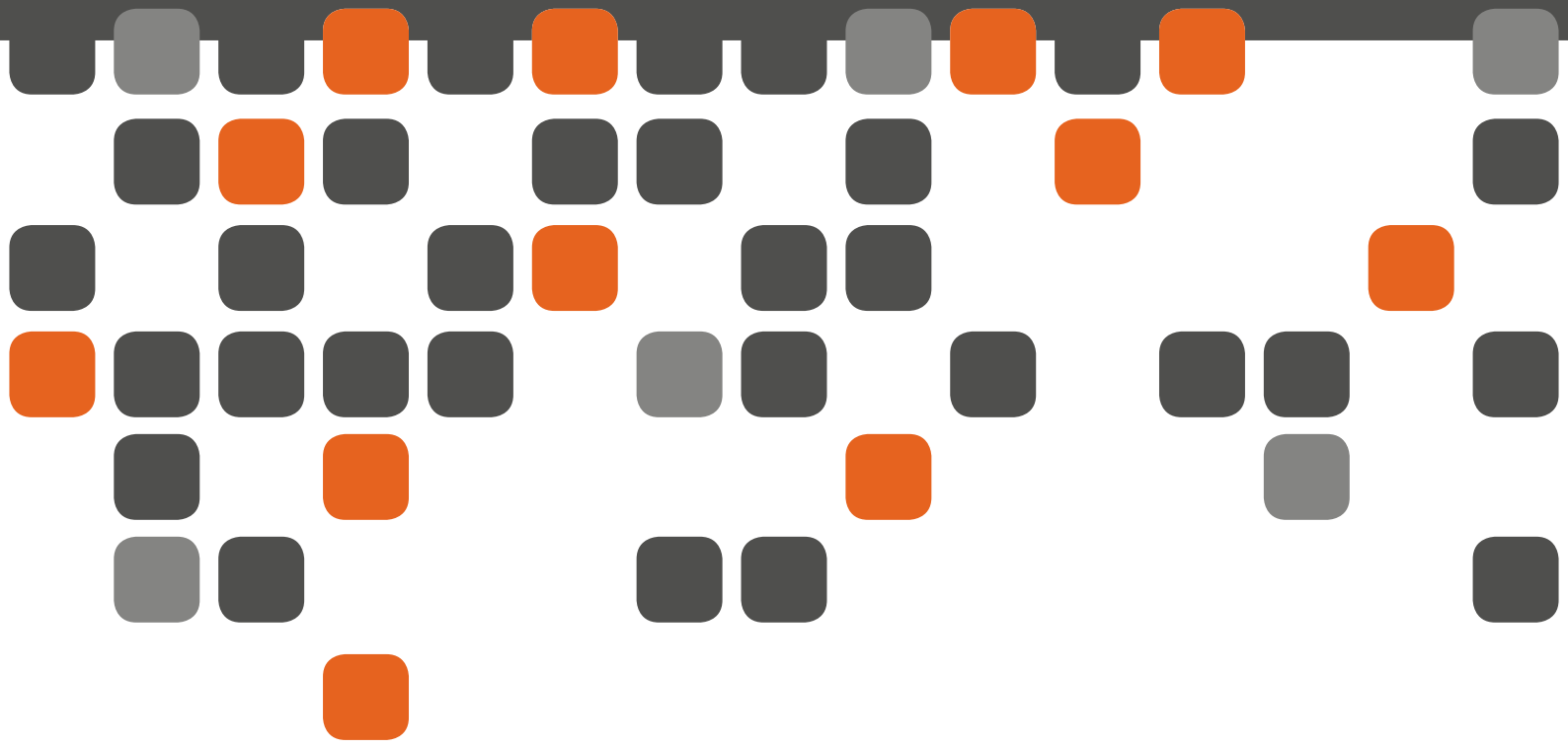
Informational Paper from The Tokenizer prepared for Maker:

TOKENIZING REAL-WORLD ASSETS

- towards a regulated and stable token-driven economy

June 2019



THE TOKENIZER

TABLE OF CONTENTS

1. Introduction

Despite heavy turbulence in the market for cryptocurrencies since the beginning of 2018, a massive downfall in the ICO (Initial Coin Offerings) market and a general widespread skepticism of anything related to crypto, something new and very promising is finally about to emerge and unfold in the crypto space like a rising phoenix from its ashes.

The keywords are tokenization of real-world assets, maturity of stablecoins and the merging incorporation of regulations. We are witnessing two fast-growing trends merge and complement each other:

The first one is tokenization, where all illiquid assets in the world, from private equity to real estate and fine art, become liquid and all liquid assets can be traded more efficiently.[1]

The second is the rise of a new token-driven economy. The new economy is enabled by the removal of the volatility in the crypto space with the help of stablecoins like Dai from MakerDAO, and by further liquidating billions of USD worth of tokenized assets through the Dai Credit System.

By unlocking the economic potential of blockchain, these two complementary and correlated trends constitute one the most important developments since the invention of the blockchain technology itself. While this might sound like science fiction, it is already happening.

During the previous year, we have seen a completely new industry of tokenization starting to grow rapidly. We think that 2019 is the year of tokenization – or rather, the first year of a new era of tokenization. We urge all stakeholders, including businesses, public authorities, and regulatory authorities, to pay close attention.

As a strong supporter of the tokenization revolution, The Maker Foundation has asked The Tokenizer to prepare this information background paper on tokenization.

Large scale tokenization of real-world assets helps The Maker Foundation realize the goal of making our stablecoin Dai available to everyone. And at the same time holders of tokenized assets can increase the liquidity of their assets even further by using it as collateral in the Dai Credit System – introducing a new phase of a second-generation tokenization.

1. Today to total amount of assets in the world has an enormous value of USD 280 trillion.

RETURN TO TABLE OF CONTENTS

2. Executive Summary

Imagine taking a shipping container, a very tangible 40-foot metal box, and moving it into a purely virtual space. Imagine putting 10,000, 100,000, or even 10,000,000 of these metal boxes on a blockchain and creating a digital representation in the form of a virtual token or coin that you can start trading for other assets or commodities. The process is just like trading bicycles, sneakers, real-estate or bonds for dollars in the traditional economy.

This scenario would have been science fiction a few years ago, but today it is a technological possibility, and soon it will likely be the basic principle of a new, revolutionary global token-driven economy - backed by tangible assets or commodities from the real world as collateral, whether shipping containers, real estate, gold, oil, grain, or in principle, anything of value.

The idea of fueling a new token-driven economy by tokenizing real-world assets and making them easy to trade – liquid – on a blockchain-based exchange is the Yin of the topic of this white paper. The Yang is the development of stablecoins to eliminate the extreme volatility of cryptocurrencies and create stability, which is a prerequisite for a token-driven economy.

We will also discuss the ability to take the tokenized assets and use them for the creation of more stablecoins to further fuel the new economy. Within the traditional economy based on fractional reserve banking money is created through loans, and the same is possible in the token-driven economy. Though, in a completely decentralized manner, this will occur at a higher speed and a lower cost.

This complex concept needs to be explained in detail. To do so, let's start by defining some basic terms and putting them into context – thematically and historically.

The initial chapters of this white paper are about defining the term 'token' and looking at different types of tokens related to the crypto space. From there we will explain the term 'tokenization', the process of tokenizing something, the new trend of tokenizing real-world assets, the relation between tokenization and stablecoins and how this will create a foundation for a token-driven economy going forward.

RETURN TO TABLE OF CONTENTS

3. Virtual tokens – the basis of a token-driven economy

3.1 Defining a token

The etymological origin of the word 'token' goes back to Old English tac(e)n and Germanic *taikna- and means 'a sign' or 'a symbol'. Tokens as different kinds of "payment signs" or representation date back to the Roman Empire under the name of 'tesseraes'. From the 1590s tokens are recorded in the meaning of a "coin-like piece of stamped metal"[2] as a representation of a certain value, either a monetary value or a service of a certain kind. These kinds of tokens have been used in many different contexts from hospitals to casinos and brothels (see below).

 [3]

More recently, the terms token and tokenization are found in the digital payment industry. Within the EMV paradigm[4] of payment cards, tokens are used for security reasons as a replacement of sensitive data like the identifier number known as Primary Account Number (PAN), which is printed on every issued plastic payment card.

In the crypto economy, the terms 'token' and 'crypto token' are often used synonymously with terms like 'cryptocurrency' and 'crypto coin,' but 'token' also has a slightly different meaning. A token is a representation for 'something' on the blockchain that does not necessarily have to be a currency – like bitcoin – but could also be a wide range of other types of assets. These tokens could be representations of intangible assets such as intellectual property or securities like shares, bonds or derivatives, as well as very tangible assets like gold, oil, real estate, collectables (fine art, antique cars) or, in principle, any real-world asset.

The prerequisite for such a tokenization process is a system that allows issuance of these blockchain tokens based on real-world assets, and enables secure tracking of the underlying assets at any time to avoid fraud – such as double-spending – or damage to the assets.

A system with these abilities would act as the ultimate springboard for a new token-driven economy.

3.2 Different kinds of crypto tokens

During the last couple years, the market has been flooded with almost 2,000 new crypto tokens or cryptocurrencies that are all tradeable on one or more of the world's many new crypto exchanges.

This huge growth in the numbers of tokens has been driven largely by the blockchain based crowdfunding method called Initial Coin Offering (ICO). The ICO concept was created by software developer J.R. Willet in 2012 in his whitepaper *The Second Bitcoin White Paper*. Willet was the first to put the ICO into play when he issued Mastercoin (now Omni) and launched the first token sale following his own model.

