



RESEARCH
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SWAN CHAIN:

How DePIN and DeREN are poised to disrupt the cloud computing industry



Cointelegraph Research Report

Content

I. Introduction	3
1.1 Cloud Computing Basics	3
1.2 Market Overview	4
II. Technological Developments of the Market	9
2.1 What are DePINs/DeRENs and Why are They Gaining Popularity in the Cloud Computing Market?	9
2.2 Technical Components and Mechanisms of DePINs/DeRENs	11
III. Swan Chain Case Study	12
3.1 Cloud Computing Concept of Swan Chain	12
3.2 ZK Computing in the Swan Ecosystem	13
3.3 Global Distribution with Data Centers	14
IV. Market Overview and Landscape	16
4.1 DePIN Market Landscape and Projections	16
4.2 The Intersection between DePIN and AI	18
4.3 Competitive Advantages of Swan Chain	20
Conclusion	21
Disclaimer and Contacts	22



I. Introduction

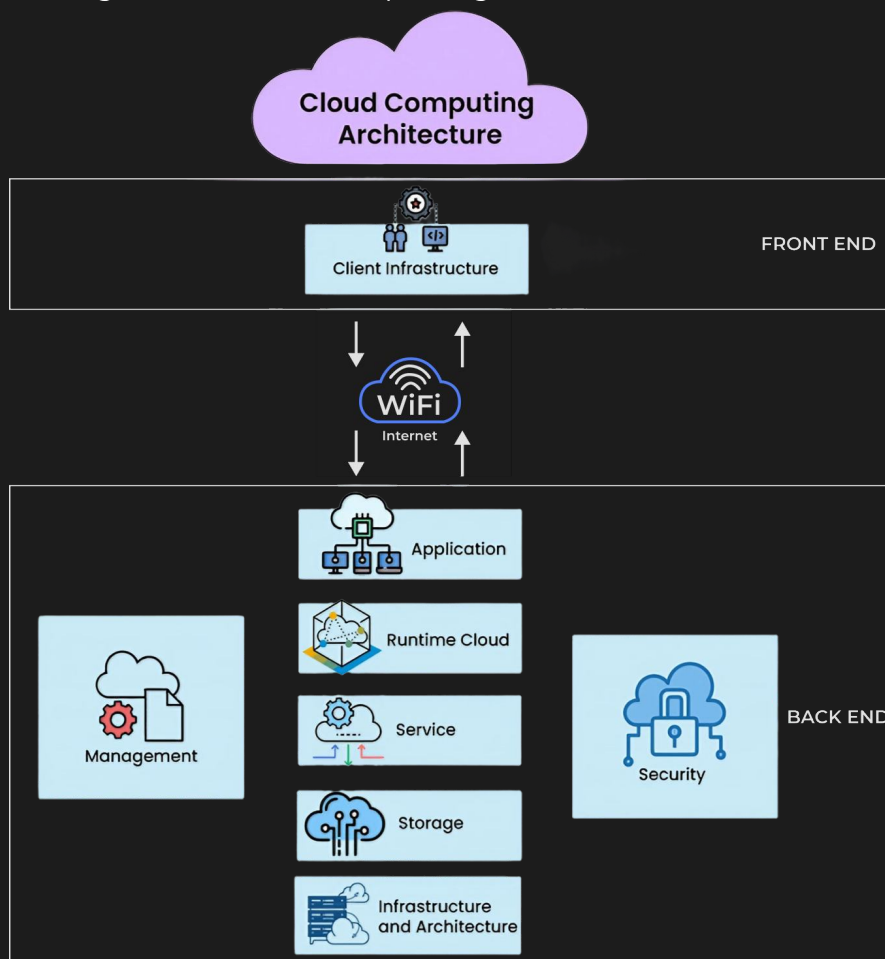
1.1 Cloud Computing Basics

Cloud computing is a technology framework that delivers a suite of computing services—such as servers, storage, databases, networking, software, analytics, and intelligence—over the internet to offer faster innovation, flexible resources, and economies of scale.

At its core, cloud computing allows users to rent access to computing power and data storage facilities rather than owning and maintaining computing infrastructures in-house. This lets businesses avoid the complexity and expense associated with managing physical servers and data center infrastructure. It also allows companies to focus on their core business instead of spending resources on computer infrastructure.

Moreover, cloud computing provides a strategic advantage by offering high scalability. Businesses can scale up as their computing needs increase and scale down as demand decreases, paying only for the services they use. Lastly, cloud computing also creates flexibility and accessibility by enabling users to access services and data from anywhere, using any compatible device.

Figure 1: Cloud Computing Architecture Scheme



Source: infosectrain.com



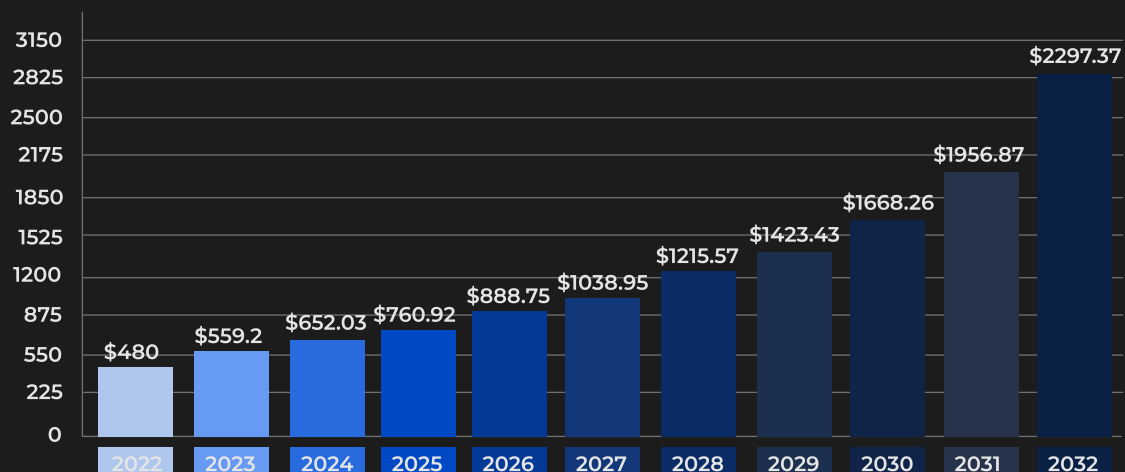
Currently, cloud computing is on the brink of transformative changes. Before we take a look at the major trends, here are some interesting statistics about the cloud computing market:

