Web 3.0 Protocol-as-Platform: Vision and Framework for Decentralized Agentic Super Intelligence

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Abstract

We present our vision for Web 3.0 as a Protocol-as-Platform (PaaP), integrating AI-driven agentic intelligence, modular blockchain infrastructure, and privacy-enhancing technologies. It addresses current Web 3.0 challenges such as fragmentation, scalability, security vulnerabilities, and overemphasis on financial speculation. The framework emphasizes interoperability through cross-chain bridges, composability via modular components, and intelligent automation using AI. Key aspects include AI-powered smart contracts, decentralized storage with IPFS/KV, and privacy-preserving computation via zero-knowledge proofs. The paper advocates for a shift from speculative economies to utility-based systems, proposing reputation-based rewards, gamified participation, and universal gas fee subsidization to drive mass adoption. Additionally, it highlights the importance of AI in enhancing governance, risk management, and user experience while ensuring privacy and security. By fostering global collaboration among developers, researchers, and policymakers, the authors aim to create a self-sustaining, decentralized AI economy that prioritizes long-term value over short-term gains.

1 Introduction

The internet has undergone significant transformations since its inception, evolving through distinct phases that have reshaped how users interact with digital content and each other. The first phase, Web 1.0 (The Static Web), was characterized by read-only content, where users passively consumed information from static HTML pages created by a limited number of content producers. This era laid the foundation for the internet but lacked interactivity and user participation. The advent of Web 2.0 (The Social Web) marked a paradigm shift, introducing interactive platforms that enabled user-generated content and social interaction. Giants like Facebook, YouTube, and Twitter emerged, fostering a culture of collaboration and sharing. However, this era also brought concerns about centralization, as these platforms amassed unprecedented control over user data and online experiences, leading to issues of privacy, data ownership, and monopolistic practices. In response, Web 3.0 (The Semantic Web and Decentralized Web) emerged as a vision for a more equitable and intelligent internet [22]. Built on blockchain technology, Web 3.0 promises decentralization, user sovereignty, and a semantic web capable of understanding and interpreting data contextually. By eliminating centralized intermediaries, Web 3.0 aims to return control to users and creators, offering transparency, resistance to censorship, and a more democratic digital ecosystem. While the initial promise of Web 3.0 is compelling, its realization remains a work in progress, as it seeks to address the shortcomings of Web 2.0 and redefine the internet's future [14, 19]. Web 3.0, despite its initial promise faces significant challenges that hinder its full potential. One of the most pressing issues is fragmentation, where the ecosystem is divided into numerous independent blockchain networks such as Ethereum, Solana, Polkadot, and Cosmos, each with its own protocols, communities, and

Working paper.

token standards. This siloed structure impedes interoperability and network effects, akin to a scenario where users of one internet service provider (ISP) cannot access websites hosted on another ISP. Mathematically, this fragmentation reduces the overall connectivity and efficiency of the network, as illustrated by network graph theory, where many small, disconnected graphs are less powerful than a single large, interconnected graph in terms of information flow and value transfer [6]. Another critical challenge is scalability, as many blockchains struggle to handle transaction volumes comparable to Web 2.0 applications. The inherent security and decentralization mechanisms of blockchains, such as Proof-of-Work (PoW) consensus, often result in low transaction throughput and high latency. Queuing theory models demonstrate how transaction arrival rates can exceed processing capacities, leading to network congestion and exorbitant fees. Scalability, often measured in Transactions Per Second (TPS), remains a significant hurdle, with current systems far from achieving the thousands or millions of TPS required for internet-scale adoption. Additionally, the Web 3.0 narrative has been dominated by an overemphasis on financial speculation, with cryptocurrencies, NFTs, and decentralized finance (DeFi) often prioritizing short-term gains over long-term innovation [7]. Game theory reveals how incentives in early DeFi systems favored speculative trading and artificial scarcity, rather than fostering sustainable growth or user utility [15]. Finally, there is a lack of genuine technological innovation at the application layer. While blockchain itself is a groundbreaking innovation, many decentralized applications (dApps) merely replicate Web 2.0 functionalities with a blockchain backend, failing to deliver fundamentally new user experiences or solve novel problems. This concentration of innovation at the infrastructure level, rather than the application layer, limits the broader impact of Web 3.0 on end-users. Addressing these shortcomings of fragmentation, scalability, financial speculation, and innovation gaps is crucial for Web 3.0 to realize its transformative potential.
Web 3.0 as a Protocol-as-Platform (PaaP) represents a transformative framework designed to address the limitations of current Web 3.0 implementations and unlock its full potential. Unlike traditional blockchain systems, Web 3.0-driven PaaP is not merely a collection of isolated networks but a conceptual evolution that establishes a foundational protocol layer akin to TCP/IP for the internet. This protocol layer provides standardized interfaces, communication protocols, and infrastructure, enabling diverse blockchain networks and applications to interact seamlessly. This shift emphasizes designing a holistic, interconnected system rather than optimizing isolated components, fostering emergent properties and network effects at a higher level. The core pillars of Web 3.0 PaaP are interoperability, composability, and intelligent AI-driven[1] agentic intelligence[2], define its transformative potential. Interoperability ensures seamless communication and data exchange across heterogeneous blockchain networks, overcoming fragmentation through technologies like Inter-Blockchain Communication (IBC) [12] in Cosmos, Polkadot's parachains, and cross-chain bridges [13]. Graph theory and cryptographic protocols underpin this interoperability, ensuring secure and efficient information flow. Composability, on the other hand, enables developers to combine and reuse modular components like smart contracts, services, and data, akin to LEGO bricks, accelerating innovation and reducing redundancy [20]. This modularity is mathematically analogous to object-oriented programming, where formal methods and type theory ensure predictable and correct interactions between components. Moreover, the integration of AI-driven agentic intelligence marks a paradigm shift, embedding intelligent systems within the Web 3.0 ecosystem. These AI agents automate tasks, personalize user experiences, enhance security, and provide intelligent services, making the decentralized web more user-friendly and functional. Together, these pillars position Web 3.0 PaaP as a foundational framework for a truly intelligent, interoperable, and composable digital ecosystem, paving the way for the next generation of decentralized applications and services.

This chapter outlines the evolution of Web 3.0, the challenges hindering its current adoption, and the need for a transformative, AI-enhanced protocol framework that goes beyond traditional blockchain networks.

1.1 The Evolution of Web 3.0 and the Need for a Paradigm Shift

The concept of Web 3.0 emerged as a response to the limitations of Web2 offering decentralization as an alternative to centralized digital platforms. While the vision was compelling, the implementation has been hindered by several issues leading to a fragmented and inefficient ecosystem. The paradigm shift introduced by Web 3.0 PaaP (Protocol-as-Platform) lies in its deep integration of Artificial Intelligence (AI) into the decentralized architecture, fundamentally re-architecting Web 3.0 to be

[1] https://intelligentinternet.substack.com/p/how-to-think-about-ai
[2] https://ii.inc (formerly Schelling AI: https://schellingai.com)

intrinsically intelligent rather than treating AI as an afterthought. This integration is driven by the need to address several critical challenges and unlock new possibilities within the Web 3.0 ecosystem. One of the primary reasons AI is essential in Web 3.0 is its ability to enhance user experience. Current Web 3.0 platforms often present a steep learning curve for average users due to their complexity and technical nature. AI can simplify these interactions by automating onboarding processes, offering personalized recommendations, and making decentralized services more intuitive and accessible. For instance, machine learning algorithms can tailor user interfaces, suggest relevant decentralized applications (dApps), and provide intelligent assistance, thereby lowering the barrier to entry and fostering broader adoption. Beyond user experience, AI plays a pivotal role in automating governance and optimizing system performance within decentralized networks. Decentralized governance, while innovative, can be inefficient and cumbersome due to the sheer volume of proposals and the complexity of decision-making processes. AI agents can streamline this by analyzing governance proposals, identifying potential risks, and even participating in voting processes on behalf of users or Decentralized Autonomous Organizations (DAOs). Additionally, AI can optimize blockchain network performance by dynamically adjusting parameters and detecting security threats in real-time. Techniques such as game theory and reinforcement learning can be employed to design AI agents that contribute to governance in a rational and beneficial manner, ensuring the stability and efficiency of decentralized systems. Moreover, AI enables the creation of entirely new forms of decentralized applications (dApps) that go beyond replicating Web 2.0 services. These include decentralized AI marketplaces, AI-driven decentralized finance (DeFi) strategies, intelligent decentralized identity management systems, and AI-powered content curation platforms. Such innovations expand the scope of what is possible in Web 3, fostering a new wave of creativity and utility. For example, AI-driven DeFi platforms can autonomously optimize investment strategies, while decentralized identity systems can leverage AI to enhance security and user control over personal data. Additionally, AI significantly enhances security and privacy within Web 3.0 ecosystems. By leveraging anomaly detection algorithms and machine learning models, AI can identify and mitigate fraudulent activities, detect vulnerabilities in smart contracts, and secure decentralized systems against emerging threats. Furthermore, AI can be integrated with privacy-enhancing technologies such as zero-knowledge proofs and secure multi-party computation to develop privacy-preserving AI applications. This ensures that users can benefit from intelligent systems without compromising their data privacy or security. In summary, the integration of AI into Web 3.0 PaaP represents a transformative shift, enabling smarter, more efficient, and more secure decentralized systems while unlocking unprecedented opportunities for innovation and user empowerment.