Interest in the new financing option (as an alternative to VC funding) subsequently grew among startups. In 2016, the popularity of the ICO phenomenon increased, and in 2017 it accelerated significantly all over the

2. https://www.etymonline.com/word/token
3. https://www.pinterest.dk/eilalie-kovuo/brothel-token/?lp=true ; https://usadisplay.net/?attachment_id=13551#prettyPhoto/0/ ; https://en.numista.com/catalogue/pieces23200.html
4. EMV stands for Europay, MasterCard and Visa, and the EMV paradigm is a set of standards related to these payment card schemes.

RETURN TO TABLE OF CONTENTS

world, raising more money – USD 5.6 billion – during than traditional VC funding. At the same time, the crypto market rose significantly in the fourth quarter of 2017 and the ICO success continued throughout the first quarter of 2018, according to Coindesk , and more capital was raised globally via ICOs (USD 6.3 billion) in Q1 of 2018 than in the whole of 2017 .

In March/April 2018 the massive growth of the ICO market ended abruptly. This was primarily a direct consequence of a general downturn in the cryptocurrency market, and an increasingly critical focus from regulatory authorities worldwide of the ICO concept, raising questions of the legal status of crypto tokens issued as part of ICOs.

The main issue in question from the SEC and others was whether some, many or perhaps all the tokens issued as part of ICOs conducted globally have in fact been securities – legally in the same category as shares, bonds and derivatives – and not just commodities or so-called utility tokens.

One huge challenge that these tokens had in common was extreme volatility, which has crippled their ability to handle some of the basic functions that they were originally created for – such as peer-to-peer payments.

This overwhelming problem of volatility fostered a new kind of token called a stabletoken, or stablecoin, with the purpose of securing some stability in the crypto space. Later in this white paper we will make a deep dive into stablecoins and see how the best among the growing number of stablecoins unlocks the token-driven blockchain based economy and makes it possible to start tokenizing some of the enormous values of real-world assets.

3.2.1 Utility tokens

On blockchains and blockchain-based platforms, native tokens often have certain functions that either enable the transaction validators to be compensated for their work and/or allow the users to utilise the services offered by the platform.

The classic examples are Bitcoin and Ethereum. In both the Bitcoin and the Ethereum proof-of-work systems, miners are compensated for their work when they solve involved mathematical puzzles and close a new block before anyone else. And in both systems, the native tokens – bitcoin and ether – are used for transaction fees. On the Ethereum platform, the transaction fee is called 'gas', and is paid in ether.

3.2.2. Security tokens

While a lot of the tokens issued as part of the many ICOs during the past two years have claimed to be only utility tokens, the starting point for issuing security tokens is completely different.

Security tokens are securities, and they are governed by the regulatory rules of the jurisdictions in which they are issued and operate. This raises both new challenges and new opportunities.

The challenges concern compliance with the relevant regulatory requirements. The opportunity is that by issuing a security token that complies with legal requirements, it is possible to make the token as attractive as traditional securities such as company shares. On top of that, because a security token is issued on a blockchain and uses smart contracts, it offers a whole new layer of encoded special features and benefits for the token owner. In other words, one of the main differentiators between a traditional share and a security token is that a token enables you to add a layer of built-in code, making the security token a programmable share.

5. https://www.coindesk.com/6-3-billion-2018-ico-funding-already-outpaced-2017/
6. *It is important to underline that the Telegram ICO takes up a disproportionately large part of the funding and without Telegram the ICO downturn that we see now would have been visible already in Q1 2018.*

RETURN TO TABLE OF CONTENTS

While a traditional share offers ownership and voting rights at the annual general meeting, the programmable share can include a number of additional features. The most important feature is that while a traditional share only gives the shareholder a cut of the bottom line figures – the profit – the security token can be programmed to pay out a cut of the top line – the revenue – too, once a quarter like a dividend. Receiving an additional cut of the revenue is a significant benefit because the revenue is 'untouched' by the company and its internal costs in a very different way than the bottom line figures.

A programmable share combining a cut from both top and bottom line would be the ideal product for a shareholder. Other benefits can be built into the programmable share. These benefits could include VIP access to certain features depending on what kind of company we are talking about or discounts on fees when using certain services offered by the company.

The increased focus on security tokens and their potential in the crypto space are partially fuelled by the constant scrutiny of the ICO concept by legal authorities around the world. This has unsurprisingly led to the development of a variation of the ICO, called an STO or Security Token Offering.

In contrast to a utility token, as typically issued via an ICO, in an STO the owner of the security token may – depending on jurisdiction – legally obtain the exact same rights as the owner of a traditional security, for instance, a company share. Since the security token is a piece of software code using smart contracts on a blockchain, it has the ability to incorporate completely new features and rights that make the security tokens far more sophisticated than traditional securities, enabling the issuer to customise the security token to specific target groups.

Stephen McKeon, a Finance Professor at the University of Oregon, talks about programmability:

> *"A key feature of security tokens is that they are programmable. Many elements of the contracting environment can be hardwired into the architecture of the security. When securities are tokenized, compliance can be automated, which means that regulated trade will no longer be restricted to walled gardens. Security tokens will be able to trade anywhere, including decentralized exchanges. Further, baking compliance into the token could help market participants navigate the extremely complex task of selling securities across borders.*[8]

It is critical to distinguish between private securities and public securities. If a token is considered and handled solely as a private security, in many jurisdictions there will be the possibility of using certain regulatory exemptions. In these cases, the comprehensive IPO (Initial Public Offering) requirements will only come into force if a token violates the restrictions related to the exemptions in question, and begins to act as a public security.

Perhaps the most important argument for choosing an STO over an IPO is, as described above, that the security token has the potential to act as a programmable share and offers a set of functionalities and attributes that a traditional share does not have. The STO allows for the creation of an investment product that is better than traditional stocks and bonds. It has the potential to reward investors both from the top line via a revenue-sharing model and from the bottom line through a dividend. Those companies that can honour an investor's request for a focus on and a profit from both top and bottom at the same time have the potential of becoming the new stars in the eyes of the investors.

7. Apparently the STO term was coined by the company Polymath.
8. https://hackernoon.com/the-security-token-thesis-4c5904761063

RETURN TO TABLE OF CONTENTS

4. Tokenization of assets

Tokenization is likely to become one of the most important and influential trends in the crypto space in the coming years.

Since these are the very early days of the tokenization revolution, we lack the precise economic potential of the expected global tokenization, but it is expected to be in the trillions of dollars. At Maker, there is no doubt the potential is huge, and they certainly intend to actively support the tokenization movement as much as possible through the Dai Credit System.

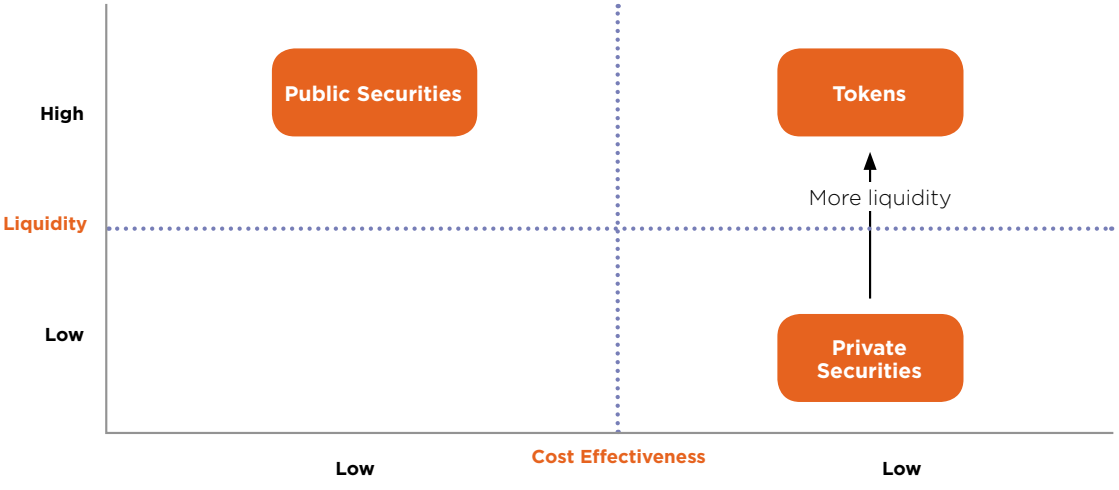
According to Credit Suisse's Annual Global Wealth Report[9], the total value of all assets in the world in 2017 added up to no less than USD 280 trillion[10]– or 280 times the value of the world's currently most valuable company, Apple. Credit Suisse even expects the number to increase further in the coming years and reach USD 341 trillion by the year 2022.

The tokenization company Harbor describes in its white paper The Regulated Token™ (R-Token™) Standard the benefits of tokenizing private securities and underscores that the economic potential is massive:

> *"By tokenizing private securities, we can potentially move them from the Low Liquidity/High Cost-Effectiveness quadrant to the Higher Liquidity/ Higher Cost-Effectiveness quadrant, as illustrated in the chart above. Tokenized private securities (i.e. crypto-securities) can be more easily traded on the secondary markets without the administrative burdens of traditional private securities. In other words, tokenized private securities can potentially have more liquidity while maintaining their cost-effectiveness.*
>
> *Given that the asset categories within the private securities market are massive (in the trillions), and that the illiquidity discount can be as high as 20-30%, the tokenization of private securities has the potential to unlock billions of dollars in value."*[11]

9. https://www.credit-suisse.com/corporate/en/research/research-institute/global-wealth-report.html
10. Notice: American 'Trillion' = European 'Billion' = 1,000,000,000,000

Liquidity versus cost-effectiveness of securities and tokens



RETURN TO TABLE OF CONTENTS

4.1 Defining tokenization

The basic idea of tokenization is the use of smart contracts on a blockchain to create a virtual representation of a certain asset in the form of a token. Depending on the type of asset to be tokenized, different tokens and token standards have been developed for the tokenization process, and different challenges and opportunities come with the tokenization of the asset in question.

