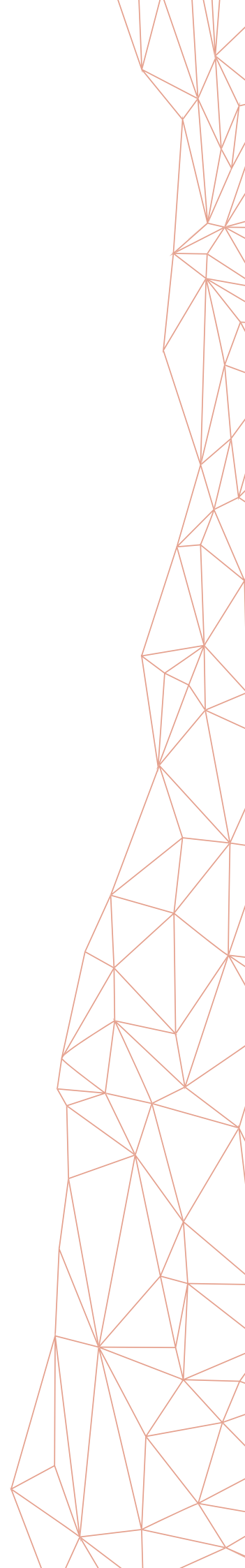

THEORY OF TOKENIZATION

Version 1.0



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INTRODUCTION

The need for digitization of assets arose along with the emergence of computing machinery and data transmission networks. Existing tools for asset management and trading are either not sufficiently automated, not reliable enough, or require complete trust from users. This greatly limits the potential of market turnover of goods and services, resulting in an overly low liquidity (the possibility to sell a certain amount of goods at a market price). In short, tokenization is needed for globalization of processes related to exchange of assets.

In the context of the theory of tokenization, assets are all tangible or intangible objects that represent certain value. A digital unit that represents user's balance as well as proves ownership of a particular asset is a token.

In this document, we present answers to frequently asked questions regarding tokenization. Having acquainted with them, one may get a basic understanding of the theory of tokenization.

Further we define 4 fundamentally different levels of abstraction at which we will consider the process of tokenization. All the questions discussed in this document are divided into categories according to these four levels.

| |
|---|
| Token usage <i>operation with a digital wallet, legal aspects, practical issues</i> |
| Business process management <i>legal aspects, provision storage, insurance</i> |
| IT infrastructure <i>managing servers and processes, roles management</i> |
| Technological details <i>account structure, transaction processing, protocol updating, cryptography</i> |

The perception of tokenization and token at different levels of abstraction is as follows:

- At the level of everyday use, the term token usually denotes ownership of something *tangible* or *intangible*. A token is a right to receive some product or service.
- At the level of business processes, tokenization assumes that digitized property rights registries are the primary sources of information considering asset owners.

- At the level of IT infrastructure, tokenization assumes that there is a set of software modules that perform accounting and updating of user balances by working interconnected.
- At the level of technological details, tokenization implies management of accounts and balances using cryptographic keys as well as database synchronization through consensus algorithms.

In **legal** terms, a tokenization platform is a typical registry of property rights and is not fundamentally different from a traditional centralized accounting system or a paper record. If a user has an account on the tokenization platform—where he stores a certain number of tokens on his balance—he is meant to have an opportunity to prove the legal title to the relevant assets.

The perception of **responsibility** for maintaining the registry of property rights at different levels of abstraction is as follows:

- At the user level, a title registry is cloud-based.
- At the business level, a tokenization platform is managed by one or several legal persons that have licenses for the appropriate software.
- At the level of IT infrastructure, a token accounting system is supported by several servers that are controlled by one company or a group of business partners.
- At the technology level, there are database software modules that store data about accounts, verify, confirm and store transactions as well as synchronize the final state of accounting system between each other.

A distinctive feature of tokenization platform is that it implements mechanisms of ensuring the integrity of entire transaction history; it also offers data processing properties such as availability, non-repudiation, robustness, and authenticity. A tokenization platform satisfies the needs of users who work on the *trust but verify* principle.

Further in the text the two expressions *“a tokenized title to an asset”* and *“a tokenized asset”* will be used interchangeably.

1 BASIC CONCEPTS

1.1 Token

What is a token?

A token is an accounting unit used to represent user's balance in a digital accounting system which allows proving ownership of a corresponding asset. The word **token** also is used in other fields: for example, certain identifiers or secrets for digital authentication are called tokens.

What does a token provide to its owner?

The token owner is provided with a legal title to a corresponding asset and is also able to quickly and reliably transfer this right to other users without having to transfer the asset directly. Owners of a token are assumed to recognize the legitimacy and uniqueness of the registry where the record of tokens is maintained; also they should trust the custodian of physical assets (in case a token is backed by any).

What is a token at the business level?

Primarily, a token implies the record in the property rights registry that an asset belongs to a certain user. In addition, this approach opens up a number of opportunities for trading—an asset can be bought, sold, or donated; the most important here is to be able to do it swiftly and reliably. This is primarily convenient since assets transfer is carried out within the digital accounting system. Note that you can implement an accounting system in such a way that the history of title transfers—provenance—can be easily traced. For example, when it comes to a medical product, it is difficult to overestimate the full value of having additional **authentic** data about it. Transferring a token “hand-to-hand” means changing the owner of the asset in the registry.

What is a token at the IT infrastructure level?

