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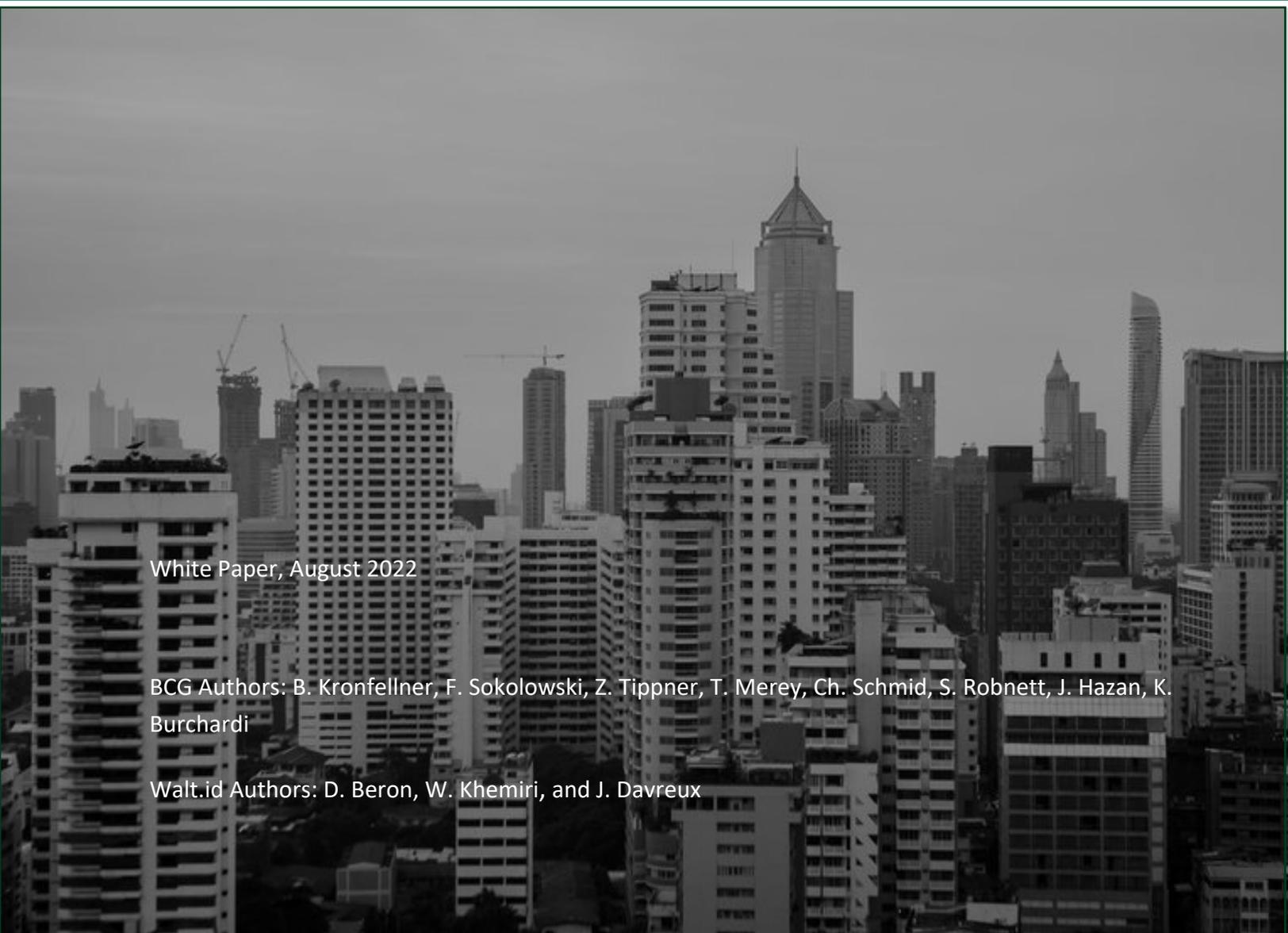# walt.id

Digital Twin of Everything

How Tokenized Assets Such as NFTs Can Change the (Digital) World

BCG and walt.id

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Walt.id is building identity, NFT and wallet infrastructure for developers and enterprises.

The company's products are used by governments, public authorities, enterprises, and DAOs (decentralized autonomous organizations) to build applications and use cases with Web3 identity, NFTs, and wallets fast and without much complexity.

