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# Blockchain gaming: An analysis of the use of blockchain technology in the video gaming industry

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# Sommario

I videogiochi stanno diventando un caso d'uso sempre più popolare di technologie blockchain. Lo sviluppo di videogiochi spesso utilizza la tecnologia al suo limite, scoprendo soluzioni ottimali a problemi comuni. Questa ricerca ha l'obiettivo di determinare le limitazioni di questo tipo di applicazioni e i potenziali benefici di un'integrazione con la blockchain, constatando se i videogiochi dApp sono un argomento degno di nota.
In questo contesto, le dApp sono applicazioni senza un server centralizzato basate su una blockchain.

Un'analisi è stata fatta sui progetti più interessanti, identificando i vantaggi e i limiti ottenuti dall'uso di una blockchain.
I principali vantaggi trovati sono il reale possesso di oggetti virtuali e un coinvoglimento maggiorato da parte degli utenti, mentre le principali limitazioni sono la scalabilità e la velocità delle transazioni.
I risultati ottenuti indicano che l'utilizzo di blockchain aggiunge valore quando è un aggiunta a videogiochi esistenti invece di essere uno dei fattori predominanti, specialmente in giochi dove è presente un'economia interna.

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# Introduction

Creating a real-time interactive experience requires levels of optimisation that are generally not needed in common use-cases.
Videogames are the most popular form of interactive experiences, and their development can lead to innovative solutions that can be scaled back to improve the underlying technology in a variety of ways.
From the improvements to rendering techniques in the early days of 3D games to the recent advancements in network optimisations needed to stream videogames over the internet, gaming has often been used as a way to push technology to its limits, while also popularising it to the masses.

A blockchain is a list of records that are linked together using various forms of cryptography. It is an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way. It usually uses a peer-to-peer network to communicate and validate new blocks. Once a block is recorded in a blockchain, it can no longer be altered without altering all subsequent blocks, which required a consensus by the majority of the nodes hosting the network.

The first blockchain was developed in 2008 by Satoshi Nakamoto to handle the ledger of the Bitcoin cryptocurrency. The use of blockchain made Bitcoin the first digital currency to not use a central server to handle and inspect its transactions, making it completely decentralised.
Blockchain has since evolved to handle a variety of use-cases that extend fur-

ther than verifying currency, such as automating contracts, securing financial services, handling large scale logistics operations and gaming.

This thesis aims to investigate how the most popular games in the blockchain space use it, and how it benefits them.
We will analyse the common problems and pitfalls encountered and the various ways the developers handled them to deliver a quality experience nevertheless.
This analysis will shed light on the different methodologies used to handle limits in regards to speed and scalability, essential to the widespread use of blockchain.
Another essential factor that will lead to the popularity of blockchain technology is the user experience; as games are user-oriented, they need to teach players the complexities of blockchain in an accessible way and help them through the process of setting up wallets and configuring nodes.

The first chapter of the thesis will focus on explaining the concepts of smart contracts and decentralised applications, while also exploring the variety of uses such technologies can have to familiarise the reader with these concepts.
The second chapter will explore how the gaming industry has approached blockchain technology, the implications it can have on the gaming landscape, how it influenced different types of media, and what the main accomplishments thus far have been.
The third chapter will analyse four of the most exciting projects, selected for the different approaches they take in regards to their integrations with a blockchain. For each project, their blockchain will be analysed, along with the interaction with its users and the common pitfalls developers have encountered.

# Chapter 1

# Decentralized applications

In this chapter, a definition of a *decentralized application* will be given. Then, an analysis will be done on the possible classifications that reflect how the dApp interacts with its blockchain.
In the chapter's conclusion examples will be given of the main categories of dApps, with a brief description of the most popular ones to familiarise readers with the concepts presented.

## 1.1 An introduction to dApps

A *smart contract* is a protocol created to facilitate an exchange between **two** entities using a digital platform in a way that is easy to verify and enforce.[1]
This agreement will be distributed across a decentralized blockchain, making the whole process trackable and irreversible.

An example of a smart contract could be an automatic form of employment between two parties, Party A tasks party B with the creation of a website for a set amount of money. A smart contract is made between the two, and A transfers the money in the smart contract. Once B has completed the task, he also submits it to the smart contract for approval, and once approved, the

payment is automatically made to B.
If B does not complete the task in the predetermined amount of time the contract is void and the funds are reimbursed to A.
Using a smart contract permits both parties to remain completely anonymous while still being able to engage in a trusted transaction, without the need for a central authority overseeing and enforcing the design.
Only in the case of a dispute between the two parties will an external, impartial judge be brought in to settle it.

A *decentralized application (or dApp for short)* is similar to a smart contract, but it lets an unlimited number of parties participate on both sides.
Any application that uses a Peer-to-peer system is an example of a dApp, all the parties make a portion of their resources available in exchange for the resources of other participants, without the need for central coordination by a single server.
Some examples of such applications are Tor and BitTorrent.

### 1.1.1 A definition of blockchain dApp

In this dissertation, we will focus on the dApps that use some blockchain to operate. From now on any mention of a dApp will refer to dApps that operate on blockchain, unless specified.
The following criteria define a blockchain dApp:[2]

- The application's data and record of operation must be cryptographically stored in a public, decentralized blockchain to avoid any central points of failure.
- The application must use a cryptographic token. This token will be necessary to access and use the application; any contribution of value should be rewarded with the application's token.
- The application must generate tokens according to a standard cryptographic algorithm acting as a proof of the value nodes are contributing

to the application.

- The application must be completely open-source, it must operate autonomously, and with no entity controlling the majority of its tokens. The application may adapt its protocol in response to proposed improvements and market feedback, but a consensus of its users must decide all changes.

The leading example of a dApp is Bitcoin.
Bitcoin has all the cited characteristics, it is entirely open-source, no entity controls it, and all the records related to its use are public.
Furthermore, Bitcoin generates its token, the bitcoins, using an unchangeable algorithm that rewards entities that confirm the transactions and produce new blocks to the chain.

### 1.1.2 Types of dApp

A classification of dApps can be made based on the type of blockchain they use so that any dApp will fall into one of there three types:[2]

- Type 1 dApps create and are based on their blockchain. Bitcoin falls into this category as do Ethereum, Ripple and other cryptocurrencies.
- Type 2 dApps use the blockchain of a type 1 dApp. These dApps are ofter protocols and have tokens that are necessary for their function.
- Type 3 dApps use the protocols of a Type 2 dApp. Type 3 dApps are also protocols and have tokens necessary for their function.

A real-life analogy for this classification would be all the actors involved in the building and furnishing of a house.
Type 1 dApps are the architects that build the foundation of the house.
Type 2 dApps are the electricians that lay the electrical wiring of said house.
Type 3 dApps are the manufacturers of appliances that require electric current to operate.

Some examples of type 2 dApps are Azure Blockchain and Cryptokitties, both based on the Ethereum blockchain. Moreover, any app that uses the Azure Blockchain infrastructure is a type 3 dApp.

