Virtualisation and the Cloud

Dr. Mohammed Kaleem

Overview

- Virtualisation and how its utilised in Cloud Services
- How virtualization works
  - What hardware and software is required to create a virtual system?
  - Hypervisors
    - Type-1 and Type-2
- How to create virtual machines using Virtual Box

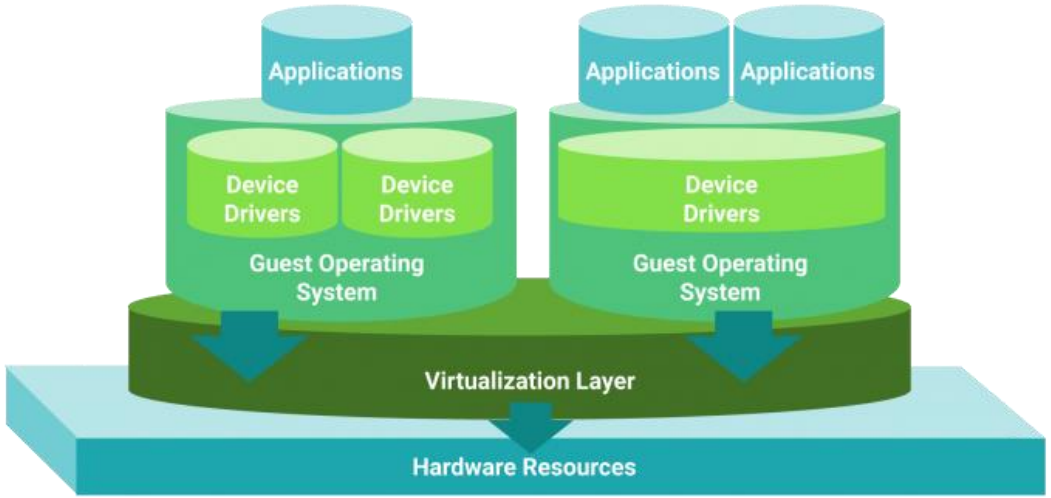
Definition

- **Virtualisation** is the ability to run multiple operating systems on a single physical system and share the underlying hardware resources*
- It is the process by which one computer hosts the appearance of many computers.
- Virtualisation is used to improve IT throughput and costs by using physical resources as a pool from which virtual resources can be allocated.

*VMWare white paper, *Virtualization Overview*

In a Nutshell…

Virtualisation allows multiple operating system instances to run concurrently on a single computer; it is a means of separating hardware from a single operating system.



Virtualisation and the Cloud

- Virtualisation is often used as a foundation of cloud computing.
- Virtualisation separates resources and services from the underlying physical delivery environment. With this approach, you can create many virtual systems within a single physical system.
- A primary driver for virtualisation is consolidating servers, which provides organizations with efficiency and potential cost savings.

