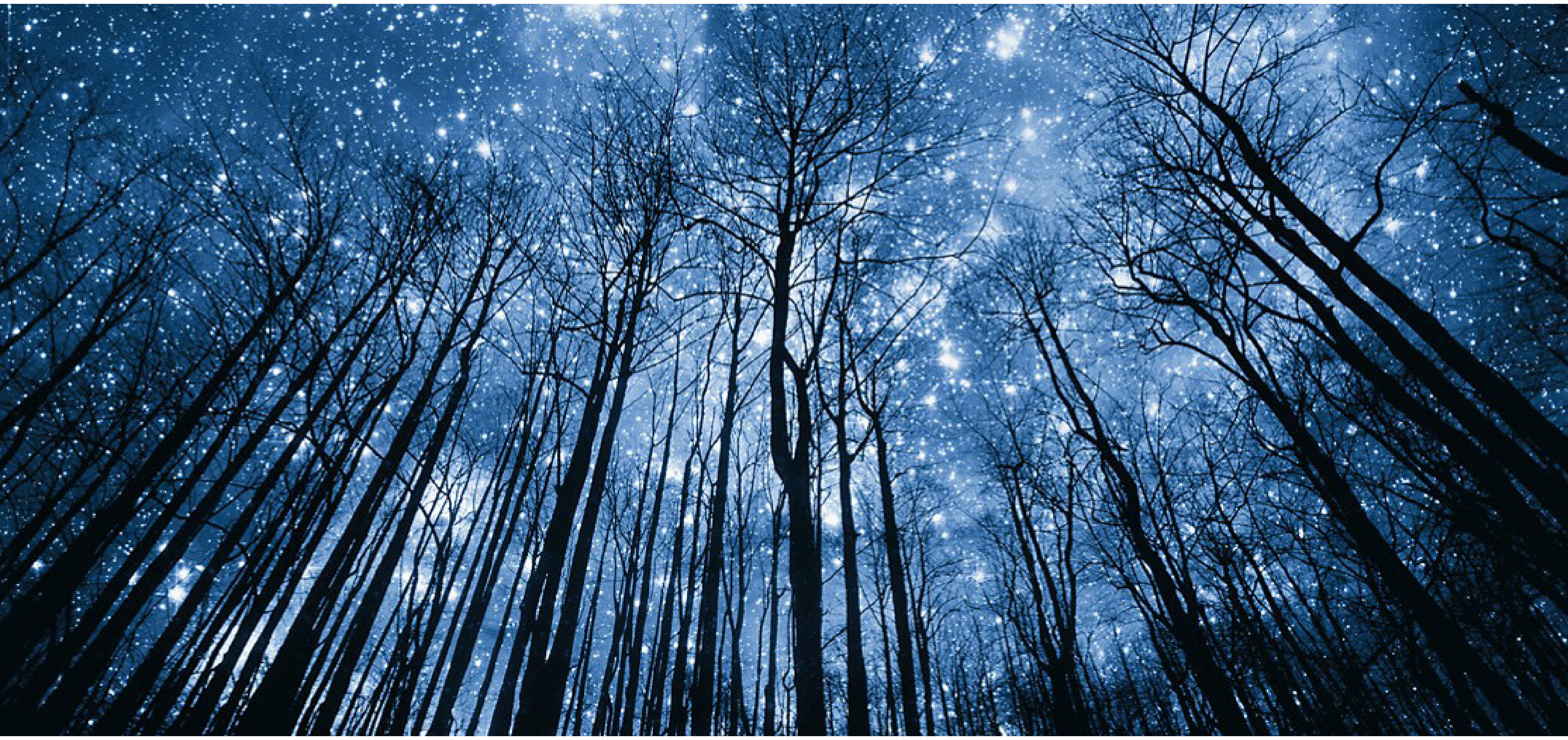
DECENTRALIZED STORAGE: INTRO TO METAVERSE



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Abstract

The extensive Covid-19 pandemic has accelerated the mix of physical and virtual worlds. People have moved activities related to commutes, entertainment, medical consultation, outdoor shopping, travel, school, colleges, office meetings, etc. from the real world to the Internet. At the same time, data generation has exploded from Web 1.0 to Web 3.0 and continues to grow exponentially with the transition from passive data browsing to enthusiastic content generation. With software and algorithm iterations and integration, the storage industry has gradually evolved from traditional disk storage to cloud data storage beyond the boundaries of hardware. Cloud commoditized creation and maintenance of web pages and apps by aggregating and refining mass-produced personal computer hardware over a global network of massive data centers. Enterprises may move from pre-purchasing and maintaining expensive, dedicated infrastructure to leasing storage, computing, and management tools on the go. Millions of entrepreneurial experiments can benefit from low-cost resources that can grow as the business grows.