A token can be viewed as a recording method in the registry, which reflects user's balance in an accounting system. At the same time, this method implements the following functions:

- Data backup
- Preservation of integrity of the transaction history
- Strict arrangement of transactions
- Automated real-time audit

What is a token at the technological level?

A token is a user's balance represented as a field in the structure of account. The account is implemented with operations for updating the state of the database, transaction model, rules for processing transactions, and mechanisms for confirming them. A token is managed using cryptographic mechanisms such as digital signature, publicly verifiable proof, etc. Thanks to the digital nature of a token, it can be divided into many parts (in this case, the owner holds a share of a particular asset).

What is the difference between direct ownership of an asset and ownership of a token backed by this asset?

The difference lies in where an asset is physically located: transferring ownership in the form of a token does not necessarily presume the physical transfer of an asset by which this token is backed.

What are examples of tokens in everyday life?

A voucher for one haircut in a barbershop can be considered a token. A subway token is another example. The US dollar before the cancellation of the gold standard was a token for a certain amount of gold.

Why have people started talking about digital tokens?

The rise in popularity of digital tokens has been caused by the advent of Bitcoin. Following Bitcoin many have tried to create digital assets that operate on a similar principle—being accounted in decentralized systems and operating through a predetermined algorithm. Such assets were most often used as internal currencies for specific ecosystems; they came to be called tokens. The multiple price growth of such tokens in 2017 caused a surge of interest. Later it became clear that this accounting model can be applied to traditional assets.

1.2 Tokenization

What is tokenization at the IT infrastructure level?

Tokenization is a process of transformation of asset accounting and management in which the ownership of an asset is represented by a digital token. The essence of tokenization is to create digital accounting systems for real values in order to record and process transactions reliably.

Why is tokenization becoming popular?

Tokenization implies the creation of complete infrastructure which has a number of prominent possibilities such as simple audit, atomic transactions, secure exchange, and the ability to expand with external modules; the maintenance of such infrastructure is significantly cheaper than with the traditional ones.

Can you give an illustrative example of applying tokenization?

One example are the warehouse receipts. Suppose that an elevator manager accepts a ton of wheat for storage. In return to the farmer who owns the grain, he gives a digital receipt (this essentially is a token). With this token you can prove ownership of a certain amount of grain; if you ever need the physical asset (grain), then you will be able to take it by presenting an appropriate receipt (token). The owner of grain can sell his receipt, which will actually mean change of ownership. He can also buy receipts from other owners and thus possess a larger amount of grain. What is noteworthy is that a physical asset is prevalently in the storage, and only its digital analog is transferred.

What is a tokenization platform?

A tokenization platform is a set of components that allow keeping records and performing operations with a particular asset through the use of a digital token as well as provide for the reliability of storage, processing, and managing of assets. These components are as follows: an accounting system, access control mechanisms, payment system, trading system, user management module, token lifecycle management module, and other modules. A tokenization platform is a comprehensive solution to the task of tokenization of assets.

1.3 Types of assets and their corresponding tokens

What are intangible assets?

Intangible assets present ideas or concepts that have no physical representation. Copyrights, shares, patents, and trademarks are all good examples.

What are fungible assets?

An asset is fungible when it can be exchanged for another identical asset of equal value. Currencies, resources, and commodities such as petrol, gold, real estate, etc. represent this type of assets. Such assets are fungible for as long as their quantity and quality remain unchanged.

Which assets are non-fungible?

Whereas units of fungible assets are equal, units of non-fungible assets may have completely different values. Such an asset is unique and indispensable. Paintings would be a proper example: there is only one original Mona Lisa in the world. Therefore, it is not—and will never be—the same as millions of its engravings or digital copies. In other words, any poster or copy of Mona Lisa is never the Mona Lisa itself, and thus it is never of the same value.

Can fungible assets become non-fungible?

A fungible asset becomes non-fungible once it obtains a certain distinguishing characteristic—this can happen in the course of time or due to a unique act of personalization. For example, a T-shirt signed by a famous football player has a higher value than the same T-shirt without the signature.

What types of tokens exist?

Tokens can be divided into several main groups (non-strict classification):

- Asset-backed tokens
- Security tokens
- Digital collectibles
- Utility tokens
- Digital currency

What are asset-backed tokens?

An asset can be a product or service. Tokens backed by assets are controlled within accounting systems where they are managed, stored, and issued either by the service provider or by the organization that stores physical goods. One such token is always backed by a fixed amount of goods or services in the 1:1 ratio, which is guaranteed by a certain party (custodian). For example, one token can grant the right on 1 kg of grain, one haircut in a salon, one square meter of real estate, or even 1/1000 of a particular artwork.

What are security tokens?

A security paper is a fungible financial instrument that represents a type of financial value and is a broad group that includes stocks, investment contracts, etc. Securities are a subset of assets.

According to the Howey test, a transaction is a security (investment) if:

- It is an investment of money.
- The investment is expected to gain profits.
- The investment of money is in a joint venture.
- Any profit comes from the efforts of a promoter or third party.

Usually, tokens of such type are recorded in systems where management, storage, and issuance are performed centrally. These processes are performed by a custodian bank or any organization with an appropriate license. One token always represents a certain number of shares or percentages of the money flow. The processing is carried out centrally by a custodian.

What are digital collectibles?

Collectibles are anything of a particular value or interest to a collector—these assets are non-fungible. In this case, a token implies ownership of a unique object. These assets are intangible and exist within an accounting system exclusively. One example are the CryptoKitties tokens.

What are utility tokens?

