

Chapter 3. Virtualization

Virtualization

- It is a technology to run multiple same or different OSs on a single physical system which are completely isolated from each other to share hardware resources.
 - Example: Run Windows and Linux in same machine
 - It is the process by which one computer **behaves as many computers**.
 - used to improve **IT throughput** and costs by using physical resources as a pool from which virtual resources can be allocated.
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- **Dual System:** A computer system in which two operating systems are installed on the same hard drive, allowing either operating system to be loaded and given control.
 - **Emulation System:** A system that pretends to be another system.
 - **Virtualization System:** A system that pretends to be two or more of the same system.
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- **VMs:** is an isolate runtime environment (Guest OS, and application).
 - VMs can be **scaled up** and **down** on demand with a high level of resources' abstraction.
 - Single physical machine can run multiple operating systems **concurrently**, each in its own virtual machine
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Virtualization Infrastructure Manger (VMM)

Several Components

- **Host:** underlying hardware system
 - **Virtual Machine Manager (VMM) or hypervisor** creates and runs virtual machines by providing interface that is identical to the host
 - **Guest:** process provided with virtual copy of the Host
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Hypervisor: A software that allows multiple OSs (guest) to share a single hardware host.

Responsible:

- **Controlling** the host processor and resources,
- **Allocating** what is needed to each operating system in turn, and
- **Making sure** that the guest operating systems (called Virtual Machines (VMs)) cannot disrupt each other.

Hypervisor Types:

1. **Full Virtualization** (native or bare-metal hypervisors)
 - all software (including all OS's) capable of executing on the raw (bare) hardware
 - It directly sitting on top of the bare hardware devices
 - Hypervisors Enable to run multi-unmodified guest operating system
 - Guest OS is not aware that it is being virtualized.

2. Para Virtualization:

- These hypervisors run on a conventional operating system (Host OS) just as other computer programs do.
 - A Guest OS runs as a process on the Host OS.
 - Para hypervisors abstract Guest OSs from the Host OS.
 - By explicitly modifying Guest OS. So, that it is aware of being virtualized to allow near native performance.
 - Improves performance & Lower overhead.
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Benefits of Virtualization

- **Consolidation:** Operate different OS's and applications on one single server
 - **Sharing of resources**
 - **Isolation:** Virtual machines are isolated from each other as if they are physically separated
 - **Encapsulation:** Virtual machines encapsulate a complete computing environment
 - **Hardware Independence:** Virtual machines run independently of underlying hardware
 - **Portability:** Virtual machines can be migrated between different hosts.
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Virtualization Ranging from Hardware to Applications in Five Abstraction Levels

- **Application Level**
 - **Library (API) Level:**
 - This layer sits as an application program on top of an operating system and exports an abstraction of a VM that can run programs written and compiled to a particular abstract machine definition
 - **OS Level:**
 - It is an abstraction layer between traditional OS and user applications.
 - This virtualization creates isolated containers from a single physical server and the OS-instance to utilize the hardware and software in datacenters.
 - **Hardware Abstraction Layer (HAL) Level**
 - **Instruction set architecture (ISA) Level**
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- **Small Scale Consolidation:** Operate different OS's and applications on one single server
 - **Production Consolidation:** A company can achieve greater efficiency and increase profitability by selling all or part of its manufacturing operations.
 - The end result - higher profitability for the company.
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Virtualization In Cloud Computing:

Virtualization Over Cloud Computing

- Benefits of virtualization over cloud computing:
 - Reduce capital expenses (CAP-EX)
 - Reduce maintenance and operation expenses (OP-EX) through server consolidation,
 - Reduce physical space needed in data centers.
 - Resource Management, Migration, Maintainability, High availability and Fault tolerance are other benefits.
- Virtualization is implemented using **hypervisors**.

Advantages of Virtualization Over Cloud Computing

- Zero downtime maintenance
- Freedom from vendor-imposed upgrade cycles
- Instant provisioning
- Pooling hardware resource
- Virtual hardware supports legacy operating systems efficiently
- Dynamic resource sharing
- Security and fault isolation
- Business continuity, backups, and automated restoration