Introduction to Virtual Machines Lecture: Virtual Machines in the Cloud

To understand what a Virtual Machine (VM) is and why it is the fundamental building block of cloud computing.

What is a Virtual Machine?

A Virtual Machine is a "computer inside a computer." It is a software file that behaves exactly like a physical computer.

- Virtual Hardware: It has its own CPU, memory (RAM), hard disk, and network interface, but they are all created by software, not physical metal.
- Independence: You can run a completely different Operating System on it. For example, you can run Linux inside a window on a Windows 10 laptop.
- The "Sandbox" Concept: Whatever happens inside the VM stays inside. If the VM gets a virus, the physical computer remains safe.

The Role of the Hypervisor

The Hypervisor is the software layer that enables virtualisation. Think of it as the "Traffic Controller" or "Manager."

Abstraction

It sits between the physical hardware and the virtual machines. It tricks the operating systems into thinking they have their own dedicated hardware.

Resource Distribution

If you have 16GB of RAM on the physical server, the Hypervisor divides it up: 4GB to VM #1, 2GB to VM #2, and so on.

Types

- Type 1 (Bare Metal): Installs directly on hardware (Used in Cloud Data Centers).
- Type 2 (Hosted): Installs as an app on your OS (like VirtualBox or VMware Player used in labs).

Multi-Tenancy (Sharing the Cloud)

Cloud providers like AWS, Azure, or Google Cloud rely on VMs to serve millions of customers simultaneously.

The Apartment Metaphor

A physical server is like a large apartment building. Each VM is an individual apartment.

Isolation

Just as neighbors cannot walk through your walls, one customer's VM cannot access the data of another customer's VM, even though they are on the exact same physical chip.

Efficiency

Without VMs, a cloud provider would need a separate physical computer for every single customer, which is impossible. VMs allow one massive server to run hundreds of small user environments at once.

Key Advantages in Computing Tasks

1

Cost Savings

Instead of buying 10 small servers, a company buys 1 powerful server and runs 10 VMs on it. This saves electricity and space.

2

Snapshots & Recovery

You can save the state of a VM at any moment (like a "Save Game" checkpoint). If an update breaks the system, you can revert to the snapshot in seconds.

3

Portability

A VM is just a file. You can copy it from a server in Pakistan to a server in the USA, and it will run exactly the same way without needing reconfiguration.

When do we use VMs?

Testing and Development

Developers use VMs to test software on different operating systems (e.g., testing an app on Windows 7, Windows 10, and Ubuntu) without buying three computers.

Running Legacy Applications

If a critical business program was written 15 years ago and only works on Windows XP, you can run a Windows XP VM on a modern server to keep it alive.

Safe Browsing

Security researchers use VMs to open suspicious files or viruses. If the virus explodes, it only destroys the temporary VM, not the real work computer.

Conclusion

Conclusion: Virtual Machines allow us to maximise hardware efficiency. Using a Hypervisor, we can partition physical resources into multiple isolated environments, making the Cloud flexible, secure, and cost-effective.

Questions

Q1: What is the main function of a Hypervisor? The hypervisor manages the physical hardware resources and allocates them to the virtual machines. It sits between the hardware and the virtual OS.

Q2: Differentiate between a Physical Machine and a Virtual Machine. A physical machine is hardware you can touch. A virtual machine is a software emulation that acts like a computer but exists only as code and files.

Q3: Why are VMs important for Cloud Computing? They allow "Multi-tenancy," enabling one physical server to host multiple users securely and separately at the same time.