which would enable different levels of access in terms of hierarchies, authorization and geographical or legal boundaries. The operating systems for Model and Payment Blockchains will be based on the StonePaper.io platform, an integrated solution for managing smart contracts on the blockchain. StonePaper was developed by Three Lefts, a leading blockchain research and development studio in Canada, and successfully used in a variety of industries, from precious minerals, asset trading, gaming, and media licensing.

The currency used on the blockchain is called "iModX utility token." It will be used as a means of payments among all users of the platform. To ensure that the stakeholders would have confidence that they can use iModX and that its value will remain relatively stable over time, iModX currency will be created in the form of a stable coin. Unlike the majority of cryptocurrencies, iModX tokens will be fully

backed by a reserve of real assets. A basket of fiat, cryptocurrency and gold will be held as a reserve in an independent custody for every iModX token that is created. The iModX Reserve will be independently administered and audited with the objective of preserving the value of iModX over time.

The iModX Consortium is an independent, not-for-profit membership organization. Its purpose is to coordinate and provide a framework for governance over iModX and reserve and lead social impact model and data application for the Common Good. This white paper is a reflection of its mission, vision, and purview. The Consortium's membership is formed from the network of validator nodes ("forgers") that operate the Model Blockchain and those who have "skin in the game" in the iModX network.

Members of the iModX Consortium will consist of geographically distributed and functionally diverse businesses, nonprofit and academic institutions. The initial group of organizations that will work together on finalizing the Consortium's charter and become "Founding Members" upon its completion will represent the following industries:

- Regulated Financial Institutions
- Hedge Funds and asset managers
- Nonprofit and academic institutions
- Blockchain developers
- Technology and software vendors
- Data companies
- Venture Capital
- Auditors
- Industry Regulators.

Our goal is to have representatives from all eight industries as members of the iModX Consortium by the target launch in the first half of 2020.

2. THE MODEL BLOCKCHAIN

The goal of the **Model Blockchain** is to serve as a solid foundation of the model and data marketplace, which could meet the daily needs of thousands of businesses and public agencies in developing and using models. Through the process of evaluating existing options, we decided to build a new private permissioned blockchain based on the following three requirements:

- **Scalable** to thousands of accounts and limited number of forgers, which have different privileges with respect to validation of transactions and their access to models and data kept in the Model and Data Repository - an efficient, high-capacity storage system.
- **Secure** to ensure the safety of information about users of the platform, data and models stored on the permissioned blockchain.
- **Flexible** to power the marketplace's governance, the platform's interoperability as well as future innovation in model and data ecosystem.

The Model Blockchain is designed to operate on the **Hyperledger Fabrics platform** with the **StonePaper operating system** in managing smart contracts and holistically addressing the above-mentioned requirements. The StonePaper is being successfully applied on Hyperledger Fabric permissioned blockchains implemented for various industries, such as precious minerals, asset trading, gaming, and media licensing.

The members of the iModX platform will enroll into the **private and permissioned Hyperledger Fabric network** through trusted **Membership Service Providers (MSP)** appointed by the iModX Consortium. iModX B2B marketplace will use a transactional network where all participants have **known identities**. Public Key Infrastructure will be used to generate **X.509 cryptographic certificates** which are tied to organizations, network components, end users and client models or applications. The "permissioned" notion of iModX platform, coupled with the existence and capabilities of channels, will help address the existing concerns in the financial services industry with respect to **privacy and confidentiality of**

information. The data access control will be governed on the broader network and on channel levels.

The Model Blockchain is flexible to create various **sub-consortia (channels)** - "groups with shared destiny", allowing a group of users to form a separate ledger of transactions. This capability can accommodate market competitors who do not want every transaction they make — a special price they're offering to some users and not others, for example — known to every user. All data, including transaction, member and channel information, on a channel are invisible and inaccessible to any network members with not explicitly granted access to that channel. This functionality would be important for establishing **interoperable permissioned network** with clearly determined **market, regulatory, jurisdictional and geographic boundaries** within the iModX marketplace, if needed.

