EXPLORING THE RONIN BLOCKCHAIN

Can Ronin serve as a blueprint for future

blockchain gaming platforms?

A case study about scalability, cost-effectiveness, and the rise of play-to-earn gaming. How it works, and why it works.

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To my dear friends Alexandra and Pedro,

whose honest feedback and thought-provoking conversations had

a profound impact on this work. Your insights gave me a clear purpose to make this paper meaningful to a wider audience, while also sparking a personal shift in my own perspectives about the true meaning of accessibility and inclusivity .

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INTRODUCTION

Cryptocurrency, blockchain technology, NFTs and decentralization are now increasingly familiar terms to many; whether its through personal investment, social media or news, work or simply something you just (yet) can't seem to wrap your head around. Either ways, Web3, the next generation of internet, has made a substantial mark on the world we live in.

These rapidly growing ecosystems of digital assets have moved from being niche to having a significant position, both in tech industry as well as everyday life, making its impact on everything from finance, healthcare, storage, art, and gaming. Decentralization is changing the conventional financial scene by offering accessible, transparent and secure systems that empower individuals and reduce reliance on centralized institutions.

DECENTRALIZATION MEETS GAMING

In this case study, I will dive deeper into the revolutionary impact of blockchain technology in gaming, with a specific focus on the Ronin blockchain platform and its approach to overcome critical obstacles in the play-to-earn industry.

Using the Axie Infinity game as a practical examples, I will explore key features like scalability and cost-effectiveness, and take a closer look at how Ronins model could serve as a blueprint for monetizing online games.

Before diving into the technology behind Ronin, we'll take a look on how blockchain technology works, what makes it so secure, and how it differs from the centralized systems we're more familiar with.

CENTRALIZED VS. DECENTRALIZED SYSTEMS

To fully grasp the technology, it's essential to understand the core differences between the centralized systems we're accustomed to and decentralized systems. Centralized systems have dominated our world for as long as we can remember, from the way our governments

operate to how social media and email services are structured, these systems rely on a single authority to regulate and manage information. On the contrary, decentralized systems spread the responsibility of storing, validating and managing information across a network, eliminating the need for a single, central authority while also empowering individuals.

There are various different advantages and disadvantages to each system. Whereas centralized systems enable efficient decision-making, are more cost-effective, and provide a clear single point of responsibility, they are highly vulnerable to security breaches, offer little to no transparency, limit user control, and face scalability challenges under high pressure.

Decentralized systems, on the other hand, offer full transparency, are nearly impossible to hack, are highly robust and resilient, and give users complete control. However, they are less cost-effective, have slower decision-making processes, and lack accountability.

The decentralized nature of blockchain systems not only ensures security and transparency, but also gives the opportunity of creating and hold ownership of unique digital assets.
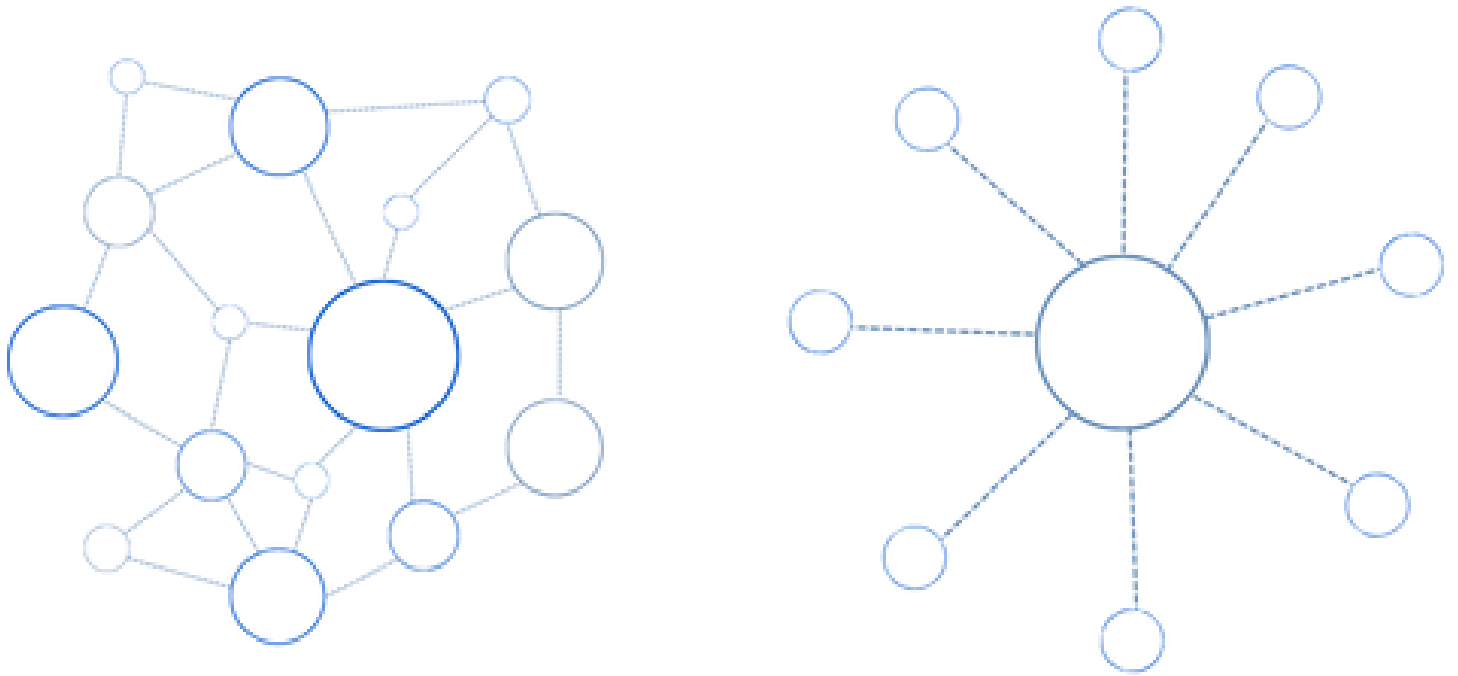
Figure 1: A decentralized network vs a centralized network