### 1.1.3 Tokenization of dApps

The difference between a dApp and a standard application does not only lay in its infrastructure, but also in the way it interacts with its users.
This model allows them to get directly involved in the project, either by providing resources or by helping contribute to it. These interactions will be incentivized by the exchange of tokens that will possibly increase in value with the success of the application. Users effectively become stakeholders in the project.

These tokens will also be used by the users to establish consensus about changes to the application or decisions that need to be made.
There are two common ways in which this is achieved:

- **Proof of Work (PoW)**: Decisions are made based on the amount of work each stakeholder makes to enable the dApp operation. In this case, the stakeholders will be called "miners"; this is the way Bitcoin operates.
- **Proof of Stake (PoS)**: Decisions are made based on the share of the dApps' tokens that each stakeholder has. The decision of a user with 10% of the total amount of tokens will be weighted as 10% of the total votes; this is the way Ethereum operates.

Each methodology has it is strengths and weaknesses; for example, PoW uses too much power. At the same time, PoS is more vulnerable to 51% attacks, because of this some cryptocurrencies decide to use both of them as the two mechanisms are not exclusive and can be used concurrently.

Choosing a methodology for reaching consensus also influences how coins are distributed.
By choosing a PoW approach, the dApp will need to reward the users for their contributions to the operations of the blockchain. Rewarding users for their contribution is commonly referred to as *"mining"*. Meanwhile, to choose a PoS system, the tokens will firstly need to be distributed across all interested users through an initial fundraising mechanism, called *Initial Public Offerings*.
This methodology can be further refined by allocating a percentage of tokens to be distributed with development mechanisms implemented further on in the dApp lifetime, such as public bounties or ambassador programs.
As was the case with consensus mechanisms, distribution mechanisms are not exclusive and can, and are often, used together.

To summarize, a dApp has all its backend code running on a decentralized infrastructure, a blockchain in our case, instead of a centralized server. This infrastructure will need to be written with specific programming languages linked to the blockchain it is based on, such as *Move* for Libra's blockchain and *Solidity* for Ethereum's.
The dApp will still be able to have frontend code running on the users' machine in order to make interactions possible, and this interface can be written in any programming language.

This new way of developing applications has the potential to become the standard as it offers a high degree of trust, flexibility, scalability and user incentives with a lot less operating and developing costs than the corresponding centralized alternative.

Throughout this dissertation, we will mainly focus on Type 2 dApps and, as we will inspect the most popular ones, they will primarily be based on the EOS, TRON, Steem, and Ethereum blockchains.

As it was for the differentiation between a decentralized app and a blockchain decentralized app, every mention to a dApp from now on will refer to a Type 2 blockchain dApp, unless otherwise specified.

## 1.2 Examples of categories of dApps

After the popularisation of the Ethereum Blockchain, developers have taken an interest in this new form of applications, experimenting with already proven concepts and trying out new ways of interacting with their users.
Some dApps are now fully-featured applications with user counts reaching the millions, while others are still in development or have been abandoned by their developers.

As of December 2019, *State Of The dApps* lists 1.5k current active dApps, with a total of 70k active users making 1 million transactions every day.[3]
The main bulk of users is divided between dApps categorised as "Finance" and "Marketplaces", with the rest of the users mainly divided between "Gaming", "Gambling", and "Marketplace" type of dApps.

Various websites have taken on the job of archiving, tracking and categorising all known dApps for easier access and discoverability.
Each website categorises them using different sets of criteria, here are listed the most common categories and the most popular dApps contained in them according to *dapp.com*[4], *State Of The dApps*[3] and *dApp Radar*[5].

Here we will list the most common classifications of dApps, along with the leading examples in each category, so that we can understand the breadth of use cases that this technology has, before focusing on the topic of this dissertation: Gaming dApps.

### 1.2.1 Finance

Finance centred applications are software that involves multiple business processes intending to deal with money.
They usually provide users with tools that facilitate handling transactions and controlling their money flow or spending.
Fintech is one of the fastest-growing fields in app development, with some successful examples like *Mint*[6], a personal finance manager, and *Revolut*[7], a completely digital bank.

One of the leading examples of a decentralised Fintech app is *Aave*[8], a lending pool based on the Ethereum ecosystem.
Users can participate as depositors or borrowers. Depositors stake a share of their assets and provide liquidity to the market while earning a passive income in the form of *aTokens*. At the same time, borrowers can easily borrow in both an overcollateralized and undercollateralized way.

### 1.2.2 Marketplaces

Applications categorised as marketplaces involve listings of classified advertisements between users, or listing of business offering certain types of services. The most famous example of a centralised application of this type is *Uber*[9].

The primary decentralised rival is the *Origin protocol*[7] . Origin powers decentralised, peer-to-peer marketplaces without the need for a middleman. This approach provides users with an average 20% savings as the developers do not get a percentage of each sale, relying instead on the growth of its token.

### 1.2.3 Exchanges

Applications listed under the exchanges category are similar to marketplaces but involve trading of stocks and cryptocurrencies.
Centralised solutions rely on a trusted entity that will manage the funds of the end-user, enabling them to exchange their cryptocurrencies with different kinds for a fee.
The most used centralised app that offers this kind of feature is *Kraken*[11].
Relying on a single entity leads to substantial security problems, its not uncommon to hear of big exchanges shutting down or being hacked, most famously with the case of Mt.Gox, a leading exchange that shat users off their accounts leading to the loss of 850,000 bitcoins with a total worth of around $450 million.[12]

The lack of security is one of the primary motivations for the rise of decentralised exchanges.
These dApps directly connect users willing to trade with each other in an automatic, secure and anonymous way.

The leading example of this is the *0x protocol*[13], built on the Ethereum blockchain. It enables the peer-to-peer exchange of assets. Every transaction is made directly wallet-to-wallet, with no deposits or withdrawals made on the 0x platform.
The use of 0x protocol is not limited to cryptocurrencies but to every asset that adheres to the ERC-20 standard.

### 1.2.4 Social

Social applications include all the tools that facilitate communication on the internet, typically utilising social networking or text and video messaging.

A perfect example of a centralised application would be *Facebook*[14], free to use for the user since it monetises the users' data and interactions.

A decentralised approach to social media would enable the sharing of the revenue generated by users' attention between shareholders and users, rewarding and promoting engagement with the platform and other users using the platform tokens.
One such example of this type of social media application is *Steemit*[15], a decentralised blogging app that rewards users for posting, curating content and voluntarily sharing information with advertisers.

### 1.2.5 Development and services

Decentralised applications are used to remove the middleman in the delivery of standard internet services. Reducing the cost of operation for the user while rewarding the new decentralised providers.

A big internet problem tackled by a dApp is web advertising.
The *Basic Attention Token*[16] project consists of a browser that lets advertisers know how opted-in users spend their time and the level of engagement they have with their products.
This transparency creates a direct digital advertising market where publishers have direct feedback on their reach, while users are rewarded with tokens and more secure ad experience.

