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RADICALIZING THE EQUITY MARKET

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Abstract: The equity market poses a very inefficient system when it comes to post-trade clearing, payment, and settlement. Trade matching occurs at the rate of hundreds of trades per second but clearing and settlement of stocks takes more than two days to complete. The equity market should consider a complete system revamp as the current systems and practice methods are based on legacy processes that are outdated. We present the ProximaX Sirius development platform as a suitable core component for an alternative equity market ecosystem which could save the industry billions of dollars a year in operational expenses. Our recommended approach looks at a clean sheet design taking cognizance of existing regulatory requirements and the need to shorten the post-trade clearing, payment, and settlement cycle. This paper is intentionally written to address a wide spectrum of readers and does not contain deep dive technical details and design. This paper also discusses how this is now being implemented as a suitable platform using the ProximaX development platform to cater for issuance of security, that is completely driven by blockchain and managed in a manner that is similar to the requirements of most jurisdictions for the equity market.

The solution, the Distributed Ledger for eXchange (DLX) can be used in a multitude of scenarios, be it for management of security token issuance and offer, crowd-funding, stock exchange, and other asset issuance, and management where complete transaction audit trail and transparency are required to satisfy regulatory requirements.

Keywords: ProximaX Sirius, equity market, Security Tokens, STO, private chain, permissible chain, decentralized ledger, distributed ledger technology, multi-ledger, blockchain, smart contract, Sirius Chain, distributed technologies, distributed storage, development platform.

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1. INTRODUCTION

The equity market is a very old market tracing its history to several hundred years ago. The Dutch East India Company was the first ever company to issue shares to the general public in 1602, giving birth to a new financial product and industry.

Today, just about every economy, whether already developed or still emerging, has a stock exchange. The manner of trading shares and payment settlement has not changed radically, but rather have morphed only very little over time. On the other hand, with the advent of electronic and Internet technologies, the means in which they are being traded and the consequent payment and settlement have changed drastically over the last 30 years. This leaves the practice method archaic by comparison to the means.

Why does one still need to make a settlement a few days after a trade (commonly known as T+X, where X is usually three days after a trade)? Why is there a time lag in reporting to regulatory authorities of a substantial shareholding disposal? Is there really a need to have share custodians, clearing houses, brokers, share registrars, and central depositories of materialized or dematerialized stocks[1]?

This paper takes on a radical approach in re-designing the equity market and proposes an "outside-the-box" thought process that may very well change the way equities are traded in the future. The approach is one of disintermediation and reintermediation, largely decentralized in design – using the ProximaX blockchain technology driven development platform[2] – and at the same time, taking out many of the risks for the parties involved, resulting in an equity market utopia of sorts.

It gives regulators a new and more efficient way of managing equity trades and transactions.

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[1]Dematerialized stocks are stocks without physical certificates, but merely electronic records.

[2] https://suite-app.proximax.io/s/yfTko5PfyyN9K5N

2. RELEVANCE

Blockchain is a decentralized and distributed ledger technology. It is a ledger solution that uses three very important technologies that have been well proven and well used for many decades – peer to peer computer node technology, database, and cryptography science.

An equity market uses ledgers to manage stock trades, reconciliation, payments and settlements, clearing, and share registration. In fact, the entire industry is driven by disparate ledger systems at its core.

As such, a suitable blockchain technology with multiple ledgers that can cross-relate and cross-transact with one another automatically, and in the most efficient manner will make a perfect fit for a very efficient equity trading ecosystem.

3. CURRENT STATE OF EQUITY MARKET SYSTEMS

Let us start with examining some of the roles of existing players in the market.

3.1. STOCK EXCHANGE

The stock exchange exists fundamentally as an electronic matching system, pairing buyers and sellers of equities. Usually, it serves broking houses and market makers selling and buying equities in the market. Stock exchanges are run by powerful computer systems with the ability to ingest multiple quotes from traders and subsequently pairing up trades, often into hundreds of transactions per second for some major exchanges.

3.2. BROKING COMPANIES

Broking companies are intermediaries to retail or institutional investors who wish to buy or sell shares. These broking intermediaries are a result of hundreds of years of legacy practice. The advent of electronic or internet trading has somewhat marginalized many of these physical brokers. Instead of physical communication via face to face or telephone orders,

most of them have now gone on to become internet trading platforms with minimal physical broking. Broking firms that still exist today are largely due to legacy regulatory requirements as well as ensuring protection of the market space in each jurisdiction. Brokers are there so that regulators can license them to officially represent traders and to abide by the rules of the regulators. The roles of brokers have changed somewhat over the years. Today, these brokers are licensed more so to protect their interest in the local industry, at the same time, giving little value to the ecosystem.

3.3. CENTRAL SECURITIES DEPOSITORY SYSTEM

In today's equity trading, most shares certificates are dematerialized in that they are made electronic or simply called scriptless. They are usually kept in a central securities depository system and managed by a central entity. Some of these entities are managed by the stock exchanges directly, while some are separately managed by a single central custodian.

Some markets may still have physical scripts, where brokers will require the use of custodian services. Most markets also have custodians, to act as clearing and settlement agents for equity transactions.

3.4. CLEARING HOUSES

At confirmation, a trade in a stock exchange needs to be appropriated and cleared by a clearing institution where share certificates (electronic or not) are arranged to be netted or grossed out between a buyer and a seller through their representative brokers/custodians. The process can be tedious and erroneous at times. Risks are continually being managed and mitigated among participating members.

Over the years, this process has been made easier using electronic means. Nevertheless, this process should be made redundant as real-time clearing should be done upon trade match. The existence of brokers has made this complicated, a result of its early days development from a few hundred years ago.

The advent of electronic means to clear did not change the process, merely facilitated the same process with less human intervention.

The ideal situation would have been to get rid of the need to have this clearing process, thereby taking away these actors in the industry.

3.5. SETTLEMENT INSTITUTIONS

Settlement institutions are normally run by central banks to make payment settlements between buyers and sellers of securities. Custodians and brokers act on behalf of these sellers and buyers to make settlement. They are normally settled as a net sum for multiple trades during the day between brokers who act on behalf of their sellers and buyers. It is a multi-staged process that requires a lot of effort.

3.6. TRADERS

Traders could be retail investors representing individuals and companies. They could also be institutional investors, representing licensed asset management companies or trust companies.

Institutional investors may want to trade directly in the stock exchange, while most go through broking companies. All retail investors go through broking companies.

3.7. SHARE REGISTRARS

A share registrar keeps records of shareholders and manages outstanding shares of issuing companies. It also manages dividend payouts and issuance of new shares by these companies.

Many a time, registrars are never accurate in the shareholders' records and often smaller shareholders go unchanged while the scripts are being passed around many times through many hands over the years.

4. EXAMINING THE PROBLEMS OF CURRENT EQUITY MARKETS

The fundamental role of a stock exchange is to match and facilitate buyers and sellers of equities, while at the same time, mitigate the risks associated with each trade. A buyer to deliver money, and a seller to deliver share certificates. Subsequently, instruments are exchanged with, if at all possible, no risk to either party, and in the shortest time possible.

In the early days, this was like an everyday affair with buyers and sellers "meeting under a tree". But then, as the process became more sophisticated, it needed something that was crucially very efficient, reducing the risks for every transacting party to a minimum.

Brokers were required to represent groups of buyers and sellers, so that the market would become a less crowded place. Imagine if the entire populace descended onto the marketplace!

In recent decades, processes were automated and systems were built around them to facilitate, ease up, and improve on the delivery for each function.

This eventually became a monolithic integrated ecosystem that we now call the stock market.

These specific systems have been well integrated in most stock markets. But there still exists many pockets of disjointed integration resulting in unnecessary work, inefficiencies, and risk for intermediaries.

Each of these solutions was a result of the need to get the fulfilment for each stage of a trade lifecycle completed efficiently. Over the years, each of these specific value chain solutions have become large and specialized business entities providing such services.

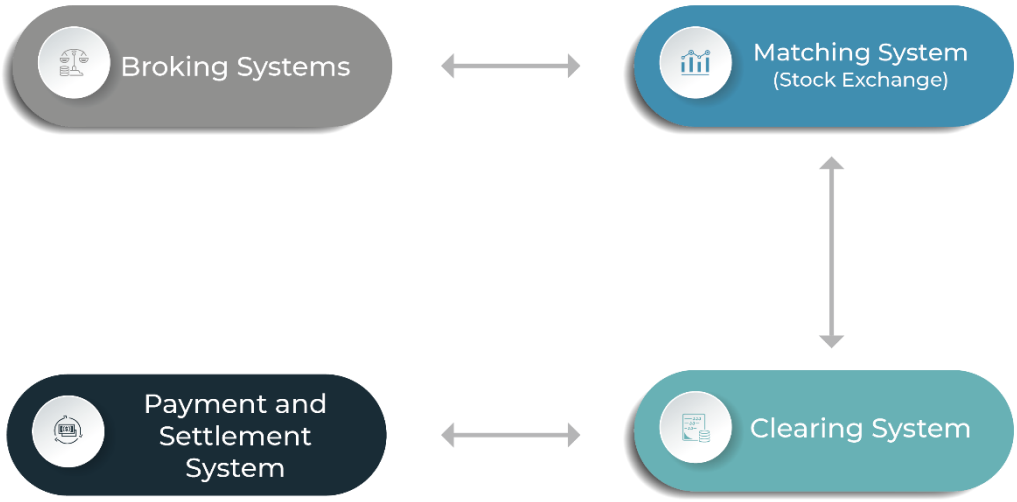

Figure 1 – Trade lifecycle

All these systems work very well in their own silos but when all these systems come together, the cost, both in resources and in terms of efficiency, can be unnecessarily high. A solution would be to take a radical step towards dismantling the entire system and rebuilding it into one complete, efficient, and straightforward system.