- According to [Allied Market Research](#), the size of the cloud computing market is expected to reach over **\$2 trillion by 2032**, up from **\$700 billion at the time of writing**.
- Within a span of 10 years, i.e., between 2010 and 2020, the market grew by **635%**. It jumped from \$24.6 billion in 2010 to \$156.4 billion in 2020, **as revealed by Cloudzero**.
- [A survey by Accenture](#) revealed that companies could save more than 84 percent of their energy costs and reduce their carbon emissions by the same number through migration to cloud computing.

1.2 Market Overview

Currently, the global cloud computing market is estimated to have a size of **\$652 billion in 2024**. According to various estimates, it **is expected to reach \$2.3 trillion by 2032**.

Figure 2: Cloud Computing Market 2022 to 2032 (USD, Billion)



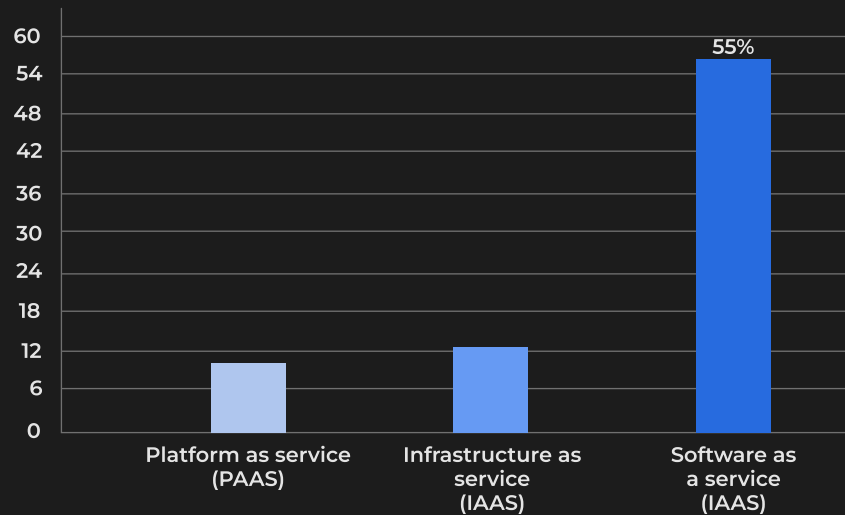
Source: precedenceresearch.com

The current cloud computing market is segmented based on services, deployment modes, organization sizes, industry verticals, and regions.



Services are typically categorized as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). IaaS provides virtualized computing resources, PaaS offers a platform for application development, and SaaS delivers software applications over the internet. IaaS users manage their infrastructure, PaaS users focus on application development, and SaaS users only need to manage their data and settings within the application. Currently, SaaS holds the largest market share.

Figure 3: Cloud Computing Market Share by Service



Source: precedenceresearch.com

Deployment modes include public, private, and hybrid clouds. Public cloud services dominate the market, followed by private and hybrid options. A public cloud relies on third-party service providers for its resources, including servers and storage. It is often referred to as an IaaS or infrastructure-as-a-service. On the other hand, private cloud resources are exclusively used by a single organization. The private cloud can be hosted on a physical data center in an office or by an external provider.

Nonetheless, all infrastructure and services, including hardware and software, are kept on a private, dedicated network, such as AWS, Cisco, IBM, and Oracle. A hybrid cloud has aspects of public and private deployment. Public and private resources connect and spread across multiple cloud locations. This usually includes “edge” and on-site data centers. Hybrid clouds are versatile and allow businesses to create many setups that support digital transformation and expansion.



Notably, AWS leads the cloud infrastructure services market with a [32% market share](#).

Figure 4: Private, Public, and Hybrid Cloud Differences

Parameter	Public	Private	Hybrid
Cost	Cost-effective	Expensive	Expensive
Security	Depends on the cloud provider	Most Secure	Secure
Scalability	Highly scalable	Limited	Highly scalable with the right architecture
Accessibility	Everyone	Limited	Medium
Maintenance	Lowest	Highest	Medium
Shared Resources	Multitenant, Shared Servers	On-premise, Private Servers	Mixed
Owner	Cloud Provider	Organization	Organization
Examples	AWS , GCP, Azure, IBM, Oracle	VMware, HPE, Dell, Openstack	Rackspace, VMware, Cisco, IBM

Source: [knowledgehut.com](#)

North America generates the most revenue on the global cloud computing market, followed by Europe, Asia Pacific, and the Rest of the World. As of January 2024, [North America accounts for 41%](#) of revenue from the global cloud computing market, reflecting its strong market presence.

[A few key companies dominate](#) the cloud computing industry, notably Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP). AWS leads the market and commands about 31%. Microsoft Azure follows with 25%, and Google Cloud holds approximately 11% in market share (Figure 5). Together, these three companies control over 60% of the entire market. Their widespread infrastructure, coupled with strategic partnerships and client relationships, has solidified their dominant positions, collectively generating approximately \$35 billion in revenue for the first quarter of 2023.

