Distributed System

In the previous chapters, we examined different ways in which devices can communicate over a network: the client-server model and the peer-to-peer model.

In many real-world services, however, the infrastructure is even more complex: multiple computers, servers, and software components work together to provide a single service. These are known as **distributed systems**.

A distributed system is a computing model in which multiple components, connected through a network, work together to perform a task or provide a service. Hardware and software resources are not located on a single computer but are distributed across multiple interconnected machines.

The goal of a distributed system is to use the available resources efficiently while improving the scalability, reliability, and availability of the overall system.

For example, when a service is distributed across multiple servers, it can handle more users at the same time and continue operating even if part of the infrastructure experiences a problem.

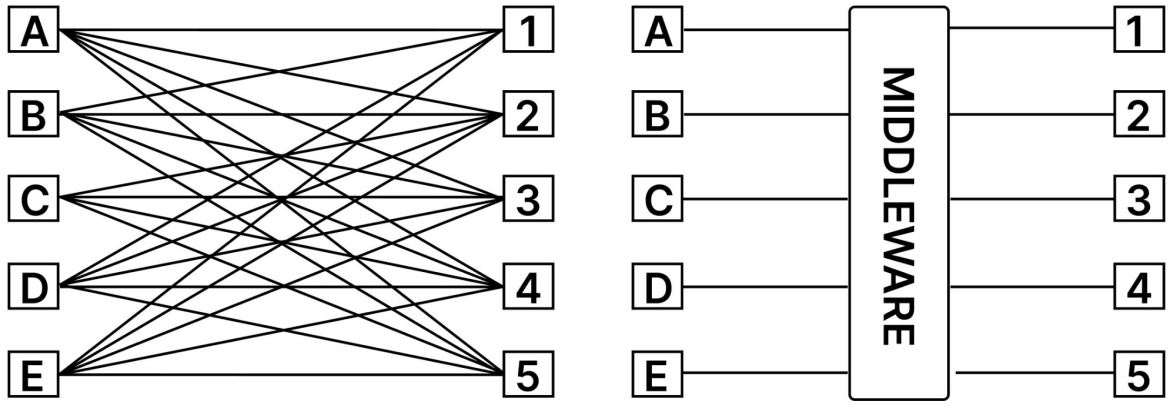
An important feature of distributed systems is **transparency**: users and developers can perceive the system as a single, consistent entity, even though its resources are distributed across multiple computers.

In a distributed system, the presence of multiple computers is invisible to the user, who has the impression of interacting with a single computing system.

Middleware is software that acts as an intermediary between applications or software components within a distributed system. Middleware is what allows users to experience this transparency.

Its main purpose is to facilitate communication, management, and interaction between the different parts of a system, especially when those parts may be located in different areas of a network.

Distributed systems therefore use middleware to achieve transparency.



On the left, a computer network without middleware; on the right, a network using middleware.

Example
Spotify is a music streaming service that allows users to listen to music online from a vast catalogue of tracks.

The service is provided through a distributed architecture: the tracks are stored across servers located around the world, but users are unaware of this and perceive themselves as interacting with a single entity.

Cloud computing

A technology that makes extensive use of distributed systems is cloud computing.

In the past, many software applications were installed and run mainly locally, that is, on the user's device. Today, however, many IT services rely on remote infrastructures that can be accessed through the Internet.

As networks have evolved, becoming much faster and more secure, IT services have increasingly shifted from local software to web-based services. In other words, users interact with the application's user interface through a web browser, while the actual processing is performed by a server, which sends only the result to be displayed back to the interface.

This change provides an advantage for users: their devices do not have to handle the entire workload of the application, because part of the processing is carried out by remote servers.

The concept of using IT services over a network is known as cloud computing. It goes beyond the simple presence of resources on the Internet and involves accessing and using virtual resources as services.