All products are open source (Apache 2), and industry-leading experts provide holistic services from conception to implementation and support to managed cloud services.

Table of Contents

1 How Can Nonfungible Tokens (NFTs) Change the World?

The digitization of our world is accelerating, and it leaves no region or industry untouched. Enabled by technological innovations, such as blockchain technology and the decentralized storing of even sensitive data, and driven by various factors, such as the outbreak of COVID, digitization is creating a world in which people do everything online.

Now, in an increasingly digital world, we are forced to rethink many traditional concepts on which we rely to make sense of the world. Confronted with this new reality, innovators are realizing the enormous opportunities that come from rebuilding important concepts from first principles, including core concepts that underpin our economy like money, equity, or property rights in general.

Looking at a digital world, it seems obvious to model ownership in a natively digital way. NFTs allow us to do just that from a technological standpoint (whereas from a legal point of view some jurisdictions are lagging behind and still need to clarify property rights and ownership issues). Due to their unique properties, NFTs offer a way to encode ownership of any type of asset in a digital format including physical assets as well as more intangible things like natively digital assets or even ideas. Moreover, since NFTs are anchored on blockchains, they are grounded in an immutable registry of records that cannot be manipulated or controlled by any single entity or by malicious actors, which gives NFTs reliability in the sense that anyone can trust that they show the correct ownership distribution of assets.

As a result, potential use cases for NFTs are abundant and can be found wherever there's a need to digitally model ownership or property rights. Consequently, NFTs will likely be among the most important building blocks on which the digital world, or something like a metaverse, will be built upon.

2 What Are NFTs?

In a nutshell, NFTs are nonfungible tokens that digitally represent ownership of something. According to this definition, each NFT has at least three properties:

1. NFTs are *nonfungible*, which means that each NFT (or token) is unique in the sense that there is no other thing just like it. In other words, each NFT is one of a kind just like there is only one painting that is the real Mona Lisa. (A fungible token, on the other hand, is not unique. It would not make any difference if a fungible token would be exchanged for another token of the same kind such as a Bitcoin.)

2. Second, NFTs *represent ownership*, which implies that an NFT is treated as the actual thing that it stands for, so that by selling an NFT you are also selling "the real thing" that it represents.

3. Third, NFTs can be used to tokenize and represent *anything*, from physical things (like a house) to natively digital assets (like a CryptoPunk) to ideas and intellectual property. *(Note that in most jurisdictions the same property rights apply to NFT s as they do to other asset categories like IP.)*

Exhibit 1 compares NFTs with other tokenized assets and describes four archetypes.

Four archetypes of tokenized assets, each with different characteristics

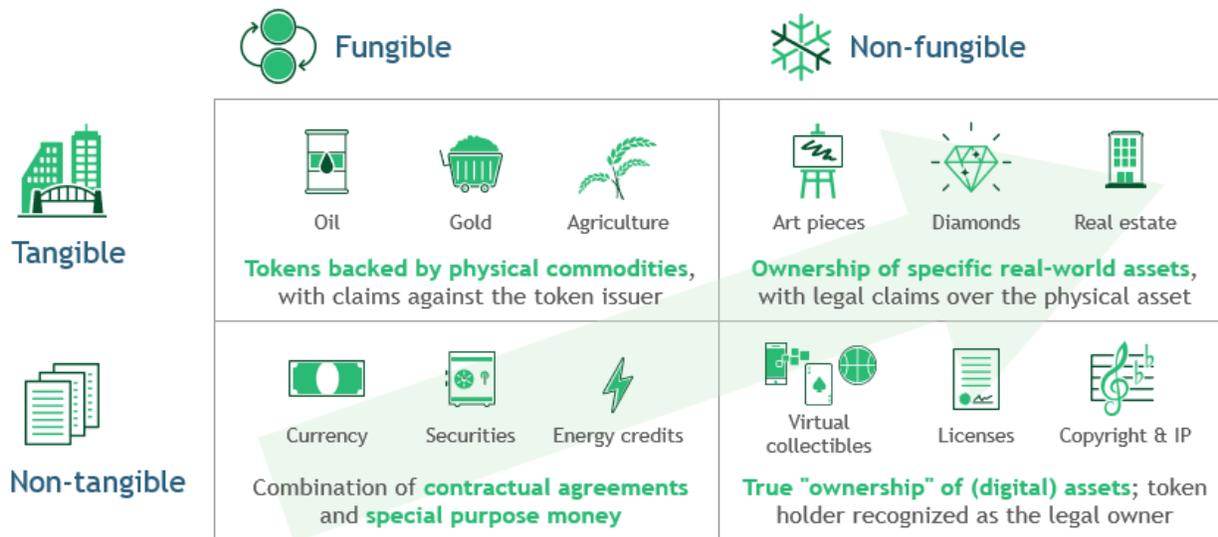|	Fungible			Non-fungible		
Tangible	Oil	Gold	Agriculture	Art pieces	Diamonds	Real estate
	Tokens backed by physical commodities, with claims against the token issuer			**Ownership of specific real-world assets, with legal claims over the physical asset**		
Non-tangible	Currency	Securities	Energy credits	Virtual collectibles	Licenses	Copyright & IP
	Combination of **contractual agreements** and **special purpose money**			**True "ownership" of (digital) assets**; token holder recognized as the legal owner		

