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# POSITION PAPER

V. 2.1

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# 1. Abstract

Currency is to the economy, what language is to the speech: with natural historic competition, borrowed features, and things lost in translation. A language evolves in the direct proportion to the number of its users and with the amount of pronounced/written/read material - "transactions" in it. What keeps it alive and saves it from extinction is its circulation and the Darwinistic ability to adapt to a change. Most traditional currencies developed naturally, similar to most dialects formalizing over time and gradually gaining success through adoption. Constructed languages have failed, in spite of their claim to a global success due to well-planned features and lack of such artifacts as, say, irregular verbs.

Now that we've entered the world of cryptocurrencies and the blockchain, despite them being constructed languages of a sort, it is becoming clear that the acquired ability to adapt to a change is what makes a platform a preferred means of transaction. While many known blockchains have rigid and clumsy designs, Enecuum's one is highly adaptive and truly decentralized, with participants being able to vote for desired new changes with no entailing protocol modification. Yet, if needed, changes on the blockchain parameters can also be introduced through a modified protocol version. You will find all the technical explanations below sharing the same core idea: we trust that our enhanced privacy, security and scalability, and, more importantly, ability to change and adapt make Enecuum the blockchain of tomorrow that comes to stay.

It is being BUILT TO LIVE ON.

## 2. Disclaimer

This whitepaper and any other documents published in association with this whitepaper relate to the intended development and use of the Enecuum platform ("**Enecuum**"). They are for information purposes only and may be subject to change.

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- **This whitepaper describes a future project**

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This whitepaper contains forward-looking statements that are based on the beliefs of Enecuum HK Limited, a Hong Kong incorporated company (CR: 2562183) ("**Company**"), as well as certain assumptions made by and information available to the Company.

Enecuum as envisaged in this whitepaper is under development and is being constantly updated, including but not limited to key governance and technical features. The ENQ token ("**ENQ**") involves and relates to the development and use of experimental platforms (software) and technologies that may not come to fruition or achieve the objectives specified in this whitepaper.

If and when Enecuum is completed, it may differ significantly from the network set out in this whitepaper. No representation or warranty is given as to the achievement or reasonableness of any plans, future projections or prospects and nothing in this document is or should be relied upon as a promise or representation as to the future.

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- **No offer of regulated products**

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ENQ is not intended to represent a security or any other regulated product in any jurisdiction.

This document does not constitute an offer or solicitation of securities or any other regulated product, nor a promotion, invitation or solicitation for investment purposes. The terms of the purchase are not intended to be a financial service offering document or a prospectus of any sort.

ENQ does not represent equity, shares, units, royalties or rights to capital, profit, returns or income in the platform or software or in the Company or any other company or intellectual property associated with the platform or any other public or private enterprise, corporation, foundation or other entity in any jurisdiction.

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- **This whitepaper is not advice**

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This whitepaper does not constitute advice to purchase ENQ. It must not be relied upon in connection with any contract or purchasing decision.

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- **Risk warning**

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The purchase of ENQ and participation in Enecuum carries with it significant risks.

Prior to purchasing ENQ, you should carefully assess and take into account the risks, including those listed in any other documentation.

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- **Views of the Company**

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The views and opinions expressed in this whitepaper are those of Enecuum and do not reflect the official policy or position of any government, quasi-government, authority or public body (including but not limited to any regulatory body of any jurisdiction) in any jurisdiction.

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- **You must obtain all necessary professional advice**

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You must consult a lawyer, accountant, tax professional and/or any other professional advisors as necessary prior to determining whether to purchase ENQ or otherwise participate in the Enecuum network.

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## 3. Introduction

Since the Bitcoin's creation in 2009, its underlying blockchain technology has opened up new prospects for evolution of the the world economy. The subsequent emergence of smart contracts <sup>1</sup>, facilitating credible automated transactions on pre-determined conditions, significantly expanded application potential of this technology. We believe that blockchain is capable of revolutionizing many areas of financial and economic activity, such as trade, financial markets, voting and even logistics.

Today almost all leading institutions compete to develop the best solutions. The largest banks and corporations are forming consortiums, while governments are looking for ways to create appropriate legal framework to support the technology.

Existing solutions, Ethereum being amongst the most prominent, are already providing ample opportunities for the application of blockchain technology in combination with smart contracts. Nevertheless, for further development and mass popularization of the technology, it is necessary to overcome a number of problems that can be grouped into these three categories: scalability, security and privacy.

### 3.1. Scalability

A disadvantage of a decentralized blockchain system is its limited bandwidth.

In fact, most existing consensus-building mechanisms utilized by distributed ledgers present a trade-off between a large number of transactions per second and degree of network centralization [1]. Thus, the desire to increase the number of processed transactions often leads to growing risks associated with the system reliability. Besides, as the size of a blockchain grows, it demands more disk space, a stronger Internet connection and higher computational power. All this may result in a decreasing number of full nodes and have a negative impact on the security of the entire network ([cf. 5](#)).

### 3.2. Security

In addition to problems associated with scalability, there is a number of threats produced by various features of the blockchain architecture itself. For example, the Proof-of-Work-based transaction confirmation mechanism can lead to a high degree of mining capacity aggregation in one location: for example, there has been aggregation of bitcoin mining capacity in Mainland China, where the cost of electricity is one of the lowest in the world. This fact greatly increases various risks associated with the centralization of the system, for instance, an opportunity for conducting a "51% attack"<sup>2</sup>.