### 1.2.6 Security

Decentralised applications listed under the Security category do not usually have a centralised alternative.
These applications use the blockchain to validate and certificate information in a trustworthy and easy to access way.

The leading dApp in this category is *Chainlink*[17].
The Chainlink network provides reliable tamper-proof connections to external resources, such as off-chain data and service APIs. Both the input and outputs of a complex smart contract can this way be securely validated to work interconnectedly with other Ethereum dApps.

Decentralisation is also utilised for the certification of digital assets, in a way to quickly and efficiently defend users from fraud.
The *V-ID*[18] validation platform undertakes this problem as its primary mission. It uses the blockchain to store digital fingerprints on files. Users will be able to quickly check the authenticity of the document they received by checking this fingerprint, much like the use of a PGP key.

In conclusion, many dApps offer new prospectives on typical applications or fundamentally change the framework of modern software development.
Having investigated the range of diverse dApps, we will now examine how dApps can influence the gaming medium.

# Chapter 2

# The blockchain gaming ecosystem

In this chapter, the main motivations and advantages behind the rise of blockchain gaming will be explained.
A digression will be made about the primary benefits and drawbacks that come from the use of bockchain in gambling. No further focus on gambling will be made because, even if it is classifiable as gaming, it is not the type of gaming under analysis.
Then, the chapter will continue in an examination of Non-Fungible Tokens, explaining the most popular types and how they relate to different media.
In the chapter's conclusion, a brief history of decentralised applications will be told to show how the technology quickly grew and adapted to the different challenges, ending with the most current trends.

## 2.1 An overwiew of gaming on the blockchain

The video game industry consists of all the companies centred around developing, marketing, and monetising videogames. It is estimated to have a global worth of $152 billion as of 2019, with the main markets centred in the Asia-Pacific region and North America, with just China and the USA

making up for almost 50% of all consumer spending.[25]

Despite the increasing worth, developers and consumers alike are finding themselves dissatisfied by the ever-increasing stagnation of the market.
Consumers are regularly exposed to predatory behaviour from the games publishers, with microtransactions and loot boxes becoming the primary way of monetisation in most of the popular titles.[26]
Furthermore, small developers are finding it hard to stand out in a market dominated by giant companies that dwarf them through marketing or polish, with the average indie developer earning only around $10 thousand a year.[27]

This monopoly by a small set of giant companies has become further apparent with the recent popularisation of the "Games as a Service" business model. Games released under this model require a constant internet connection to play, with all the players' information stored on a centralised server owned by the developers. This centralised behaviour means that users can be completely shut out from their purchase once the game servers are shut down by the developer, a common occurrence with unsuccessful or older titles.[28]

Some developers claim that the introduction of blockchain can solve many problems with the current gaming industry. They say that the proper execution into online gaming can revolutionise how players interact with the game and with each other, leading to new designs and genres and the improvement on already existing concepts.[29]

Integration of blockchain technology in traditional gaming has already started, with almost half of the most used dApps being games, totalling a unique user count of around 20 thousand every week.[3]
While still being a niche market, game designers have proven the workability and the profitability of blockchain games, with some of the most famous examples even clogging the blockchain on which they are based.

The prominent example of this is CryptoKitties, which blocked the Ethereum infrastructure at the peak of its popularity in 2017, making up 25% of the total transactions at the time.[30]

We can divide the potential benefits that come from the implementation of blockchain in two categories: The benefits for developers and the benefits for users.

The main benefits for users are the new ways that they can interact with the game and mostly stem from the concept of real-world ownership.
Digital tokens represent game assets, which are stored in the players' wallet, giving them total control of their use. Ownership of the items empowers them to recive a tangible output from their efforts, as they will be able to trade and sell them even after the game shuts down.

From the development perspective, we find that most of the benefits come from the reduction of upkeep costs and enhanced engagement from the user-base.
As players will be made stakeholders of the project, they will be more motivated to invite new users, marketing the project via word of mouth. A dedicated community of involved players can also keep a game alive even after development's end via content creation and modding.
Moreover, having a tokenised structure lets developers host their game entirely on the blockchain, outsourcing all network fees to miners and validators. It is possible, and regular, for an online blockchain game to have no expenses of upkeep.

All these characteristics and more will be further analysed in a different part of the dissertation, also putting a focus on the various drawbacks that come from the use of blockchain technology.

## 2.2 An analysis of gambling on the blockchain

Online gambling refers to any form of gambling that is conducted on the Internet. Numerous sites offer a variety of services related to gambling, with virtual lotteries, slot machines and sports betting being the most common examples.

Much like its physical counterpart, online gambling is heavily regulated, or outright banned, in most of the world.
In countries where online gambling operations are allowed, they are often required to hold some form of licence and can be held accountable if any of their users break gambling laws.
All of the numerous legislations do not seem to stop the market from growing, with multiple online casinos and other forms of gambling thriving every day.

The total worth of the online gambling market is estimated to be around 40 billion dollars as of 2018, with the certainty of further growth.[19]
Many developers are starting to see blockchain as a way to disrupt the gambling market, bringing the advantages of a decentralised solution while trying to find a way into the large market share of online casinos.

### 2.2.1 The good

There are many ways in which the use of blockchain can significantly improve online gambling. The most apparent form of improvement is the reduction of transaction fees.
With an estimated daily turnover of 200 thousand dollars[20], the reduction of fees would mean a massive decrease in the running costs of a casino.

These transactions would also be very fast, removing one of the chief complaints of traditional gambling, and most importantly non-reversible, pre-

venting fraud for the operators while also guaranteeing transparency in the deposit and withdrawal processes for the user.

The transparency will also be expanded to all the functions of the casino, leading to trust in what would be an otherwise untrustworthy situation.
Most online establishments are entirely closed source, with no way for the users to know the fairness of the games other than relying on external certifications organisations that also frequently keep their certification processes secret.
The decentralised nature of a gambling dApp provides the user with all the information needed to verify that operators are not cheating them.

Another advantage for the users of gambling dApps is the possibility of playing in a houseless casino. By adding a fee to every transaction, the operators can profit on the number of users instead of the number of user losses, opening up the opportunity of removing the house edge, often necessary to turn a profit. Furthermore, providing a fair environment for users.

### 2.2.2 The bad

All the different laws and regulations associated with online gambling lead to a complex entanglement of red tape that, while being difficult to understand under normal conditions, becomes exceptionally complicated with the introduction of decentralisation.

For regular types of gambling sites to operate legally, they need to obtain gambling licences from approved licensing authorities. The authority is entrusted with certifying operators' adherence to the correct practices and laws for the country in they are located.
This condition immediately becomes a problem in a decentralised application, as it does not have any single state from which it operates, thus not being obliged to rely on any form of legislation.

For now, the legislation regarding the use of cryptocurrencies in the gambling market is still very immature, leaving much room for grey-area operations that revolve around a lack of laws.
Most of the nations in which gambling is regulated do not recognise cryptocurrencies as a real currency, rendering all existing legislations void when applied to decentralised alternatives.