Exhibit 1: Archetypes of tokenized assets

The combination of these properties reveals why a growing number of people are excited about NFTs.

Until recently, the mainstream assumption was that digital assets are necessarily fungible, because any digital asset could simply be copied. Now, if digital assets are inherently abundant, they cannot be scarce, they cannot really be "owned," and they cannot have value like scarce physical things do.

NFTs change that by introducing digital scarcity, such as that digital assets that are represented as NFTs can no longer simply be copied in a way that original and copy are indistinguishable, which means that digital assets can be just as valuable as physical things because they can be unique. (Note that, like in the physical world (e.g., painting), a NFT can be copied, but in the metadata and in the origin blockchain it can be verified which is the original NFT and which is a copy.)

This way, NFTs can be understood as a natively digital way to model ownership of any type of asset.

3 How Do NFTs Work?

To understand how NFTs work, one must consider two perspectives:

- The functional perspective, which is about understanding the implications of NFTs for its adopters and the market, particularly what NFTs enable one to do (that could not be done without NFTs).
- The technical perspective, which is about understanding the technologies on which NFTs are built and their properties that give rise to NFTs' functionality in the first place.

Functional Perspective

NFTs allow us to have digital representations of potentially anything in a way that these representations are unique, trustworthy (or at least a tamper-proof record of ownership) and can be traded. We can distinguish, as also shown in exhibit 2, between the following roles or functionalities:

1. **Creator:** Some person or entity is the original creator of the smart contract holding all NFTs
2. **Smart contract:** NFTs and ownership information are stored in a list within the smart contract; each NFT points to a URL serving its metadata
3. **Minter:** A minter, who can also be the creator, mints (creates) new NFTs through an authorized account
4. **Owner:** An owner owns one or more NFTs via their blockchain accounts
5. **Data storage:** Metadata containing information about an NFT is stored off-chain in any location set by the minter
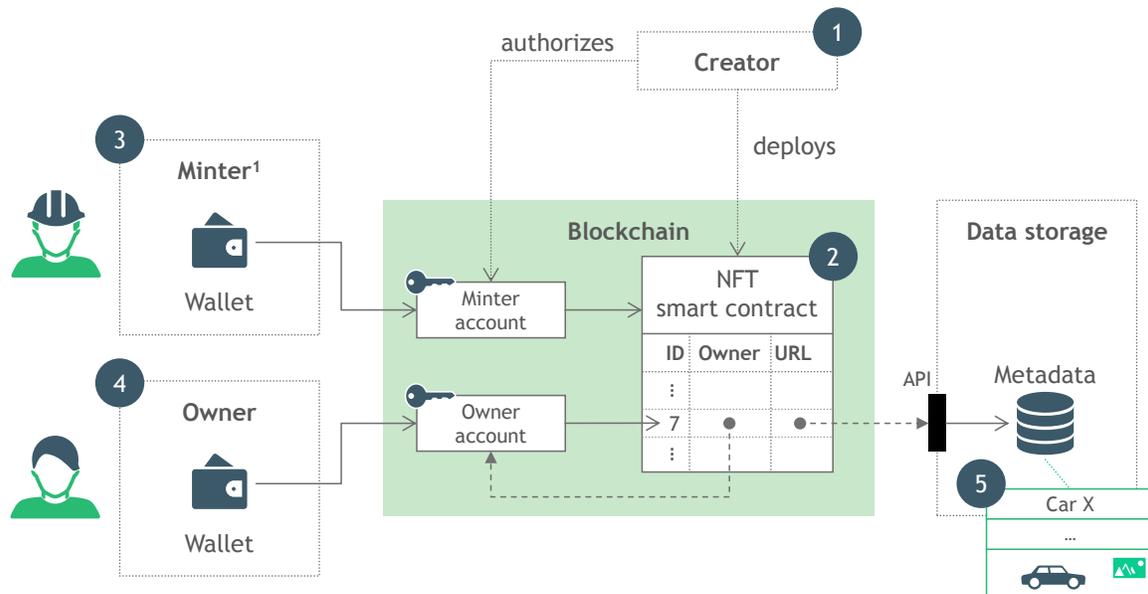