BLOCKCHAIN TECHNOLOGY

Blockchain is the foundational technology that enables decentralization.

To explain the technology in simpler terms, we can see blockchain as a shared digital ledger, like notebook containing important information, where everyone in the network holds an identical copy. Unlike centralised systems, where a single authority manages the information, blockchain relies on all participants in the network to validate information on the network, and by that keeping it accurate.

Bitcoin, Ethereum, and most other cryptocurrencies operate on blockchain networks, where transactions are recorded in blocks. When a new transaction is made, it is bundled together with other transactions in a block. Each block is secured with a key, and is linked to the block before it, creating a *chain of blocks*.

ASSETS ON THE BLOCKCHAIN

Blockchain networks supports the creation, transactions and ownership of digital assets, in broader terms we can divide them into two types: fungible assets and non-fungible assets. These are the main drivers behind the economic activity on the networks, enabling innovative technology to take place in multiple industries.

FUNGIBLE ASSETS

In this category we find assets such as cryptocurrencies, these are interchangeable in value - meaning that one Bitcoin (BTC) is worth the same as another BTC. Similar to traditional currencies, but digital and decentralized, these assets are ideal for financial transactions and serve as the primary medium of exchange within blockchain networks.

NON-FUNGIBLE TOKENS

Non-fungible tokens (NFTs) are a unique digital assets that represent ownership of a specific item or property, and has had a huge impact on digitalising art amongst many examples. Unlike fungible assets, NFTs can not be exchanged on a one-to-one basis due to every token being unique. NFTs are like valuable, digital items you hold or sell for fungible assets, they are used in art, music, collectibles and in-game assets like characters, tools and land.

In gaming, fungible tokens often serve as in-game currencies or rewards, while NFTs are used to represent individual assets like characters, tools, land plots or similar. Blockchain technology makes all this possible with real-world values, fully elevating the traditional gaming experience.

BLOCKCHAIN CONSENSUS MECHANISM

Blockchain technology is unique in terms of security, once information is added to the chain it can not be changed or deleted without consensus of all participants/nodes in the network. This consensus mechanism is the foundation of decentralization and a core principle of any blockchain, as it ensures integrity and security for the entire system.

Different blockchains use different consensus models, each tailored to meet specific goals such as security, scalability, or energy efficiency. These models can generally be categorized into proof-based mechanisms, reputation-based mechanisms, hybrid approaches, to specialized or even experimental mechanisms. The most commonly used consensus mechanisms are:

- **Proof of Work (PoW)**
  Used by Bitcoin as well as other early blockchains, Proof of Work (PoW) relies on computers (miners) solving complex mathematical puzzles to validate transactions and add them to the blockchain. These puzzles require significant computational power, which secures the network by making it extremely difficult for anyone to alter the data. This method is however very energy demanding compared to newer methods.
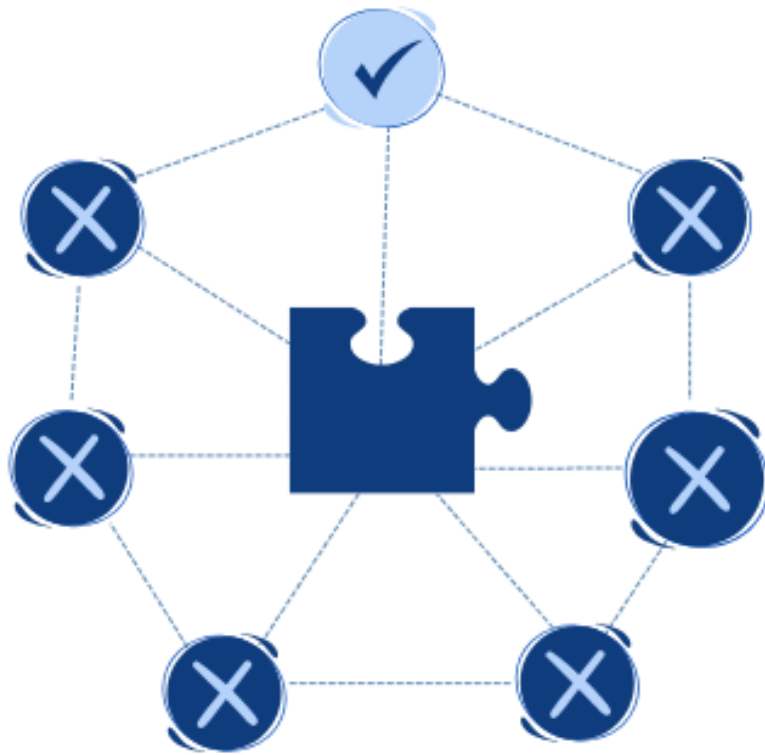
Figure 2: Proof of Work

