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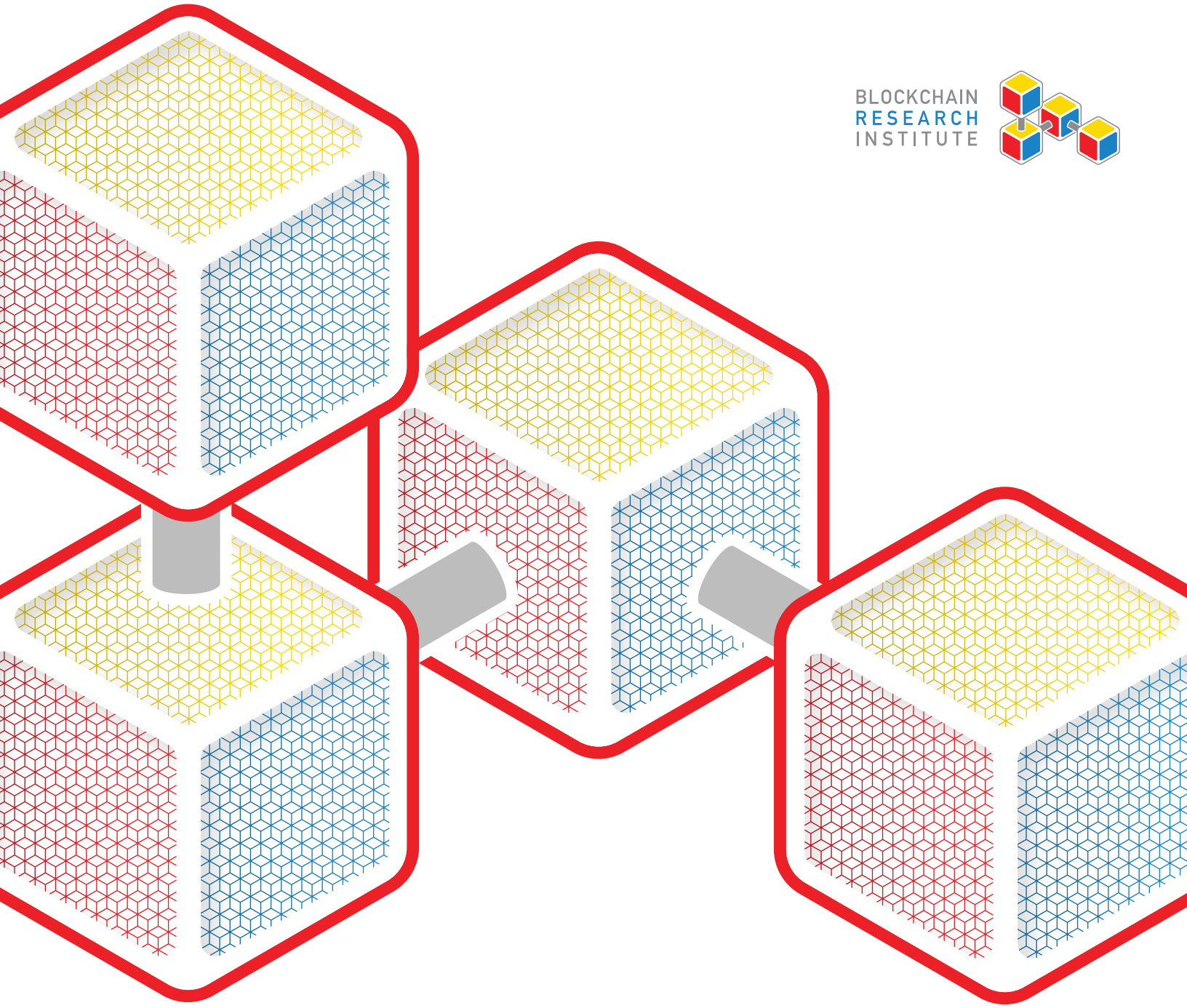

NON-FUNGIBLE TOKENS

Transforming the Worlds of Assets, Gaming, and Collectibles

Alan Majer
GoodRobot.com

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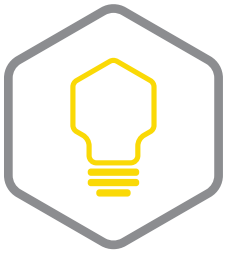
A BLOCKCHAIN RESEARCH INSTITUTE BIG IDEA WHITEPAPER



Realizing the new promise of the digital economy

In 1994, Don Tapscott coined the phrase, "the digital economy," with his book of that title. It discussed how the Web and the Internet of information would bring important changes in business and society. Today the Internet of value creates profound new possibilities.

In 2017, Don and Alex Tapscott launched the Blockchain Research Institute to help realize the new promise of the digital economy. We research the strategic implications of blockchain technology and produce practical insights to contribute global blockchain knowledge and help our members navigate this revolution.

Our findings, conclusions, and recommendations are initially proprietary to our members and ultimately released to the public in support of our mission. To find out more, please visit www.blockchainresearchinstitute.org.

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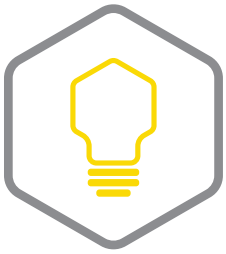


Foreword

This project explores the non-fungible token (NFT) or what we called crypto collectibles.

In the updated version of *Blockchain Revolution*, Don Tapscott and I outlined eight types of cryptoassets. First are cryptocurrencies like bitcoin and altcoins—litecoin, monero, dash, and Zcash and Ripple's XRP—used in payment networks. Second are *platform tokens* or *protocol tokens* such as NEO, ICON, or ether, which is probably the best known. Ether functions as "gas" to fuel the distributed applications (Dapp) running on the Ethereum network, and so we could have put it under the next category. Third are *utility tokens* (a.k.a. *app coins*) specific to Dapps—such as augur tokens in the Augur prediction network or golem tokens in the Golem decentralized cloud computing platform—that could perform any number of functions within a particular Dapp.

Fourth are so-called *security tokens*, digital versions of securities—stocks or bonds—in which parties invest money in an entity (e.g., the DAO) with a reasonable expectation of profits derived from the managerial efforts of others, or else parties loan money to an entity with the expectation of reimbursement of their principal plus interest.[1] Fifth are *natural asset tokens*, digital assets associated with commodities in the real world, from pork bellies to barrels of crude oil. The list of potential tokens is considerable: agricultural (e.g., grains, soy), biofuels, coal and crude oil, distillates, emissions, energy, environmental, ethanol, industrial metals, meats (e.g., pork bellies), minerals, nanomaterials, precious metals, rubber, and timber.

Sixth are *stablecoins* such as Tether and Facebook's proposed Libra, the value of which is pegged to a certain fiat currency (e.g., TrueUSD) or a basket of particular assets (such as the International Monetary Fund's special drawing right) in an attempt to address the volatility of the typical cryptocurrency's price. Seventh are *crypto fiat currencies*, digital assets created and controlled by governments such as Venezuela's failed Petro, backed by the country's oil reserves.[2] China is close to issuing its crypto renminbi; China has acknowledged the traceability of cryptocurrencies compared to print money.[3]

This project explores the eighth type, the *non-fungible token* (NFT) or what we called crypto collectibles. Its project leader, Alan Majer, explains the concept of the NFT and illustrates how it works through the best-known NFTs, CryptoKitties. While the bubble for the digital pets may have deflated, the phenomenon revealed how businesses might create and use digitally unique and scarce assets in their business models beyond cryptocurrencies. Alan also looks at the changing online gaming market—both packaged software and downloadable content—and describes how companies might tokenize their digital and physical assets.

Alan is the CEO of Good Robot and an avid participant of the Toronto "maker" scene. Over the past two decades, he has worked on many research programs with the Tapscott Group. He brings his many years of experience as an entrepreneur, researcher, and writer to this project. It is his third project for the Blockchain Research Institute. The other two are case studies: "Slock.it: Enabling IoT and the Universal Sharing Network" and "How Blockchain Could Help Regulators: A Case for Piloting Government Agency Projects."

ALEX TAPSCOTT
Co-Founder
Blockchain Research Institute

Capturing the origins, ingredients, and histories of individual assets makes them unique and creates value in the process.

Idea in brief

» Physical and digital marketplaces often focus on *fungibles*: goods under contract that can replace or be replaced by other goods without breaking the terms of the contract.[4] Yet, this commodity treatment ignores variances that increase value: a baseball jersey worn by Babe Ruth is worth vastly more than a brand new one. Capturing the origins, ingredients, and histories of individual assets makes them unique and creates value in the process.

» Blockchain-based NFTs are useful in securitizing assets. *CryptoKitties*, a digital crypto-collectible game launched in 2017, introduced a new class of digital asset, the ERC-721 token, which offered the purchasers of game assets (i.e., collectible digital kittens) a permanent way to own and trade these assets with others. Unlike a typical less than $20 in-game purchase, sales of some crypto collectibles commanded more than $100,000.[5]

» Digital content purchases are an increasingly strategic revenue source for the consumer gaming market. In 2017, digital downloadable contents ($13.2 billion) surpassed packaged revenue ($11.2 billion).[6] It's a key part of mobile revenues and even helps to combat piracy.[7] But most of this content exists within walled gardens that confine its usefulness. Blockchain-based NFTs offer an open alternative.

NFTs offer an opportunity to think beyond the walls of gaming environments and consider how brands and assets can have life in other environments and ecosystems.

» NFTs allow consumers to own the digital gaming assets they purchase, giving them additional value and utility outside the games they're derived from. In conventional models, publishers have control, but they limit consumers. NFTs create vast new areas of potential for a diversity of digital assets, enhancing their value and consumers' willingness to pay.

» NFTs offer an opportunity to think beyond the walls of gaming environments and consider how brands and assets can have life in other environments and ecosystems. Developers

recognize the shift: "86 percent of game developers believe tradable virtual items will be even more important in future games."[8] Used appropriately, NFTs offer the potential to use *downloadable content* (DLC) to extend client relationships far beyond the contexts in which they originate, and engage with other ecosystems in meaningful ways.

» There are opportunities to securitize many other assets classes across industries and applications. Securitization affects digital game assets but has physical opportunities as well. Non-fungible tokens create important opportunities to marry physical assets with the digital realm and to create valuable new marketing and transaction opportunities.

Non-fungible tokens create important opportunities to marry physical assets with the digital realm and to create valuable new marketing and transaction opportunities.

Introduction to non-fungible tokens

Most items in the world are *non-fungible*; they each have characteristics and properties that uniquely distinguish them. These can be small distinctions (like whether a bushel of wheat is grown organically), or as big as the difference between a poodle and a stack of lumber. In short, non-fungible items are not all the same—one item is not necessarily a substitute for another.

Fungible items, on the other hand, are commodities that are more or less interchangeable: for example, one ounce of 999.9 fine gold is the same as any other. It comes from the Latin *fungi* meaning "to perform" as a substitute. So a *fungible* commodity like gold is easily divided into parts—unlike a house, for example. Money is also a great example of a fungible item that's divisible (five $1 bills are equivalent to one $5 bill). These interchangeable fungible items rarely arise naturally in the real world—parties to a contract must work to ensure that physical commodities meet an accurate specification. Dieter Shirley, chief technology officer (CTO) of Dapper Labs and co-creator of CryptoKitties, said, "In the real world, everything is non-fungible. Fungible is the weird part."[9]

"In the real world, everything is non-fungible. Fungible is the weird part."