1.1.1 The Shortcomings of Current Web 3.0 Architectures

While Web 3.0 architectures promise a decentralized, user-centric, and AI-enhanced future, they are not without significant shortcomings. These limitations are particularly evident when examining their application in decentralized finance, social decentralized applications (Social dApps), and artificial intelligence (AI). Below is a detailed analysis of these shortcomings across different models,

1. **Decentralized Finance:** DeFi is one of the most prominent use cases of Web 3.0, but it faces several critical challenges:
    - **Scalability Issues:** Most blockchain networks, such as Ethereum, struggle with scalability, leading to high transaction fees (gas fees) and slow processing times during peak demand. Layer 2 solutions (e.g., rollups) and alternative chains (e.g., Solana, Avalanche) have emerged, but they often compromise on decentralization or security. This limits the accessibility of DeFi to users with lower capital, as high fees make small transactions economically unviable.
    - **Security Vulnerabilities:** Smart contracts, the backbone of DeFi, are prone to bugs and exploits. Despite rigorous auditing, vulnerabilities like reentrancy attacks, oracle manipulation, and flash loan exploits have led to significant financial losses. These vulnerabilities undermine trust in DeFi platforms, deterring mainstream adoption.
    - **Regulatory Uncertainty:** DeFi operates in a regulatory gray area, with governments worldwide struggling to define frameworks for decentralized financial systems. This uncertainty creates risks for developers, users, and investors. Lack of clear regulations can lead to sudden crackdowns, stifling innovation and adoption.
    - **Lack of Interoperability:** DeFi protocols often operate in silos, with limited interoperability between different blockchains. Cross-chain bridges, while promising, are

themselves vulnerable to hacks. Fragmentation reduces liquidity and limits the potential for a seamless financial ecosystem.

2. **Social Decentralized Applications (Social dApps):** Social dApps aim to decentralize social media, giving users control over their data and content. However, they face several hurdles,
   - **User Experience (UX) Challenges:** Most social dApps have poor user interfaces and complex onboarding processes, such as managing private keys or interacting with wallets. This creates a steep learning curve for non-technical users. Poor UX hinders mass adoption, as mainstream users are accustomed to the seamless experience of centralized platforms like Facebook or Twitter.
   - **Scalability and Performance:** Decentralized social networks often struggle with performance issues, such as slow content loading times and high storage costs, due to the limitations of blockchain infrastructure. This makes them less competitive compared to centralized alternatives, which can handle large-scale data and user interactions efficiently.
   - **Monetization and Incentive Models:** While social dApps aim to reward users for content creation, their monetization models (e.g., token rewards) are often unsustainable or prone to manipulation (e.g., Sybil attacks). This undermines the economic viability of these platforms and discourages genuine user participation.
   - **Content Moderation:** Decentralized platforms often lack effective content moderation mechanisms, leading to issues like spam, misinformation, and harmful content. This creates a hostile environment for users and raises ethical concerns, limiting the appeal of social dApps.
3. **Artificial Intelligence in Web 3.0:** AI integration in Web 3.0 is still in its infancy, and several challenges need to be addressed,
   - **Data Availability and Quality:** AI models require large amounts of high-quality data to function effectively. However, Web 3.0's emphasis on privacy and data ownership often restricts access to such data. This limits the ability of AI systems to learn and adapt, reducing their effectiveness in decentralized environments.
   - **Computational Constraints:** Training and deploying AI models require significant computational resources, which are often incompatible with the resource-constrained nature of blockchain networks. This creates a trade-off between decentralization and the performance of AI-driven applications.
   - **Trust and Transparency:** While AI agents in Web 3.0 are designed to be autonomous, their decision-making processes are often opaque, raising concerns about trust and accountability. Without transparency, users may be reluctant to rely on AI-driven systems, especially in critical applications like finance or healthcare.
   - **Integration Challenges:** Integrating AI with blockchain technology is complex, as the two paradigms have fundamentally different design principles. For example, AI relies on centralized data processing, while blockchain emphasizes decentralization. This creates technical barriers to seamless integration, limiting the potential synergies between AI and Web 3.0.

Cross-Cutting Challenges: Beyond the specific shortcomings in DeFi, social dApps, and AI, there are broader challenges that affect all Web 3.0 architectures:

- **Energy Consumption:** Many blockchain networks, especially those using proof-of-work (PoW) consensus mechanisms, consume vast amounts of energy, raising environmental concerns. This undermines the sustainability of Web 3.0 and conflicts with global efforts to reduce carbon emissions.
- **Governance Issues:** Decentralized governance models, such as DAOs (Decentralized Autonomous Organizations), often suffer from low voter participation, governance attacks, and inefficiencies in decision-making. This limits the effectiveness of decentralized governance and can lead to conflicts or stagnation in project development.
- **Adoption Barriers:** Web 3.0 technologies are still niche, with limited awareness and understanding among the general public. Additionally, the complexity of these systems

deters non-technical users. Without widespread adoption, Web 3.0 cannot achieve its vision of a decentralized internet.

While Web 3.0 architectures hold immense potential, their shortcomings in scalability, security, usability, and integration with AI highlight the need for continued innovation and refinement. Addressing these challenges will require collaborative efforts from developers, researchers, regulators, and the broader community to create a more robust, inclusive, and sustainable decentralized ecosystem. Only then can Web 3.0 fully realize its promise of transforming finance, social interactions, and AI-driven applications.

1.1.2 Web 3.0 as a Protocol-as-Platform

To address these issues, Web 3.0 must evolve beyond isolated blockchain networks to a cohesive, intelligence-driven protocol framework. Web 3.0's Platform-as-a-Product paradigm leveraging AI represents a transformative shift in how decentralized systems are designed and operated. At its core lies AI-Driven Agentic Intelligence, which is the foundation of this paradigm shift. These AI agents are decentralized operating on infrastructure free from central control, ensuring resilience and trustlessness. They are agentic, meaning they act autonomously and proactively on behalf of users or the system, and intelligent utilizing advanced AI algorithms to perform complex tasks, learn from interactions and adapt to dynamic environments. Examples of such agents include decentralized autonomous agents (DAAs) for managing smart contracts, AI-powered oracles that provide reliable data feeds to blockchain systems, intelligent bots for decentralized trading, and AI-driven personal assistants embedded within Web 3.0ecosystems. The design and analysis of these systems often rely on mathematical frameworks such as game theory to model agent interactions, control theory to manage agent behavior, and machine learning to enable continuous learning and adaptation. This ensures that AI agents can operate effectively in decentralized environments while maintaining alignment with user and system goals. To support the demands of AI-driven systems and ensure interoperability, Web 3.0 PaaP relies on a *Modular Blockchain Infrastructure*. This architecture breaks down blockchain functionalities into interchangeable modules, enabling customization, scalability, and optimized performance for specific use cases. Modularity is analyzed using principles from systems theory and software architecture emphasizing the design of systems from well-defined, reusable components with clear interfaces. This approach aligns with the mathematical concepts of abstraction and decomposition, which are essential for managing the complexity of decentralized systems. Examples of modular blockchain frameworks include Substrate used by Polkadot, and the Cosmos SDK, both of which enable developers to build tailored blockchain solutions that can seamlessly integrate with other systems. This modularity is critical for supporting the diverse and evolving needs of AI-driven applications in Web 3.0. Privacy is another cornerstone of Web 3.0, and the Privacy-Enhancing Economic Model is designed to incentivize privacy-preserving behaviors and technologies. This model includes tokenomics that reward the use of advanced cryptographic techniques such as zero-knowledge proofs and secure multi-party computation, which ensure data confidentiality and integrity. Additionally, it emphasizes decentralized identity and data ownership, empowering users to control their personal information through decentralized identity solutions and privacy-preserving data storage systems. Governance mechanisms within this model are also designed to prioritize privacy, ensuring that decision-making processes do not compromise individual rights. The design of such economic models draws on mechanism design and game theory to align incentives with privacy goals, while cryptography provides the foundational primitives for privacy-enhancing technologies. Together, these components create a robust framework that supports the ethical and efficient operation of AI-driven, decentralized systems in Web 3.0. The key transformations required for this paradigm shift include:

- From Siloed Chains to Unified Protocols: Creating a multi-layered, interoperable infrastructure that integrates multiple blockchain and off-chain solutions.
- From Static to Adaptive Networks: Implementing AI-driven automation to enable self-optimizing networks that enhance security, governance, and economic incentives.
- From Speculative Economies to Value-Centric Systems: Redesigning incentive mechanisms to promote sustainable digital economies beyond financial speculation.
- From High Technical Barriers to Inclusive Access: Developing plug-and-play blockchain modules that allow Web2 developers to seamlessly integrate with Web 3.

1.1.3 The Role of AI in Web 3.0's Future

Artificial intelligence will be central to Web 3.0's transformation, introducing adaptive intelligence to decentralized networks:

- Autonomous Decision-Making: AI-powered smart contracts can dynamically adjust consensus mechanisms, optimize resource allocation, and automate governance.
- Self-Learning DApps: Intelligent decentralized applications can evolve based on user behavior, creating more efficient and personalized interactions.
- Enhanced Security and Fraud Detection: AI-driven threat analysis can detect anomalies and prevent malicious activities in real-time.
- Scalable and Efficient Consensus: AI can enhance existing consensus mechanisms, reducing energy consumption while maintaining security.

1.2 Limitations of Current Blockchain Ecosystems

While blockchain technology has laid the foundation for decentralization, its current design presents several roadblocks to mass adoption.

1.2.1 Scalability and Network Congestion

Traditional blockchain networks, such as Ethereum and Bitcoin, experience slow transaction processing times and high fees due to network congestion. Layer-2 scaling solutions exist, but they introduce additional complexity and interoperability challenges.

1.2.2 Fragmentation and Lack of Cross-Chain Interoperability

Blockchain networks operate in silos, preventing seamless communication and liquidity sharing between different ecosystems. This lack of interoperability limits the potential for truly decentralized multi-chain applications.

1.2.3 High Entry Barriers for Developers and Users

Developers need to master blockchain-specific languages (e.g., Solidity, Rust), which significantly limits the talent pool. Moreover, complex wallet management, gas fees, and key security concerns deter non-technical users from engaging with Web 3.0applications.