Metaverse is a concept of a persistent, online, 3D universe that combines multiple different virtual spaces. Think of it as a future iteration of the internet. Metaverse enables users to collaborate, meet, play, and interact in these 3D spaces. A common requirement for Web 3.0 applications is the ability to process large amounts of information and transform it into factual knowledge and useful content for the user.

The act of moving physical life online and growing user-generated content (UGC) is creating a huge demand for data storage with significant business and application prospects. Due to high costs and factors such as prerequisite storage specifications, it is difficult for centralized storage to keep up with changes in capacity, read/write speeds, security, and data relationships as the rate of growth increases. exponential of online data. Thus, decentralized storage was born.

Web 3.0 data storage is primarily divided into centralized storage and distributed storage.

Central storage stores data entirely on a central server. Distributed storage uses distributed storage technology to store data segments in multiple independent storage providers.

Centralized data storage meets enterprise-level storage needs with high stability and low cost. Distributed storage is favored in the long tail market for customized storage solutions, economic incentive models, and strong privacy to meet the unique needs of these companies.

In both Web 3.0 and Metaverse, the importance of decentralized storage has become more prominent, raising awareness of data security and user data ownership. In this article, we examine Web1.0, Web 2.0, and the future of decentralized storage in Metaverse and Web 3.0 technology along with its key components and applications. We will also consider the challenges associated with the metaverse and its applications; Decentralization which also comes with significant legal and regulatory challenges; and Storage needed to scale and everything about web evolution.

Introduction

As consumers and developers, we all agree that the Internet has evolved considerably over time. Since its emergence in the early-1990's, the World Wide Web become the primary tool used by billions of people to exchange, read, and write information and communicate with others. This article examines the evolution of the web from version 1.0 to 2.0 to 3.0.

Web 1.0

The first stage of World Wide Web evolution, Web 1.0 offered presentation-oriented content viewing services built on technology that supported static Web pages (mostly hard-coded HTML pages) with little interaction. Often referred to as the read-only web, Web 1.0 was the first version of the internet. Its purpose was to be a place for businesses to broadcast information, enabling their users to search and read the information. Instead of a web application developed in a dynamic programming language like Perl, PHP, Python, or Ruby, webpages in Web 1.0 were built using Server Side Includes or Common Gateway Interface (CGI).

Internet users were consumers of content provided by content providers during the Web 1.0 era, which lasted from 1991 to 2004.

Web 1.0 site includes four design prerequisites:

1. Static pages
2. The Server's file system serves the Content
3. Webpages are created using Server Side Includes or Common Gateway Interface (CGI)
4. The elements on a page are positioned and aligned using frames and tables

Web 2.0

Web 2.0 is the present state of the web or internet. It has a lot of content that is generated by the user and the usage is more seamless to end users when compared to Web 1.0. The evolution of web 1.0 to Web 2.0 was significant; Web 2.0 is now mostly referred to as read write web or Social Web.

Web2.0 refers to a change in how people use the internet in the twenty-first century. The term "Web 2.0" was first used in 1999 as the Internet began to shift toward a system that actively engaged and involved the user. Rather than just consuming information, users were encouraged to provide it. People could now write comments, publish their articles and the user could create his or her profile in various sites which eventually led to increased participation. Web 2.0 fueled the rise of web applications, self-publishing platforms like WordPress, and social media sites.

Wikipedia, Facebook, Twitter, and different blogs are examples of Web 2.0 sites that have changed the way information is shared and delivered. Web technologies such as HTML5, CSS3, and Javascript frameworks such as ReactJs, AngularJs, VueJs, and others have become increasingly popular for developing Web 2.0 sites.

The five major features of Web 2.0 are:

1. Information sorting is free, allowing users to retrieve and classify data
2. Interactive, dynamic material that responds to user input

3. Information is exchanged between the site owner and users via evaluation and online commenting
4. Developed APIs to enable self-usage, such as by a software application
5. Web access causes a wide range of concerns, ranging from the typical Internet user base to a broader range of users

Use of Web 2.0

People express their ideas, opinions, thoughts, and experiences on the social Web, which includes a variety of online tools and platforms. Web 2.0 applications are more likely to engage with the end user. As a result, the end user is not only a user of the app, but also a participant in:

- Blogging
- Social bookmarking
- Tagging
- Social networking
- Podcasting
- Web content voting
- Social media
- Curating with RSS

Web 3.0

Web 3.0, also known as Semantic Web or read-write-execute, is the era (from 2010 onwards) that embodies the web's future. Artificial Intelligence (AI) and Machine Learning (ML) enable computers to analyze and interpret data in the same way that humans do. Leveraging AI, Web 3.0 enables computers to process data without having to go via centralized databases. In this case, data is shared rather than owned, and different services display different perspectives of the same site / data.