- **Proof of Authority (PoA)**

  PoA, as formerly used by Ronin, is a method where preapproved validators are responsible for maintaining the network. This method is sacrificing at fair amount of decentralization as it places the responsibility with a smaller group of validators, but in return it helps to tackle scalability and performance, making it suitable for gaming platforms requiring low fees and rapid transactions. The validators are usually known entities within the ecosystem, such as companies, organizations, or individuals with established reputations

Figure 3: Proof of Authority

- **Proof of Stake (PoS)**

  Proof of Stake (PoS) select validators based on the amount of cryptocurrency they hold and are willing to "stake". Staking is the process of locking up cryptocurrency in to support the operations of a blockchain network, in return the stakers earn a reward similar to putting money into funds with interest or with newly minted coins. If the validatiors would act maliciously their stakings can be slashed, this ensures a mutual trust in the process. The PoS method is more energy-efficient and faster than PoW, making it a preferred method for blockchains like ETH.

Figure 4: Proof of Stake

- **Delegated Proof of Stake (DPoS)**
  As a combination of PoS, DPoS is a more democratic method allowing stakeholders to vote for their validator, instead of every holder participating in the process. This specific method allows for more scalability as it increases efficiency, but sacrificing some decentralization on the way. The voting number is proportional to the amount of token the holder has staked, more tokens equals more influence. The number of chosen validators varify anything from 20-100 *block producers* in a network, all chosen by the community. In turn the validators receive fee's or block rewards

Figure 5: Delegated Proof of Stake

GAS PRICES

Transaction fees, commonly referred to as gas prices, are a fundamental aspect of blockchain networks. These fees are used to compensate validators for processing and securing transactions, ensuring the overall integrity of the system. The gas prices will vary due to network congestion and the complexity of the transaction, and also what specific consensus mechanism thats in use. While this system is fundamental for maintaining blockchain operations, high gas fees have resulted in challenges for platforms with large transaction volumes.

ETH: THE GAS PRICE CRISIS

With the sudden rise in popularity for decentralized finance back in 2020/2021, the Ethereum (ETH) network experienced substantial congestion that resulted in sky high gas prices on transactions. This is

known as the ETH gas price crisis, with the network limited to only 15 transactions per second (TPS), the high demand created a supply-demand imbalance, pushing gas prices through the roof. Beyond the steep costs, the overwhelming demand also caused significant delays, with transactions taking hours to process for users unable to pay the high prices to get prioritized.

CHALLENGES IN PLAY-TO-EARN GAMING INDUSTRY

The issue of high gas fees highly impacted the emerging play-to-earn (P2E) technology, a technology that allows for players to earn real-world value in gaming through activities like trading, battling, or crafting. As a result of a high gas prices, the potential earnings of players would often break even with the fees, resulting in little to no profit for the players and a significantly lowered game experience overall.

Together, these factors emphasized the need for more cost-effective and scalable solutions, urging developers and users to seek for better alternatives.

CUSTOM SOLUTIONS: LAYER 2 AND SIDECHAINS

This marks the birth of Layer 2 (L2) solutions which operates on top of the ETH mainnet, like an actual second layer, in order to reduce the load on its main system and help ease congestion. However, these solutions still relied on ETHs underlying infrastructure, which means that while L2 solutions significantly enhanced the networks capacity, they still relied on the mainnet for security and final validation, which in the end resulted in network congestion, underlining the fact that the technology was still not yet fully there. This opened up for more

tailored solutions, like *sidechains*.

Sidechains are independent blockchains that operate under their own set of rules. They are connected to the Ethereum mainnet via a bridge, which allows them to interact with the network and leverage its ecosystem without being restricted by limitations.

Among the most notable tailored sidechains, we find the platform Ronin. By making low-cost, high-speed transactions possible, the Ronin sidechain is designed for gaming and is demonstrating how specialized solutions can reshape the industry.

RONIN BLOCKCHAIN

Ronin was created by the global developer team Sky Mavis out of necessity, to address the critical issue of ETH gas prices affecting Sky Mavis' own game, Axie infinity. With the game being unable to run on the congested ETH mainnet, and L2 solutions still not being able to

tackle the problem to a satisfactory degree, there seemed to be no real solution for the problem on the market. With this, the team took the challenge in their own hands and created the solution themselves; the Ronin sidechain.

