WIFIN WORKING PAPER 16/2023

Non-fungible Token
–
Overview and Use Cases

Carolin Diefenbach

,

28 April 2023

Non-fungible Token
–
Overview and Use Cases

Carolin Diefenbach

Hochschule RheinMain University of Applied Sciences
Wiesbaden Business School
Bleichstr. 3
D-65183 Wiesbaden
E-Mail: carolin.diefenbach@hs-rm.de

28 April 2023

Kurzzusammenfassung: Aufgrund des rasanten Wachstums, das der Markt für Non-fungible Token im Jahr 2021 erfahren hat, ist das Thema deutlich präsenter geworden. Auch Personen, die sich zuvor nicht mit dem Thema Kryptoassets auseinandergesetzt haben, finden Interesse daran. Was genau sich hinter dem Begriff NFT verbirgt, welche Einsatzgebiete es gibt und in welche Richtung sich die Kryptotoken entwickeln, soll in diesem Artikel kurz dargestellt werden. Dabei werden signifikante Veränderungen am Markt und im technologischen Bereich beleuchtet sowie Chancen und Herausforderungen.

Abstract: Due to the rapid growth experienced by the market for Non-fungible Tokens in 2021, the topic has become much more present. Even people who have not previously dealt with the topic of crypto-assets are finding interest in it. What exactly is hidden behind the term NFT, which areas of application there are and in which direction crypto tokens are developing will be briefly presented in this article. Significant changes on the market and in the technological field will be highlighted, as well as opportunities and challenges.

Keywords: crypto-assets, virtual assets, Non-fungible Token, smart contracts, blockchain, proof of work, proof of stake

I. Prerequisites

I.1 Definition of Terms

When searching for a uniform definition of *Non-fungible Token*, it is difficult to find one. In terms of content, however, the definitions are based on similar concepts. For example, a Non-fungible Token (NFT) is a digital asset that represents an object from the real world, such as art, music or in-game items. Trading takes place online and is often done with cryptocurrencies (Conti, Schmidt, 2022). Another definition describes NFTs "as a unit of digital information (token) stored on a blockchain" that is not interchangeable with other digital assets (non-fungible) (Chohan, 2021)." In summary, then, an NFT is a cryptographically unique, non-divisible, and non-exchangeable token that represents an existing digital or physical asset on a blockchain (Valeonti et al., 2021).

To further understand what a Non-fungible Token is, it is helpful to look at the word *fungible* in isolation. The term fungible originates in accounting literature as well as economics and is defined as anything that is interchangeable with a similar or identical object. Memorable examples include traditional forms of currency (both as paper money and as an identical sum of valuable metals), common stocks, or options (Chohan, 2021). The equal value that fungible objects hold classifies them as mediums of exchange, as a dollar always has the value of a dollar, or a Bitcoin always has the same value to another Bitcoin (Conti, Schmidt, 2022). Thus, one can substitute a five-dollar bill with another five-dollar bill without loss or gain.

In contrast, non-fungible objects of value are, for example, cars, paintings, or baseball trading cards, as these contain unique attributes that affect their value (Chohan, 2021). As a result, one cannot simply exchange a painting with another painting or a trading card with another trading card.

Originally, in the virtual world, it was difficult to ascribe unique value to objects because code consisting of 1s and 0s could be reproduced at any time. This would make digital objects fungible to a certain extent (Chohan, 2021).

I.2 Blockchain as a Technological Basis

The blockchain is the fundamental technology for the field of crypto-assets. It is a shared database that is accessible to everyone and organized in a decentralized manner (Valeonti et al., 2021). In this context, one also speaks of the so-called DLT, the Distributed Ledger

Technology. This is a storage unit that makes it possible to store transactions and information in such a way that manipulations become almost impossible (Metzger, 2018). Those manipulations can be avoided since each block of the blockchain determines the existence of the previous and the following block. Moreover, since transactions take place publicly and can be viewed by anyone, the blockchain is difficult to compromise (Frankenfield, 2023). So-called *node operators* additionally play an important role in ensuring the proper functioning of the blockchain. To do so, they provide the resources of their computer, such as RAM, disk space, or bandwidth, by running software that keeps a copy of the blockchain and propagates transactions across the network (Valeonti et al., 2021).