To facilitate agreement among all **validator or ordering nodes** on transaction execution and ledger maintenance to be executed, and the order in which they are executed, the Model Blockchain will adopt the **Practical Byzantine Fault Tolerance (PBFT) approach** to **consensus protocol,** which is being successfully used on the Hyperledger Fabric. This approach builds trust in the network because PBFT consensus protocols are designed to function with fewer nodes. A separate group of **peer nodes** will be freed from ordering (consensus) workloads and they won't have to trust all ordering nodes, and vice versa. This class of consensus protocols enables high transaction throughput, low latency, and a more energy-efficient approach to consensus than "proof of work" used in some other blockchains.

The Model Blockchain platform is friendly to data owners for **sharing synthetic or anonymized proprietary data in pools** with selected developers for training their models. The data owners can safely "rent" their proprietary data to a specific pool or set of participants in a private channel by taking advantage of the platform's architecture, which is built on the basis of **per-channel legers and smart contracts (chaincodes)**. Even further, if a subset of organizations on that channel need to keep their **transaction data confidential**, a private data collection (collection) can be used to segregate this data in a private database, logically separate from the channel ledger, accessible only to the authorized subset of organizations.

SHA-256 Cryptographic Hash Algorithm will be applied for **integrity verification** of 'hashed' versions of smart contracts, model and data related documentation, such

as model development, validation and audit reports, program codes, reference tables, etc. SHA-256 is one of the strongest hash functions available, and it has not yet been compromised in any way.

The iModX Consortium will oversee the evolution of the iModX Blockchain protocol and network, and it will continue to evaluate new techniques that enhance privacy in the blockchain while considering concerns of practicality, scalability, and regulatory impact.

2. 1. REPOSITORY OF MODELS AND DATA

Model Blockchain will manage and control changes in the state of Model & Data Repository as well as the usage of Models and Data kept in this repository. Financial Institutions and other model users will be able to choose from an array of models, created by other organizations and experienced developers that have been independently validated and certified on the Model Blockchain, which is controlled by the iModX Consortium. This will allow the users to share **certified models** between each other for a price. The validation, audit and even regulatory approval of the models will become more concentrated and extremely efficient because iModX will eliminate the duplication of efforts to validate models that currently exists within the financial services industry. The blockchain will effectively move the bulk of model validation and control activities away from a bespoke in-house model management to a modular workflow with a **common industry wide model certification process** on iModX.

Integrated Model Development Environment (IMDE) will be offered to the platform stakeholders as a tool along with the **Blockchain Composer** for development and deployment of models and model-based software solutions along with smart contract development and blockchain analysis. IMDE would have access to proprietary data sets and well-structured library of software models and solutions that are capable to transform inputs (financial and non-financial data) to produce outputs (prices, risk measures, or forecasts) kept in the Repository. The proprietary (anonymized or synthetic) and external data sets would be used in pools for training and calibrating new models in IMDE. The models and software solutions would be self-contained units, with inputs and outputs which financial institutions could use to input their proprietary and market data, and log it into their databases. We are calling

each **modular unit** a "**Circuit**," and since each circuit is modular it is perfectly ready for connecting multiple "Models" or "Circuits" together as parent and child models for every increasingly complex calculations and software solutions.

Each "**Circuit**" **is a self-contained unit with its own API that runs on a virtual machine**. The nature of this virtual machine would prevent the "Circuit" from being able to access any outside resources except through the **certified Input, Outputs, and Oracles**. This avoids the Circuit from being a security risk for the users, as it cannot leak data outside their network or interact with the organization's data in any other way.

The "**Circuit**" would be **hashed and digitally signed**, and registered on the Model Blockchain. This blockchain entry would contain encrypted program code or compiled file for the Circuit, as well as model development and validation documentation that would allow **certification of the Circuit** and determination of its capabilities and limitations. The information about the key attributes of the Circuit will be shared among the platform's participants, including industry regulators, in a form of a **decentralized ledger**. Any updates in the program code or model documentation would require re-certification of the Circuit, which will effectively create new version of Circuit and hashed records on the block.

In a short- and medium-term, the population of models and software solutions in the repository will primarily grow as a result of **conversion of existing models** and solutions into the blockchain friendly format. Selected models from big libraries of models available in a public domain (e.g. QuantLib, GitHub, R-project, Python packages, etc.) will be translated from various formats **into blockchain formats in line with "industrial grade" standards**. In addition, an independent model validation and comprehensive model documentation will be produced to comply with the existing financial industry standards and regulatory requirements for model risk management. Software vendors will be invited to use iModX tools and standards for converting their existing software packages into the blockchain friendly format, get them independently validated and put in the repository for sale.

