**What is Virtualization:**

Virtualization is the process of creating a virtual representation of hardware such as server, storage, network or other physical machines. It Supports multiple copies of virtual machines(VMs) to execute on one physical machine each with their own operating system and programs. This optimizes hardware efficiency and flexibility and enables resources to be shared between multiple customers or organizations.

Virtualization is a key to providing Infrastructure as a Service (IaaS) solutions for cloud computing, whereby the user has access to remote computing resources.

**Why is Virtualization Important:**

Virtualization is important because it let's you get the most out of your computer or server resources. Consider it like being able to use one physical box as many smaller, independent "virtual boxes. There are multiple virtual boxes, each having its own program to run and data to store, but they use the same physical box.

**1. Better use of Resources**

Instead of allowing for numerous unused machines, virtualization enables you to host multiple programs or systems on one computer, which is more effective.

**2. Cost Utilization**

Companies can save their money on hardware, power, and maintenance by using less physical equipment.

**3. Flexibility**

Virtual machines can be easily installed, relocated and resized to suit changing requirements. If a virtual machine requires more power, it can obtain it rapidly without requiring new hardware.

**4. Security**

Virtualization isolates various applications or systems from each other, so if one of them has an issue, it won't affect others.

**How does Virtualization Work:**

Virtualizations uses special software known as hypervisor, to create many virtual computers (cloud instances) on one physical computer. The Virtual Machines behave like actual computers but use the same physical machine.

* **Virtual Machines (Cloud Instances)**

After installing virtualization software on your computer, you can set up one or more virtual machines. The Virtual machines are similar to other applications on your computer. The Actual computer is **Host** and the Virtual Computers are **Guests.**You can have several guests on a single host, and each guests can have its own operating system, which may be the same or different from the host.

* **Hypervisors**

A hypervisor is the software that gets virtualization to work. It serves as an intermediary between the physical computer and the virtual machines. The hypervisor controls the virtual machines' use of the physical resources (such as the CPU and memory) of the host computer.

**Types of Virtualization:**

1. **Application Virtualization**
2. **Network Virtualization**
3. **Desktop Virtualization**
4. **Storage Virtualization**
5. [**Server Virtualization**](https://www.geeksforgeeks.org/server-virtualization/)
6. **Data virtualization**
7. **Application Virtualization**: Application virtualization enables remote access by which users can directly interact with deployed applications without installing them on their local machine. Your personal data and the applications settings are stored on the server, but you can still run it locally via the internet. It’s useful if you need to work with multiple versions of the same software.

**Example:**Microsoft Azure lets people use their applications without putting them on their own computers. Once this application is setup in the cloud then employees can use it from any device, like a laptop or tablet.

1. **Network Virtualization**: This allows multiple virtual networks to run on the same physical network, each operating independently. You can quickly set up virtual switches, routers, firewalls, and VPNs, making network management more flexible and efficient.

**Example:**Google Cloud is an example of Network Virtualization. Companies create their own networks using software instead of physical devices with the help of Google Cloud. They can set up things like IP addresses, firewalls, and private connections all in the cloud.

1. **Desktop Virtualization**: Desktop virtualization is a process in which you can create different virtual desktops that users can use from any device like laptop, tablet. It’s great for users who need flexibility, as it simplifies software updates and provides portability.

**Example:**GeeksforGeeks is a Edtech company which uses services like **Amazon WorkSpaces** or **Google Cloud (GCP) Virtual Desktops** to give its team members access to the same coding setup with all the tools they required for the easy access of this team work.

**4. Storage Virtualization**: This combines storage from different servers into a single system, making it easier to manage. It ensures smooth performance and efficient operations even when the underlying hardware changes or fails.

**Example:**Amazon S3 is an example of storage virtualization because in S3 we can easily store any amount of data from anywhere. Suppose a MNC have lots of files and data of company to store.

1. **Server Virtualization**: This splits a physical server into multiple virtual servers, each functioning independently. It helps improve performance, cut costs and makes tasks like server migration and energy management easier.

**Example:**A startup company has a powerful physical server. This company can use server virtualization software like VMware vSphere, Microsoft Hyper-V or KVM to create more virtual machines(VMs) on that one server.

1. **Data Virtualization**: This brings data from different sources together in one place without needing to know where or how it’s stored. It creates a unified view of the data, which can be accessed remotely via cloud services.

**Example:** Companies like Oracle and IBM offer solutions for this.

**Benefits of Virtualization:**

Here are some of the benefits of using Virtualization in Cloud Computing:

* More flexible and efficient allocation of resources.
* Enhance development productivity.
* It lowers the cost of IT infrastructure.
* Remote access and rapid scalability.
* High availability and disaster recovery.
* Pay peruse of the IT infrastructure on demand.
* Enables running multiple operating systems.

**Characteristics of Virtualization:**

* **Increased Security:** The ability to control the execution of a guest program in a completely transparent manner opens new possibilities for delivering a secure, controlled execution environment. All the operations of the guest programs are generally performed against the virtual machine, which then translates and applies them to the host programs.
* **Managed Execution:** In particular, sharing, aggregation, emulation, and isolation are the most relevant features.
* **Sharing:** Virtualization allows the creation of a separate computing environment within the same host.

**How is Virtualization Different from Cloud Computing:**

Below is the table that shows the comparison between virtualization and Cloud Computing:

| **Aspect** | **Virtualization** | **Cloud Computing** |
| --- | --- | --- |
| **What it is** | Creating multiple virtual versions of a physical resource | Accessing computing resources (like storage, servers) via the internet |
| **Where it runs** | On physical machines or servers | On remote servers provided by cloud service providers |
| **Focus** | Efficient use of physical resources | On-demand access to resources over the internet |
| **Example** | Running multiple virtual machines on a single physical server | Storing data on Google Drive or renting a virtual machine on AWS |
| **Control** | You have more control over the virtual environment | Cloud providers manage the physical hardware; you manage only what you use |

**Uses of Virtualization:**

The following are the uses of virtualization:

* **Resource Optimization**: Maximizes hardware utilization by running multiple virtual machines on a single server.
* **Cost Reduction**: Reduces hardware and maintenance costs by consolidating servers.
* **Scalability:** Enables quick scaling of resources based on demand.
* **Flexibility**: Dynamically allocates resources to applications as needed.