The payment and settlement system comprises banks coming together to make payments on behalf of their clients. Each of these banks have their own electronic ledger system at their core. Money as we know it in its physical form, can easily be paid directly between two parties without an intermediary. Money in an electronic form needs an intermediary that can bring multiple banking systems together so that they can exchange values and update their respective ledgers. There is no single ledger but, instead, a multitude of banks, each with their own ledgers. The settlement platform is therefore, a platform where they agree to update their ledgers upon confirmation of a payment – a rather inefficient method with elements of risks, but a necessary solution today.

The sale and purchase of equities involves money, making it necessary for a payment and settlement system to be part of an equity market. And along with it, a complicated process arises, because money as an asset or instrument of exchange, is not part of the assets that are embedded into the equity market system. This makes it physically and electronically distinct from the equity market system. This point will be illustrated further when we present a solution to the problem.

Custodians, the stock exchange, and brokers are involved in a highly complicated and entangled web of clearing after a matching trade is done. This results in at least a day or two to complete the clearing process before a payment settlement can be made. The cost is high as it involves both electronic and sometimes manual checking and reconciliation to get each trade matched and cleared. This process involves many parties and systems, making it expensive and tedious.

5. CHANGING THE PARADIGM

Let's for a moment not look at all the convoluted requirements of current systems in the equity market and start from a clean sheet.

There is a need to make electronic share scripts that cannot be duplicated so that these electronic share scripts can be circulated or change hands electronically between known parties in a closed environment.

There is also a need to use a pivoting currency that can be used as an electronic medium of exchange in the same system, i.e., traded inside the exchange so that settlement is done as trades are matched. This pivoting currency cannot be duplicated and again, can be easily exchanged between known parties. Like casino chips, they are only recognized as a currency of exchange and not fungible or exchangeable outside the equity market. This digital money is a constant (i.e., value is not volatile as each unit is pegged to a specific unit of fiat money) which will be used to purchase securities. It is classified as a special class of "stock" or asset in the system and represents the only medium of exchange in the system for equity. Cashing out in actual fiat money will require the help of a payment processor to exchange this closed system digital money into fiat money.

To put the above into perspective, let's say the USD is represented by a "dematerialized asset" in the exchange, then selling a stock called Blue Sky is exchanged with the asset called USD. Settlement becomes defunct as the matching constitutes a completed transaction between a seller and a buyer. A buyer deposits the "asset" USD into the exchange. Likewise, a seller

does the same with Blue Sky shares. When they trade, the assets switch over.

In line with global changing trends and risk management, investors should be required to make prepayments before they can buy equities. This prepayment is then turned into digital money as an asset that behaves like a stock with a non-volatile reference value in the stock exchange.

There is one particular group of traders that thrives on high frequency trades during the day and do netting at the end of the trading period. This group may be impacted by the need to make prepayments. However, one should take note that there is a risk of non-payment in the traditional trading method. This risk is now mitigated with prepayment. But if prepayment is not something acceptable, in the end, it is a regulatory issue to minimize risk or not. These traders alternatively, can collateralize their assets to get more credit to trade. It calls for a different consideration on how these high frequency traders should trade. The absence of it could stymie liquidity, and the presence of it could cause market collapse.

In the new paradigm, main players in the ecosystem would then be:

1. A central identity and ledger management system
2. Public Companies
3. Stock Exchange
4. Payment processors
5. Investors – retail and institutional
6. Banking system for eventual fiat conversion

Excluded and mostly defunct players are:

1. Custodians
2. Brokers
3. Clearing Houses
4. Settlement and payment system
5. Share Registrars

Custodians are not required because there shall exist one main central body - the central identity and ledger management system – that will replace them.

Brokers are not required as investors now act and trade directly in the exchange without a broker. The old system required brokers because the market place could not house the physical presence of everyone. With electronic means, everyone does not need to be physically present in order to make a trade in the stock market. As it is now, physical brokers are getting lesser and lesser, and broking houses are taking on a different role of an added layer of intermediary for clearing and settlement.

Clearing houses and payment and settlement systems are not required because there is nothing to clear nor settle anymore. There is no more netting of assets as they change hands when a trade is matched, instantly. Consequently, there is no more payment and settlement after a trade.

Some of these ecosystem players may still exist, although they would need to reinvent their roles and perform different functions in the new paradigm. An example would be a bank providing the service to on-ramp and off-ramp fiat money into/from the system via a payment processor gateway in the exchange.

5.1. CENTRAL IDENTITY AND LEDGER MANAGEMENT SYSTEM

A central identity management system will be required to register all investors in the equity market. It can assume the same responsibility of current Central Securities Depository (CSD) bodies where every investor that has attained a certain legal age and/or wealth, an institutional investor, or a legal entity must undergo a “know-your-counterparty” (KYC) assessment in order to be registered with a CSD.

Each registered entity will be given an account that is to be used for trading equities.

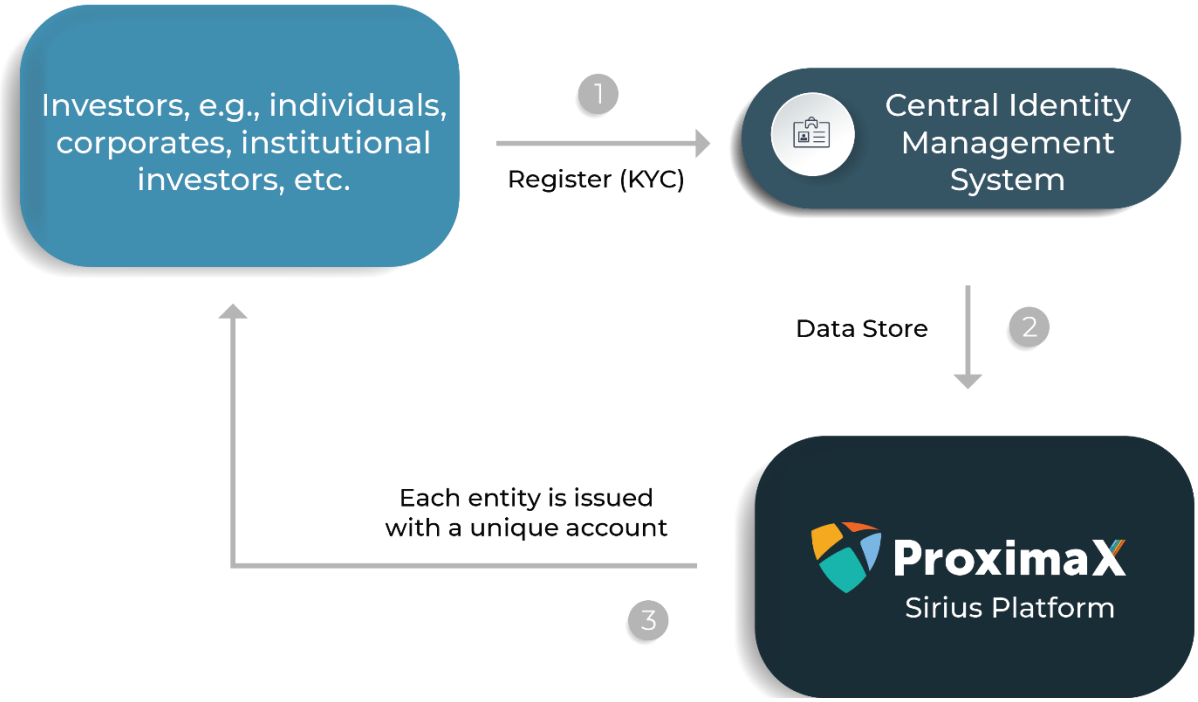

Figure 2 - Every entity must register with a central identity system

In accordance with regulatory requirements, a central identity system is required so that all investors will be known and documented. It is also necessary that a unique account is accorded to every investor so that all subsequent equity ownership will be registered with the rightful owners as bearer shareholders. This eliminates the need to do duplicate work by share registrars to manage these shareholders. The CSD holds a record of all shareholders of every listed company and therefore does the job of the registrar while allowing a decentralized system to automatically manage stock movements in a real time manner.

5.2. PUBLIC COMPANIES

Each company that has been approved to list their shares will be required to issue a fixed number of shares in accordance with their stated prospectus or as approved by the Securities Commission.