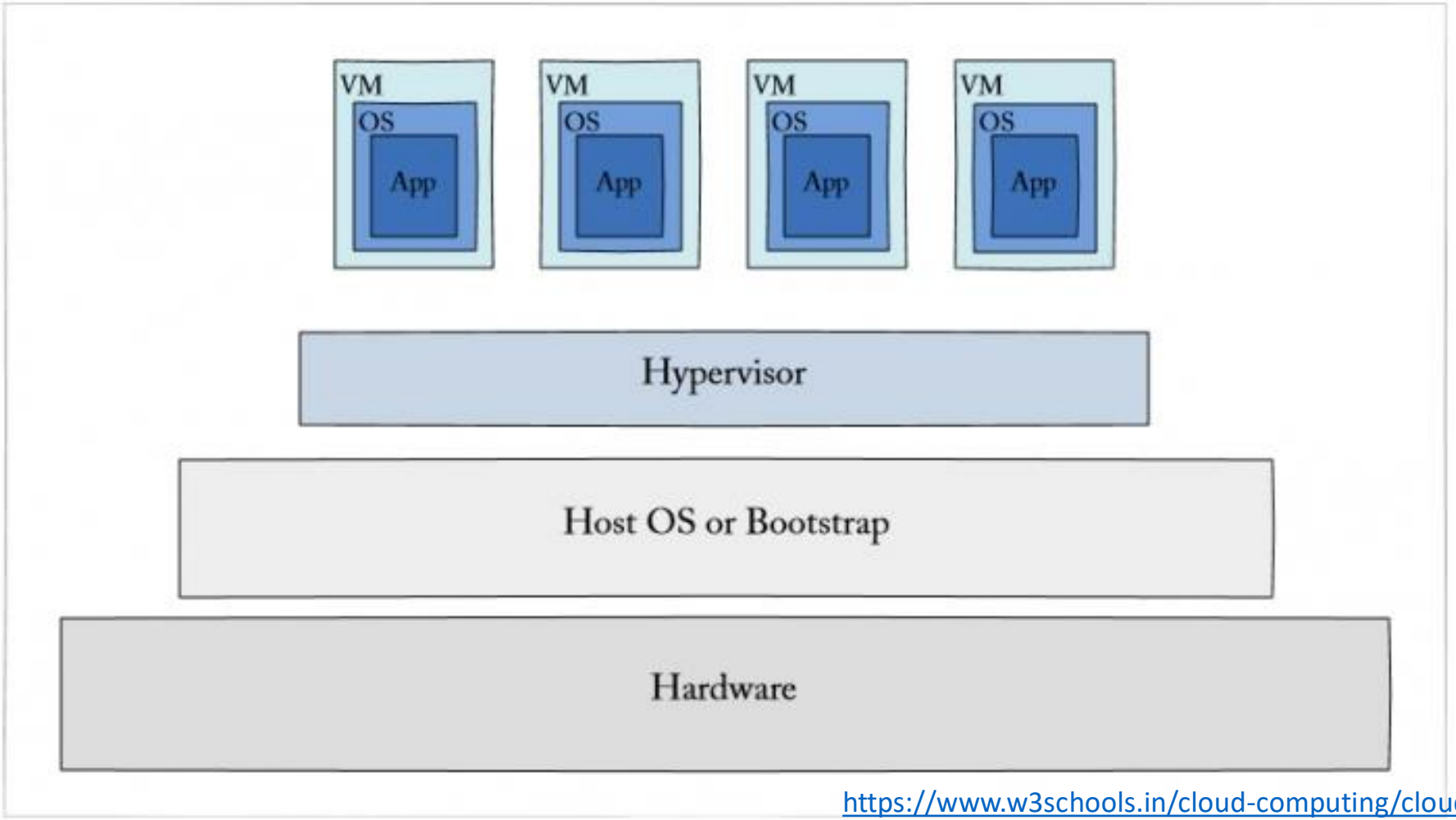
Cloud Services For Dummies, IBM Limited Edition (2019)

Virtualisation in Cloud Computing

Cloud computing takes virtualisation one step further:

- You don’t need to own the hardware (avoid heavy investment costs)
- Resources are rented as needed from a cloud
- Various providers allow creating virtual servers:
  - Choose the OS and software each instance will have
  - The chosen OS will run on a large server farm
  - Can instantiate more virtual servers or shut down existing ones within minutes
- You get billed only for what you used

Cloud Virtualisation Overview



https://www.w3schools.in/cloud-computing/cloud-virtualization/

Cloud Virtualisation Architecture Overview

The cloud is comprised of many complex interconnected processes and hardware. At a high level overview it can be broken down in to four categories:

- **Hardware**
- **Host Operating System**
- **Hypervisor**
  - Manages the guest virtual machines
- **Virtual/Guest Systems**
  - The virtual system/s that run on the host system, sharing its resources.

https://www.w3schools.in/cloud-computing/cloud-virtualization/

Hardware

The physical hardware/metal resources that you can touch. Usually very powerful server hardware comprised of:

- Xeon processors
- Huge Amounts of RAM
- Terabytes/Petabytes of Storage
- Commercial Grade Graphical Processing Hardware (render farms, AI)