The platform users would be able to purchase a flat subscription to the platform or license for specific Circuits on the Blockchain network. They could pay the platform subscription and Circuit licensing fees, or a small amount each time the Circuit processes a transaction - "**pay-as-you-play**" (these would be batched and written to

the Blockchain during the process). This architecture and approach (see **Diagram 1**) would allow for **flexible pricing structure**, with models and software packages that are guaranteed to work and already have been independently validated and possibly blessed by industry regulators.

The new platform will generate **big data** about the deployment of all certified models and software solutions. That includes, but not limited to, the frequency of model usage, its interdependencies, and materiality of model inputs/outputs. That information combined with a comprehensive classification of models, types of data inputs and outputs would allow to move the model management practices to the next level. Current predominantly qualitative model risk management practices will be enhanced with **quantitative measures of model risk** at the enterprise level, for specific countries, or the global financial services industry. The situations of a massive use of inappropriate models for specific decision making could be detected and remediated in a timely manner. A phenomenon of global mis-application of the Gaussian Copula for credit derivatives and structured products that the financial services industry experienced prior to the latest 2008 financial crisis would be prevented. It will become technically viable and practical to use AI and ML techniques for advancing **computer assisted development of software** solutions (Model CAD) and model risk management practices.

3. The Payment Blockchain

The goal of the **Payment Blockchain** is to support operations of the Model Blockchain by **executing payment transactions** with a medium of exchange – **iModX utility tokens** - between participants of the iModX marketplace. The Payment Blockchain can also provide a **technological platform for a custodian solution** to be implemented and maintained at arm's length independent financial institutions. The private permissioned Payment Blockchain will meet the following three basic requirements:

- **Scalability** to tens of thousands of accounts (wallets) with limited number of forgers (validator nodes) that enables internal transfers of iModX tokens in an efficient and low-cost manner,
- **Security** to ensure military grade safety of storage and transfer of iModX tokens between the wallets, relative **stability** of intrinsic value and **fungibility** of iModX tokens, and
- **Flexibility to** support the iModX marketplace's governance, the platform's interoperability as well as future innovation in payment ecosystem on the blockchain.

The Payment Blockchain will operate as a **dedicated Channel of the Model Blockchain** Hyperledger Fabrics platform with the StonePaper operating system to manage smart contract chaincodes and holistically address the afore-mentioned requirements. The Payment Blockchain Channel will provide a mechanism for private communications and private data exchange between participants of the Channel with respect to payments and movements of iModX tokens. We note that Hyperledger Fabric will allow an efficient sharing of infrastructure of the iModX marketplace while maintaining **data and communications privacy** within every channel to be created, including the payment one.

The Payment Blockchain will be leveraging Endorsement Policies, Certificate Authorities and ordering and peer nodes of the core Model Blockchain. The **StonePaper** operating system will manage separate smart contract chaincodes related to execution of payments from model users to developers and validators.

The **iModX utility token** is designed to be a **stable digital cryptocurrency** that will be fully backed by a reserve of assets — the **iModX Reserve** — and supported by the private permissioned Payment Blockchain that will operate as an exchange for buying and selling iModX tokens. To provide a high degree of assurance that participants of the iModX marketplace can convert their digital currency into a fiat currency, an iModX reserve will be formed and maintained at independent regulated financial institutions performing custodial services for the marketplace. The utility tokens will have properties of a **stablecoin** - 100% of the **iModX tokens will be backed by a basket of fiat currencies, cryptocurrencies and gold**. The weightings of the components of the basket will be determined by an optimization algorithm with a goal of achieving contained volatility against the Special Drawing Rights (SDR) and sustainable long-term preservation of the basket's market value to withstand the ongoing fiat currencies debasement. The value of the SDR is based on a basket of five currencies—the U.S. dollar, the euro, the Chinese renminbi, the Japanese yen, and the British pound sterling. The iModX basket will be rebalanced on a regular basis in line with an iModX Reserve Management Policy.

iModX tokens will not be circulated outside the platform to avoid speculation and deviation of its price from the fair value of underlying reserve assets held in custody.