Tokenizing tangible real-world commodities differs from tokenization of intangible assets like a software licence. Tokenizing fungible assets like identical types of shares differs from the tokenization of non-fungible assets like a unique work of fine art.

Regardless of the type of asset to be tokenized, the basic purposes and benefits are the same: by tokenizing assets and thus equipping them with a virtual representation in the form of a token on a blockchain, it is possible to cut away costly and inefficient middlemen. This makes it faster and easier to trade and exchange the assets far easier and faster, and in a much more decentralised manner than ever before. Let us take a brief look at different asset types and corresponding token standards, and afterwards, we will look closer at the benefits of tokenization.

4.1.2 Fungible tokens

The type of asset to be tokenized, and whether the tokens should be fungible or non-fungible, determine the specific process for tokenization.

A group or class of fungible tokens are all identical and the value of all the tokens in the same class is always the same. This means that one token can be replaced with another token of the same class and it will make no difference.

The ERC-20 Ethereum standard was designed for issuing of all kinds of fungible tokens, whether unbacked intangible tokens like bitcoin or fungible tokens representing fungible real-world assets like gold, oil or electricity. For instance, the fungible gold-backed DGX token issued by DigiX with the value of one gram of gold is an ERC-20 token.

4.1.3 Non-fungible tokens (NFT)

For tokenization of non-fungible assets, a corresponding standard – ERC-721 – for the building of non-fungible tokens has been developed for the Ethereum blockchain.

Each token built on ERC-721 standard represents a unique piece of an asset. This can be tangible real-world assets like real estate, works of art, diamonds, antique cars or other unique collectables. But it can also be intangible non-fungible assets. These include legal contracts, copyrights, proof of identification, different kinds of licenses like software licenses or unique virtual collectables like the popular phenomenon Cryptokitties, which in fact was the first example of a non-fungible asset tokenized via the ERC-721 standard.
On Github, typical use cases for NFTs built on ERC-721 are described like this:

> *"NFTs can represent ownership over digital or physical assets. We considered a diverse universe of assets, and we know you will dream up many more:*
> - *Physical property — houses, unique artwork*
> - *Virtual collectables — unique pictures of kittens, collectable cards*
> - *'Negative value' assets — loans, burdens and other responsibilities*

11. https://harbor.com/rtokenwhitepaper.pdf. Stephen Kade, Co-founder of TrustToken, makes the same comparison in this article: https://blog.trusttoken.com/introducing-the-trusttoken-platform-tokenization-you-can-trust-67f1998b77ec

RETURN TO TABLE OF CONTENTS

In general, all houses are distinct and no two kittens are alike. NFTs are distinguishable and you must track the ownership of each one separately."[12]

4.1.3.1 ERC-1155 Crypto Item Standard

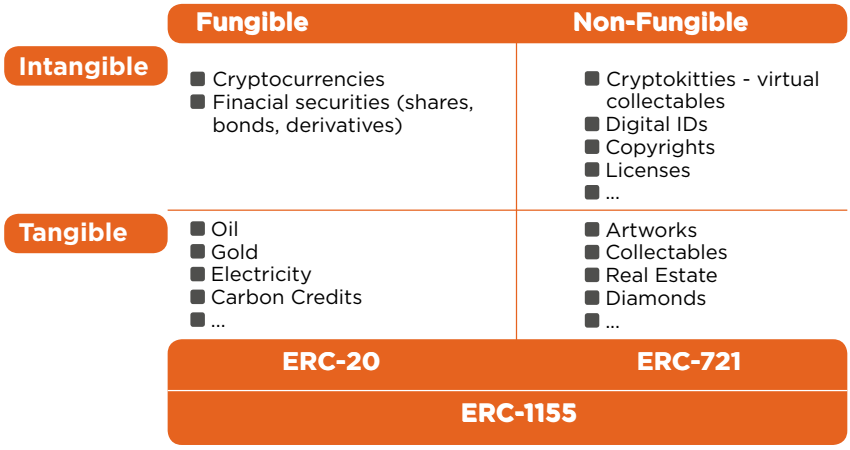
The latest development within token standards pushed forward by the gaming industry is a standard called ERC-1155 that makes it possible to combine fungible and non-fungible tokens in the same smart contract. The developer Witek Radomski explains its purpose on Github:

> *"This standard outlines a smart contract interface where one can represent any number of Fungible and Non-Fungible assets in a single contract. Existing standards such as ERC-20 require the deployment of separate contracts per token. The ERC-721 standard's Token ID is a single non-fungible index and the group of these non-fungibles is deployed as a single contract with settings for the entire collection. Instead, the ERC-1155 Crypto Item Standard allows for each Item ID to represent a new configurable token type, which may have its own total supply value and other such attributes."*[13]

4.2 How and why tokenize real-world assets?

A new group of companies that specialises in delivering services within the field of asset tokenization has already emerged.

This group includes companies like Factora, Harbor, Swarm, Polymath and TrustToken. These companies are all developing blockchain and smart contract based tokenization platforms. These companies are creating solutions for tokenization of all kinds of real-world assets from intellectual rights over commodities and collectables to real estate with the purpose of increasing liquidity, cutting costs, enabling fractional ownership of assets and opening up the USD 280 trillion market of real-world assets for investment. This makes it possible for anyone, anywhere in the world to invest and create a future global investment market far more democratized than the market of today.



These tokenization services specialists obviously have a technical focus, but they also have a regulatory focus. The services provided by these platforms are worth nothing if they do not ensure that the customers using the platforms comply with relevant legal requirements when tokenizing assets through their platforms and services.

Factora provides smart contract-based infrastructure to create automation for issuers and transparency for investors—"enabling standardization, transparency, and liquidity across capital markets." *Harbor describes themselves as the "all-in-one platform for digital securities".[14]

12. https://github.com/ethereum/EIPs/blob/master/EIPS/eip-721.md
13. https://github.com/ethereum/EIPs/issues/1155. Read more about ERC-1155 here: https://blog.enjin-coin.io/erc-1155-the-crypto-item-standard-ac9cf1c5a226
14. https://harbor.com/

RETURN TO TABLE OF CONTENTS

Polymath states that their "Polymath ST-20 standard embeds regulatory requirements into the tokens themselves, restricting trading to verified participants only."[15] TrustToken explains how their SmartTrust is "a new type of trust developed in collaboration with the top trust law attorneys in the world".[16] And finally, Swarm's Market Access Protocol (MAP) "takes care of compliance so that token issuers can focus on their core function of managing the assets and conveying their investment's value proposition." [17]

Relevant areas of regulatory compliance for the tokenization of real-world assets certainly encompass securities laws in the jurisdictions in which the tokenization is taking place, the jurisdictions in which the tokens are expected to be traded, and most likely also KYC/AML policies, tax laws and marketing practices acts.

Provided that the legal requirements are met, tokenization of real-world assets unlocks valuable benefits that cannot be redeemed in a conventional environment. McKeon lists eight features of tokenized assets that he believes "form the foundation of the thesis that security tokens will see widespread adoption across numerous asset classes in the coming years."[18] The eight features are:

- 24/7 markets
- Rapid settlement
- Asset interoperability
- Automated compliance
- Reduction in direct costs
- Increased liquidity
- Fractional ownership
- Expansion of the design space for security contracts.

Since neither the internet nor blockchain have any limitations regarding time or time zones it is very likely that the future markets of security tokens will be around the clock **24/7 markets**. And since trading of tokens will be on-chain events cutting away the middlemen from the traditional securities trading world, we should expect **rapid settlement,** which means that settlement will be cut down significantly. Currently, securities traded on traditional exchanges settle between one and three days after the transaction date (T+1 to T+3) depending on the type of security, while bitcoin transactions settle in approximately ten minutes. McKeon is confident that we will reach a point of rapid settlement, but he warns about the complexity involved:

> *"Trades for bitcoin or ether settle in minutes, not days, but there are a lot more parties involved in securities transactions—more than most investors appreciate. There are complexities such as short selling and margin buying. Blockchain has the potential to increase settlement speed for securities, but it's more complicated than a comparison to cryptocurrencies. The degree to which these processes can be automated through interoperable smart contracts will determine the gains in settlement speed."*[19]

Interoperability and automation are certainly recurring keywords when describing features and benefits related to tokenization of assets. McKeon says about the feature of **asset interoperability**:

> *"The thesis underpinning the idea that everything will be tokenized is grounded in the aspiration that everything will be interoperable. If the ecosystem for global assets becomes interoperable, it means we can hold ownership claims to a commercial building, early-stage equity, corporate bonds, a*

15. https://blog.polymath.network/unveiling-polymath-core-toro-62ec6562359d
16. https://www.trusttoken.com/
17. https://medium.com/swarmfund/map-for-security-token-issuers-3d4af2d4ae24
18. https://hackernoon.com/the-security-token-thesis-4c5904761063
19. https://hackernoon.com/the-security-token-thesis-4c5904761063

* http://www.factora.io

RETURN TO TABLE OF CONTENTS

T-bill, a single-family residence, and a decentralized network on the same platform. Further, we could self-custody these types of ownership claims in a single hardware wallet, if so desired."[20]

Furthermore, smart contracts will have the ability to include compliance as well. Harbor's CEO Josh Stein has described a future trading scenario in a blockchain and smart contract based environment with **automated compliance** built into the security tokens like this:

> *"By automating compliance, issuers can allow their investors to trade to the limit of their liquidity across multiple exchanges. Now imagine a world where buyers and sellers around the world can trade 24/7/365 with near instantaneous settlement and no counterparty risk — that is something only possible through blockchain."*[21]

An interesting related question is how the development of exchanges will play out as tokenization gains momentum. Are the likes of Harbor going to develop the next generation exchanges for the trading of regulated security tokens? Will it be the cryptocurrency exchanges? The players from the old world like Nasdaq? Or perhaps a combination of all the above? Time will show and most likely very soon.[22]

When it comes to **reduction on direct costs**, McKeon points at reconciliation as one of the areas in which trading of a tokenized asset could lead to substantial cost savings over traditional securities. Many others, including CEO of Digital Asset, Blythe Masters, have pointed out the savings potential in eliminating "the need for reconciliation"[23] by using blockchain or distributed ledger technology (DLT).

