Cloud Computing – SWE 2022 [~KShawki]

***Chapter 2. 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.
* **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.
* **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

**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

**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.

**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.

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
* **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.

**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