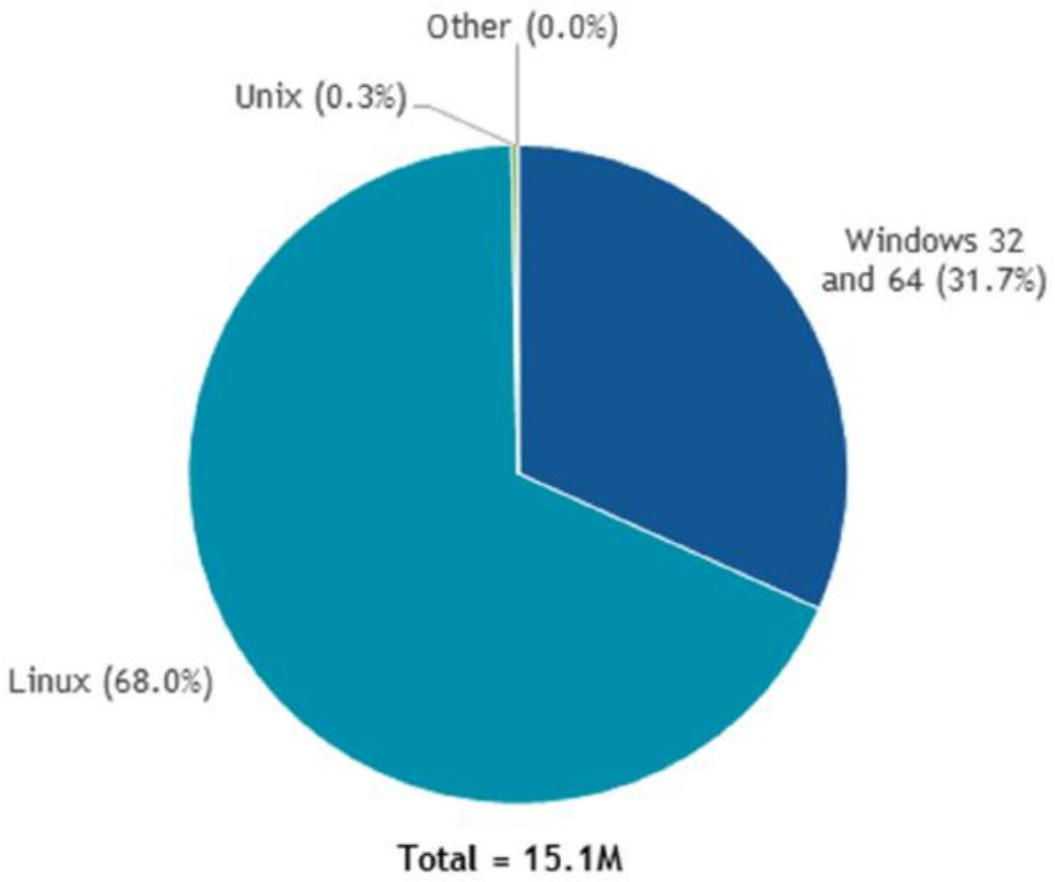
Host Operating System (OS)

- The OS used to run the server
- All of the major OS suppliers (Microsoft, Linux and Mac OS) have a dedicated version of their OS that is specifically meant to run on server hardware. Server OS's are more powerful than their desktop counterparts and can utilize the increased hardware resources more efficiently.

The most popular server OS's are:

- Linux
- Microsoft

Server OS Market Share (2018)



https://www.redhat.com/en/blog/red-hat-continues-lead-linux-server-market

What is a Hypervisor?

- A hypervisor or virtual machine monitor (VMM) is a piece of computer software, firmware or hardware that creates and runs virtual machines.
- A computer on which a hypervisor is running one or more virtual machines is defined as a host machine.
- Each virtual machine is called a guest machine.
- There are two types of hypervisors:
  - Bare Metal Hypervisors
  - Software Hypervisors

Type-1: Bare Metal Hypervisor

- Type 1 hypervisor is installed directly on bare-metal hardware, it doesn't require an additional OS, it is the OS, even it it is a light or minimal OS.
- E.g. Kvm and Xen
- Advantages:
  - System is thin,
  - the hypervisor has direct access to the HW,
  - higher density hardware.
- Disadvantages:
  - Really large VMs are not supported,
  - HW used to build the server should support virtualization technology,
  - Costs more compared to Type-2 HV’s,
  - Un-user friendly console interface.