II. The Concept of „Non-fungible Token"

In summary, NFTs are understood to be a digital title deed for collectibles with exclusive ownership rights. They exist on a blockchain that serves as a DLT, recording transactions and securing the tokens (Conti, Schmidt, 2022). In addition, NFTs typically have only one owner at a time, ownership can be easily verified, and tokens can be traded and transferred quickly. Specific information can be stored in the metadata of NFTs, such as a signature of the artist to ensure the uniqueness of the NFT (Ethereum.org, 2022).

When an NFT is created, it is referred to as *minting*. This creation process takes place on the basis of smart contracts. When an NFT is minted, code is executed which assigns ownership and is responsible for the transferability of the NFT. This resulting information is added to the blockchain where the NFT is managed (Ethereum.org, 2022). A specific number defined and assigned by the contract to the NFTs metadata makes them uniquely identifiable (Prinz, 2021). In most cases and up to this point, minting is executed on the Ethereum blockchain (Conti, Schmidt, 2022).

Before minting, the creator of an NFT determines how scarce the asset should be, i.e., how many NFTs should be issued on an asset. A distinction is made between exact replicas of an NFT, very similar copies, or a single one. Nevertheless, each NFT has a unique identifier, thus rarity is intended (Ethereum.org, 2022).

The minting process is comparatively simple. First, the asset of the issuer of the NFT is confirmed on the blockchain by the network and the account balance of the owner is updated. The transaction confirming this is added to a block and therefore, perpetuated on the blockchain. Members of the network confirm the block and transaction as "correct,"

eliminating the need for intermediaries – the network agrees that the NFT exists and who owns it (Ethereum.org, 2022).

Trading NFTs is not complicated either. To buy an NFT, all you need is a digital *wallet* (name for the folder in which you can also deposit and store cryptocurrencies and map a digital wallet (Coinbase, 2022)) that can also store NFTs. This will be linked to a marketplace. In addition, one usually needs cryptocurrencies, which can be purchased via credit card and platforms such as Coinbase, Kraken or PayPal. Then, an NFT is purchased on trading platforms for NFTs and transferred from the platform to the wallet (Conti, Schmidt, 2022).

This process may incur *gas fees*, fees that are charged for transactions on blockchains and are paid to node operators to register and execute new transactions. They vary depending on the volume of trading that exists at the time. Trading platforms where investors can purchase NFTs include OpenSea, which operates without gas fees, Nifty Gateway, which trades in U.S. dollars, or Rarible (Valeonti et al., 2021, and Schwartz, 2021).

The asset an NFT was minted for differs into physical or digital. Physical assets are delivered to the buyer after the NFT has been acquired (e.g., trading cards). Digital assets, on the other hand, are usually stored off the blockchain because storing them on the blockchain would be too expensive. To ensure that the owners of the asset still have access to the object, the token is linked to the asset, e.g., via a link in the metadata (Valeonti et al., 2021).

III. Application Areas – Art, Collectibles and Gaming

In addition to areas such as trading cards and music, NFTs are especially popular in gaming and arts (Conti, Schmidt, 2022). In gaming, many NFTs hold a future especially in the context of the *Metaverse* (Morris, 2022). The Metaverse describes a vision of the future in which people interact primarily online (Wang et al., 2021) and use items from e.g. one game in other games (Morris, 2022). Buying items in games with real money is not new. However, when linked via an NFT, items could be resold after the game is not further developed. But even if a game is no longer in development or playable, NFTs allow people to continue to keep the purchased items in their collection. This gives original in-game items value outside of the game world. Decentraland, a virtual reality game, already implements this concept and even allows players to purchase NFTs representing virtual parcels of land (Ethereum.org, 2022).