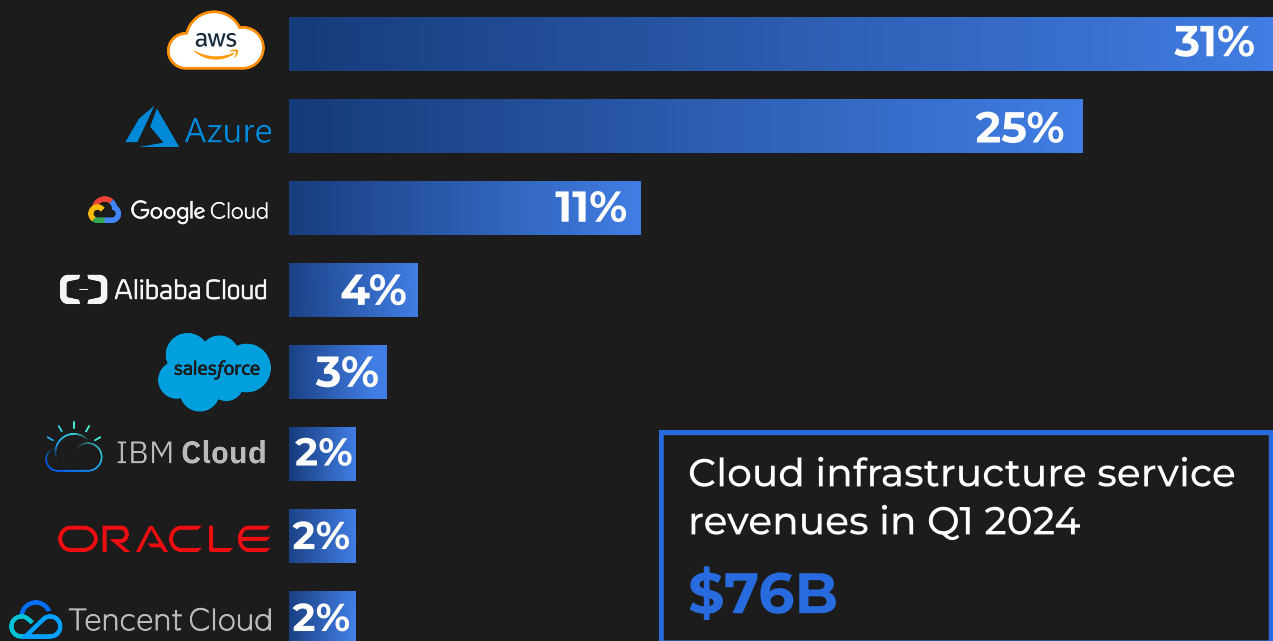
Practices such as vendor lock-in exacerbate this oligopoly. While [Flexera's 2023 State of the Cloud Report](#) indicates that over 81% of enterprises have adopted a multi-cloud strategy, the high costs of data egress (e.g., [AWS charging up to \\$0.09 per GB](#)) make it financially burdensome for customers to migrate data between providers. [Apple](#) reportedly incurred \$50 million in data transfer costs in one year, representing 6.5% of their total AWS bill. Another lock-in tactic used by providers is to intentionally hinder interoperability through reconfigurations, custom APIs, and firewalls. While AWS, Azure, and GCP all offer managed Kubernetes services, they use different containerizing technologies that are not fully compatible with each other. [AWS uses EKS](#), while Azure and GCP use [AKS](#) and [GKE](#), respectively. As a result, redeployment with a different provider is a multi-staged process that requires reconfiguration, name transmission, and manifest updates.

For instance, [Gartner's 2023 report on cloud infrastructure](#) notes that 64% of organizations struggle with interoperability issues when managing multiple cloud environments, leading them to keep critical applications on their primary cloud platform. This stifles competition and innovation.

Moreover, reliance on centralized cloud computing providers created conflicts with regulators and compliance challenges for multinational organizations. For instance, the European General Data Protection Regulation (GDPR) imposes strict data protection requirements that often conflict with less stringent regulations in other jurisdictions.

[A survey by McAfee](#) in 2020 revealed that 52% of companies have experienced compliance issues due to the location of their cloud data centers. In 2020, [British Airways faced](#) a proposed fine of £183 million for GDPR breaches, partly related to inadequate data protection measures in their cloud infrastructure. The control cloud service providers have over data poses security and privacy concerns. For instance, [the U.S. Cloud Act of 2021](#) allows American authorities to access data stored by U.S. cloud providers, regardless of where the data is physically located.

Figure 5: Cloud Computing Market Distribution in Q1 2024



Source: [statista.com](https://www.statista.com)



In addition, the limited number of providers for critical cloud infrastructure creates potential risks of systemic failures. If one of these major players experiences a significant outage, the effects can be systemic and impact numerous businesses and services globally. [Meta's recent outage](#) affected thousands of users with more [than 600,000 reports on Downdetector](#) and limited the use of key Web2 platforms and websites for more than 2 hours.

The Web3 landscape is not an exception. Chainstack's analysis found that [60.77% of Ethereum nodes](#) are hosted on cloud service providers, with around [35% of all Ethereum nodes](#) running on AWS.

Such reliance on centralized cloud providers introduces a paradox where critical blockchain infrastructure remains under the control of a few large corporations, which contradicts Web3's ethos of decentralization. Service outages or disruptions of AWS can impact a large number of dApps and blockchain operations, highlighting the need for more resilient and distributed infrastructure solutions.



II. Technological Developments of the Market

2.1 What are DePINs/DeRENs and Why are They Gaining Popularity in the Cloud Computing Market?

In response to the aforementioned challenges, there is a growing interest in decentralized cloud computing solutions, such as those offered by decentralized physical infrastructure networks (DePIN) and decentralized resource networks (DeREN). These networks aim to distribute data storage and processing across multiple locations and owners. Hence, they reduce reliance on single points of failure and address concerns about data sovereignty and low market competition.

DeREN focuses on making idle hardware and other fungible resources available to a permissionless market. Resources such as computational power, storage, or bandwidth are abstracted away from the underlying physical devices and allocated to users that require them. DeREN networks primarily operate with location-independent hardware. Control and operational responsibilities are shared among multiple stakeholders in a distributed network. Notable use cases for DeREN include decentralized storage and decentralized computing platforms that allow for distributed problem-solving.

DePIN is an umbrella term for blockchain-based networks that facilitate the deployment of location-dependent, nonfungible hardware devices through token incentives. This includes data centers, connectivity networks, and energy systems. DePIN uses blockchain technology to distribute control and ownership without central control through a single entity. Examples may include decentralized internet service providers (such as **Helium Network**) that utilize a blockchain to manage bandwidth allocation or smart grid technologies (such as **Rowan Energy**) that use decentralized protocols to manage energy distribution and usage more effectively.