THE RONIN BRIDGE

In order for Ronin sidechain to connect and leverage the ETH mainnet while still operating under their own set of rules, the Ronin Bridge was created as a tool to connect the two, allowing users to transfer assets across the networks. It works by locking assets on the ETH mainnet by a smart contract, producing (minting) the equal amount Ronin, and thereby creating a 1:1 representation of the assets. This way Ronin can use ETHs ecosystem, while avoiding the obstacles on ETH mainnet.
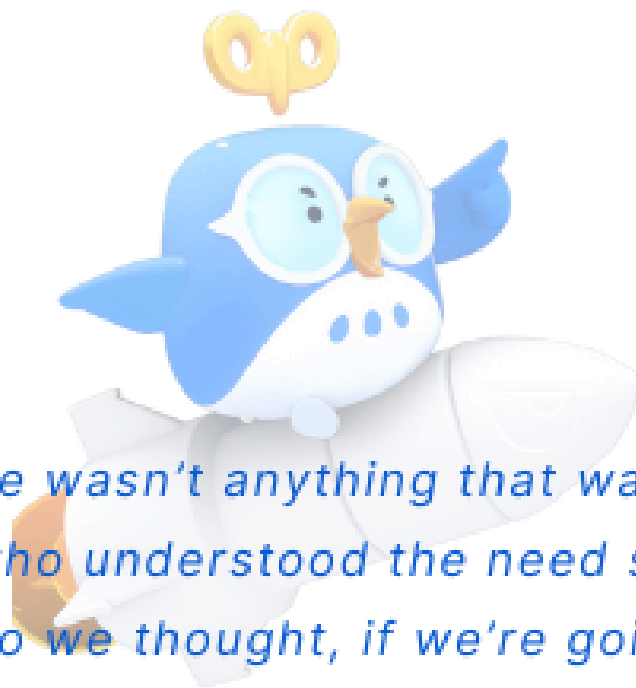
"And there wasn't anything that was really built by people who understood the need specifically for gamers. So we thought, if we're going to make this for ourselves, we can use it to supercharge the entire ecosystem and make it available for the most thoughtfully-crafted web3 games out there."

Jeff Zirlin

SHIFT IN CONSENSUS MECHANISM

With this vision in mind, Ronin may have been created as a solution for Axie Infinity specifically, but from there quickly expanded to become redefining for the play-to-earn industry, unlocking possibilities that had never been explored before. To truly understand how Ronins scalable, efficient and user-friendly platform changed the game, its crucial to understand the mechanisms Ronin is built on, why and how that offers unique advantages to users of all sorts.

Built as a sidechain specifically designed for gaming, Ronin introduced innovative mechanisms and custom built solutions that are revolutionizing the field. At the very foundation of this is the transition from the consensus mechanisms Proof of Authority (PoA) to Delegated Proof of Stake (DPoS), making it all possible.

As earlier outlined in this paper, PoA relies on a small number of pre-approved validators responsible for validating transactions and maintaining the blockchain. For Ronin specifically this consisted of nine trusted validators, including members and partners of the Sky Mavis team. This mechanism allowed them to quickly validate transactions, without requiring computer work, thereby keep costs down. However, the system sacrificed a considerable amount of decentralization, as the few selected validators resulted in a concentrated power within the network, and also making it vulnerable to potential hacks. Although this consensus mechanism worked for Axie infinity, it didnt offer much scalability, and a decentralized solution was needed to support additional games and apps on the blockchain.

The transition from PoA to DPoS carved out a niche as a blockchain designed for and by gamers, being able to demonstrate that specialized solutions indeed are possible with the interoperability of the Ronin Bridge.

THE RONIN BRIDGE HACK

As any pioneering technology, Ronin has faced challenges, including the 2022 Ronin Bridge hack, which stands out as one of the largest blockchain exploits in history (over $600 million assets stolen) - which targeted the bridge rather than the blockchain itself. Attackers overpowered five of the nine validators, leading to a theft of over $600 million worth of assets. This event highlighted the vulnerabilities of the PoA model, and tested the resilience of Sky Mavis and its commitment to its community. The team acted promptly, reimbursing affected users and implementing extensive security upgrades, including increasing the number of validators, introducing multi-signature wallets, and transitioning to a more decentralized DPoS consensus mechanism. These efforts restored trust and showcased Sky Mavis's dedication to its building a secure and solid ecosystem.

Shifting to Delegated Proof of Stake, DPoS, empowered the token holders by giving them a voting system to select for their preferred validators. The number of votes a participant could cast, was based on the number of tokens staked. This shift was not merely a security measure but also a strategic response to criticism of the lack of decentralization inherent in the PoA mechanism. Additionally, it significantly enhanced scalability for the sidechain, making Ronin more sustainable for expansion. By actively involving stakeholders in the network, it also cultivated a stronger community engagement and

participation, reinforcing Ronins commitment to decentralization and user empowerment.

The transition from PoA to DPoS represents a big move towards balancing efficiency with decentralization, enabling Ronin to scale as it continued to grow. With this shift, the Sky Mavis team fully embraced the core principles of Web3; decentralizing power, empowering individuals, and fostering community ownership. By prioritizing transparency, inclusivity, and user control, Sky Mavis is aligned with Web3s fundamental values to fundamentally reshape how we interact with technology and the digital landscape.