In terms of trading volume, NFTs have so far been most widespread in the art segment (Nadini et al., 2021). Through NFTs, artists have the opportunity to sell their artworks without

intermediaries such as galleries or auction houses. Thus, they receive the complete return on their artwork. In addition, each time their work is resold, they receive a share of the resale price (Conti, Schmidt, 2022).

IV. Development

A study by Nadini et al. (2021) shows that a large part of the trading volume in % (approx. 75-80 % at the beginning of 2021) can be assigned to the art sector since mid-2020, followed by trading cards and gaming. Looking at the daily trading volume in USD, it can also be seen that these three areas reach the largest shares in the same order. However, in terms of shares of transactions, it is noticeable that the area of art has decreased sharply since 2020. This means that although there are fewer transactions in this area, the value of the transactions has increased significantly.

However, future prospects are also interesting. Crypto organisations see the tokenization of physical items as always evolving. Ethereum.org (2022), for example, predicts real estate, fashion items, and others such as cars coming into focus, making NFTs even more prominent as a digital ownership token. As part of this, Ethereum's thoughts also become strong on pushing forward with mechanization and using the NFT wallet as a key for, say, a house or car based on the title deed. In addition, NFTs of valuable assets could be used as collateral for decentralized loans that are assigned to the creditor in case of default.

Fractionalized ownership is also a new construct where NFT creators can create shares of their NFTs and thus divide ownership of a single token. In the case of physical goods, this area could become particularly interesting. In addition, particularly high-priced NFTs and thus the actual goods behind them will become more accessible (Clarke, 2022).

V. Status Quo

V.1 Consideration of Trading Volumes

OpenSea’s trading volume peaked at around USD 5.8 billion in January 2022. However, trading on the platform declined steadily in the first two quarters of the year 2022, falling to USD 3.1 billion in May 2022. June 2022 experienced the largest month-on-month decline in the exchange’s history, when trading volume plummeted by 74 % to USD 826 million (Craig, 2022).

On the website The Block (www.theblock.co, 2023), one can monitor further trading volumes and figures, mainly referring to Ethereum and Solana as the largest NFT trading platforms. The website also distinguishes the number of minted NFTs and the trading volume. The following data refer to this source.

Looking first at the number of NFT minted, one can observe a resurgence after mid-June 2022 to mid-July 2022. The spike amounted approximately 373.66 thousand minted NFTs on Ethereum on July 10, 2022. Within two weeks, the number dropped to 36.46 thousand new NFTs by July 26, 2022. Since then, the number continued to drop at a low rate, with few exceptions. For example, there was another spike around September 17, 2022, when the number of new NFTs reached 140.27 thousand on the Ethereum blockchain.

The number of new NFTs on the blockchain Solana is less noticeable overall, due to the fact that the number of mints was also in a corridor of 26.78 thousand and 146.27 thousand before summer 2022 and therefore, lower compared to the amount of minted NFTs on Ethereum to begin with. A single peak in the last year seems conspicuous: On September 7, 2022, the number of new NFTs on Solana was 312.21 thousand, which is an exceptional value for this blockchain until then. After that, the numbers oscillated in a similar range as before, but with a new cap for 2022 in terms of number, which seems to be around 55 thousand.

Looking at last year's (2022) trading volumes across all major NFT blockchains (Ethereum, Solana, ImmutableX, Polygon, Flow, and six others), The Block shows that after an annual peak on January 5, 2022, with a total trading volume of USD 1.75 trillion, the collapse occurred directly. On May 8, 2022, the trading volume amounted around USD 630.21 million only, and on May 15, 2022, USD 319.4 million. Since mid-July 2022, the trading volume has been moving below USD 200 million per day without any further peaks.

Possible reasons for the downturn could be the current inflation, which needs to be investigated empirically. Furthermore, general downturns of cryptocurrencies influence each other (Ferroni, 2022) – it would be conceivable that the current strong fluctuations of cryptocurrencies also influence the purchase of NFTs. This also needs to be proven empirically, as there is also nothing forcing one to rely on cryptocurrencies when buying NFTs, depending on the trading platform, as discussed earlier.

