RADICALIZING THE EQUITY MARKET LANDSCAPE

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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 transactions per second but clearing and settlement of stock 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a complete system revamp as the current systems and practice methods are based on legacy process practices that are outdated. We present the NEM blockchain technology as a suitable core component to re-design the 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 cognisance 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.

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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, giving birth to the practice in 1602.

Today, just about every economy, whether already developed or still emerging, has a stock exchange. The practice of trading shares and payment settlement has not changed radically, but rather have morphed only very little over time. On the other hand, the *means* in which they are being traded and the consequent payment and settlement has changed drastically over the last 30 years through the advent of electronic and Internet technologies. 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 lag (in time) on/when reporting to the Securities Commission 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 dis-intermediation and re-intermediation, largely decentralized in design – using the NEM blockchain technology – 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 and securities commissions 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. RELEVANCE

Blockchain technology is a decentralised 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[2].

The 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.

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 marginalised many of these physical brokers. Instead, most of them turned into electronic trading platforms to continue to serve their customers. Instead of physical communication via

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[2] http://nem.io/catapultwhitepaper.pdf

face to face or telephone orders, most have gone on to become Internet trading platforms with minimal physical broking.

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 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.

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 settlements. They are normally settled as a net sum for multiple trades during the day between brokers who act on behalf of 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.

Big 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.

4. EXAMINING THE PROBLEMS OF CURRENT EQUITY MARKETS

The fundamental function 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!

Over the years, things were automated and systems were built around the process to facilitate, ease up, and improve on systems built for each function.

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

These specific systems have been well integrated into most stock markets. But there exist many pockets of inefficiencies resulting in unnecessary work and risk for intermediaries who work on addressing these issues.

Each of these solutions was a result of a need to get the fulfilment for each stage of the trade lifecycle completed efficiently. Over the years, each of these specific value chain solutions have become large and specialised business entities operating it as a service.
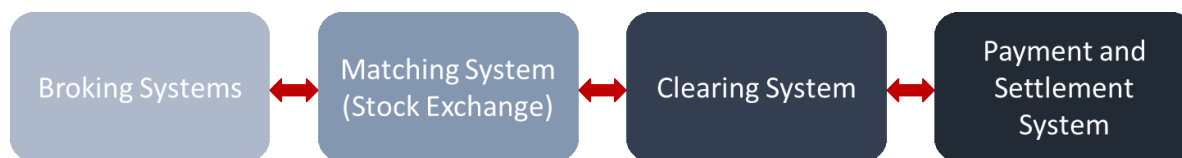
| Broking Systems | ⟷ | Matching System (Stock Exchange) | ⟷ | Clearing System | ⟷ | Payment and Settlement System |

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 is a fiat money system comprised of banks coming together to make payments on behalf of their clients. Each of these banks have their own electronic ledger system at its 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 absolutely 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 can be high as it involves both electronic and sometimes manual checking and reconciliation to get each trade matched and cleared. This process involves too many parties and systems, making it expensive and tedious.

5. CHANGING THE PARADIGM

Let's for a moment examine a clean sheet, look at the equity market and forget about all the convoluted requirements of current systems in the equity market.

There is a need to make electronic share scripts that cannot be duplicated so that these electronic share scripts can be circulated or changed 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 recognised 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 with each unit pegged to a specific unit of fiat money) that is used to buy stocks. 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 into fiat money.

To put the above in perspective, let's say if the USD is made an 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 puts the USD in escrow. 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 "embedded" asset that behaves like a stock with a non-volatile 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 minimise risk or not. These traders alternatively, can collateralize their assets to get more credits 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.

The main players in the new ecosystem would be:

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

Excluded and mostly defunct players shall include:

1. Custodians
2. Brokers
3. Clearing Houses
4. Share Registrars

Some of them may still exist, although they would need to reinvent their roles and do different things to function in the new paradigm.

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, an institutional investor, or a legal entity must register with the CSD.