Another tricky factor that often comes into the discussion when talking about the regulation of decentralised gambling is the users' anonymity.
While being a crucial aspect of blockchain technology, this characteristic hinders legislations as it renders almost impossible any form of investigation into the users.

A complete lack of user identification removes the possibility of blocking access to users from countries where gambling is illegal. Countries with strict gambling policies are forced to straight-up ban all forms of cryptocurrencies, such as is the case of China.[21]
The anonymity also makes it easier for underage teenagers to get involved in illegal gambling. While also making it more challenging to enforce protection mechanism against compulsive gambling behaviours, leading to a potential increase in social costs.

### 2.2.3 And the ugly

One of the main counterpoints against the popularisation of decentralised casinos is the volatility of the cryptocurrencies on which they are based. Users end up not only gambling on the outcomes of the casinos' games but also in the rise of the value of the cryptocurrency.
This volatility leads to situations in which users may end a gambling session with a positive-sum of cryptocurrency while being at a net loss in fiat currencies.

Being such a new and unproven technology also attracts a lot of malicious actors that try to scam users using the same characteristics designed to keep them safe. It is not unheard of companies and dApps suddenly shutting down all operations and disappearing without a trace in what is called an "Exit Scam". A recent example is the decentralised gambling platform JoyToken, closed after a successful ICO of $3.3 million.[22]

Other forms of fraud can involve illegal money-making projects such as Ponzi schemes, which had a decentralised resurgence with the rise of cryptocurrencies. Famous examples include the OneCoin scandal, one of the most profitable cases of blockchain fraud [23], and PonziCoin, a dApp that mocked blockchain Ponzi schemes while also being one of the best examples of it.[24]

### 2.2.4 Popularity

An analysis of dApp usage using dAppRadar reveals that an astonishing amount of transactions on the EOS and TRON blockchains are linked to gambling applications, being as high as 70% in the case of EOS and 90% in the case of TRON.

Users are even more attracted to dApps in the "High Risk" category, where only apps of dubious nature are listed. Websites even warn potential users about the sketchy nature of these dApps, suggesting not to interact and send money to them.
However, this does not seem to stop the popularity of these kinds of applications; it seems that even in the decentralised ecosystems users care less about security when there is a possibility of making money in a fast, albeit risky, way.

## 2.3 Non Fungible Tokens

*Non Fungible Tokens (NFTs)* are unique digital tokens traded on the blockchain that describe items.
They have a vast range of use cases, with the most commons being digital art ownership, collectables, domain names and records for physical assets.

Fungible items are defined as *"being something (such as money or a commodity) of such a nature that one part or quantity may be replaced by another equal part or quantity in paying a debt or settling an account"*.[31]
Non-fungible goods, by contrast, cannot be interchanged, making them unique. This category includes an endless range of items, such as people, furniture or artwork.

The concept of non-fungible digital items exists from before the emergence of cryptocurrencies; every unique digital asset is by definition, non-fungible. For example, domain names, digital tickets and usernames are some of the most common variations of non-fungible digital assets. Definitions start to get murkier when the concept of ownership is brought up.
While users feel like they own their digital assets, most of the time, they are only renting licences to the content, with the owner still being of the provider.[32]

The use of blockchain technology facilitates the concept of digital ownership, adding several unique proprieties to non-fungible assets while also increasing the level of interaction that users can have with their proprieties.
In the blockchain ecosystem, fungible goods are common in the form of cryptocurrencies, and every standard token is considered a *Fungible Token*.
Meanwhile, *Non Fungible Tokens*, the blockchain equivalent of Non Fungible Assets, did not become commonplace until the popularization of the ERC721 standard, introduced by Cryptokitties.

### 2.3.1 Standards

Three different standards make up the basics of the current NFT ecosystem, and they differ from each other on some key characteristics.

The ERC721 standard is the first and most basic form of NFT, it consists of a mapping of unique identifiers, each representing a single asset, to addresses, which represent the owner of said asset, and a function to transfer the token to another address.[33]

The ERC1155 standard implements a concept of semi-fungibility. An ERC1155 ID is not a unique asset as it is for ERC721, but rather a class of assets with a limited supply. This new standard has been widely adopted as the new default because of its status as a superset of ERC721. It is possible to simulate an ERC721 token by creating a class with a total supply of 1.[34]

The ERC998 standard, also called Composables, provides a protocol in which NFT can own other assets. The transfer of one of these assets will also lead to the transfer of all of its belongings.[35]

### 2.3.2 Main characteristics

The standardization of the concept of a digital asset led to advancements in multiple characteristics of decentralized applications, with the main one being interoperability between different applications.

With the introduction of ERC721, assets are no longer usable by only a single application, but instead by any dApp that is programmed to recognize that type of ID.
For example, a user can receive a piece of artwork as a reward from a game, and then expose it in a museum dApp, without the need for any additional code.

This interoperability also leads to an ease of tradability, removing the barrier of entry for new users, in turn increasing the liquidity of the market.

Like traditional digital assets, NFTs are fully programmable, making it possible to integrate functions directly into the asset. The programmability leads to a vast amount of possibilities for developers who can create unique behaviours for different assets.

### 2.3.3 Uses in gaming

The ERC721 standard was created to operate a game, so it is to no surprise that the most popular form of dApps that use NFTs are blockchain games. These unique tokens often represent items that a player can earn in-game or some other asset that a player may own.

The interoperability has been used to effectively create game "universes", made up by different games that share the same items, rendering it possible for players to advance in one game while playing in another.
This integration can happen even without the knowledge or help of the original developer with what are called *layer two games*, games which function with the use of tokens acquired only in other games.[36]
The first "layer two" games were built using the Cryptokitties tokens by third-party developers with no affiliation to the original teams. Users could play various games using the kittens that they had bred in the main application.
The original developers, in turn, incentivized this kind of applications by allocating fund to finance a official *Kittyverse*.[37]

### 2.3.4 Uses in the art world

Cryptokitties were inspired by another project, *Cryptopunks*.[38]
This project featured a limited supply of original collectable characters with proof of ownership, all stored on the Ethereum blockchain. Cryptopunks is commonly associated with the rise of the CryptoArt movement.[39]

The demonstrable uniqueness and scarcity of these digital artworks have proven successful in the art world, leading to the creation of various artwork marketplaces[40], and the popularization of virtual museums.[41]
This digital art movement has also translated into the real world, with brands like Nike planning to distribute their shoes with unique digital artworks [42], and with the surge of real-world auctions for crypto artworks.[43]

## 2.4 History and evolution

With the rise of cryptocurrencies, many experiments were made to gamify the interaction with the blockchain. Here we will get a bird's eye view on the main contributors to the foundation of today's market and how they shaped what would come to be.