Utility tokens represent the right to use some system functionality. They simultaneously possess various properties: ownership of goods (or a service), the right to receive a certain part of profit, and certain properties of a currency. Utility tokens are often an internal currency of a system which is designed to “accumulate” value created within the system. Decision-making and issuance are usually centralized.

2 AREA OF APPLICATION OF TOKENIZATION

2.1 Tokens and familiar things

What is the difference between tokens and currencies (money)?

Despite the fact that people already use this word in their everyday life, **token** is a technical term that in practice denotes the right to any asset, including a currency.

Money is used as a means of exchange. In general, the most liquid commodity is always apt to become money (e.g., in ancient times—shells; in prisons—cigarettes).

Tokens are a digitized right of ownership of an asset and can also be used as a means of payment. Exchange of tokens or payment in tokens for other goods and services are equal to **barter**.

What is a cryptocurrency?

It is an independent digital currency in which management of the following processes is decentralized: coin issuance, transaction confirmation, data storage, audit of accounting system, and governance (such as decision-making about the updates). To own cryptocurrency coins and make payments, you do not need to obtain any permissions: all users have equal rights to use it.

Can you call cryptocurrency a token?

Sometimes the term **token** is used to denote an entire group of digital assets: digital collectibles, complementary currencies, and cryptocurrencies. The opposite statement, however (i. e., any token is a cryptocurrency), is false because tokens can be issued either in a centralized (managed by a particular organization) or decentralized (managed by an upfront specified algorithm) way; respectively, they can either be fully controlled or completely independent. Thus, only a narrow subset of tokens can be considered cryptocurrencies.

How can users tell the difference between digital tokens and digital coins?

A coin often represents an accounting unit or a currency note. The concept of a token, however, is much broader and implies ownership of a certain asset, for example, proof of the vote right, a digital identity, a loyalty point in a chain of stores, etc.

2.2 The role of tokenization in processes of issuing and accounting of assets

What is the difference between tokenization and digitization?

A system where there is a common digitization of documents, bills, and property rights is not enough self-sufficient and cannot be managed completely remotely. For example, for

some transactions—even those that deal with assets accounted digitally—there is no way around a physical presence of participants, notary visits, etc. Nowadays there are many examples of digitized assets; yet the access to accounting systems that keep the record of these assets is limited. And those who do have access are essentially those who receive user requests for transferring assets and those who execute these orders. Tokenization transforms asset management: *an order execution model is replaced with a model of direct asset management using cryptographic mechanisms.*

What is the difference between the registry of authenticity and the title registry (ownership registry)?

A registry of authenticity associates a specific asset (e. g., a designer bag) with its manufacturer and allows verifying its authenticity. This registry contains only objects without current owners.

A title registry is an information resource that contains data about existing and terminated ownership rights to certain assets.

What is a token in legal terms?

Once tokenization platform is considered a primary source of information about the ownership rights, the possession of a token for an asset becomes legally equivalent to the ownership of an asset itself—change of ownership of a token is equal to a change of ownership of an asset. However, due to the fact that some tangible assets need to be stored, the binding of digital ownership to an asset must be performed by a trusted party (or many independent parties). For the real estate or intangible assets, the ownership record is actually equivalent to the ownership of an asset (e. g., land, shares, or intellectual property).

How are tokenization and blockchain technology related?

A digital accounting of value prompts a number of risks. It is important to have a system where issuance, storing, and transferring of value is performed with a sufficient level of reliability, efficiency, and transparency for all participants. For this reason, blockchain technology is well suited: security of data is guaranteed by cryptography, while any attempts to violate the accounting rules are particularly apparent to an auditor. Moreover, ordinary users, if have detected any violation in the operation of a tokenization platform, now have an opportunity to indisputably prove an auditor that they have been deceived.

2.3 Legal aspects of tokenization

What is the legal power of tokens?

A token can imply the right to a currency, share, etc. Currently, token regulation can be split into two areas:

- Utility tokens, which are a hybrid financial instrument that does not have any well-defined approach to regulation

- Asset-backed tokens, which are regulated similarly as the assets by which they are backed

In this document we consider only the second type of tokens. It is also worth noting that a big question is admitting decentralized autonomous registries as a legitimate approach to keeping the record of ownership rights.

How can a token be pegged to a physical asset?

In this situation the owner of a token trusts a custodian who is responsible for backing these tokens with an appropriate asset; the token owner must also trust the issuer who ensures that the number of tokens matches the physical asset of a custodian. For more details, see *Roles* (4.2).



3 PROBLEMS THAT TOKENIZATION SOLVES

What are the current issues of accounting systems?

The key ones are:

- Lack of transparency in the accounting process, particularly in the history of changes
- Low level of adaptation with other platforms
- Need to trust the management of a system to a third party
- High complexity of audit
- Vulnerability to unauthorized changes

What are the causes of problems in traditional accounting systems?

The primary reasons are as follows:

- Technical incompatibility of data formats and a lack of unified API
- API does not support managing using cryptographic methods
- Final state of the database is, by default, considered the main source of data, making it difficult to trace the causes of errors
- Vulnerability to malicious actions
- Impossibility of synchronous and atomic updating

All the above-mentioned factors lead to inefficient operation, the need for manual intervention, and additional expenses on audit and insurance.

What opportunities does tokenization provide?