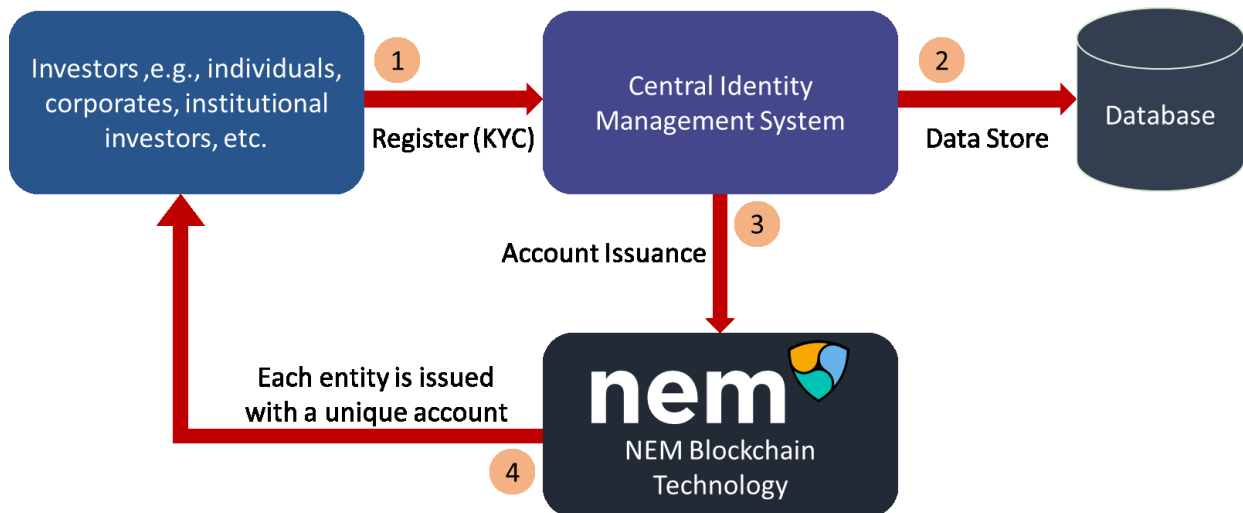Each registered entity will be given an account that is to be used for trading equities.

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 this unique account is accorded to every investor so that all subsequent equity ownership will be registered with the rightful owners as the 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 decentralised 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.

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 anyone 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 makes a deposit through the existing financial infrastructure before any trade can be done. This prepayment shall be turned into digital currency and acts as an asset in the

stock exchange with each unit pegged to a unit of fiat money deposited. Subsequently, this asset shall be used as the asset to be exchanged for the purchase of every stock in the market.
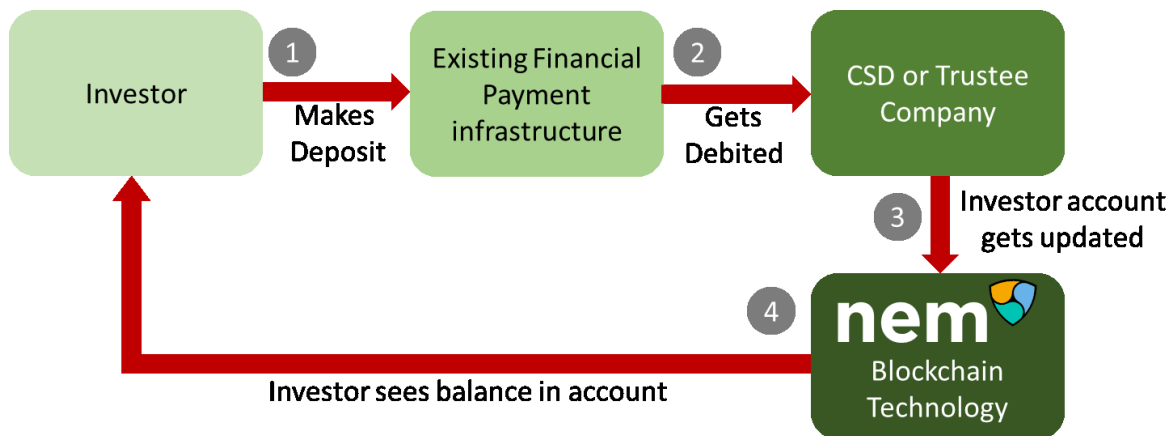

Figure 4 - Fiat money exchanged for trading digital money. Reverse is true.

Every investor can withdraw their digital money in a reverse action, 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

The blockchain is the latest technology enigma. The technology is a decentralised 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 labour 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, the 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 proof the transaction so that it cannot be changed. Another feature that is rarely used in blockchain is the encryption of messages.

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

The 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 datacentre and disaster recovery centre to house its core system. A blockchain is itself a datacentre and disaster recovery centre 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 NEM BLOCKCHAIN TECHNOLOGY

The NEM blockchain solution is a purpose built solution. In addition to the standard run-of-the-mill blockchain solution, it has incorporated special features into its blockchain technology. 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 such as digital money, securities, precious metals, etc.

- A global namespace solution for unique registration of each set of ledgers within the blockchain ecosystem.