And EY reached the same conclusion in their report Chain Reaction in 2016, saying that "within a typical finance team at banks and insurers, between 50 and 100 working days are lost each month reconciling differences. Adopting a shared ledger approach will help, by enabling all parties concerned to identify the same transactions at the source, with data being published simultaneously — significantly reducing the number of reconciliations required."[24]

Increasing liquidity is a major driving force behind the growing trend of tokenization of real-world assets. Of the total wealth of USD 280 trillion in the world in 2017, financial assets account for 54%, debt accounts for 13% and real (non-financial) assets the remaining 33%[25]. These numbers vary a great deal from country to country, and most of the world's wealth is already in relatively liquid assets, but a significant part is placed in other, non-financial and less liquid asset types. For a large percentage of these, it must be assumed that tokenization could be considered an option.

Already liquid asset classes like traditional financial securities, such as shares, can benefit from tokenization. In May 2018 VC firm Morgan Creek announced their plan for a full tokenization of all the shares of the IT company Anexio. Partner Anthony Pompliano stated: "Once all assets are tokenized, then we believe the entire financial system will be more efficient and compliant. Morgan Creek is focused on tokenization because that's where we believe there is less hype and more sustainable value being created." While tokenization of already relatively liquid assets makes sense, the biggest opportunity is the tokenization of more illiquid asset classes like equity from non-exchange, privately traded companies, real estate, and art, antiques

20. https://hackernoon.com/the-security-token-thesis-4c5904761063
21. https://techcrunch.com/2018/08/28/security-tokens-will-be-coming-soon-to-an-exchange-near-you/?guccounter=1
22. The above-mentioned article (note 25) discusses the exchange question.
23. http://www.portfolio.hu/en/companies/front-line-eyewitness-of-2008-crisis-a-supporter-of-blockchain--interview.36624.html
24. https://www.ey.com/Publication/vwLUAssets/EY-chain-reaction/$FILE/EY-chain-reaction-how-blockchain-technology-could-revolutionize-the-finance-function.pdf
25. https://www.credit-suisse.com/corporate/en/research/research-institute/global-wealth-report.html, p. 47.

RETURN TO TABLE OF CONTENTS

and collectables. Because the liquidation of such assets is more difficult and costly (the right buyer must be found, and if the seller needs to sell immediately he is likely to lose money) the valuation often includes a so-called illiquidity discount which takes these disadvantages into account.

Making these asset types more liquid through tokenization should remove the illiquidity discount, which could add up to considerable amounts. In the R-Token white paper published by Harbor the conclusion is that "given that the asset categories within the private securities market are massive (in the trillions), and that the illiquidity discount can be as high as 20-30%, the tokenization of private securities has the potential to unlock billions of dollars in value."[26]

Another key feature and major advantage of tokenization is a new opening for **fractional ownership.** Fungible assets are well suited for fractional ownership – you can buy just 1 gram of gold or 10, 100 or 1,000 grams – no matter if the asset is traded in a real-life scenario or in a virtual space represented by tokens. But for non-fungible assets, the matter is quite different. A non-fungible asset like an oil painting is a unique piece of art and until now fractional ownership of artworks has not been an option.[27]

However, this might be about to change with the ability of tokenizing non-fungible assets by using a standard such as ERC-721 or ERC-1155. Oliver Dale from Blockonomi puts it this way:

> *"Tokenizing a work of art introduces a digital signature that cannot be altered. The digital token representing the Mona Lisa is one of a kind. It is not a copy. But the token can be broken down into sub-tokens, each also digitally signed. In this way, "shares" of a unique piece of art can be sold to the general public. [...] Each holder of a Mona Lisa token doesn't have a copy of the Mona Lisa – they actually own a part of the artwork itself, which they can keep as a store of value or sell to another willing buyer."*

It is believed the first company in the world to realise this idea is Masterworks[29] founded by serial entrepreneur and art collector Scott Lynn in 2017. The first piece of artwork to be tokenized and sold off in fractions by the company was Andy Warhol's 1 Colored Marilyn reversal series, which Masterworks bought at a Phillips auction in New York in November 2017. Lynn explains the blockchain-based platform for trading of art:

> *"The platform lets anyone invest in major works of art for as little as $20 per share. [...] There are two ways an investor can get a return. Firstly, an investor can sell their shares to another investor on an approved trading platform. Secondly, a collector can make an offer to purchase a painting from investors, and they can vote on whether or not to sell. [...] Blockchain allows us to approve multiple exchanges to trade each painting's tokens to provide more liquidity to investors."*[30]

26. https://harbor.com/rtokenwhitepaper.pdf
27. It is not that it would be impossible to do without tokenization and blockchain, but it would be very burdensome and there is absolutely no tradition for such things in the traditional world of art or investments – even though we have seen a few experiments like this one: https://www.reuters.com/article/us-britain-art/london-art-exchange-lets-collectors-buy-shares-of-a-banksy-idUSBREA3A0TT20140411
28. https://blockonomi.com/tokenization-blockchain/
29. https://www.masterworks.io/
30. https://venturebeat.com/2018/07/26/masterworks-offers-fractional-ownership-of-fine-art-through-the-blockchain/

RETURN TO TABLE OF CONTENTS


31

Art is just one example of a market in which we will see fractional ownership based on tokenization of non-fungible assets. But much larger and far more valuable is, of course, a market like real estate. If token-based fractional ownership might look like a curiosity when it comes to fine art, it seems a lot more obvious and likely in the case of real estate.

Imagination is the only limit when it comes to tokenizing real estate. Anything from skyscrapers to football stadiums, private estates to public buildings and landmarks could be tokenized in the future, and offered in small fractions to anybody in the world. Smaller investors would be able to build up their own portfolio containing fractions of whatever interests them within the global real estate market – ranging from world-famous buildings to local shopping centers.

4.3 Challenges of tokenizing real-world assets

Some definitions of tokenization underline an obvious but important limitation regarding the virtual representation of tokenized assets:

"Tokenization is a method that converts rights to an asset into a digital token."[32]

Tokenization converts **a right** to the asset in question, but not the asset itself. This evident limitation for tokenization of tangible, real-world assets leads to plenty of concerns.

A major challenge is how to establish a genuine and trustworthy link between the digital tokens and the actual physical asset:

- How can I be sure that the assets, which are supposed to back my tokens, exist in real life?
- How can I be sure that the assets are not being resold, replaced, stolen or destroyed?
- How can I legally claim ownership of (part of) the asset backing my token?

In the case of DigiX[33], which is a company offering gold on the Ethereum blockchain, 1 DGX token = 1 gram of "bullion from LBMA-approved refiners that we store with our custodial vault"[34], and DigiX promises that anyone holding at least 100 DGX will be able at any time to redeem their tokens for genuine gold.

DigiX has even developed a protocol called the Proof of Provenance (PoP) to keep track of "the movement of physical assets (gold in the case of DGX) through the change of hands, from the bullion supplier to the custodial vault in a transparent and cryptographically secure manner. PoP proves the existence of the physical asset, the authenticity of its ownership and the security of its storage in the custodial vault."[35]

DigiX explains that the protocol uses "private keys and documentations uploaded onto IPFS, a distributed file sharing database, and the blockchain" to prove that the link between the DGXs

31. *1 Colored Marilyn reversal series, 1979 by Andy Warhol, oil and silkscreen inks on canvas 18 1/4 x 13 3/4 in. (46.4 x 34.9 cm). Estimate $1,500,000 - 2,000,000. Sold for $1,815,000. HTTPS://WWW.PHILLIPS.COM/DETAIL/ANDY-WARHOL/NY010717/18*
32. https://medium.com/coinmonks/asset-tokenization-on-blockchain-explained-in-plain-english-f4e4b5e26a6d
33. https://digix.global/
34. https://digix.zendesk.com/hc/en-us/articles/360001814051-How-does-the-price-of-1-DGX-1-gram-of-gold-
35. https://digix.zendesk.com/hc/en-us/aticles/360001785952-What-is-the-Proof-of-Provenance-PoP-protocol-

RETURN TO TABLE OF CONTENTS

in circulation and the gold bullions stored in a physical vault somewhere in Singapore[36] is always genuine and unbroken.

This example shows that it is possible to establish and secure a trustworthy link from the digital tokens to the actual physical asset, but its setup could be relatively complicated.

In the case of gold, a critical issue is the physical security for the real-world asset. The advantage, on the other hand, is that an asset like gold is not being moved around, but stays in the custodial vault. The opposite is the case, if we take shipping containers as an example. The value of each container is relatively low – around USD 2,000 - and containers are far from as exposed to theft as gold. But the problem here is that containers are being moved around all the time, which makes it far more challenging at any time to keep track of their whereabouts.

In many cases of tokenization of real-world assets – like in the DigiX case – a certain degree of centralization when it comes to securing of the link between the actual asset and the virtual representation will have to be accepted. The owners of DGX tokens have to trust DigiX and their business partners, and that the bouillons are kept safely in the vault in Singapore. – and to some extent, this, of course, collides with the basic idea of blockchain and decentralization.