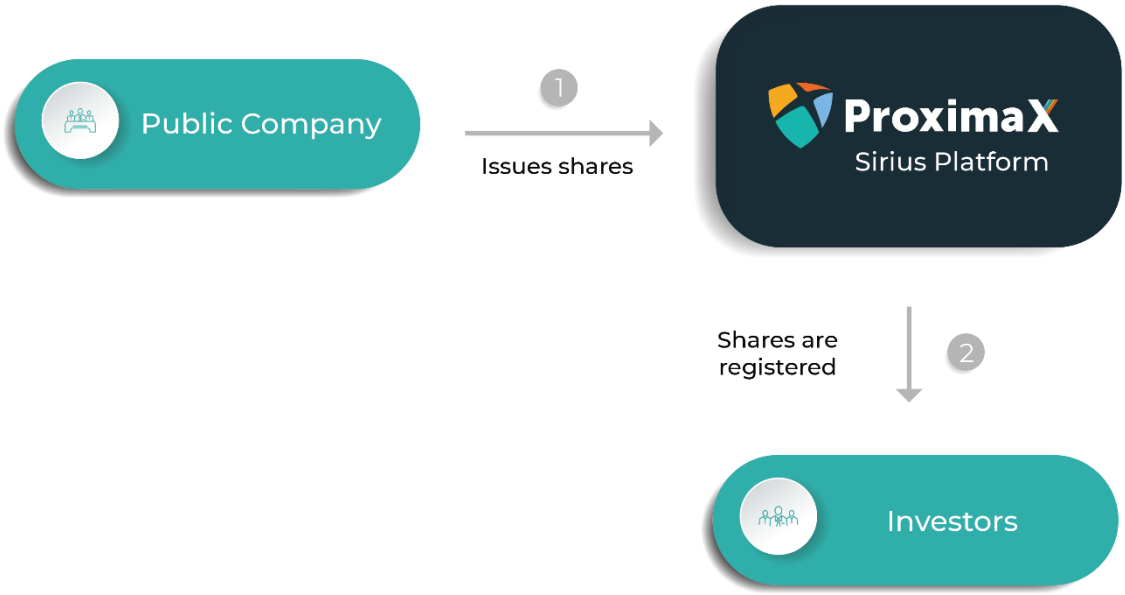

Figure 3 - Share allocation and registration at IPO stage

These shares shall be issued out as electronic units using the same system that is managed by the CSD. The system comes with inherent security features that do not allow for share duplication and fraudulent issuance nor change in share or asset quantities, unless approved. At the IPO stage, each shareholder will be issued with the requisite number of shares that they have successfully subscribed for. Bearers of such electronic units are the holders of the shares.

There is no need to have a registrar, or the registrar function is very much reduced to just management and allocation of such shares to account holders, all of whom must already be registered with the central identity management system.

Only investors that are registered with the CSD will be able to trade in all shares that are listed in the stock exchange. Accordingly, shares owned by all investors will be updated as they get traded and will be known to the CSD in almost real-time.

5.3. THE STOCK EXCHANGE

The stock exchange shall act as a focal point for trading shares. A few conditions will need to be satisfied before one can trade in the stock exchange. These include:

1. Every investor must be registered with the CSD.
2. Money must first be deposited with the CSD or a regulated trustee and exchanged for the pivoting digital money asset issued by the CSD system.
3. Every investor shall be registered with the stock exchange with the same account number that is supplied by the CSD.
4. For the sale of stock, each investor must already have stock in the account, which is reflected in the account held at the CSD.

5.3.1. Depositing Money with the CSD

Every investor shall make a deposit through the existing financial infrastructure before one can purchase any security. This prepayment shall be reflected as an amount deposited with the stock exchange, less any associated costs. Subsequently, this "asset" shall be used as the asset to be exchanged for the purchase of every stock in the market.

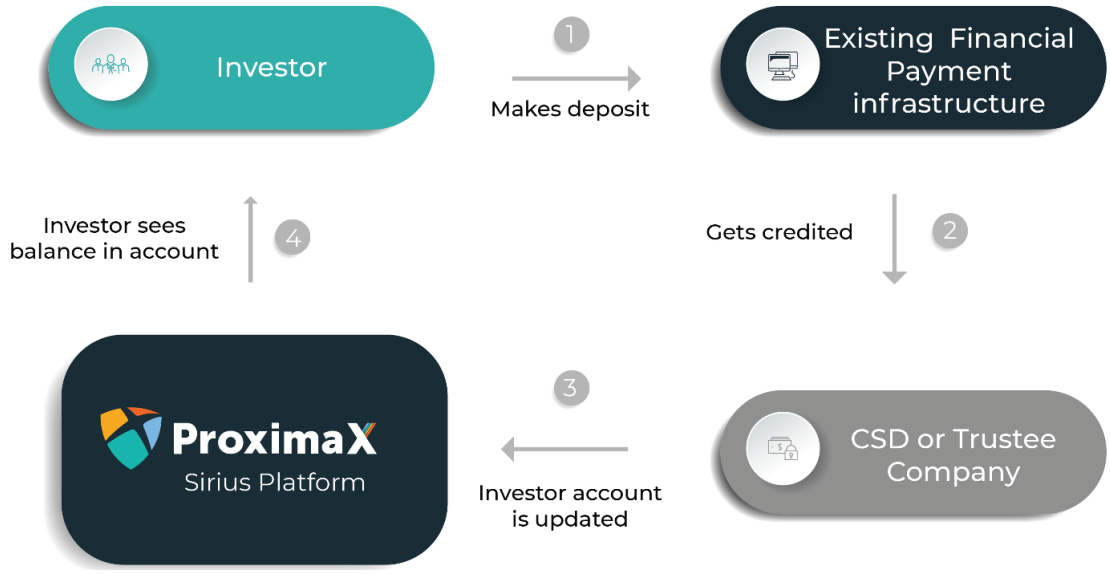

Figure 4 - Fiat money exchanged for trading digital money. The reverse also applies

Conversely, every investor can withdraw their digital money, i.e., return digital money back to the CSD or trustee. The CSD or trustee then credits the bank account of the investor through the existing financial infrastructure system.

6. BLOCKCHAIN TECHNOLOGY

Blockchain technology is a decentralized ledger solution with enhanced security and is suitable for financial transactions. Many of them are simple solutions while a couple are full featured, powerful, simple in design, and most importantly, inexpensive to operate.

Blockchain technology does not purport to give a new impetus to existing financial technologies. Rather, it is a very cost-effective solution that will save a tremendous amount of money, time, and labor in comparison with existing technologies. At the same time, blockchain can cut some processes and reduce them to nothingness, thereby possibly saving the industry a lot of running costs. Blockchain technology changes the paradigm of financial thought processes, giving more and doing less, and with complete accuracy.

The blockchain solution is a technology that is a synthesis of past, well tested, and proven technologies. Specifically, blockchain technology is designed from a combination of:

- Computer peer-to-peer technology
- Cryptography science
- Database system

The end result is a powerful ledger system that is immutable and irreversible, meaning to say that transactions cannot be changed once signed and transferred. A transaction, is therefore final and there can be no double-spend.

The use of cryptography science encompasses two factors. The first being the fact that it is used for signing off a transaction by the user. The second being that it is used to prove the transaction so that it cannot be changed. Another feature that is rarely used in blockchain is the encryption of messages.

This tamper-evident design makes it so powerful that it does not require additional security solutions to protect the authenticity of transactions.

Blockchain technology, using a computer peer-to-peer configuration and approach, changes the design architecture of traditional systems, making it simpler and very cost effective in its deployment. Crucially, the system will always be up, eliminating any downtime and removing the need to use a data center and disaster recovery center to house its core system. A blockchain is itself a data center and disaster recovery center already by design.

Blockchain technology is nascent. While the technology itself offers tremendous potential and possibility, the industry is just "waking up" to apply the technology to its financial systems.

7. THE PROXIMAX SIRIUS DEVELOPMENT PLATFORM

ProximaX is a next-generation Integrated and Distributed Ledger Technology ("IaDLT") infrastructure platform solution powered by blockchain technology.

It extends beyond traditional blockchain protocols by integrating off-chain, peer-to-peer storage, streaming, and database service layers that are often found in traditional software-as-a-service ("SaaS") centralized architectures. Together, the blockchain protocol and off-chain service layers form the ProximaX Sirius platform, the core platform solution in the ProximaX ecosystem.

By integrating the blockchain protocol with off-chain service layers in a distributed network with manageable but distinct layers, the ProximaX Sirius platform solution provides both the advantages of a blockchain-based network, and traditional centralized database solutions. It leverages inherent blockchain features while solving the conundrum in blockchain ledger transactions by providing for flexibility, ease of adoption and integration, security and speed, and cost-efficiency all packaged within one extensive framework.

Users and developers can store and stream data of large sizes in the distributed service layers whilst transactions are conducted with speed on the blockchain to ensure security, transparency, immutability, irreversibility and traceability. ProximaX Sirius greatly expands and facilitates use cases beyond what traditional blockchain projects can do, particularly for enterprise clients.