The Semantic Web (3.0) claims to establish "the world's information" in a more rational manner than Google's current engine schema can. This is especially relevant from the standpoint of machine conceptualization versus human comprehension.

The following are key characteristics that can help us define Web 3.0:

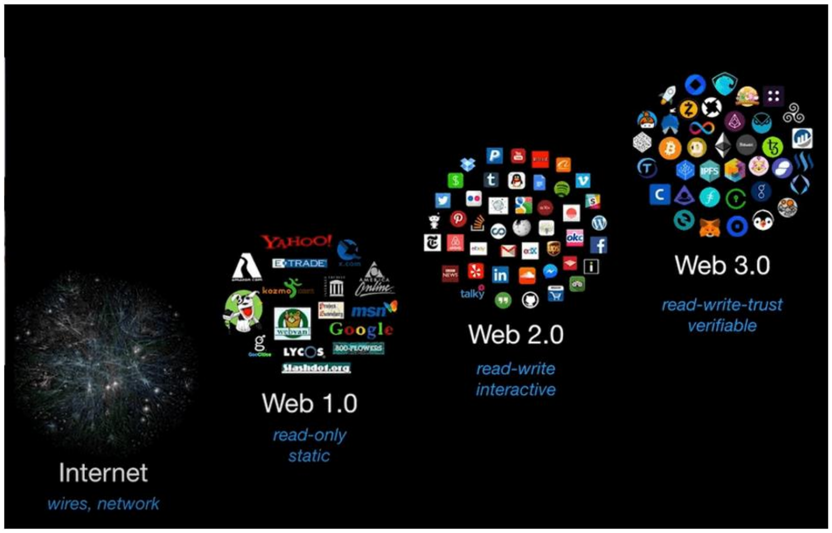
- **Semantic Web**
  The Semantic Web is the next step in the Web's evolution. It enhances web technologies that are in demand for creating, sharing, and connecting content through search and analysis based on the ability to comprehend the meaning of words rather than keywords or numbers.
- **Decentralization**
  Web 3.0 allows information to be retrieved based on its content that can be kept in several locations at the same time, making it decentralized.
- **Artificial Intelligence**
  By combining the power of AI with natural language processing (NLP), computers in Web 3.0 will be able to distinguish information in the same way that humans do, resulting in faster and more relevant results. To meet the needs of users, they become increasingly intelligent.
- **Trustless and permissionless**

Web 3.0 will also be trustless (i.e. participants will be able to engage without the need for a trusted intermediary) and permissionless (i.e. anyone can participate without the need for permission from a governing authority). As a result, Web 3.0 applications will run on blockchains, decentralized peer-to-peer networks, or a combination of both, referred to as dApps (decentralized apps).

- **3D Graphics**
  In Web 3.0, three-dimensional design is frequently used in websites and services. 3D graphics are used in museum tours, computer games, e-commerce, geographical contexts, and other applications.
- **Connectivity**
  Information is better connected with Web 3.0 because of semantic metadata. This progresses the user experience to a new level of connectivity that takes advantage of all accessible data.
- **Ubiquity**
  Multiple applications can access content, and because every device is connected to the internet, the services can be used anywhere.

Web 1.0	Web 2.0	Web 3.0
Mostly Read-Only	Wildly Read-Write	Portable and Personal
Company Focus	Community Focus	Individual Focus
Home Pages	Blogs / Wikis	Live-streams / Waves
Owning Content	Sharing Content	Consolidating Content
WebForms	Web Applications	Smart Applications
Directories	Tagging	User Behaviour
Page Views	Cost Per Click	User Engagement
Banner Advertising	Interactive Advertising	Behavioural Advertising
Britannica Online	Wikipedia	The Semantic Web
HTML/Portals	XML / RSS	RDF / RDFS / OWL

Image Source - https://www.geeksforgeeks.org/web-1-0-web-2-0-and-web-3-0-with-their-difference/



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Web 3.0 - The Decentralized Internet of the Future

Web 3.0 enhances the internet as we know it today by adding new features. Web 3.0 is:

- Verifiable
- Self-governing
- Distributed and robust
- Trustless
- Stateful
- Permissionless
- Native built-in payments

Web 3.0 applications can be built on blockchains, decentralized networks of numerous peer-to-peer nodes (servers), or a hybrid of the two. These programs are known as dApps (decentralized apps), a term referenced a lot in the Web 3.0 community.