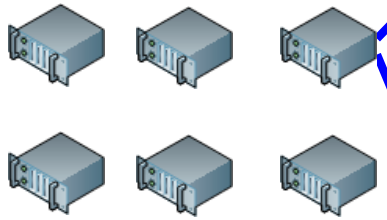
Type-2: Hosted Hypervisors

- Type 2 is more of an application installed on an operating system and not directly on the bare-metal.
- E.g. VirtualBox and Vmware Workstation
- Advantages:
  - Run on a greater array of HW because the underlying Host OS is controlling HW access,
  - Easy user interface,
  - Data can be secured on the desktop .
- Disadvantages:
  - Decreased security,
  - Loss of Centralized Management,
  - Lower VM Density,
  - Cannot support as many VMs are the first type.

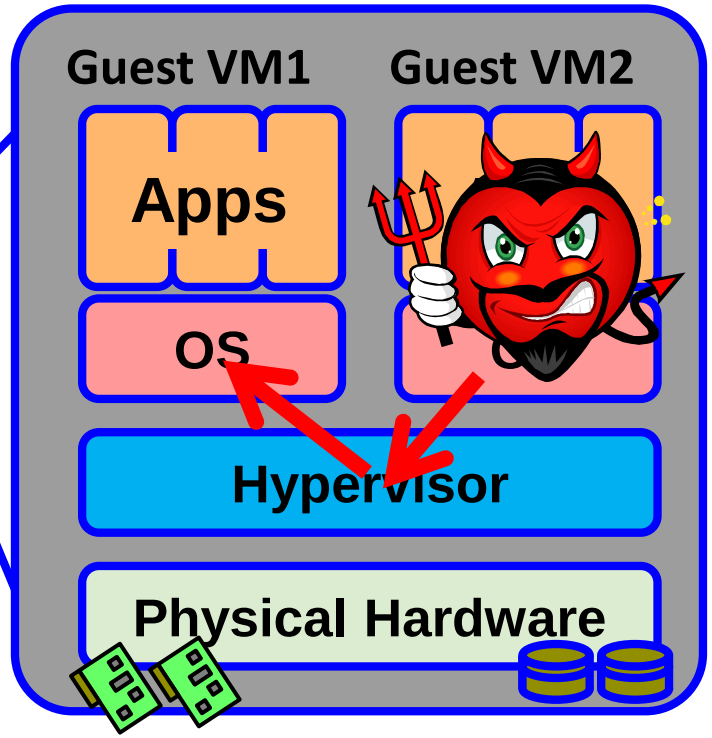
Hypervisor Vulnerabilities

Malicious software can run on the same server:

- Attack hypervisor
- Access/Obstruct other VMs

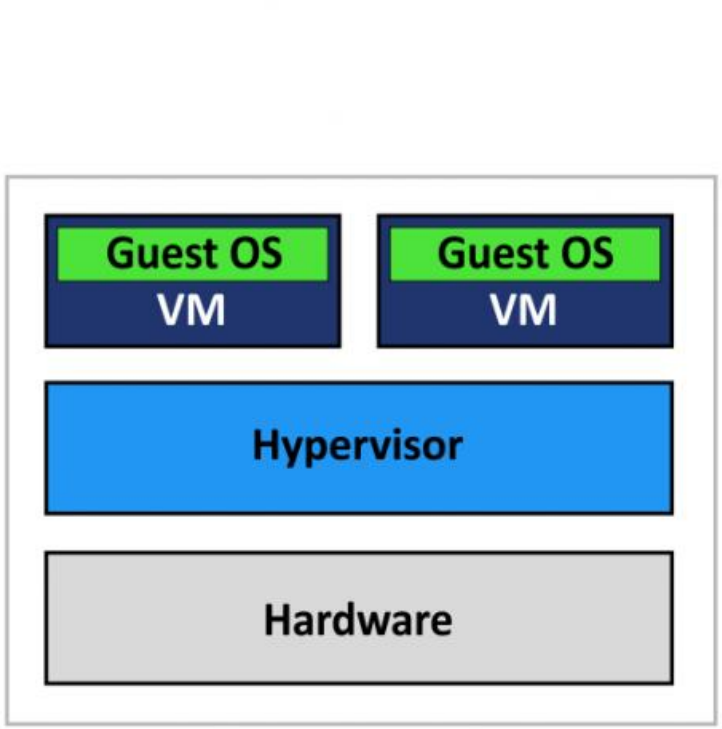


servers

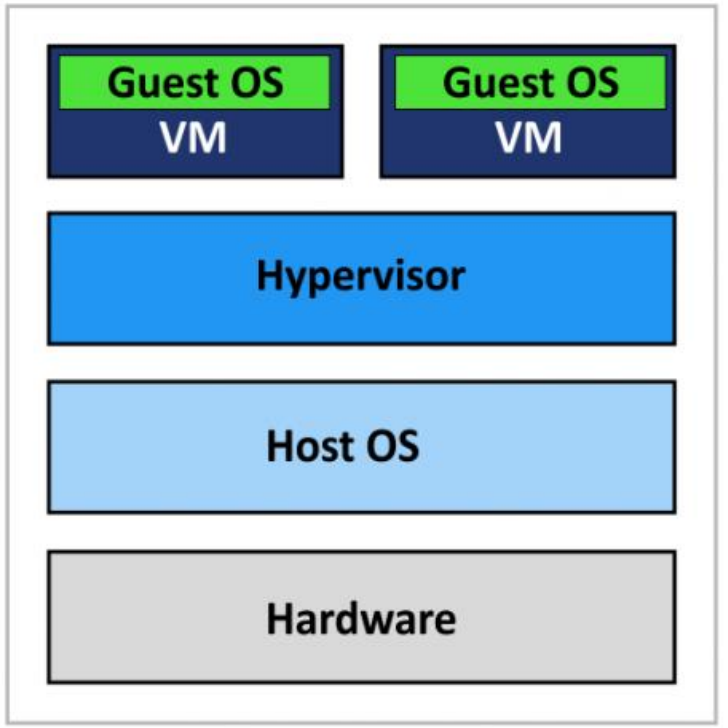


Note: the Sony PlayStation 3 was first “hacked” due to a vulnerability found in the hypervisor, which was subsequently removed in later hardware/software revisions. Read more in this [here].

Type-1 Vs Type-2



Type 1 Hypervisor
(Bare-Metal Architecture)