Although DePIN and DeREN are similar in their decentralized ethos, key differences exist between them. DePIN specifically **focuses on the infrastructure aspect**, i.e., physical components and real-world systems. In contrast, DeREN **deals more broadly with abstract digital resources**, optimizing how they are allocated and used across a network without centralized control. (Figure 6).

Figure 6: DePIN vs DeREN Comparison

	DePINs	DeRENs
Infrastructure type	Physical	Resource-based
Resource	Consumable, nonfungible	Consumable, fungible
Utility	Leverage incentives for hardware deployment	Incentivizes resource utilization and trade
Hardware dependency	Location-dependent	Location-independent
Incentive mechanism	Deployment incentives	Marketplace incentives

Source: cointelegraph.com



DePIN and DeREN solutions are gaining popularity as they could offer advantages over traditional cloud computing services provided by major companies such as Google, Amazon, and Microsoft. Decentralized solutions promise enhanced privacy and security by distributing data across a network of nodes rather than centralizing it in data centers.

Additionally, they may provide greater cost efficiency by addressing the monopolistic practices and pricing models of traditional cloud providers. This shift represents a significant evolution in cloud computing as it moves toward a more distributed and user-governed infrastructure. A more detailed comparison is compiled in Figure 7 below.

Figure 7: Comparison of DePIN/DeREN vs Centralized Cloud Computing Services

Aspect	DePIN and DeREN	Traditional Cloud Computing
Security	Data spread across many nodes, <u>reducing the impact of certain cyberattacks</u>	Data stored in a few data centers is vulnerable to certain <u>targeted attacks</u>
Administrative Costs	<u>Lower costs</u> due to distributed infrastructure and no middlemen	High costs for administration, maintenance, and scaling
Operational Costs	<u>Pay-as-you-go model</u> with lower overall costs	<u>Pre-set packages</u> often have higher costs and force customers to pay for unnecessary services
Transparency	Blockchain provides a secure, auditable and immutable ledger	Data stored in centralized data centers is less transparent
Scalability	Token-based incentives encourage user participation and resource contribution	Requires significant up-front investment and capital deployment
Data Processing	<u>Edge computing</u> <u>reduces</u> latency and enhances speed	Centralized data centers are <u>often suboptimal</u>



2.2 Technical Components and Mechanisms of DePINs/DeRENs

There are four main components of DePINs: Physical Infrastructure Network, Off-Chain Computing Infrastructure, Blockchain Architecture, and Token Incentives.

Various physical infrastructure controls can be decentralized through DePIN. Below, we present an overview of the current landscape of such projects.

Figure 8: DePIN's Use Cases Display

Sector	Use Case	Project
Geospatial Data	Collection of street-level imagery using specialized dash cams and their provision to customers as an alternative to mapping services offered by Big Tech companies	<u>Hivemapper</u>
Health Data	Collection and monetization of anonymized health data through DePIN for research and product development to improve citizen well-being	<u>HealthBlocks</u>
Electricity	Management of surplus energy through DePIN for sharing between participants and maximizing the utilization of renewable energy sources	<u>HealthBlocks</u> <u>Green Power Network</u>
Bandwidth Networks	Delivery of multimedia content via decentralized bandwidth networks using DePIN to serve content at a low cost	<u>Theta Network</u>

DePIN offers a diverse range of use cases across sectors, such as geospatial data collection, health data monetization, and bandwidth network delivery.



III. Swan Chain Case Study

3.1 Cloud Computing Concept of Swan Chain

A notable example of a decentralized physical infrastructure network is Swan Chain. Swan Chain offers a decentralized cloud computing platform designed to provide resources such as computational power, storage, and bandwidth for AI applications, smart contracts, and other decentralized services.

Swan Chain's AI computing and storage bid market pursues an innovative approach. [Users can post requests](#) for computing power or storage space, including requirements and budgets, and other users can bid to provide these services. Moreover, Swan Chain's bidding market lets users rent computing power for tasks such as rendering 3D graphics or machine learning.

Built on Swan Chain, this market offers an AI computing toolkit and multichain storage capabilities. It caters to a wide range of user needs, from fast forking and deploying AI models to supporting high throughput protocols. For example, a user needing to render a complex 3D animation can bid for computing power, reducing the time and cost compared to traditional cloud services.

Additionally, a data scientist working on a machine learning project can utilize Swan Chain's AI toolkit to quickly fork and deploy models, leveraging the platform's decentralized infrastructure to ensure high performance. This infrastructure enables users to efficiently allocate resources and manage complex computational tasks, enhancing both the flexibility and scalability of their projects.

[At the core of Swan Chain's ecosystem lies its Computing Layer](#), a decentralized network of providers that execute computing tasks. Computing Providers (CPs) offer computational resources and bid for tasks submitted by users. Through a system of task submission, execution, and rewards, Swan Chain ensures accountability and reliability. CPs collateralize Swan tokens to participate. They face penalties for unfulfilled commitments.

[Swan Chain's Computing Layer is cross-chain compatible](#) and allows payments using various blockchain tokens. It is a key component of Swan Chain's ecosystem and integrates with other Swan services, such as storage provider selection and data management. Swan Chain integrates storage and computing capabilities to provide a comprehensive solution for users. Also, Swan Chain leverages multiple platforms to optimize data availability and versatility.

For instance, Swan Chain utilizes the IPFS for decentralized file storage, ensuring data is securely distributed and easily retrievable. Filecoin, on the other hand, provides a marketplace for long-term storage solutions, securely archiving large data sets. Storj is integrated to stream media files, offering uninterrupted streaming experiences. Additionally, Swan Chain's integration with platforms like BNB GreenField and its utilization of cross-chain contracts enables the dynamic selection of storage solutions based on task requirements.



3.2 ZK Computing in the Swan Ecosystem

Swan Chain employs zero-knowledge (ZK) computing technology, which serves as a tool for ensuring data and transaction privacy in decentralized networks. The overview below explains how [Swan Chain integrates this technology](#) into its ecosystem and its overall impact on the development of DePIN networks.