DIETER SHIRLEY
CTO, Dapper Labs
Co-Creator, CryptoKitties

Cryptocurrencies like bitcoin, ether, and the DAI stablecoin are all fungible since their currency units are identical.[10] That's also true of the ERC-20 tokens frequently used as tradable securities or initial coin offerings. But the fungible nature of online assets changed with blockchain games like *CryptoKitties* that began issuing NFTs as unique crypto collectibles. These CryptoKitty tokens are NFTs because the token for each kitty is unique—no two kitties are the same. These NFTs have since become much more widespread and are used to represent in-game assets, virtual land, artwork, and more. While it's still early days, even companies like Google, Samsung, and Andreessen Horowitz are beginning to explore their potential.[11]

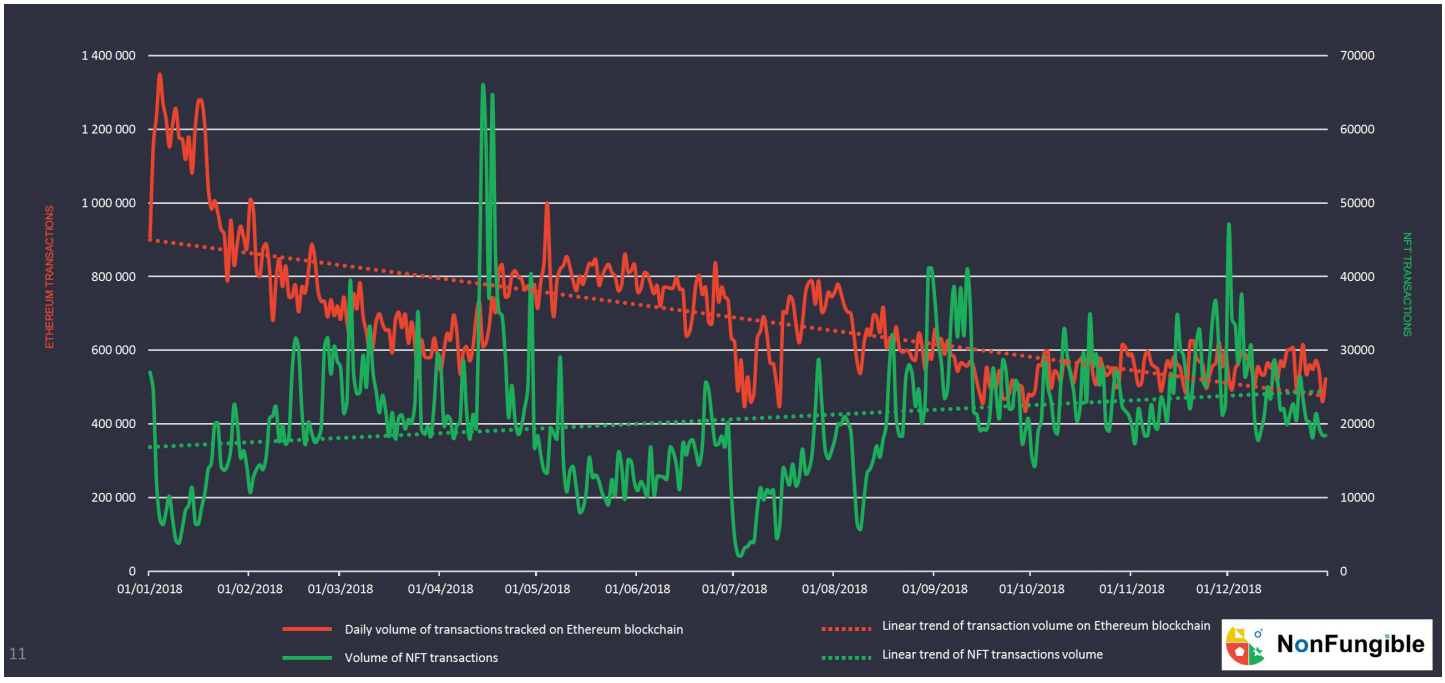
This research explores NFTs in a variety of contexts. We examine both gaming and entertainment examples such as *CryptoKitties*

Adoption of non-fungible tokens today has been exciting as a percent of blockchain activity, with exciting use cases.

and *My Crypto Heroes*, as well as non-gaming examples such as Decentraland and AgriDigital. In addition, we investigate opportunities for secondary markets and exchanges for NFTs such as OpenSea, Rare Bits, and other ecosystems that extend NFTs beyond the games in which they originate. Rapid innovation in a still-nascent market has led to several different NFT standards, not only within Ethereum, but on other blockchains. NFTs also create opportunities to securitize other forms of both physical and intangible assets into new digital forms (like Dharma's protocols for issuing and trading debt).[12] Organizations like AgriDigital are doing the same for grains and cotton, creating a not-for-profit entity Geora, focused on building open-source blockchain protocols for agriculture.

But where are NFTs today, and what is their ultimate potential? Adoption today has been exciting as a percent of blockchain activity (see Figure 1). Measured in numbers of users, adoption has been modest and limited by user interface and scalability challenges. However, if these challenges can be overcome, there's a vast array of both physical and digital assets that provide exciting use cases for NFTs. This research plumbs the transformative potential of NFTs for video games, collectibles, and commercial applications. While blockchain-based NFTs already demonstrate modest potential today, ongoing usability and scaling improvements point toward an extremely bright future. The features offered by NFTs offer tremendous opportunities for:

Figure 1: Transaction volume: Ether (ETH) versus non-fungibles



© 2019 NonFungible Corporation. Used with Gauthier Zuppinger's permission, 25 March 2019. See Daniel Kelly and Gauthier Zuppinger, "Non Fungible Tokens Yearly Report: 2018," NonFungible.com, 19 Feb. 2019, slide 11.

While blockchain-based NFTs already demonstrate modest potential today, ongoing usability and scaling improvements point toward an extremely bright future.

- *Growing into mainstream gaming.* Digital gaming assets are a large and strategically important market. Blockchain provides valuable new features for these assets, and this ready market represents an important growth opportunity for NFTs.
- *Using ecosystems as a form of competitive advantage.* NFT are valuable because they make assets more portable among ecosystems—not only increasing their value for end users but allowing developers to focus more on innovation rather than duplicating each other's efforts. These ecosystems hold the potential to out-compete their centralized counterparts.
- *Going beyond fungibles to create new value.* Whether it's 100 bushels of heirloom organic grain that commands a premium price, or a valuable digital sword once wielded by a celebrity gamer, NFTs excel at codifying uniqueness that users will pay for.

The first non-fungible tokens: CryptoKitties

For reasons unknown, cats are a source of endless fascination on the Internet. Whether it's the celebrity status of Grumpy Cat, an astounding number of cat memes, or the latest video of a cat riding a Roomba, the prominence of cats on the Internet is hard to miss. Just googling for "cat videos" turns up 817 million results. So, when the company Axiom Zen was looking for a consumer-friendly way to demonstrate the possibilities of blockchain, it naturally turned to cats.

On 19 October 2017, the first version of CryptoKitties was launched without much fanfare at an Ethereum hackathon in Waterloo, Ontario.

Shirley, then-technical architect of Axiom Zen, described his co-worker Mack's moment of inspiration: "He came to me and said, 'Dieter, we're going to put cats on the blockchain.'"[13] Shirley asked what that meant. Mack responded that, while he didn't quite know, everyone on the Internet loved cats, and so that ought to be the project.[14] The more they thought about it, the more they realized that it was perfect: it was simple, nontechnical, didn't invoke the kind of legal concerns that a new currency issuer might have, and was interesting.[15] With that, CryptoKitties—the idea of digitally breedable cats—was born on the blockchain. (Axiom Zen spun out the project under Dapper Labs in February 2018.[16])

On 19 October 2017, the first version of CryptoKitties was launched without much fanfare at an Ethereum hackathon in Waterloo, Ontario.[17] Over the next two months, the community transformed from a handful of users who were experimenting with inexpensive tokens to a wildly popular blockchain phenomena where the most collectible cats were selling at six-figure prices.

The growth was so rapid that heavy trading and breeding in CryptoKitties nearly ground the entire Ethereum network to a halt.

The growth was so rapid that heavy trading and breeding in CryptoKitties nearly ground the entire Ethereum network to a halt. The activity around CryptoKitties made up to one-third of all Ethereum transactions at its peak. Shirley recalled: "When it blew up, it was a real surprise. We weren't expecting it to grow as quickly as it did. And we really weren't expecting the network to fall over as quickly as it did."[18] This explosion of CryptoKitties on the blockchain marked an exciting new chapter for blockchain. On one hand, it highlighted some of the more pressing challenges for blockchain scalability; on the other, it instantiated a new class of digital assets.

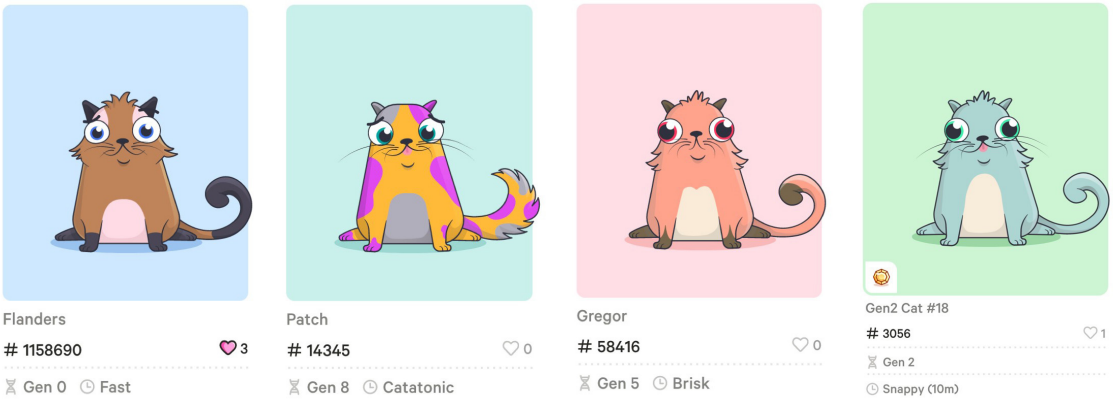
A cycle of speculative mania

The rise

On 2 December 2017, CryptoKitty #1, "Genesis" (a.k.a. CryptoKitty #1, Figure 3, next page) was sold for the record-breaking price of $114,481.[19] CryptoKitties are tokens on the blockchain that represent a sequence of cat genes. This hundred-thousand-dollar price wasn't an anomaly either: the top ten CryptoKitties sold for a collective value of $1.06 million, with total purchases of all digital kittens amounting to $27.4 million.[20] By early December 2017, the speculative frenzy was in full swing, and the volume of cat trading started to clog up the network, accounting for 13.95 percent of all Ethereum network traffic.[21]

What drove this speculative mania? Its easy-to-understand premise, its accessible user interface, and its fit within the culture of sharing pet images and videos all contributed. It was a rare case of an application that was enticing enough to draw new users into the blockchain ecosystem. The mechanics of the game were simple enough—buy and breed new digital cats. Media coverage was

Figure 2: A clowder of CryptoKitties



From left to right: © 2018, 2017, 2017, and 2017 Dapper Labs. "Flanders," "Patch," and "Gregor" held by Hilary; and "Gen2 Cat #18" held by CyborgKittie. Used with holders' permission under Nifty License 2.0, 16 April 2019.

another driver. It was one of the first blockchain-based distributed applications (Dapps) to break into the consumer mainstream—receiving coverage by *Forbes*, *CNN*, *New York Times*, *Bloomberg*, *Financial Post*, and more. The cuteness of the kitties themselves, intricacies of breeding and traits, ability of consumers to generate their own new kitties, and widespread reports of fantastic price increases created a gold-rush-like interest in raising digital kittens. Many (including this author) were swept up in the excitement.