We note that one iModX token will not always be able to convert into the same amount of a given local currency (i.e., iModX is not a "peg" to a single currency). Rather, as the value of the underlying assets in the basket moves, the value of one iModX token in any local currency would fluctuate. However, the reserve assets and their weightings in the basket will be determined to not only **contain short-term volatility**, but also **sustain long-term value preservation**, so holders **of iModX tokens** can trust the currency's ability to maintain its value over time. The **custodians** of the iModX Reserve will be **regulated financial institutions with**

investment-grade credit ratings to ensure adequate security of the assets and high quality of custodial services.

iModX utility tokens will be minted on the Payment Blockchain with simultaneous increase in the reserve assets held in custody. The number of utility tokens in circulation will be affected by the usage of models, redemption of tokens for fiat or major cryptocurrency, or velocity (speed of token movements that change the hands). Increase in velocity would drive additional minting because there will be **nominal fees** charged by the platform for all transactions with data, models and token transfers.

The assets behind iModX token are the major difference between it and many existing cryptocurrencies that lack such intrinsic value and hence have prices that fluctuate significantly based on expectations. iModX token is a cryptocurrency that possesses several attractive properties embedded in digital currencies: the ability to move money quickly at low cost, the security of cryptography, and the freedom to easily transmit funds within the platform across the borders.

We do not expect that a cash-like Reserve would earn any interest from investing or rehypothecation of the underlying assets. At the same time, if any interest on the reserve assets were earned, it would be used to cover the costs of the marketplace, ensure low transaction fees, pay dividends to investors who provided capital to jumpstart the ecosystem, and support further growth and adoption. The rules for allocating interest on the reserve will be set in advance and will be overseen by the iModX Consortium. Participants of iModX marketplace will not receive a return from the reserve.

3. 1. INDEPENDENT CUSTODY

The basket of reserve assets will be formed from the combination of gold, fiat and cryptocurrencies with a goal to stabilize the intrinsic value and provide adequate liquidity of iModX utility tokens. The diversity of the reserves held in the form of gold bullion, fiat currencies and digital assets would require custodians and possibly sub-custodians with diversified and advanced infrastructure. There should be no issue to keep part of the reserves in the form of gold bullion and fiat currencies at **well-established custodians** (BONY, State Street, RBC etc.), whose core business is to secure and provide associated custodial services for conventional assets (equities, bonds, gold, and currencies).

The challenge might be to find a regulated financial institution that would provide custodial services for digital assets and cryptocurrencies. Our intention is to hold a fraction of the reserve assets in the form of major and most liquid cryptocurrencies such as Bitcoin, Ethereum, XRP, Litecoin, etc. The iModX blockchain implementation on the Hyperledger Fabric platform with StonePaper operating system would allow the creation of additional **private channels** dedicated to **custodial services for digital assets**. Regulated financial institutions could "own" the custodian channels on iModX blockchain or connect their in-house custodian blockchains with the **iModX's custodian channels**. In both cases, an independence of custodians from iModX marketplace will be fully achieved.

The custodian channels might require development of **Endorsement Policies, Certificate Authorities** and ordering and peer **nodes independent** from the core Model Blockchain. The **StonePaper** operating system will manage separate smart contract chaincodes related to transactions with digital assets and cryptocurrencies.

4. THE IMODX CONSORTIUM

With the full transparency and the gratitude we would like to acknowledge the influence of the Libra project and the blueprint of its governing body – The Libra Association, as well as Utility Settlement Coin (USC) Consortium – on the governance structure and design of the iModX Consortium.

To make the mission of iModX a reality — an international model exchange that democratizes model and data ecosystems — the iModX Blockchain, Model & Data Repository and iModX Reserve need a **governing entity** - the **iModX Consortium** - that is comprised of exchange investors and platform participants representing businesses, industry associations, and academic institutions. The consortium is designed to facilitate the operation of the iModX Blockchain; to **coordinate** the agreement among its stakeholders — the network's validator and peer nodes — in their pursuit to **promote**, **develop**, and **expand** the network, and to **manage** the reserve.

The consortium is governed by the iModX Consortium **Council**, which is comprised of one representative per validator node and exchange investors. Together, they make decisions on the governance of the network and reserve. All decisions are brought to the council, and major policy or technical **decisions require** the consent of two-thirds of the votes, the same **supermajority** of the network required in the PBFT consensus protocol.