Tokenization has plenty of promising possibilities. Some of them are:

- Creation of accounting systems with verifiable transaction history
- Reliable real-time audit of an accounting system
- Storing and transferring assets in different systems with guarantee of authenticity and finality of transactions
- Reduced expenses on IT infrastructure (resulting in lower fees)
- Increased user convenience by using uniform software
- Ability to ensure fractional ownership (investors may own a percentage of a certain asset)

4 PRINCIPLES OF OPERATION OF A TOKENIZATION PLATFORM

2.1 Tokens and familiar things

What are the basic principles of tokenization?

There are the following principles:

- Direct asset management by an asset owner
- Reliable and automated audit of entire transaction history
- Increasing fault tolerance of tools for storing, transferring, and exchanging assets
- Self-sufficiency of tokenization infrastructure and mechanisms for its updating
- Openness of specification of an accounting system and digital wallets

What does tokenization mean for accounting?

At the user level:

- Users have a software that verifies all transactions and their history.
- Users must trust a custodian (if an asset is tangible).

At the business level:

- An owner sets the rules of work, roles, commission fees, etc., and their change procedure.
- A platform is created to provide all its participants with a guaranteed possibility of auditing.

At the infrastructure level:

- An accounting system is distributed between servers that may belong to different legal persons or organizations.
- Synchronization of data between independent servers is performed permanently.
- Servers build trust policies between themselves.

At the technological level:

- All operations (including the service ones) represent signed transactions.

- Balance management is performed using cryptographic keys.
- A system has open APIs.

4.2 Roles

What are the roles present in the tokenization platform?

- Validator—a party that participates in collective confirmation of transactions. If there is a single validator on the tokenization platform (a centralized accounting system), then he usually is the owner
- Auditor
- Custodian—a party that provides physical storage of an asset
- Issuer—a party that issues tokens provided by a custodian on a tokenization platform
- Administrator
- Corporate user—a business that owns assets. This business interacts with a custodian and an issuer as well as delivers tokens to retail customers
- User

Who can be the validator in the token accounting system?

The validator could be anyone who is able to maintain the normal functioning of a computing system in accordance with the protocol of the token accounting. The role of a validator can either be performed by one person or by an entire organization. In general, transaction validators could be auditors, regulators, as well as partners of the creator (owner) of a tokenization platform (e.g., members of a consortium performing a particular business function).

What is a tokenization platform?

If a company decides to tokenize its asset and independently control the validators of a tokenization platform, then essentially it is the owner of a platform. The company centrally makes decisions on updating the protocol and relevant rules for token accounting. If the task is to decentralize the accounting system, then the validator role can be distributed among partners or even clients of the company. In this case, the platform becomes independent referring to processing and confirmation of transactions as well as provides the trustless property when dealing with corresponding tokens.

4.3 Responsibility distribution

If the case is about a tokenized gold, then who is liable to an owner of the gold-backed token for the safety of a unit of gold?

The custodian of gold is responsible for the safety of the physical asset (see 4.2. Roles). It is specifically this party that is also liable for the withdrawal of tokens from circulation at the token owner's request of the reverse exchange.

Who is responsible for errors on the tokenization platform?

If a tokenization platform is centralized, then it is the owner who is responsible. If a platform is decentralized, then responsibility gets distributed among its validators or users.

4.4 Ensuring platform security

How to store, manage, and access tokens?

Each user in the accounting system has their own account and the corresponding balance –tokens are recorded using this balance. Initiation of operations to update the status of an account and balance is performed using a special digital wallet, which authenticates transactions with a digital signature. No one but an owner of a private key from which a digital signature was computed can change the status of the corresponding account. Even if several validators of an accounting system have colluded, they cannot change the status of accounts and balances unnoticeably. Moreover, an automated audit of accounting system instantly recognizes the mismatching between transaction history and the final state of accounts as well as fake digital signature.

5 THE LIFECYCLE OF A TOKEN

What is the lifecycle of a token?

- Token creation (parameters setting)
- Token pre-issuance (tokens are issued on the smart contract balance)
- Token issuance (tokens are sent to the balances of regular accounts)
- Initial distribution
- Transactions and trading
- Token redemption (reverse exchange of tokens for a product or service)

How are tokens issued?

Issuance is performed by an issuer based on the information from a custodian. Tokens can be issued either in a centralized (the amount to be issued is set by the responsible party) or decentralized (several validators reach consensus about how to issue tokens) way.

Why is it important to withdraw a token out of circulation after it is exchanged for a physical asset?

Token redemption is equivalent to redeeming the liabilities of one party towards another. During the settlement (for instance, the physical asset is transferred from a custodian to a user), the token (i.e., the right of claim) must be revoked. There are special operations for the destruction of tokens that can be initiated by sending a special transaction to an accounting system; to initiate them, an account must have appropriate rights.

What happens when purchasing tokens?

During the purchase, a user first gets a digital wallet, where private keys are processed to manage the account on a tokenization platform. A digital wallet returns its user a special identifier for receiving the payment and displays a list of transactions related to this identifier as well as their status.

How are transactions canceled in case of errors or attacks?

Deleting or modifying transactions as such is impossible. However, there are service transactions that lead to changes in the current balance (thereby logically adjusting the results of actions). As a result, both wrong and corrective transactions remain in the history. This is necessary for reliable audit and protection against attacks of a system's operator.

How is a token destroyed and is it possible to destroy a token so that the proof of ownership remains?

Destruction of a token—redemption of an obligation on the provision of an asset—does not lead to destruction of transaction history.

6 FEATURES OF APPLICATION OF TOKENIZATION

What are the advantages of tokenization?