While some complained about silly digital cat transactions clogging up Ethereum, it also had a lot of support from influential figures in the blockchain community. Said Vitalik Buterin, creator of Ethereum, "I actually like the digital cat games. They illustrate very well that the value of a blockchain extend far beyond applications that would literally get shut down by banks or governments if they did not use one."[22]

The fall

While the future of CryptoKitties is uncertain, the innovations it pioneered will have a long-lasting influence.

Yet such growth, much of it hinged on pure speculation, was bound to fail; the market for digital kittens collapsed with nearly the same vigor as it began (Figure 4, next page). While the future of CryptoKitties is uncertain—there are still active groups of traders—the innovations it pioneered will have a long-lasting influence.

While the novelty of CryptoKitties has worn off since its speculative peak, the story is not yet over. Dapper Labs, the inventor of

Figure 3: One fancy kitty

© 2018 Dapper Labs. "Genesis" held by Stimpson J. Cat, Fancy Kitty press pack_v2-04, used courtesy of the copyright holder.

CryptoKitties and an Axiom Zen portfolio company, sees it as the beginning of a much longer journey. Dieter Shirley declined to reveal anything publicly about the company's plans, but he did say that bringing new capabilities to digital kittens was a key focus.[23] In 2018, Shirley told *CoinDesk*, "Ultimately, our mission here is to bring a billion people to the blockchain. We think blockchain has real value for consumers but we're never going to get them to see that value by explaining it."[24]

Lessons from CryptoKitties

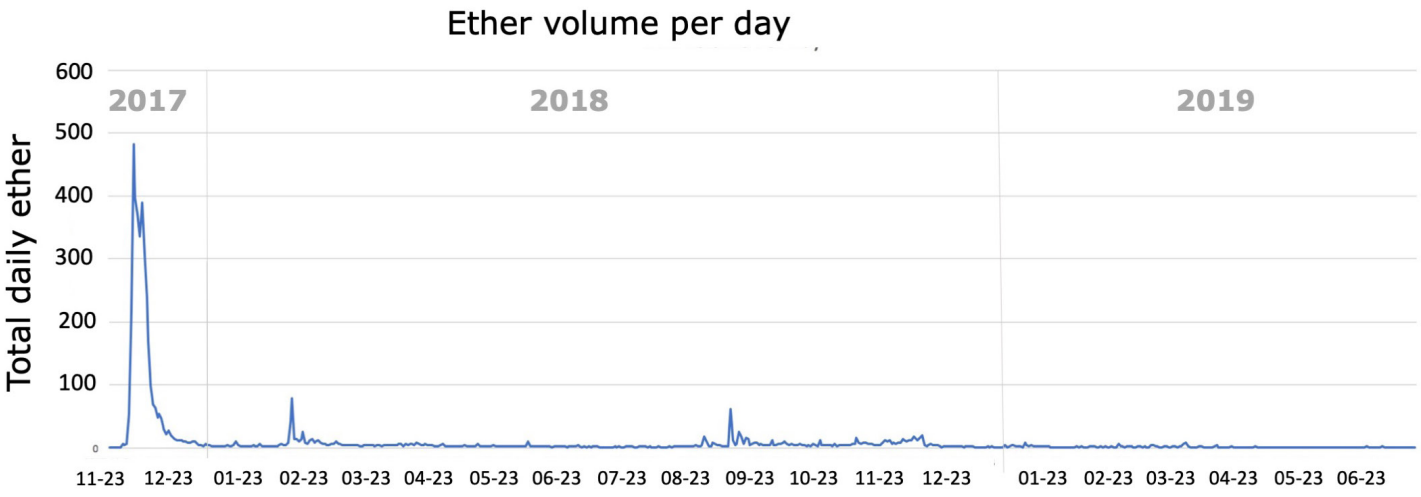
Blockchain apps can be difficult to use, so making CryptoKitties accessible was key.

The growth and popularity of CryptoKitties were no accident. Attempts at related concepts like CryptoPunks and MoonCatRescue often suffered from a less-than-stellar consumer experience.[25] For CryptoKitties, Dapper Labs worked behind the scenes to engineer a rewarding blockchain-based game and generate demand for its CryptoKitty collectibles. CryptoKitties offers several important insights for firms looking to create blockchain technologies:

» **Focus on user experience:** Blockchain apps can be difficult to use, so making CryptoKitties accessible was key. The design choices, such as engineering for fun/speculative breeding via a functioning genome, a simple browser-based wallet (MetaMask), a clean website, and handling user's technical issues behind the scenes produced a functional user experience. Above all, making CryptoKitties "more interesting" made it worth the extra effort required to play a blockchain-based game.[26]

» **Clearly articulate governance and blockchain roles and responsibilities:** The company makes it clear that crypto-collectible CryptoKitty tokens are 100 percent owned by

Figure 4: The rise and fall of CryptoKitties



Source of data: www.kittyexplorer.com/stats, as of 15 July 2019.

their users (a key design choice to encourage speculation).[27] Source code is shared for key contracts, there is a well-laid-out system of roles for managing contracts (separate CEO, COO, CFO roles), sophisticated API/dashboards, as well as the ability to pause the system in the case of emergencies—a feature only the CEO role may trigger. (See source code in Figure 5.[28])

The open nature of Ethereum's blockchain contracts makes it easy to build interesting and useful applications on top of the CryptoKitties ecosystem.

» **Make sensible divisions among on-chain and off-chain capabilities:** On-chain transactions are slow, costly, and expensive or impossible to revert. As a result, organizations need to be extremely careful about what aspects of their application will reside on the on-chain, and be clear about why they're necessary, and economize the use of this expensive resource. Putting everything on-chain is a bad idea, but keeping the wrong key features off-chain may erode the legitimacy of what you aim to accomplish. For example, some CryptoKitties users took issue with the fact that they owned their Kitty's genes (on-chain), but not the graphical expression of those genes (off-chain).[29] In this case, it wasn't a blockchain fix, but rather the creation of a new "Nifty" license that preserves the right of an owner to use and publish the "art" of their CryptoKitty.[30]

» **Harness the benefit of ecosystem innovations:** The open nature of Ethereum's blockchain contracts makes it easy to build interesting and useful applications on top of the CryptoKitties ecosystem. In a short time after its launch, CryptoKitties was joined by a number of websites and services that became part of its ecosystem (Table 1, next page).[31] Support of the NFT standard itself (ERC-721) is consistent with the open approach.

Figure 5: CryptoKitties contract source code describing governance

```
/// @dev See the KittyCore contract documentation to understand how the various contract facets are arranged.
contract KittyAccessControl {
    // This facet controls access control for CryptoKitties. There are four roles managed here:
    //
    //     - The CEO: The CEO can reassign other roles and change the addresses of our dependent smart
    //         contracts. It is also the only role that can unpause the smart contract. It is initially
    //         set to the address that created the smart contract in the KittyCore constructor.
    //
    //     - The CFO: The CFO can withdraw funds from KittyCore and its auction contracts.
    //
    //     - The COO: The COO can release gen0 kitties to auction, and mint promo cats.
    //
    // It should be noted that these roles are distinct without overlap in their access abilities, the
    // abilities listed for each role above are exhaustive. In particular, while the CEO can assign any
    // address to any role, the CEO address itself doesn't have the ability to act in those roles. This
    // restriction is intentional so that we aren't tempted to use the CEO address frequently out of
    // convenience. The less we use an address, the less likely it is that we somehow compromise the
    // account.
```

Source: CryptoKitties contract source code, "KittyCore," Etherscan.io, as of 12 Aug. 2019. Used with permission.

Challenges for non-fungible tokens

It's still early days for NFTs. While NFTs on the blockchain have been around for almost two years, they are part of a dynamic environment that's expanding rapidly. Innovation and competition continue at breakneck pace, and the landscape is likely to evolve in ways that are difficult to anticipate.

Innovation and competition continue at breakneck pace, and the landscape is likely to evolve in ways that are difficult to anticipate.

The lack of maturity of NFTs presents its own challenges. Unnecessarily complex user experiences, competing standards, and questions about scalability are all factors that limit current adoption rates. Yet the benefits of NFTs mean that many organizations are attempting to overcome these difficulties and bring the value of NFTs to businesses and consumers alike. Let's take a look at some of the more pressing issues that industry participants are trying to overcome.

Table 1: CryptoKitties ecosystem

Party	Service	Site
CKBox (CryptoKitties Toolbox)	A free Chrome extension that pulls data from CryptoKitties website and adds tools: search and profile listings, individual kitty profiles, special cats, codex, breeding, cattributes	www.ckbox.co
Crypto Kitty Sales	Sortable list of all cats ever sold	kittysales.herokuapp.com
Dapper	Smart contract wallet that provides access to CryptoKitties on owner's mobile phone	www.meetdapper.com
Kitty Explorer	Search for cats according to their traits	www.kittyexplorer.com/kitties
Kitty Race	Game in which owners can race their kitties with one another	KittyRace.com
KittyCalc	CryptoKitties breeding calculator that predicts offspring	kittycalc.co
KittyHelper	For MetaMask users, a dashboard with CryptoKitties events, breeding calculator, rarity factors, search, various histories, leaderboards, user balance, and trait tools	kittyhelper.co
KotoBaza	Started as Russian speaking site about CryptoKitties, converted into a blog for news and guides for English-speaking players	blog.kotobaza.co
KotoWars	A semi-blockchain game based on CryptoKitties tokens	kotowars.com
Niftytown	CryptoKitty auction site	www.niftytown.com
Wrapped Kitties	ERC-20 tokens, each backed 1:1 by an ERC-721 CryptoKitty	wrappedkitties.com

Poor user experience

While many blockchain aficionados find it easy to move their cryptocurrency around, new users face some barriers.

While many blockchain aficionados find it easy to move their cryptocurrency around, new users face some barriers. For example, buying a CryptoKitty is a daunting process for the average person, more involved than signing up to a website, joining a game, or placing an order with a retailer. Typically, new users must:

- Find a person or an entity that can help turn the new user's fiat into crypto.
- Undergo identity verification and credentialing.
- Turn fiat currency into ether (or fiat to bitcoin to ether).
- Find, download, and install wallet software.
- Create and save a long security code for the new wallet.
- Find a CryptoKitty available for purchase.
- Learn about a concept called *gas*, a type of transaction fee that cryptocurrency miners receive, and how much to use. Said Shirley, "We would have happily paid for gas for our users if we could have, but that wasn't an option."[32] With gas, it's not so much the transaction fee itself; it's that users need to think about it and perform math to complete a transaction.
- Submit the offer and the gas and purchase the kitty.

While many of these points of friction relate to blockchain in general and not to NFTs specifically, they remain barriers just the same. A large and motivated base of developers is working on minimizing this friction. Some, like fiat conversion and easy-to-use wallets, are already improving as a result of competitive pressures. Others like 0xcert focus on making development easier through tools and libraries. Urban Osvald, 0xcert's chief strategy officer (CSO), said, "You want to start building on day one. You don't want to be reading about Solidity and blockchain for the next month."[33]

Yet, some challenges (like the awkward and counterintuitive concept of gas) are tied to Ethereum itself and not so easy to overcome. That's perhaps one of the reasons why Dapper Labs isn't wedded to any blockchain. The company is pragmatic when it comes to its technology choices: it puts user experience ahead of technical considerations. "The choice of blockchain is based on where we can create the most value," Shirley said.[34]

Competing non-fungible token standards

When CryptoKitties launched, the creators knew they couldn't use the ERC-20 standard for fungible tokens, because each kitten would

be unique. To get the features the company needed, Shirley created a new token standard called ERC-721 (with William Entriken finalizing it later).[35] Because they wrote it as an open-source standard rather than as a proprietary feature of CryptoKitties alone, various other non-fungible games and token types have used the same token standard.