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<sup>1</sup> Smart contract a.k.a cryptocontract - code that is stored, verified and executed on a blockchain. Smart contracts allow the performance of credible transactions without third parties.

<sup>2</sup> 51% Attack – a hypothetical attack on a blockchain done by a group of miners controlling more than 50% of the network's mining hashrate, or computing power.

Another threat to security arises in relation to smart contracts which are more susceptible to vulnerabilities and bugs than the blockchain itself, and have already resulted in millions of dollars of losses for users and inflicted damage to the industry. We expect that the number of smart contracts in use will continue to grow; however, the existing ways of identifying their weak spots are still inadequate.

Another burning issue these days is the effect that centralization can have on blockchain direction and control. This may arise where there is power centralization in the hands of a small group of people who can effect modifications to the core protocol [2]. If and when the opinions of these groups contradict the interests of the community, this may lead to a conflict that can completely paralyze the process of system modernization necessary for its stable development. It can lead to a split in the community and the blockchain ([cf. 5](#)).

### 3.3. Privacy

Some blockchain systems strive for transparency of all transactions. However, we believe that this feature limits their commercial attractiveness and infringes individual privacy. While transparency is one of the main advantages of a distributed registry, this property is not always desirable, especially when it comes to transfers between business counterparts, particular financial transactions, and other kinds of transactions that users may legitimately prefer to keep private and confidential.

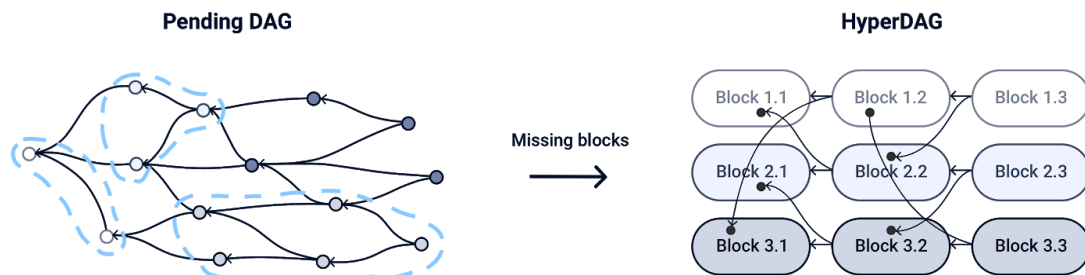
We believe these issues are being confronted by a large number of developers working on dozens of different projects. As a result, more and more ad hoc blockchain platforms are designed every day to solve specific tasks in various areas. This brings to us to another problem, related to the interoperability of different types of distributed networks, and several cross-chain projects have already been launched to tackle it.

Nevertheless, a universal solution that effectively solves the above-mentioned problems in one protocol has yet to be presented. We are confident that the solution to them is Enecuum, a blockchain system based on a fundamentally new structure that allows a full realisation of all the advantages of the distributed registry technology in everyday life ([cf. 5](#)).

## 4. Product Description

Enecuum is designed as a next generation decentralized blockchain platform with unique features that have the potential to help implement a large number of secure and well-scalable blockchain services and decentralized applications.

One of Enecuum's key advantages over other platforms is the "HyperDAG"<sup>3</sup> - a data model for storing and writing transactions, with flexible settings that offer new opportunities for the practical application of blockchain technology. HyperDAG supports the creation of separate branches where the rules can be tailored to solve numerous potential business problems including the ability to handle a large number of transactions cheaply and quickly. Furthermore, this solution allows to integrate the 'sharding' technology<sup>4</sup> that is successful in solving the scalability problem.



**Figure 1. Pending DAG as a part of a HyperDAG**

Enecuum uses a hybrid consensus algorithm combining the Proof-of-Work ("PoW") [3], Proof-of-Stake ("PoS") [4] and Proof-of-Activity ("PoA") [5] algorithms as part of its consensus mechanism. *PoA is proposed to be applied for the first time in a real world context through Enecuum.* Utilizing a combination of consensus mechanisms makes it possible to confirm transactions from virtually any device connected to the network. That, in turn, leads to the maximum possible decentralization of the system, and means Enecuum is likely to be highly resistant to various types of attacks.

Enecuum has developed "SHARNELL Smart Contracts"<sup>5</sup> [20] to operate on the Enecuum platform. These contracts consist exclusively of formulae and business oriented linear logic<sup>6</sup>. SHARNELL Smart Contracts aim to contribute to a high security level within Enecuum. Linear logic allows for reliable automatic certification of smart contracts prior to their publication to

<sup>3</sup> HyperDAG (Hyper Directed Acyclic Graph) - a graph in which a generalized edge can join any number of vertices.

<sup>4</sup> Sharding is the process of storing data records across multiple machines while keeping consistency of this data. Sharding is an effective approach to meeting the demands of data growth in the system.

<sup>5</sup> SHARNELL Smart Contracts are a new type of smart contracts invented by Enecuum. These contracts consist exclusively of math formulas and business oriented linear logic. SHARNELL stands for Shared Noncommutative Exponential Linear Logic.

<sup>6</sup> Linear logic is a non-classical logic of actions and resources allowing to describe dynamics of processes and resource handling. It can be considered as a suitable interface between logic and computer science because it can manipulate the events of real world in natural way.



the system, which we believe significantly reduces potential vulnerabilities, misuse, freezes, deadlocks, and other undesirable outcomes in the system.