### 2.4.1 The beginning of cryptocurrencies and gaming

The first significant occurrences of blockchain with gaming date back to 2013, with the popularisation of faucets.
Faucets are a way for people with Bitcoin wallets to gather minimal amounts of the currency for free. Websites would give away Bitcoins to users through these faucets for promotional purposes or to incentivise potential users to try the website.

One most the most popular faucet was Gambit, an online website which offered various small multiplayer competitive games, such as battleships and Monopoly.
Players could wager Bitcoins on the outcome of the games, each player adding to a pot that would go to the winner. They could also play certain games for free, with tiny Bitcoin prizes awarded to the winner by the platform.[44]

Other examples of early integration of blockchain with gaming were plugins in popular games, such as Minecraft. Different servers around 2013 offered Bitcoin faucets for recurring players, with Bitcoins being the centre of the servers' game economy.

Many of the faucets of that period quickly went out of business; the surviving ones pivoted their business strategy away from faucets or cryptocurrency altogether.

### 2.4.2 Games hosted on the Blockchain

One of the first and most famous examples of games entirely hosted on the Blockchain is Huntercoin.
Huntercoin started as a 1-year experiment in 2014 to test how well a blockchain network could handle thousands of transactions happening in real-time, but due to an explosion in popularity development continued and it is still active to this day as an open-source initiative.[45]

The game consists of a massively multiplayer game, in which players were tasked with gathering the titular Huntercoins and killing other players.
The coins collected through what the game calls "human mining", the gathering of the coins from the game world, are added to the player's wallet when they deposit them into a bank. If a player dies while holding the coins, they will all be dropped and collected by the killer.
Moves and actions players make are stored as a transaction on the Hunter

blockchain, along with the world's information.
Every detail related to the game is ultimately stored in the blockchain.

Any player who wants to access the game downloads a client and becomes a node in the blockchain, mining for blocks to verify the game's integrity.
Miners are compensated with only 10% of the block reward, instead of getting the full recompense like in more traditional blockchains, and the other 90% is distributed in a random location of the game's world as an objective for players to get.

### 2.4.3 Cryptokitties

Cryptokitties are digital, collectable cats built on the ethereum blockchain as NFTs. Born from a Hackathon idea and released officially in November 2017, they had a considerable impact on blockchain gaming by creating new standards and being one of the first gaming projects that garnered massive popularity.
A player can breed two different cats to create a third one, with its phenotype determined by the shared genetic proprieties of his parents, along with random mutations.

One of the pioneering features of Cyptokitties was the introduction of the ERC-721 protocol for NFTs, which rendered each kitten unique instead of being another form of cryptocurrency.
Each token also contains the genetic code needed in the breeding process, making the creation of a new token completely automatic.
Another innovation made by the Cryptokitties project was the introduction of a Dutch auction for the distribution of the initial tokens.
In this type of sale, prices are set arbitrarily by the seller, and they decrease as time goes on. The winning bid is the first bid that accepts the current price.
This was made to contrast the high gas fees needed to run a classic auction

using blockchain and because asking users to pay just to bid on the auctions was deemed lousy user experience.

After their introduction, the project blew up in popularity, with one of the auctions closing at 253 ETH ($110,000) and completely blocking the Ethereum network with breeding transactions for a week.[46]
This was one of the first indications that traditional blockchain was not meant for gaming. Other similar projects soon followed, selling a low quantity of high-value items used only for speculation.

### 2.4.4 Layer-two games

With the popularisation of NFT across different projects, the interoperability of this new type of assets became a defining feature across various type of games. These new "layer two" games used NFTs from other games to fuel their gameplay. Players could only access these games by using items they had acquired from other sources.
Extending the Cyptokitties example, independent developers started creating games in which users could interact with their kittens in multiple ways, from playing with them to using them in races or card battles. These indie projects later became official games under the Kittyverse, an incubator for layer-two games based on the Cryptokitties assets.

### 2.4.5 Gaming blockchains, off-chain games and Sidechains

As more projects started development, problems with using the blockchain as a gaming platform were quickly discovered, transaction fees and low response times meant that more complex games were not feasible with the current technology. The current iteration of blockchain games usually try to solve these problems in one of three ways:

Off-Chain Games are games that interact with the blockchain only for part of their functionality.
This definition, for example, includes dApps in which the asset ownership is proven via blockchain, while all the game logic, data and interactions are stored on a centralised server.
This approach gives the developers all the flexibility they need with proven infrastructures while decentralising only the parts that need it.

Sidechains are multichain platforms interoperable with different blockchains, capable of hosting applications that require a high amount of transactions.[47] Developers can deploy their dApps on a sidechain and interact with other blockchains via the use of standardised APIs, using the same code to interact with smart contracts of several blockchains.
A game hosted on a Sidechain is comparable to Off-Chain games where instead of using a centralised server the dApp is hosted on a separate blockchain.

Completely dedicated gaming blockchains have also been developed, offering serverless, decentralised hosting at fast transaction speeds by using the players' computers as nodes.
However, this approach is reliant on the game's popularity to keep it running, making it a risky choice for developers.

# Chapter 3

# Analysis of the main gaming dApps

In this chapter, an analysis of some of the most intriguing projects is made.
A significant focus is put on how they handle the interactions with the blockchain, how users can use the applications' tokens, and in what way the use of blockchain technologies benefits them.
The applications have been chosen for their different use cases and technologies utilised.

- Forgotten Artifacts uses a sidechain to power most of its transactions.
- Socios creates a decentralised voting platform.
- Decentraland proves ownership of virtual land hosted on a decentralised content distribution system.
- Tauron uses a custom blockchain to host the game world and its interactions.

## 3.1 Case study : Forgotten Artifacts

*Forgotten Artifacts* is a hack and slash game in which players explore dungeons in an isometric view of the world.[51]
While exploring, the player can complete quests and find treasure chests that contain loot and equipment to grow their characters and become better at the game.
The game is realised using the Unity engine, a free tool suite for game development, and uses the Enjin sidechain to handle blockchain transactions.
Some of the items that the player can find are ERC-1155 tokens; the player can trade or sell them as part of the game economy.
The closest centralised equivalent to Forgotten Artifacts is the Diablo franchise.
Developed by Blizzard, with the first entry being published in 1997, the saga garnered massive success right from the beginning, with the last entry, Diablo 3, coming out in 2012.

### 3.1.1 Implementation on the blockchain

Forgotten Artifacts uses the *Enjin Wallet* to manage all its blockchain assets, which are represented by *ERC-1155* tokens hosted on the Ethereum Mainnet.
The Enjin Wallet is part of the *Enjin platform*, a sidechain especially created for gaming, and it is powered by *Enjin Coins* (ERC-20 Tokens) to handle transactions.[52]

Enjin is a decentralised platform designed to manage different kinds of transactions that centre around gaming; with the main ones being microtransactions, gift cards, subscriptions distribution and trading of virtual goods. It aims to be a simple addition to traditional games, easy to use for players and easy to implement for developers.