V.2 Merge of the Blockchain Ethereum

On September 15, 2022, the Ethereum blockchain officially switched from the validation process Proof of Work to Proof of Stake (Lindrea, 2022). Both terms describe a consensus

mechanism designed to verify transactions on the blocks of the blockchain and to ensure the integrity of the data, as a central authority for such matters is not available on decentrally organized blockchains (Napoletano, 2023).

In simplified terms, the Proof of Work consensus mechanism works exclusively through a lot of computing power. Those blockchain participants who ensure that new blocks are created and thus new transactions can be verified are called miners. In order for the new block to be formed, a code must be generated, called a hash, which is calculated by solving complex mathematical problems. The miner who finds this code first gets a certain amount of cryptocurrency as a reward, depending on the blockchain in question. However, this consensus mechanism requires enormous amounts of power due to the high use of computing power necessary to solve the mathematical problem (Napoletano, 2023).

According to Ethereum, Proof of Stake is designed to reduce the amount of computing power required significantly (Ethereum.org, 2023a). Instead of miners, the concept of this mechanism is to select validators randomly who then verify transactions and thus new blocks. This does not create a competition based on computing power – and therefore, there is no need for a high energy consumption. To be selected as a validator, however, blockchain participants must own a certain amount of cryptocurrency and deposit it as collateral. In the case of Ethereum, this security amounts to ETH 32 (equivalent to USD 57,457.6, as of March 24, 2023, BTC Echo).

V.3 Meta's Exit

In 2021, the company Facebook announced a rebranding with which it wanted to make clear which goals it was aiming for in the future, and has since called itself Meta, with regard to the Metaverse. The company had previously attempted the launch of the cryptocurrency Diem (Schuler, 2021). In 2022, Meta also entered the field of NFTs and wanted to enable users of the social media platforms Instagram and Facebook to post NFTs and link their wallet to these platforms (Mehta, 2022). On Instagram, there has also been the ability to mine and trade NFTs, as well. On March 13, 2023, Meta announced to discontinue the NFTs division (Peters, 2023). Possible reasons could be the cost-cutting measures on the part of Meta (Lulay, 2023) and could thus also be related to the downturn in the sales figures of NFTs.

VI. Critical Discussion

VI.1 Opportunities

NFTs offer a unique opportunity for artists to market their art directly, without having to pay a margin to intermediaries. Artists also receive a margin on resale – uncommon in standard artwork trading. Trading on a blockchain occurs quickly with verifiable ownership (Ethereum.org, 2022). In gaming, NFTs also allow acquired items to remain with owners even if the game is not further promoted by developers. In the Metaverse domain, digital carryover to other games is additionally envisioned (Morris, 2022). Fractionalized ownership could also ensure that physical and digital goods become accessible to less affluent people and that they can invest their money in art, for example (Clarke, 2022).

NFTs also offer the possibility to finance crisis areas. For example, Ukraine also uses NFTs to finance the war and hopefully, rebuild cities later (Helms, 2022).

VI.2 Risks

The biggest risk is the security of the crypto wallet, as with other crypto tokens or assets. Some NFT platforms offer to manage the cryptographic keys used to encrypt the wallet for their users. In that case, the term custodial wallet is used. Custodial wallets are easy to use, do not require any prior knowledge regarding blockchain. In return, one is able to recover passwords and retrieve accounts. As a disadvantage, users of custodial wallets do not have full ownership of their NFTs, as they are not stored in their own wallet. Thus, if the provider's infrastructure is compromised, or the company goes bankrupt, there is a risk of loss to that effect. Similarly, if the NFT owner self-manage their wallet and lose the cryptographic key, and thus access to the wallet, risks of loss prevail (Valeonti et al., 2021).

