Decentralization:

Decentralization is a core benefit and service provided by blockchain technology. By design, blockchain is a perfect vehicle for providing a platform that does not need any intermediaries and that can function with many different leaders chosen via consensus mechanisms. This model allows anyone to compete to become the decision-making authority. A consensus mechanism governs this competition, and the most famous method is known as **Proof of Work** (**PoW**).

Decentralization is applied in varying degrees from a semi-decentralized model to a fully decentralized one depending on the requirements and circumstances. Decentralization can be viewed from a blockchain perspective as a mechanism that provides a way to remodel existing applications and paradigms, or to build new applications, to give full control to users.

Information and communication technology (**ICT**) has conventionally been based on a centralized paradigm whereby database or application servers are under the control of a central authority, such as a system administrator. With Bitcoin and the advent of blockchain technology, this model has changed, and now the technology exists to allow anyone to start a decentralized system and operate it with no single point of failure or single trusted authority. It can either be run autonomously or by requiring some human intervention, depending on the type and model of governance used in the decentralized application running on the blockchain.

The following diagram shows the different types of systems that currently exist: central, distributed, and decentralized.

Different types of networks/systems

Centralized systems are conventional (client-server) IT systems in which there is a single authority that controls the system, and who is solely in charge of all operations on the system. All users of a centralized system are dependent on a single source of service. The majority of online service providers, including Google, Amazon, eBay, and Apple's App Store, use this conventional model to deliver services.

In a **distributed system**, data and computation are spread across multiple nodes in the network. Sometimes, this term is confused with *parallel computing*. While there is some overlap in the definition, the main difference between these systems is that in a parallel computing system, computation is performed by all nodes simultaneously in order to achieve the result; for example, parallel computing platforms are used in weather research and forecasting, simulation, and financial modeling. On the other hand, in a distributed system,

computation may not happen in parallel and data is replicated across multiple nodes that users view as a single, coherent system. Variations of both of these models are used to achieve fault tolerance and speed. In the parallel system model, there is still a central authority that has control over all nodes and governs processing. This means that the system is still centralized in nature.

The critical difference between a decentralized system and distributed system is that in a distributed system, there is still a central authority that governs the entire system, whereas in a decentralized system, no such authority exists.

A **decentralized system** is a type of network where nodes are not dependent on a single master node; instead, control is distributed among many nodes. This is analogous to a model where each department in an organization is in charge of its own database server, thus taking away the power from the central server and distributing it to the sub-departments, who manage their own databases.

A significant innovation in the decentralized paradigm that has given rise to this new era of decentralization of applications is **decentralized consensus**. This mechanism came into play with Bitcoin, and it enables a user to agree on something via a consensus algorithm without the need for a central, trusted third party, intermediary, or service provider.

We can also now view the different types of networks shown earlier from a different perspective, where we highlight the controlling authority of these networks as a symbolic hand, as shown in the following diagram. This model provides a clearer understanding of the differences between these networks from a decentralization point of view,

Different types of networks/systems depicting decentralization from a modern perspective

In the middle we have distributed systems, where we still have a central controller but the system comprises many dispersed nodes. On the right-hand side, notice that there is no hand/controller controlling the networks.

This is the key difference between decentralized and distributed networks. A decentralized system may look like a distributed system from a topological point of view, but it doesn't have a central authority that controls the network.

A traditional distributed system comprises many servers performing different roles

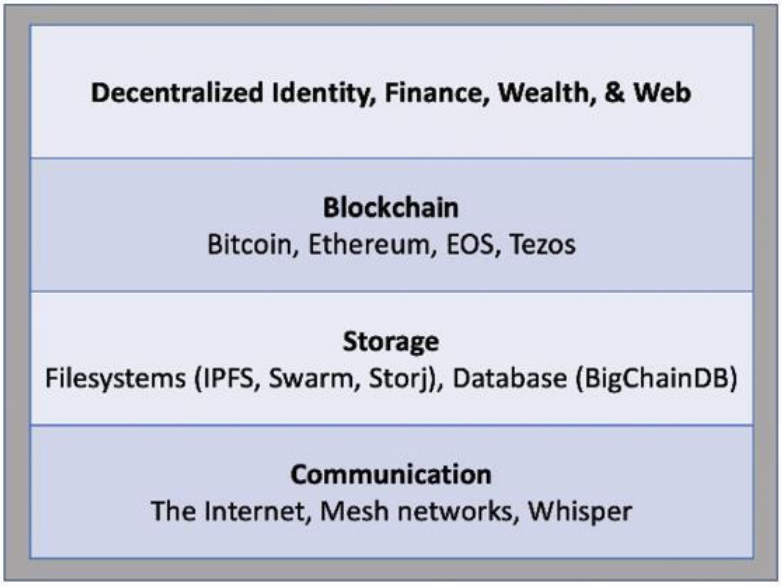
The following diagram shows a decentralized system (based on blockchain) where an exact replica of the applications and data is maintained across the entire network on each participating node:

A comparison between centralized and decentralized systems (networks/applications) is shown in the following table:

Feature	Centralized	Decentralized
Ownership	Service provider	All users
Architecture	Client/server	Distributed, different topologies
Security	Basic	More secure
High availability	No	Yes
Fault tolerance	Basic, single point of failure	Highly tolerant, as service is replicated
Collusion resistance	Basic, because it's under the control of a group or even single individual	Highly resistant, as consensus algorithms ensure defense against adversaries
Application architecture	Single application	Application replicated across all nodes on the network
Trust	Consumers have to trust the service provider	No mutual trust required
Cost for consumer	Higher	Lower

The comparison in the table only covers some main features and is not an exhaustive list of all features. There may be other features of interest that can be compared too, but this list should provide a good level of comparison.

The following diagram shows an overview of a decentralized ecosystem. In the bottom layer, the Internet or mesh networks provide a decentralized communication layer. In the next layer up, a storage layer uses technologies such as IPFS and BigChainDB to enable decentralization. Finally, in the next level up, you can see that the blockchain serves as a decentralized processing (computation) layer. Blockchain can, in a limited way, provide a storage layer too, but that severely hampers the speed and capacity of the system. Therefore, other solutions such as IPFS and BigChainDB are more suitable for storing large amounts of data in a decentralized way. The Identity and Wealth layers are shown at the top level. Identity on the Internet is a vast topic, and systems such as bitAuth and OpenID provide authentication and identification services with varying degrees of decentralization and security assumptions:



Decentralized ecosystem

The blockchain is capable of providing solutions to various issues relating to decentralization. A concept relevant to identity known as **Zooko's Triangle** requires that the naming system in a network protocol is secure, decentralized, and able to provide human-meaningful and memorable names to the users. Conjecture has it that a system can have only two of these properties simultaneously.

Nevertheless, with the advent of blockchain in the form of **Namecoin**, this problem was resolved. It is now possible to achieve security, decentralization, and human-meaningful names with the Namecoin blockchain. However, this is not a panacea, and it comes with many challenges, such as reliance on users to store and maintain private keys securely. This opens up other general questions about the suitability of decentralization to a particular problem.

Decentralization may not be appropriate for every scenario. Centralized systems with well-established reputations tend to work better in many cases. For example, email platforms from reputable companies such as Google or Microsoft would provide a better service than a scenario where individual email servers are hosted by users on the Internet.

There are many projects underway that are developing solutions for a more comprehensive distributed blockchain system. For example, Swarm and Whisper are developed to provide decentralized storage and communication for Ethereum.