1.2.4 Privacy and Security Deficiencies

Most blockchains lack privacy-preserving features, exposing transaction details to the public. The absence of zero-knowledge proofs and confidential computing solutions presents risks for businesses and users handling sensitive information.

1.2.5 Governance Inefficiencies

Decentralized governance models, such as DAOs, face coordination challenges, including voter apathy, governance attacks, and centralization risks. Token-based voting mechanisms often concentrate power among wealthy stakeholders rather than ensuring equitable decision-making.

1.3 Vision for a Decentralized, Agentic Super Intelligence Protocol

The imperative for a new Web 3.0 framework stems directly from the limitations of current blockchain implementations, demanding solutions that are inherently intelligent, dynamically scalable, and rigorously privacy-preserving. The Protocol-as-Platform paradigm emerges as a strategic response, architecting a system that fundamentally integrates Artificial Intelligence-driven automation, a modular blockchain architecture, and decentralized governance mechanisms to surmount existing challenges. A core tenet of this new framework is the establishment of seamless cross-chain interoperability. The present Web 3.0 landscape is characterized by a proliferation of isolated blockchain networks, creating fragmented ecosystems where the transfer of data and digital assets between chains is often cumbersome, insecure, or simply impossible. The PaaP approach aims to rectify this by providing a unified architectural foundation that inherently facilitates communication and value exchange across disparate blockchain networks. This can be achieved through standardized communication protocols and cross-chain bridges, potentially leveraging Inter-Blockchain Communication (IBC) protocol [3] or similar technologies that establish secure channels for data and asset transfer. Furthermore, the standardization efforts in networking protocols, such as those defined by ISO/IEC standards, ISO/IEC 8802 for local and metropolitan area networks [1] can provide valuable precedents for designing interoperable blockchain communication layers. The successful realization of cross-chain interoperability will be pivotal in creating frictionless Web 3.0 experiences, allowing users and applications to operate across the entire decentralized web without being confined to single blockchain silos. Enhancing scalability represents another critical objective addressed by the Protocol-as-Platform framework, particularly through the integration of AI-optimized resource management. Traditional blockchain consensus mechanisms, especially Proof-of-Work (PoW), are notoriously resource-intensive and suffer from limited transaction throughput. Web 3.0 PaaP proposes leveraging AI-driven consensus mechanisms to dynamically optimize resource allocation and transaction processing. This could involve employing machine learning techniques, such as reinforcement learning [18] to adapt consensus parameters in real-time based on network conditions and transaction demand. For instance, AI algorithms could be trained to predict network congestion and proactively adjust block sizes, block times, or even dynamically switch between different consensus algorithms to maintain optimal performance. Furthermore, AI could optimize the selection of validators or consensus participants based on their historical performance and resource availability, ensuring efficient resource utilization and potentially minimizing energy consumption associated with blockchain operations. Research in AI-optimized distributed systems provides a strong theoretical foundation for this approach. A significant impediment to broader Web 3.0 adoption lies in the steep technical learning curve and inherent complexities faced by developers, especially those transitioning from Web2 environments. The Protocol-as-Platform framework addresses this by advocating for a modular architecture designed to substantially lower technical barriers for developers. A modular blockchain architecture decomposes the complex functionalities of a blockchain system into interchangeable and reusable modules, such as consensus, networking, storage, and smart contract execution. This modularity enables developers to focus on building specific application logic without needing to master the intricacies of the entire blockchain stack. By providing well-defined interfaces and Software Development Kits (SDKs) for each module, PaaP facilitates a "plug-and-play" development paradigm. This approach mirrors successful software engineering principles of modular design and abstraction [16] allowing Web2 programmers to leverage their existing skills and rapidly prototype and deploy Web 3.0 applications. Frameworks like Substrate[3] used in Polkadot and the Cosmos SDK[4] exemplify modular blockchain architectures, demonstrating the feasibility and benefits of this approach in simplifying blockchain development and fostering innovation. Privacy and security are paramount concerns in any digital ecosystem, and Web 3.0 is no exception. The Protocol-as-Platform framework emphasizes strengthening both privacy and security through the implementation of advanced cryptographic techniques like zero-knowledge proofs (ZKPs) and confidential computing. Zero-knowledge proofs, such as zk-SNARKs and zk-STARKs allow for the verification of information without revealing the information itself, enabling privacy-preserving transactions and computations on the blockchain [17]. Confidential computing technologies, including Trusted Execution Environments (TEEs) like Intel SGX and ARM TrustZone, create secure enclaves for processing sensitive data in isolation, protecting it from unauthorized access even within the computing environment. By integrating these privacy-enhancing technologies, Web 3.0 PaaP (as shown in Fig. 1 aims to protect user data and enhance transactional privacy, addressing a crucial requirement for mainstream adoption and building user trust in decentralized systems. The cryptographic rigor and security properties of these technologies are extensively studied and documented in academic literature and cryptographic standards.

The Protocol-as-Platform (Fig. 1) aims to democratize access to advanced AI capabilities by providing a decentralized platform for developing, deploying, and utilizing AI agents. The platform is built on the Blockchain infrastructure, ensuring transparency, security, and immutability. The three constructs – Infrastructure, SuperDApps, and AI Ecosystem – work in synergy to create a comprehensive environment for agentic super intelligence. The Agentic Super Intelligent System on Web 3.0 Genesis Cloud is a unified framework designed to address critical challenges in the AI and Web3 industries while pushing the boundaries of decentralized intelligence. It aims to create a seamless

[3]https://substrate.io
[4]https://v1.cosmos.network/sdk

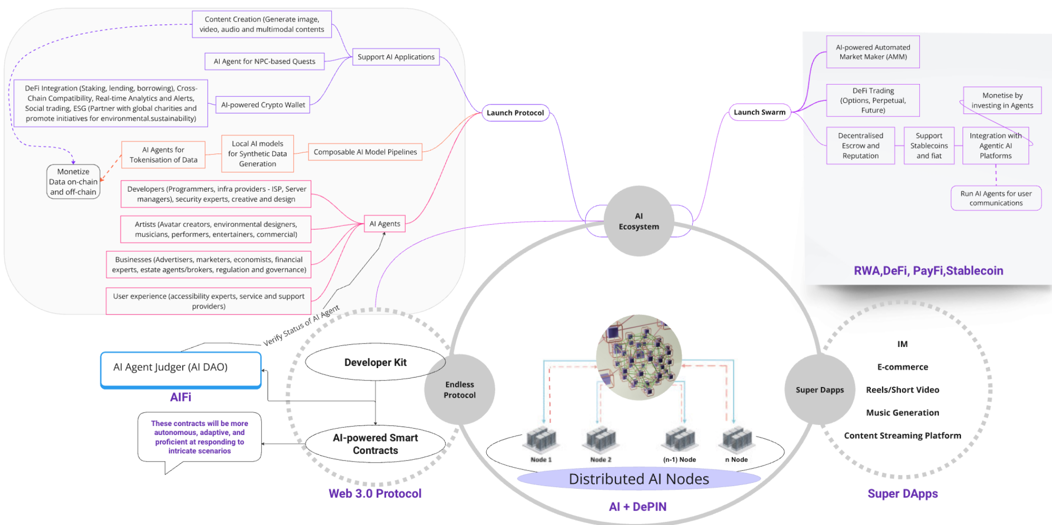

Figure 1: Our first attempt on the architecture of the Protocol-as-Platform which serves the notion of Decentralized Agentic Super Intelligence

integration of artificial intelligence and blockchain technologies, enabling a new era of decentralized, scalable, and interoperable systems. We are building this framework to tackle issues such as the centralization of AI infrastructure, the lack of fair monetization for AI services, and the difficulty of bridging digital and physical assets in Web 3.0 ecosystems. By leveraging advanced technologies like decentralized physical infrastructure networks, real-world asset tokenization, AI finance, and payment finance (PayFi), our framework provides a robust and future-proof solution for the next generation of intelligent systems.

Also, to address the inherent challenges of decentralized governance, the Protocol-as-Platform framework proposes redefining governance with AI-driven coordination. Traditional decentralized governance models can suffer from decision-making bottlenecks, lack of efficient information processing, and potential vulnerabilities to power concentration. AI can play a transformative role in facilitating more efficient and inclusive decentralized governance. AI-driven tools can assist in analyzing governance proposals, summarizing complex information, and identifying potential risks and opportunities associated with different governance decisions. Furthermore, AI agents could be employed to model and simulate the impact of various governance policies, enabling communities to make more informed decisions. Agent-based modeling and simulation, as described in works on computational social science [12], can be applied to understand the emergent behavior of decentralized governance systems under different rules and participation levels. AI can also facilitate more dynamic and adaptive governance models, potentially allowing for automated adjustments to governance parameters based on community feedback and network conditions, ultimately reducing decision-making bottlenecks and promoting more equitable and efficient decentralized governance processes.

The challenges outlined above highlight the necessity for a new Web 3.0 framework that is intelligent, scalable, and privacy-enhancing. The Protocol-as-Platform approach offers a solution by integrating AI-driven automation, modular blockchain architecture, and decentralized governance to:

- Ensure Seamless Cross-Chain Interoperability: A unified framework will facilitate data and asset transfers across multiple blockchain networks, enabling frictionless Web 3.0 experiences.
- Enhance Scalability Through AI-Optimized Resource Management: AI-driven consensus mechanisms will ensure faster transaction processing while minimizing energy consumption.
- Lower Technical Barriers for Developers: A modular architecture will simplify blockchain development, enabling Web2 programmers to build Web 3.0 applications with ease.
- Strengthen Privacy and Security: Implementing zero-knowledge proofs and confidential computing will protect user data and enhance transactional privacy.

- Redefine Governance with AI-Driven Coordination: AI can facilitate more efficient decentralized governance models, reducing decision-making bottlenecks and power concentration.