RONIN TIMELINE

2018: LAUNCH OF AXIE INFINITY
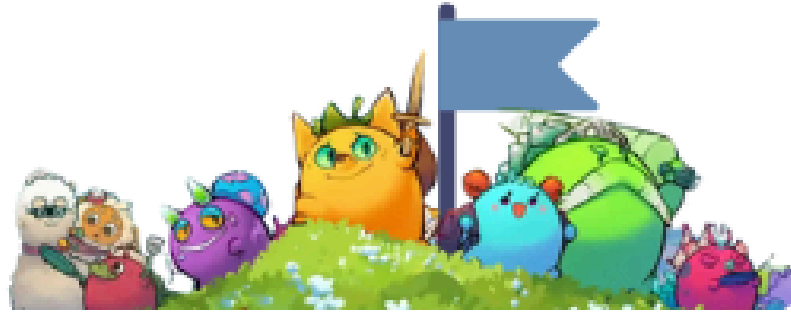ON ETH MAINNET

2020: ETH GAS PRICE CRISIS

EARLY 2021: RONIN IS CREATED
Running on PoA

MID 2021: AXIE MIGRATES FULLY TO RONIN

LATE 2021: $ONE BILLION IN GAME TRADING VOLUME
The most popular blockchain game to date

2022: RONIN BRIDGE HACK
Forcing Sky Mavis to enhance overall security

2023: MIGRATION FROM PoA to DPoS
Enhancing security, decentralization and scalability

2023: ECO SYSTEM EXPANSION
Allowing third party developers to use the Ronin platform for games and apps

2024 TO PRESENT: FOCUS ON FURTHER DECENTRALIZATION
Working towards making Ronin "permissionless"

Figure 6: Ronin Timeline

AXIE INFINITY ORIGINAL

Let's take a closer look at the game itself to fully understand how the technology enhances gameplay. In Axie Infinity, players gather teams of three Axies to compete in battles against other players (PvP) or computer-controlled opponents (PvE).Each Axie comes with a unique set of skills and abilities, requiring players to strategize carefully to succeed. Beyond battles, players can also breed Axies to create new ones with

unique traits and trade them in the in-game marketplace.

To better illustrate how these elements come together, let's explore a video example showcasing the Ronin Bridge and in-game economical system.
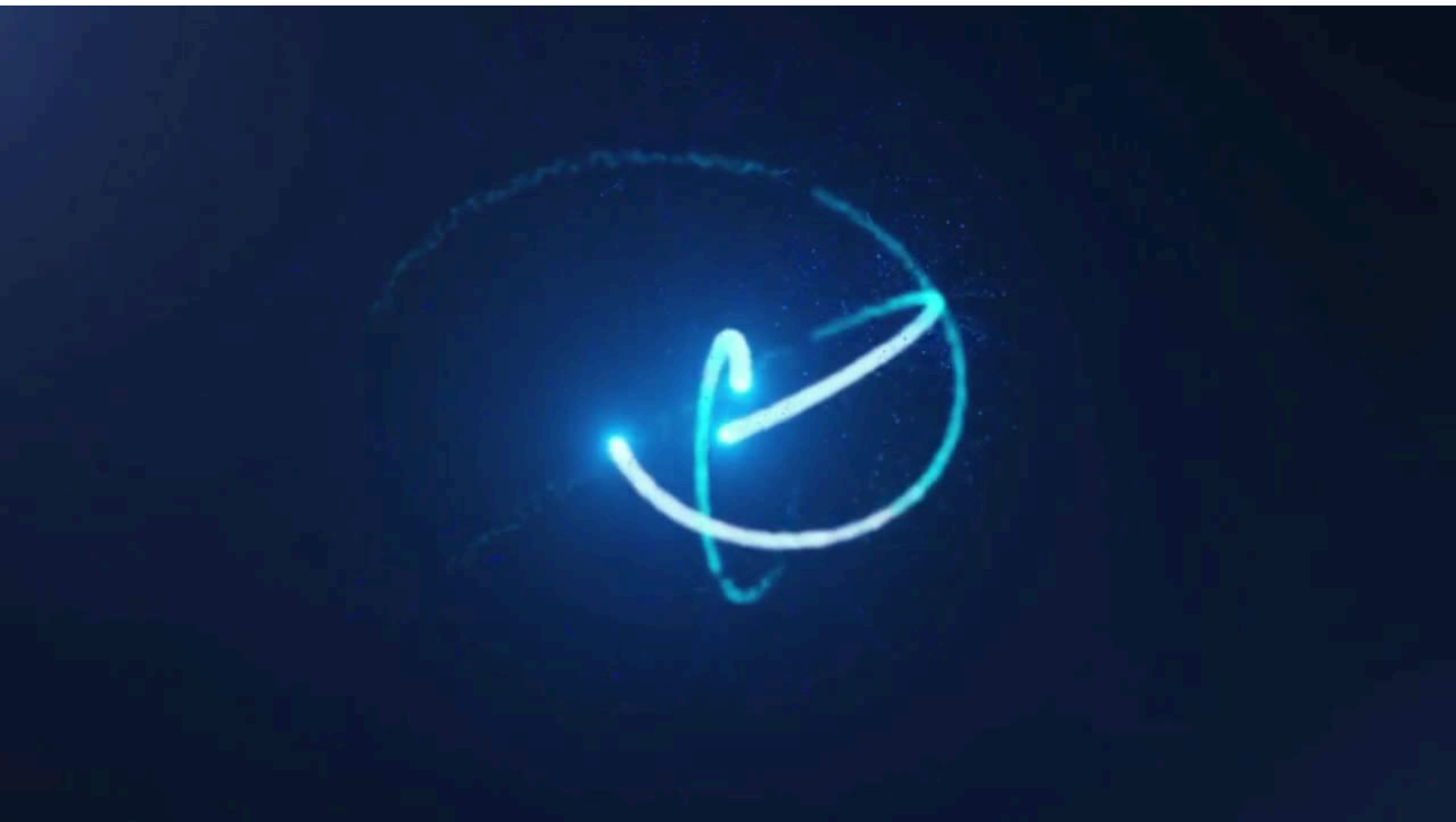
RONIN IN USE IN OTHER GAMES

As we've covered so far, Ronin was originally built to tackle Axie Infinity's own in-game challenges, but has since then expanded to be a multifaceted platform not only for Sky Mavis native games but also for hosting games developed by third-party developers. To gain a deeper understanding of how Ronins sidechain platform works for other games, we will explore its key features, integrations, and the success stories of developers using and benefiting from this ecosystem. While

Axie is the flagship of Ronin, Sky Mavis has continued to develop games for the platform, showcasing its versatility and power.