This points to a need to think about the legal situation of the link between the virtual representation – the token – and the assets that the token represents. This is a work-in-progress because the area is new and legislation is still being developed around the world.

The potential value of tokenization of real-world assets is not currently quantifiable, but there is little doubt that it should be counted in billions of dollars. And as we will see below, the potential does not stop with the sheer tokenization of assets – sometimes called first generation tokenization. Although tokenization is still in its very early days, it is time to look even further and explore the potential of a second-generation tokenization, where global stablecoin systems are integrated into the ecosystem.

The Dai Credit System has the ability to further increase the liquidity of a large variety of tokenized asset types by enabling the token owners to take out loans against the tokenized assets. By doing so, new non-volatile money – Dai – is created in a process that resembles the way 95% of all money is created today in the traditional banking system – by fractional reserve banking – except for the fact that Dai is backed by more than a full reserve of assets.

In the following chapters, we will explain the mechanics as well as the potential of this second-generation tokenization in more detail, but first, we will give a short introduction to stablecoins followed by a presentation of Maker and the Dai Credit System.

36. https://www.thesafehouse.sg/

RETURN TO TABLE OF CONTENTS

5. Stablecoins – a brief introduction

So far, we have described utility tokens and security tokens. Stablecoins are the third category of tokens, which will play a key role in the development of a token-driven economy.

Stablecoins certainly have a utility: to keep a stable price. If a stablecoin – like Maker's Dai – is pegged to the USD, it must keep its value at one dollar or very close to one dollar, despite what happens in the market.

5.1 Fighting volatility

Until now virtually all cryptocurrencies on the market, regardless of history, market maturity or volume, have turned out to be volatile to such an extreme degree that they are useless in a wide range of contexts – that is in cases of payments, loans, remittance, value storage, and more.

Stablecoins offer a solution to the critical issue of high volatility, which can paralyze the entire crypto market, as many cryptocurrencies[37] "tend to be correlated, i.e. they fall and rise together". Since today's market is often irrational, it is nearly impossible to predict performance. This uncertainty scares away potential investors.

In the next sections, we will take a closer look at an important relation between tokenization of real-world assets and stablecoins. We will also explain how the downward spiral of the crypto market can be broken by a successful uptake of tokenization and stablecoins – or to be more precise: multi collateral-backed stablecoins like Dai.

Dai currently offers the most comprehensive and genuine answers on how to fight volatility and at the same time helps realize the potential of a future token-driven economy.

37. As pointed out in among others this article: https://medium.com/@Digix/partnership-announcement-makerdao-and-digix-dgx-gold-tokens-to-play-a-crucial-role-in-the-dai-8ed4c05b622c

RETURN TO TABLE OF CONTENTS

6. Maker and the Dai Credit System

Maker was founded in 2014 and its offering, the Dai Credit System, was the first stablecoin project on the smart contract based Ethereum blockchain.

In addition, Maker issues MKR, the governance token for the Dai Credit System. MKR holders have voting rights on key strategic decisions regarding the development of Maker and its technological platform. MKR owners concurrently act as safeguards, securing the stability of the Dai Credit System in case of unexpected turbulence in the system.

As the Dai Credit System grows and evolves, Maker has established more than two hundred partnerships globally.

Later we will review just three of these partnerships and see how they utilise Dai, but first a closer look under the hood of the Dai Credit System.

6.1 The mechanics of the Dai Credit System

To make any kind of trading – from simple buying and selling to professional trading – on a blockchain applicable and attractive, it is crucial to eliminate the high volatility synonymous with all cryptocurrencies today.

Cryptocurrencies that might lose 10 or 20% of their value within hours are unattractive for blockchain based trading – like instant settlement, low fees, decentralisation, and high security – unless stability is introduced in the system.

The classic example is the story of the developer who bought two pizzas in 2010 for 10,000 bitcoins, blissfully unaware that 10,000 bitcoins today would correspond to USD 65 million.[38] But, apart from extreme examples like this, daily volatility has meant that, in practice, bitcoin no longer serves the purpose intended by Satoshi Nakamoto, when he wrote in his famous white paper that:

> *"What is needed is an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party."*[39]

This was written in 2008, but paradoxically bitcoin has been completely useless as a payment means for years now, ever since it became popular as an asset class and started to attract investors.

The Dai stablecoin aims to remove the volatility seen in the crypto market, making it possible to start using cryptocurrencies for real-life practical purposes, and serve as a foundation for a token-driven economy.

A core element of the Dai Credit System is the Collateralized Debt Position or CDP, which is a fully autonomous/ automated smart contract enabling anyone to deposit certain types of assets as collateral on the Maker platform and take out loans in Dai against the collateral.

6.1.1 The CDP interaction process

Step 1: Creating the CDP and depositing collateral

To create a CDP, the user sends a transaction that transfers the amount and type of collateral that will be used to generate Dai to a smart contract in the decentralized MakerDAO system. At this point, the CDP is considered collateralized.

38. *Would have been approx. three times as much in late 2017!*
39. *https://bitcoin.org/bitcoin.pdf*

RETURN TO TABLE OF CONTENTS

Step 2: Generating Dai from the collateralized CDP
The CDP user then sends a transaction to retrieve the amount of Dai they want from the CDP, and in return the CDP accrues an equivalent amount of debt, locking them out of access to the collateral until the outstanding debt is paid.

Step 3: Paying down the debt and Stability Fee
When the user wants to retrieve their collateral, they must pay down the debt in the CDP, plus the Stability Fee that continuously accrues on the debt over time. Once the user sends the requisite Dai to the CDP to pay down the debt and Stability Fee, the CDP becomes debt free.

Step 4: Withdrawing collateral and closing the CDP
With the debt and Stability Fee paid down, the CDP user can freely retrieve all or some of their collateral back to their wallet by sending a transaction to Maker.[40]

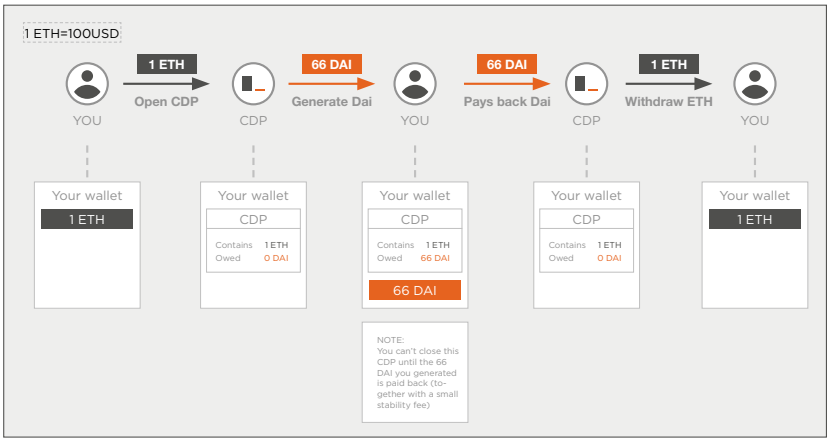


Fig. 1: *This figure shows the normal interaction process as described in the four steps above when opening a CDP, generating Dai, paying back Dai, withdrawing collateral (ETH) and closing the CDP.*

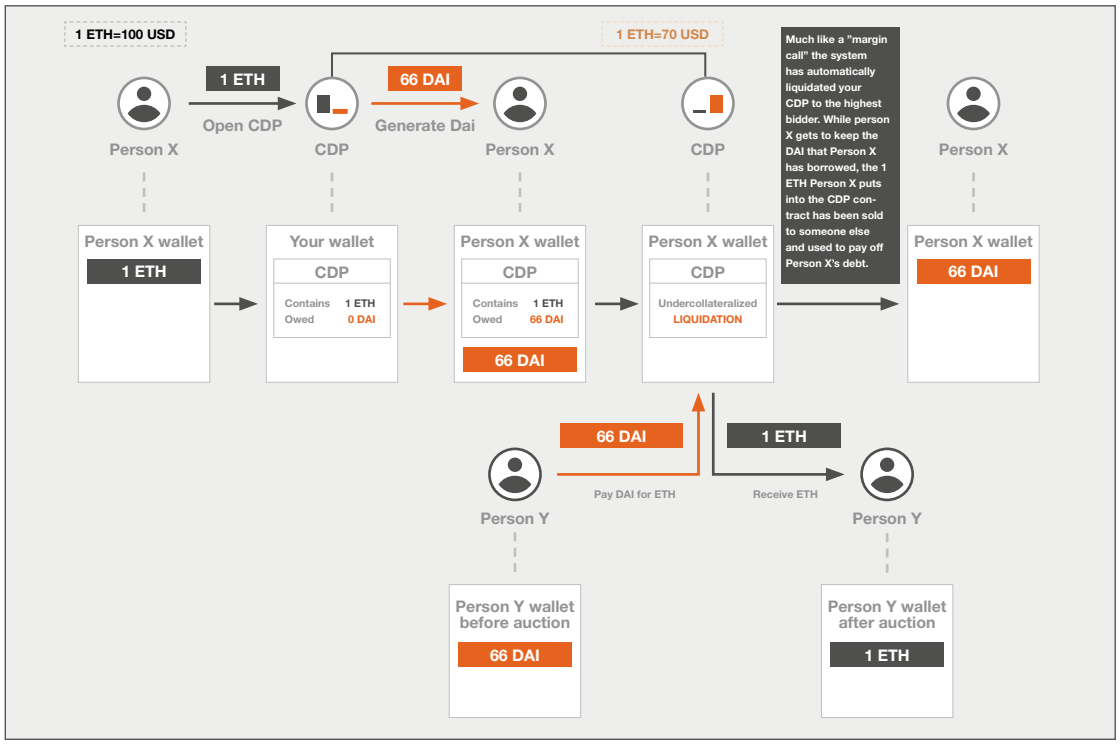


Fig. 2: *This describes the event of automatic liquidation of a CDP in case of undercollateralisation. To ensure there is always enough collateral in the system to cover the value of all outstanding debt (according to the Target Price), a CDP can be liquidated if it is calculated to be too risky. The Maker Platform determines when to liquidate a CDP by comparing the Liquidation Ratio with the current collateral-to-debt ratio of the CDP. Each CDP type has its own unique Liquidation Ratio that is controlled by MKR voters and established based on the risk profile of the particular collateral asset of that CDP type. Liquidation occurs when a CDP hits its Liquidation Ratio. The Maker Platform sells off enough collateral to cover the outstanding debt. Any surplus collateral will be returned to the CDP, so the CDP owner can withdraw it.*

40. https://makerdao.com/whitepaper/Dai-Whitepaper-Dec17-en.pdf p. 4

RETURN TO TABLE OF CONTENTS

6.2 Entering the Second-Generation Tokenization Phase

As described earlier in this white paper, the process of tokenizing an asset unlocks numerous advantages like increased liquidity, fractional ownership, rapid settlement, and more. This can be considered 'first-generation tokenization', and as mentioned above, several companies around the world are currently developing or offering this kind of asset tokenization.