ZK computing is a privacy technology for blockchain transactions and smart contract execution. It leverages zero-knowledge proofs (ZKPs), a cryptographic technique that allows one party to prove to another that a statement is true without revealing any additional information beyond the statement's validity. Swan Chain's platform offers outsourcing services for ZKP computations and supports global blockchain networks such as Aleo. Within two months of its launch, the ZK market on Swan Chain has processed over 50,000 ZK computing tasks.

ZK computing allows [AI models](#) and data to be processed and analyzed [without exposing the unencrypted information to external parties](#). This ensures data privacy and confidentiality, crucial for industries handling sensitive information, such as healthcare, finance, and government. By using zkML, these sectors can leverage advanced AI capabilities while maintaining strict data security and compliance with privacy regulations. Moreover, with ZK computing, [Swan Chain enables secure and verifiable transactions across its network](#). By employing cryptographic techniques, transactions can be validated without disclosing the transaction details. This ensures their integrity and authenticity.

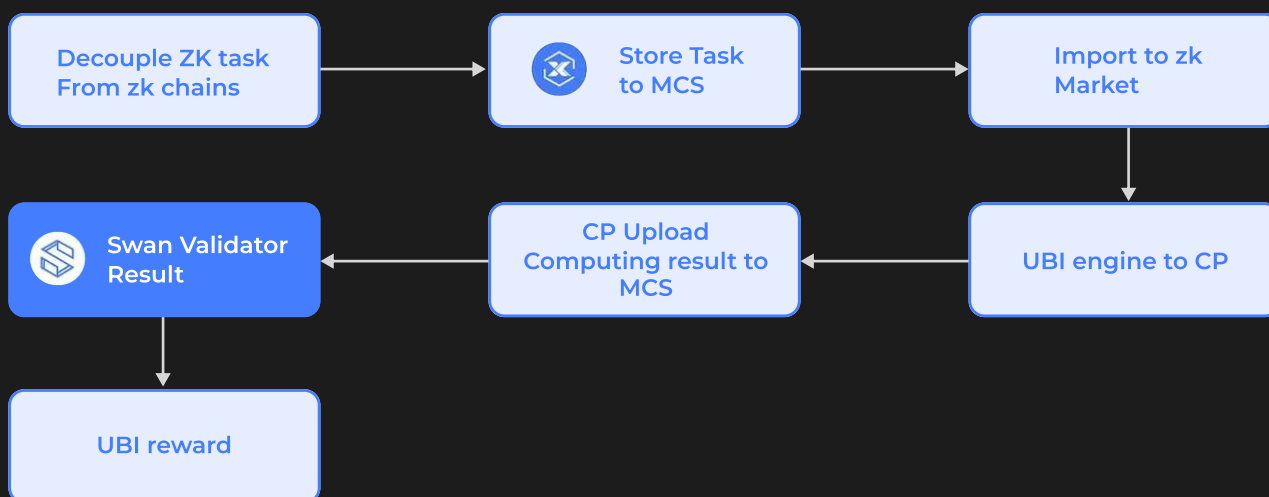
ZK computing also enhances the governance mechanisms within Swan Chain's ecosystem by enabling secure and transparent voting processes. Participants can vote on network proposals and decisions without revealing their identities or voting preferences, thus ensuring fair and democratic governance. By offloading computational tasks to ZK computing protocols, Swan Chain improves efficiency in AI computing and data processing. It allows for faster and more [cost-effective execution](#) of complex computations. Swan Chain also integrates underutilized computing resources from community data centers, which can [cut costs by up to 70%](#) and monetize idle computing assets.

Furthermore, within Swan Chain's ecosystem, the [ZK Market](#) plays an important role. The ZK Market uses distributed computing, particularly GPUs, for Zero-Knowledge (ZK) proof generation. By creating a specialized ZK market, Swan Chain offers a platform where these compute-intensive tasks can be outsourced to a global network of computing providers.

During the Saturn Testnet, more than [15 countries, 20 cities, and over 80 computing providers](#) joined the network. The majority of the providers are located in T3 data centers. The Saturn Testnet saw Swan Chain processing over 145 million transactions, engaged more than 25 million wallet addresses and deployed upward of 630,000 contracts in two months. Additionally, it provided over 2.85 million CPU hours and 600,000 GPU hours of computing resources.