- Transparent business processes
- Instant audit
- Reliable storage of transaction history
- Creation of a secondary market for assets
- Possibility to decentralize decision-making
- Possibility to build an ecosystem of applications that does not rely on (and does not belong to) a single organization and thus remove the issue of competition and strengthen cooperation
- Low costs per transaction while preserving the security requirements at least identical (or higher) compared to the traditional approach

What is the process of asset tokenization and what benefits does it give?

Tokenization changes the very mechanisms of asset management: instead of managing through execution of orders by system operators, an asset is managed directly through the digital signature of its owner.

The difference of management methods is similar to that between traditional payment systems and Bitcoin. To transfer money through a bank payment, a user gets authorized in a bank and places an order to perform the desired operation, which will be processed by bank employees. To transfer a cryptocurrency, a money owner authenticates a transaction directly, using their own digital signature, which is enough for the network participants to accept it.

The idea of tokenization is to apply such an approach to the management of all digitized assets and thus improve the security of transactions, reduce expenses and response time of the system.

A trading infrastructure must include the following components: depository (an accounting system), exchange (bidding process), payment processing engine, user interface (wallets). Tokenization processes are aimed at integrating all of these components in a much more efficient—compared with the traditional approach—manner. In this way, we can distinguish three fundamental elements of tokenization platform:

- Application of cryptographic tools for managing accounts
- Open specification of components and interfaces
- Decentralization of transaction processing and audit

These infrastructural changes have several advantages: in terms of system functionality, there are modules for business logic and smart contracts; in terms of security, there is a possibility of a reliable real-time audit and data synchronization between bidders. In addition to the digitization of assets which allows increasing productivity, security, convenience of asset management, and removes transaction intermediaries, tokenization gives assets certain properties which were not inherent before:

- Possibility to prove history of ownership
- Division into fractions
- Integration of management principles into an asset itself (e.g., the weight of a participant's vote is proportional to their token balance)

What assets are the easiest to tokenize?

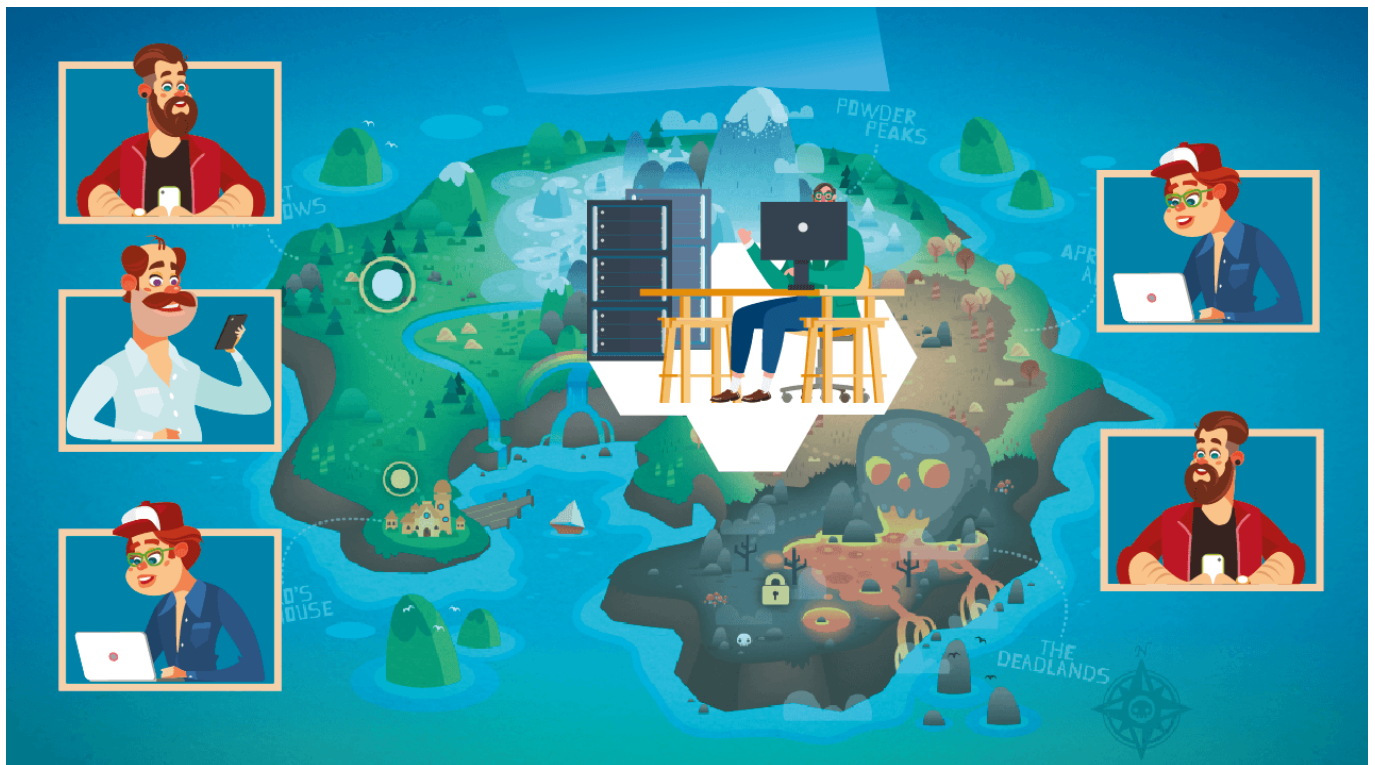
- Intangible (there is no necessity of storing the provision)
- Fungible (processes of grouping, transferring, and dividing into shares are much easier)



7 EXAMPLES OF APPLICATION OF TOKENIZATION

7.1 Increasing transparency of profit generation in online games

The problem. Creation of value in online games is not transparent to investors. The ecosystem is always tied to the game developer, which leads to dependence on their decisions. At the moment, in such business, developers manage all the servers and control the balances in a local currency as well as in the in-game items. If a currency is traded on an exchange (such as for Warcraft), then users must trust the developers—that they do not issue “non-backed” in-game gold.