As a holistic platform, ProximaX Sirius is able to provide a very powerful solution for the equity market. ProximaX has developed a Distributed Ledger for eXchanges (DLX) based on the concept that has been presented in this paper. This DLX can have many features not found anywhere else. These special features include:

- Ability to create multiple ledgers in a single blockchain platform to manage multiple asset transactions. These assets could be assets of different classes or financial instruments such as digital money, securities, precious metals, bonds, derivatives, trust units, etc.
- Unique ledger registration within the blockchain ecosystem, i.e., each stock or security is considered one unique ledger registration.
- Simple, out-of-the-box contracts in the form of transaction management so that users of the solution can be governed by regulatory requirements.
- The ability to implement multiple private and permissioned chains including cross-chain transfers.
- Tightly coupled with the ProximaX KYC application as an identity management system for identifying and screening both individual and corporate entity shareholders.
- Metadata and tagging of accounts.
- Supercontracts.

The solution has a Software Development Kit (SDK) and uses industry standard JSON RESTful APIs. It is compatible with any application that conforms to a messaging standard such as ISO20022, or a mark-up language such as such as FpML. They are treated as processes with defined outputs to update or broadcast transactions into the ledger. This method of integration and interoperability allows for the reuse of legacy applications and solutions.

The existence of API server gateways enables the blockchain to act as a core to applications that require the use of a ledger in the blockchain. It is therefore, an open system and allows for standards conforming applications, including legacy and new decentralized Supercontracts (ProximaX Sirius platform's built-in version of an enhanced and highly flexible smart contract platform) to integrate with the ledger seamlessly.

8. THE PROXIMAX SIRIUS DEVELOPMENT PLATFORM FOR THE EQUITY MARKET

The equity market is a ledger driven solution. The ProximaX development platform could be used for the following:

- KYC management for identity and verification of traders.
- Share registry, operated directly by listed companies or their appointed agents, in line with current practices or new practices where appropriate.
- Auto-accounting and movement of shares.
- Auto-clearing, payment and settlement – in one transaction – dismantling existing processes.
- Complete view of shareholding and movements, providing regulators with real-time visibility of substantial shareholding movements.
- Tagging every account belonging to a substantial shareholder, directly or indirectly, and monitoring movements of equity including locked up equity as a moratorium.
- Monitoring of market anomalies and identifying trading irregularities.
- Immutable and irreversible records of all transactions which are timestamped and auditable.
- Shareholders can view and manage their portfolio of securities in near real-time.
- Support for OTC trades or transfers between shareholders requiring private key signatures from both participants and the CSD.
- Support for share issuance, share cancellation, share splits, and reverse splits, each requiring private key signature from the issuer.

- Support for lost of private keys and re-issuance of private keys so that users will not lose their securities if they lose their private keys.
- Allow issuers to distribute shares and currencies for IPO and dividends.
- Ready for integration to support cash withdrawals and deposits by shareholders.
- Support for multiple currencies represented as transferable assets on the blockchain.
- Key Security Token Offering (STO) functionalities.
- Crowdfunding and OTC functionalities.

The ProximaX Sirius development platform thus represents a core building block for the equity market, and in fact for any financial instrument exchange market. There can be a few approaches in the way trades can be made. A typical stock exchange does anything from a few hundred thousand trades to as many as fifteen million trades a day. In times of market chaos or volatility, the volume could involve tens of billions of shares changing hands.

We will examine two possible types of trading options.

8.1. TRADING – OPTION 1

Trading will not require any broker. Each and every investor shall trade directly on the stock exchange. In the past, the presence of brokers was required because it would be almost impossible to house all traders and physically trade in one location. Hence, they were represented by brokers who would each occupy a seat on the exchange floor. When stock exchanges went electronic, these seats were replaced by licenses for each member to trade on these stock exchanges. These licensed members became brokers, with each of them operating their own electronic trading platform for their investors.

It is not necessary to have an exchange floor today because this very same “floor” is made virtual and trades can be done by each and every investor or trader. The computer screen is a window to the floor and the price bid “shouting” is now carried out by keying in the asking and bidding prices of any stock by every trader in a trading platform operated by broking firms. There is no need to “shout” a price. There are also more sophisticated tools that allow

traders to make trades directly, including automated bots and high frequency trading.

That is the old and present. However, to dismantle it further, the stock exchange could simply do away with licenses for members. Instead, now, another way would be to accept direct bidding and asking by investors. The stock exchange will have a repository of money as well as stocks pledged by investors to the system in its real-time database. Trading occurs real time and it would be capable of high-frequency trades.

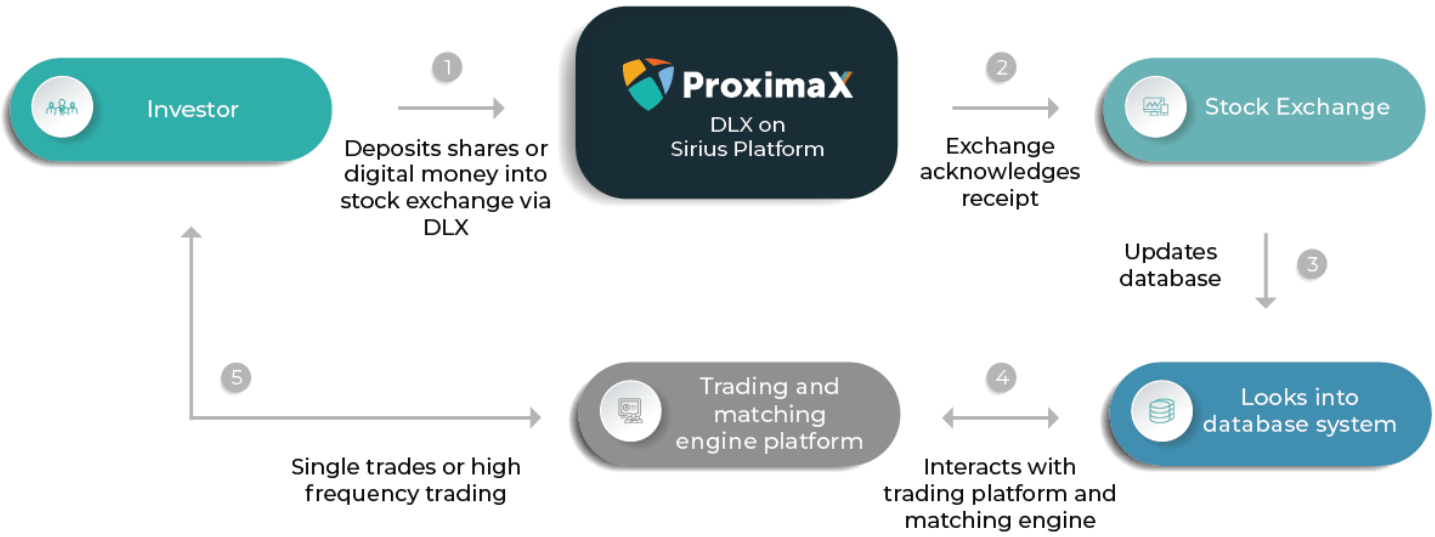

Figure 5 - Trading process

The way it works: it starts with an investor depositing money into the CSD or its trustee. This deposit is converted into digital money and deposited into the account of the investor in the blockchain. This same account of the investor will also hold all the units of shares that the investor owns. Each share owned reflects the bearer shareholder title to it.

Initially, the blockchain will reflect the true position of every trader or investor. Subsequently, when an investor wishes to purchase a stock, digital money is moved into the stock exchange from the CSD.

Similarly, whenever an investor wishes to sell a stock, the stock is moved into the stock exchange from the CSD. Once moved into the stock exchange, the actual number of shares the investor holds as reflected by the blockchain in the CSD will no longer be true because some will be residing in the CSD and the rest in the

exchange. The investor may be trading, acquiring/disposing shares in the stock exchange such that the actual quantity owned will be the sum total held in both the CSD and the stock exchange.

During trades, transactions are "cleared and settled" in the database of the stock exchange at the conclusion of every matched trade. There is no need for further settlement. Transactions are reduced to T+0.

Movements of shares and money from the CSD to the stock exchange indicate an intention to trade. The amount of money and the number of stocks in the real-time database of the stock exchange will indicate the total amount moved from the CSD into the stock exchange.

Investors can withdraw their shares and/or digital money from the stock exchange by way of issuing a withdrawal instruction to the stock exchange. At withdrawal, the blockchain is updated with the transaction.

Digital money withdrawn from the stock exchange is credited into the account of the investor at the CSD. Further, a withdrawal of fiat money can be initiated by the investor from the CSD through the traditional financial payment infrastructure.

This method of trading requires an investor to make specific transfers into the stock market in order to trade. It may not be the optimum way of doing things as there is a need to make transfers before one can trade.

One immediate benefit of this method is that multiple stock exchanges can exist, allowing investors to choose which stock exchange they want to trade in. Arbitrage is possible too, with multiple exchanges. With instant settlements, exchanges can now operate at different times of the day, including having the option to operate 24 hours a day.

A setback will be the actual holding of the investor. The CSD will not reflect the true holdings of an investor as some of the securities may be in the stock exchanges. In fact, this option is a hybrid version between existing stock exchanges and a fully blockchain-powered solution, which is presented in section 8.2 below.

8.2. TRADING – OPTION 2

Another method which can be more efficient is to make the stock exchange download a snapshot of the current position of all shareholdings from the CSD just before the market starts.

During trading hours, other than giving sole access to the stock exchange, all other transactions into the blockchain apart from creating new accounts and making queries will be frozen. The blockchain is therefore not made accessible for transacting just before the market starts, during trading hours, and just after the market closes. Any off-market transaction can only happen at, say, one hour after the market closes till say, one hour before the market starts on the next trading period.