Because the token standard was written as open-source rather than as a proprietary feature of CryptoKitties alone, various other non-fungible games and token types have used the same token standard.

However, the choice of ERC-721 is not a slam dunk for Ethereum users. That's because there are other standards like ERC-1155 and ERC-721x, which claim to offer advantages over ERC-721. Witek Radomski, CTO and co-founder of Enjin, a platform provider for blockchain games, said the level of adoption of ERC-721 is still very small in real-world terms, and so we must ask whether it's truly the best option.[36] "ERC-721 has a number of flaws," Radomski said. It is expensive to execute in that it uses a lot of gas, it doesn't permit bulk operations or group transfer features, and it has a non-safe transfer function, which limits the ability of contracts to respond to a received transfer.[37] So Enjin elected to create ERC-1155, "the most perfect future-proof token standard that [it] could." It offers the features that Enjin found lacking in ERC-721.

ERC-1155 isn't the only alternative to ERC-721: there is also ERC-721x, which we could loosely describe as a backward-compatible response to some of the features added by ERC-1155. NFTs have also begun showing up on other blockchains as well. For example, the game *Blockchain Cuties* supports non-fungible breedable and tradable creatures on Ethereum, TRON, and EOS. EOS also has at least two competing NFT standards, SimpleAssets and dGoods.[38] Other NFT trading platforms like the Worldwide Asset eXchange (WAX) have created their own blockchain (based on a variant of EOS).[39] Gauthier Zuppinger, co-founder of NonFungible.com, summarized the proliferation of standards: "We now see NFT

Table 2: Comparison of token standards

Standard	Distinguishing Feature(s)
ERC-20	Fungible token standard, adopted by Ethereum.
ERC-721	The first Non-Fungible Token standard, adopted by Ethereum. One of the most common NFT standards to date, ERC-721 is used by games such as CryptoKitties.
ERC-721x	This Ethereum token standard offers advanced features, such as batched transfers and the creation of multiple classes of items, while maintaining backward compatibility with ERC-721.
ERC-1155	Like ERC-721x, this Ethereum token standard offers batched transfers and group transfer features. However, it is not backward compatible with ERC-721. Created by Enjin, it's used mainly for games, but other companies such as AgriDigital have embraced it too.
SimpleAssets, dGoods	NFTs are also being adopted by blockchains other than Ethereum. SimpleAssets and dGoods are examples created for the EOS blockchain.

standards on Stellar, on Bitcoin, on NEO, EOS, and TRON. So there are something like eight different standards on eight different blockchains."[40]

In short, it's early days for NFTs, and there's not yet a clear dominant standard. While early standards like ERC-721 have led to interoperability among different games and marketplaces, adoption is still at a very small scale. The winning standard will likely be the one that achieves broad consumer adoption, not just technical superiority or features.

In short, it's early days for NFTs, and there's not yet a clear dominant standard.

Scalability of transaction volume

Most blockchains today suffer from scaling issues: the more decentralized the structure, the greater the scaling challenges. Fully decentralized blockchains like Ethereum and Bitcoin have proven to be much more useful for selective high-value transactions than high throughput. For example, on-chain bitcoin transactions amount to nearly 800 billion a year (a respectable 13% of the $6 trillion US Mastercard and Visa credit and debit transactions in 2018), yet Bitcoin's throughput is only seven transactions per second (a paltry .03% of what Visa is capable of).[41] But perhaps the best evidence of blockchain's speed bottleneck is the existence of centralized cryptocurrency exchanges. Given the risks and trust issues of centralized systems (a problem blockchain is supposed to solve), one of the main reasons these exchanges exist at all is the high volumes and near instantaneous execution speed they offer. The result is that while Bitcoin's on-chain daily volume is $2.2 billion, the value of all Bitcoin traded on centralized exchanges is $22.8 billion daily. The implication: don't attempt to put high volume transactions on-chain.

CryptoKitties found that out the hard way. With several thousand users, the popularity of kitty breeding and trading brought the entire Ethereum network to its knees. Gas prices went up almost 100 fold, and many weren't able to fill their transactions at all.[42] And with proof-of-work blockchains consuming so much energy in the first place, some might argue it's a waste to spend all that energy and effort on simple games. For most blockchains, the way out of this trap is to find a means to scale up the number of transactions per second. But that's more difficult than it seems according to Shirley: "Almost all of the scaling systems that are being proposed are highly dependent on this notion of *sharding*" (a way of splitting up a single blockhain into a larger number of smaller pieces operating in parallel).[43] Yet, sharding is unsuitable for breeding kitties. Said Shirley, "If you want to have objects that have behavior associated with them, then a sharded blockchain makes that incredibly difficult."[44]

The winning standard will likely be the one that achieves broad consumer adoption, not just technical superiority or features.

Nevertheless, none of these barriers are insurmountable. Judicious choices about what goes on-chain and what stays within an application are critical. Additionally, some blockchains like EOS have managed to offer much higher transaction throughput (at the cost of being slightly less decentralized). Others may choose to use private blockchains to dispense with fees altogether and merely

hash periodically to a public chain.[45] Of course one of the best ways to improve efficiency is through the standards themselves: better-structured NFT standards and contracts can pare down transactions to the absolute minimums, becoming more cost-effective in the process.

Today, virtual assets are a strategic part of video games and their business models.

Games and non-fungible tokens

NFTs are a recent turn in what has been a long evolutionary path of digital in-game assets. The very first in-game assets to be bought and sold were done so through informal channels. But then in the late 1990s and early 2000s, formal marketplaces like PlayerAuctions and Internet Gaming Entertainment enabled the trading of in-game characters, currency, and assets.[46] These assets also came to be important revenue generators for online communities themselves—virtual worlds like Second Life transitioned almost entirely from selling user subscriptions to selling virtual land. However, in these systems, the games themselves tended to control the ownership systems for these virtual assets, so outside trading in characters or virtual items was usually discouraged. Apart from a few exceptions like Second Life, virtual goods were seen as an intriguing growth area, but certainly nothing to rival traditional revenue sources. Today, virtual assets are a strategic part of video games and their business models. In a survey of a thousand gamers, Worldwide Asset eXchange discovered that:

> *Greater than 50 percent of gamers of all ages in the [United States] already own cryptocurrency. However, 87 percent have not used it in gaming before and 80 percent are interested in using cryptocurrency to make transactions within gaming. Close to two-thirds wish there were more opportunities to do so. … Over 69 percent are interested in converting their virtual goods into tokens they could then exchange for other cryptocurrencies.*[47]

These virtual goods represent a large and vibrant base of assets that blockchain is directly relevant to—but only if blockchain can create new value, match the usability of current systems, and handle the necessary transaction throughput.

In 2018, the free-to-play revenue model accounted for $88 billion—that's 80 percent of all game industry revenues.

The changing market for games

Today, the environment for downloadable content has changed considerably. The dramatic success of games like *Fortnite*, for example, has proven once and for all the viability of free-to-play and downloadable content models—becoming the world's most popular game and earning $2.4 billion for parent company Epic Games (more than any other game in history).[48] *Fortnite* was not alone; in 2018, the free-to-play revenue model accounted for $88 billion—that's 80 percent of all game industry revenues.[49]

The rise of downloadable content

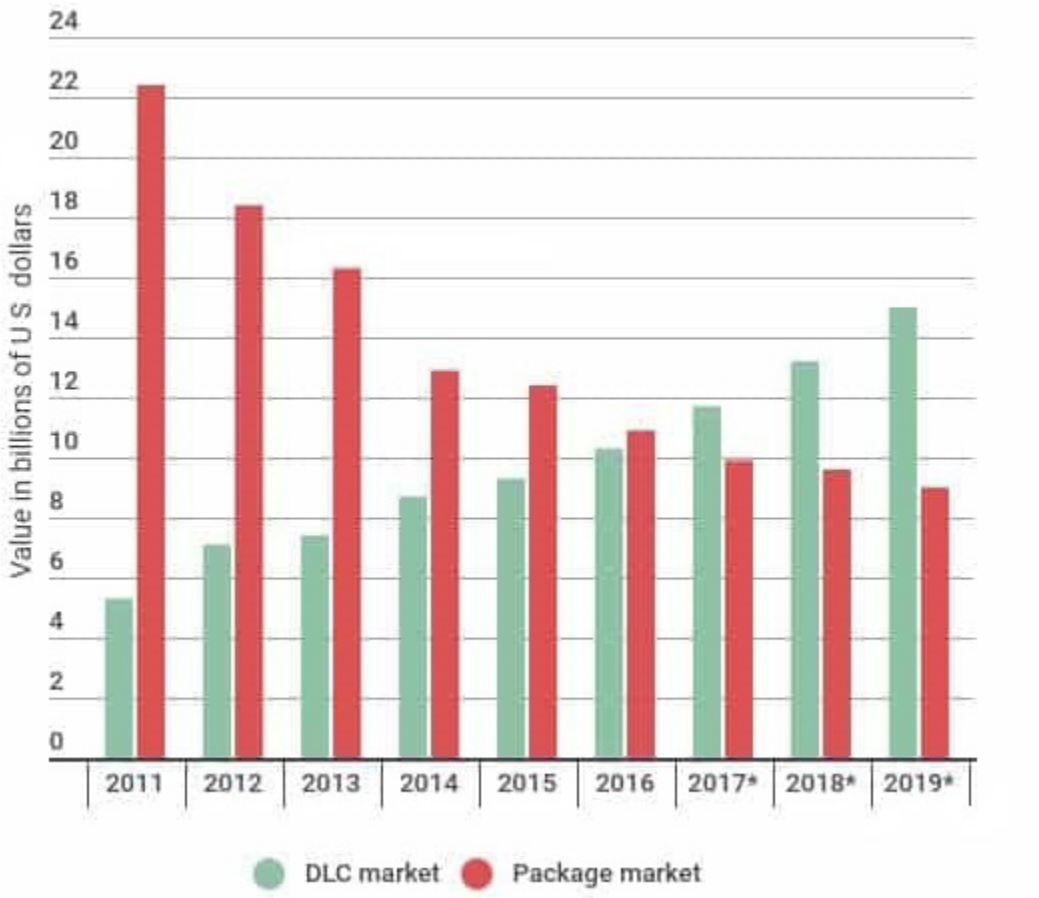
Player expectations have risen alongside their digital content purchases.

The rapidly growing market in downloadable content has made digital assets more strategic than ever—in video games, they have completely overtaken packaged software purchases (Figure 6), and promise to keep on growing (Figure 7, next page). The result is an enormous opportunity to securitize game assets via tokens that allow for true user ownership—increasing these assets' value and utility, and with it, consumers' willingness to pay.

That's because player expectations have risen alongside their digital content purchases. One survey of a thousand US gamers found: "Around 64 percent of gamers believe the current methods of buying, selling and/or trading online gaming items need improvement."[50] One way to improve the status quo is to give users a bigger stake in these items: "68 percent of gamers said that they feel players deserve to truly own the items they purchase."[51]

Figure 6: The growing importance of downloadable content

Worldwide value in billion US dollars of video game consumer market from 2011 to 2019.



Sources of data: Capcom Co. Ltd. and International Development Group. "DLC Market," created by WePC.com, May 2018. Used courtesy of WePC.com under CC BY 3.0 US.

Making an application free but offering downloadable content is a business model that works on nearly every platform.