The solution. With tokenization it is possible to release a decentralized version of the game, in which players are joined in a network, and each of them stores a complete copy of the game state. The accounting of internal currency and game items is maintained on a game-specific blockchain, which is distributed among all players—game developers also have an account. Since accounting is performed in a decentralized way, balances cannot be falsified.



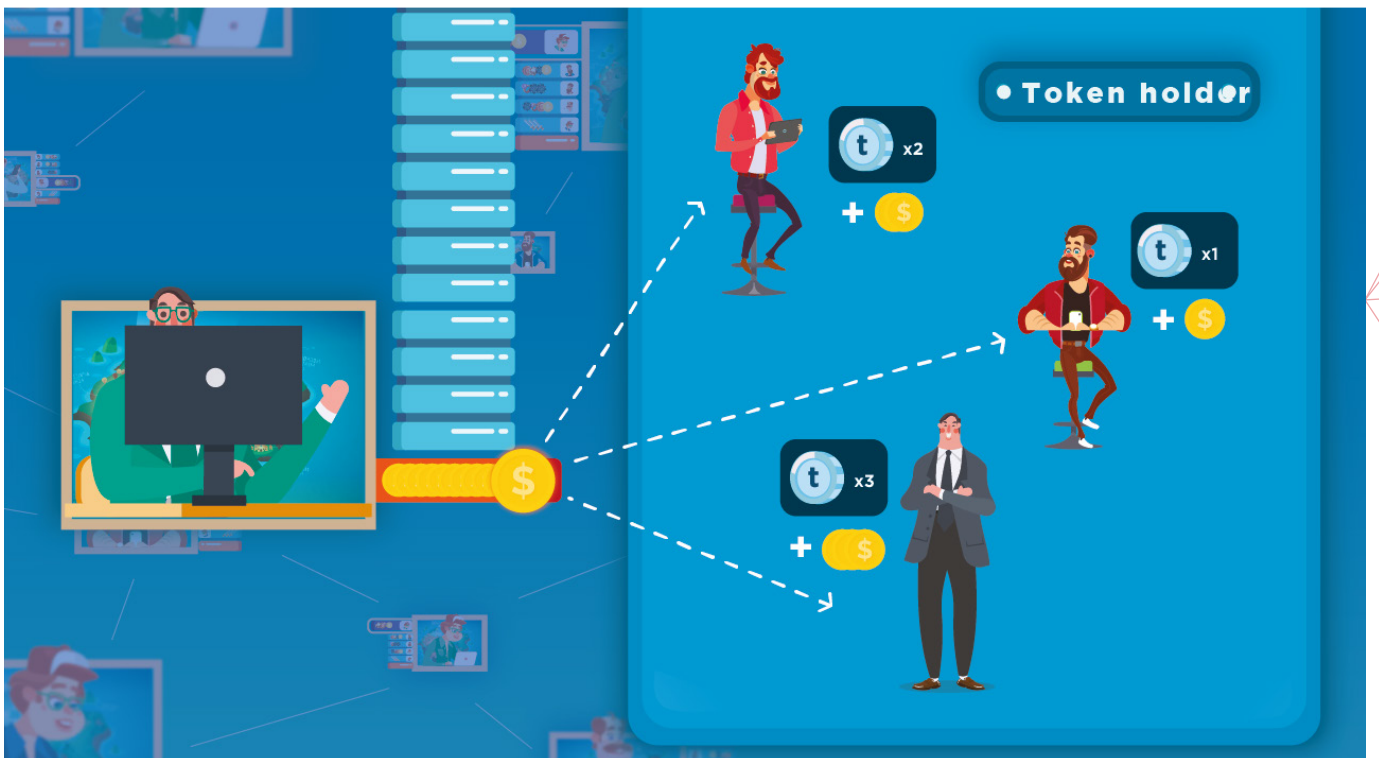
The gaming platform also includes exchanges, where you can deposit real money to buy an in-game currency (developers may have no legal relation to the exchanges).



Originally, in the game, there can be a rule that each transaction (which transfers in-game currency or items) between players must include a small fee which is accumulated on the developers' account. Collected fees (i.e., taxes on operations) will be the profit of game developers.



In order to make investor relations transparent, there is a separate token that represents “shares” of the game. In the program code, profits (collected fees) are distributed proportionally among the token owners. These “shares”, even before the development of the game has started, can be sold either to investors or to the future players.



Important outcomes of this approach are the following:

1. A game does not require presence of servers controlled by the developer (which leads to direct cost reduction).
2. The company creating the game can be completely virtual and may not even require a physical office, bank account, and paper contracts for investors.
3. The profit of the company is transparent to all players and investors because the distribution of this profit is no longer controlled by developers.