One advantage of Enecuum is that it is a highly adaptive system. Users can take part in its development and vote for other participants' proposals in regard to improving system functionality. There are two ways to factor in changes of system parameters:

- to branch the project repository on GitHub<sup>7</sup> and present a modified version of the protocol (likely to be used by experienced developers); or
- to vote for adjustment of any network parameters that do not require protocol modification.

The latter is provided by the system architecture and can be used by all holders of ENQ, which is the native cryptographic digital token that is proposed to operate on Enecuum. Following the test period the voting algorithm is proposed to be open for the users to present changes to the Enecuum's consensus model. During the test period, the Enecuum team proposes to retain control over the protocol for testing and debugging purposes.

Enecuum has been developed using Haskell, a programming language used because of stability of execution and reduced chances of side effects. A custom version of Cryptonight<sup>8</sup> [6] (Keccak + AES + X11) as the core cryptographic protocol has been chosen because of its high resistance to application-specific integrated circuit ("**ASIC**") devices.

ENQ is the native token of Enecuum. ENQ are proposed to be generated according to system specific parameters and paid out to miners as a reward for spending their computational power. ENQ can be received and sent with no fees. They can also be used as a payment for publishing smart contracts to the network, performing complex mathematical computations on a smart contract, creating custom macroblocks, new Tokens and branches, and participation in PoS mining.

## 4.1 Transactions

In our view, there are two broad approaches to storing transactions in distributed registries:

- as blocks (Bitcoin, Ethereum and many others); and
- as directed acyclic graphs ("**DAG**")<sup>9</sup> - (IOTA, Byteball, Universa).

The advantage of the former is its high reliability that is achieved through 100% registry duplication among all nodes in the network. However, that approach imposes certain restrictions on the network speed and scalability. In the latter, DAG, there are no blocks, and every new incoming transaction refers to up to several previous ones effectively confirming them. As a result, registries of this type can quickly process large amounts of transactions, but their level of security raises certain concerns in the community [12].

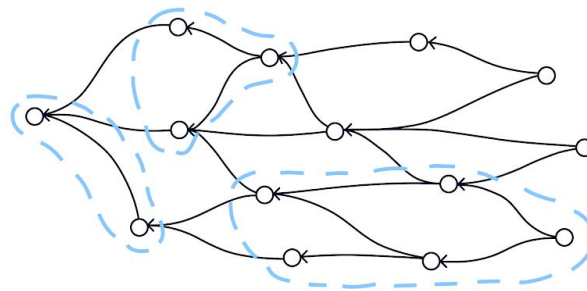
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<sup>7</sup> Enecuum on GitHub: <https://github.com/Enecuum>

<sup>8</sup> Cryptonight is a Proof-of-Work algorithm. It is designed to be suitable for ordinary PC CPUs, but currently no special purpose devices for mining are available.

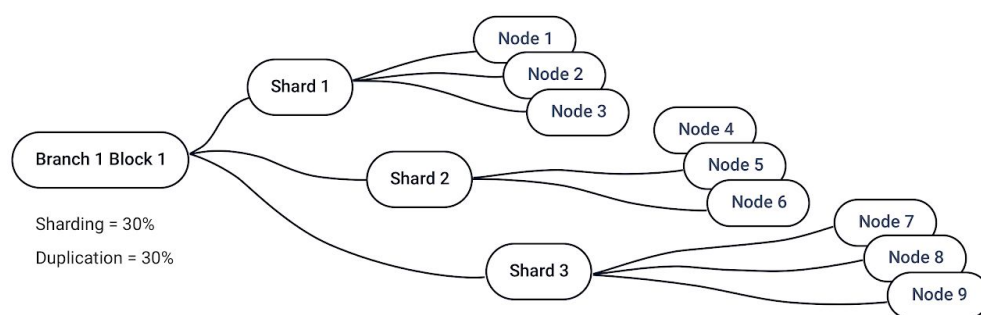
<sup>9</sup> Directed acyclic graph is a directed graph that has a topological ordering, a sequence of the vertices such that every edge is directed from earlier to later in the sequence.

We seek to combine these two approaches and created a fundamentally new method for recording transactions called “HyperDAG”. Its key difference from the DAG is that a transaction entering the system can refer not only to a single previous transaction, but also to a group of them residing in a block (Figure 2). In this way, HyperDAG successfully combines advantages of both approaches and, at the same time, remedies the material shortcomings described above, so it is able to process thousands of transactions per second while having a high level of cryptographic protection against attacks.



*Figure 2. Principles of HyperDAG: Neighboring transactions are grouped into blocks*

Such method of representing transactions offers vast opportunities for their sorting, analysis and sampling. For example, it is possible to create different branches (chains of blocks) in the frame of one network, and also to apply the sharding technology to increase the network speed and eliminate the need for 100% registry duplication among all the nodes.



*Figure 3. Sharding*

In Enecuum, transactions are proposed to have several parameters: duplication<sup>10</sup>, sharding and quality of service (referred to as “**QS**”; in our case - the speed of a transaction). While duplication increases the overall security of the system, it reduces the network speed. Sharding produces the opposite effect. By default, duplication is given 30%, sharding - 30%, QS - none.