Through the consortium, the validator nodes align on the network's technical roadmap and development goals. Since iModX will rely on a growing distributed community of developers to further itself, the consortium would be a necessary vehicle to establish guidance with respect to protocols and specifications to develop and adopt.

The iModX Consortium also serves as the entity through which the iModX Reserve is managed, and hence the stability of the intrinsic value of the iModX tokens are achieved. The consortium is the only party able to create (mint) and destroy (burn)

iModX utility tokens. Tokens are only minted when authorized resellers have purchased those tokens from the consortium with fiat assets to fully back the new tokens. Tokens are only burned when the authorized resellers sell iModX token to the consortium in exchange for the underlying assets. Since authorized resellers will always be able to sell iModX tokens to the reserve at a price equal to the value of the basket, the iModX Reserve acts as a "buyer of last resort." These activities of the consortium are governed and constrained by a Reserve Management Policy that can only be changed by a supermajority of the consortium members.

In these early stages of the model exchange development, there are administration activities that need to be performed on behalf of the consortium:

- The recruitment of Founding Members to serve as validator nodes; the fundraising to jumpstart the ecosystem, and
- The design and implementation of incentive programs to propel the adoption of iModX, including the distribution of such incentives to Founding Members.

5. NEXT STEPS FOR IMODX

This section outlines the goals for iModX marketplace and launching iModX.org as a home for the Consortium. It will continue to be updated over the coming months.

There are a number of important steps to be made before the target launch in 2020:

- **Governance**: Over the coming months, the Founding Members of the Consortium will work with the community to form the core of the Consortium. The goal is to engage key players of the model ecosystem for validation of nodes and work on the Consortium as representatives of the following model-implicated industries: Regulated Financial Institutions, Hedge Funds and asset managers, Nonprofit and academic institutions, Blockchain developers, Technology and software vendors, Venture Capital, Auditors and Industry Regulators. The Consortium will develop and adopt a comprehensive charter and a set of bylaws for the Consortium on the basis of the currently proposed governance structure. The Consortium members will be reviewing and approving the initial set of model exchange frameworks, policies and procedures pertaining to the governance of the blockchain, asset reserve, and payment system.

- **The iModX Blockchain**: iModX team will work with the consortium members and the community to bring the iModX Blockchain prototype to a production-ready state. There will be a series of pilot projects with regulated financial institutions on development of Enterprise Version of iModX Blockchain, where a private and permissioned model blockchain will be owned by the financial institution. In particular, this work will focus on ensuring the security, performance, and scalability of the protocol and implementation.

- **The Data & Model Repository**: Along with the iModX Blockchain development we will be building the repository of models and data in a blockchain friendly formats. The selective models from the existing public libraries (QuantLib, GitHub, etc.) and proprietary software packages will be translated, compiled, hashed, encrypted and put into the Repository. The IMDE – Integrated Model

Development Environment tools and APIs will be developed and well-documented to enable model developers, validators and users to interact with the iModX Blockchain and Repository.

- **The iModX Payment Blockchain**: The separate channels dedicated to the payments and custodial services will be developed of the main model blockchain.
- **The Reserve Custody**: Geographically distributed registered financial institutions will be contracted to provide custodial services for the Reserve basket of bullion, fiat- and cryptocurrencies. In case of cryptocurrencies, dedicated Hyperledger Fabric's blockchain channels would be offered to financial institutions that would provide the custody. Alternatively, interoperable Payment Blockchain channel will be connected with a native custodial blockchain of the financial institution.
- **The Reserve**: The consortium will determine the exact composition of the Reserve assets and establish policies and procedures for rebalancing the Reserve basket in accordance with weightings obtained from the optimization algorithm.

6. How to Get Involved

The consortium envisions a vibrant ecosystem of developers building models and services to spur the global use of iModX marketplace. The consortium defines success as **BBdoB** - enabling any qualified person or business globally to **Build, Buy** or **do Business** with models and data on the iModX blockchain platform. For example, success will mean that a group of quants or academics have tools to put their models and software solutions on the exchange, independent consultants validate the models and software solutions, and registered online bank use those models and solutions for fair valuation and risk management purposes and pay the quants/academics and model validators with utility tokens on a per-use basis.