Some might think that an internal in-game currency is a utility token—yet, this is not the case: its rate is not aimed at growing over time. What will grow, however, is the “GDP” of the game, due to the increase in the number of users and their activity in the game. The token—“share” of the game—will exactly fit the definition of a security token.

A game is a good example because its economy is closed (i.e., there are no exports or imports). Therefore, you can test various technologies and new economic models on it.

7.2 Real estate investment (REITs)

The problem. Today, real estate is generally traded by indivisible pieces, which are defined—trivially—by the construction plan. If an investor wants to buy real estate in a particular district, inside a particular building—due to particular investment reasons—he is obliged to buy the entire facility. This retains the overall market: minor investors are unable to enter it, while the diversification of risks is almost unattainable.

The solution. In terms of tokenization, there will be a digital property registry in which security tokens—micro-shares of a particular building—are issued. Therefore, an investor, when buying a token, gets ownership of a part of a building rather than of the entire office; he can buy/sell any number of tokens either on the secondary market or from/to the developer. At the same time, the managing company can rent offices and distribute profits proportionally between the owners of tokens. If all buildings in a district are tokenized, it is possible to create a token that will represent the commercial real estate index of a district (at that, it is not simply an index but a direct ownership of micro-shares). In this case, an investor will be able to invest in the growth of real estate in the whole district if, for example, he knows that a new subway station or Google office will be opened there soon. Similarly, you can make an index of a city or a state. Investors will choose an individually acceptable investment strategy—from a particular building to even a state.

7.3 Company owners voting

The problem. To make decisions considering important issues, it is necessary to hold a shareholders’ meeting: this often requires significant logistical and time expenses.

Solution. The registry of owners of a company is tokenized, and each shareholder will have their own digital wallet in which their share is accounted, so you can perform voting among the token holders. Any token holder will be able to initiate voting by posing a question with answer options. All other holders of tokens receive notification of a new voting and gain an opportunity to poll their vote for the proposed answer options. The weight of a voter is proportional to the number of owned tokens. As a result, the process of collecting and counting votes is completely transparent and safe for all shareholders, leading to a significant acceleration of decision making and reduction of expenses.

7.4 Warehouse receipts

As an example, imagine a grain storage (its business essentially is that it stores grain). Farmers bring grain for storage and in return receive a receipt. Later, they take back the grain (the grain returned should be of the same quality as it was brought). Tokenization of this process will allow achieving the following goals:

- Optimization of expenses related to system ownership
- Creation of a secondary market (the warehouse can collect fees for each transaction on the secondary market)
- Increasing transparency of operations for the warehouse owner (all operations for the exchange of receipts are evident at any time as well as who and how much someone holds them)
- Ensuring the authenticity of receipts (users can be sure that their receipts are not fake)

7.5 Virtual services

A good example would be the mailing service that dispatches emails using its database of clients' addresses. In terms of tokenization, one email can be equivalent to one token.

Now, instead of a free package of 1000 emails per month, all newly registered users are given 1000 tokens on their wallets with which they will pay for the services. If a particular user needs to send more than 1000 emails, they can purchase more tokens (to motivate your customers, you can set a rule that only purchased tokens can be transferred between users).

The benefits of this approach are the following:

1. Free users are stimulated to "pay" for the service.
2. Business operations are transparent (this helps improving analytics as well as proving investors the turnover amount).

3. You can create a secondary market and have a flexible control over it (users will no longer be afraid to pay for the services in advance, as they will always be able to sell them in case of disuse; also, it is now much easier to tell speculators from the users who actually benefit from the functionality).
4. Business is permanently ready for an instant switch to a flexible pricing model— auction (in addition, activity on the secondary market will show the real demand for the service, hence improving price discovery).

7.6 Crowdfunding and crowd-investing

In order to increase the transparency of investments in a startup, shares can be tokenized. A tokenized accounting system of shares will allow all investors to be confident that *their share is accounted and that their share is a certain part of a total investment*.

Everything not accounted in the tokenized accounting system (which is, in fact, accessible to all investors) is considered non-valid.

7.7 Gift certificates

Currently, the process of issuing gift certificates is prone to several issues:

1. Gift certificates most often have a physical form, which leads to expenses on their creation and distribution.
2. The transfer of a gift certificate requires physical interaction, and its speed is limited.
3. Risk of counterfeit is possible (the buyer is not able to verify that the certificate is indeed issued by the business).
4. In the case of using digital codes as certificates, there is a risk that the certificate can be reused since a code itself is a secret value.

Tokenization allows solving all the above-mentioned issues. A digital token is used as a certificate, and a user's wallet is used as a storage. A token can be transferred online without the risk that the previous owner will be able to reuse a certificate after it is sold. Transaction expenses for issuing, transferring, and trading certificates are close to zero.

8 CONDITIONS FOR IMPLEMENTATION OF A TOKENIZATION PLATFORM

What is required for implementation of a tokenization platform?

1. ***Digital identity***, which would allow linking participants' actions in the network with their actual identities
2. ***Digitization*** of all processes of an organization
3. An ***established scheme*** of key storage and management

9 RISKS

What are the risks of using tokenization platforms?

1. The provision of a token (for which a custodian is responsible) may be stolen (this means that, while accounts of users display correct balances in the accounting system, real assets can be replaced, destroyed, or stolen: this problem mostly relates to properties of tangible assets rather than a tokenization platform).
2. Personal keys of users can be lost or stolen; this risk is hard to estimate and hence against.

10 COMPARISON WITH TRADITIONAL ACCOUNTING SYSTEMS

How does a tokenization platform increase reliability of accounting compared with traditional systems?