- Simple, out-of-the-box smart contracts in the form of transaction management so that users of the solution can be governed by regulatory requirements

- The ability to implement a private chain using the mijin solution, and the soon to be released, Version 2, Catapult[3].

The NEM blockchain technology uses a consensus mechanism to manage every transaction. It consists of a network of nodes (either permissioned or permission-less) networked together in a peer-to-peer (P2P) configuration. Transactions are broadcast out and each P2P node will record these transactions and verify them as they come in. At periodic intervals, called the block time, these transactions are grouped together and the transactions undergo a hash process (digital finger printing) linking it to the previous block. They are then added on as a new block of information in the blockchain. The private and permissioned ledger does not have mining per se, and follows a controlled Proof of Stake algorithm, while the permission-less (Public Chain) is based on an algorithm called Proof of Importance[4].

Built into the NEM blockchain solution is a mechanism (Eigentrust++ reputation management algorithm) for ensuring each P2P node is reputable and therefore not fraudulent.

The NEM blockchain solution has also created an all-new P2P time synchronisation algorithm to ensure that each node is synchronised with one another in the right time slot.

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[3] Catapult and Mijin are developed and marketed by Tech Bureau, Corporation as a permissioned/private ledger. Both Catapult and Mijin shall be released as part of NEM's Open Source solution at a later date.

[4] NEM Technical Reference - https://www.nem.io/NEM_techRef.pdf

The solution is intentionally designed as an open system realised through a set of 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 allow for 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. It is, therefore, an open system and allows for standards conforming applications, including legacy and new decentralised smart contracts to integrate with the ledger seamlessly.

8. THE NEM BLOCKCHAIN TECHNOLOGY FOR THE EQUITY MARKET

The equity market is a ledger driven solution. The NEM blockchain technology could be used for the following:

- KYC management for document control and authenticity
- Share registry, operated directly by listed companies or their appointed agents, in line with current practices or new practices where they are appropriate
- Auto-accounting and movement of shares
- Auto-clearing, payment and settlement – in one transaction – dismantling existing processes
- Complete view of shareholding 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 such accounts
- Monitoring of market anomalies and identifying trading irregularities

The blockchain technology thus represents a core building block for the equity markets. 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 15 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 at the stock exchange. Before, the presence of brokers was required because it would be almost impossible to house all traders and physically trade. Hence, they were represented by brokers who'd occupy a seat each 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 platforms for their investors.

It is not necessary to have an exchange floor today because this very same "floor" is made virtual and trades can actually 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 the 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.
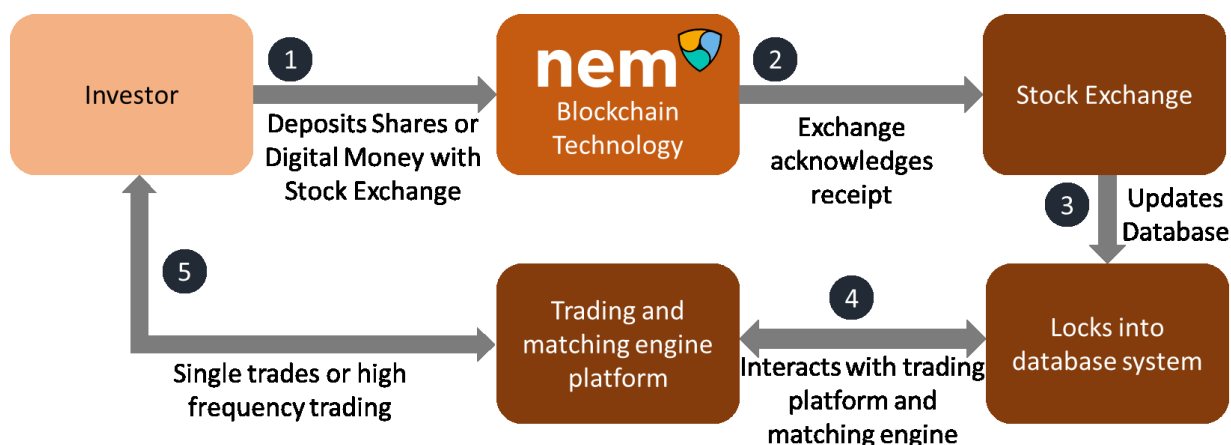
Figure 5 - Trading process

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.

At any one time, the blockchain will reflect the true position of every trader or investor. 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.

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 stock 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.

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 day.