Four contributing factors

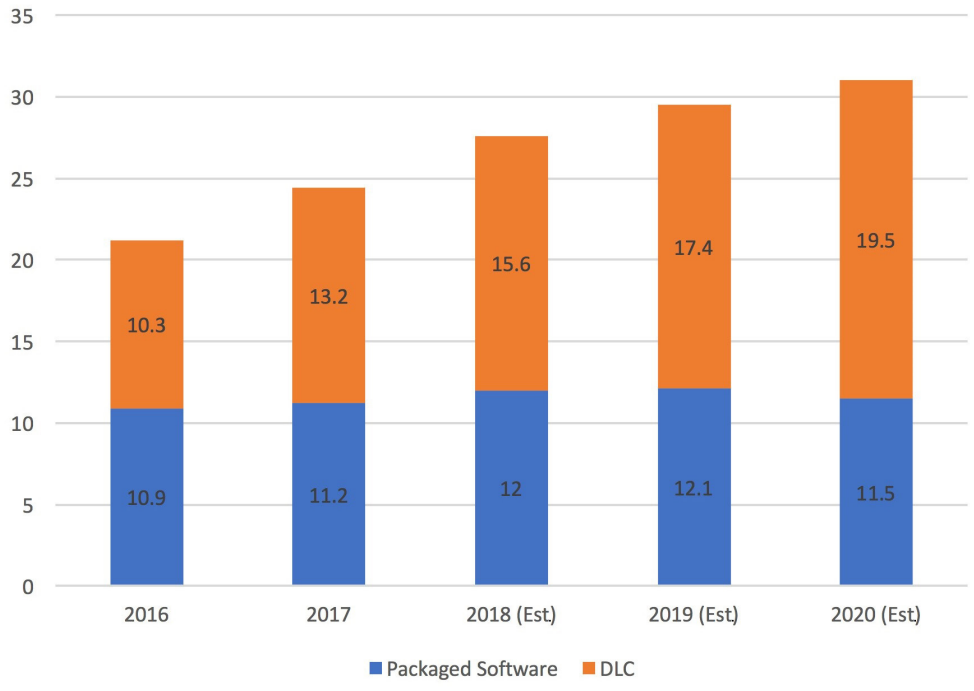
There are several reasons for DLC's popularity. First, it complements existing packaged software: once users have already purchased a package, it becomes easier to cross-sell additional content. Second is the rise of mobile, where freemium models are a proven moneymaker. Additionally, it offers publishers protection from pirated copies, as well as limiting competition from the used market.[52] Last, downloadable content models offer a consistent business model that scales well across multiple devices and platforms. While expensive packaged software might work OK for a PC or game console, mobile users are a lot more price sensitive when it comes to apps, and it would be hard to justify price differences. Making an application free but offering downloadable content is a business model that works on nearly every platform.

The impact of true ownership of game assets

Despite the popularity of DLC and gamers' ability to purchase these assets, they don't "own" them in the true sense of the word. Because these assets are centrally controlled, their continued existence, scarcity, and ability to transfer them to others is largely at the

Figure 7: Downloadable content versus packaged software

While the consumer market (in $ billions) for DLC overtakes packaged software, both continue to grow.



Source of data: International Development Group, as found in Capcom Integrated Annual Report 2018: Aiming for the Top, *Capcom Co. Ltd., 2 Oct. 2018, p. 75.*

mercy of game developers. Vitalik Buterin recalled the pitfalls of these kinds of centralized arrangements when he was growing up: "I happily played *World of Warcraft* during 2007-2010, but one day Blizzard removed the damage component from my beloved warlock's Siphon Life spell. I cried myself to sleep, and on that day I realized what horrors centralized services can bring."[53] Shirley echoed that sentiment, suggesting that baked-in ownership limitations undermine users' contributions: "There are people who put significant parts of themselves into these games and they really don't feel like—it feels like a lease, it feels almost like serfdom. You need to work for it, but at the end of the day you don't really own it." [54]

Which new possibilities do different ownership rights and economies provide to both gamers and game developers?

Others are skeptical of whether true ownership of game assets is what players really want. Urban Osvald, CSO of 0xcert, suggested that plenty of games lack true ownership but are still fun to play. So while game economies exist, they are not the only feature that matters.[55] Osvald is right: it's not "true ownership" itself that matters. Rather, it's the potential that various kinds of ownership rights and economies offer to gamers, if they are implemented correctly. So which new possibilities do different ownership rights and economies provide to both gamers and game developers?

Lessons from cryptoeconomics

Ownership rights and economies offer three key benefits to games:

- Real-world consequences make games more exciting
- Freedom of exchange yields a richer surface of interactive possibilities
- Sovereignty for players creates stronger roles and a greater stake in the system

Let's take a look at each of those benefits in turn.

Real-world consequences make games more exciting

Games without consequences are boring. One survey, which asked players about their most *satisfying* and *infuriating* experiences, found that 27 percent said their most *satisfying* experience had occurred within a game, while 33 percent said their most *infuriating* experience happened in a game.[56] The truth of the matter is that gamers are drawn to the emotional rollercoasters that drive their gaming experiences.

True asset ownership amplifies the emotional content of a game by altering players fortunes in the real world.

True asset ownership amplifies the emotional content of a game by altering players fortunes in the real world. Winning (or losing) items with actual tangible value increases the consequences of gameplay—heightening the emotional content possibilities. Kyle Davis of Valve said there's an explicit link between player engagement and the random distribution of assets, the value of which is determined by players.[57] "This is not an accident. This is by design," explained Davis

in a 2014 talk. "[We see] e-mails from our players saying, 'I'm not really sure what happened, but I've been playing *Dota* for the last week or two, and I made $100 selling these items that I got.' This is hugely successful for us."[58]

Strong ownership rights enhance the emotional content of games: finding a rare and valuable item is exciting, as is losing it or putting it at risk during gameplay.

The promise and peril of speculation helped spur the rapid adoption of CryptoKitties. It's one thing to see the value of your CryptoKitty rise if that happened with make-believe gold pieces. It's quite another if a lucrative trade on a kitty provides an actual $200 windfall. That emotional consequence is important even when things *don't* go well. The game *EVE Online* has a "death mechanic" that plays an important role in amplifying the consequences of user choices: when players die in game, the players lose all the items they had with them.[59] In 2005, an undercover assassin in the game killed one of *EVE Online's* most advanced players, destroying a priceless ship, and enabling the theft of $16,500 worth of virtual items.[60] While large monetary losses can be painful, the possibility of placing genuine assets at risk makes everything within the game far more valuable. Similarly, strong ownership rights enhance the emotional content of games: finding a rare and valuable item is exciting, as is losing it or putting it at risk during gameplay.

Freedom of exchange yields richer interactions

In a single-player game, the only way to get ahead is to work within the game's structure. In a multiplayer game, other players and the interactions with them are part of the experience—that's what makes them so interesting. Managing these aspects isn't easy for game creators. Tom Bollich, co-founder of Zynga, said, "To have a commercially successful game, you need a good economy. To have a good economy, you need an aspirational loop. To have an effective aspirational loop, you need to know your target market very well."[61]

It involves systems thinking; instead of directly manipulating the user experience, you need systems and infrastructure that facilitate value creation among peers. Davis of Valve said that developers need to "come up with systems that let users generate value for each other."[62] The assets within the game are a key part of those systems, especially the ability to exchange them with other players. "Trade is a system by which two customers can interact with each other, and both improve each other's experience," Davis added. It's an incredibly valuable system that "makes every item that is tradable more valuable."[63]

The benefit to the community isn't just about the monetary value of airdropped assets; it's also about the social and community structures that develop as a result.

The ability to trade or exchange game assets has positive net benefits to players. Zuppinger said, "What is interesting about NFTs and the use of blockchain in gaming is not the decentralized aspect, it's that you can build new business models, a new way to take your players and give them real valuable assets."[64] The benefit to the community isn't just about the monetary value of airdropped assets; it's also about the social and community structures that develop as a result. Larger groups organize and pool their resources, specialized roles emerge, players acquire social power or rank, communities make judgments about which items are rare or significant, and

members orchestrate new systems of activity as innovation unfolds. The extent to which these assets have life (and value) outside the game also affects real-world social bonds and interactions, not just virtual ones. Zuppinger paraphrased the motto of the game *My Crypto Heroes* when he summarized the impact: "Your time and your passion will become your assets."[65]

The rights associated with game assets are a valuable foundation on which to build rich interactions and social structures.

As a result, the rights associated with game assets are a valuable foundation on which to build rich interactions and social structures. The interactions with these assets can evolve dynamically over time, resulting in greater engagement both within and outside the game.

Player sovereignty creates a greater stake in the system

Those with sovereignty over resources are more likely to develop and protect them. That's an area where public blockchains are often game changers: they reduce the risk of expropriation that often occurs when building on proprietary platforms and offer governance that's proportional to the stakes of system participants.[66] In centrally-managed systems, gamers don't have that sovereignty; instead game developers exercise absolute authority over game assets, managing them as they see fit. But games have the opportunity to give that sovereignty to players—by turning game resources such as objects or land into persistent assets with ownership rights attached to them.

One of the easiest ways to do this is to change the process for launching a game. Simply owning a game asset automatically gives someone a stake in the success of a game. According to Osvold of 0xcert:

> *With traditional gaming, you see first [the] creation of gameplay—awesome graphics awesome stuff people can use and interact. You have [a] long beta program, refine that, you create that stickiness loop, and so on. Whereas here, what we see is the actual sale of assets comes first, and then the second step, "Ok now we have the money, now let's create the actual gameplay and then everything which follows."*[67]

Games have the opportunity to give that sovereignty to players—by turning game resources such as objects or land into persistent assets with ownership rights attached to them.

It's also a user-friendly promotional vehicle. Enjin has paid a lot of attention to the end-user experience when designing its blockchain-based gaming platform. The company has worked hard to deliver a seamless experience by taking a hands-on role with every detail of its platform—developing the ERC-1155 token standard, building a blockchain wallet, creating simple developer interfaces for blockchain-based functions, as well as offering an easy way to scan and import tokens with the use of QR codes.

Scanning a QR code to get a token allowed Enjin to convert one of the pain points of blockchain (the multistep process required to purchase tokens) into a strategic advantage. Using these QR codes, any celebrity promotor (e.g., a Twitch-based streamer) could do a mass airdrop of items, allowing users to scan in a code, and

immediately receive a digital item.[68] Radomski, CTO of Enjin, said, "Now people can receive items, and they'll be excited to try the game to see what their virtual item does. They didn't have to go through any complicated process. … Just scan the code, and receive an item."[69] Now, everyone who received an asset becomes an ally of the game developer.

Creating persistent digital game assets is a way for game developers to share ownership and sovereignty of the universes they create, and engage gamers in co-creation.

Owning part of the world, such as game assets (or even parcels of virtual land, as in Decentraland), motivates them not only to try it but also to take a hands-on role—getting involved in community activities, rule- and decision-making, or maintaining and/or improving the community—all to enhance the richness of their experience and the value of their assets.[70]

What looks like a subtle change, creating persistent digital game assets, is actually much more—it's a way for game developers to share ownership and sovereignty of the universes they create, and engage gamers in co-creation.

Agile businesses use ecosystems for competitive advantage

Conventional game platforms use ecosystem tactics

Game platforms have long used ecosystem tactics to compete with each other, attract game developers, and retain gamers. These platforms vary widely, from Valve's steam (50-80% of the game distribution market according to *Esports Observer*) and Epic Games Store, to hardware platforms like Xbox and PlayStation and mobile app stores or social/streaming platforms like Twitch and many others.[71] Although the capabilities of these platforms vary widely, many include such features as:

Game platforms have long used ecosystem tactics to compete with each other, attract game developers, and retain gamers.

- Simplified payment/billing for game purchases
- Management of user login, identity, and profile/achievements
- Social, rating, or communications tools
- Marketplaces for game assets
- Promotional or marketing features (like item drops)
- Metrics and data logs
- Development tools, libraries, or packages

These ecosystem capabilities complement the efforts of game developers, speeding development times, providing access to markets and customers, or just saving on some of the basic

infrastructure required to self-launch a game. But leveraging these platforms often comes at a price—a percentage of sales, an exclusivity contract with the platform, or other costs.