Ragnarok: Monster World

Developed with in collaboration with Gravity, the team behind the original Ragnarok Online game, it blends the iconic roleplay game (RPG) elements of questing, exploration, and character building with Web3 technology and principles, powered by the Ronin blockchain. By integrating NFTs for assets like the games own "Ragmons", land plots, and rare items, the game allows players true ownership, seamless trading, and real-world value within a decentralized ecosystem. Unique features like guild-based land occupations and interactive gameplay highlight how Ronins low fees and scalability helps to create a dynamic in-game economy. This innovative fusion of traditional RPG mechanics and blockchain technology exemplifies Ronins potential to support immersive gaming experiences.

Project K

Project K is not a standalone game per se, but a innovative expansion of the Axie Infinity universe that leverages the capabilities of the Ronin sidechain even more. In Project K players can acquire and develop virtual land plots, gather resources to build items, that can be traded in-game as NFTs, adding an extra level of strategy to the gaming experience. Project K enhances the complexity and economic system within the game, as players now need to manage and transport goods, adding a deeper level of strategy and logistics. A unique feature of Project K is letting the players craft items to be used by non-player characters (NPC), where the performance can directly influence the player's rewards and progression in the game. This creates a dynamic where virtual workers can generate real-world value for the players. While Axie is more about collecting, breeding and gathering Axies (NFTs) throughout the game, Project K introduces a fully developed economic system where players can own land, manage resources, and engage in a market of goods and services. Project K is a significant evolution of the Axie Infinity platform, showcasing even more of Ronins features.

With Ronin opening its platform to third-party developers in 2023, a variety of new games have emerged alongside its flagship, Axie Infinity. This demonstrates the blockchains ability to support a diverse range of games and economicsystems. Lets have a look at some of them.

APEIRON

Coming from the Foonie Magus developer team, Apeiron is a blockchain-powered game where the player is invited to create and manage their own planets, as well as combat other players in the game. The god game (where the player is acting like a higher entity) leverages from Ronins quick and low-fee transactions for trading and holding player-owned assets in game.

Apeiron demonstrates how sidechains like Ronin can enhance gaming by prioritizing scalability and affordability for players.

Zoids

Developed by ACT Games, Zoids Wild Arena is a blockchain-based trading card game where players engage in turn-based battles using NFT cards representing mechanical creatures called Zoids. The game's migration to the Ronin sidechain enhances the trading and management of the player-owned assets with the fast transaction and low fees.

Pixels

Developed by the Pixels team, Pixel is a blockchain-based farming simulation game that invites players to cultivate virtual land, harvest crops, and engage in various activities. By taking use of the Ronin sidechain, Pixels ensures a smoothly running gaming experience with rapid transaction and minimal fees. This game serves as another example of how Ronin can make gaming experiences even more meaningful for the players, and the general diversity that can emerge from the platform.

GAME	GENRE	DEVELOPER	STATUS	REVENUE MODEL
Axie Infinity	Turn based strategy	Sky Mavis	Live	Play-to-Earn, NFT Sales
Project K	Simulation/ Strategy	Sky Mavis	In dev.	TBD
Ragnarok	Tower defense	Gravity	Live	Free to play, in game buys
Apeiron	God simulation	Foonie Magus	Beta	Play-to-Earn, NFT Sales
Zoids	Trading card game	ACT Games	Live	Free to play, NFT Sales
Pixel	Farming simulation	Pixel games	Live	Free to play, in game buys

COMPETING SOLUTIONS TO RONIN

In the world of blockchain, gaming is not a new concept, we can track back all the way to 2014 and find Huntercoin as one of the first ever to connect the two. Although, no platform before Ronin has offered a fully integrated solution tailored to the unique challenges of blockchain

gaming. But, with the growing popularity of the technology in gaming, Ronin is no longer the only platform focused to tackle what has come to be well known challenges.

Here are some noteworthy alternatives:

- **Polygon:** A Layer 2 scaling solution operating on the ETH mainnet, supporting a variety of decentralized applications, including games like Decentraland. Although an effective L2 solution for general purposes, it lacks the specific gaming-focus.
- **Immutable X:** Another Layer 2 solution made for trading NFTs in game,
offering zero gas fees. Games like Gods Unchained have thrived here, but the model being specific for NFTs makes it less attractive for larger gaming economies.
- **Avalanche:** Introducing tailored subnets for any desires from finance to gaming, it allows projects to create dedicated ecosystems especially customized. However, its flexibility across industries makes it less it not gaming specific.
- **Flow:** A unique, standalone Layer 1 blockchain purposely built to make the technology accessible for the mainstream user. While Flow onboards new users easily by allowing them to trade NFTs in high volume, it still lacks specificity to offer broader in-game economies.
- **Arbitrum and Optimism:** Layer 2 solutions operating on ETHs mainnet, but they can offer zero gas fees as they handle validation off-chain, built specifically to tackle ETHs gas price capabilities rather than being for gaming.