The topic of NFTs (and crypto in general) must also be viewed very critically in terms of the environment. Most NFTs are stored on the Ethereum blockchain. In May 2021, the energy consumption of this blockchain resulted in about 48.7 terawatt-hours per year – equivalent to the annual energy consumption of Malta (Digiconomist, 2022). Meanwhile, Ethereum has admittedly changed the consensus mechanism from the energy-intensive Proof of Work to Proof of Stake, which they hope will result in potential savings of over 99 % in both, energy consumption and CO_2 emissions (Ethereum.org, 2023b). Nevertheless, the amount of collateral required to be selected as a validator should be viewed critically: The need of ETH 32 and the resulting equivalent in fiat money probably limits the number of possible validators significantly.

The final point that can be mentioned in this brief thematic introduction is the volatility of NFTs. For example, although the strong upswing in the art sector caused prices to rise enormously in February 2021. On March 25, 2021, however, the market recorded a fall in value of more than 85 % – within a single day (Sriram, 2021).

VII. Potential Research Approaches

It would be interesting to find out whether there are country-specific differences in the attractiveness of NFTs – both, in terms of overall attractiveness and in individual areas. For example, it would be interesting to learn whether there are differences in attractiveness between Asian countries, European countries, or the U.S., and whether individual countries focus more on collectibles, art, or gaming, for example. It would also be interesting to find out correlations between the willingness to invest in cryptocurrencies, as well as general demographic characteristics in order to create a possible buyer persona or target group.

Following these marketing-specific approaches in research, it would also be interesting to find out the exact reason(s) for the downturn in trading volumes. For the time being, only conjectures can be made, which need to be empirically validated. The influence of energy prices and resource scarcity is another point that should be investigated. In this respect, the new Proof-of-Stake concept, which Ethereum has now implemented and with which it wants to reduce the energy required for mining cryptocurrencies and NFTs, should also be kept in mind.

References

BTC ECHO (2023): Ethereum-Kurs Daten, BTC Echo, https://www.btc-echo.de/kurs/ethereum/, last checked on 24.03.2023

CHOHAN, U. W. (2021): Non-fungible Tokens: Blockchains, Scarcity, and Value, Critical Blockchain Research Initiative, Discussion Paper Series: Notes on the 21st Century

CLARKE, A. (2022): Fractional NFTs and what they mean for investing in real-world assets, Cointelegraph, https://cointelegraph.com/news/fractional-NFTs-and-what-they-mean-for-investing-in-real-world-assets, last checked on 11.11.2022

COINBASE (2022): What Is a Crypto Wallet?, https://www.coinbase.com/de/learn/crypto-basics/what-is-a-crypto-wallet, last checked on 24.05.2022

CONTI, R., SCHMIDT, J. (2022): What Is An NFT? Non-fungible Tokens Explained, Forbes, https://www.forbes.com/advisor/investing/cryptocurrency/NFT-non-fungible-token/, last checked on 25.04.2022

CRAIG, T. (2022): Is the NFT Boom Over? Trading Volumes Hit 12-Month Lows, Cryptobriefing, https://cryptobriefing.com/is-the-NFT-boom-over-trading-volumes-hit-12-month-lows/, zuletzt abgerufen am: 02.08.2022

DIGICONOMIST (2022): Ethereum Energy Consumption Index, https://digiconomist.net/ethereum-energy-consumption/, last checked on 30.06.2022

ETHEREUM.ORG (2022): Non-fungible Tokens (NFT), Ethereum.org, https://ethereum.org/en/NFT/, last checked on 27.04.2022

ETHEREUM.ORG (2023A): Proof-of-Stake, Ethereum.org, https://ethereum.org/en/developers/docs/consensus-mechanisms/pos/, last checked on 22.02.2022

ETHEREUM.ORG (2023B): Ethereum's energy expenditure, Ethereum.org, https://ethereum.org/en/energy-consumption/, last checked on 05.02.2022

FERRONI, F. (2022): How Interconnected Are Cryptocurrencies and What Does This Mean for Risk Measurement, Federal Reserve Bank of Chicago,

https://www.chicagofed.org/publications/chicago-fed-letter/2022/466, last checked on 26.08.2022

FRANKENFIELD, J. (2023): What Is Distributed Ledger Technology (DLT)?, Investopedia, https://www.investopedia.com/terms/d/distributed-ledger-technology-dlt.asp, last checked on 21.03.2023