The platform is based on the Ethereum Mainnet, so the transactions confirmations are limited to the block speed of Ethereum, which can be quite slow when there is much traffic, and can not be sustainable for enjoyable user experience.
Enjin gets around this limitation by using a system of off-chain notification from the developer to the platform.
Trusted Platforms, applications developed with the Enjin SDK, will send an instant notification to the user's Smart Wallet for each Transaction Request. When the transaction is accepted and created on the blockchain, the wallet will call the Trusted Platform API with the transaction to watch. The game or website can then be updated immediately with a temporary placeholder item that will not be tradable. Once the transaction is approved, the placeholder is replaced by the real object.
In the case of currency transactions, the user balance will immediately be updated, but any unconfirmed portions will be locked until they are confirmed on the blockchain.

### Distribuion of tokens

Enjin Coins work on a PoS protocol, 1.000.000.000 coins have been minted during the ICO. The coins have been distributed between pre-sale buyers (40%), public sale buyers(40%), operational tokens for marketing and promotion (10%), and payment tokens for the team and advisors (10%).
A new user can acquire tokens by buying them from other users via token exchange marketplaces.

### Interaction between the game and the Enjin platform

In Fallen Artifacts, developers create new blockchain items in a custom application developed by them. Here they set up various parameters that relate to the item, such as its rarity, and the number of copies it will have.
Once the item is created, it is added to the drop pool along with the other blockchain items.

When a user opens a chest or kills an enemy, they will have a small chance of obtaining one of these items.
To avoid congestion, the developers have implemented a queue system to batch various transactions in a single one, making use of the placeholder items system to keep the game functioning in the meantime.

#### Problems derived from the use of blockchain

The main problem that comes from using the blockchain in this implementation is the congestion of the network.
To avoid issues related to congestion, the developers have designed their blockchain interactions in a way that renders them less real-time. They also implemented ways to manually override processing if the processing time exceeds what is acceptable.

### 3.1.2 Token utilization

In Forgotten Artifacts, the users interact with NFT in the form of weapons and equipment. The equipment is entirely owned by the players, letting them trade it with others in the game economy.
The use of NFT also allows the developer to integrate particular objects from other games into Forgotten Artifacts, creating custom equipment for owners of particular custom coins. This is a heavy focus of the Enjin project for a shared Multiverse between all its games, where players will be able to play every game using the same equipment and items.

The Enjin platforms support a variety of uses; developers can integrate the use of Enjin Coins (shortened as *ENJ*) into their games in the following ways:

- Creating and Managing Virtual Goods:
  Developers can mint unique items, currencies, and privilege tokens using the platform by creating Mint contracts. These custom tokens are

backed with ENJ and are interchangeable between them. If the developer allows it, anyone will be able to send ENJ to the Mint contract to receive the custom coin, and vice versa, anyone can send the custom coin to the Mint contract to receive the equivalent in ENJ

- Community Integration:
  The ENJ ecosystem has an SDK for existing forums and websites, letting developers use the APIs to implement transactions directly in websites, enabling functionalities such as tipping, polls and rewards based on user engagement.

- Decentralised Payment Gateway:
  Developers can use the SDK to receive payments in ENJ Coins and all the Custom Coins in the ENJ ecosystem. A notable feature of this gateway is the possibility to have multiple payees, who will be specified in a contract during the creation of the gateway.

- Automatic Payments:
  Users will be able to allow trusted platforms to make payments on their behalf.

- Enjin Wallet:
  Users use the Enjin Wallet to interact with the ENJ ecosystem. Each user links it to their Ethereum Address. This wallet will handle all the user's ENJ asset, display any active API connection, automatic payments and subscriptions that the user may have set up.

- Virtual Stores:
  Users will be able to create virtual stores where they can sell and display any asset they have gathered in the ENJ Ecosystem. It also allows for custom scripting and automation.

- Subscriptions:
  Developers can create subscription services for users. Subscriptions

involve three parties: developers, users and Trusted Platforms. A developer can set up the subscription API in the Trusted platform which, when the user requests it, will send the terms of the subscription to the user's wallet. If he accepts, the subscription will starts and funds will start to be withdrawn from his account at regular intervals until the user stops the subscription, or the contract expires.

- Trading Escrow:
  Users can trade with each other setting up custom smart contracts containing trades. When all the requirements are confirmed, the trade between users happens, guaranteeing the safety of both parties.

### 3.1.3 Advantages from the use of blockchain

One of the most crucial parts of games of this kind is the loot economy; the game incentivises people to keep playing by rewarding them with powerful equipment. The most powerful items are also precious in the game economy, as they are sought after by most of the players. In these type of games, the economy is player-driven but entirely localised within the game world, meaning that the currency gathered in the game has no real-world value.
However, this did not stop the rise of grey markets in most popular games, where players exchange items with money using third-party marketplaces or directly between them. This leads to a large number of people getting scammed and losing their money or their items.
The use of blockchain lets the developers of Forgotten Artifact have a completely safe and integrated item economy that rewards players for their time.

## 3.2 Case study : Socios

*Socios* is a platform that lets sports fans take part in guiding the various decision making of their favourite team and having a more direct and impactful relationship with it with the use of Fan Tokens.[49]
*Fan Tokens* represent the tokenization of loyalty programs, proving the support of a customer through the number of tokens they hold in their account. Sport is one of the industries most dependant on fans engagement, making up their value mostly by brand equity[48], the value that derives from consumer perception of the brand name of a particular product or service, rather than from the product or service itself.
The brand equity is often bolstered via the means of fan clubs that offer interactions with the clubs' followers via events and meetups. The utilization of fan tokens brings a more engaging and innovative alternative to the traditional fan club.

### 3.2.1 Implementation on the blockchain

The Socios platform is a sidechain that holds and allocates the Fan Tokens to users. It is based on the Chiliz ERC20 tokens, which are part of the main Ethereum blockchain. The Chiliz tokens are associated with transactions from fans funding and withdrawing from the platform. The main token vault is also hosted on the Ethereum blockchain.

Fan Tokens are frequently utility tokens, meaning that they do not represent an entitlement to future dividends, but they provide access to functionalities from the service they are issued.
The tokens can then be used to vote on issues concerning matters of the platform, exchanged with merchandise, used to prove the requirements needed to access other forms of VIP statuses or different types of interaction with the Club.

### Distribution of Fan Tokens

A common way to handle an initial distribution of Fan Tokens is via a *Fan Token Offering*, it is comparable to an ICO, but the money gathered is not going toward building the application but towards fan events or merchandise. Usually, only part of the finite supply of tokens is offered in the FTO. The rest are handed out to participants during events, fan gatherings, raffles, or with the purchase of specific things as promotions.
If a user misses the FTO, these events will be the primary way of acquiring the tokens, other than buying them from other users. As the tokens are hosted on a blockchain, they are entirely in the user's ownership, who can exchange them with other members or platforms, opening up possibilities of social interactions and community growth.