Web 3.0 must transition beyond isolated blockchain solutions to an integrated, intelligent, and privacy-preserving protocol framework. By adopting a Protocol-as-Platform approach, Web 3.0 can overcome the shortcomings of existing blockchain ecosystems and pave the way for a truly decentralized and user-centric digital economy. The following chapters will explore the technical architecture, governance mechanisms, and AI-driven capabilities necessary to realize this vision.

2 Industry Background and Market Challenges

2.1 The State of Web 3.0: Market Growth and Challenges

Web 3.0, the evolving iteration of the internet, is characterized by decentralization, user ownership, and enhanced user experience. While still in its nascent stages, it has demonstrated significant growth potential, driven by advancements in blockchain technology, artificial intelligence, and the increasing demand for data privacy and security.
Market Growth:

1. Expanding Applications: Web 3.0 has transcended its initial cryptocurrency focus, encompassing diverse sectors like decentralized finance (DeFi), non-fungible tokens (NFTs), decentralized identity (DID), and the metaverse.
2. Growing User Base: Although the active user base remains a fraction of the total cryptocurrency holders, it signifies a gradual increase in user adoption.
3. Increased Investment: Venture capital firms and institutional investors are increasingly pouring funds into Web 3.0 projects, fueling innovation and development.
4. Technological Advancements: Continuous advancements in blockchain technology, such as scalability solutions and interoperability protocols, are paving the way for wider adoption and improved user experience.

The proliferation of blockchain technology has led to the emergence of decentralized applications (DApps), smart contracts, and cross-chain solutions. However, despite this rapid expansion, several industry-wide challenges persist. **Challenges:**

1. Scalability and Interoperability: Many blockchain networks face limitations in terms of transaction speed and cost, hindering widespread adoption. Interoperability issues between different blockchains also pose a significant challenge.
2. Regulatory Uncertainty: The lack of clear regulatory frameworks in many jurisdictions creates uncertainty for businesses and investors, hindering innovation and investment.
3. Security Concerns: The decentralized nature of Web 3.0 can also present security challenges, such as vulnerabilities to hacks and scams.
4. User Experience: The complexity of Web 3.0 technologies can be daunting for many users, hindering mainstream adoption.
5. Data Privacy: While Web 3.0 promises enhanced user privacy, concerns remain regarding the potential for data breaches and the misuse of user data.

2.2 The Disconnect Between Vision and Implementation in Current Web 3.0 Architectures

Web 3.0 was envisioned as a decentralized, trustless, and permissionless digital ecosystem that would empower users with ownership, privacy, and autonomy. However, the current state of Web 3.0 often diverges from these ideals due to the following factors:

- Centralization in Decentralized Systems: Many blockchain networks still rely on centralized intermediaries, such as node operators, oracles, and custodians, limiting the promised decentralization. For example, major DeFi platforms often depend on centralized stablecoins (e.g., USDT, USDC), contradicting their decentralized ethos.

- Economic Incentives Over User Empowerment: The Web 3.0 landscape has largely been dominated by financial speculation rather than delivering meaningful user-centric applications. High transaction fees, rug pulls, and poorly designed tokenomics have created an ecosystem driven more by short-term profit than by sustainable technological progress.
- Poor User Experience and High Barriers to Entry: For mainstream adoption, Web 3.0 platforms must provide seamless and intuitive user experiences comparable to Web2 applications. However, interacting with decentralized applications still involves complex processes such as managing private keys, calculating gas fees, and understanding smart contract risks, deterring non-technical users.

2.3 Barriers to Decentralized Intelligence and Autonomous Systems

The integration of AI with Web 3.0 has been touted as a transformative force, promising decentralized intelligent agents that can operate autonomously on-chain. However, significant hurdles remain in achieving this vision:

- Computational Power and Infrastructure Constraints: AI models require significant computational resources, which blockchain networks currently struggle to provide efficiently. Most AI models are hosted on centralized cloud providers, making it challenging to ensure true decentralization.
- Lack of Standardized Frameworks for AI-Web 3.0 Integration: Interoperability remains a significant challenge, with few unified standards governing how AI models interact with smart contracts and blockchain networks. AI-powered decentralized applications (SuperDApps) require better frameworks to facilitate seamless integration and automation.
- Security and Trust in AI-driven Smart Contracts: AI-powered contracts introduce new attack vectors, such as adversarial AI manipulation and biased algorithmic decision-making. Ensuring transparency, accountability, and fairness in decentralized AI systems [8] remains an unresolved issue.

2.4 Fragmentation in Interoperability and User Experience

Web 3.0's potential is undermined by fragmentation across multiple dimensions, including technology stacks, governance models, and user accessibility. Some of the most pressing challenges include:

- Interoperability Challenges Across Blockchains: Most blockchain networks operate in silos, making it difficult for users and developers to interact across ecosystems. Cross-chain bridges and interoperability protocols, while promising, remain prone to exploits and inefficiencies.
- Data Silos and Lack of Seamless Identity Solutions: Decentralized identity (DID) and zero-knowledge proof (ZKP) technologies offer a vision of self-sovereign identity, but adoption remains limited due to inconsistent implementation and lack of universal standards.
- Regulatory Fragmentation and Compliance Complexity: Different jurisdictions have varying approaches to Web 3.0 regulation, making it difficult for developers and businesses to navigate legal compliance. The lack of unified regulatory frameworks stifles innovation and creates uncertainty.

Despite its rapid evolution, Web 3.0 still faces significant challenges that must be addressed to realize its full potential. Key issues include scalability, user experience, security, and interoperability. The next chapter will explore how a Decentralized Agentic Super Intelligence Protocol can overcome these barriers and create a unified, intelligent, and autonomous Web 3.0 ecosystem.

3 A New Framework for Web 3.0 Protocol-as-Platform

The Web 3.0 landscape has evolved with significant technological advances, yet major challenges such as interoperability, scalability, data privacy, and governance remain unresolved. To establish a Protocol-as-Platform vision for a truly decentralized agentic super intelligence, we propose a framework that integrates modular design, AI-powered automation, cryptographic security, and decentralized governance.

3.1 Defining a Modular, Composable, and Interoperable Web 3.0 Infrastructure

A truly scalable and developer-friendly Web 3.0 infrastructure must be modular, composable, and interoperable, enabling seamless integration of decentralized applications (DApps) with flexible development tools. The key components are:

- Componentized Development: A modular approach allows developers to select smart contract modules, decentralized storage, identity verification, and AI services without deep blockchain expertise.
- Interoperability Protocols: Web 3.0 platforms must support cross-chain transactions and data bridges that ensure smooth interactions between Ethereum, Solana, BSC, and other blockchains.
- Adaptive Smart Contracts: AI-enhanced smart contracts dynamically adjust execution based on real-time data, improving efficiency and security.
- Developer-Friendly SDKs: Supporting JavaScript, Python, and Rust, Web 3.0 SDKs lower entry barriers for Web2 developers transitioning to blockchain development.

These elements reduce development complexity while ensuring high scalability and security in a multi-chain environment.

3.2 The Role of AI in a Decentralized Protocol

AI plays a transformative role in Web 3.0 automation, security, and governance. In a Protocol-as-Platform ecosystem, AI-powered decentralized systems enable:

- Smart Contract Optimization: AI-powered audits enhance contract security by detecting vulnerabilities in real-time.
- Autonomous DAOs: AI-driven decentralized autonomous organizations (DAOs) optimize governance by dynamically adjusting consensus mechanisms.
- AI-Powered Smart Contracts: AI models embedded within smart contracts automate decision-making, such as adjusting lending rates in DeFi protocols.
- Personalized AI Services in Web 3.0 Apps: AI enhances user experience through recommendation engines, fraud detection, and automated interactions.
- On-Chain AI Marketplaces: Decentralized AI training and federated learning enable collaborative AI models without compromising data privacy.

A trustless AI-powered framework allows autonomous decision-making while ensuring security through cryptographic proofs.

3.3 Enhancing Data Autonomy, Privacy, and Security Through Cryptographic Innovations

With privacy concerns growing in Web 3, advanced cryptographic methods must be integrated to protect user data and ensure trust. The key cryptographic solutions are:

- Zero-Knowledge Proofs (ZKPs): Allow privacy-preserving transactions where users can prove identity or ownership without revealing sensitive information.
- Fully Homomorphic Encryption (FHE): Enables computation on encrypted data, allowing confidential AI models to process data securely.
- Decentralized Identity (DID) Systems: Users control their personal data via blockchain-based identity verification.
- Secure Multi-Party Computation (sMPC): Allows privacy-preserving AI collaborations, enabling decentralized systems to process shared data without exposing raw information.

By embedding these privacy-focused cryptographic innovations, Web 3.0 ecosystems can achieve true data sovereignty while maintaining usability and security.

3.4 Multi-Layered Infrastructure for Scalable and Decentralized Computing

Current Web 3.0 networks face scalability challenges, requiring a multi-layered architecture to handle high-speed, decentralized applications. Infrastructure layers consist of,

- Decentralized Compute Networks: Distributed AI nodes provide GPU-based decentralized computing, enabling real-time AI processing.
- Layered Blockchain Design: A hybrid approach includes Layer 1 for security and Layer 2 for high-speed transactions, reducing congestion.
- Cross-Chain Asset Transfers: Interoperability solutions like cross-chain bridges and atomic swaps enable secure asset movement across blockchain ecosystems.
- AI-Optimized Resource Allocation: AI-based load balancing and dynamic sharding improve blockchain performance.
- Off-Chain Computing and zk-Rollups: Off-chain data storage and processing reduce on-chain computation costs while preserving decentralization.

This multi-layered Web 3.0 infrastructure enables high scalability, cross-chain compatibility, and optimized AI integration.