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

As an example, if there are 10 million trades per day for 7 hours, the average number of transactions per second is about 800 (1 trade is considered two transactions in the blockchain space). If we split that into 8 batches per second streaming into the blockchain, the number of transactions per batch is 100. At about 200 bytes per transaction, this equates to be at least 1.28 Mbps for each node, which is very achievable.
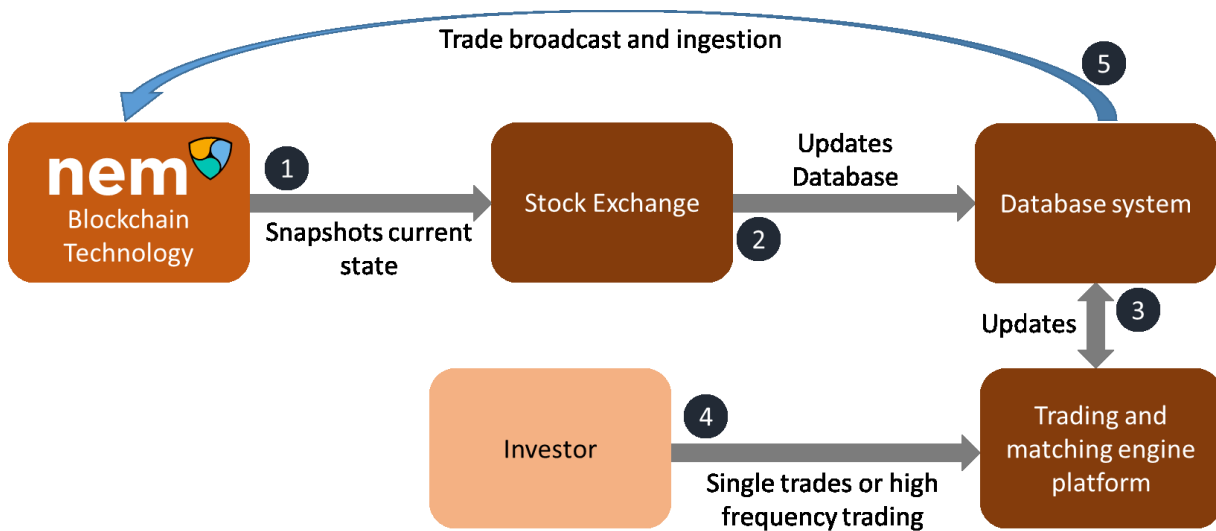

Figure 6 - Freezing up the blockchain during trading hours

The advantage of having such a topology would be that trades are updated onto the blockchain in real time as they are being matched. Further, this method does not require the investor to upload their assets into the exchange as the exchange itself will do an automatic upload prior to the opening of the market.

Ingestion and transaction throughputs 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. Everything else equal, this is the main difference between a centralised solution and the blockchain solution.

If we consider the above analysis, we can conclude that the NEM blockchain technology is an incredibly accommodating solution as the required average transaction rate of 800tx/s is quite achievable. It will be even more so with the release of the new Catapult solution, which is capable of volumes up to 4,000tx/s at its last official count.

8.3. 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 CSD. This method of bookkeeping is tamper-proof 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 CSD for all shares traded in the exchange in real time.

Substantial shareholders need not report to the securities commission as the CSD 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 upon matching is final. Upon each trade matching, clearing, payment and settlement are done concurrently.

The CSD 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.

With a single CSD, based on the aforementioned trading option 1, the ecosystem now can easily open up the market to multiple exchanges who wish to offer trade matching services, thereby creating a competitive environment.

The cost of trading will reduce substantially as a result of dis-intermediation. 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 held in the

CSD. 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 trade matching vis-a-vis traditional systems where it is being carried out as a separate settlement exercise – shortcutting all the 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 CSD and the stock exchange to single out market anomalies, AML activities, and insider trading ever more efficiently, thus allowing regulators 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.

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 CSD.