Figure 9: ZK UBI Mechanism



Source: docs.swanchain.io

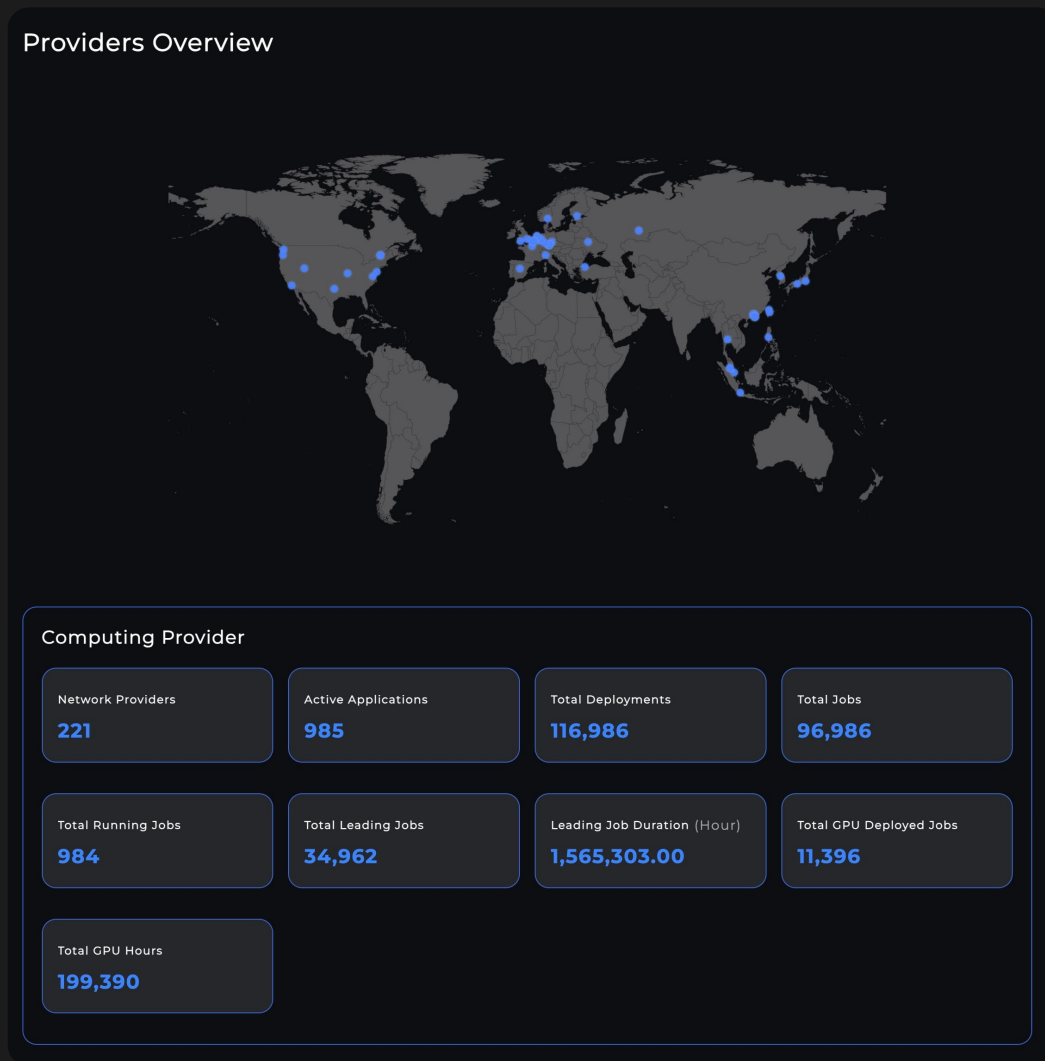
3.3 Global Distribution with Data Centers

Swan Chain offers an array of resources including CPUs, GPUs, storage, bandwidth, and memory. Central to its infrastructure is the [Swan Orchestrator](#), a system designed to manage and coordinate distributed computing resources on a global scale. Using scheduling algorithms, the Orchestrator dynamically allocates resources tailored to the specific requirements of each task while leveraging state-of-the-art encryption and sharding technologies to safeguard the confidentiality and integrity of data and model codes.

In addition to its computing capabilities, Swan Chain boasts a global distribution network anchored by strategically positioned data centers. Swan's network has over 1600 computing nodes located in key regions such as the USA, Canada, Germany, the U.K., Vietnam, Japan, South Korea, the Netherlands, Singapore, Ukraine, China, and more (Figure 10).



Figure 10: Global Distribution of Computing Providers



Source: orchestrator.swanchain.io

Notably, Swan Chain's global reach extends to regions that traditional cloud service providers such as AWS and Google often overlook. For instance, Google ceased operations in [Russia](#) after the government seized its bank accounts, rendering it impossible to function locally. Similarly, Google's services are blocked in China due to the country's online censorship system, the "[Great Firewall](#)."

Unlike traditional Big Tech companies, Swan Chain's decentralized infrastructure allows it to operate independently, maintaining services in areas with stringent government regulations and censorship.



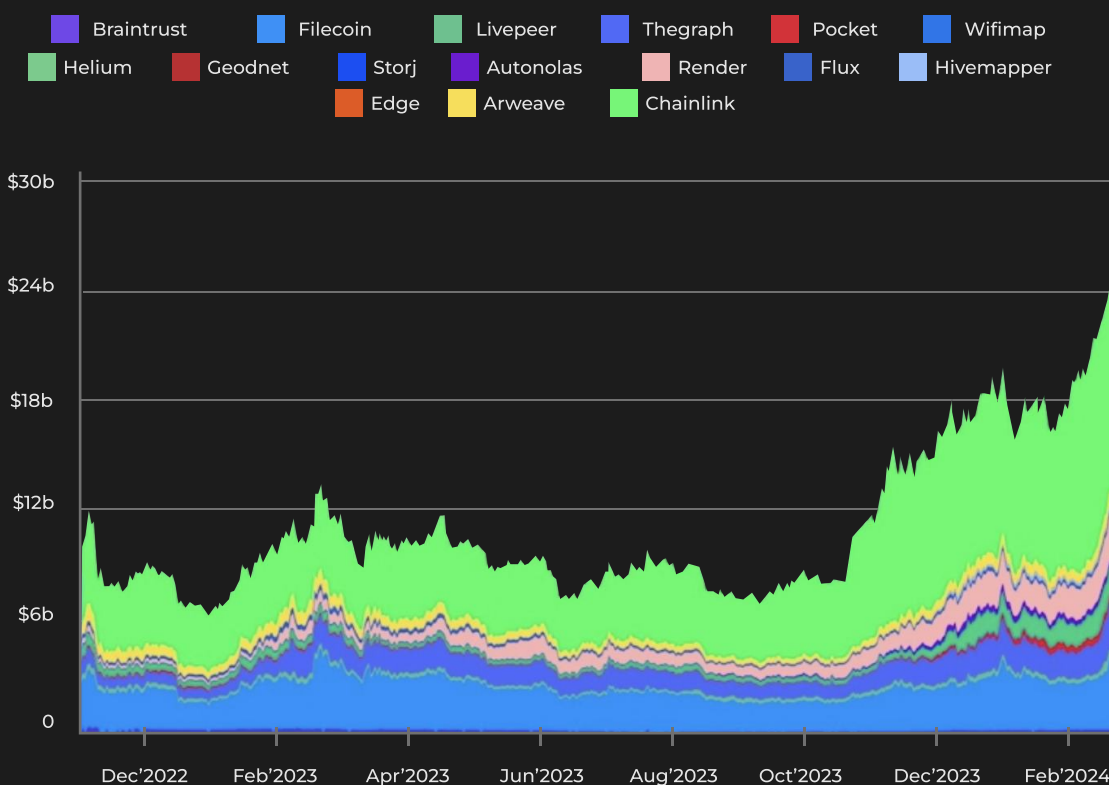
IV. Market Overview and Landscape

4.1 DePIN Market Landscape and Projections

The potential market impact of DePIN solutions could be profound if they can challenge existing cloud computing, energy networks, storage and blockchain markets. The DePIN sector is experiencing significant growth and market expansion. Projections have estimated [a market size of \\$3.5 trillion by 2028](#). As of 2024, the market capitalization of DePIN projects has expanded dramatically, growing from approximately [\\$10 billion to \\$25 billion](#) in just six months (Figure 11).