When it comes to Web 3.0, cryptocurrency is frequently mentioned since many of these protocols rely heavily on cryptocurrencies. It offers a monetary incentive (tokens) to anyone who wishes to help create, govern, contribute to, or improve one of the projects themselves.

Web 3.0 Design Choices

- **What to decentralize:** This is a unique and important approach. Most early developers aimed to decentralize as much as possible and put everything on the blockchain. However, due to the slow and expensive nature of today's blockchains, this is not feasible at scale. Crypto Kitties was one of the first dApps that attempt to centralize certain aspects. Their breeding logic, for example, is not open to the public. Though they have been criticized for this, customers have spent a large amount of money on cats bred using this logic. Gods Unchained is another example of a game that will be hosted on a standard cloud architecture but will track asset ownership through the State Layer.

Although many dApps may take different techniques to decentralization, adopting a "minimally viable public state" approach as a first rule is a good place to start. If you're creating a game where players can own assets, you should put ownership on the blockchain. If you're creating a prediction market, your market's reporting and payout should be done on the blockchain. Users will value your app if they can claim actual ownership of the important activities it allows them to do.

- **Web app vs native app**: This is a decades-old option that takes on new meaning with Web 3.0 applications. Most dApps today are online apps for two reasons: 1) users don't have to download a new app every time they use it; and 2) users don't have to create a new wallet every time they use it. The minimal amount of native dApps available all lead to the creation of a new wallet, which isn't the best user experience. It's clear to see why this isn't a viable future, given that users are unlikely to have keys for hundreds of wallets. There will be more seamless solutions to enable native apps to overcome this UX difficulty in the near future, but for now, online apps provide a far better onboarding experience.

- **Desktop vs mobile:** The Web 3.0 version of this decision isn't about picking one over the other, but about how your dApp is used on both platforms. On the desktop, most users have interacted with dApps via a Chrome plugin like MetaMask. Despite the fact that the user must download a new extension, the user is still engaging with a familiar browser experience. Extensions, on the other hand, are not possible on mobile, at least not on iOS. That's why some wallet programmes, such as Coinbase Wallet, include browsers in their applications. The dApp experience is the same in the browser view as it is on the desktop. Although when creating for mobile, there are a few technical considerations to keep in mind during the design phase.

Other challenges with no solutions to date:

Who pays for gas: Every dApp launched on Ethereum today requires its users to pay the Ethereum blockchain's transaction cost, known as gas. If millions of non-crypto native individuals utilize Web 3.0 applications, this won't be possible in the long run. There are a few theoretical alternatives, some of which are closer to being realistic, such as gas relayers, but none of them are now operational.

App-specific accounts or not: Universal identity is one of the most promising uses of Web 3.0. Because there aren't many viable identification solutions available today, several dApps still require users to register an account in order for their activity on the app to be associated with their identity. This is very similar to how things are done in Web 2.0. How should dApps treat and offer decentralized identity solutions once we have them? Despite the lack of a clear response, several have already presented proposals, such as Origin's ERC-725 and 735 demos.

Native payments

Tokens also enable a truly borderless and seamless native payment layer. Stripe and PayPal, for example, have generated billions of dollars in value by facilitating electronic payments. These methods are extremely complicated, and they still don't allow for true international interoperability among participants. To use them, you must also provide sensitive information and personal data.

Web 3.0 applications may use crypto wallets such as MetaMask and Torus to make international payments and transactions simple, anonymous, and safe. Solana offers latency in the hundreds of milliseconds and transaction costs that are a fraction of a penny. Users do not have to go through the customary many, friction-filled procedures to engage with and participate in the network, as they do in the present financial system. They only need to download or install a wallet to begin sending and receiving payments without any restrictions.

Metaverse

A metaverse is a network of 3D virtual worlds' order to encourage social interaction. The term "metaverse" was created as a combination of "meta" and "universe" in the 1992 science fiction novel Snow Crash. It's a hybrid of technology features such as virtual reality (VR), augmented reality (AR), and video in which users "live" in a digital realm.

Although the metaverse does not yet exist in its entirety, metaverse-like elements can be found on various platforms. Currently, video games give the closest metaverse experience available. By holding in-game events and building virtual economies, developers have pushed the boundaries of what a game can be.

Cryptocurrencies, while not needed, can be a perfect fit for a metaverse. They enable creation of a digital economy based on various utility tokens and virtual collectibles (NFTs). The use of crypto wallets like Trust Wallet and MetaMask would also benefit the metaverse. Furthermore, blockchain technology can be used to create transparent and trustworthy governance structures.