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 CSD 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 CSD and in the stock exchange itself (for trade option 1)
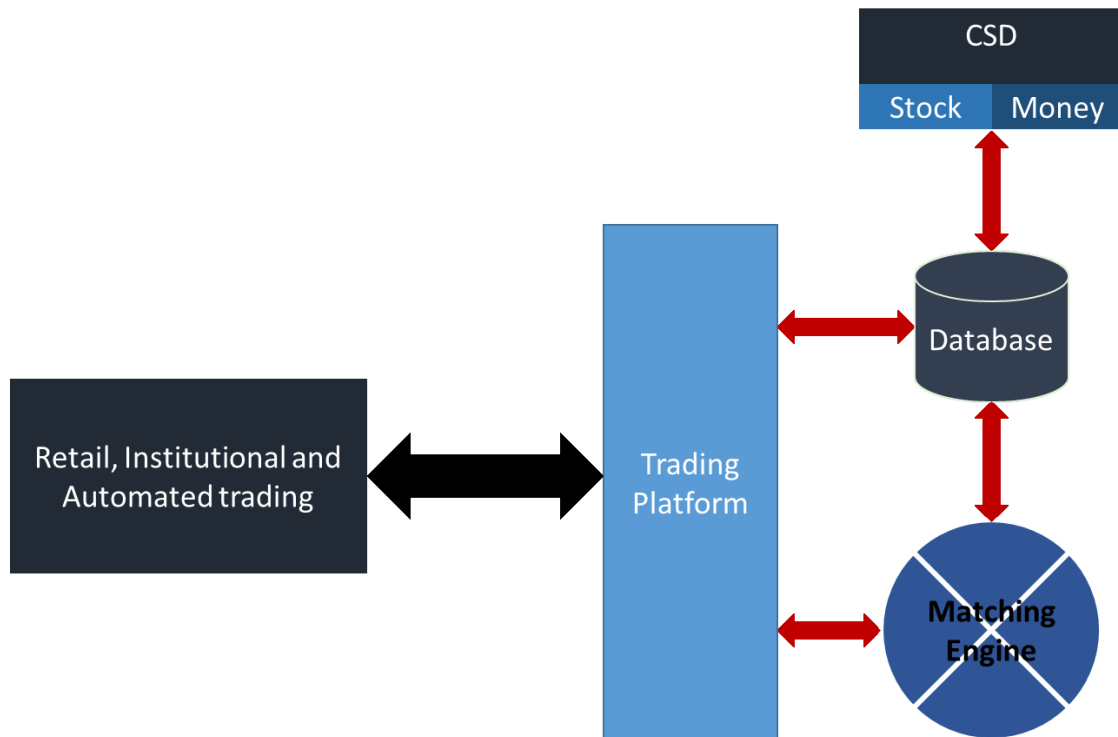
Figure 7 – Proposed Stock Exchange System

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

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. As the CSD is a bespoke solution;, applications around its core blockchain system will have to be developed. These applications could include the following:

1. Bank integration modules for deposits and withdrawals
2. KYC and user registry
3. Stock issuance module
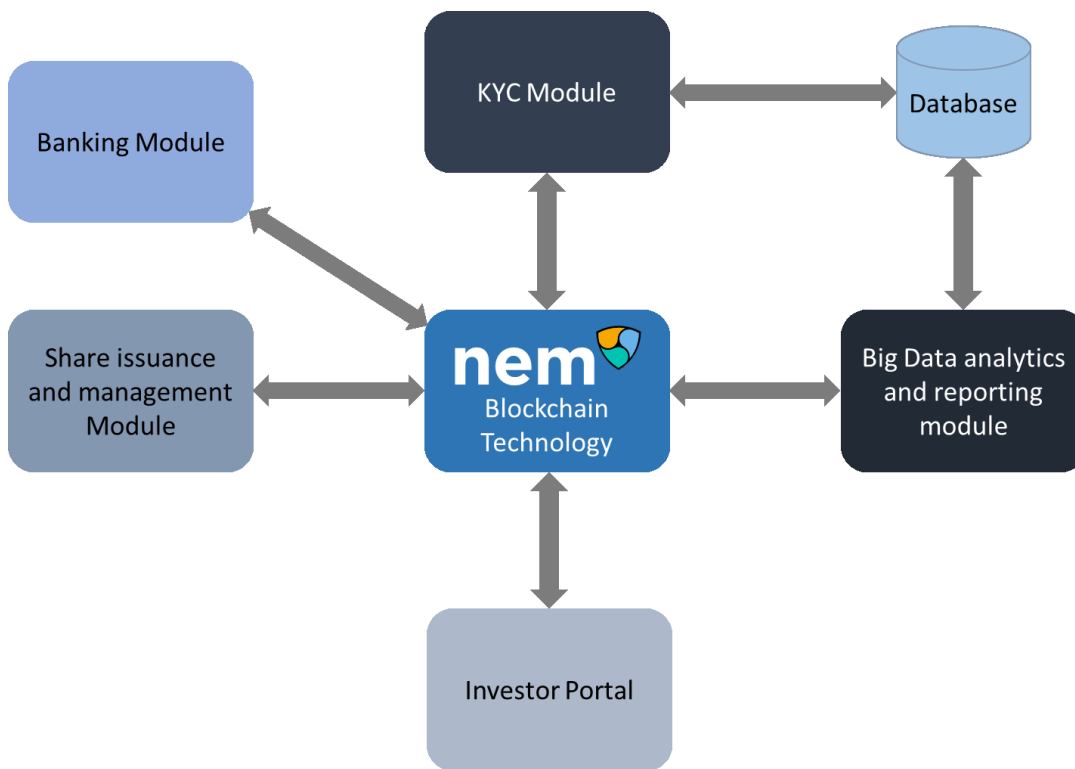4. Big data analytics, monitoring and reporting modules