However, it is important to note that a considerable portion of this market capitalization is based on speculative valuations of projects that have yet to achieve substantial real-world adoption. While the potential for transformative impact is high, the current market enthusiasm may not fully reflect the practical deployment and integration of these technologies.

Figure 11: Aggregated DePIN Market Capitalization



Source: [depin.ninja](#)



Investment in blockchain technologies has been robust, but DePIN-focused ventures are only beginning to attract attention from venture capitalists and institutional investors. Investments into new DePIN-related projects have exceeded \$100 million since the start of 2024, according to the [Cointelegraph Research VC Database](#). Meanwhile, the broader blockchain infrastructure market has seen significant capital inflows and surpassed the [\\$3 billion mark](#) in the same period.

The growth projections for blockchain technology, which underpins DePIN, suggest a [CAGR of more than 60%](#) over the next five years, indicating a bullish outlook. This projection underscores the potential for DePIN to capture a significant portion of the value in the digital infrastructure landscape.

The following comparison showcases examples of the most notable industry pioneers that can potentially set a standard for the future development of the DePIN market.

Figure 12: Notable Players on the DePIN Market

Project	Concept	Key Features
 Filecoin (FIL)	A decentralized network for data storage, allows users to rent unused space for storage	Ensures high decentralization and storage reliability
 Render Token (RNDR)	A platform for decentralized graphic rendering, leveraging GPU power for processing tasks	- Enables reduction in rendering costs and time for content creators - Maintains high performance in rendering tasks
 Helium (HNT)	Project for creating decentralized wireless networks, enabling anyone to deploy nodes	- Aims to create a global IoT network with low connection costs and high availability - Users earn HNT for transmitting data through their devices
 Theta Network (THETA)	A platform for decentralized video streaming, improving quality and efficiency	- Allows users to earn tokens for watching ads and sharing excess bandwidth - Enhances video streaming experience through blockchain technology
 Siacoin (SC)	Focuses on decentralized cloud storage and offers secure and cost-effective solutions	- Provides lower costs and higher data security compared to traditional cloud providers - Enables renting unused storage space for data storage

4.2 The Intersection between DePIN and AI

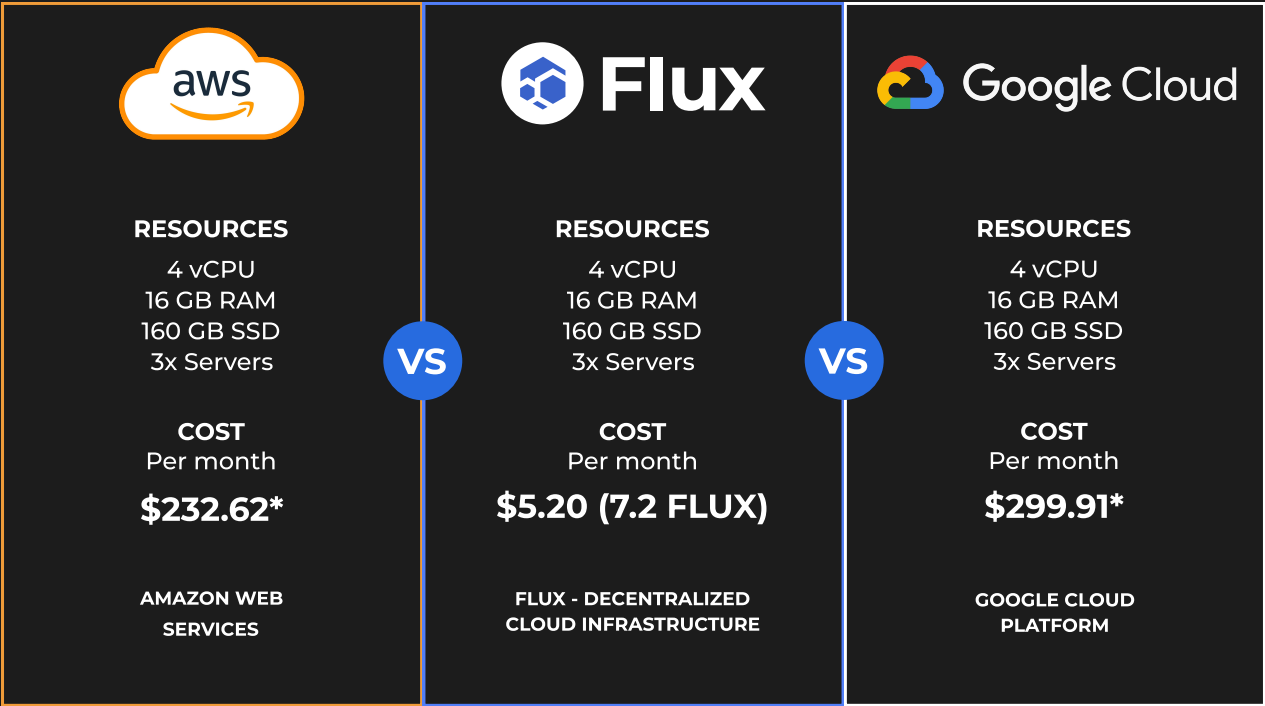
DePINs are emerging as a transformative force in the AI market, enhancing the development and deployment of AI applications through their unique infrastructure capabilities. DePINs enable the collection of extensive, varied data sets from multiple decentralized nodes, including Internet of Things (IoT) devices spread across diverse geographic locations. This vast data aggregation is crucial for training AI models that require comprehensive, real-time inputs to enhance their accuracy and effectiveness.