Combining first-generation tokenization and global multi collateral-backed stablecoin systems will allow us to enter a second-generation tokenization phase in which the potential of the tokenized assets will be further developed and utilised – and at the same time we will be able to create the necessary setup for issuance of sufficient amounts of non-volatile cryptocurrencies to fuel the future token economy.

6.2.1 The Dai Credit System's importance for tokenized assets

In the Dai Credit System, tokenized assets can be used as collateral in a CDP. This enables the owner of the tokenized asset to take out loans in Dai against the collateralized asset and use Dai within the token economy – just like a crypto counterpart to fiat currency – or to exchange Dai for USD, or to leverage the owners' position and buy more assets to put into the CDP.

Currently, ether is the only collateral available in the Dai Credit System, but in a short while we expect to see more asset classes accepted as collateral. Because assets like real estate or gold are far less volatile than cryptocurrencies, the Dai Credit System is expected to be much more stable and efficient for users as they will be able to take out more Dai against less volatile assets without jeopardising the security of the system.

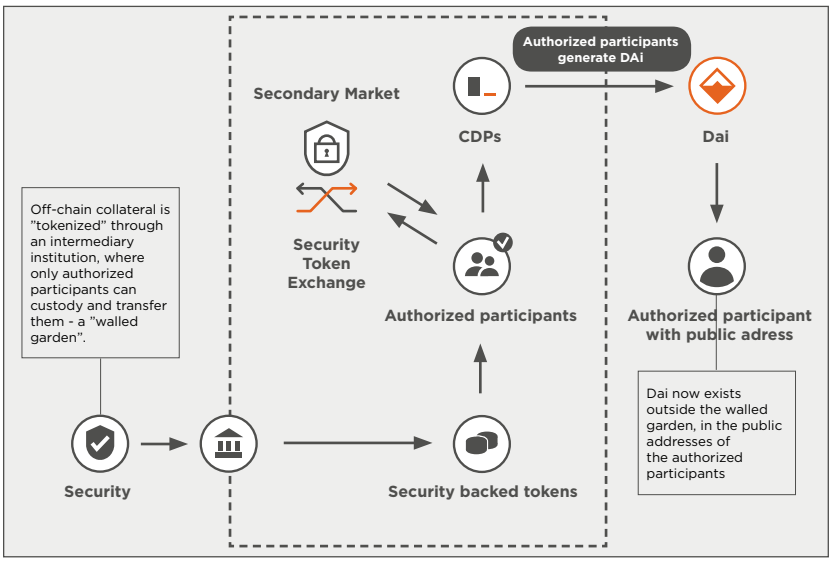


Fig 3: *This shows how Maker can facilitate decentralized lending on regulated products.*

In an interview with the CEO of Nomics, Clay Collins, in July 2018, Josh Stein, CEO of Harbor notes:

> *"I think it [tokenized securities and real estate] has the potential to become the foundation or the basis for Stablecoins. So today, for example, I'm a big fan of the MakerDAO project and some of the other Stablecoin projects that are out there. There is so much friction involved because the cryptocurrencies are so volatile, and there's so much commerce that wants to be done in what is essentially fiat, and folks are looking for crypto fiat, and that's what the Stablecoin projects are about. The issue is, let's take the MakerDAO for example, you pledge collateral, and in order to get Dai, you have to significantly over-collateralize that contract if you're using cryptocurrencies precisely because they are so volatile. There is a confidence issue in the value there. And you are vulnerable to a classic run*

RETURN TO TABLE OF CONTENTS

on the bank, a classic loss of confidence that's catastrophic and causes the currency peg to break. But now imagine a world in which you have a bunch of tokenized securities. You have all these security tokens based on high-quality real estate. So, in other words, assets that are not volatile. Assets that are volatile 10% a year rather than 10% every 10 minutes. In that world, you can imagine folks using those security tokens, pledging them as collateral to produce Dai, and people really trusting these Stablecoins."[41]

This means the asset owner is able to tokenize the asset and simply trade it on an exchange – which is the core of first-generation tokenization. But in addition, by combining tokenization and the Dai stablecoin system, the asset owner is now able to keep his or her asset and use it to open a CDP and draw Dai at a very low interest rate, which can be used for whatever the asset owner wants.

Furthermore, the asset owner still owns the collateralized assets in his CDP, and can free up the assets and get it back anytime just by paying back the loan in Dai. In the event that the asset goes up in value while being collateralized and held in the CDP, the owner not only gets a very cheap loan in Dai, he also gains a profit because he had his value tied as collateral. This is the core of the second-generation tokenization.

Stein is convinced that tokenization is going to be transformative for the crypto economy. He says in the interview mentioned above:

> *"So, now imagine a crypto economy powered by fiat currency that you can trust. What are the various things that you can do? When you have a blockchain-based ride-sharing solution. When you have a blockchain-based any other sort of service, look at Harbor's potential services down the road distributing dividends to folks. Rather than doing that in cryptocurrencies, you could do that in a crypto Stablecoin that people know and trust, and that opens up the crypto economy and the services you can provide in a way that I think is truly transformative. So, tokenizing securities doesn't just have transformative effects on private capital formation liquidity. I think it will have transformative effects on the crypto economy."*[42]

6.2.2 Asset tokenization's importance for the Dai credit system

As described, there is a mutual dependence between tokenization of assets and the further development of the multi-collateral Dai Credit System. For Maker and the Dai Credit System, a strong development of tokenization of real-world assets is important for three reasons:

Stability – The stability of the system depends on the collateral in the system. Until now the system has managed to maintain its peg with only ether as collateral. In the long run, the best way to secure the platform's stability is to have a diverse mix of as many asset types as possible for collateral. As important as the number of collateral types is, the Maker Community's must have the ability to make a correct risk assessment of each of the asset types and to make sure to have the right spread of asset types.

Growth – All platforms need a critical mass of users to become successful. This

41. https://blog.nomics.com/flippening/security-token-documentary/, Part 3 Transcript [17:30]
42. https://blog.nomics.com/flippening/security-token-documentary/, Part 3 Transcript [19:00]

RETURN TO TABLE OF CONTENTS

goes for the Maker platform as well. The Maker platform is growing quickly, but the acceleration of tokenization of real-world assets and the link to stablecoins has the potential to hugely boost the growth of this platform in the coming years.

Supply of Dai – Dai can only be created through generation of Dai against collateral in a CDP. That is why the scalability of Dai is hugely dependent on the popularity of creating CDPs and generating Dai.

6.3 The challenge of scalability and the link to tokenization of everything

Dai is minted in a CDP against the collateral in the CDP. This means that for Dai to reach critical mass, a lot of CDPs must be created on an ongoing basis – and a lot of Dai must be generated against collateral to get enough Dai in circulation.

Once again, tokenization comes into the picture as a crucial element. As we have already seen in this white paper, this is a combination of tangible (real-world off-chain) and virtual (on-chain) assets, and fungible and non-fungible assets.

Tokenization of on-chain assets is not a challenge since they – like ether – are already tokenized by nature, but for several reasons, on-chain assets alone are nowhere near adequate as a basis for supply of Dai. The cryptocurrency market with its current market cap of USD 122 billion[43] is far from sufficient as a foundation for the full scaling of Dai as a future global stablecoin and a driver of a new token-based economy.

Even if the joint market cap of all the cryptocurrencies reached a sufficient level of value, there is another reason why a wide range of tokenized off-chain real-world assets as collateral would still be needed. Because the prices of cryptocurrencies are – primarily for psychological reasons – highly correlated, the Maker platform does not necessarily become more secure and stable by having ten or a hundred different cryptocurrencies as collateral instead of just ether, as is the current case.

To secure long-term stability and security, cryptocurrencies as collateral need to be supplemented with as many different types of off-chain tokenized asset types as possible.

6.3.1 Critical elements for the scale of the Dai Credit System

- Awareness. A critical role of the Maker team is to drive awareness for the Dai Credit System and build relationships with companies and organisations who want to create new types of collateral for the CDPs. Maker has partnerships with companies all over the world, and the number increases every week. Maker also needs to attract creators and users of CDPs, who want to leverage their collateral and take out liquidity in the form of Dai. Education and training are key components of helping new people engage with the Dai Credit System, which is why the Maker Foundation is investing in their community resources and education, as well as marketing and business development.