Exhibit 2: Illustration of functional roles in NFT ecosystems

Technical Perspective

Understanding NFTs from a technological perspective requires understanding a few core concepts:

- Registries, typically blockchains, serve as a shared and trusted record of information. They serve as a layer of trust and a single source of truth.

- Cryptographic keys convey control over NFTs and enable other crucial functionalities such as authentication.

- Token IDs are used to distinguish NFTs on a blockchain such that each token ID is linked to a unique address (establishing a public key infrastructure) and to metadata. This way different parties can easily find and interact with each other as well as benefit from blockchains' unique properties like immutability.

- Metadata can be anything like a piece of digital art or a digital representation of a physical asset. Importantly, metadata can be stored on-chain or off-chain.

- Smart contracts can be thought of as the programs or apps that run on a blockchain and are responsible for minting NFTs.

- Wallets are used to store keys or potentially even metadata. They also enable NFTs to be managed and shared via easy-to-use applications.

Exhibit 3 will illustrate the main technical concepts on an exemplary trade process where the seller (former owner) will sell it to the buyer (future owner).
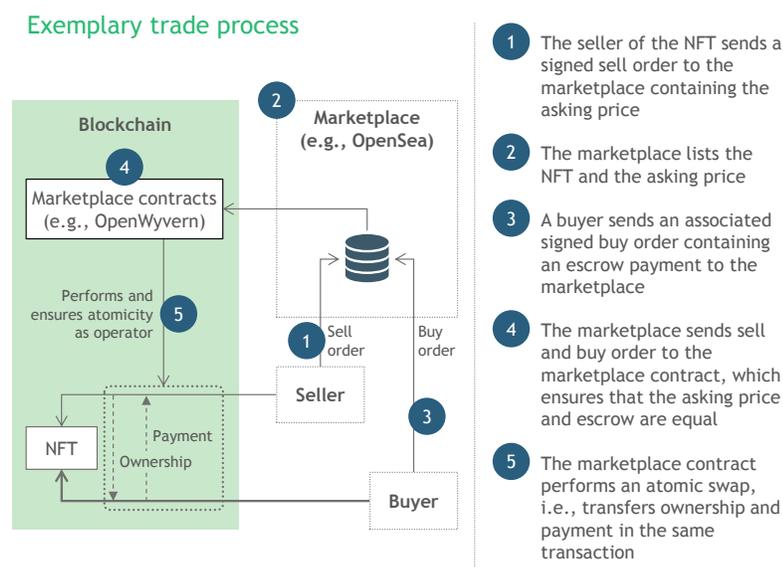

Exhibit 3: NFTs' main technical concepts illustrated on an exemplary trade

One can think of these core concepts as different building blocks that are available in different variations and can be put together in different ways. For example, different blockchains (or other distributed ledger technologies) can be used to establish registries (e.g., Ethereum, Polygon, Solana, Avalanche, Polkadot, Tezos, and IOTA). Similarly, NFT metadata can be stored in different ways such as on blockchains, other distributed data storage protocols (e.g., IPFS or filecoin) or even traditional databases. Similarly, different smart contract development standards with different strengths and weaknesses can be used (e.g., ERC-721 or ERC-1155 for EVM-compatible chains like Ethereum).

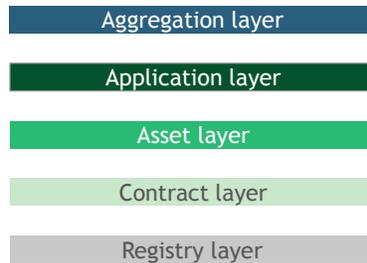| Aggregation layer |
| :---: |
| Application layer |
| Asset layer |
| Contract layer |
| Registry layer |

Exhibit 4: Core concepts and building blocks of NFTs

As a result, there are many different flavors of NFTs depending on what variations of which building blocks have been used and how they have been put together.