CRITIQUE OF RONIN

There is no doubt that Ronin has introduced innovative solutions for blockchain gaming industry, but, like any other great platform, it is not without limitations or critiques. As we are already familiar with, the most fundamental criticism stems from its level of centralization.

Initially, when Ronin operated on a PoA mechanism, it relied on a small number of validators, mostly Sky Mavis' own partners. This not only heightened concerns about power concentration but also exposed the platform to substantial security vulnerabilities, as the 2022 hack showed. The incident significantly damaged Ronins reputation, casting doubts on its security measures. On the contrary, other networks like Ethereum and Avalanche maintain a larger pool of validators, keeping decentralization first priority.

A noteable critique of any blockchain gaming platform is the barriers to entry, and in the case of Axie Infinity, the learning curve can be steep. Fresh players are to understand how to set up and use crypto wallets, which can be intimidating. Additionally, the process of converting ETH into WETH, transferring it from the Ethereum network to the Ronin network via the Ronin Bridge, adds another layer of complexity. As these steps are critical to get to purchase Axies, yet they demand some degree of technical knowledge, potentially hindering casual gamers or mainstream audiences. Without proper guidance, new users might feel overwhelmed and hesitant to enter.

The cross functionality of the platform is also subject to criticism, as Ronin often falls short in terms of interoperability, particularly when

compared to platforms like Polygon and Avalanche. This is a concern regarding third party developers seeking broader more functional platforms to launch their games. Serving as a double-edged sword, with Ronins primary strength of being solely focused on gaming also being seen as a disadvantage, as this narrow focus limits its appeal to other industries. This raises concerns that the platforms opportunities for growth may be compromised.

Ronins success is closely tied to its flagship game, Axie Infinity. While the game is very well achieved, the platform is highly vulnerable if the player engagement would drop. Some argue that Ronin risks becoming too dependent on its own game and should place more emphasis on what is offered to third-party developers on the platform. Criticism regarding the lack of solid documentation, financial incentives, and support has been voiced.

CONCLUSION

The Ronin blockchain represents a defining moment in blockchain gaming, offering a specially tailored platform for the play-to-earn industry, made by and for gamers. With its low gas prices, ability to process rapid transactions and gaming specific tools, Ronin sure raised the overall bar and opened up a new horizon for innovative, enriching games.

The 2022 hack serves as a firm reminder of the importance of balancing efficiency with security, keeping decentralization as a foundation. It also highlighted Sky Mavis' prompt response to breaches and core loyalty to its community. Even so, its dependence on Axie Infinity, the limited ecosystem diversity, and lack of centralization still,

reveal areas where the platform must evolve in order to remain competitive. Ronins ability to adapt, diversify, and embrace enhanced decentralization, will determine its lasting impact on the industry.

As nothing is perfect in this world, Ronin is no exception. Still, its journey has given rewarding insights for the future of blockchain gaming, paving the way for new solutions to emerge and fresh perspectives to be implemented.

Ronins story is not only about successes and failures, wins and lessons learned, but also a story of bravery, belief, resilience, and the bold ambition to turn setbacks into golden opportunities. It's a narrative of daring to dream big, and instead of letting challenges overshadow the light, let them shape the path to innovation.

If not a blueprint for the entire play-to-earn technology, more importantly, Ronin is a testament to how Web3 platforms can inspire innovation, transform obstacles, and contribute in unexpected ways to the ever evolving world of the digital economy.

DICTIONARY

- **Blockchain**: A decentralized digital ledger for recording transactions securely and transparently.
- **Bridge**: A tool for transferring assets between different blockchain networks.
- **Consensus Mechanism**: A process by which blockchain networks validate and secure transactions.
- **DeFi**: Decentralized finance, blockchain-based alternatives to traditional financial services.
- **DPoS**: Delegated Proof of Stake; stakeholders vote for validators to secure the blockchain.

- **DApps:** Decentralized applications
- **Ecosystem**: The interconnected applications, assets, and tools within a blockchain platform.
- **Ethereum**: A blockchain platform enabling smart contracts and decentralized applications.
- **Fungible Assets**: Interchangeable digital assets of equal value, like cryptocurrencies.
- **Gas Prices**: Transaction fees paid to validators for processing blockchain transactions.
- **Layer 1**: The base layer of a blockchain, like Ethereum or Bitcoin, providing core functionality.
- **Layer 2**: Secondary solutions built on Layer 1 to enhance the platform.
- **Ledger:** A secure digital record often used for tracking finances or in blockchain.
- **Mainnet**: The primary, live blockchain where real transactions occur.
- **Minting**: The process of creating new tokens or assets on a blockchain.
- **Mining**: The computational process of validating transactions on Proof of Work blockchains.
- **Network Congestion**: Overload in a blockchain network causing slower transactions and higher fees.
- **Non-Fungible Assets**: Unique digital assets that cannot be exchanged on a one-to-one basis, like NFTs.
- **NPC**: Non-player character; a computer-controlled character in games.