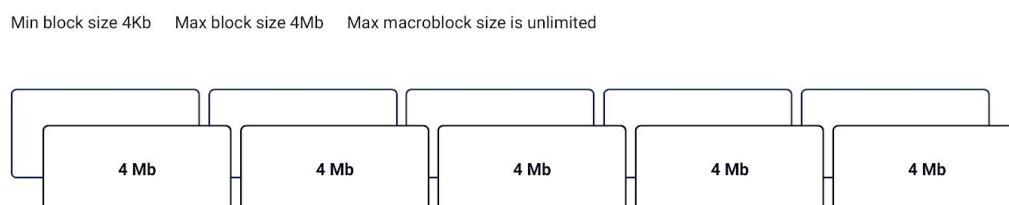
<sup>10</sup> Duplication is the process of duplicating data (transaction records, etc) on all nodes on the network to achieve a high reliability of the ledger.

The option to change these settings seek to allow for easy scalability and creation of unique services within individual branches of the system.

## 4.2 Blocks

The moment HyperDAG accumulates a sufficient number of transactions to start assembling a block, the block creation process begins. Analyzing specified parameters of each transaction, miners determine its value for the system and add it into a corresponding block. Thanks to the introduction of double hash links to previous transactions[MD1], up to  $n$  blocks containing different transactions can be mined at once, which essentially accelerates the transaction throughput  $n$ -fold. The limit of  $n$  is dynamic and can be, for example,  $1000$ , resulting to  $1000 \times 62 \times 40 = 2,480,000$  transactions per second, where  $40$  is the maximum number of transactions in the smallest block,  $62$  is the number of devices in a PoA team verifying the transactions (64 members in a team in total), and  $1000$  is the number of blocks being mined simultaneously.

In Enecuum, the block size is not proposed to have a fixed value and may vary from 4 KB to 4 MB. Essentially, minimum size blocks can be created to reach the minimum delay in speed per operation, and as the load on the network increases, so does the block size. In circumstances where a user needs a block of the size bigger than 4 MB, the system also supports combining any number of blocks into a macroblock, thereby allowing to store large volumes of data on the blockchain.



*Figure 4. Varying block size*

Bitcoin-NG protocol is proposed to be introduced into Enecuum macroblocks [12] to reduce the latency between the creation of blocks, so that each microblock inside a macroblock is created in realtime and adds transactions to the blockchain immediately upon their arrival. In this way we do not have to wait until a macroblock is completed, its hash is found, and it is synced between all nodes on the network - microblocks can be generated concurrently inside a macroblock.

Structurally, a block consists of 3 main sections represented in the following picture:



Figure 5. Block structure

## 4.3 Branches

Using HyperDAG to store and effect transactions enables creating branches (chains of blocks) containing only homogeneous transactions. Each branch is, in essence, a separate blockchain, and, at the same time, is a part of the whole system. Each branch may dictate its own specific rules for creation and confirmation of new blocks. Nodes do not have duplicate all auxiliary Enecuum branches.

Schematically, the process of allocating blocks by branches is represented in Figure 6.

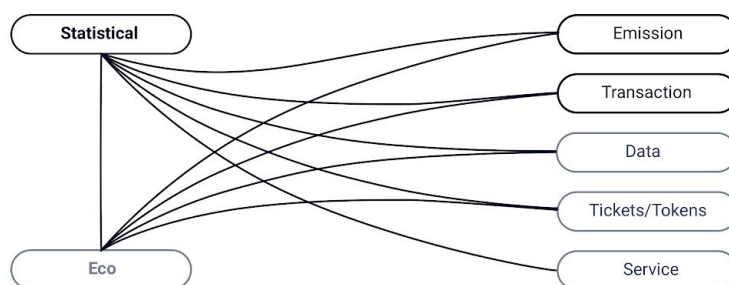


Figure 6. Allocation of different blocks to different branches

The main branches of the system are proposed to be:

1. **The Transactional Branch** aiming to include all ordinary transactions between the users of ENQ.
2. **The Emission Branch** aiming to contain transactions generating new ENQ as mining rewards.
3. **The Statistical Branch** aiming to accumulate and analyze statistics on the operations in the system. This branch contains data on the overall number of nodes, mining records, block sizes and a multifold of other parameters, including PoA mining reward sizes.

Also, Enecuum proposes to support the creation of other branches described below:

1. **Ecological branches** seek to filter out suspicious operations and transactions that fail validation. If, for example, a newly created wallet sends an unusually large quantity of outgoing transactions, they will first go to the ecological branch for detailed analysis.
2. **Ticket<sup>11</sup> branches** seek to provide opportunities for implementing different scenarios through Tickets. Tickets are intended to allow the creation and access to dedicated, private blockchain branches, which we call “ticket branches” ([cf. 4.6](#)). If, for instance, a user creates a Ticket and issues Tokens on that Ticket branch, all operations involving this Ticket can be encrypted and stored in this dedicated branch. Moreover, these Ticket branches may have their own rules, for example, all nodes can be recognized as valid, in turn transactions coming from them can be processed much faster, since there is no need for the consensus between all network members.
3. **Service branches** seek to provide decentralized services, for example, for polling, surveying, instant messaging, document management, etc. Transactions in service branches can include additional information thus reaching a high enough level of flexibility to solve numerous business problems using blockchain.
4. **Data branches** which can act as decentralized repositories. The underlying principles are similar to those of the BitTorrent protocol, however, instead of traditional hashing, Enecuum proposes to offer its own solution - the seamless hash algorithm<sup>12</sup>. It is designed to enable authorized access to a part of any size in the encrypted file, without rehashing and sharing the hashtable between the nodes again, which cannot be done in BitTorrent.