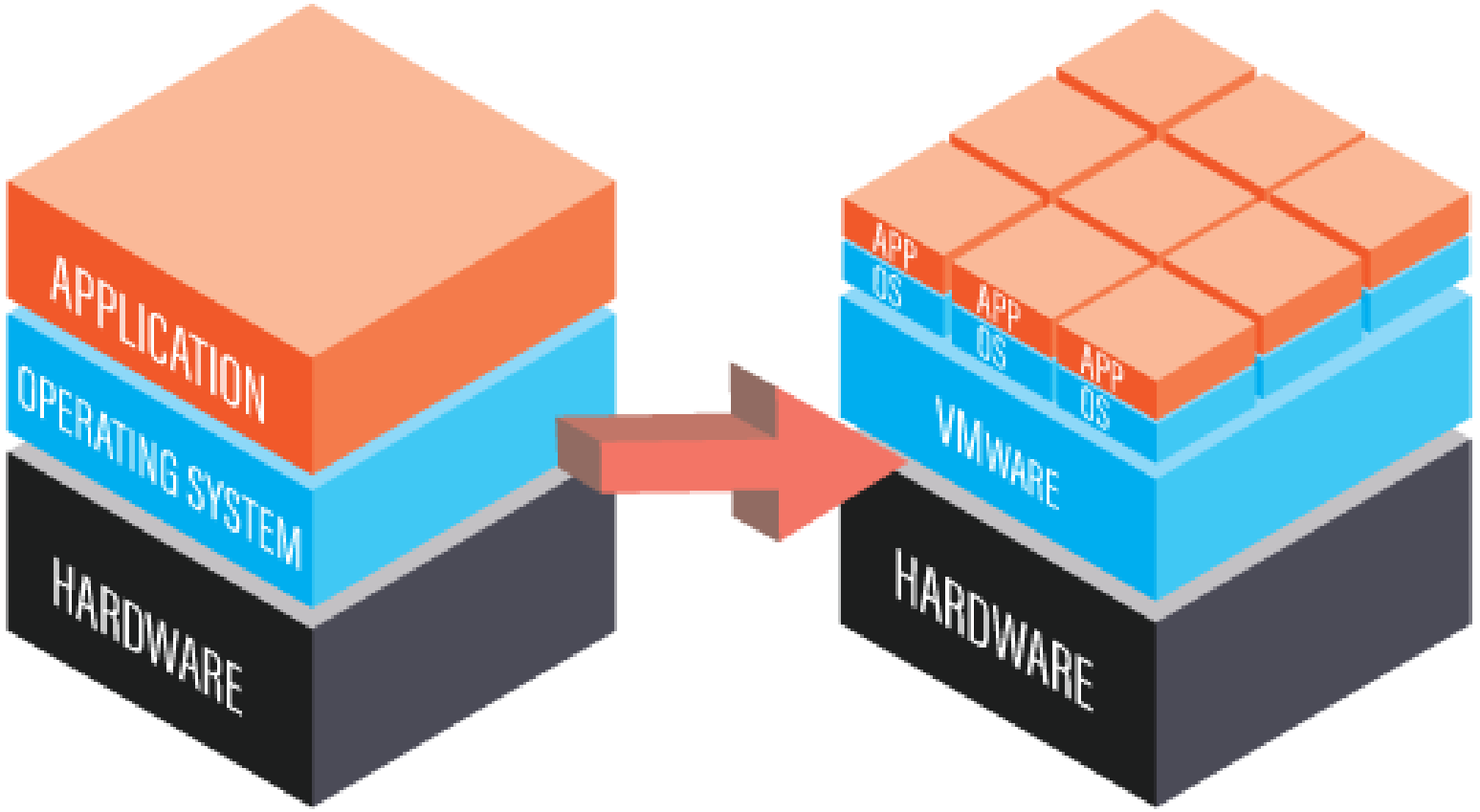


Type 2 Hypervisor
(Hosted Architecture)

The Virtual System

- A “**virtual system**” is also known as an the “**guest**”, or an “**appliance**” or an “**instance**” or a “**client**” depending on the technology/platform you use to implement your virtualisation needs.
- A virtual system runs on a host system by sharing the hardware resources available to the host.
- The hardware can be pre-configured/fixed or left to the hypervisor to allocate as and where required (depending on demanding and server load).
- Most operating system can be virtualised
  - Desktop OS
  - Server OS
  - Mobile OS

Traditional Vs Virtual



Virtualisation Advantages

- **Cost-effectiveness – less hardware**
  - Multiple virtual machines / operating systems / services on single physical machine (server consolidation)
  - Various forms of computation as a service
- **Isolation**
  - Good for security
  - Great for reliability and recovery: If VM crashes it can be rebooted, does not affect other services (fault containment)
  - VM migration
- **Development tool**
  - Work on multiple OS in parallel
  - Develop and debug OS in user mode
  - Origins of VMware as a tool for developers

The Big Players in the Cloud Virtual Space

Exercise

- Implement a virtual server capable of hosting Web Applications.
  - Ubuntu server 18.04
    - Tomcat
    - JDK
    - LAMP Stack
      - Apache
      - MySQL
      - PHP