Our journey is just beginning, and we are inviting the community to join the bandwagon. If you believe in what iModX could do for thousands of quants and model/data stakeholders in developed and developing markets, share your perspective and join in. Your contribution to the Uberization of model ecosystem would pay back in the form of utility tokens which fair value would be protected against the ongoing debasement of fiat currencies.

We are subscribing to the initial group of organizations and individual quants that will work together on forming the iModX Consortium as representatives of the following industries:

- Regulated Financial Institutions
- Hedge Funds and asset managers
- Nonprofit and academic institutions
- Blockchain developers
- Technology and software vendors
- Data companies

- Venture Capital
- Auditors
- Industry Regulators.

If you consider yourself or your organization belong to one of those industries and interested to work on the iModX Consortium, please subscribe here.

The Consortium will work with the global community in the coming months and continue to partner with policymakers worldwide to further the mission.

7. CONCLUSION

This is the goal for iModX platform: A model and data marketplace built on a secure and private permissioned blockchain, backed by a reserve of cash-like assets, and governed by an independent consortium.

Our hope is to “uberize” the model and data ecosystems by creating more access to better, cheaper, and transparent models — no matter whether you are an academic at a university or quant working for an organization - internationally active well-established bank or niche online alternative lender startup, vertically integrated software vendor or software boutique firm.

We recognize that the road to building the model and data marketplace may not be smooth and easy. At the same time, we hope that you will join us to disrupt the model ecosystem dominated by a few global software powerhouses and get benefits from the commoditization and democratization of models and data.

8. FAQ

What is a model?

There exist many definitions of a model, depending on a context, industry, and application. We find that one of the most comprehensive definitions was given by the Feds and OCC in their SR Letter 11-7 – Supervisory Guidance on Model Risk Management: "… the term model refers to a quantitative method, system, or approach that applies statistical, economic, financial, or mathematical theories, techniques, and assumptions to process input data into quantitative estimates. A model consists of three components: an information input component, which delivers assumptions and data to the model; a processing component, which transforms inputs into estimates; and a reporting component, which translates the estimates into useful business information. Models meeting this definition might be used for analyzing business strategies, informing business decisions, identifying and measuring risks, valuing exposures, instruments or positions, conducting stress testing, assessing adequacy of capital, managing client assets, measuring compliance with internal limits, maintaining the formal control apparatus of the bank, or meeting financial or regulatory reporting requirements and issuing public disclosures. The definition of model also covers quantitative approaches whose inputs are partially or wholly qualitative or based on expert judgment, provided that the output is quantitative in nature."

Even though that definition was developed in the context of regulated financial institutions, banks primarily, it could be extended towards models used in other industries and applications, including weather forecast or genetics simulation. It could cover a full spectrum of models, starting from fairly simple valuations up to and including models underpinning Machine Learning (ML) and Artificial Intelligence (AI) techniques.

What is a blockchain?

A blockchain is, in the simplest of terms, a time-stamped series of immutable records of data that is stored in a distributed ledger and managed by cluster of computers,

called nodes, not owned by any single entity. Each of these blocks of data (i.e. block) are secured and bound to each other using cryptographic principles (i.e. chain). The blockchain's network of nodes and distributed ledger of records have no central authority — it is the very definition of a democratized system. Since it is a shared and immutable ledger is distributed, the information in it is open for everyone who have access to the blockchain or its channels. For instance, members of iModX Consortium and those who are registered on the iModX blockchain platform or its channels can see transactions on the entire platform or private channels only.

Is iModX disruptive?

Yes, as a FinTech innovation, the new iModX marketplace will reshape the model and data ecosystem. iModX will radically decrease cost of model deployment and eliminate barriers of the model ecosystem for thousands of smaller organizations and qualified individuals. It will be done in a similar manner as Uber did for millions of riders and individual car owners.

The disruption comes through introduction of the distributed ledger blockchain technology that leads to fundamental changes in model management infrastructure and processes at the enterprise level and for the entire model ecosystem.

The iModX distributed ledger technology drastically reduces the cost of trust among competing or conflicting patrons of the model ecosystem. The iModX architecture involves smart contracts and the Practical Byzantine Fault Tolerance (PBFT) approach to consensus protocol that will automatically enable voting on and registering new deals and transactions on the platform without involving intermediaries or central authority.