### How Fan tokens distinguish themselves

The only differentiating characteristic of a fan token from a traditional token is the emphasis put on the support.
Whereas standard tokens represent a share in the platform or some way to access functionalities, fan tokens are used **only** to further affirm loyalty to the brand and drive customer engagement.
The owner of a fan token wants to be recognized for his support of the brand rather than being involved in the development.

### Token handling

Each Club that joins the platform will have its custom Fan Token made. The tokens will be offered via an FTO, in which users will be able to buy them using Chiliz tokens.
After the Initial offering has ended, users will be able to collect additional tokens in Token Hunts, Augmented Reality minigames that will have the users visiting Club locations to collect them in the real world.

### 3.2.2 Token utilization

Fans who obtain Fan Tokens gain voting rights for that team.
Each vote is executed as a smart contract. The Club creates a voting poll via the Socios platforms, and fans leverage their ownership of Fan Tokens to send them to various answers in that poll.
When an agreement is made, either by reaching a certain voting threshold or when a timer runs out, all votes become final and the results valid. All the votes and results will be stored in the Socios blockchain for transparency and auditability, ensuring that neither the Socios platform nor the organization fuelled by it can manipulate or ignore them.

Holding a Fan token lets users access to the Fan Token marketplace, where they can auction their Fan Tokens to other users in exchange of Chiliz tokens. Each transaction in the marketplace will involve a fee that will go towards the club owners and the platform.

### 3.2.3 Advantages from the use of blockchain

Creating a Fan Token system on the blockchain is mainly done as a straightforward way to implement a voting system using smart contracts. All votes will be calculated without a middleman and with a lower risk of manipulation from bad actors. The smart contracts will also be visible to the users, increasing trust between them and the platform.
Other benefits of tokenization are the reduced costs in infrastructure; As the users will have complete ownership of the tokens, the platform does not have to keep information on them.
Another critical factor in this decision is the scalability of a blockchain approach. The platform will be able to reach global audiences without the need to involve itself with the legislature of each marketable country.

## 3.3 Case study : Decentraland

*Decentraland* is an online virtual world where users can socialize in shared spaces, explore and interact with other people's creations.
Users who own LAND, the game's way to represent ownership with NFTs, have a right to some space in the world where they can build any 3D creation and add interactivity to it with various scripting languages.
This space will be placed in specific coordinates in the world, and all users will be able to find and view it.
The centralized equivalent to Decentraland is Second Life, also an online virtual world, developed by Lined Lab.
Published in 2003, it is one of the most lasting, largest and active online worlds, with almost a million active players even 17 years after it's release.

### 3.3.1 Implementation on the blockchain

Decentraland bases most of its systems on MANA, an ERC-20 token. MANA is the utility token of Decentraland, and it is mainly used to make micropayments towards all the nodes of the P2P network that hosts the virtual world.[55]
MANA is also used to back the value of LAND, via a conversion rate of 1000 MANA burned for the purchase of one parcel of LAND.
LAND are the Non Fungible Tokens that represent the ownership of parcels of land in the virtual world. Only the user who holds the LAND token associated with a plot can modify its contents; however, the tokens are freely tradable between users.

#### Blockchain validation of P2P sharing

The infrastructure behind Decentraland is organized in three layers: A Consensus layer used to track land ownership with the Ethereum blockchain, a Content layer used to distribute assets in a decentralized way, and a Real-Time layer used to enable interaction between users.

In the Consensus Layer, an Ethereum smart contract is used to maintain a ledger of ownership for all the various land plots in the world. Each plot of land is associated with a LAND NFT that contains unique X/Y coordinates, a reference to the owner and a content description file. The description file is comprised of a reference to a magnet link from which the user's client will be able to download all the objects, textures and sounds needed to render the scene from BitTorrent, the mechanics of this interaction are handled in the Content layer. Also included in the file is a reference to the server used to coordinate connections between users that are exploring that tile. Anyone can buy LAND by burning MANA with a smart contract that handles all new parcel registrations.
All new parcels are required to be adjacent to a non-empty parcel to guarantee the cohesiveness of the world.

### Blockchain for a network of microtransactions

Decentraland uses MANA tokens as a fast and low-cost way of transferring money.
Players can exchange funds between them for payments and services in the game without the risk of exposing personal details and credit card information to a third party.
Low transaction fees also allow for regular micropayments towards the node operators that power the infrastructure.
Instead of paying a subscription for every part of the game, users will directly send payments only to the nodes that they use.

### Token distribution

Despite being a PoS token, not all MANA has been minted at the creation of the project.
This project follows a minting process knows as *continuous token model*, where instead of only pre-selling tokens during a launch phase, the tokens

are minted as needed through various means.[56]
In the case of Decentraland, a public smart contract mints new MANA tokens to support development.
The price of exchange between ETH and MANA is decided by the consensus of a board of advisors, and it is regularly updated to follow the market price.
There is a cap on the amount of MANA that can be issued per Ethereum block; this is done to reduce inflation, limit price fluctuations and to restrict the annual increase of MANA tokens by 8% of the initial crowd sale.

#### Problems with using the blockchain

The main problem with using a blockchain to distribute content to users is the content curation.
Users can upload anything to the blockchain and have every other user see it without any form of confirmation or approval by a trusted party; this can lead to the sharing of copyrighted and illegal content.
This type of distribution also doesn't allow for personalized filtered experience for users who do not want to be exposed to specific kinds of content, such as gambling or violence.
The only system the developers have in place to combat bad behaviour is a community-driven reputation system that highlights good practices and hides the rest.

### 3.3.2 Token utilization

LAND Tokens are the certificate of ownership of a digital plot of land. The user will be able to create anything using traditional 3D modelling tools and place it in his plot of land.
MANA tokens are instead used as a utility token to interact with the world. Other than to acquire new LAND, MANA tokens are also used to purchase in-world goods and services, customize users avatars, and take part in the shared marketplace in which creators can sell digital items and accessories.

### 3.3.3 Advantages from the use of blockchain

Using a blockchain to verify content distribution in a P2P system ensures that every player is receiving the same content and that no peer is spreading malicious data. Also, this provides the certainty that no malicious actor will be able to modify a magnet link and make clients download objects that the owner of the LAND didn't intend to place in the first place.
Storing the magnet links on the blockchain also provides persistence to the world. As long as there is at least one node in the system, the players' creation will remain visible even after development on the project ends.
The system in place for all microtransactions is also enhanced by the use of blockchain, as using traditional payment methods would imply costly fees for every transaction that would in time add up to amounts that most players are not willing to pay.