Many of these platform benefits are subject to change based on the whims of a platform owner. Take the example of an end customer that has purchased a game asset through Valve's marketplace. If the developer's contract with Valve ends, then the end customer may find themselves unable to resell those assets in the very same marketplace they purchased them from in the first place.[72] So while ecosystem platforms can be of enormous benefit, leveraging these benefits has typically put companies at the mercy of platform owners.

NFTs are open and interoperable, and the platform itself is a global blockchain infrastructure that includes payments and smart contracts.

Blockchain NFTs offer an open alternative

Using a combination of blockchain and NFTs, games can realize many of the same benefits of typical gaming platforms. Yet, unlike most centrally-controlled platforms, NFTs are open and interoperable, and the platform itself is a global blockchain infrastructure that includes payments and smart contracts.

Open NFT marketplaces

Today, blockchain-based NFT marketplaces are a rich example of interoperability—allowing gamers to easily trade assets with one another, *even when the buyer and seller are on two different marketplaces*. It's an innovation that would be nearly impossible without an open NFT standard. These markets are part of a growing ecosystem; at first, there were no third-party marketplaces at all for NFT gaming assets. Instead, games like *CryptoKitties* ran its own marketplace that allowed kitties to be purchased via Dutch auctions. Now, there are several different options for buyers or sellers of any given NFT asset:

- Exchanges: 0x.org, for example, supports both ERC-721 and ERC-20 assets.[73]
- NFT marketplaces: Rare Bits and OpenSea represent a new type of non-fungible marketplace for buying and selling NFTs.
- Direct: Many NFTs (e.g., CryptoKitties) can still be bought and sold directly from the game's own website.

Anyone can build a system interoperable with NFTs without needing permission to do so.

The high degree of interoperability among all these options is unusual in the world of gaming assets. It stems from two main factors. First, an NFT standard exists. Second, anyone can build a system interoperable with NFTs *without needing permission to do so*. It's very unlike a traditional marketplace for gaming assets, said Devin Finzer, co-founder of OpenSea.[74] He said, "Every game economy, even if [it has] a marketplace, operates as this centrally controlled, highly restrictive place, where there's only certain things you can do with the items."[75] OpenSea offers the exact opposite—an unrestricted public asset marketplace where anyone can buy and sell.

OpenSea also focuses on making blockchain-based NFTs more accessible to developers. "We want it to be easier from a technology perspective; we don't want people to have to reinvent the wheel; and implement their own smart contracts," said Finzer.[76] Instead of building a marketplace from scratch, developers can use OpenSea's infrastructure. Finzer added:

> *That's the exciting model for us. What is compelling is a game can actually launch items without having to build the entire marketplace from scratch, and immediately after deploying an ERC-721 non-fungible contract, [users] immediately get access to all of those buying and selling features.*[77]

Such an open ecosystem approach offers several advantages to end users and developers alike:

- *Interoperable ecosystems.* Developers can focus on the pieces that they do best: game mechanics or character art instead of marketplaces.
- *Greater utility of assets.* Because developers can use other's assets, NFTs can be brought to life in other games or ecosystems, increasing their value to end users.
- *Ecosystem lock-in rather than game lock-in*. In most games, the hundreds of hours you spend building your character or collecting resources is stranded within the confines of that individual game. In an ecosystem, all that work and effort can be preserved, allowing things like identity, reputation, and assets to follow your account.
- *Fewer inherited platform liabilities.* For traditional game platforms, managing ecosystems with multiple participants creates trust and reputation challenges since the platform owner is held responsible for the behavior of all parties. (See the example of OPSkins in the section, "The strategic challenges of using open ecosystems," below.) Blockchain-based interoperability helps to relieve many of these concerns by acting as a shared utility, where no single party is responsible for participants or their behavior.
- *Assets with perpetuity.* In most games, assets are useful only as long as the game in which they originated survives. But anyone can breathe new life into blockchain-based assets, even if their game of origin has expired.

In an ecosystem, the hundreds of hours you spend building your character or collecting resources can be preserved, allowing things like identity, reputation, and assets to follow your account.

An open ecosystem approach doesn't necessarily mean that developers or players can do whatever they want or include whoever they want: OpenSea and others have lengthy terms of use or service that generally proscribe user conduct and prohibit activity that is illegal—such as laundering money; funding terrorism; infringing upon the privacy, property, and human rights of others; trading child pornography; or soliciting and onboarding minors without parental consent—in keeping with the jurisdictions in which the software may

be used. These often include terms of arbitration for disputes.[78] Moreover, communities like Decentraland have developed and maintain their own governance, setting additional boundaries around acceptable behavior and the consequences of offenses

Shared game universes

With NFTs, the rollout recipe allows for richer and more complex gaming ecosystems—where one game may inherit features or assets of another, and players will bring assets and characters in with them.

While open marketplaces for trading game assets are a good first step, it constrains our thinking by positioning games as the primary area of importance, and marketplaces as mere extensions of them. What if we use blockchain to enable more participative environments and gaming universes where characters, narratives, and assets are the primary focus? In traditional games, the developer rolls out the universe and offers it to you, the client. With NFTs, the rollout recipe allows for richer and more complex gaming ecosystems—where one game may inherit features or assets of another, and players will bring assets and characters in with them.

James Martin Duffy, co-founder of Loom Network, envisions a shared game universe: "With true ownership of digital items that cannot be taken away from you, blockchains enable us to do crazy new things in online games and virtual realities — like having virtual avatars that aren't owned by any company and can persist between worlds."[79]

While blockchain enables that kind of interoperability, Osvald said game industry incumbents will not likely champion this kind of openness: "Incumbents have a very, very strong position. Game industry incumbents are not just going to lean in here and say, 'Blockchain is so good, let's create something open source and interoperable.' 'No, these are my users, I've got a million users and I'm building my own ecosystem here, so I don't need you.'"[80]

It's far more likely to come from a new breed of game developer, an organization that's already used to thinking in ecosystem terms. Hironobu Ueno is chief executive officer and CTO of Double Jump.Tokyo, creator of *My Crypto Heroes*, currently one of the most popular ERC-721-based games.[81] Ueno sees interoperability as a net benefit for everyone: "If we have more blockchain games and are able to interact among them, we think the platform would grow."[82]

"If we have more blockchain games and are able to interact among them, we think the platform would grow."

HIRONOBU UENO
CEO and CTO
Double Jump.Tokyo

Decentraland is another such company. It sees third-party development as critical to the value of assets—so much so it's investing $5 million to seed games and interactive content built upon Decentraland.[83]

Early games like *Kitty Race* (allowing CryptoKitty owners to race their kitties with one another) offers a simple proof of concept, illustrating how one game can use another's assets (and, no, creators Charlie Hine and Eugene Otto didn't ask for permission from Dapper Labs first).[84] Although such multi-game assets are easy to implement technically, turning that into a compelling user experience is easier said than done. "It sounds really good, but it's not that simple," said Osvald.[85] He suggested that it raises a lot of new questions about how (or whether) different assets should appear between games—

should a tattoo for my forearm from one game appear on another, or does a weapon earned in one first-person shooter have the same features and behavior in the context of an entirely different game?[86]

One company that's thought a lot about these issues is Enjin. Having created an easy-to-use platform (with its own wallet, developer SDK, and the ERC-1155 standard), the company is now heavily focusing on content and attracting game developers. It has been experimenting with what Enjin calls generic "multiverse items," such as swords and shields that it offered to its early-adopter game developers.[87] Rather than taking a prescriptive approach that attempted to guide how these items would get used, Enjin simply suggested incorporating these assets in any games that made sense, with the result that these multiverse items have been featured in 15+ games so far.[88] Radomski of Enjin doesn't see this approach as a difficult engineering task. Rather, it's an opportunity for exploring from the bottom up:

> *They don't have to overthink this. Just start with simple things. Start tokenizing some items, start trying to cross-collaborate with various companies—either game developers or other brands or whatever you want to do. I see that all of our game developers have really cool unique idea about how to use this stuff. They just love the creative opportunities. They're not struggling too hard with finding ways to use them.*[89]

With free-form exploration, game developers also need feature sets that offer fine-grained control over the rights associated with their assets.

However, with such free-form exploration, game developers also need feature sets that offer fine-grained control over the rights associated with their assets. Seemingly small distinctions in how an asset is acquired or traded can have big impacts on its social possibilities. For example, a "bound" item is an item locked to a player's account—they can't trade it—and so anyone who held such an asset had to earn it via gameplay, not buy it on a marketplace.[90]

An extension of that feature is what Enjin called "melting," where even a "bound" item can possess a residual value that users can realize any time by melting it down. For example, if you have a sword you don't need, you simply melt it down and release its value into your account. The melt value also protects against a game shutting down: even if you can't use an item anymore, you always hold that melting value.[91]

The strategic challenges of using open ecosystems

Despite the benefits of ecosystems, managing them often presents strategic challenges. Take Valve Software's skirmish with a marketplace for virtual goods called OPSkins. While third parties like OPSkins were a steady source of profitable transactions, some of these parties perpetuated fraud and underage gambling. Valve Software found itself with a front-row seat to the scandal. As early as 2015, $2.3 billion in skins were being bet on the outcomes of esports matches with Valve taking 15 percent of all skins sold; it was directly implicated in these transactions.[92]

Moritz Maurer, head of eSports Integrity at Genius Sports, was quoted in *Bloomberg*: "Nothing about *Counter-Strike* is about the game anymore. … It's all about betting and winning."[93] According to the UK Gambling Commission, "11 percent of eleven- to sixteen-year-olds claim to have personally ever participated in 'skins' betting."[94] Given the circumstances, Valve had to clean up its act and re-examine its relationships with third-party markets.

As a result, Valve banned OPSkins from its marketplace, causing OPSkins' customers to lose $2 million's worth of skins in the process.[95] For OPSkins, this heavy-handed approach by Valve was a symbol of the tyranny of centrally-controlled virtual assets. From Valve's perspective, third-party marketplaces such as OPSkins were a huge reputation risk, not only enabling underage gambling (with virtual goods as payment) but also defrauding customers in some cases.

The expulsion from Valve's marketplace had another important impact: it led OPSkins to embrace NFTs. The OPSkins blog described how NFTs help overcome some of problems that it experienced with Valve:

> *If they don't like who you're trading with, they can ban your account, and all of your items on your account are gone because this centralized entity decided that they don't want you to have access to them anymore. … It doesn't seem fair, right? It's not. You bought or earned these items. They are yours. Why does a centralized entity get to decide what you do with it? With NFTs, ownership is decentralized, so your items can never be banned, destroyed, replicated, or subjected to trade holds. Owners of NFTs truly own their items since they are blockchain-based, and there is no centralized entity controlling the existence of your item.*[96]

With a renewed focus on NFTs, the Worldwide Asset eXchange began trading common NFTs like CryptoKitties, as well as its own blockchain creation, VGO items, which are tradable game assets like pistols, knives, rifles, and more.