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<sup>11</sup> Ticket is a system object, a cryptographic surrogate, serving as both an access key and base for Tokens with a custom value.

<sup>12</sup> Seamless hash algorithm is Enecuum's invention: it is a hashing algorithm that provides a direct access to a file part of varying size without the need to recreate and re-distribute the hashtable between all the sharing nodes.

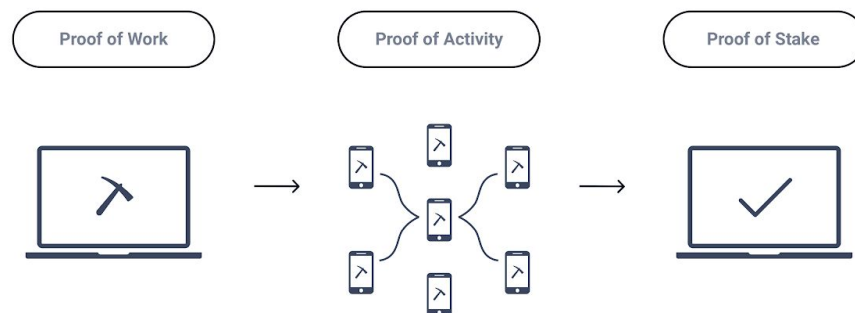
## 4.4 Hybrid Consensus Algorithm (PoW, PoA, PoS)

In Enecuum, consensus is proposed to be achieved through interaction between the following three mining algorithms: Proof-of-Work (“**PoW**”), Proof-of-Activity (“**PoA**”) and Proof-of-Stake (“**PoS**”). This combination makes it possible to achieve a high degree of network decentralization, while significantly increasing both the network security level and its speed.

The transaction confirmation process that is proposed to be implemented in Enecuum can roughly be divided into 3 stages corresponding the algorithms mentioned above.

### Stage 1:

There are two approaches to the first stage. The regular one is where miners connected to the PoW network calculate the hash for blocks of varied size, each for its own block, in parallel. After a hash satisfying the current requirements for its complexity is found, a miner fills the block with transactions and translates it to the network for the second stage involving transaction verification by PoA miners. The second approach is for a PoW miner to calculate the hash, create a macroblock and hold it open for a team of PoA miners to fill it with microblocks containing transactions.



*Figure 7. Hybrid consensus algorithm*

### Stage 2:

During the second stage, PoA miners, divided into teams act correspondingly to the chosen PoW scenario. In the case of the first PoW scenario described above, they check the hash in the translated block's header and verify the transactions in the block. In the case of the second PoW scenario, they check the hash in translated block's header, create a microblock, fill it with transactions, and send it to the macroblock of the PoW miner. In total, a team send to the

macroblock 62 microblocks each containing 40 transactions. Then, depending on the transactions included in the block, PoA miners attach it to one of the system's branches. Checking the block hash for correctness does not require large computational capability, and this operation can be performed even by simple devices, including a mobile phone.

The same applies for microblock creation, filling it with transactions and transaction verification. The process of a PoA team formation involves calculating a hash to enter the team. Each team can have up to 64 participants and is organized based on an analysis of several parameters, including the node's geographic location and other parameters, in order to achieve the highest consensus security level.

### **Stage 3:**

During the third stage, PoS miners continuously re-check balances of all the wallets in the system. For this activity, PoS miners are proposed to receive a portion of the mining reward, in the form of a percent from the emission. The reward depends on the miner's balance in two ways: first, the system defines the minimum and maximum balance thresholds outside of which a miners is not able to gain any reward, and second, the reward grows as the PoS miner's balance grows from the minimum to maximum threshold.

In contrast to existing reward methods, where the network generates new coins immediately upon discovering a valid block, Enecuum, at this stage, issues Marks<sup>13</sup> ([cf. 4.6](#)) that are added to the wallet balance, whereas the real mining payment is performed, on average, once a day. In this way the system is protected against possible attacks on the mining algorithm as well as attempts to gain control over the majority of the computational capacities (e.g. through ASICS).

By default, the mining reward is distributed between the participants as follows: PoW - 70%, PoA - 20%, PoS - 10%. However, the presence of a statistical branch ([cf. 4.3](#)) enables the system to control this distribution scheme, protecting its interests from possible abuse.

## **4.5 SHARNELL Smart Contracts**

Smart Contracts in Enecuum are proposed to be written in JavaScript and executed on Google's V8 engine. The system supports two types of contracts:

1. "Light" (logical) smart contracts that are proposed to be composed exclusively of mathematical formulae and based on the business-oriented SHARNELL linear logic. Linear logic is completely predictable, hence minimizing the chance of any potential vulnerability.

Logical smart contracts are proposed to consist of a "data card" containing conditions and parameters, and the formula itself which takes into account these conditions and parameters with the possibility of full or partial achievement and actuating. Each condition of a logical contract is proposed to be placed in the data card and assigned a corresponding symbol.

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<sup>13</sup> Mark (in Enecuum) is a special tag denoting a specific function of the tagged object.