Augmented reality will power the metaverse, with each user managing a character or avatar. The metaverse will incorporate economy, digital identities, decentralised government, and other applications, in addition to games and social media.

Key features of blockchain that make it suitable for the metaverse are:

- **Digital proof of ownership**: You can instantaneously prove ownership of activity or an asset on the blockchain if you have a wallet with access to your private keys. To demonstrate accountability, you could, for example, show an exact transcript of your transactions on the blockchain while at work. A wallet is one of the safest and most reliable ways to establish a digital identity and proof of ownership.

- **Digital collectability**: We can prove that an item is original and unique in the same way that we can prove who owns it. This is critical for a metaverse wishing to incorporate more real-world activity. We can make items that are 100 percent unique and can never be duplicated or forged using NFTs. A blockchain can also be used to represent tangible property ownership.

- **Transfer of value**: A metaverse will require a secure method of transferring value that consumers can trust. Multiplayer game-in-game currency are less safe than crypto on a blockchain. Users will want a dependable currency if they spend a significant amount of time in the metaverse and even make money there.

- **Governance**: Users should be able to control the rules that govern their interactions with the metaverse. In the real world, we may vote in corporations and elect presidents and governments. Fair governance will be required in the metaverse, and blockchain is already a proven method of doing so.

- **Accessibility**: On public blockchains, anyone from anywhere in the world can create a wallet. You do not need to pay any money or disclose any information, unlike a bank account. As a result, it's one of the easiest methods to manage finances and a digital identity online.

- **Interoperability**: The compatibility of blockchain technology across many platforms is constantly improving. Polkadot (DOT) and Avalanche (AVAX) are two projects that allow you to create unique blockchains that can communicate with one other. Multiple projects will need to be linked together in a single metaverse, and blockchain technology already has answers for this.

Metaverse examples

- **SecondLive**
  SecondLive is a 3D virtual environment where users can socialise, learn, and do business by controlling avatars. A NFT marketplace for swapping collectibles is also part of the idea.

- **Decentraland**
  Decentraland is a virtual environment that blends social components, cryptocurrencies, and non-fungible tokens with virtual real estate. Furthermore, participants actively participate in the platform's governance. NFTs are used to represent cosmetic collectibles in NFTs, as they are in other blockchain games. They're also used for LAND, which are 16x16 metre land pieces that players may buy for MANA (in-game official cryptocurrency of the platform) in the game. All of these factors combine to form a complicated crypto economy.

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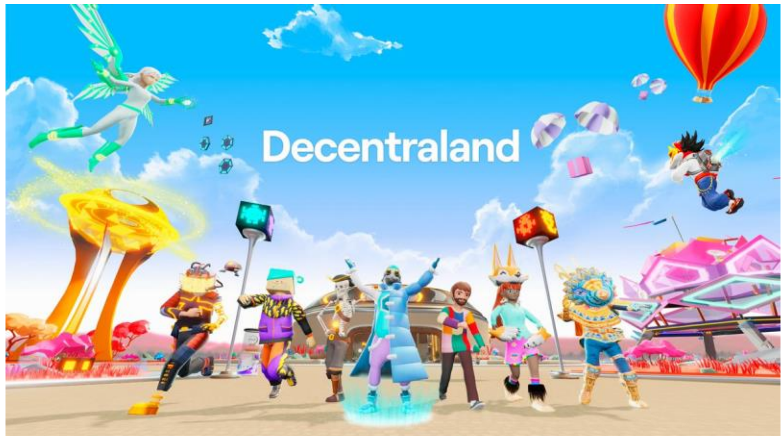

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Storage is important for the development of the Metaverse since it is one of the pillars of blockchain technology (which relates to computing, storage, and network). From a business standpoint, the tremendous data storage requirement caused by the Metaverse and Web 3.0 has significant commercial potential.

Centralized and decentralized storage are the two basic types of data storage business models. Centralized storage stores all data on a single server. Decentralized storage employs dispersed storage technology to store sliced data among numerous independent storage providers.

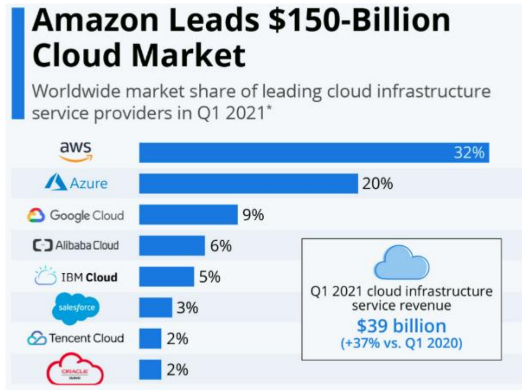
Centralized Storage

Storage of files, data, and databases shared between computing servers through a network is referred to as centralized storage. It's also referred to as networked storage. With its high stability and low cost, centralized data storage fits the enterprise-level storage need. The advantages of centralised storage are numerous. It's easier to manage both hardware and data when everything is in one place, enabling tighter data protection, version control, and security controls. It refers to a single set of data that is consistent and entails greater hardware configuration, capacity, and performance control. Furthermore, concentrating efforts in one location saves money and reduces risk.