The iModX blockchain technology allows the platform to record events, manage records, process transactions, pay royalties, and trace models, data and tokens, in an immutable manner. The blockchain is essentially a continuously growing list of records about the deals and transactions on the platform. Its append-only structure only allows data to be added to the distributed database: altering or deleting previously entered data on earlier blocks is impossible.

iModX blockchain based platform will support ecosystem's stakeholders through the entire model lifecycle, from model design, development, implementation, validation, audit, deployment, monitoring, and up to decommissioning. Here is a high-level overview of how iModX might impact key model stakeholders' modus operandi:

Model Stakeholders	Impact on Sophisticated/ Large Stakeholders	Impact on Emerging/ Small Stakeholders
Developers	- Model development becomes a profit center function at financial institutions that upload existing in-house models onto iModX - Less of a single model development work and more design and architecture of model-based solutions - Development of better models with AI and ML techniques, and after getting access to industry data pools - Robust protection of IP and copy rights	- Emergence of independent model developers and solution architects - Affordable engagement of model developers or solution architects - No development needed; can choose existing standard solutions from the shelf - Development of models with AI and ML techniques and use of industry data pools
Validators	- Model validation becomes a profit center function when existing validation reports are posted on iModX - Less of a single model validation work and more of an end-to-end validation of model-based solutions - Decreased headcount of model validation departments	- Emergence of independent validators - Choice of using models and solutions with(out) independently performed validation - Shared cost of validation of new models with other organizations
Deployment resources	- Fast implementation and low-cost maintenance of solutions with scalable computing power on the cloud - Decreased infrastructure cost and headcount required for deployment of models - Access to comprehensive information about model and data usage at own company and industry wide	- Fast implementation and low-cost maintenance of solutions with scalable computing power on the cloud - De minimis cost of building and maintaining model infrastructure - Access to comprehensive information about model and data usages
Auditors	- Model audit might become a revenue generating function - Reliance on a third-party audit work under the risk-based audit approach - Decreased headcount in model audit groups	- Emergence of independent specialized model auditors - Decreased cost of a third-party model audit work
Model users	- Significant savings in model development, validation, deployment and audit through lightening inhouse infrastructure, processes and headcount - High efficiency and transparency of model usage - Agility in introducing new and decommissioning obsolete models	- Emergence of new model users across industries enabled by a low-cost access to data, technical expertise, and commoditized models - Low entry barriers for adopting models with manageable pay-per-play or subscription cost

Model Stakeholders	Impact on Sophisticated/ Large Stakeholders	Impact on Emerging/ Small Stakeholders
	- Lower cost of model related regulatory compliance	- Increased competitiveness of small and new players in a digital economy through adoption of models
Bank clients	- Bank clients can get secured by blockchain access to some of bank's models as part of the superior customer services available to valuable clients.	- Broader range of model driven products (e.g. types of insurance or investments) that were not previously available due to lack of modelling and quantitative resources
Data providers	- Emergence of data pools - Emergence of new providers of anonymized, disguised or synthetic proprietary data - Expanded clientele base for well established data providers - Enhanced protection of data sets in distributed ledger through encryption	- Low cost access to services of well-established data providers - Emergence of non-homogeneous data pools built by niche playing or small businesses
Software vendors	- Emergence of new distribution channel - Compressed profitability margins - Increased flexibility in revenue generation with a flat subscription and pay-per-play sources	- Ability for small vendors to reach the global model market place and effectively compete with big software houses in a transparent manner
Independent contractors	- Improved depth and breadth of services to be offered to the platform stakeholders	- Emergence of new businesses and shops with "a laser focused" services offered to the platform stakeholders
Academics	- Supported conversion of algorithms from academic research and papers into the industrial quality models - Friendly marketplace for testing academic ideas and algorithms in real world and business	- Breaking the wall between the leading academic research and its application across industries and businesses
Industry regulators	- Improved transparency in local and global model usage - Streamlined lower cost regulatory model approval process - Ability to identify and mitigate systemic model risk (e.g. 2008 Gaussian copula phenomenon) - Ability to observe emerging AI and ML practices and respond with adequate prudential regulation	- Steepened learning curve for establishing model regulation locally - Ability to identify best model management practices globally to enhance prudential processes locally - Better calibration of adequacy of local regulatory practices given the observed materiality of model exposures in own jurisdiction
Board of Directors	- Better managed fiduciary role in providing oversight in model risk management through enhanced transparency of in-house model usage	- Ability to learn about and adopt appropriate model risk oversight standards - Enhanced ability to challenge the organization's management in model