With a renewed focus on NFTs, the OPSkins Worldwide Asset eXchange (WAX) began trading common NFTs like CryptoKitties, as well as its own blockchain creation, VGO items, which are tradable game assets like pistols, knives, rifles, and more. The company has also made mainstream gaming companies part of its merchandising and promotion efforts, inking deals with esports players such as Fnatic.[97] The company has streamlined the process for acquiring NFTs. Instead of complex steps involving wallets and purchasing and exchanging crypto, users register for an account, pay through whatever form is convenient, and complete their NFT purchase.[98] It's an approach that appears to be paying off; WAX transaction volumes are approximately $1 million daily (as of 28 May 2019).[99]

Large transaction volumes are sustained despite the fact that most of these VGO items are usable in very few games, and are not currently using an NFT standard.[100] Pages like VGOsites.gg suggest that the original use case—gambling—may still be in play for these assets.[101] Esports gambling supported by NFTs is not a difficult cross-sell. "We've seen that betting increases fans' engagement with the content they bet on," said Jurre Pannekeet, the head of eSports at marketing research firm Newzoo.[102] Gambling spends already dwarf

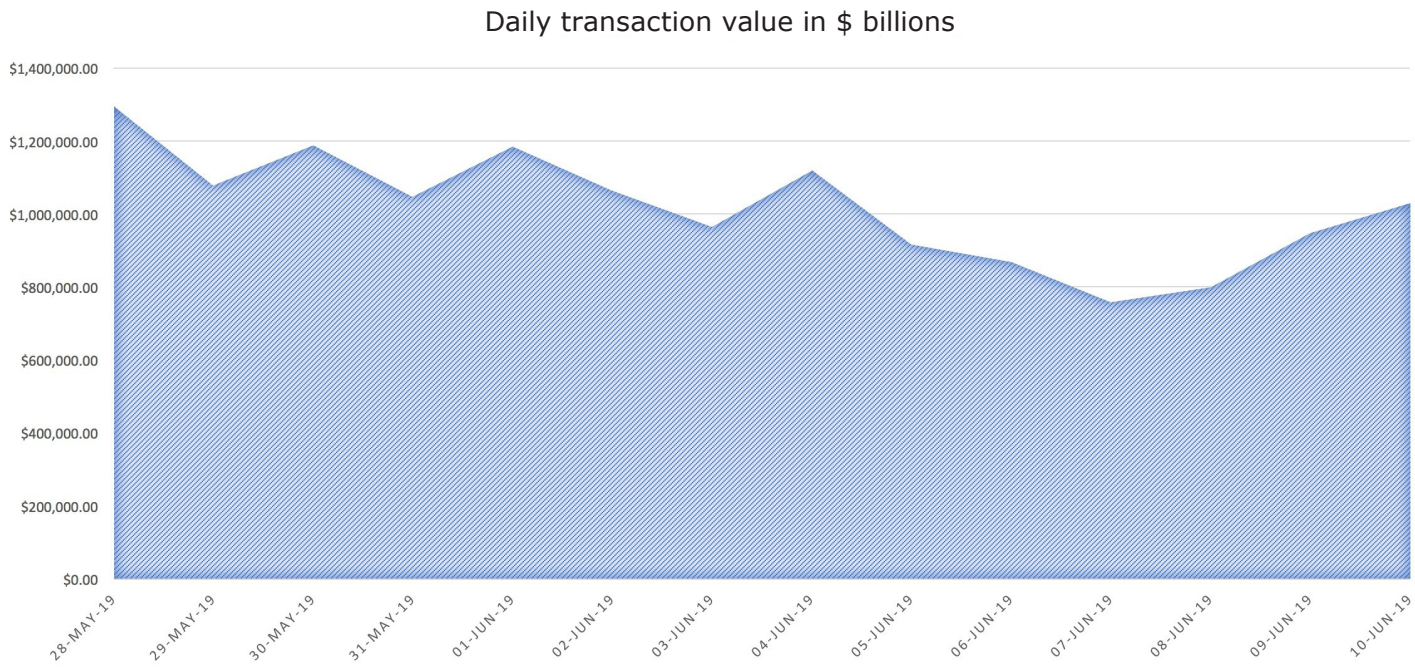
the market for NFTs; DappRadar.com shows the top three gambling Dapps are on track to hit an annual run rate of $5.6 billion (Figure 8).[103]

The lack of a standard suggests that these assets may depend on a centrally managed blockchain infrastructure.

Yet, use of blockchain (or NFTs) does not always equate to open interoperability. OPSkin's WAX demonstrates one of the challenges of running a virtual goods ecosystem: the temptation to keep it closed. For all the references to NFTs—although WAX supports the trading of true NFTs from third parties—when it comes to its own VGO items, these do not appear to follow any existing NFT standard. The lack of a standard suggests that these assets may depend on a centrally managed blockchain infrastructure. Even the company's long-term plans suggest that the system will build its own blockchain (an EOS variant) rather than embrace an existing public blockchain. True ownership and open participation in WAX assets would appear to be a long way off. Such cases are not unusual: *EOS Knights*, a popular blockchain game and the fourth most popular Dapp, does not appear to support the SimpleAssets or dGoods NFT standards common to EOS.[104]

The implication is that not all blockchain-based virtual assets are open NFT ecosystems. In fact, a closed approach to managing virtual goods is just as possible on a blockchain application as it is on any other technical infrastructure. In contrast, an open approach requires both a public blockchain and the adoption of an NFT standard that offers permissionless assets transfers (i.e., transfers don't require any involvement by the asset creator).

Figure 8: Daily value of items traded on Worldwide Asset eXchange



Source of data: WAX Explorer, as of 11 June 2019.

Tokenization: Turning fungibles into non-fungibles

Treating digital and physical products as identical commodities is often a vast oversimplification that throws away economic value.

NFTs have enormous potential to grow any economy they are part of. Today, most of our information and record-keeping systems do a poor job of handling individual variance. Instead, we prefer dealing with standardized items to keep things simple. A typical lumberyard charges the same amount for two different pieces of two by four foot lumber, even though one of them might be knotty and warped, while the other is laser-straight and knot-free. Also, the lumberyard and its customers both know that it's not really a 2 × 4 either; the actual dimensions are likely to be 1.5 × 3.5 inches. The truth is, treating digital and physical products as identical commodities is often a vast oversimplification that throws away economic value.

Imagine two NY Yankees baseball jerseys—one is a brand new, the other is a game-worn Babe Ruth jersey from the 1920s. The new jersey costs between $50 and $100 on Amazon, but Babe Ruth's fetched $5.64 million in an auction in June of this year.[105] That's where NFTs come in. They allow us to recognize the unique individual variances that lead to marked differences in value on otherwise similar items. It's the kind of variance that made CryptoKitties interesting. These cats were anything but commodities, exhibiting variations—both in visual appearance and attributes, as well as their hidden genetic possibilities.

NFTs and the value of game assets

Just like the price of a baseball jersey can vary a lot because of small differences in provenance and history, small variations among digital game assets can also yield dramatic differences.

Small variations among digital game assets can yield dramatic differences.

The simplest source of variation is the items themselves—attributes such as the skills and abilities of a game character, the visual appearance of a CryptoKitty, the accuracy of a weapon, or the qualities of a spell ingredient. Radomski described how that works in a game called *War of Crypto* where gameplay starts with a crystal: "You crack open that crystal and get a base character with genes and stats. You might get one of dozens of different characters that you can use to fight in an arena."[106] Because all gameplay can be tracked, it's easy to create a log of a character's or weapon's actions. Davis said players care a lot about those kinds of stats, citing an example of a weapon that tracks its history:

> *Weapons that come out of crates have the same gameplay as weapons that you would buy in the store, or find for free playing the game, but they track gameplay statistics for the current owner of that weapon. So this particular guy, he has a scatter gun that he's killed almost 1000 people with. He's interested in tracking the number of heavy weapons players he's killed, and the number of buildings he's destroyed.*[107]

While these stats are of interest to the owner of the weapon, permanent logs of weapons or characters can be of great interest to others. For example, in *War of Crypto*, as a character fights in arena battles, "your character gets metadata added to it, so it levels up, it gets more experience points, things like that," said Radomski. "Having that unique variance of that monster with all those unique stats, and the way that it was leveled up, and that history and who was defeated—I think that adds a real cool dimension."[108] In a game with NFT weapons or characters, those stats are of more than casual interest, since they can help pinpoint combinations of traits with advantages worth paying for.

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The provenance of a digital item can also bestow the same status and rarity as a record-breaking jersey. As the esports market grows in popularity, competitive games and their celebrity-status players have become big business. In 2019, the esports market is projected to top $1 billion for the first time, reaching over 450 million viewers worldwide.[109] Prize money is growing too, with games like *Dota 2* and *League of Legends* offering $25 million and $6 million in prize money respectively.[110] With US sports memorabilia worth an estimated $5.4 billion annually, it's hard to imagine that exotic digital game memorabilia won't have an equally strong base of collectors (especially if provenance can be 100% guaranteed).[111]

The provenance of digital assets creates interesting opportunities. "It could be like a famous streamer or PewDiePie," said Radomski. "They could say 'I had this sword while doing my famous video' and then they could trade it to somebody. That history of each item is a really powerful thing. That would even work with existing games."[112]

Collectors may pay handsomely for an item that struck a famous game-winning blow, or was part of a noteworthy event. Celebrity gamers could use their star power in other ways too. "You could have a famous player sign a non-fungible item and now that item will have some sort of intrinsic value," said Radomski, "Tokenizing their items, maybe just the rare or the interesting items, could be very interesting for them, and would get players a lot more involved in the game."[113]

Collectors may pay handsomely for an item that struck a famous game-winning blow, or was part of a noteworthy event.

Even the modest achievements of a lesser player might improve the value of an otherwise mundane item or character. Or it could serve to advance the narrative of a game. Radomski suggested:

> *Imagine you're playing games and you bring in your character—let's say your D&D [Dungeons & Dragons] character that's tokenized—and now you have a whole history attached to that character. And people or NPCs [non-player characters] in the game can be like: "I see that you killed the dragon of blah blah blah." They can actually build a storyline around the blockchain history that was attached to your character.*[114]

It all adds up to a more personalized style of play, and a greater number of built-in variations that bring additional value to game assets.

NFTs help innovate physical commodities

NFTs are not just about fun and games; they hold the keys to unlocking new value in physical supply chains as well.

NFTs are not just about fun and games; they hold the keys to unlocking new value in physical supply chains as well. Global commodities account for approximately $6 trillion of global exports, a sizable portion of the $17.4 trillion in global merchandise exports.[115] It would be easy to conclude that these physical products are identical and standardized, yet the reality is that not all physical commodities are equal. Substantial variations exist, even among commodity products.

The best proof of these differences lies in real-world prices. According to a US Congressional report authored by Randy Schnepf, these prices are often inconsistent with commodity markets; and the report provides examples of these inconsistencies:

> *It is possible for the overall supply of a generic commodity to be in abundant supply, while a specific variety of that commodity possessing the desired end-use traits may be in short supply. As a result, substantial price premiums and discounts may develop based on the commodities' end-use characteristics. …*
>
> *Supply and demand conditions in agricultural markets—whether it be markets for export, feed rations, fresh products, food processing, or textile manufacturing—may depend on a commodity's particular variety, quality, or end-use characteristic more than the overall supply of the generic commodity. For example, a flour processor may base wheat purchase decisions primarily on the specific variety of wheat and its particular milling and baking characteristics.*[116]

There are also important geographic differences that affect pricing. Transport costs have a clear impact on the prices that result:

> *In cases where local demand exceeds local supply, whether due to a crop shortfall or a nearby processing plant, the basis may be less than the transport margin or even exceed the futures market price. For example, local corn demand may be bolstered by the existence of an ethanol plant or a major livestock feeding operation.*[117]

So while commodities play an important role in global trade, the reality of these supply chains is often far more complex. Emma Weston, CEO of AgriDigital, suggested that in some ways there is a little bit of conceit in the idea that the commodities traded on an exchange are completely fungible: "There is a layer of abstraction, to make the exchange work, that is then accepted by the market. … We deal at that abstraction layer and then we don't really worry about what's happening at the physical layer."[118]

Weston describes AgriDigital as a supply-chain technology firm, not a marketplace. The company tracks that physical layer—the flow and status of grains and cotton across the agriculture supply chains—with the focus on three different use cases:[119]

- Transaction and payment security
- Network and market efficiency
- Provenance and whole-of-chain assurance

The result is an information layer that supports a diverse range of transactions—a stark departure from commodity exchanges. "If we are able to start facilitating the exchange of *real things*, and we have data about those real things, … then that has implications for commodity based supply chains," said Weston. "We can start to facilitate more local and regional supply chains that leverage and build on that difference."[120]

The result is a migration away from the commodity-based industrial food complex that has created opacity between consumers and farmers. Said Weston, "That taps into a more general consumer sensibility around not being part of the machine but being part of something that is more meaningful within their local or their regional area."[121]

AgriDigital sees blockchain as an essential piece of record-keeping technology that can buttress the grain and cotton applications, which are core to AgriDigital's business.