Popular Storage Configurations

- **Network-Attached Storage (NAS)** – Multiple app servers can be connected to centralised storage servers with replication and failover using a NAS architecture. Each app server has access to the same information.
- **Storage Area Network (SAN)** – For high availability and higher disc I/O performance than NAS, a Storage Area Network (SAN) provides a redundant array of discs perceived as a local volume by the computers attached to it. Virtualization clusters and SANs are commonly used to provide centralised access to I/O-intensive databases.
- **High-Availability Cluster** – An HA cluster contains two or more services, including a file storage server and a database server, as well as an application server or web server. Traffic is distributed by a load balancer that guarantees failover in the event of hardware or application failure.

The data is centralized in a single location, such as the cloud, providing simple access, mobility, and rapid deployment across all devices, as well as backups and unlimited storage – all at a low cost. Large corporations such as Google, Microsoft, Amazon, Samsung, Alibaba, and Apple now offer cloud storage solutions via Infrastructure-as-a-Service (IaaS).



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While implementing and managing a centralized cloud storage system, businesses encounter the following issues.

- **Lack of ownership and control**
  Using a centralized storage system, data of an enterprise is stored on the host's central server. Any data can be monitored, censored, or even disclosed to third parties by the hosts. Naturally, the company loses control over and customization of its data storage configuration. Larger enterprises with more complex data demands will find this lack of control and customization inconvenient.
- **Increasing storage costs**
  Thanks to centralized storage systems, enterprises no longer need to invest in servers and costly infrastructure for data storage. Cloud service providers, on the other hand, charge astronomical fees for bandwidth transmission and data security. Additionally, hiring expertise or migrating from one cloud vendor to another becomes costly for enterprises. A handful of business owners claim that up to 30% of their cloud expenditure is wasted.
- **Data breaches and security risks**
  In 2020, the Verizon Data Breach Investigation Report (DBIR) identified 32,002 security events and 3,950 data breaches, with 58 percent of data breaches containing personal data. Nearly every major industry player has reported data breaches in the last few years. Cloud servers that are centralised are almost always housed in a single location. In the event of a power outage, the entire network could become paralysed, resulting in loss of previously saved data chunks.
- **Low transmission speed**
  Centralized servers are situated in faraway locations, far from the user's business. Transmission speed is slowed due to the distance constraint.

As a result of these challenges, businesses world-wide seek faster, more secure, and less expensive ways to store their ever-increasing volumes of data. In the form of decentralised storage, blockchain technology provides a solution. The rapid increase of data gowth necessitates greater storage capacity, expansion speed, and data backup capabilities. Decentralised storage has emerged as an attractive option to the high infrastructure costs and entry barriers of centralised storage.

Decentralized Storage

Decentralized storage systems, unlike centralized servers managed by a single corporation or organization, are made up of a peer-to-peer network of users that each hold a share of the overall data, resulting in a resilient file storage sharing system. These can be found in any peer-to-peer network or in a blockchain-based application.

Retention of retrievable data on a computer or other electronic device is referred to as storage. We use storage on a regular basis with our phones and computers, and it's easy to understand with the content we save to a USB stick. Storage has come a long way from the days of having to save files on a floppy disc to now being able to save files in the 'cloud.'

Decentralized storage, which is based on blockchain technology, has improved scalability, security, efficiency, automatic fault tolerance, reliability, and cost.

- **Scalability**: The number of storage nodes can be increased endlessly, and each node's storage capacity can be modified in real time.
- **Security**: Without knowing the service providers or seeking third-party confidence, the stored data is broken into fragments and distributed amongst several nodes. Data encryption occurs in all links of storage networks using methods such as zero-knowledge proof and private network keys access and is not confined to end-users and applications.
- **High efficiency**: Files can be shared directly between nodes on the same network.
- **Automatic fault tolerance:** Multiple copies of data are useful when data transmission or storage faults arise because stored data has been disseminated to a large number of nodes in the network.
- **High reliability**: The storage system includes a verification mechanism that assures the saved files are complete and accurate, and users have access to them 24/7.
- **Low cost**: It is estimated that iQiyi will have to pay a typical storage provider $1 million to store a single episode of The Rap of China at a cost of $0.001 per GB. InterPlanetary File System (IPFS) distributed transmission, on the other hand, can save 60% of bandwidth costs.