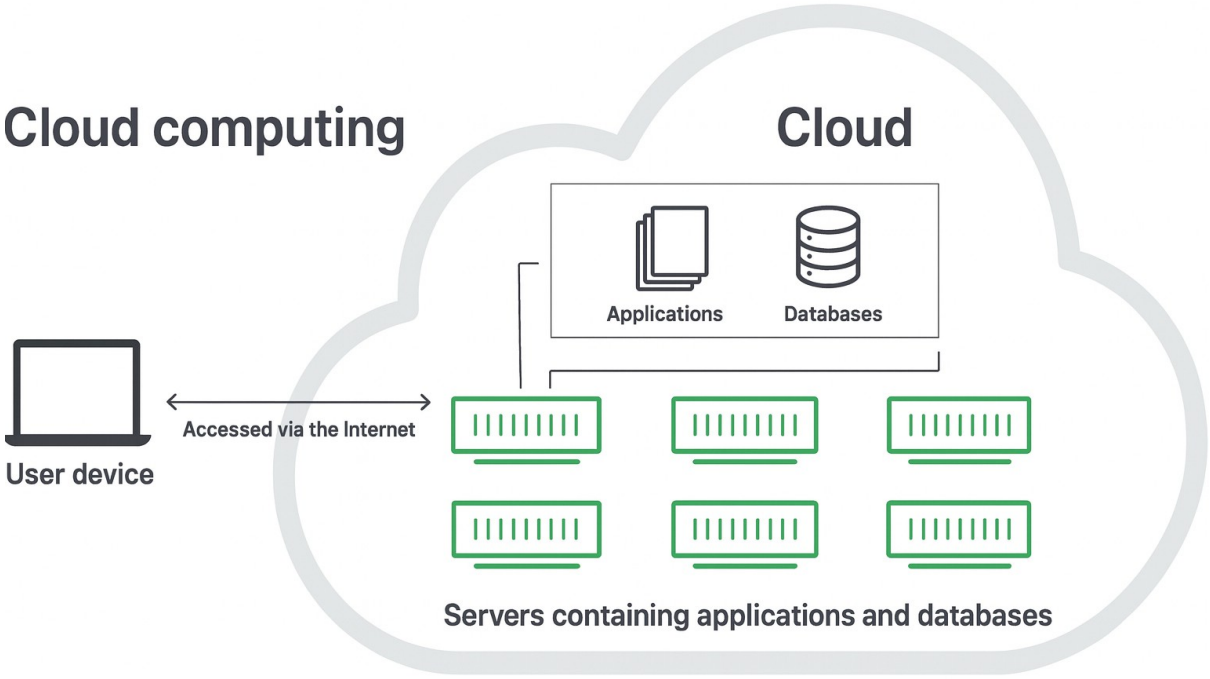
These services may include data storage, data processing, application delivery, data analysis, and much more.

Therefore:

- Cloud computing is a model for providing IT services over the Internet.
- Instead of using only local resources, such as the hard drive or processing power of their own computer, users can access remote resources, including storage space, applications, processing power, databases, and other services.
- In cloud computing, a significant part of the processing, storage, or service management takes place on remote distributed systems. The user's device may simply display the interface and send requests, although in many cases it also performs some local processing.

The term **cloud** refers to the collection of hardware and software resources that make cloud computing possible: servers, storage systems, networks, software, and interconnected data centres.

Therefore:
The cloud is the collection of hardware and software resources used to provide cloud computing services.



Cloud computing is a conceptual model that allows a user's device to access the cloud via the Internet and use its services

The cloud allows users to access the same files and applications from virtually any device because processing and storage take place on servers located in data centres rather than locally on the user's device.

This is why users can access their Instagram account from a new phone after their old one has broken and still find their account, photos, videos, and conversation history.

Example
Google Drive is considered a cloud system for several reasons:

- Remote storage: Google Drive allows users to store their files and documents on remote servers managed by Google. These files are not physically stored on the user's device but primarily on Google's servers in distributed data centres.
- Access from anywhere: Users can access their Google Drive files from any Internet-connected device, such as a computer, tablet, or smartphone. This means that they can view, edit, and share their documents wherever they are.
- Sharing and collaboration: Google Drive allows users to share files with other people, enabling real-time collaboration. Multiple users can work on the same documents and see changes as they are made.

- Automatic synchronisation: Changes made to files in Google Drive are automatically synchronised across all the devices from which the user accesses their account. This ensures that the latest versions of the files are always available.
- Scalability: Google Drive offers flexible storage space that can easily be expanded according to the user's needs. Users can purchase additional storage space when necessary.
- Centralised management: Users can organise and manage their files through an intuitive web interface. They can create folders, divide files into categories, and use search tools to quickly find what they need.
- Automatic updates: Google Drive is a service managed by Google, which means that users automatically receive new features and improvements without having to install updates manually.

For businesses, moving to cloud computing can eliminate some IT-related and fixed costs. For example, companies no longer need to upgrade and maintain their own servers because this work is carried out by the cloud service provider they use.

This is particularly significant for small businesses, which may not be able to maintain their own internal infrastructure but can outsource their infrastructure needs conveniently through the cloud.

The cloud can also make it easier for companies to operate internationally because employees and customers can access the same files and applications wherever they are, provided they have an Internet connection.

The cloud is often based on distributed systems because the service is provided by many coordinated resources, including servers, storage systems, networks, and data centres.

From the user's perspective, however, most of this complexity is hidden: the service appears as a single application accessible through the Internet.