AgriDigital sees blockchain as an essential piece of record-keeping technology that can buttress the grain and cotton applications, which are core to AgriDigital's business. That's one of the reasons it put its developed protocols into a not-for-profit foundation called Geora:

> *It's a purpose-built blockchain protocol on top of Ethereum, for trade, trace and financing Agri supply chains. And there's a really full pipeline of users coming on board which is much wider than the AgriDigital focus on grains and cotton which is where we aim to be a very strong application provider into that vertical segment perspective. Geora is a much more horizontal and wider application or platform from a blockchain perspective. We've had everything from livestock through to horticulture, and at both the consumer and on-farm ends of the supply chain*[122]

Currently, that blockchain is a private instance of Ethereum, a necessity because of transaction speed and cost limitations of the public blockchain. It also uses the ERC-1155 standard for non-fungibles.[123] Despite AgriDigital's private instance, the company can also take hashed snapshots of its records and post them to the public blockchain. The result is a robust and complementary system of records that the company can adjust over time—depending on cost-effectiveness and the specific benefits of having particular records on- or off-chain.

The outcome will be novel kinds of digital assets along with all the nuanced information required to perform valuations of them. In the past, handling that real-world information complexity would have been a barrier, but not so with modern automated valuation. Said Weston:

> *There is going to be a role for algorithmic valuation of the different tokens in real time to facilitate exchange using the properties of blockchain. What is going to be more important is not fungibility or non-fungibility in the commercial sense, but actually how we value that exchange and how that value is actually calculated and then transferred. …*
>
> *Instead of being forced into an exchange where you have to exchange the same thing (because there is only one price and there is only one transparency solution to that exchange), … there could be multiple prices and there could be multiple views of an asset.*[124]

The end state is a blockchain-based system that uses information to remove supply-chain friction and digitizes complex assets to (a) enhance their transaction possibilities and (b) increase their value in a way that fungible commodity markets cannot.

NFTs are therefore not only about "true ownership" of digital assets. Rather, along with a rich description of the assets themselves, NFTs also offer granular new ways to specify bundles of rights or derivatives associated with a particular asset. Some of those rights may look like conventional "ownership" as we know it today, but there are other possibilities: narrow slices of ownership interests or obligations, collective ownership and rights regimes, or asset-based derivatives. As Dapper Lab's Shirley put it: "Blockchain will genuinely create opportunities for whole new kinds of businesses that have never existed before."[125]

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Conclusions and recommendations

In a remarkably short spand of time, the popularity of a single blockchain game, *CryptoKitties*, has set off a wave of interest in blockchain-based NFTs. There is a wide variety of NFT-based games, and developers are using NFTs in other physical and digital applications and on multiple blockchains. While NFTs face many challenges (e.g., complex user interfaces, competing standards, and scaling transaction), early results suggest NFTs have significant opportunities ahead of them:

- Gaming represents a massive market for NFT features and capabilities. Early adoption of marketplaces like WAX suggest blockchain-based NFTs will have mainstream appeal if the feature set and ease of use is up to the task.

- Game economies reinforced by NFTs offer a promising source of user engagement that can enhance game experiences. Used appropriately, blockchain NFTs offer opportunities to increase the utility and value of downloadable content, and with it, consumer's willingness to pay.

» Ecosystem-based competitors using interoperable NFTs can innovate rapidly on platforms that compete with gaming incumbents. The result will be new types of relationship building and engagement with consumers across a vast array of new ecosystems and platforms.

While NFTs face many challenges, early results suggest they have significant opportunities ahead of them.

Long term, the most potent benefit of NFTs will be their ability to grow conventional economic systems based on commodity assets. Standardizing digital and physical assets made it easier for information and record-keeping systems to handle them, but asset commoditization also throws out all the economic value of product variety. Non-fungible tokens, and the individual variances they permit, are key to unlocking the value of diverse assets. For physical and digital economies, NFTs represent an enormous growth opportunity to recover that economic value—turning run-of-the-mill commodities into assets with rich variation, histories, and provenance. They will have direct benefits in gaming and far-reaching impact in many other industries. What might leaders of conventional firms and blockchain-based businesses do to take advantage of NFT opportunities?

» **Invoke your brand with digital assets.** NFTs offer a chance for brands to experiment with new ecosystems and contexts. Downloadable branded content offers opportunities to connect with consumers in new venues that matter to them.

» **Make relationships and governance explicit.** The permanence and precision of a blockchain contact is a double-edged sword: on one hand smart contracts are great at executing instructions exactly as coded, on the other, mistakes or unanticipated consequences can be difficult to unwind.[126] Implementing a system of smart contracts and NFTs confronts these issues head on, making roles, responsibilities, processes, and governance explicit and public—something that's particularly helpful when working with external partners or supply-chain participants.

What might leaders of conventional firms and blockchain-based businesses do to take advantage of NFT opportunities?

» **Lay the groundwork for tokenization.** Treating products as individual items rather than commodities helps position your assets for tokenization. Look at areas where information in the form of provenance, history, identity, or certification offers a potential to personalize offerings, create value, remove risk, or improve efficiency.

» **Prepare for variation.** Treating assets or products as individually unique NFTs creates complexity, which in turn places new demands on internal information systems. For example, it's far simpler to sell apples by the pound than it is to assign apples a dynamic price based on unique combinations of features and characteristics (what AgriDigital calls *algorithmic valuation*). These complex variations will place new demands on internal information systems, requiring new systems and approaches.

In enterprise platforms and supply chains, companies could apply NFTs to all kinds of assets—invoices and receivables, certification and credentials, authorizations, source records for master data management, and roles or signing authority authorizations.

» **Securitize new types of assets.** NFTs enable simple tokenization of even low-cost assets. When items are tokenized, the bundle of rights associated with those assets becomes more versatile, helping to optimize value and efficiency. Rights associated with titles, ownership, collateral, possession, and revenue streams allow optimization via highly-structured trades and transactions; for example, a lender obtaining a right to future revenue streams in lieu of collateral.

» **Tokenize novel ecosystem assets.** In blockchain-based games, open ecosystems create interesting player-centric opportunities—reusable multiverse assets, portable avatars, or public reputations and histories. In enterprise platforms and supply chains, companies could apply NFTs to all kinds of assets—invoices and receivables, certification and credentials, authorizations for distributed version control, source records for master data management, roles or signing authority authorizations, certification of oracles (to provide real-world status), and shared logs and transaction histories.

» **Tokenize physical assets.** representing *physical* assets as NFTs is more challenging, because it still involves off-chain processes, people, and the Internet of Things—none of which are 100 percent reliable, immutable, incorruptible—and the resulting NFTs may not be legally recognized or acceptable across jurisdictions. Those who overcome those challenges—as AgriDigital has done in agriculture, and Everledger, in the diamond market—can help to catalyze industry transformation.

» **Remove friction and risk.** Nearly every business transaction involves small amounts of risk—whether it's a payment that fails to settle or a transaction that you can't insure. Strong ownership rights in the form of NFTs mitigate these risks through *atomic transactions* that turn what was once a linear process (where each step came with risk) into a single all-or-none transaction. Atomic transactions remove risk and friction. Supply chain activities also typically involve complex digital and physical handoffs between information systems. NFTs help simplify these handoffs by maintaining a blockchain-based record of supply chain assets and their status.

» **Leverage open ecosystems as permissionless platforms.** Nearly every business utilizes privately-owned platforms for part of its activities—from cloud invoicing and payment systems to communications and social media. Yet contributions to these systems (e.g., ratings and reviews) benefit primarily platform owners. Blockchain-based NFT infrastructures create opportunities to rebuild these services on open permissionless platforms. Unlike typical private platforms, contributions to blockchain-based systems can

benefit everyone and are easily extended by others. Because NFT assets are portable, system users can always "vote with their feet" if they don't like a system's features or policies. However, managing these ecosystems also requires cultivating new skills and capabilities suited to open collaborative ecosystems.

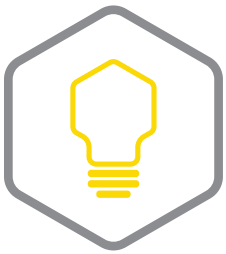
» **Provide stronger incentives for user-created content.** Most platform owners love user-created content—it comes free of charge and makes these platforms more valuable. But content creators have limited rights on these platforms: policies can change and content is often used as a lock-in strategy (i.e., leave the community and your content gets left behind). Blockchain NFTs provide a way to permanently assign ownership rights to user-generated content (and potential revenues associated with it), creating powerful contribution incentives.

» **Allow others to extend and innovate enterprise processes.** Putting NFT assets (and the smart contracts to manage them) on the blockchain is an easy way to allow others to integrate with and extend your business processes. It's like an open application programming interface for your business, but it provides visibility and access to the extensions that others have built. Implementing business processes in smart contracts and NFTs also makes businesses themselves more modular, allowing easier integration after a merger or acquisition.

NFTs are still bleeding-edge technology: adoption is limited, standards are still evolving, and blockchain itself is still contending with scaling challenges.

» **Explore pragmatic approaches to transformation.** NFTs are still bleeding-edge technology: adoption is limited, standards are still evolving, and blockchain itself is still contending with scaling challenges. The result is that any major initiative must still pick and choose among a rapidly-evolving series of technology and blockchain options. It requires a pragmatic approach focused on goals and user experience—and only then adopting the technologies and features that can enable it.

» **Try prototyping with off-the-shelf options.** A variety of marketplaces and services are now available to help issue and manage NFTs, and libraries and development tools help simplify the process of working with smart contracts. In short, experimenting with NFTs has become easier than ever. Why not test new concepts or develop minimum viable products?



About the Blockchain Research Institute

Co-founded in 2017 by Don and Alex Tapscott, the Blockchain Research Institute is an independent, global think tank established to help realize the new promise of the digital economy. For several years now, we have been investigating the transformative and disruptive potential of blockchain technology on business, government, and society.

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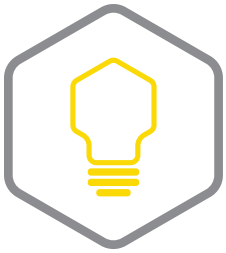

About the author

Alan Majer is the founder of Good Robot. For the first half of his career, Alan worked as a technology researcher and writer, helping to identify cutting-edge technology and business innovations. Today, Alan also works with technology hands on, exploring the potential of connected sensors and the Internet of Things, new display technologies, machine intelligence, robotics, and interactive interfaces. The result is exciting new opportunities to innovate and transform client experiences, and the ability to combine strategy and research activities with a real-world approach to their implementation. Alan is an active member of the local "maker" scene, frequenting spaces like HackLab.TO and InterAccess. He holds an MBA from McGill University.

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Disclosures

As of the date of this initial publication, the author has no professional or personal affiliation with or ownership stake in any company or agency discussed in this paper. He is, however, the proud owner of several CryptoKitties.

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