Later, a mathematical formula is created fully reflecting the terms of the contract. The  $\pi$ -calculus system<sup>14</sup> is used to ensure computations are run in parallel.

This type of smart contracts is ideal for performing the most common operations and transactions, such as multisig, escrow and so on. It is proposed that in the first version of our system they will be created via a graphical editor based on Petri Nets<sup>15</sup>.

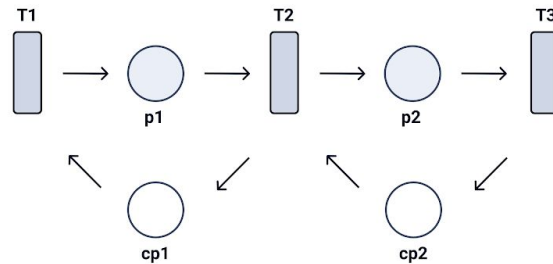


Figure 8. Smart contracts

2. “Heavy” smart-contracts are proposed to contain code intended for solving more complex problems, such as conducting scientific calculations and training neural networks. These are executed in a dedicated branch of the system with a payment for the calculations. It is proposed that payment for such calculations will be given in ENQ, at a user-defined rate. It is also proposed that they will use the  $\pi$ -calculus system, and channel system with session types.

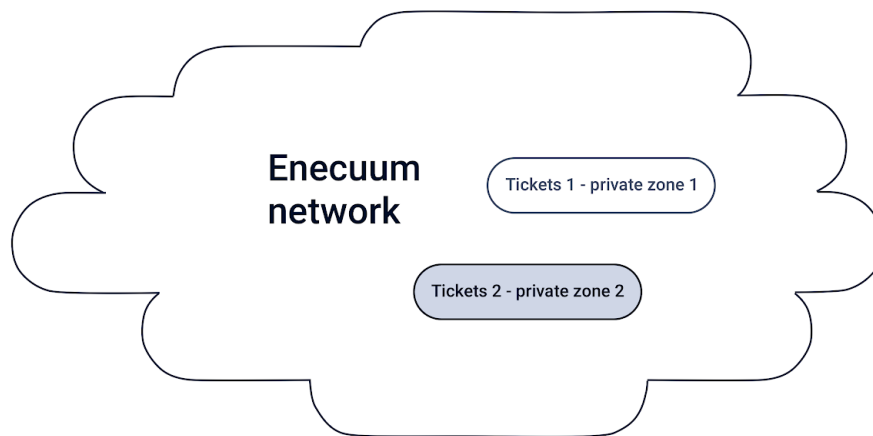
## 4.6 Tickets and Marks

As was noted earlier, Enecuum aims to support the notion of a “ticket” (also “Ticket”, “Tickets”, as applicable). A Ticket is a cryptographic surrogate, similar to a token, and can be created by any user of the system. A Ticket is used to create a dedicated branch where circulation of the ENQ is not intended. A Ticket is used both as an access key to the corresponding branch and the decryption key for the transactions in this branch, and can be freely transferred between users of Enecuum.

<sup>14</sup>  $\pi$ -calculus is a formal algebra for concurrent, communicating and mobile systems. It provides a tool for the high-level description of interactions, communications, and synchronizations between a collection of independent agents or processes.

<sup>15</sup> Petri Net is also known as place/transition (PT) net and is one of several mathematical modeling languages for the description of distributed systems. A Petri Net is a bipartite graph that consists of two types of nodes: Places and transitions connected by directed arcs.





*Figure 9. Tickets and Ticket branches (Global ENQ network, Ticket branch #1, Ticket branch #2)*

A Ticket can be the base medium of exchange to be accepted in the corresponding Ticket branch. Conversion of these Tokens into ENQ is proposed to occur via the corresponding Ticket.

The key purpose of Ticket branches is to facilitate creation of a blockchain-based flexible environment for easy interaction between businesses and their customers.

“Marks” are another tool that aims to extend the functionality of Enecuum (“Mark” or “Marks”, as applicable). Marks aim to label Tokens, transactions or wallets and do not exist as a separate unit, but only coupled with a payment unit. Marks are used to denote specific functions of the tagged objects and ensure a strict execution of the stipulated terms or certain tasks. Mark is intended to be final and irreversible - it cannot be changed and is determined prior to its creation.

Enecuum aims to provide the following types of Marks:

- **Transaction Acceleration Marks** promote higher speed of transactions.
- **Proofs Remuneration Marks** are converted into ENQ upon data accumulation in the statistical branch ([cf. 4.3](#)).
- **Token Labeling Marks** impose custom rulesets on the payment unit, for example, limiting the list of actions applicable to the marked unit and stating it can only be transferred to the wallets containing a corresponding Mark. This functionality can help effective management of budgets, purchase control and assist with directed loan management.

## 5. Problems and Solutions

### 5.1. Scalability

One of the most important topical problems facing an open blockchain system is facilitating a large number of transactions cheaply and securely. Scalability is necessary for global scale adoption of the technology. The throughput of Bitcoin and Ethereum is often compared to the VisaNet system capable of processing over 50,000 operations per second [14] - a number thousands times greater than the current throughput of most popular cryptocurrencies. Given the number of cryptocurrency users growing globally at an enormous speed, the peak times fees for transactions in the current decentralized systems can reach prohibitive levels.