4 Who Should Care about NFTs?

Adoption

Industry leaders, major brands, and household names, as well as influential individuals, like creators and celebrities, are already adopting NFTs to reap the benefits of this new innovation.

Examples can be found in almost any industry including legendary consumer brands (Nike[1], Adidas[2], or Louis Vuitton[3]), social media giants (Meta[4] or Twitter[5]), payment and e-commerce infrastructure providers (Visa[6], Mastercard[7], or Shopify[8]), leaders in entertainment (Disney[9], Marvel[10], DC[11], or Spotify[12]) and gaming (Atari[13] or Ubisoft[14]), sports (FIFA[15] or NBA[16]), automotive (Lamborghini[17], Porsche[18], or Audi[19]), travel (Emirates[20]), marketplaces (OpenSea, Rarible, or eBay[21]), and obviously leading Web3 companies like exchanges and wallet providers (Coinbase, FTX, Kraken, or Metamask).
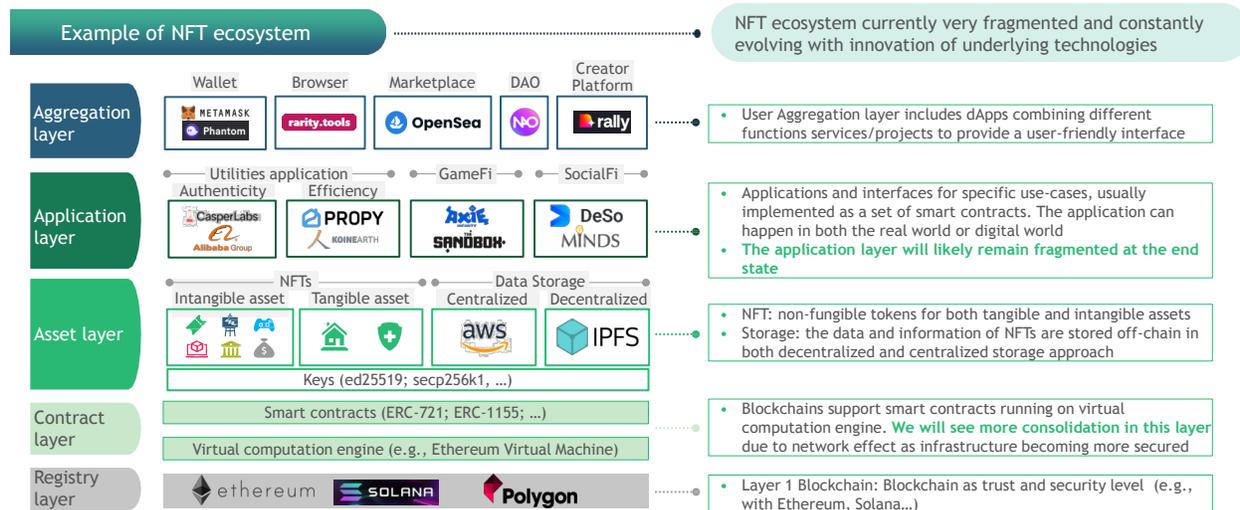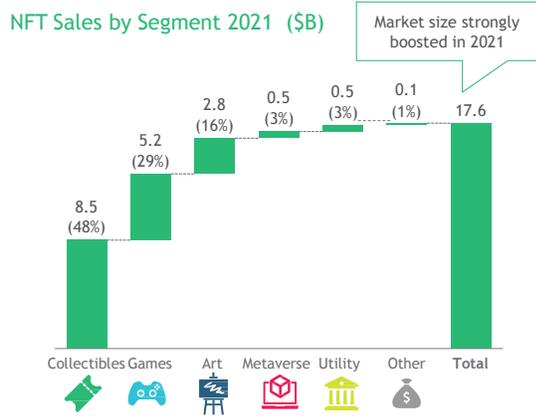