For this type of arrangement, only one stock market can exist per blockchain. As trades are made, they are signed in batches and are broadcast into the blockchain.

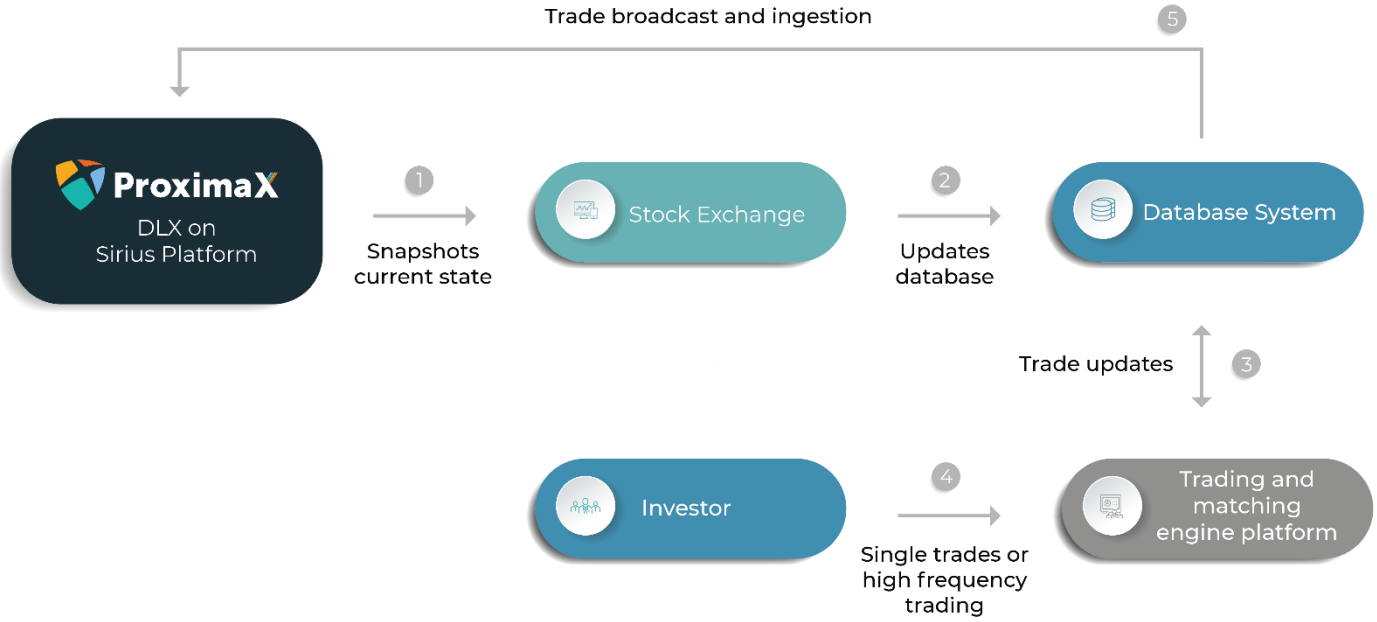

Figure 6 - Freezing up the blockchain during trading hours

More secondary markets can be created by way of each secondary market having a separate sub-DLX instance and the use of cross-chain to swap assets with the mother DLX.

Scalability on blockchain powered solutions has always been a hot topic of discussion because of the inherent problems

associated with peer-to-peer technology. If we examine one of the highest transaction rates in the market such as those found in major bourses of the world, the number of trades can go as high as 10 million trades per day for 7 hours in times of high volatility. One trade can take on a few matches to be complete, i.e., partial filling as a result of partial purchases of a lot of shares. Assuming a total of 3 matches per trade, this can total up to 30 million matched transactions per 7-hour period. This amounts to about 1200 matched transactions per second. In blockchain terms this is double of that, i.e., 2400 transactions per second.

If we split that into 8 batches per second streaming into the blockchain, the number of transactions per batch is 300. At about 200 bytes per transaction, this equates to be at least 3.84 Mbps for each node, which is achievable. The rated transaction rate of the platform design is 4,000 transactions per second. At the time of writing, we have been testing at 200 transactions per second, which will suffice current needs. However, we will be pushing the envelope as we progress further. In any case, this is not a critical issue because backlogs in transactions can be queued and broadcast into the blockchain network at a later time and during in lull periods as well.

Ingestion and transaction throughput are the main bottlenecks for any blockchain solution. This is a problem inherent with P2P technology where every node must receive the same data in the fastest possible time. Other things equal, this is the main difference between a centralized solution and the blockchain solution.

If we consider the above analysis, we can conclude that a platform solution that can achieve a substantial number of transactions per second will be able to support this architecture. Most exchanges today do not require such high transaction rates and our observation is that having a transaction rate of 200 transactions per second will suffice in most situations in the near future. The ProximaX Sirius platform should be able to support this transaction rate.

To sum up, the advantage of having such a design topology would be that trades are updated onto the blockchain in near real-time as they are being matched. Further, this method does not require an investor to upload her assets into the exchange as the

exchange itself will do an automatic upload prior to the opening of the market.

If there is a need for a secondary listing in another exchange for a particular stock, it can be done by installing another set of blockchains for this exchange. The ProximaX platform is able to do cross-chain transfers and therefore allow for the establishment of satellite exchanges.

8.3. THE DISTRIBUTED LEDGER FOR EXCHANGE (DLX) SOLUTION

ProximaX has developed a solution to showcase the concept. This solution, the DLX solution, has been developed specifically to model the concepts put forth in this paper. The DLX solution is designed to be integrated with a front-end trade matching engine which is typically operated by exchanges.

There are three personas in the DLX solution:

- Shareholder - investor or trader who buys and sells assets
- Issuer - company that issues shares
- CSD administrator - operator (who may be part of the exchange) who oversees the operations of the DLX solution

A shareholder can see her portfolio of assets, transaction history, deposits from, and withdrawals into her bank as well as conduct off-market, over the counter transactions.