3.5 Distributed Governance and Risk Management in Web 3.0 Protocols

For a Protocol-as-Platform to succeed, it must balance decentralized decision-making with security and adaptability. The Governance model spans,

- AI-Driven DAO Governance: AI-augmented DAOs analyze network activity and dynamically propose governance updates.
- On-Chain Voting Mechanisms: Token-based staking models ensure democratic decision-making with incentives for participation.
- Decentralized Treasury Management: Smart contract-based treasuries allocate resources transparently, preventing fund mismanagement.

And, the risk management emphasis on security aspects which are,

- AI-Powered Security Monitoring: AI-driven fraud detection systems analyze real-time network threats to prevent security breaches.
- Governance Fail-Safes: Multi-signature wallets and decentralized arbitration mechanisms help mitigate protocol risks.
- Bug Bounty and Security Audits: Regular smart contract audits and community-driven security testing ensure network resilience.

By integrating risk-aware AI governance, Web 3.0 protocols self-improve over time, ensuring a balance between innovation, security, and decentralization. The transition to Web 3.0 Protocol-as-Platform demands a fundamental rethinking of blockchain architecture. By integrating AI-driven automation, cryptographic security, decentralized scalability, and risk-aware governance, Web 3.0 can evolve into a truly intelligent, scalable, and trustless ecosystem. This visionary framework enables global adoption of decentralized applications while preserving security, privacy, and user empowerment.

4 Key Technological Innovations and Their Role in a Web 3.0 Protocol-as-Platform

4.1 Decentralized Storage and Data Integrity

Decentralized storage is fundamental to Web 3.0, addressing the limitations of centralized data systems by offering improved security, redundancy, and autonomy. The decentralized storage system integrates IPFS (InterPlanetary File System) and KV (Key-Value) storage technologies, providing scalable and globally distributed data storage. This ensures redundant backups, high availability, and

protection against single-point failures.
Data Encryption & Security:

- AES-256 Encryption: All stored data is encrypted using AES-256, ensuring high levels of security.
- Shamir's Secret Sharing (SSS) Algorithm: Key fragmentation and distribution across nodes ensure secure access control.
- Zero-Knowledge Proofs (ZKP): Enable verification of information without revealing private details, enhancing privacy in storage operations.

4.2 Privacy-Preserving Computation Using Zero-Knowledge Proofs

Privacy is a major concern in Web 3.0. Zero-Knowledge Proofs (ZKPs) allow users to verify transactions and credentials without exposing sensitive data. The key applications of ZKPs in Web 3.0 are,

- Anonymous Transactions: Users can prove asset ownership without revealing balances.
- Decentralized Identity Verification: Allows users to prove eligibility for services without disclosing personal data.
- Secure Data Processing: Enables computations on encrypted data without decryption, preserving confidentiality.
- Our framework implements dynamic end-to-end encryption with a session-based key exchange mechanism. This ensures each transaction uses a unique encryption key, mitigating risks of replay attacks and key leakage.

4.3 AI-Driven Smart Contracts and Intelligent Agents

AI is becoming a transformative force in Web 3.0, enhancing smart contract automation and efficiency. Our AI-powered smart contracts in PaaP consists of,

- Autonomous Execution: AI-driven contracts adjust dynamically based on on-chain and off-chain data.
- Decentralized AI Agent Swarms: Enables intelligent decision-making across DeFi, gaming, and social applications [21].
- AI-Driven DAO Judger: Evaluates AI agents on-chain for credibility and trustworthiness.

AI enhances contract efficiency by optimizing performance, predicting fraudulent activities, and dynamically adjusting governance mechanisms based on real-time data.

4.4 Gas Optimization and Economic Sustainability

Gas fees remain a barrier for Web 3.0 adoption. Our framework introduces gas subsidy mechanisms and optimized smart contract structures to reduce transaction costs. The key innovations in gas efficiency,

- Batch Processing & Layer 2 Solutions: Reduces on-chain transaction loads.
- AI-based Fee Prediction: Smart contracts dynamically adjust execution strategies to optimize gas costs.
- Staking and Fee-Burning Mechanisms: Ensures sustainable ecosystem growth by redistributing transaction fees among stakeholders.

This model enhances accessibility, reducing the burden on new users while maintaining blockchain security and scalability.

4.5 Cross-Chain Interoperability for a Multi-Chain Ecosystem

Interoperability is crucial for a seamless Web 3.0 experience. Our framework integrates cross-chain bridges that allow secure asset and data transfers across multiple blockchains. The improvements on the interoperability in our framework are,

- Cross-Chain Asset Transfer & Contract Invocation: Supports Ethereum, Polygon, BSC, and upcoming networks.
- Decentralized Oracles & Data Verification: Ensures real-time, verifiable data availability across blockchains.
- Multi-Chain Smart Contracts: Enables unified application logic across different blockchains.

PaaP fosters a multi-chain ecosystem that breaks silos between blockchains, promoting data liquidity and seamless interactions across different ecosystems.

4.6 Dynamic Governance Mechanisms for Sustainable Evolution

Web 3.0 governance must be adaptable to support long-term sustainability. PaaP implements a dynamic governance framework that balances decentralization with efficient decision-making. The key governance mechanisms in PaaP are,

- AI-Assisted Decision Making: AI models analyze governance proposals and provide insights to stakeholders.
- Token-Based Voting: Stakeholders participate in decision-making through weighted token governance.
- On-Chain Dispute Resolution: Utilizes AI-empowered DAOs to mediate conflicts in decentralized ecosystems.

By leveraging AI and decentralized governance models, our framework ensures continuous improvement and long-term adaptability in a rapidly evolving Web 3.0 landscape. This chapter outlined the technological innovations that underpin Web 3.0 Protocol-as-Platform, ensuring security, efficiency, and interoperability in a decentralized digital landscape. These technologies provide the foundation for a scalable, privacy-preserving, and intelligent decentralized ecosystem, aligning with the vision of a truly agentic and autonomous Web 3.0 future.

5 AI as the Next Catalyst for Web 3.0

5.1 AI and Web 3.0 Convergence: The Need for Decentralized Intelligence

The integration of artificial intelligence (AI) and Web 3.0 is emerging as a defining paradigm shift, fundamentally reshaping decentralized systems. AI, with its capabilities in automation, prediction, and data analytics, has the potential to enhance the efficiency and intelligence of decentralized applications (DApps), blockchain governance, and data management. However, existing AI implementations in Web 3.0 remain largely centralized, contradicting the core principles of decentralization, user autonomy, and trustlessness. The challenge lies in designing truly decentralized AI infrastructures that preserve user sovereignty, ensure algorithmic transparency, and leverage distributed computational resource. Some core drivers for AI-Web 3.0 convergence include,

- Decentralized AI models that eliminate reliance on centralized providers like OpenAI or Google.
- Blockchain-based data marketplaces for verifiable, privacy-preserving AI training datasets.
- On-chain AI-driven governance mechanisms ensuring fairness and transparency in protocol upgrades and decision-making.

By embedding AI into decentralized networks, Web 3.0 ecosystems can unlock new use cases, from intelligent smart contracts to self-evolving decentralized autonomous organizations (DAOs).

5.2 AI-Powered Decentralized Applications (DApps)

AI-powered DApps, or SuperDApps, are a natural evolution in Web 3.0 applications, enhancing user experiences and functionality through machine learning and automation. The key AI-Enhanced Web 3.0 applications are,

- DeFi: AI agents can optimize lending rates, detect fraudulent activities, and execute high-frequency algorithmic trading autonomously.
- Social Media: AI-driven personalized content curation, sentiment analysis, and automated moderation.
- NFT & Gaming: AI-generated digital assets and dynamic NFT attributes that evolve based on real-world or user-driven events.
- Supply Chain: AI-enabled real-time tracking and predictive logistics to enhance transparency and efficiency.

Decentralized AI allows DApps to function autonomously, eliminating the need for intermediaries and reinforcing trustless environments.

5.3 AI-Driven Consensus Mechanisms and Autonomous Agents

Traditional blockchain consensus mechanisms (Proof-of-Work, Proof-of-Stake) suffer from scalability, energy inefficiency, and susceptibility to Sybil attacks. AI presents solutions through adaptive, intelligent, and autonomous consensus models. The AI-Enhanced consensus models comprises of,

- Reputation-based consensus: AI-powered reputation scores dynamically adjust node voting power based on past contributions and behavior.
- Swarm Intelligence: AI agents coordinate decentralized agent networks, mimicking biological ecosystems to reach efficient consensus.
- AI-Powered DAO Governance: AI models assist in proposal analysis, risk assessment, and fraud detection to optimize decentralized decision-making.

These innovations enhance security, efficiency, and adaptability, making decentralized AI networks more resilient and intelligent.

5.4 The Role of Large Language Models (LLMs) in Web 3.0 Automation

Large Language Models (LLMs), like GPT-4, have revolutionized natural language understanding, enabling Web 3.0 applications to automate decision-making, optimize governance, and enhance user interactions. The LLMs in Web 3.0 use cases,

- Smart Contract Generation: AI-driven contract analyzers write, optimize, and audit Solidity contracts, reducing vulnerabilities.
- Decentralized AI Chatbots: Web 3-native LLMs power trustless AI assistants that operate on decentralized infrastructure.
- Autonomous Legal Frameworks: AI assists in automating regulatory compliance, making DAOs and DeFi platforms legally robust.
- Self-Optimizing DApps: AI models analyze user behavior and automatically adjust DApp UI, tokenomics, and engagement strategies.

Unlike traditional LLMs controlled by centralized providers, Web 3-native LLMs will be open-source, decentralized, and privacy-preserving, ensuring algorithmic fairness.