We believe that a simple increase of block size is a partial and temporary solution to the problem, however it will not solve the underlying scalability issue. Currently, the data in the block is stored there permanently and this means the size of blockchain will keep growing steadily. With an increase in throughput, its size will grow even faster. As a result, only big corporations will be able to allocate enough resources to store and update this vast data set, which is likely to lead to an increasing centralization of the network.

Using HyperDAG ([cf. 4.1](#)) to record and store transactions, we believe that Enecuum is ideally suited for implementation of the sharding technology that allows for division of the blockchain into several smaller parts presented by separate branches or parts of those branches and processed in parallel. Combining sharding with varying block size, Enecuum can efficiently handle tens, even hundreds of thousands of transactions per second without jeopardizing the security of the system. It is intended that the resulting commission for transactions in most cases will be zero or minimum.

In addition, the support of potentially unlimited number of branches in the system makes it possible to create various decentralized business applications, without the need for their own blockchain or more workload on the main Enecuum branch. It is possible that each branch can have a custom ruleset individually tailored to reflect service-specific needs. Furthermore, it is proposed that each branch can either be open for all the members of the system or be private with a defined list of participants. If the transaction speed or block size need to be upgraded in a certain branch, it is proposed that it can introduce its own nodes to modify the consensus rules. The only constraint in this case is the nodes capacity in this branch.

It is intended that Enecuum's architecture will support macroblocks of potentially unlimited size - a solution allowing the protocol to scale in parallel with the growing performance of modern CPUs.

## 5.2. Security

### *Low Decentralization Problem*

First generation blockchain systems used PoW for transaction confirmation. PoW is a reliable algorithm with a proven efficiency in protecting blockchain systems from various types of attacks, such as Denial-of-Service (**DoS**) and spamming. As the popularity and value of cryptocurrencies increased, PoW mining turned into a large-scale business with hundreds of millions of US dollars invested in mining projects.

Low electricity and labor cost in China led to a massive aggregation of mining capacities in Mainland China. This situation put the relevant blockchain system security at jeopardy due to potential collusion between large pools of miners and an increased “51% attack” possibility. The emergence of ASIC devices further exacerbated the problem, as using regular mining rigs lost any economic sense, and led to an even higher degree of mining capacity centralization in the hands of large investors [16].

It is believed that the combination of three types of mining and the use of the Cryptonight cryptographic protocol in Enecuum makes it possible to achieve a high degree of decentralization in the system, not only geographically but also in regard to different device types and demographics. We believe that these features will help make Enecuum one of the most secure distributed registries. In addition to that, the presence of the statistical branch ([cf. 4.3](#)) in the system for collecting and analyzing blockchain status data, will further protect Enecuum and its users from potential threats of various types by evenly distributing the degree of influence on consensus among all its participants.

### *Vulnerabilities in Smart Contracts*

The invention of smart contracts gave the whole cryptocurrency industry a powerful push, but to date their implementation has many weak spots. Once a smart contract is published on the blockchain, it is closed for modification, hence an error during its creation can result in multimillion-dollar losses for its users - a situation that happened not once in various cryptocurrency projects [16].

The existing methods of assessing the security of smart contracts mostly boil down to manual code auditing by the developers in the community. It is submitted that this method of smart contract creation and testing is very inefficient. Especially taking into account that the number of smart contracts being created grows outstrippingly fast and so does their complexity. Ethereum, the most popular platform for smart contracts, proposes to write them in a specific programming language, Solidity [17], which is yet to gain popularity in the developer community. It results in a drastic shortage of experienced Solidity developers, and, in our opinion, does not alleviate the problem.

The linear logic, which is proposed to be used in the implementation of SHARNELL Smart Contracts, seeks to take the security of this technology to a new level. It proposes to introduce reliable automatic testing of every smart contract before it is published on the blockchain. This in turn aims to minimize chances of any errors and potential vulnerabilities.

In addition, the proposed language of the SHARNELL Smart Contracts will be JavaScript, which is one of the most popular scripting programming languages, so a large number of professionals have a chance to engage in creation of SHARNELL Smart Contracts, which proposes a reduced cost of smart contract development.

### *Centralization of Power over the Blockchain*

The failed Segwit2x upgrade of the Bitcoin network and its hard-fork that resulted in creation of Bitcoin Cash highlights the potential disagreements in the community [18]. Unfortunately, the Bitcoin's architecture is arranged in a way that its miners, developers and ordinary users have different motives, which shape their views on proposed changes to the protocol [2]. The competing interests have the effect of slowing down adaptation to changing market conditions. It may lead to system obsolescence if not resolved.

Enecuum is seeking to solve this problem by providing users with a fairer opportunity to influence the platform improvement process by conducting on-chain voting for users' proposals on any parameters or new changes. Moreover, the implementation of any changes is proposed to involve a secure process, as changes can be tested for potential failures in one of the auxiliary branches prior to their release in the main system branch.

## 5.3. Privacy

A popular belief is that cryptocurrencies are anonymous and thus provide ample opportunities for illegal activities. It is also a common belief that, despite the fact that all transactions inside the network are transparent and open, real individuals and companies behind them are unknown. However, this is not entirely true, since every operation in an open blockchain leaves a digital trace kept there forever, and a detailed analysis performed on this trace can help determine real counterparties with a high degree of accuracy. Hence, if intruders manage to match a public address with a real person or company, they can gain access to important confidential data and cause irreparable damage [15] [19].