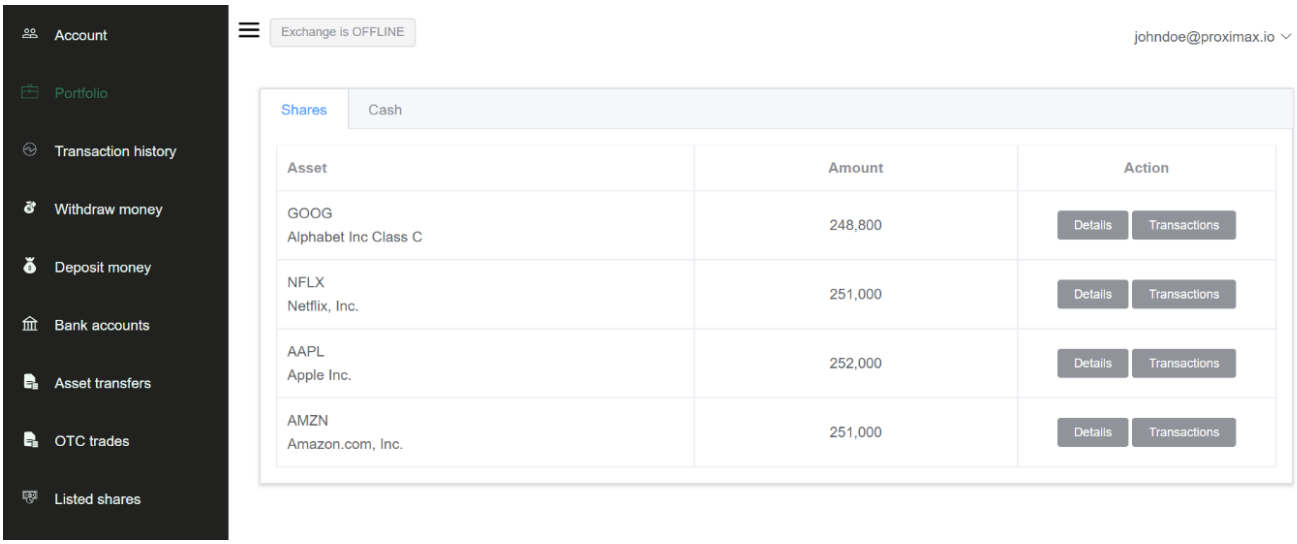

Figure 7 - Shareholder's portfolio

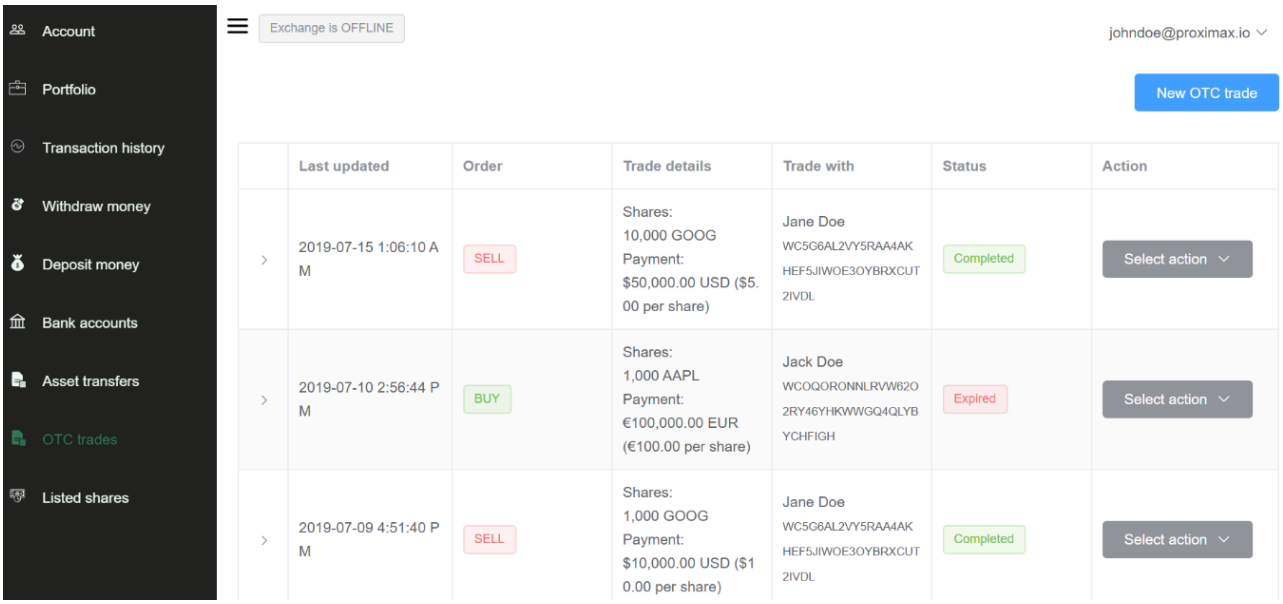

Figure 8 - Over the counter transaction between shareholders (only in offline mode)

A company issuer can initiate and complete various events such as share/warrant/loan stock/bond issuances, share cancellations, share repurchases, share splits/reverse splits, bonus issues, and dividends. It can also conduct bulk transfers to its shareholders in events such as dividend payments.

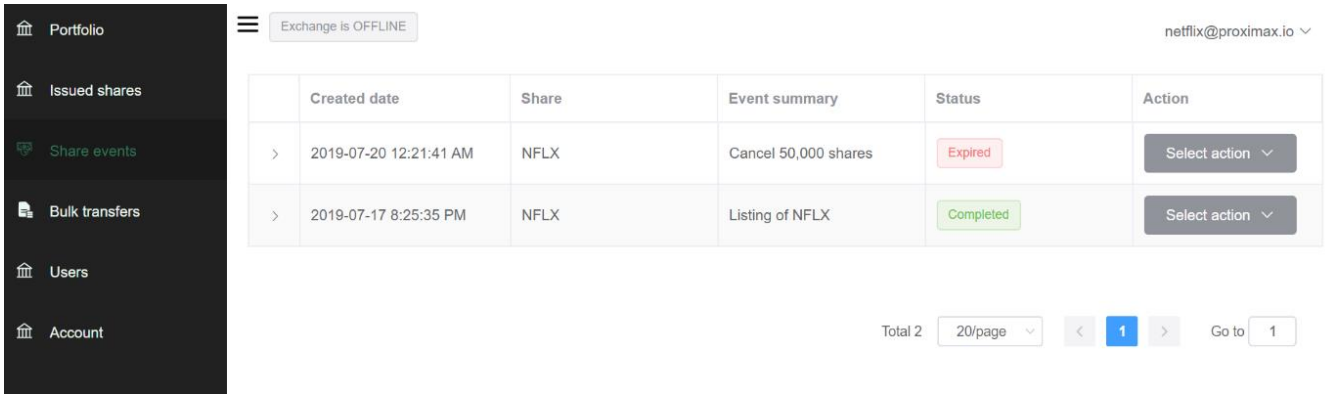

Figure 9 - Issuer's past share transaction events

An administrator oversees the entire DLX operation and is a co-signatory to many types of transactions and events to ensure security and integrity of transfers.