5.5 AI-Powered Risk Assessment and Decision-Making in Decentralized Networks

One of AI's most critical applications in Web 3.0 is real-time risk analysis, which can drastically reduce security breaches, Sybil attacks, and protocol failures. The role of AI in Web 3.0 risk Managements are,

- Smart Contract Security: AI-powered formal verification tools automatically detect vulnerabilities in contracts before deployment.
- Fraud Detection: AI analyzes transaction data to identify malicious activity and prevent rug pulls in DeFi. An example of the Ronin hack[5] is reported in Fig. 2

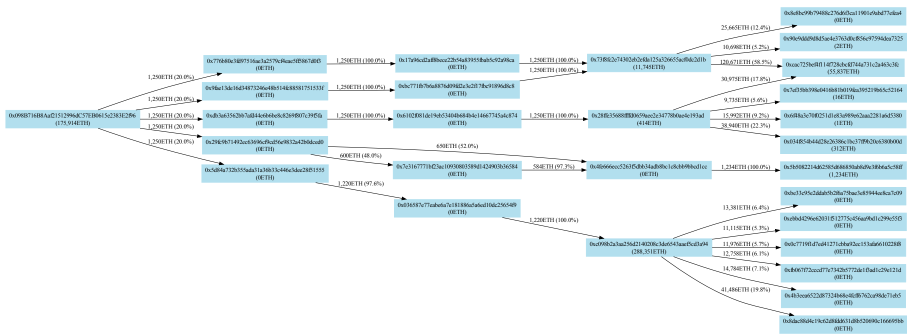

Figure 2: AI-driven Identification of Illicit Transactions with an analysis of well-known Ronin Network attack tied to Axie Infinity

- On-Chain Credit Scoring: AI models assess borrower credibility in decentralized lending using on-chain history rather than traditional credit ratings.
- Autonomous Risk-Oriented DAOs: AI agents act as on-chain auditors, predicting and mitigating risks in governance decisions.

By leveraging AI-driven risk analytics, decentralized systems become more secure, efficient, and transparent, reducing reliance on human oversight. AI is not just an add-on for Web 3, it is the next catalyst for fully autonomous, intelligent, and scalable decentralized ecosystems. The integration of decentralized AI, LLMs, and AI-enhanced governance will define the next era of Web 3.0 innovation, pushing blockchain technology beyond financial speculation into intelligent, decentralized infrastructure.

6 The Future of Web 3.0: A Holistic Ecosystem

6.1 The Role of Agentic Intelligence in Decentralized Systems

Agentic Intelligence refers to the deployment of autonomous, AI-driven agents within decentralized environments. These agents operate with minimal human oversight and perform tasks integral to the stability and evolution of blockchain-based ecosystems. In contrast to conventional software routines that merely respond to inputs, agentic AI systems are designed to anticipate changing conditions, learn from their interactions, and proactively optimize outcomes [11]. As such, they offer a robust mechanism for managing network-wide processes, ranging from smart contract execution to governance, while retaining the decentralized ethos of Web 3.0.

A principal function of these intelligent agents is the administration of self-executing smart contracts. By embedding AI models within the contract logic, these contracts dynamically adapt to real-time fluctuations in network usage, transaction load, and user preferences. For instance, smart contracts may autonomously adjust transaction fees or regulate execution order to avoid congestion. This continuous optimization ensures that decentralized applications are more resilient to unforeseen changes in demand, mitigating performance bottlenecks that often arise in less adaptive systems. In

[5] https://etherscan.io/address/0x098b716b8aaf21512996dc57eb0615e2383e2f96

doing so, AI-enhanced contracts reduce the need for manual oversight, contributing to a more fluid user experience without compromising on trust and security.

Beyond contract optimization, Agentic Intelligence plays a transformative role in decentralized governance. Instead of relying on manual voting or static rules, AI agents can act as decision-making nodes within Decentralized Autonomous Organizations (DAOs). These agents employ advanced analytical techniques to evaluate proposals, predict potential risks, and gauge community sentiment, thus improving both the efficiency and fairness of governance processes. By facilitating near real-time data analysis and removing biases tied to human decision-making, intelligent agents elevate the rigor and transparency of DAO-based frameworks. This fosters a governance model that is more inclusive yet methodical, where decisions and protocol upgrades are guided by verifiable logic rather than mere speculation.

Moreover, Agentic Intelligence introduces new methods of network optimization referred to as AI-swarm optimization [9]. In this scenario, multiple AI agents coordinate across diverse computational nodes to distribute workloads, balance resource allocation, and reduce overall gas fees. Such coordination mirrors swarm behaviors observed in biological systems, where individual agents collectively solve complex tasks that exceed the capability of any single member. Applied to Web 3.0 infrastructure, this swarm-based approach can pinpoint resource constraints and reconfigure network parameters to sustain higher throughput without sacrificing decentralization. The outcome is an environment in which computational tasks are handled with greater efficiency, and blockchain networks become more agile in adapting to ever-changing user demands.

Also, Agentic Intelligence equips decentralized systems with an unparalleled capacity for self-management, thereby minimizing human intervention while maximizing operational efficiency. By autonomously optimizing contracts, governance, and resource distribution, AI agents serve as the linchpin for the next generation of Web 3.0 applications. This intelligent, adaptive foundation not only reinforce current use cases but also opens new avenues for innovation, ultimately paving the way for a truly holistic, trust-minimized, and user-centric decentralized ecosystem.

6.2 Creating Incentive Structures for Mass Adoption

Despite rapid growth, Web 3.0 adoption remains relatively low outside of DeFi and NFTs. A major reason is the lack of real-world incentives beyond financial speculation [2]. The future of Web 3.0 must focus on engagement-driven incentives to drive mass participation. The key strategies for incentivization in our work are threefold, which are reputation-based reward mechanisms [10], gamified participation and gas fee subsidization. One of the core obstacles to widespread adoption in decentralized ecosystems is the perceived lack of trust among participants. By implementing reputation-based reward systems, platforms can address this challenge and foster genuine community engagement. Such systems rely on AI-enhanced decentralized identities, which securely record the user's on-chain behavior and off-chain achievements [5, 4]. When integrated with verifiable credentials, these digital identities enable more accurate reflections of each individual's contributions, whether through software development, content creation, or collaborative decision-making. As a result, well-intentioned users benefit from transparent and fair compensation for their efforts, while malicious or low-effort actors find fewer avenues for exploitation. This alignment of incentives strengthens user loyalty, reduces spam, and promotes an environment where productive collaboration is consistently recognized.

Beyond offering tokens or other monetary rewards, a more engaging model involves weaving game-like elements into the user experience. Gamification strategies employ real-time data analytics and AI-driven personalization to align users' evolving interests with meaningful tasks and challenges. For example, quests, leaderboards, and digital collectibles can be integrated into platforms to encourage a sense of belonging and friendly competition. By rewarding activities related to learning, community governance, or knowledge sharing, such models elevate user satisfaction and cultivate a longer-term commitment than short-lived speculation. Furthermore, this approach broadens the demographic base, appealing to both tech-savvy users and individuals seeking more interactive and socially oriented incentives.

A significant deterrent to novice participants is the unpredictable or prohibitive cost of on-chain transactions, often exacerbated by periods of high network congestion. Universal gas fee subsidization, guided by AI-driven pricing algorithms, offers a viable method to reduce this barrier. Rather than placing the entire cost burden on the end user, smart contracts can dynamically adjust fees or allocate subsidies in real time based on network conditions, user profiles, or task importance. This adaptive mechanism not only expands accessibility for newcomers unfamiliar with blockchain economics but also preserves overall network functionality by preventing cost spikes and ensuring equitable resource allocation. As a consequence, users are more inclined to experiment with decentralized applications, thereby accelerating the broader goal of mass adoption. Incentive structures alone are insufficient to drive mass adoption. A sustainable Web3 economy must also provide reliable, real-world value beyond token speculation. This requires AI-driven financial mechanisms that balance accessibility with long-term economic viability.

6.3 Building a Sustainable Web 3.0 Economy Beyond Financial Speculation

Many current Web 3.0 platforms resemble financial products rather than true decentralized ecosystems. Although blockchain-based platforms have ushered in new forms of digital interaction, many still rely heavily on speculative activity rather than meaningful utility.

This dynamic often manifests as "pump-and-dump" tokenomics, where short-lived trading frenzies inflate prices with little regard for underlying value. In such environments, true innovation is overshadowed by quick profits, deterring developers from committing long-term resources to platform development. Consequently, user retention suffers, and projects risk stagnation once market excitement wanes. A more enduring approach requires elevating value creation above hype, thereby encouraging ecosystems designed for consistent contributions and sustained growth.

One viable path toward greater stability involves the introduction of AI-powered stablecoins and smart payment mechanisms. By employing automated models to monitor real-time market data and adjust token issuance or collateralization, AI-managed stablecoins like NUSD can counteract severe price fluctuations and maintain user confidence. These AI algorithms could link stablecoin value to a basket of real-world assets (RWAs), dynamically rebalancing reserves based on market conditions. These same models also facilitate personalized credit services, enabling participants to access lending products tailored to their specific on-chain behavior or financial history. Over time, such intelligent financial tools reduce the volatility that often dissuades newcomers, while providing avenues for both individuals and businesses to engage in a more predictable and transparent digital economy.

Beyond monetary applications, AI-driven frameworks can rejuvenate digital content and data services by granting users genuine ownership rights. Web 3.0 platforms that embed intelligent algorithms into NFTs transform static collectibles into interactive, functional assets—for instance, AI-generated music or algorithmically licensed media. Parallel to this, decentralized AI-powered identity solutions enhance user experiences through personalized data analytics, yet they preserve user sovereignty by storing identifiable information off-chain or in encrypted formats. This dual focus on utility and user-centric design increases the attractiveness of decentralized technologies, prompting creators, consumers, and entrepreneurs to innovate across various domains rather than concentrate purely on speculative gains.