- **P2E**: Play-to-earn; games where players earn real-world value through in-game activities.
- **PoA**: Proof of Authority; a consensus model using a small group of trusted validators.
- **PoS**: Proof of Stake; validators are chosen based on the amount of cryptocurrency staked.
- **PoW**: Proof of Work; miners solve complex puzzles to validate transactions and secure the blockchain.
- **RPG**: Role-playing game; a game where players control characters in a fictional world.
- **skeEVM:** A scalable, Ethereum-compatible platform for efficient smart contracts and dApps.
- **Sidechain**: An independent blockchain connected to a main blockchain via a bridge.
- **Slashing**: Penalty for malicious or faulty validators, resulting in a loss of staked cryptocurrency.
- **Smartcontract**: Self-executing contracts with terms directly written into code.
- **Stake**: Locking cryptocurrency in a blockchain to participate in validation or governance.
- **Subnet**: A customizable, independent blockchain within a larger platform like Avalanche.
- **TCG**: Trading card game; a game where players collect, trade, and play with cards.
- **Validators**: Nodes that verify and secure transactions in a blockchain network.

- **Web3**: The next generation of the internet, focusing on decentralization and user ownership.

REFERENCES

Centralized vs decentralized systems

101 Blockchains. (2021). "Decentralized vs. Centralized: A Detailed Comparison", ⊕ Decentralized vs. Centralized: A Detailed Comparison

Blockchain technology

Skelton, O. (2024). "The Best Gaming Blockchains: Ultimate Guide for Players and Developers",

⊕ The Best Gaming Blockchains: Ultimate Guide for Players and Develop...

. Kunal, G. (2023). "Exploring Decentralized Storage in Blockchain",

⊕ Exploring Decentralized Storage in Blockchain

Blockchain consensus mechanisms

Defi-planet. (2021/2023). "8 types of blockchain consensus mechanisms you should know",

⊕ 8 Types Of Blockchain Consensus Mechanisms You Should Know

ETH: Gas price crisis

Fries, T. (2021). "Explained: Ethereum's Scalability Problems and Growing Backlash",

⊕ Explained: Ethereum's Scalability Problems and Growing Backlash - Tok...

Jagati, S. (2020). "Ethereum scalability issues exposed as high gas fees stall DeFi boom",

⊕ Ethereum scalability issues exposed as high gas fees stall DeFi boom

Challenges in play-to-earn technology

Inno, O. (2022). "How Blockchain Games are Overcoming the Problem of Scalability",

⊕ How Blockchain Games are Overcoming the Problem of Scalability - Token G...

Custom solutions: Layer 2 and sidechains

Astar, (2023). "Ethereum Layer 2 Scaling Technologies Explained",

⊕ Ethereum Layer 2 Scaling Technologies Explained │ Astar Network

Ronin

Endemic. "How Ronin Layer-2 and zkEVM Integration Will Transform the Gaming Ecosystem",

⊕ How Ronin Layer-2 and zkEVM Integration Will Transform the Gaming Ecosys...

Gem Wallet. (2024) "A beginners guide to Ronin blockchain",

⊕ A Beginner's Guide to Ronin Blockchain │ Gem Wallet

OneSafe Content Team. (2024). "Ronin: The Game-Changing Blockchain for Gaming and Finance?",

⊕ Ronin: The Game-Changing Blockchain for Gaming and Finance? - One...

. Imperator.co. (2021). "What is Ronin (RON) - A Comprehensive Blockchain Overview", ⊕ What is Ronin (RON) - A Comprehensive Blockchain Overview

Thai, P. (2024). "Scalability on Ronin: Enshrined skeEVM",

⊕ Ronin Blog │ Scalability on Ronin: Enshrined zkEVM

Williams. (2024). "Ronin Chain: Revolutionizing Blockchain Technology for the Gaming Ecosystem",

⊕ Ronin Chain: Revolutionizing Blockchain Technology for the Gaming Ec...

. Jordan, J. (2023). "Sky Mavis' Jeff Zirlin – "Ronin is starting to blossom",

⊕ Sky Mavis' Jeff Zirlin - "Ronin is starting to blossom"

The Ronin Bridge

Shift in consensus mechanisms

The Roning Bridge hack

Smalley, S. (2022). "Hackers steal more than $600M from Ronin blockchain used to play Axie Infinity",

⊕ Hackers steal more than $600M from Ronin blockchain used to play Ax...

Ronin timeline

Axie Infinity

ChainPlay. (2024). "Unveiling the Dynamics of the Ronin-Axie Infinity Partnership",

🌐 Unveiling the Dynamics of the RONIN-Axie Infinity Partnership - ChainPlay.gg

Ronin in use in other games

Ming, A. (2024). "Ragnarok: Monster World Releases Whitepaper, Sets Stage for Blockchain Tower Defense Game",

🌐 Ragnarok: Monster World Releases Whitepaper, Sets Stage for Blockch...

Ronin. (2024). "Pixels on Ronin Guide", 🌐 Pixels on Ronin Guide

GamesBeat. "Sky Mavis launches new Features and products for Axie Infinity fans", 🌐 Sky Mavis launches new features and products for Axie Infinity fans