HELMS, K. (2022): Ukraine's Government Launches 'Museum of War' NFT Collection, Bitcoin.com, https://news.bitcoin.com/ukraines-government-launches-museum-of-war-NFT-collection/, last checked on 17.04.2022

LINDREA, B. (2022): Breaking: Historic day for crypto as Ethereum Merge to proof-of-stake occurs, Cointelegraph, https://cointelegraph.com/news/breaking-historic-day-for-crypto-as-ethereum-merge-to-proof-of-stake-occurs, last checked on 15.09.2022

LULAY, R. (2023): Keine NFTs mehr bei Instagram und Facebook – Projekt wird nach wenigen Monaten wieder eingestellt, Handelskontor, https://handelskontor-news.de/news/keine-NFTs-mehr-bei-instagram-und-facebook-projekt-wird-nach-wenigen-monaten-wieder-eingestellt/, last checked on 14.03.2023

MEHTA, I. (2022): Meta now lets you post your NFTs on both Facebook and Instagram, techcrunch, https://techcrunch.com/2022/08/30/meta-now-lets-you-post-your-NFTs-on-both-facebook-and-instagram/, last checked on 15.09.2023

METZGER, J. (2018): Distributed Ledger Technology, Wirtschaftslexikon Gabler, https://wirtschaftslexikon.gabler.de/definition/distributed-ledger-technologie-dlt-54410/version-277444, last checked on 30.09.2022

MORRIS, D. Z. (2022): How the Metaverse Could Be a Game-Changer for NFT Gaming, https://www.coindesk.com/layer2/Metaverseweek/2022/05/23/how-the-Metaverse-could-be-a-game-changer-for-NFT-gaming/, last checked on 30.06.2022

NADINI ET AL (2021): Mapping the NFT revolution: market trends, trade networks, and visual features, Sci Rep 11, 20902, DOI: https://doi.org/10.1038/s41598-021-00053-8

NAPOLETANO, E. (2023): Proof of Work Explained, Forbes, https://www.forbes.com/advisor/investing/cryptocurrency/proof-of-work/, last checked on 18.02.2023

PETERS, J. (2023): Meta gives up on NFTs for Facebook and Instagram, The Verge, https://www.theverge.com/2023/3/13/23638572/instagram-NFT-meta-facebook-quits-digital-collectibles, last checked on 13.03.2023

PRINZ, W. (2021): NFT – Was passiert da eigentlich?, GIMI Research, https://www.gimi.cologne/2021/04/14/NFT-was-passiert-da-eigentlich, last checked on 30.06.2022

SCHULER, M. (2021): Facebook heißt jetzt Meta, Tagesschau, https://www.tagesschau.de/wirtschaft/unternehmen/facebock-umbennung-meta-103.html, last checked on 25.04.2022

SCHWARTZ, D. (2021): What Are Gas Fees, https://coinmarketcap.com/alexandria/article/what-are-gas-fees, last checked on 30.06.2022

SRIRAM, S. (2021): Analyst Suggest 'Silent Crash' May be Underway As NFT Prices Floors Plummet, Benzinga, https://www.benzinga.com/markets/cryptocurrency/21/04/20476681/analysts-suggest-silent-crash-may-be-underway-as-NFT-prices-floors-plummet, last checked on 24.05.2022

THE BLOCK (2023): NFT, https://www.theblock.co/data/NFT-non-fungible-tokens/NFT-overview, last checked on 16.03.2023

VALEONTI ET AL. (2021): Crypto collectibles, Museum Funding and OpenGLAM: Challenges, Opportunities and the Potential of Non-fungible Tokens (NFTs), Appl. Sci. 2021, 11, 9931, DOI: https://doi.org/10.3390/app11219931

WANG ET AL. (2021): Non-fungible Token (NFT): Overview, Evaluation, Opportunities and Challenges, arXiv, DOI: https://doi.org/10.48550/arxiv.2105.07447