There are a few things to consider when choosing decentralized storage (dStorage) options.

- **Persistence Mechanism / Incentive Structure**
  - **Block-chain based**

    A persistence mechanism is required for a piece of data to persist indefinitely. When running a node on Ethereum, for example, the persistence mechanism is that the entire chain must be accounted for. The chain continues to grow as new pieces of data are added to the end, requiring each node to reproduce all the embedded data. The term for this is "blockchain-based persistence." Ethereum and Arweave are two platforms with blockchain-based persistence.

  - **Contract based**

    Data cannot be duplicated by every node and preserved indefinitely; hence contract-based persistence assumes that data must be kept using contract agreements. These are agreements reached between numerous nodes to hold a piece of data for a set amount of time. They must be refunded or renewed after they expire for the data to be preserved. Filecoin, Skynet, Storj, and 0Chain are platforms with contract-based persistence.

- **IPFS**
  IPFS is a distributed file, website, application, and data storage and access system. It doesn't come with an incentive plan built in, but it may be combined with any of the contract-based incentive options mentioned above for longer-term success.

- **Data Retention**
  To keep data, systems must have a mechanism in place to ensure that data is kept. One of the most common methods for ensuring data retention is to issue a cryptographic challenge to the nodes to ensure that they still have the data.

- **Consensus**

  Most of these tools have their own consensus process, usually based on proof-of-work (PoW) or proof-of-stake (PoS).

  Proof-of-work is the consensus mechanism that allows the decentralised Ethereum network to agree on topics such as account balances and transaction order. This prohibits users from "double spending" their tokens and makes the Ethereum network extremely difficult to hack or control. Ethereum, like Bitcoin, currently uses a Proof-of-Work consensus protocol. This allows the Ethereum network's nodes to agree on the status of all data stored on the Ethereum blockchain, preventing some types of economic threats.

  Proof-of-stake is a consensus technique that blockchain networks use to reach distributed consensus. Proof-of-stake is replacing proof-of-work as Ethereum's consensus mechanism.

Decentralized Storage and Metaverse

With the listing of Roblox in 2021, the concept of the metaverse swept throughout major businesses such as the Internet, virtual reality, and financial investing. People have progressed to the metaverse's edge by inventing microcomputers, virtual reality equipment, and 5G high-speed network technology. The metaverse's economic structure, as indicated in our previous study, The Metaverse Overview: From the Past to the Future, is the last touch.

First, a blockchain-based open payment and settlement system can meet real-time, fair, transparent, and rapid P2P payment needs. Second, monetizing users' virtual items or creations in the metaverse protects users' rights and interests in the same way that they are protected in the physical world, while also promoting the circulation and transaction of assets in the metaverse to encourage accumulation of wealth through user innovations. Behind it all, if the monetized virtual asset loses its protection from trusted blockchain storage and its related metadata becomes invalid or tampered with, it will become a worthless check with no acceptance.

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Major Decentralized Storage Solutions

- **Bittorrent**

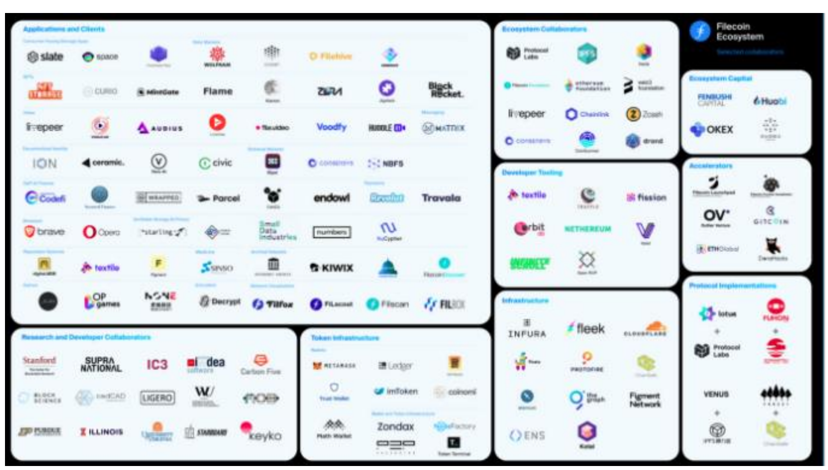
  In 2003, software engineer Bram Cohen proposed BitTorrent, sometimes known as the "BT download," as the first decentralised transmission solution. BitTorrent uses peer-to-peer (P2P) download to overcome the drawbacks of traditional download methods.