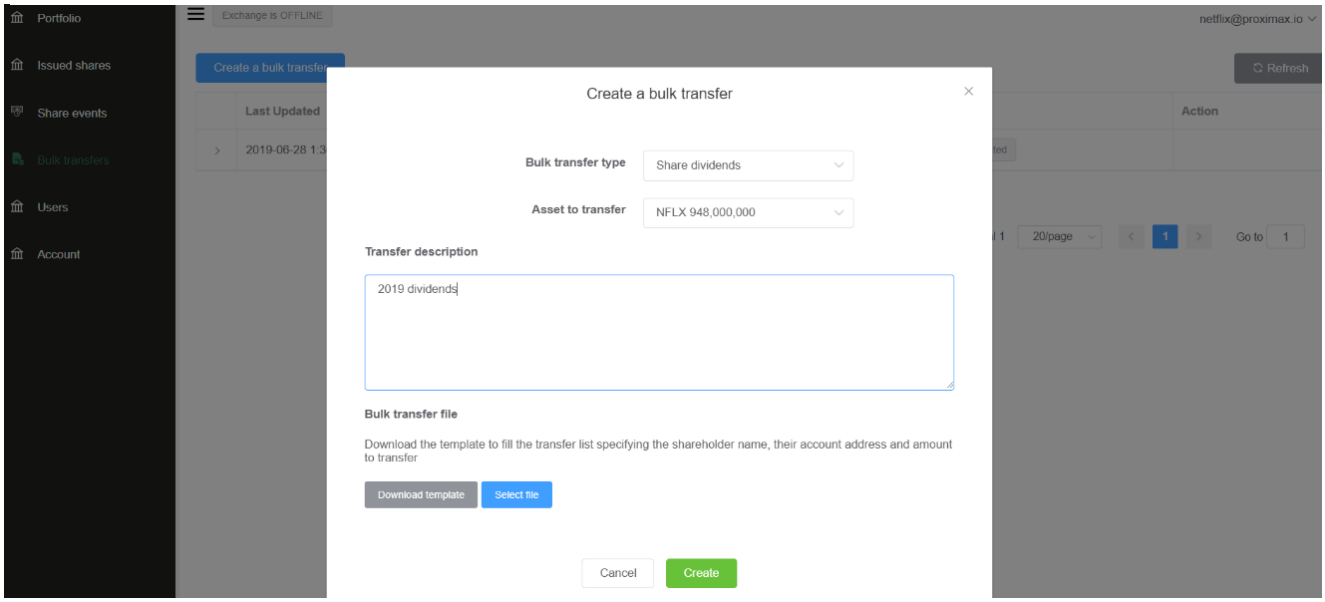

Figure 10 - Issuer initiating a bulk transfer

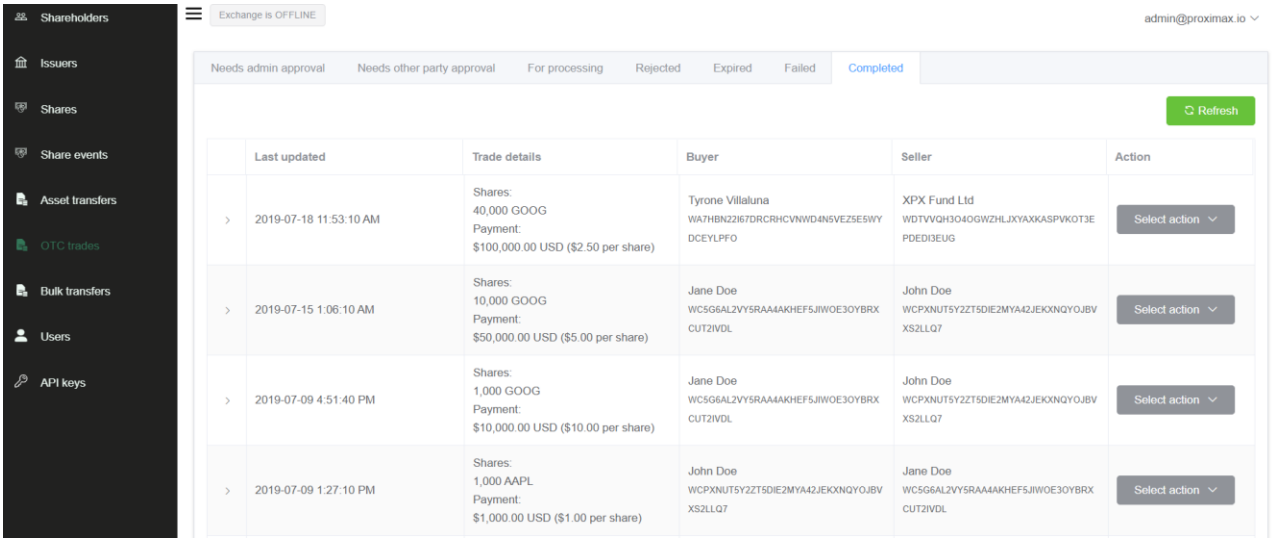

Figure 11 - Completed over the counter transactions

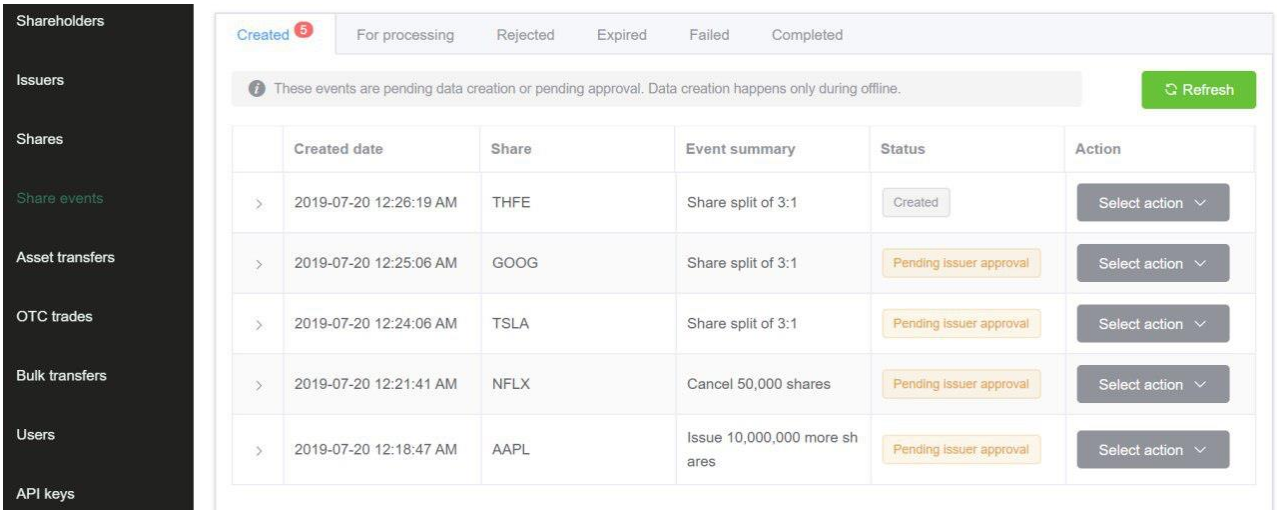

Figure 12 - Screenshot of the DLX control panel

The DLX is a solution ready to deploy and be integrated into a trade matching engine. It has all the features and functions of the aforementioned concepts including a KYC solution that is tightly coupled to the DLX and running on the ProximaX Sirius platform.

8.4. SOLUTION HIGHLIGHTS

Every holder of a unit of share in the company is represented by the electronic balance the user has in the blockchain ledger at the DLX. This method of bookkeeping is tamper-evident and provides a complete audit trail of all transactions of the user. No

registrar is required to keep a register of shares held by any party. Everything is recorded in the DLX for all shares traded in the exchange in real time.

Substantial shareholders need not report to the regulators as the DLX will reflect real-time substantial shareholder equity movements. With a proper business rule put in place, tracking of substantial shareholdings can be extended to include nominee and indirect ownerships by tagging the accounts of these substantial shareholders.

Any investor who is in possession of a block of shares can trade off-market and send that block of shares directly to a buyer in a separate agreement outside the exchange.

There is no more share netting, nor any clearing, payment, and settlement. Every trade is final upon matching. Upon each trade matching, the stock is matched with money as an instrument of exchange, hence avoiding the need to clear, pay, and settle. In other words, this is taken out of the process.

The DLX now also takes the role of being a manager of fiat money, converting in and out of digital money for the stock exchange. It is basically an escrow system for the stock exchange. In the case where the regulatory framework requires that the CSD operator is required to have a license, this can easily be arranged with a financial institution to act as trustee.

The ecosystem can easily open up the market to multiple exchanges that wish to offer secondary trade matching services for these stocks, thereby creating a competitive environment. However, a new set of satellite DLXs will need to be put in place for these exchanges in order to trace ultimate beneficial owners of nominee accounts. Liken this to a distributed broker where instead of one nominee account which is usually the case to hold securities, the ultimate beneficiaries will now be tracked as well, so that regulatory reporting is made easier, real-time, and more transparent with these satellite DLXs.

The cost of trading will reduce substantially as a result of disintermediation. Brokers, custodians, clearing houses, and highly complicated settlement systems become redundant.

Trading risks will be reduced because there shall be no short-selling or over-buying. Every entity can only trade in the system with what they have sent into the stock exchange or hold in the DLX. Other risks including settlements and clearing shortfalls become non-existent.

Exchanges use a pivot digital currency to trade in a one (digital money) to many (all the stocks on offer in the market) and many to one relationship. Digital money becomes a fixed value asset and part of a trade matching pair vis-a-vis traditional systems where it is being carried out as a separate settlement exercise – shortcutting all complicated processes.

Exchanges can also offer trading in multiple currencies, opening up the entire market to the global stage, where regulatory requirements can extend to include trading of local stocks in foreign currencies.

The ecosystem allows for streamlined big data analytics to work on the DLX and the stock exchange to single out market anomalies, AML activities, and insider trading ever more efficiently, thus allowing regulators a bigger breadth of monitoring and regulating these companies and investors in real-time.

Snapshots of shareholdings can be taken at any instant of time and dividends can be given out to entities holding such shares current at that time.

Stocks can be pledged to financial institutions in an off-market arrangement in exchange for margin financing.

The platform is also ready for STOs, issuance, and management, in line with what most jurisdictions are working on currently in a new class of tokens being issued on the blockchain as it follows a similar process.

The DLX is able to also perform “low frequency trades” where transactions can be done between buyers and sellers without the help of an escrow in an on-chain manner. This is a very powerful tool and opens up a new experience and solution including powering up crowd-funding platforms. In fact, the DLX is a one-stop-shop for crowd-funding platforms where there is an in-built KYC element, share issuance, dividend,

bonus, and registrar. It also takes it one step further by allowing shareholders to trade via over-the-counter (OTC) – all part of the DLX solution.

9. IMPLEMENTATION

The implementation of such a system calls for radical views and actions. It is not impossible as this can easily be sandboxed initially. Some of the existing systems, such as the core matching engine, can be replicated and new solutions can be put on top to complete the system build.

New stocks or low volume stocks can be put onto the system to test its usefulness. Simulations, too, can be made to parallel the new solution with the ongoing stock exchange trades.

9.1. STOCK EXCHANGE

Implementation of this solution for the stock exchange requires the implementation of an investor trading platform instead of the traditional broker trading platform. This trading platform could be adapted from established trading platforms offered by many existing trading platform providers with some improvisation. This will include taking out some of the broking functionality and integrating the database to check the balance availability before trading can be done. The trading platform shall integrate directly with the existing matching engine of the stock exchange. It shall also integrate with the blockchain solution at the DLX.

The key elements of the trading platform should include the following:

1. Ability to provide bot trading for high-frequency trading and programmed trading.
2. Integration with the stock exchange matching engine.
3. Integration with the DLX for stock deposits and withdrawals, including digital money, to be traded by each institution or retail investor.
4. Checking balances and trade history in the DLX and in the stock exchange itself (for trade option 1).

Other features should include normal charting software, price quotations, and standard features that typically come with a trading platform.

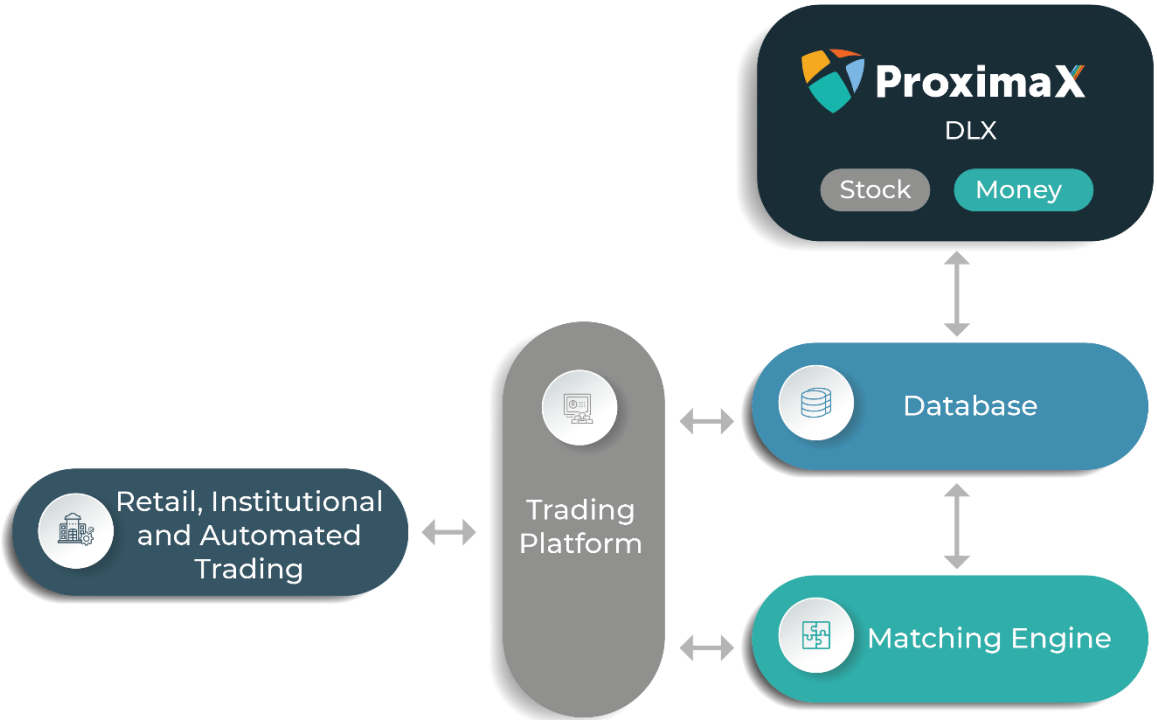

Figure 13 – Proposed Stock Exchange System

9.2. CENTRAL SECURITIES DEPOSITORY SYSTEM

The CSD's new role shall include a fund management element in the system. This fund management element handles depositing and withdrawal of money from the equity market. With the DLX in place, other applications around the core offering will have to be developed. These applications could include the following:

1. Bank integration modules for deposits and withdrawals (payment processor) for each jurisdiction in question.
2. Big data analytics, monitoring, and reporting modules.