Exhibit 5: Adoption of the ecosystem and players per layer

[1] https://www.cbsnews.com/news/nike-metaverse-rtfkt-nikeland-roblox-nft/
[2] https://www.theverge.com/2021/12/16/22822143/adidas-nft-launch-into-the-metaverse-price-release-date
[3] https://www.voguebusiness.com/technology/louis-vuitton-to-release-new-nfts
[4] https://www.coindesk.com/business/2021/10/28/facebooks-metaverse-will-support-nfts/
[5] https://www.coindesk.com/business/2022/01/20/twitter-launches-nft-profile-picture-verification/
[6] https://www.forbes.com/sites/ninabambysheva/2021/08/23/visa-enters-metaverse-with-first-nft-purchase/?sh=64c5481168b3
[7] https://www.cnbc.com/2022/01/18/mastercard-strikes-nft-payments-deal-with-coinbase-amid-wave-of-crypto-partnerships.html
[8] https://www.shopify.com/nft
[9] https://cryptonews.net/news/nft/2443425/
[10] https://www.marvel.com/articles/gear/first-ever-marvel-digital-comic-collectibles-nft-veve
[11] https://www.dccomics.com/blog/2021/09/29/dc-partners-with-palm-nft-studio-for-epic-digital-collectibles-drop-for-dc-fandome
[12] https://musically.com/2022/05/13/spotify-artists-promote-nfts/
[13] https://www.theverge.com/2021/4/1/22362707/atari-corporate-entity-centipede-nft-sale-pong-collection
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[16] https://www.nba.com/bulls/nft
[17] https://nft.lamborghini.com/
[18] https://www.nft.porsche.com/
[19] https://www.ledgerinsights.com/audi-launches-novel-fractional-nft/
[20] https://www.emirates.com/media-centre/emirates-to-launch-nfts-and-experiences-in-the-metaverse/
[21] https://www.entrepreneur.com/article/428197

While many early adopters of NFTs share a legendary track record of harnessing innovations to drive business value and/or the ability to create unique brands with which their customers strongly identify, the way in which these businesses apply NFTs are just as diverse and colorful as the use case they are building.

- **Art:** Digital art can be monetized by making unique digital assets that can have exclusive properties, on top of being easily sold or rented. In DeFi (decentralized finance), art NFTs can also be used as collateral for a loan.

- **Music:** In a similar way to digital art, musicians and singers can link their music to NFTs, which makes it possible to own a piece of a song or album and receive royalties from it.

- **Ticketing**: Event organizers may issue event tickets using NFT, as it would avoid fraud (by providing an easy way to verify tickets), but it would also allow for a better traceability of all the tickets that are resold.

- **Real estate:** Property ownership documents can also be made (created and issued) via NFTs, which would represent a digital and immutable certificate of ownership of a physical real estate property. In another fashion, NFTs are also used to represent virtual properties.

- **Gaming:** Items in online games can now be truly owned by the players, which offers many new possibilities such as selling and buying items outside of a game's centralized marketplace as well as using those items in other digital environments like in other games.

- **Product authenticity:** Similar to the property ownership documents for the real estate use case, NFTs can also be used to prove the authenticity of any other physical products, such as clothing items, jewelry, cars, etc.

- **Fundraising and crowdfunding:** Foundations and charities have already started to raise money by selling their own NFT collections, but crowdfunding platforms are now challenged by NFTs, as it allows startups to raise funds in a peer-to-peer way.

- **Access management:** Decoupling access to a product or service from a user's identity is also possible, as access can be given to the owner of a specific NFT but without having to know the identity of the owner in advance.

NFT Sales by Segment 2021 ($B)

Market size strongly boosted in 2021

	Collectibles	Games	Art	Metaverse	Utility	Other	Total
	8.5 (48%)	5.2 (29%)	2.8 (16%)	0.5 (3%)	0.5 (3%)	0.1 (1%)	17.6

Key drivers of growth

1. **Collectibles** • Driven by very high value of sales of Profile Picture collections (like BAYC, Cryptopunks); *NBA Top Shot* was one of the top successes

2. **Game** • Driven mostly by performance of the blockchain game *Axie Infinity*, which let players earn money on NFT item sales

3. **Art** • As digital artists continue to gain recognition, such as *Beeple* and *Pak*, art is expected to become a core feature of the NFT asset class

4. **Metaverse** • Sales picked up as the Web3.0 Metaverse has gone viral (e.g., Sandbox), expected to grow strongly as brands invest in Metaverse

5. **Utilities** • Known to be the most promising segment, this comprises of diverse range of use cases across finance, ticketing, insurance, and social clubs

1. Bored Ape Yacht Club
Source: Nonfungible.com, BCG analysis

6

Exhibit 6: NFT categories—forms of NFT have emerged in the market

Unique Benefits

NFTs can create significant value for your organization by enabling you to create natively digital assets that are scarce and to craft unique digital experiences. Similarly, NFTs can help you overcome major business challenges like preventing fraud or high transaction costs for trading assets.