The Ticket branches ([cf. 4.3](#)) seek to offer Enecuum users a means for conducting transactions in a private mode minimizing risks of identity disclosure. A Ticket is the key encrypting transactions in the branch, thus only the holders of the Ticket be able to see details of the transactions carried in it. Ticket branches also propose to allow for specific Tokens to be issued on the specific branches (Ticket branches). If such Tokens need to be exchanged for ENQ, the main medium of exchange of Enecuum, a Ticket seeks to act as key to effect the exchange. This way a Ticket serves as an encryption key reliably protecting transactions inside the Ticket branch from outside attention, while using capacity of the entire network to confirm such transactions seeks to guarantee high speed.

## 6. Use cases

### 6.1 Initial Coin Offering Platform

The proposed high throughput of the Enecuum blockchain seeks to allow startups to raise funds at any scale, without the risk of a network hang-up. Hence, initial coin offering ("**ICO**") participants can be sure they can participate in the ICO and quickly receive their Tokens. Since smart contracts in Enecuum are proposed to be implemented in JavaScript, they will be easy to write for any web developer, thus cost of their creation is likely to decrease significantly. In addition, the use of linear logic helps eliminate potential vulnerabilities in smart contract code and helps minimize the risks of hacking.

The "cancellation model" allows issuers to implement complex ICOs with step-by-step raising and return of the funds to the participants, at any stage of the process. System-specific notation of Tokens, similar to the ERC-20 notation, is intended to simplify entry of the Tokens created on the basis of Enecuum to a cryptocurrency exchange service after the ICO.

Token issuers will be responsible for the appropriate design of their Tokens use cases and ensuring that their Tokens comply with all applicable legal and regulatory obligations.

### 6.2 Infrastructure for financial services and payments

Using Enecuum's Tickets and Marks, it is our aim to enable banks, government agencies and transactional organizations to be able to reliably control targeted spending of received credit and budget funds. The Enecuum infrastructure can also be leveraged to enable secure and efficient payments.

For example, a bank may have a database of customers, which it categorizes based on the nature of their business (construction company, industrial equipment supplier, etc). The bank has the potential to issue a customer a directed loan in Tokens having a specific and distinct Mark. The customer will only be able to use these Tokens to pay certain predefined organizations, and be able to spend them according to the purpose of the issued loan.

Moreover, the possibility to add annotation to transactions may for example allow for a blockchain-based insurance service that keeps each client's history. The service has the potential to keep user ratings directly on the blockchain and store for example information regarding insurance coverage for each user by conducting automatic calculations via smart contracts.

## 6.3 Distributed computations

Enecuum aims to have the ability to run "heavy" smart contracts in dedicated branches. Enecuum also aims to permit complex calculations that require high computational power without increasing workload on the main Enecuum branches (useful for neural networks training, scientific calculations, rendering computer graphics, JS libraries, etc). Payment for using such "heavy" smart contracts intended to be made in ENQ at a flexible rate, similar to the transaction price concept in the Ethereum blockchain. Creating the request to perform the calculations, the customer sets the price and miners decide whether it is beneficial for them to provide their computational power for the task. In the case miners agree to the terms, the customer's funds are reserved by the smart contract for future payment. When the task is completed and valid results are provided, the funds are released and automatically transferred to the miners.

## 6.4 Decentralized storage

The application of sharding technology and possibility to change the transaction duplication parameters allows for effective use of disk space on users' devices. For instance, if 4 users provide 5 GB of space each and the duplication and sharding parameters are set to 50%, the effective storage capacity for files is 10 GB. Extrapolating this pattern to the entire network, the size of the "global decentralized disk" will grow proportionally preserving the availability of data and a sufficiently high speed of access. This means users may in the future build on top of the Enecuum Blockchain such services as decentralized hostings, cloud data storage services and content delivery networks.

Again, applying SHARNELL Smart Contracts and Tickets as encryption keys on top of such data branches, users can create complex paid access services with decentralized (and immutable) content paid for in Tokens.

## 6.5 Microtransactions and IoT applications

The workload of the Enecuum system will increase as the number of users on Enecuum grows, and decentralized applications are developed on top of the Enecuum blockchain. However, Enecuum proposes to allow for creation of separate blockchain branches with their own consensus rulesets, thus taking the workload off the main system. This in turn seeks to stimulate miners' activity, and create conditions beneficial for implementation of microtransaction services.

Enecuum proposes zero transaction fees for a decentralized microtransaction service, and very low fees per transaction in case of a centralized microtransaction services that involve a lot of microtransactions from a single wallet. For example, 10,000,000 transactions a day could easily be recorded in several large macroblocks of 10 MB each. The fee would be calculated per block, thus it is proposed that there will be extremely low fees per transaction.

We believe this is a perfect use of Enecuum's functionality in relation to the "Internet of Things". An implementation of a simple client for PoA mining on various devices could be able to completely cover their carried transaction fees. Besides, the Enecuum network protocol is designed to provide a high availability of such devices by establishing a mesh network<sup>16</sup> between them.

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<sup>16</sup> A mesh network is a local network topology in which the infrastructure nodes connect directly, dynamically and non-hierarchically to as many other nodes as possible and cooperate with one another to efficiently route data from/to clients. Mesh routers can route data destined for other devices, while hosts are able to sleep for long periods of time.

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