Tokenization ensures key security features which are necessary for reliable operation of the system as well as reducing expenses related to managing and controlling it. The features are as follows:

- Integrity (provided for the transaction history and account statuses and is implemented using digital signature)
- Accessibility (can be implemented through decentralization of an accounting infrastructure and a lack of a single point of failure)
- Non-repudiation (implemented through the use of a digital signature and its binding to user *identities*)
- Robustness (achieved through the consensus which allows being resistant to internal and external attacks)

11 THE FUTURE OF TOKENIZATION

What will be tokenized first?

- Bonus and loyalty points
- Gift certificates
- IOU and money
- Securities
- Registries of owners of precious metals in vaults
- Warehouse receipts and their derivatives
- Intellectual property
- Real estate and other proprietary rights

How can you monetize a tokenization platform?

- Fees for payments conducted within the platform
- Fees on the capital raised
- Data collection and analysis
- Revenue sharing with third-party services (insurance, advertising, etc.)

What can tokenization provide in the future?

In the near future, tokenization platforms will take place of traditional accounting systems which are being widely used now; tokenization platforms can become the primary source of data on individuals' property rights.

What is the role of tokenization in future financial industry?

In the future, application of tokenization platforms may lead to:

- Democratization of access to the venture capital
- Implementation of business logic through smart contracts followed by solving problems related to inefficient resource allocation
- Creation of conditions for the evolvement of barter—where it makes sense
- Reduction of expenses related to developing and maintaining asset accounting systems as well as for maintaining the IT infrastructure in general
- Increase in the number of transactions for exchanging value

Due to the difficulties of creating the infrastructure in general as well as of designing decentralized accounting systems, they are likely to progress in an evolutionary way. At first, there will be the development of blockchain-based accounting systems which, however, will operate in centralized and controlled environments; this will simplify and accelerate the prototyping of working systems as well as preserve the further possibility of modifying them towards openness and independence.



GLOSSARY OF TERMS

Accounting system—a system for processing and storing transactions which uses a decision-making mechanism for their validation. In the context of tokenization, the primary task of an accounting system consists in the processing of transactions and in updating the end state of balances of all users (ledger).

Asset—everything tangible or intangible which may have a certain value.

Auditor—an individual with the right to verify an accounting system. In the context of the blockchain technology, an auditor downloads data of all blocks of the chain and, while preserving the protocol rules, verifies that the final state of an accounting system matches the transaction history.

Balance—a set of revenues and expenses, statistics, and assets and liabilities in the preparation of financial reports.

Blockchain—a technology that describes a way to organize data by means of grouping it into blocks; each block contains a hash value calculated from the previous block data. The way the chain of blocks is formed makes it impossible to modify the data without being noticed by other participants who support it.

Confirmation—the process of verification and coordination of data (transactions), which is performed by validators of an accounting system.

Consensus—a state of unanimity among users regarding the transactions they consider correct.

Cryptocurrency—an independent digital currency in which management of the following processes is decentralized: coin issuance, transaction confirmation, data storage, system audit, and governance (such as decision-making about the updates). To own cryptocurrency coins and make payments, no specific permissions are required: all users have equal rights to use it.

Decentralization—the process of distributing people, powers, performed computations, and stored data from a single location or a central governing body.

Digital signature—an analog of a handwritten signature that provides the possibility to verify the authenticity and integrity of a document as well as protects it from modification and substitution.

Digital wallet—a software or hardware that processes transactions and digital signature keys and supports the connection with a tokenization platform in order to update an account status, display user's balance in tokens, and transfer tokens to another user.

Internal exchange—an accounting system for exchange orders (which is built in an accounting system of a tokenization platform) and the mechanism for their execution.

Ledger—a table (usually in the form of a digital file), which is used to record the results of execution of transactions, that reflects the final state of an accounting system obtained by processing the entire transaction history.

Merchant—a payment accepting service which uses digital currencies and payment systems.

Module—an independent element of tokenization platform that implements a single aspect of the desired functionality, so that any such element could easily be replaced with an alternative implementation.

Private key—a key (in a public key encryption system) designed to encrypt messages and is known only to one person (a key owner).

Property rights registry—an information resource (ledger) that contains data about the current distribution of ownership rights of property items between users of a particular tokenization platform.

Public key—a key (in public key cryptosystems) that can be published and is known to all. Knowledge of a public key does not provide the possibility to compute a private key or decrypt the message.

Token—a unit of accounting that is used to represent the user's balance in a digital accounting system and allows proving ownership of the corresponding asset.

Token creation—the first of the three steps of adding a new asset to a tokenization platform, which implies setting parameters and restrictions on using a token that may be issued in the future.

Token issuance—the process of transferring tokens to the issuer's balance with the possibility of manual or automatic distribution of tokens among users of the platform.

Token pre-issuance—the process of granting an issuer the right to issue a certain number of tokens.

Tokenization infrastructure—a set of interrelated service elements which includes a tokenization platform, applications for working with the platform, and parties performing certain roles on the platform.

Tokenization platform—a computing environment where digital tokens are stored, processed, and managed. A tokenization platform includes an accounting system as well as a set of modules for its management.

Validator—a participant of an accounting system which performs full verification of transactions and is directly involved in their confirmation. If the database of an accounting system is blockchain-based, then validators are the participants who are involved in new blocks generation

Verification—the process of checking data for compliance with the protocol rules..