- **Unlock natively digital assets**: NFTs enable your company to create scarce and tradable assets that are natively digital and that can be of significant value for your customers. This is particularly true for creative and consumer-facing industries as well the creator economy.

- **Craft unique brand experiences:** NFTs enable your company to create unique experiences for different customer segments and to drive customer affiliation, affection, and identification with your brand, such as by providing customers with limited editions of NFTs that come with access rights to physical or digital experiences (e.g., events) or other benefits (e.g., discounts).

- **Combat fraud:** NFTs can help your company combat fraudulent practices like counterfeiting or illegal reselling that devalue and/or negatively impact the customer experience and by extension your brand. Related use cases are common in the event and ticketing industries as well as for fashion and luxury goods.

- **Reduce transaction costs:** NFTs enable you to tokenize assets and trade these assets digitally to reduce transaction costs such as by cutting out middlemen.

- **Supercharge apps:** NFTs can infuse your existing apps with the ability to manage and trade digitals assets in order to create significant value for your users. This can be particularly interesting for apps that are already used to manage valuable assets, such as in the field of banking and financial services, payments and crypto, or art and real estate.

- **Fractionalization of assets:** A fractional NFT refers to a set of fungible tokens tied to a whole or a set of NFTs. As the name suggests, it implies fractional—or proportionally shared—ownership of an NFT. When an NFT is fractionalized, the original NFT is locked up in a vault, and someone issues a limited supply of fungible tokens that represent ownership over that NFT.

- **Transparency and zero trust:** NFTs are stored on a decentralized blockchain that is validated constantly. Especially in an environment of no trust, this storage and transparency of ownership make NFTs different from the ownership of goods in the traditional world.

- **Platform economy:** the platform allows owners to trade and further monetarize their assets/NFTs. Royalties pay the creator of a NFT a percentage of sales or profit. The functionalities of these royalties are set in the minting process and are defined in the smart contracts.

5 Deep Dive: NFTs and Identity

Considering that NFTs are increasingly used to model digital identity, it's important to clarify the issues that come with this approach. At their core, all issues are rooted in the fact that ownership and identity are two entirely different creatures.

Ownership versus Identity

For ownership it's fine to exclusively rely on decentralized systems like blockchains, because all one needs is an immutable record of transactions. If there is such a record, one can simply view the history of all transactions to verify the state of ownership at any given point in time without having to trust anyone else. There must only be trust in the technology (and incentive structures).

However, with identity that's not the case. Having an immutable history of records is not enough, which is illustrated by the following example.

If I tell you my name is Luke Skywalker, you probably won't believe me, regardless of whether there is a record of it on a blockchain. Even if you manage to find a couple (or even thousands) of people to confirm that I am Luke Skywalker, you cannot be sure that it's true. To be sure, you would need to see an official identity document, like my passport, which was issued by an authoritative entity or at least a source that you trust.

Here's the problem. You cannot rely on people to tell the truth about their own identity, which means that identity must always be asserted or vouched for by someone else, typically a highly trusted authority—like a government for your core identity or a university for your diploma.

A blockchain can only tell you about the ownership distribution of things anchored on it. It cannot tell you whether the things are in a sense "true." This is also the reason why plagiarism is a problem for NFTs: While a blockchain can tell you that there is only one NFT and who owns it, it cannot tell you whether the NFT represents, for example, a real CryptoPunk or merely a copy. To find out, you need a trusted authority that verifies the CryptoPunk's authenticity, such as by verifying if it has really been minted by the original artist.

Why You Should Not Use NFTs for Digital Identity

There are least four reasons why NFTs are typically not a good solution for identity use cases.

- Insufficiency: While NFTs are good for modeling ownership of assets, they are not sufficient for modeling digital identity in all its facets.
- Privacy: NFTs are typically anchored to public blockchains, which creates obvious privacy issues if used for any type of identity data.
- Compliance: Using NFTs to model the identity of individuals typically violates data protection regulations considering the tensions between individual data rights (e.g., GDPR's right to be forgotten) and blockchains inherent properties (e.g., immutability).