Figure 8 - CSD application modules

The solution is not hard to design and implement because the blockchain core solution is the most difficult part in the design of the system. Fortunately, this is a ready-to-run solution using the NEM blockchain technology.

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 CSD system. The combination of the two is easy to put together and does not require a lot of work if well planned.
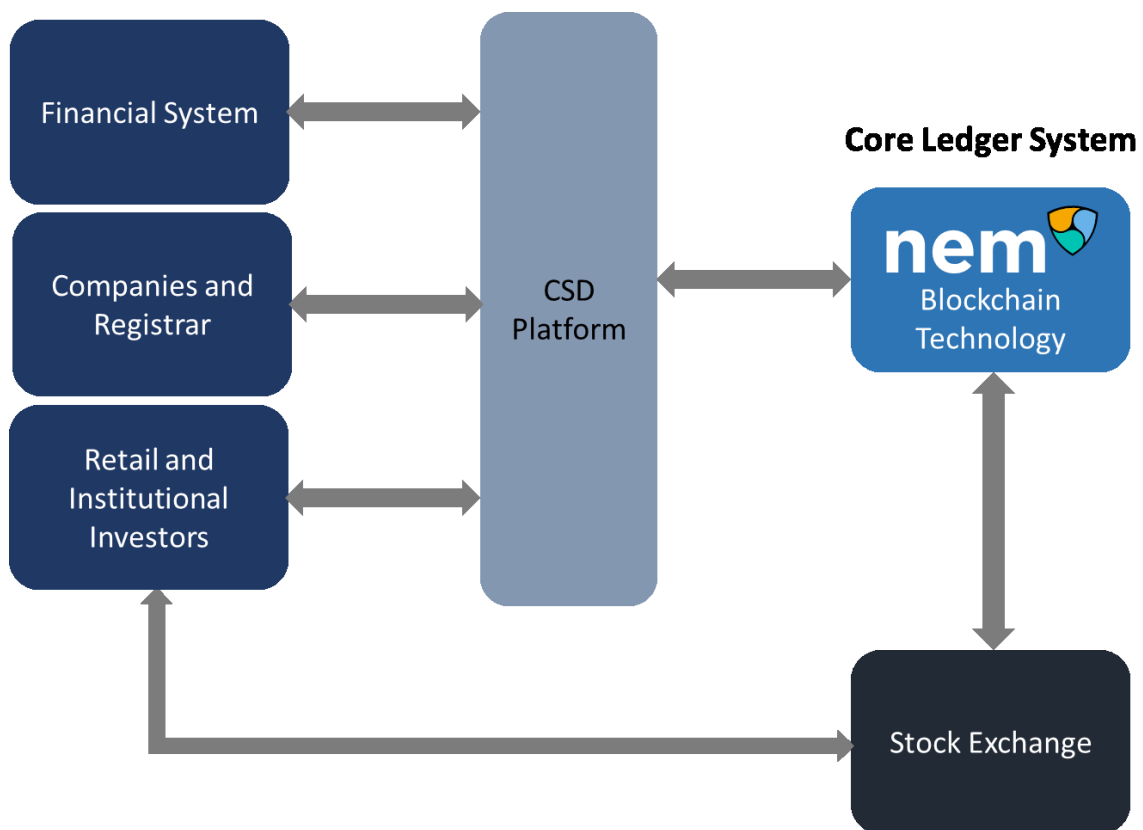
Figure 9 - Equity market ecosystem

9.4. 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.

10. SUMMARY

The equity market was examined and the various players in the ecosystem were considered. The use of the NEM blockchain 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 CSD to perform the registrar function
5. Retail and institutional investors
6. Securities Commission

Conspicuously missing shall be 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 a general idea and macro approach has been presented. Smaller details can easily be done once the final design is mapped out.