In terms of data security, the integration of blockchain technology within DePINs ensures that data transactions are secure and immutable, addressing significant concerns in AI applications that manage sensitive or personal information. In a DePIN setup, where control is distributed among various nodes rather than centralized, users often interact with the network [under pseudonyms or through decentralized identities](#).

This setup minimizes the amount of personally identifiable information (PII) that needs to be disclosed to any single entity, reducing the risk of identity exposure. This level of security is particularly critical in sectors such as healthcare or financial services, where data integrity and privacy are paramount.

Furthermore, AI and machine learning computations demand substantial processing power, often resulting in high up-front costs when centralized cloud services are employed (Figure 10). DePINs alleviate this issue by distributing computational tasks across the network, utilizing idle computing resources from various nodes. This not only optimizes overall resource utilization but also potentially lowers the costs associated with AI computations, making these technologies more accessible to a broader range of users and developers.

Figure 13 : Comparison of DePIN Costs with AWS and Google Cloud Solutions



AI's contribution is expected to lead to significant growth of the DePIN market. [According to a Fortune research report](#), the global AI market is projected to reach approximately \$1.4 trillion by 2029, a CAGR of around 20.1% from 2022.

Below are examples of projects that leverage the DePIN infrastructure of Swan Chain to develop and operate AI solutions in various market sectors.

Figure 14: AI Projects that Leverage the DePIN Infrastructure of Swan Chain

Project	Description
<u>MusicGen</u>	MusicGen is leveraging AI to generate original tunes from text prompts. This is a new approach to creating music and empowers musicians, composers, and artists to explore new genres, styles, and compositions with unprecedented ease and creativity.
<u>Stable Diffusion</u>	Stable Diffusion uses AI to create high-quality images from textual descriptions. Bridging the gap between language and visual content opens up new avenues for artists, designers, and creators to express themselves, generate visual content, and explore innovative design concepts.
<u>Text-to-Speech</u>	Text-to-speech technology enhances communication and accessibility by converting written text into natural-sounding speech. This project has implications for various industries, including education, accessibility, entertainment, and customer service.
<u>ComfyUI</u>	ComfyUI simplifies image generation, making it more accessible and user-friendly for designers, developers, and creators. By providing intuitive tools and interfaces, this project accelerates visual content creation, facilitates collaboration, and empowers users to bring their creative visions to life more efficiently.
<u>Lagrange DAO</u>	Swan Chain facilitates AI model deployment in conjunction with Lagrange DAO, a decentralized autonomous organization (DAO) focused on data value realization. Lagrange serves as a decentralized computing platform, providing secure storage and deployment capabilities for code and enabling developers to create Web3 applications with extensive tooling options. By leveraging industry-standard technologies such as Chainlink, Lagrange DAO aims to democratize access to computing resources.



4.3 Competitive Advantages of Swan Chain

When comparing Swan Chain with other distributed computing projects in the DePIN space, such as Flux, Akash, and IO.NET, several competitive advantages are apparent.

Swan Chain distinguishes itself from Akash Network in several key aspects. Firstly, it offers a more integrated ecosystem that provides decentralized computing, storage, and data management services, whereas Akash Network primarily focuses on decentralized cloud computing with less emphasis on integrated storage solutions. Additionally, Swan Chain incorporates advanced privacy features such as ZK computing to ensure heightened privacy and confidentiality. Furthermore, Swan Chain supports cross-chain payments, allowing users to transact with various blockchain tokens, whereas Akash Network primarily relies on its native AKT token for payments and governance, with limited cross-chain capabilities.

To sum up, Swan Chain offers several advantages. It leverages OP Stack's Ethereum layer 2 technology to provide a decentralized and scalable infrastructure for storage, computing, bandwidth, and payments, optimizing resource usage and reducing costs. This approach addresses the high computational costs of traditional cloud computing, making AI and Web3 projects more affordable and accessible, and reduces reliance on centralized providers, enhancing application resilience and security.

Also, Swan Chain's UBI model distributes tokens as rewards to computing providers, ensuring a stable income and encouraging continuous participation, which maintains a reliable decentralized network. The advanced marketplaces for decentralized storage, AI computing, and ZK-proofs simplify AI model deployment and create opportunities for monetizing idle computing resources, promoting efficient use of global computing power.

The collateral and slashing mechanism enhances network security and trust by ensuring commitment and integrity among computing providers, reducing the risk of fraud. User-friendly tools and infrastructure, including LagrangeDAO, simplify AI model deployment, making AI development more accessible and accelerating innovation. Advanced staking and governance mechanisms allow users to participate in network decision-making, fostering an inclusive and engaged ecosystem that evolves according to community consensus, ensuring long-term sustainability.



Conclusion

This report examined the role of DePIN and DeREN in transforming the traditional cloud computing landscape. These networks offer a resilient, scalable, and cost-effective alternative by leveraging decentralized technologies that distribute storage and processing capabilities across multiple independent entities. This enhances security by reducing reliance on single points of failure (i.e., centralized data centers) and also minimizes administrative and operational costs. Hence, it offers a more transparent and efficient computing environment.

Technological foundations of DePIN and DeREN, emphasize their capabilities in providing specialized services through location-specific hardware and fungible resources, respectively. The Swan Chain case study illustrates the practical applications of these technologies in enabling decentralized computing resources. DePIN/DeREN has the potential to facilitate a range of industries, including healthcare, finance, and IoT, to harness AI and blockchain innovations.

As we navigate toward 2025 and beyond, the outlook for DePIN is highly promising. In the energy sector, decentralized smart grids can optimize energy distribution and reduce wastage by dynamically adjusting to real-time demand. In telecommunications, DePIN projects can enhance connectivity in underserved areas by leveraging community-owned infrastructure. Decentralized cloud computing platforms can provide more affordable and resilient alternatives to traditional cloud services, fostering innovation in fields such as machine learning, AI and big data analytics. DePIN is set to play a crucial role in creating more sustainable and inclusive infrastructure solutions globally as these technologies evolve.



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research@cointelegraph.com