A final dimension involves the evolution of decentralized finance (DeFi) into a more robust ecosystem enhanced with AI. Advanced machine learning techniques can optimize critical processes such as lending, stake, and liquidity provisioning. In particular, AI-based risk management tools can detectct precarious investment behavior, reducing the likelihood of systemic losses that have previously jeopardized user trust. Coupled with automated financial advisory services, this next generation of DeFi offers participants a blend of autonomy and informed guidance. By refining the balance between innovation and prudence, AI-powered solutions help ensure that digital financial systems remain efficient, equitable, and positioned for responsible long-term expansion.

6.4 Integrating Web2 Developers into the Web 3.0 Ecosystem

Developers accustomed to Web2 paradigms often encounter a steep learning curve when transitioning to blockchain-based frameworks. Instead of relying on familiar languages and infrastructure, they must familiarize themselves with new programming models, cryptographic methods, and distributed ledgers. This shift frequently involves rethinking fundamental design principles to ensure that decentralized applications maintain both security and autonomy. For many developers, the additional complexity of managing private keys, understanding consensus algorithms, and integrating zero-knowledge proofs or smart contract logic can be daunting, slowing the pace of widespread adoption.

To mitigate these difficulties, modular approaches to smart contract development offer an effective starting point. This can provide AI-generated low-code/no-code smart contracts will lower the barrier for Web2 developers. Rather than requiring mastery over every facet of blockchain technology, these frameworks break down key functionalities, such as consensus, execution, and storage, into smaller, reusable components. By selecting the modules most relevant to their use cases, developers can tailor solutions without wading through extraneous code. Together, AI-based tools can further enhance productivity by identifying potential bugs, suggesting refinements in contract logic, and verifying code integrity. These automated assistants act as a real-time layer of quality control, minimizing the likelihood of critical oversights that could lead to security breaches or performance inefficiencies.

Finally, the widespread availability of Web 3.0 SDKs designed for languages such as Python, JavaScript, and Rust provides a critical on-ramp for people accustomed to traditional software development. Such SDKs abstract away many low-level blockchain operations, allowing teams to focus on building robust interfaces, integrating essential data streams, and creating seamless user experiences. By combining simplified tooling with the inherent advantages of distributed networks, these initiatives foster a more inclusive environment, lowering the barriers to entry, and sparking fresh innovation within the broader Web 3.0 ecosystem.

6.5 Ensuring Long-Term Governance and Security in an Open and Transparent System

Despite the ongoing evolution of decentralized governance frameworks, many still exhibit notable shortcomings. In some instances, token-based voting systems concentrate authority in the hands of large stakeholders, undermining the principle of inclusive participation. Similarly, enthusiasm for participating in governance can wane when stakeholders perceive the decision-making process to be overly complex or tedious. These issues underscore the importance of refining on-chain governance, both by redesigning token distribution approaches to foster broader engagement and by introducing incentive structures that reward constructive input. Over time, such refinements enhance the community's sense of collective ownership, thereby solidifying the protocol's resilience against hasty or unrepresentative resolutions.

Equally pressing are the security risks that threaten decentralized systems. High-profile incidents such as the Ronin Bridge and Nomad Bridge breaches have revealed vulnerabilities in smart contract logic, bridging mechanisms, and overall protocol design. These breaches not only compromise funds but also erode public trust in nascent blockchain technologies. In response, rigorous auditing methodologies and real-time threat detection must become standard practice. Such measures can be strengthened by advanced AI-driven analysis, capable of identifying unusual transaction patterns or code irregularities at an early stage. By actively monitoring for deviations and swiftly isolating compromised modules, these intelligent frameworks transform threat response from a reactive to a preventive posture.

The confluence of refined governance processes and robust security practices rests on achieving transparent yet adaptable oversight. AI-powered solutions for decentralized governance can assist in evaluating proposals, modeling the potential impact of various policy adjustments, and suggesting course corrections that prioritize sustainable, long-term performance. When paired with zero-knowledge proofs or other privacy-enhancing cryptographic methods, these systems can facilitate efficient decision-making without revealing sensitive participant data. Taken together, the ongoing integration of AI in governance and security provides a constructive balance: it encourages engagement through open, user-focused processes while simultaneously fortifying networks against emergent threats. AI can automatically generate governance proposals by analyzing on-chain data, predict voting results, and improve DAO participation rate. By adopting these practices, decentralized ecosystems evolve into enduring communities capable of weathering unforeseen disruptions and consistently adapting to new technological opportunities.

By integrating AI and cryptographic innovations, Web 3.0 can achieve secure, scalable, and transparent governance. The future of Web 3.0 must transcend financial speculation and embrace AI-powered decentralization, enabling *agentic intelligence in governance and finance, sustainable Web 3.0 economies driven by AI, developer-friendly SDKs for seamless Web 2 integration, and Long-term, AI-optimized decentralized governance*. By embracing these principles, Web 3.0 will evolve into a truly decentralized and intelligent ecosystem.

7 Roadmap and Call to Action

7.1 Immediate Priorities for Implementation

Establishing the Foundational Infrastructure

The cornerstone of a robust Web 3.0 ecosystem is the establishment of composable, modular, and interoperable infrastructures. Rather than relying on fragmented solutions, developers and stakeholders must jointly deploy fully decentralized platforms capable of hosting multifaceted applications in a reliable, trust-minimized environment. Equally essential is the integration of AI-driven agents at the architectural level to enhance automation, on-chain governance, and strategic decision-making. These intelligent modules not only boost operational efficiency but also serve as a preventative layer against security breaches by actively monitoring network activity and adjusting system parameters in real time. In parallel, privacy-preserving technologies like Zero-Knowledge Proofs (ZKPs) and homomorphic encryption must be integrated to secure data storage and computation. By safeguarding sensitive information without compromising functionality, these cryptographic mechanisms could gain broader trust among users and potential enterprise partners. Finally, to avoid isolated development, infrastructure planning should prioritize interoperability with major networks such as Ethereum and Solana. Lightweight cross-chain solutions, including Inter-Blockchain Communication (IBC), streamline asset transfers, reduce transaction overhead, and facilitate collaboration among diverse protocols, setting a precedent for continued expansion into additional networks in the future.

Developer and User Adoption Initiatives

A sustainable Web 3.0 ecosystem hinges on strong developer engagement and a seamless user experience. In the short term, community-led grant programs can incentivize open-source contributions while catalyzing the rapid iteration of decentralized applications (DApps). Such incentives not only encourage technical breakthroughs but also create vibrant support structures for emerging teams. Meanwhile, toolkits and software development kits (SDKs) specifically tailored for Web2 developers help lower the barrier to entry, simplifying blockchain interactions via widely adopted programming languages and intuitive interfaces. On the user side, the development of accessible wallets equipped with automated gas fee subsidies can reduce the financial burden associated with on-chain activities, especially for newcomers. AI-driven transaction optimizers further enhance this experience by predicting network conditions, thereby minimizing wait times and transaction failures. Together, these measures foster a more inclusive environment for both experienced engineers and those new to decentralized technology.

Governance and Regulatory Alignment

Early alignment with governance and regulatory frameworks is critical to preventing disjointed policy battles later in the deployment cycle. A Decentralized Autonomous Organization (DAO) governance structure can democratize decision-making, ensuring that protocol upgrades and resource allocations are transparent and grounded in community consensus. By introducing reputation-based voting or tiered staking, such frameworks strike a balance between inclusive participation and the need for credible contributions. Simultaneously, establishing dialogues with regulatory bodies allows the ecosystem to shape a supportive legal environment for AI-driven, decentralized protocols. This can include clarifications on data privacy obligations, asset classification, and enforceable smart contract parameters. Compliance with privacy legislation such as the General Data Protection Regulation (GDPR) also becomes more tractable through well-defined guidelines. By addressing these priorities now, the emerging Web 3.0 landscape can evolve within a stable policy framework, thereby reducing uncertainty for developers, users, and institutional actors alike.

7.2 Medium-Term Development Goals

Optimizing Economic and Incentive Models

A robust and enduring Web 3.0 ecosystem depends on tokenomics that promote both affordability and active engagement. One way to achieve this involves deploying a dynamic fee mechanism capable of adjusting to evolving network conditions. Rather than binding users to a rigid fee schedule, such a structure balances operational costs with real-time utilization data, ensuring predictable expenses without threatening platform sustainability. Complementing this approach is a pioneer model specifically designed for decentralized AI services. Here, stakeholders commit tokens to validate or train AI models, receiving rewards commensurate with their contributions and the accuracy of those models' outputs. This effectively shifts system maintenance from an isolated group of validators to a broader network of collaborative participants. Finally, introducing an AI-driven governance layer can further refine decision-making processes by automating tasks such as consensus adjustments or conflict resolution. By leveraging real-time analytics and predictive modelling, this governance innovation not only bolsters protocol security but also streamlines the path to consensus in an increasingly complex, multi-stakeholder environment.

Scaling Infrastructure and Ecosystem Growth

Mid-term strategies must also prioritize scalable and resilient infrastructure capable of accommodating a continually expanding user base. The creation of decentralized cloud networks represents a critical step in this direction, mitigating reliance on centralized data centers that can otherwise form bottlenecks or single points of failure. Alongside infrastructural advancements, forming collaborative relationships with AI research institutions injects new intellectual capital into Web 3.0 platforms, catalyzing fresh ideas and use cases. Such alliances can yield breakthroughs in areas ranging from advanced cryptographic methods to innovative data-sharing frameworks. Meanwhile, developing AI-enabled services—such as credit scoring or risk modelling—empowers DeFi and PayFi applications to extend financial products to a broader audience. Collectively, these measures enhance global reach and signal the ecosystem's commitment to driving real-world utility.