Model Stakeholders	Impact on Sophisticated/ Large Stakeholders	Impact on Emerging/ Small Stakeholders
	- Enhanced ability to challenge the organization's management in model oversight matters by leveraging the platform-based information about model management standards	oversight matters by leveraging the platform-based information about model management standards
Model risk governance	- Decreased overall cost of model management - Streamlined governance structure and processes through an effective outsourcing of key governance functions to iModX - Harmonization and simplification of industry-wide model governance practices	- Ability to introduce a practical low-cost in-house model governance that relies upon the platform's processes governed by the blockchain consensus protocols and smart contracts
Risk management	- Decreased headcount and cost of measuring organization's risks and calculating capital - Enhanced automation of risk measurement and management - Ability to better quantify model exposures by leveraging information from iModX about the usage, materiality, and interdependencies of models - Application of AI and ML techniques for measuring and managing risk exposures	- Ability to quantify model risk exposures by leveraging information from iModX about the usage, materiality, and interdependencies of models - Application of AI and ML techniques for measuring and managing risk exposures

Is iModX platform safe?

Safety and security are iModX's highest priorities. Security is built into the very design of the iModX Blockchain with the best available cryptography standards to prevent malicious activity, protect the intellectual property of model developers, privacy of proprietary data, prevent hacking of models and software solutions, and safety of holding iModX utility tokens.

What is a utility token?

A utility token is a digital token of cryptocurrency that can be used to purchase a good or service offered by the issuer of the cryptocurrency. The iModX utility tokens will be issued to support all transactions on the iModX platform, such as payments of model users to model developers, validators and data providers.

The iModX utility tokens have properties of a stablecoin - 100% of the iModX tokens are backed by a basket of fiat currencies, cryptocurrencies and gold. The iModX tokens are designed to minimize the volatility of its price, relative to the Special Drawing Rights (SDR), and ensure sustainable long-term preservation of the basket's market value.

The iModX utility token is designed to be a stable digital cryptocurrency that will be fully backed by a reserve of assets — the iModX Reserve

Is iModX token a cryptocurrency?

Yes. iModX token is a cryptocurrency designed to be a stable digital cryptocurrency that is fully backed by a reserve of assets — the iModX Reserve – and which cannot be circulated outside the iModX platform.

Is iModX token available now?

Not yet! Over the coming months, the consortium will be working to develop and grow the iModX's network. If you are an organization interested in joining the iModX Consortium, you can learn more here.

Is iModX token real money?

Not yet. iModX utility tokens are used exclusively for payments on the platform. The patrons of the platform can buy or sell tokens for fiat or cryptocurrency from/to the iModX "central bank". The value of an iModX utility token is determined by the market value of the iModX Reserve divided by the number of tokens in circulation.

In the future, when the number of patrons of the platform become significant, the iModX Consortium might decide to convert the iModX permissioned private blockchain into a Decentralized Autonomous Organization (DAO) and open the circulation of iModX tokens outside the platform. In that case, the tokens might become a real money that could be converted into a local currency based on the market exchange rates.

What is the difference between iModX token and other cryptocurrencies?

Unlike many cryptocurrencies whose values fluctuate based on speculation, iModX token is backed by a reserve of assets. This is similar to how other currencies have been introduced in the past — to help instill trust in a new currency and gain

widespread adoption, it was guaranteed that a country's notes could be traded in for real assets, like gold. In a similar manner, the iModX Reserve will back up 100% of the tokens with a basket of gold, fiat and cryptocurrencies.

What is the iModX Reserve?

The iModX Reserve was created to preserve the value of the iModX tokens. Each iModX token will be backed by a basket of gold, fiat and cryptocurrencies held in the reserve. The weightings of the components of the basket are determined by an optimization algorithm with a goal of achieving contained volatility against the Special Drawing Rights (SDR) and sustainable long-term preservation of the basket's market value to withstand the ongoing devaluation of fiat currencies.

How can I get iModX token?

You will be able to buy iModX tokens from the iModX "central bank" after your organization is registered on the platform.

Is iModX token legal?

iModX token is legal and can be used as a means of payments on the iModX platform.

Annex: Diagram 1 - iModX Platform