The solution is not hard to design and implement because the ProximaX Sirius platform is the most difficult part in the design of the system. The DLX is a system application solution running on top of it, ready to run as an out-of-the-box solution.

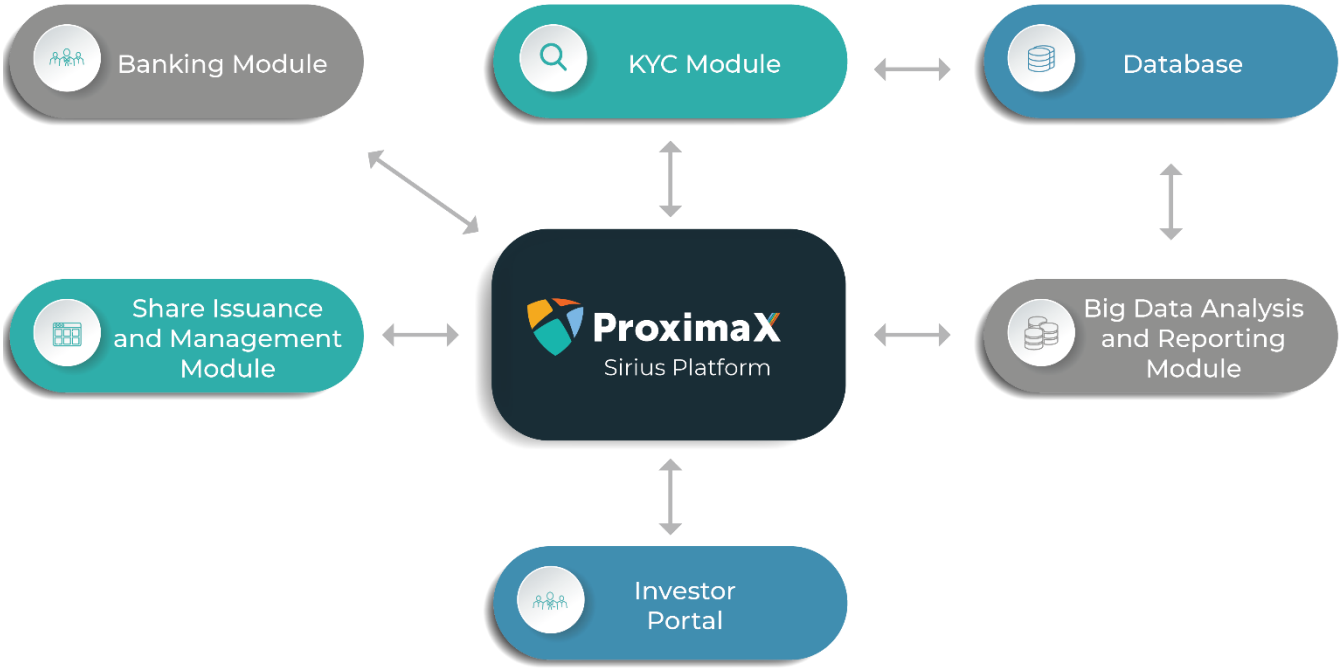

Figure 14 - DLX application modules

9.3. EQUITY MARKET ECOSYSTEM

Overall, the equity market ecosystem is now reduced to 2 main systems, that is, the stock exchange system and the DLX system. The combination of the two is easy to put together and does not require a lot of work if well planned.

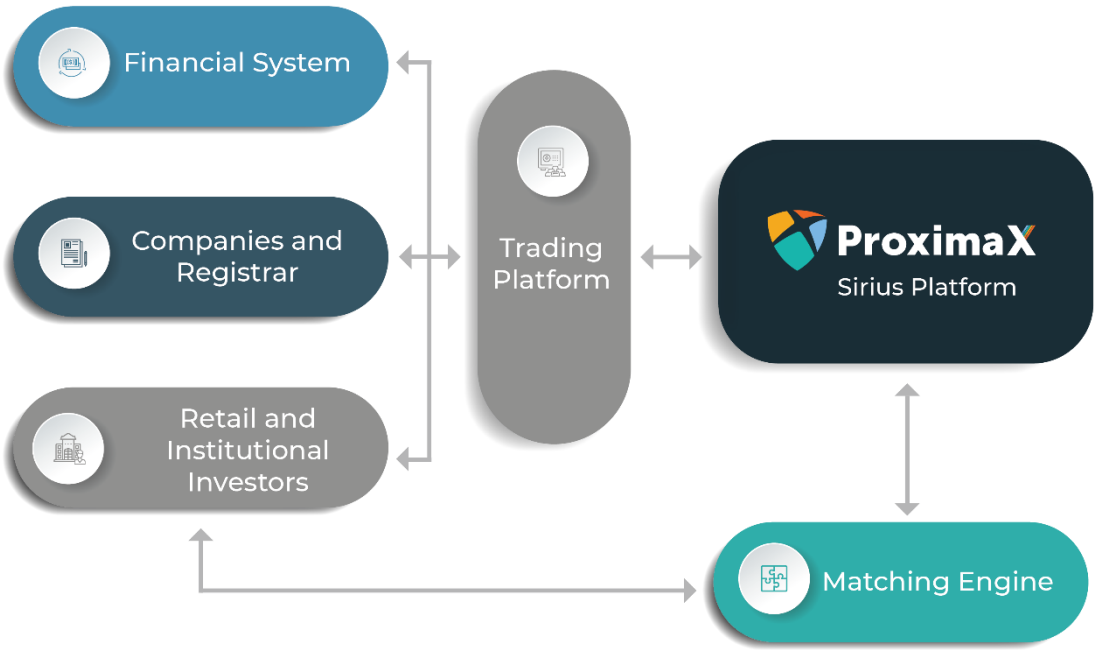

Figure 15 - Equity market ecosystem

9.4. CROWD-FUNDING AND STO PLATFORMS

The DLX in itself can be used as a platform for STO and crowd funding. Essentially, both are the same. It has all the necessary features and functions to issue and manage securities.

Additionally, it has low frequency trade functions as part of the platform solution, thus allowing for buyers and sellers to trade these securities in what otherwise is called, over-the-counter (OTC) trades.

The solution is ready to be implemented.

9.5. OTHER EXTENSIONS

The stock market matching engine becomes a system and solution to match assets to be traded. New instruments and assets can be freely traded in the system as it is now reduced to merely a matching engine where settlements are made immediately upon successful matching.

The solution may be revolutionary as well as being very extensible. It would not necessarily be limited to the stock market alone, but may also include precious metals and a host of other assets and instruments.

The sky is the limit and, if properly regulated, this technology opens up a whole new dimension for investors and exchange operators.

9.6. REGULATORY REQUIREMENTS

There are other requirements that need to be considered. These include selling substantial share blocks, moratorium, maximum sell amount and various other types of rules. These are considered business rules and can easily be integrated as an adjunct rule-based engine to determine if a holder of a stock can sell the shares or not. They act as stops to any transaction in the system and can easily be blacklisted or whitelisted to prevent or allow anyone to trade her shares.

10. SUMMARY

The equity market was examined and the various players in the ecosystem were considered. The use of the ProximaX Sirius platform could solve the problem of a prolonged settlement procedure that is fraught with legacy processes that are unnecessary.

To implement such a solution, a new approach that requires a system revamp is proposed. This approach calls for redesigning the system and reducing the number of actors to 6 as opposed to a multitude of actors before. These actors are:

1. Stock Exchange.
2. A CSD that will assume a bigger role.
3. Banks and the financial infrastructure playing a different role.
4. Listed Companies with perhaps outsourced managers using the DLX to perform the registrar function.
5. Retail and institutional investors.
6. Regulators.

Conspicuously missing shall be the brokers and custodian services, including the whole settlement process. The end result is a much more efficient ecosystem that allows for the following advantages:

1. Real-time visibility of trades and movements which can be monitored closely by regulators.
2. No settlement requirement as they are settled at the point of trade.
3. No more reconciliation of stocks caused by many brokers coming together to net their trades against one another at the end of a trading day.

The solution and design may not be exhaustive but these smaller details can easily be done once the final design is mapped out, and in accordance with any local jurisdiction and regulatory requirements.

Consequently, ProximaX has developed a solution (DLX) based on the above design concept, including the use of it for crowd-funding and STO, and is now ready for deployment.