- **Storj**

  Storj, which runs on the Ethereum cloud network, is a storage-only platform that has been around for a while. While Storj's storage system is decentralized, the settlement and indexing functions are centralised. On its alpha network, developers can test their storage capabilities.

- **IPFS/ Filecoin**

  Another decentralised storage method proposed in 2015 is IPFS. It addresses BitTorrent's drawbacks by producing several versions of a file and pre-downloading content, resulting in a decentralised, fast, high-efficiency, dependable, and secure content storage system. Filecoin allows anyone to monetize their idle hard drive and bandwidth capacity by providing data storage and retrieval services.



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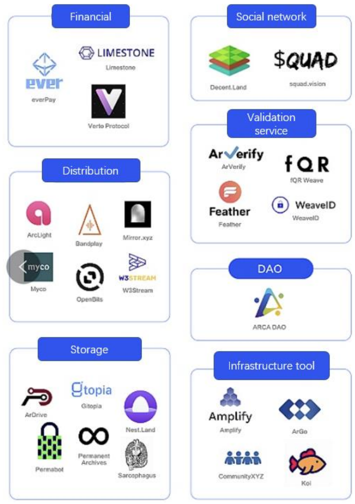
- **Arweave**

  Unlike Filecoin, which stores data off-chain, Arweave's new solution method stores data directly in the blockchain, emphasizing permanent storage and on-chain decentralized storage.



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Limitations of decentralized storage systems

Despite their potential, decentralized storage solutions remain in early stages of development and are not without their drawbacks. Researchers are attempting to overcome the issues that the technology poses. Challenges involved with deployment and development of decentralized blockchain-based data storage systems include:

- **Lack of trust**
  Decentralized data storage systems use peer-to-peer technology, which eliminates the need for centralized regulatory authority. However, because the decentralized network are not responsible for lost data or forgotten transactions, businesses and customers may find it difficult to trust it. Because of this lack of trust, engineers are attempting to create the most secure decentralized network possible. Businesses may have to wait a while before putting their faith in new technology.

- **Complications in development**
  The consensus process becomes difficult to implement while constructing a blockchain-based decentralized storage network. The Proof-Of-Storage protocol requires a consensus mechanism. In layman's terms, this means that each participating node must demonstrate that the data they supply qualifies them to add new records.

- **Security concerns**
  Even if the decentralized storage network is bulletproof, assailants may create malicious nodes and launch hub-attacks that distort and harm the entire network.

Conclusion

While a unified metaverse is likely a long way off, trends are seen that could lead to its establishment. Another sci-fi use for blockchain technology and cryptocurrencies appears to be in the works. It's unclear whether we'll ever truly arrive at a metaverse. In the meantime, we may already participate in metaverse-like projects and continue to integrate blockchain into our daily lives.

Demand for safe and low-cost storage technologies is expanding as the volume of commercial data grows. Decentralized data storage systems that properly balance security, scalability, and price have gotten a boost thanks to blockchain technology.

Because the technology is still relatively new, it may take some time before it is widely adopted and mainstreamed. As we've seen, engineers are still working on addressing the obvious flaws. The benefits of decentralized blockchain-based storage, on the other hand, already outweigh those of centralized storage systems – and this technology is anticipated to improve in the near future.

Without a doubt, decentralized storage is a valuable alternative to centralized data storage. However, be patient; it will take some time before it becomes widely adopted.

References

- Web 2.0 and Web 3.0 Definitions – [Investopedia]
- Is There a Web 1.0? – [HowStuffWorks]
- Web Evolution from 1.0 to 3.0 – [Medium]
- Web 1.0, Web 2.0 & Web3 Explained – [Dev Community]
- Basic Definitions: Web 1.0, Web. 2.0, Web 3.0 – [Brian Getting]
- What is Web 1.0 – [IGI Global]
- Web 1.0, Web 2.0 and Web 3.0 with their difference – [GeeksForGeeks]
- What is Web3? The Decentralized Internet of the Future Explained – [freeCodeCamp]
- Understanding Web 3 — A User Controlled Internet – [Coinbase]
- Web3 Architecture and How It Compares to Traditional Web Apps – [Richard MacManus]
- Decentralized Storage – [Ethereum]
- The benefits of centralized storage for servers – [Iweb]
- Decentralized Storage: Where Web 3.0 Meets Metaverse – [Id-Capital-Medium]
- Decentralized Data Storage: Pros, Cons and Prospects – [PixelPlex]
- The Pros and Cons of Decentralized Data Storage – [Enterprise Networking Planet]