- Community/Developers/Ecosystem. Just as collateral is critical for the system, so is demand for Dai. This means that we need a full community of developers that wants to build a relevant application on top of the Dai Credit System. It must be ensured that there are top class development documentation, tools, tutorials, workshops etc. Services from other providers are also needed to create a full ecosystem that is easy to build applications on top of. This is for example about making sure Dai is on relevant exchanges, that there are on/off ramps where the user can go from fiat to crypto and vice versa, etc.

43. November 27, 2018

RETURN TO TABLE OF CONTENTS

7. Tangible use cases for the Dai Credit System

As mentioned earlier, Maker currently has more than two hundred partnerships with companies, who are making use of Dai in many ways. But since Dai is intended to be the future crypto counterpart of any relevant FIAT currency this is only the beginning; the number of use cases is likely to keep growing rapidly going forward. In this chapter, we will give just two examples of companies who are currently preparing to start using Dai and additionally planning to contribute different types of collateral to the Dai Credit System at some point in a not too distant future.

NOTE: Before any collateral can be added to the Dai Credit System, it has to be approved by the MKR Governors, so the examples below just describes potential collateral types. The process for adding collateral types to the system will be described later in this paper in the section "Adding tokenized assets as collateral for Dai"

7.1 DigiX

For Maker, the partnership with DigiX makes sense because Maker wants to further secure the Dai Credit System by offering as many different types of collateral as possible. And DigiX already offers tokenized gold which should be a good collateral type, given the relative low volatility on the price of gold.
For DigiX it makes sense to offer their users, which means the owners of their gold backed and gold pegged 'stable' coin DGX the opportunity to move from DGX into Dai. The problem with DGX is that it is not always stable since the value of gold, which it is pegged to is not always stable. Not as stable as USD that Dai is pegged to (notice that it's interesting that this coin is backed by and pegged to the same asset. So, even though gold goes down in value the coin doesn't need additional collateral, because the value of the asset it is pegged to goes down simultaneously, obviously, because they are the same). But on top of this reason there are two other reasons why DigiX would want to power their coin with a decentralized stablecoin like Dai:

> *"Although fiat collateralized tokens (or commodity backed tokens for that matter) do bring a degree of stability, it's unlikely to become an everyday token of choice for two main reasons. One, it's not scalable – you will need fast amounts of capital to serve as collateral if you want to mint enough tokens to have the ability of mass adoption (for example, the value of all the money on earth is around $90 trillion). And two, a central authority or custodian will have to be trusted with keeping the collateral (e.g. banks). This is counterintuitive as the possibility of a central influence is exactly what cryptocurrencies want to safeguard against."*[44]

7.2 Tradeshift - tokenizing invoices

Maker and Tradeshift announced their partnership in July 2018 "to unlock liquidity access for small businesses around the globe from the $9T of capital trapped in outstanding receivables."[45]

Tradeshift digitises and connects everything that happens between a buyer and a seller, and helps businesses:

44. https://cointelegraph.com/news/stable-coins-analysis-is-there-a-viable-solution-for-the-future
45. https://medium.com/makerdao/tradeshift-and-makerdao-leverage-blockchain-to-democratize-access-to-financing-for-worlds-small-98076fd05f86

RETURN TO TABLE OF CONTENTS

- Connect with their buyers and suppliers to help them transact digitally across procure-to-pay
- Access payment and financial services that benefit from insight into the digitized trade in the network
- Buy and sell through supply chain marketplaces that integrate payments, financial services and apps

Lack of liquidity is a major problem for small and medium businesses and one of the most common causes of bankruptcy. The goal of the partnership between Maker and Tradeshift is to unlock the power of the next generation of blockchain applications for small business. The partnership aims to solve the liquidity problem by allowing businesses to get paid instantly by selling off their invoices via a trading platform. It also aims to explore how receivables could be used as collateral in CDPs, thereby allowing firms to "lend themselves money".

Traditional factoring services have been around for years, but by including blockchain technology and the Dai stablecoin, Tradeshift and Maker opens completely new and attractive low-risk asset class for crypto investors. Assets are converted into standardized tokens on a blockchain through an automated process after which they can be acquired by crypto investors via Dai at an auction.

In such a model, businesses get near instant access to the financing they need, on terms that they select. For the investors, this unlocks an opportunity to invest in a totally new type of asset class in the crypto space. And because Dai is the denomination, investors are not exposed to any crypto volatility. In other words, the partnership opens up a new type of risk exposure, and a new type of return on investment. Additionally, the investors help small business get access to the liquidity they need to run their companies.

Co-founder of Tradeshift, Gert Sylvest, says:

> *"The trade receivables market has very tight margins, which leaves no room for a volatile digital currency as an instrument for settlement. The Dai Credit System is a unique vision for a transparent and stable token that allows anyone to represent real-world currency settlements on the blockchain. It is a vision that we are very excited about."*[46]

Invoices as collateral

In addition to the already mentioned benefits for companies as well as investors, the partners are exploring how to unlock another innovative feature.

By tokenizing invoices from companies and bundling those invoice tokens into classes, they can be risk assessed, sold on secondary markets, and used as a separate type of asset which can then act as collateral in the Dai Credit System.

Owners of these invoice tokens will then be able to put them into a CDP and generate Dai against them. And by doing so, invoices, just like any other real-world tangible asset whether fungible or non-fungible, creates liquidity on one hand, which helps stimulate the overall economy, and on the other hand helps to further secure the Dai Credit System.

To summarize, this partnership 1) solves a crucial liquidity problem for small and medium business while at the same time 2) unlocking a new low-risk market for crypto investors, and 3) introducing a new type of collateral – tokenized invoices – to generate Dai against a CDP.

46. https://briandcolwell.com/2018/08/makerdao-the-future-of-finance/.html

RETURN TO TABLE OF CONTENTS

7.3 Adding tokenized assets as collateral for Dai

Tokenization of real-world assets is already happening.
Maker receives many requests to make specific tokens available in the MCD system. Of course, the final decision is up to MKR holders. But here are a few steps all prospective Dai Collateral types will want to keep in mind:

1. Tokenize the real-world asset
   a. Make sure all is set up as required by regulators (perform KYC on traders, perform reporting as required by AML etc.)

2. Make sure the price of the tokenized asset always can be determined, and the asset is sufficiently liquid to be sold off in case a CDP where it is used as collateral is liquidated.[47] This can, for example, be accomplished by enabling the tokenized asset to be traded on a secondary market.

3. To apply to have the tokenized asset approved as collateral for Dai (as a collateral type), it must be risk assessed.[48]

The process to compile data through due diligence has three parts and is conducted sequentially to use resources as efficiently as possible.

The three parts are:
a. The Initial Collateral Onboarding Process: this covers the trade support structure, distribution of token holdings and available data series.
b. The Operational Assessment Process: this covers the functionality behind the token, from the organisation itself, through to the governance mechanisms and rights of the token owner.
c. The Technological Assessment Process: this covers the robustness and security of the underlying technology.

4. A risk team working for the MKR governors will create a qualitative risk template and assign ratings on this template. The model and information will be made available for MKR Token Holders and other risk teams to use for themselves.

Based on the risk evaluations, the following suggested risk parameters are proposed:

a. Debt Ceiling - The maximum amount of Dai it will be possible to generate based on this collateral type. This is determined based on how much exposure of this collateral type MKR Token Holders are willing to take. The Debt Ceiling controls the risk of creating an illiquid market due to holding too much of one token or creating the effect of an illiquid market by liquidating too much inventory.

b. Liquidation Ratio - The liquidation ratio is the required amount of collateral as a proportion of the Dai being generated against the collateral. Participants in the system (Keepers) liquidate the collateral if the collateral to debt ratio falls at or below this level.

c. Stability Fee - A continuously accrued fee that is due when a CDP owner pays back Dai to release the collateral locked up in the CDP. The stability fee is similar to an interest rate, which is made up of a few components. In short, an interest rate must compensate for purchasing power, so it must first pay for inflation. The second component is the operating cost and policy instrument of the organisation. The third is a premium that is paid to compensate Maker token holders for providing the above-mentioned insurance. Traditionally this would be a credit risk premium attached to the borrower's credit quality, but in this system, the credit risk is shifted entirely to the collateral.

47. A CDP can be liquidated if it is deemed to be too risky. Liquidation occurs when a CDP hits its Liquidation Ratio. The Maker Platform will automatically buy the collateral of the CDP and subsequently sell it off.
48. See MakerDAO Governance Risk Framework, Part 2 https://medium.com/makerdao/makerdao-governance-risk-framework-fc8939f3d4e9

RETURN TO TABLE OF CONTENTS

5. The MKR Token Holders will use the available information to decide whether to include the token into the collateral portfolio. This is done using the Maker governance mechanism.[49] The governance mechanism has two sets of functionalities: the first is proactive and the second is reactive. Proactive governance includes debate, resolution and automated implementation. Reactive governance contains procedural intervention.

The consideration of a new token as collateral, its acceptance and inclusion in the portfolio, along with the deployment of its risk parameters, are examples of proactive governance. The need to potentially increase exposure to that collateral because it has grown is an example of reactive governance. Voting will have two forms, and the first requires resolution.

The second will be a vote to enact that resolution into the system.

a. The first type of vote is a **Governance Vote**, and its objective is to represent resolution on a matter or collection of matters. In our context, the purpose of the vote will be to get resolution of the three risk parameters for the collateral type as described above.

b. The second type of vote is an **Executive Vote**, and its objective is to change the state of the system. In our context, the executive vote will perform the actual changes to the system that are needed to enable the new tokenized asset collateral type.