Enhancing Decentralized Intelligence

Finally, an integral medium-term goal revolves around embedding intelligence more deeply into on-chain processes, effectively taking decentralized systems to a higher echelon of autonomy. AI-powered smart contracts capable of dynamic optimization, for instance, can modulate parameters like gas costs or execution pathways based on evolving market or network data. Simultaneously, newly introduced decentralized autonomous agents operate beyond simple event-driven scripts, using reinforced learning algorithms to interact, negotiate, and even forge multi-step logical agreements. Over time, self-improving AI models ensure that the network matures in response to both on-chain activity and off-chain signals, forming a feedback loop that refines performance. By systematically weaving intelligence into the fundamental structure of Web 3.0 ecosystems, these initiatives pave the way for platforms that are not merely decentralized in theory, but genuinely adaptive and enduring in practice.

7.3 Long-Term Vision for the Web 3.0 Protocol-as-Platform

Achieving Fully Autonomous Decentralized Intelligence

One of the ultimate aspirations of a Web 3.0 protocol framework involves transitioning beyond semi-autonomous operations to a genuinely self-sustaining AI-driven infrastructure. In this envisioned environment, agentic intelligence takes on comprehensive roles in resource allocation, governance, and economic coordination, thereby reducing reliance on human oversight and decreasing susceptibility to human error or partiality. The backbone of this model lies in cryptographically verifiable processes, which ensure that algorithmic decisions remain transparent, accountable, and mathematically sound. Just as important is building trustless systems for AI collaboration, where models can securely exchange data and align on outcomes without exposing sensitive information or requiring centralized control. In parallel, emerging models of decentralized AI cooperatives (DAICs) present a novel framework by allowing autonomous agents to function as legitimate economic participants in their own right. These agents can transact, hire services, and respond to network incentives, effectively broadening the market beyond human actors. Over time, this level of autonomy underscores a shift from decentralized systems that merely facilitate transactions to those that actively foster dynamic, AI-powered communities.

Global Expansion and Adoption

Sustaining the next phase of Web 3.0 growth on a worldwide scale demands ongoing collaboration among regulatory bodies, standard-setting institutions, and private-sector innovators. A forward-looking strategy entails actively engaging with global governance frameworks to clarify the legal status of AI-driven protocols, mitigate risks, and harmonize regulations across diverse jurisdictions. This includes lobbying for and contributing to international standards that guarantee consistent operational and security benchmarks for AI-enabled blockchain applications. Parallel to these governance efforts is the expansion of cross-chain interoperability, a critical step that allows heterogeneous networks to coordinate effectively. Such a move opens the door to multi-domain integrations, from healthcare to supply-chain management, where AI-driven analytics can refine and streamline real-world processes. Finally, laying the groundwork for specialized AI education—through both academic curricula and professional training—bolsters a new generation of developers and policymakers who grasp the intricacies of decentralized technologies. Ultimately, a more informed global community is better positioned to nurture and scale innovations in AI-based Web 3.0 systems.

7.4 Global Collaboration and Standardization Efforts

Building Industry-wide Web 3.0 and AI Standards

A key stepping stone in evolving Web 3.0 into a truly global infrastructure is the articulation of shared protocols and guidelines that transcend individual platforms. Formal cooperation with international standard-setting bodies—such as the International Organization for Standardization (ISO), the Institute of Electrical and Electronics Engineers (IEEE), and the World Wide Web Consortium (W3C)—can help define technical benchmarks for decentralized AI governance, data handling, and security. These standards not only foster transparency and interoperability across diverse blockchain networks but also provide a clear blueprint for teams aiming to create or enhance AI-driven functionalities. By developing interoperability protocols focusing on cross-chain collaboration, stakeholders reduce fragmentation in the wider ecosystem and encourage seamless data transfer, dynamic contract invocation, and distributed computing. Expanding beyond technical integration, partnerships with academic institutions and specialized research centers further energize the push toward decentralized AI. Such collaborations combine rigorous methodological inquiry with practical development, ensuring that emerging protocols remain both theoretically grounded and operationally sound.

Policy and Regulatory Advocacy

Achieving a stable, supportive legal environment for decentralized AI requires unified dialogues with policymakers and regulatory authorities around the world. Specifically, Web 3.0 advocates and industry consortia should prioritize the creation of compliance frameworks that align new AI-intensive protocols with existing regulations, covering areas such as data privacy, consumer protection, and cross-border data governance. By proactively engaging with legislators and regulatory agencies, these groups can help shape a balanced legal landscape—one that protects individual rights without stifling innovation. In this context, decentralized identity (DID) solutions emerge as an indispensable tool, empowering users to manage personal data securely while meeting regulatory demands around identity verification. In parallel, forming self-regulatory guidelines tailored to blockchain-based AI can help establish best practices in risk assessment, code audits, and ethical AI deployment. Through these measures, the Web 3.0 movement not only demonstrates its commitment to responsible innovation but also lays the groundwork for robust market confidence and sustained global adoption.

7.5 How Developers, Researchers, and Policymakers Can Contribute

For Developers Developers occupy a central role in bringing the Web 3.0 vision to reality. By actively participating in open-source projects, they can shape the technical underpinnings of blockchain and AI systems, whether by building new smart contract modules, refining AI models, or designing decentralized infrastructure components. In parallel, hackathons and ecosystem challenges serve as opportunities to test novel ideas, reinforce collaboration, and enhance community engagement. Beyond these initiatives, a strategic focus on AI-enhanced DApps for finance, logistics, and governance allows developers to broaden the utility spectrum of blockchain networks, making them more accessible and valuable to both commercial and public interests.

For Researchers

Researchers similarly contribute to Web 3.0 by deepening the theoretical and empirical foundations of AI-driven, trustless networks. Specifically, advanced inquiries into decentralized governance, cryptographic privacy methods, and secure multiparty computation pave the way for more robust and scalable systems. Findings from these investigations should be disseminated through publications, workshops, and open-source platforms, fueling a cycle of continuous improvement. Moreover, establishing robust benchmarks and standardized performance criteria for AI-enabled Web 3.0

applications allows both academia and industry to gauge progress, identify bottlenecks, and direct research efforts more effectively.

For Policymakers

At the policy level, an active and nuanced approach is essential for balancing innovation with public safety and ethical considerations. Policymakers can shape regulatory frameworks that encourage investment in decentralized AI while safeguarding against malpractice and systemic risks. Collaboration with industry experts and academic institutions helps align national and global standards, ensuring that legislation keeps pace with rapid technological change. Finally, structured public-private partnerships can integrate AI-driven infrastructure into existing societal frameworks—ranging from identity verification systems to public services—thereby anchoring Web 3.0 innovations within a stable legal and technological context.

8 Conclusion

The evolution of Web 3.0 has promised a decentralized, user-driven digital ecosystem free from the constraints of centralized authorities. However, as we have explored throughout this manifesto, the current state of Web 3.0 is fraught with challenges—fragmentation, scalability issues, security vulnerabilities, and an overemphasis on financial speculation. To overcome these hurdles and realize the full potential of a truly decentralized and intelligent digital economy, a paradigm shift is necessary. This paper has introduced Web 3.0 Protocol-as-Platform, a vision that integrates AI-driven agentic intelligence, modular blockchain infrastructure, and privacy-enhancing technologies to create a unified, scalable, and sustainable Web 3.0 ecosystem.

Key Takeaways

1. Decentralization Must Go Beyond Financialization: The promise of Web 3.0 is not merely to replicate financial markets on decentralized ledgers but to create a user-first, value-driven digital economy. The focus must shift from speculative trading of tokens and NFTs to real-world applications that empower individuals, businesses, and societies.
2. AI and Blockchain Must Converge to Enable Decentralized Intelligence: The integration of AI-driven autonomous agents, smart contracts, and decentralized governance models can significantly enhance security, efficiency, and user experience. AI-powered automation in consensus mechanisms, risk management, and privacy protection will drive Web 3.0 toward a more intelligent and scalable future.
3. Interoperability and Modularity Are Critical for a Unified Web 3.0: The fragmentation of current blockchain networks limits usability and adoption. By establishing cross-chain interoperability, modular blockchain architectures, and AI-driven scalability solutions, Web 3.0 can function as a cohesive, user-friendly ecosystem that accommodates developers, businesses, and end users.
4. Security and Privacy Must Be Prioritized: The future of Web 3.0 must integrate zero-knowledge proofs, homomorphic encryption, decentralized identity solutions, and AI-driven security monitoring to ensure that users can operate in a secure and privacy-preserving environment.
5. Decentralized Governance Must Evolve with AI and Cryptographic Mechanisms: Governance structures in Web 3.0 often fall prey to token-based plutocracies, voter apathy, and security vulnerabilities. The introduction of AI-assisted decision-making, dynamic governance models, and reputation-based voting can create more fair, adaptive, and trustless governance mechanisms.

A Call to Action
To realize this vision, collaboration across developers, researchers, policymakers, and industry leaders is essential. The future of Web 3.0 is not merely about technological advancements but about reshaping the internet into a truly decentralized, secure, and intelligent infrastructure that serves humanity rather than speculative markets.

- For Developers: Build AI-powered decentralized applications that enhance automation, efficiency, and security.

- For Researchers: Push forward new cryptographic innovations, AI models, and decentralized computing solutions that make Web 3.0 safer and more scalable.
- For Policymakers: Craft clear, forward-thinking regulations that support decentralized intelligence while safeguarding user rights.
- For Entrepreneurs and Investors: Foster value-driven ecosystems that prioritize long-term sustainability over short-term financial speculation.

The Path Forward
Web 3.0 is at a crossroads. The decisions we make today will determine whether it becomes a truly decentralized, intelligent, and user-empowered digital economy or simply a rebranded extension of the Web2 status quo. By embracing agentic intelligence, modular blockchain architectures, privacy-enhancing technologies, and sustainable incentive structures, we can build a Web 3.0 Protocol-as-Platform that reshapes the digital world for generations to come. The future is decentralized, intelligent, and interconnected. It is time to build.

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