- Costs and scalability: The use of blockchains in the context of NFTs implies transaction costs and potential scalability issues.

In a nutshell, NFTs are good for modeling what you own but not for modeling who you are.

Identity Use Cases for NFTs

Even though NFTs are not the right solution for most identity use cases, there is at least one set of use cases that make sense. We refer to these use cases as "ownership-based access management." That means that access to information, services, products, or other benefits depend only on what you own, not on who you are. Consider these exemplary applications:

- Content, like articles, music, or podcasts, that can only be accessed by people who already hold NFTs from the respective creator.

- Special discounts for or early access to new products that can only be claimed by holders of NFTs from a special series.

- New maps or challenges in online games that can only be played by holders of NFTs that represent certain digital assets, like skins or trophies.

Also, there is an important difference between ownership-based and identity-based access management that completely changes use case dynamics.

In the first case (ownership), the right to have access and benefits is tradable, which is not possible if access rights are tied to one's identity. In other words, NFTs allow us to model access rights as a commodity that can be bought and sold and exists independently of its owner's identity.

As per the examples above, creators may choose to create unique experiences that can only be consumed by a limited number of people without determining who these people are in advance. Clearly, NFTs that come with such special access rights can become incredibly valuable. Think about what someone would pay for the privilege of being one in only a hundred people on this planet able to have a special experience like hearing a special song by their favorite artist or playing a special map on their favorite online game.

Next to ownership-based access management, NFTs may be used for nonhuman identity, meaning use cases that do not involve individuals or their personal data and, therefore, do not trigger privacy and compliance issues. In other words, NFTs could be used for modeling the digital identity of legal entities or machines (IoT). Even here, however, NFTs are usually not the best option considering the advantages of other approaches like self-sovereign identity (SSI) such as lower cost and higher scalability due to off-chain data storage and transactions.

6 What Steps Do You Need to Take to Get Started?

Industry leaders are already adopting NFTs on a global scale with global consumer brands leading the way. If you are not already exploring NFTs, the following steps will help you navigate the shift in your infrastructure strategy.

Identify Opportunities

Analyze your business with a focus on either opportunity for creating natively digital assets or unique digital experiences or challenges like fraudulent practices and high transaction costs for selling or renting assets.

- Digital assets: Does your company have an opportunity to create natively digital assets that could be valuable for your customers, particularly if such assets could be scarce and tradable?
- Unique experiences: Does your company have an opportunity to create unique experiences for different customer segments that can potentially drive customer affiliation, affection, and identification with your brand? (Think particularly about use cases for ownership-based access management.)
- Fraud: Is your company battling fraudulent practices that devalue and/or negatively impact customer experiences and by extension your brand, such as counterfeiting and forgery or illegal reselling?
- High transaction costs: Does your company sell or rent assets for which transaction costs are high, caused by middlemen or other factors?
- Existing apps: Does your company have an app with a large consumer or enterprise user base that could benefit from integration capabilities to manage or trade NFTs or digital assets more generally? This would increase trust and transparency on your brand/product/experiences and constitute real added value for your customers/users.
- Platform economics: Does your company trade ownership of virtual assets and accelerate the economic and social activities on such a platform?

Analyze and Select Use Cases

Prioritize use cases based on your organization's goals, challenges, and product or service portfolio. Make sure to include risk assessments that evaluate the cost of doing nothing, such as risks related to security breaches, compliance penalties and related brand damage, or losing customers to competitors who adopt NFTs.

Build Pilots and Applications

Plan and implement proof of concepts to build up knowledge, evaluate feasibility, and establish the ROI (return on investment) of NFTs for your organization. If you decide to pursue further initiatives and build production systems make sure to screen solutions for the following:

- Technology fit with the use case, degree of going with a partner versus doing it in-house
- Support of different blockchains and Web3 ecosystems (e.g., ETH, Polygon, Tezos, and IOTA)
- Holistic functionality to enable end-to-end use cases and speed up implementation (e.g., minting NFTs, supporting different distribution mechanisms, verifying ownership and metadata, plus advanced functionality like dynamic NFTs)
- Ease of integration with your infrastructure via (e.g., backward compatibility with your existing identity and access management (C/IAM) solutions; support of legacy authentication protocols like OpenID Connect; support for multicloud and custom key stores/HSMs)
- Open source licenses (e.g., Apache 2)

7 About the Authors

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