## 3.4 Case study : Taurion

*Taurion* is a Massively Multiplayer Online Real-Time Strategy game in which players compete with each other for land and resources by commanding different types of units.
The game is played on a giant persistently online world where all players' constructions are public and interactable by everyone.
To advance in the game players will need to send their units to mine for resources, or steal them from other players.
These resources can also be exchanged for the tokens that power the custom blockchain the game runs on; this is what the game calls "Human Mining".
Developed by the same team that created Huntercoin, the game is made using Unreal Engine, a free tool suite for game development, and it is based on the XAYA blockchain.
A centralized equivalent to Taurion is World of Warcraft, a fantasy Massively Multiplayer Online Role-Playing Game released in 2004 by Blizzard Entertainment that garnered massive popularity with over five millions active

players as of 2020.[54]

### 3.4.1 Implementation on the blockchain

Tauron is hosted on a decentralized system powered by the XAYA blockchain, where it stores all the game's data and player actions.
The XAYA platform is a set of tools that allows developers to interact with its blockchain easily; it includes a game launcher/wallet for the players and an SDK for the developers.[53]
Players that install the XAYA game launcher can opt-in to become active nodes in the system, allowing the use of their computational power to host part of the game and validate other users' transactions, it is akin to mining in a PoW blockchain.
CHI tokens are the main currency in the ecosystem and fuel all the blockchain's transactions.

To handle the speed of transactions and scalability needed to host massively multiplayer online games, the XAYA team introduced three mechanisms: Atomic Transactions, Game Channels and Ephemeral Timestamps.

#### Atomic Transactions

Atomic Transactions allow trustless trading of assets for CHI tokens between two parties, by transferring both items in a single transaction.
For the transaction to happen, both participants need to sign it, so that either both transfers occur or none.
This type of transaction helps prevent classes of fraud where one of the parties transfers their share of the trade but does not receive anything from the other person.

### Game Channels

Game channels allow players to perform a turn-based game in a trustless way without committing a transaction on the blockchain for every move.
XAYA achieves this by dynamically creating a side chain where the players will record all their moves. The use of digital signatures and hashes assure that moves cannot be forged or modified.
At the end of a game, both parties agree on the match's outcome. If there is no disagreement, the winning side gets rewarded, and the sidechain is merged into the main blockchain.
This example can be extended to more meaningful game channels with more players and faster transactions, allowing real-time gameplay.
If there is a disagreement on the outcome of the game, a dispute is opened.

### Ephemeral Timestamps

Ephemeral Timestamps are XAYA's way to resolve disputes in a way that requires as few transactions as possible to keep costs down for the users.
The implementation of ephemeral timestamps requires that every node may be able to send some data to be timestamped by the public network without costing space and fuel on the blockchain.
When a dispute arises, timestamps are used to determine which of the participants did not act legally. The act of proving a bad behaviour with a timestamp requires a transaction on the blockchain, but the transaction fees required are offset by the prize held in escrow by the dispute.
Malicious participants will still be able to create fake disputes. However, honest participants will be able to instantly prove their fairness and get rewarded with the game channel's prize for doing so.

### Distribuion of tokens

The XAYA blockchain runs on a PoW protocol with an initial presale to gather funding. In the ICO, 40.5% of the total supply of tokens have

been distributed, for a total of 150,000,000 coins. Another 40% have been allocated for future miners, 10% of the tokens have distributed to the team and locked, and the other 9.5% have been locked for various marketing and operational costs.
The distribution of PoW coins to miners follows the Bitcoin approach, halving the block reward every four years.

#### Interaction between the game and the XAYA platform

When a miner finishes a block, he gets 10% of the block reward in CHI, the other 90% gets added to a pot that is then distributed to developers so they can reward to players.
In the case of Taurion, the CHI coins get turned into gold and resources for players to collect in-game, it functions in the same way Huntercoin does.
When a player collects coins in the world, he can then spend it in the game to advance his character, buy equipment, or turn it back into CHI tokens to send outside the game.

#### Problems derived from the use of blockchain

The main drawback with using the blockchain this way becomes apparent when there is not enough population to sustain the P2P decentralized servers. During off-peak hours players will experience lag and connection problems unless the network is helped with the developers' servers, introducing additional costs that may not be sustainable for smaller developers.

### 3.4.2 Token utilization

The CHI tokens are used to fuel all transactions happening in the blockchain, and so players will be required to hold some amount of them to keep playing regularly.
In addition to powering gameplay, the tokens are used to manage the players' accounts, resolve disputes and can be converted to the various games' specific

coins.

### 3.4.3 Advantages from the use of blockchain

Using the blockchain to power al the game's systems brings a wealth of different advantages for both players and game developers.
For developers, it means that the game world, the players and the gameplay are all stored directly on the blockchain; This leads to lower server costs and provable fair gameplay, also lowering costs of anti-cheating countermeasures.
For players, they have complete control of their characters and assets, and some form of control over the game world. As the game itself is hosted on the blockchain, developers will not be able to fundamentally change the game without a consensus of the majority of its players.
All these characteristics have the potential to provide a more reliable and engaging experience than what is provided in traditional multiplayer games.

# Conclusion

Through an analysis of the different projects, it is shown that the main problems blockchain games face are related to scalability and transaction speed.
These issues are solved in different ways, depending on the level of integration the game has with its blockchain. In games wholly linked with their blockchain, such as Taurion, custom solutions have been developed. Through the use of dynamic sidechains and atomic transactions, the integrity of the blockchain is kept while minimising the number of transactions needed to verify the game state.
In other instances, blockchains are involved in only part of the game functions, such as in the case of Forgotten Artifacts. In these cases, the problems are handled by batching large amounts of small transactions into bigger, less frequent ones. Unvalidated, placeholder items are given to players to keep the game interactive. After the corresponding transaction is validated, the placeholders are replaced by the real items.
In both cases, smart treatment of the transactions was vital to make the games interactive enough for real-time use.

The main advantages that the projects received from the use of a blockchain were the actual ownership of game assets and a heightened involvement from their users.
In games that are based around the concept of ownership, such as Decentraland, a blockchain is an easy way to prove the uniqueness and scarcity of

particular objects, giving them inherent value. This value is then conveyed to the owners who will be in turn more attached to their inventories, opening up possibilities of community created stories and cooperations.
Furthermore, in projects based around the notion of user engagement, such as Socios, a blockchain provides a compelling way to incentivise and keep track of user interaction.
With the popularity of in-game economies in traditional games, these advantages will be pivotal to furthering the satisfaction and preservation of players.

Though showing significant signs of potential, the current state of blockchain gaming cannot be considered as an enjoyable form of entertainment.
From a general survey of the market, most blockchain games can be considered as a form of gambling or are perpetually in development without showing any sign of real progress.
The most promising implementations enhance their strongest points with the implementation of a blockchain instead of basing all their mechanics around it.
While the lack of any project from more prominent publishers leaves space for smaller teams to thrive, it also creates a fragmentation between userbases of different games, leading to a situation with a large number of games each having minimal player counts.
Additionally, substantial scalability limitations will require developers to use already existing blockchains to keep the game's integrity.

Substantial developments in this field will either be accomplished with the integration of blockchain to enhance successful functionalities in mainstream games or with the emergence of small projects that break entirely new ground.

In conclusion, the issues faced in the analysed projects are becoming increasingly common in the blockchain space, and the solutions encountered

provide general concepts that can be applied to any project to refine its user experience.

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