6. After the **Executive vote**, the tokenized asset can then be used as collateral for Dai.

49. See MakerDAO Governance Risk Framework, Part 1 https://medium.com/makerdao/makerdao-governance-risk-framework-38625f514101

RETURN TO TABLE OF CONTENTS

8. The future of a token-driven economy

When crypto became known to the general public, it was for all the wrong reasons. Endless media stories about Silkroad linking the use of bitcoin to criminal activities and massive negative press coverage in the wake of incidents like the bankruptcy of Tokyo based crypto exchange Mt. Gox in 2014 effectively managed to discredit the crypto space.

Despite this bumpy beginning, cryptocurrencies suddenly started to catch the attention of millions of ordinary people around the world in an more positive way when their prices started to rise significantly in 2017. Unfortunately – as we know now – this hyper growth was unhealthy and unsustainable, and since December 2017 the overall trend of crypto prices has been downward. The crypto market, in general, has revealed high volatility and in practice cryptocurrencies like bitcoin can no longer be used as a means of payment, as originally intended.

While 2017 was characterised by a wild bull run of crypto prices and a period of frenzied ICOs, 2018 was a year of transition – cleaning up, separating the sheep from the goats and reflecting on new and more sustainable, regulated ways of further developing the crypto space.

It has been said that whereas ICOs were about avoiding regulation, STOs are about embracing it – a non-regulated path forward for crypto does not exist. And as we have seen in this white paper, STOs are just a small part of a much bigger and more important trend of tokenization, which again is linked to the ongoing development of stablecoins.

8.1 Realising the potential of the token-driven economy

This is where we are today, in a period of transition. The market has a new focus on compliance, a movement toward asset-backed security tokens, a clear trend of tokenization of real-world assets, and the arrival of the stablecoin as an answer to the devastating challenge of volatility on the crypto market.

Dan Doney, CEO & Co-founder of Securrency, says:

> *"2019 is undoubtedly the year of the security token. It is transformational in terms of the impact. There is an estimation that there will be two trillion USD worth of values in securities by the end of 2019 [...] Certainly within the following year it will blow way beyond."*[50]

In a report by the IBM Institute for Business Value published in 2018, the authors express their expectations for the development of blockchain and a new token-driven economy:

> *Putting real-world assets into digital form using tokens so they can be exchanged easily and without friction promises to be disruptive. Between now and 2021, we expect the blockchain opportunity for providers of blockchain platforms, services and owners of blockchain networks to grow five to ten times greater with a significant portion of this opportunity in the digital token*

50. https://www.youtube.com/watch?time_continue=14&v=MBQg-g7LkUxs

RETURN TO TABLE OF CONTENTS

economy. Industries will reinvent themselves, and new digital assets and asset classes will give rise to entirely new primary and secondary markets with low cost and minimal friction."[51]

The big question now is what it takes to exploit the full potential – for the crypto and blockchain industry as well as the surrounding communities? At least two elements need to be in place:

- Scalability
- Regulation

8.1.1 Scalability

The need for scalability concerns several key components of the token-driven economy.

A. Tokenization platforms

The most basic prerequisite for realising the potential of real-world asset tokenization is the companies and platforms executing the actual tokenization process – the technical issuance of the security tokens, the regulatory aspects, the compliance, the security of the process, and more.

We have already mentioned some of the companies within this field such as Polymath, TrustToken, Swarm, Factora, and Harbor, with many more popping up as we speak – companies like Securrency (www.securrency.com), Slice (www.slice.market), Tokeny (www.tokeny.com), Vertalo (www.vertalo.com), Desico (www.desico.io) and Blocksquare (www.blocksquare.io).

B. Exchanges

For tokenization of real-world assets to flourish, a basic prerequisite is a secondary market on which the security tokens can be traded and, consequently, a certain number of exchanges. Since we are still in the very early days of tokenization we need to wait and see how this market will unfold, but already now half way into 2019 we see a lot of new activity in the exchange space. Players like Open Finance Network (www.openfinance.io), tZero (www.tzero.com) and Templum (www.templuminc.com) were the first to announce their trading platforms for security tokens, followed by platforms like Gibraltar Stock Exchange (www.gsx.gi), SIX (www.six-group.com), Currency (www.currency.com) and more.

C. Stablecoin platforms

The need for scalability of the Maker platform has already been discussed earlier in this white paper: to reach the number of CDPs containing the necessary asset value to mint enough Dai for market demand, Maker needs to be able to welcome many different types of assets as collateral in the CDPs. This will take some time but it needs to move as quickly as possible.

8.1.2 Regulation

Thorough regulatory considerations are now almost baked into every single element of the tokenization space. Harbor, for instance, writes:

> *"The Harbor platform and compliance protocol ensure tokenized securities comply with existing securities laws at issuance and on every trade, everywhere across the globe."* [52]

The topic of regulation in relation to tokenization calls for a white paper on its own. But we will simply say this: everybody in the tokenization space is keenly aware of the importance of regulation. What is needed as a natural next step is a broader dialogue between more regulatory authorities across

51. https://www-935.ibm.com/services/us/gbs/thoughtleadership/tokenassets/ (p. 7)
52. https://harbor.com/

RETURN TO TABLE OF CONTENTS

different jurisdictions around the world. Maker wishes to take an active part in these dialogues globally, and welcomes the initiation of such a regulatory dialogue process with the involvement of as many players as possible.

8.2 Maker's role in unlocking the economic potential

At the time of writing[53], the Dai Credit System is still a single collateral system based on ether (ETH), but Maker is soon launching its new system bringing Multi-Collateral Dai to market.
The code for the Multi-Collateral Dai was released on the Kovan testnet in September 2018, and the Maker teams have nearly completed building the application layer and the UX for the new system. They are currently finalizing the last details regarding the collateral partners required to deliver the complete implementation of the future Dai Credit System.

This imminent launch is crucial for Maker's ambitions to support the tokenization revolution, to generate enough Dai to support future global demand, and to make the Maker platform even more stable.

Maker anticipates a vastly diversified portfolio of tokenized asset types acting as collateral in the Dai Credit System in the future – which is also indicated by the examples of collateral partners mentioned in this white paper (DigiX – gold, Tradeshift – invoices). But it is still too early to give an estimate of the exact number of collateral types or a precise outline of the categories of collateral in the future system.

53. June 2019

RETURN TO TABLE OF CONTENTS

9. Conclusion

In this white paper, we painted a picture of the new and potentially transformative development of tokenization. The Maker Foundation believes that the tokenization revolution has in fact already started.
Maker believes this revolution will eventually be of benefit to large and very diverse groups of people – including the historically underrepresented and underserved – all over the world.

Tokenization in combination with high-quality stablecoins like Dai will create a solid foundation for a future token-driven economy and for development of future innovative financial instruments.

It takes a healthy ecosystem for this to succeed. This isn't just about disruptive technology, or forward-looking regulation. Attention is required to all of the following four areas:

- Technology
- Regulation
- Business models
- Market infrastructure

The Maker Foundation will perform "ice-breaking" activities in all areas to pave the way for ecosystem partners that want to be part of the Tokenized collateral economy.

The Maker Foundation will share lessons learned from these activities, and encourage regulators, security token platform providers, exchanges and issuers of Security Tokens to reach out and engage in a dialogue about how we together can accelerate the move toward the tokenization of all kinds of relevant assets.

RETURN TO TABLE OF CONTENTS

Appendix 1: Glossary of Maker Terms

- **Collateralized Debt Position (CDP):** A smart contract whose users can generate a stable asset (Dai). The CDP user has posted collateral in excess of the value of the Dai generated in order to guarantee their debt position.
- **Dai:** The cryptocurrency with price stability that is the asset of exchange in the Dai Stablecoin System. It is a standard Ethereum token adhering to the ERC20 standard.
- **Debt Auction:** The reverse auction selling MKR for Dai to cover Emergency Debt when a CDP becomes undercollateralized.
- **Collateral Auction:** The auction selling collateral from a CDP undergoing liquidation. It is designed to prioritize covering the debt owed by the CDP, and secondarily to give the CDP owner the best possible price for their excess collateral refund.
- **The Maker Foundation:** The organization tasked with bootstrapping the Maker system to ensure that it can survive as a fully decentralized organization. The Maker Foundation employs people to develop the strategies and manage the tasks required to build enough momentum so that the Maker system can successfully thrive on its own. Per the Foundation Proposal, decentralization is a top priority and is ongoing.
- **Keepers:** Independent economic actors that trade Dai, CDPs and/or MKR; create Dai or close CDPs; and seek arbitrage on the Dai Stablecoin System. As a result, Keepers help maintain Dai market rationality and price stability.
- **MKR:** The ERC20 token used by MKR voters for voting. It also serves as a backstop in the case of insolvent CDPs.
- **MKR Voters:** MKR holders who actively manage the risk of the Dai Stablecoin System by voting on Risk Parameters.
- **Maker:** The name of the Decentralized Autonomous Organization that is made up of the Maker Platform technical infrastructure, and the community of MKR voters.
- **Oracles:** Ethereum accounts (either contracts or users) selected to provide price feeds into various components of Maker Platform.
- **Risk Parameters:** The variables that determine (among other things) when the Maker Platform automatically judges a CDP to be risky, allowing Keepers to liquidate it.

RETURN TO TABLE OF CONTENTS

RETURN TO TABLE OF CONTENTS

Informational Paper from The Tokenizer
prepared for Maker:

TOKENIZING REAL-WORLD ASSETS

- towards a regulated and stable token-driven economy

Developed by The Tokenizer (www.thetokenizer.io)
in collaboration with Maker (www.makerdao.com)

Text by Michael Juul Rugaard and Kristian T. Sørensen,
Founders of Norfico & The Tokenizer

Copenhagen, June 2019

MAKER

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