CLOUD COMPUTING

/INFRASTRUCTURE as a SERVICE (IaaS)
/VIRTUALISATION AND THE CLOUD

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/01   UNDERSTANDING HOW IaaS IS DELIVERED

➢ How is IaaS possible?
  ➢ Virtualisation
  ➢ Hypervisors

/02   VIRTUALISATION IN THE CLOUD (DEMO)

➢ How to provision cloud Virtual Machines (VM)
  ➢ AWS
  ➢ GCP
  ➢ Azure
➢ How to deploy the web apps we make to the cloud on a cloud VM.

KEY CONCEPTS COVERED

/VIRTUALISATION

It is the process by which one computer hosts the appearance of many computers, known as virtual machines (VMs).
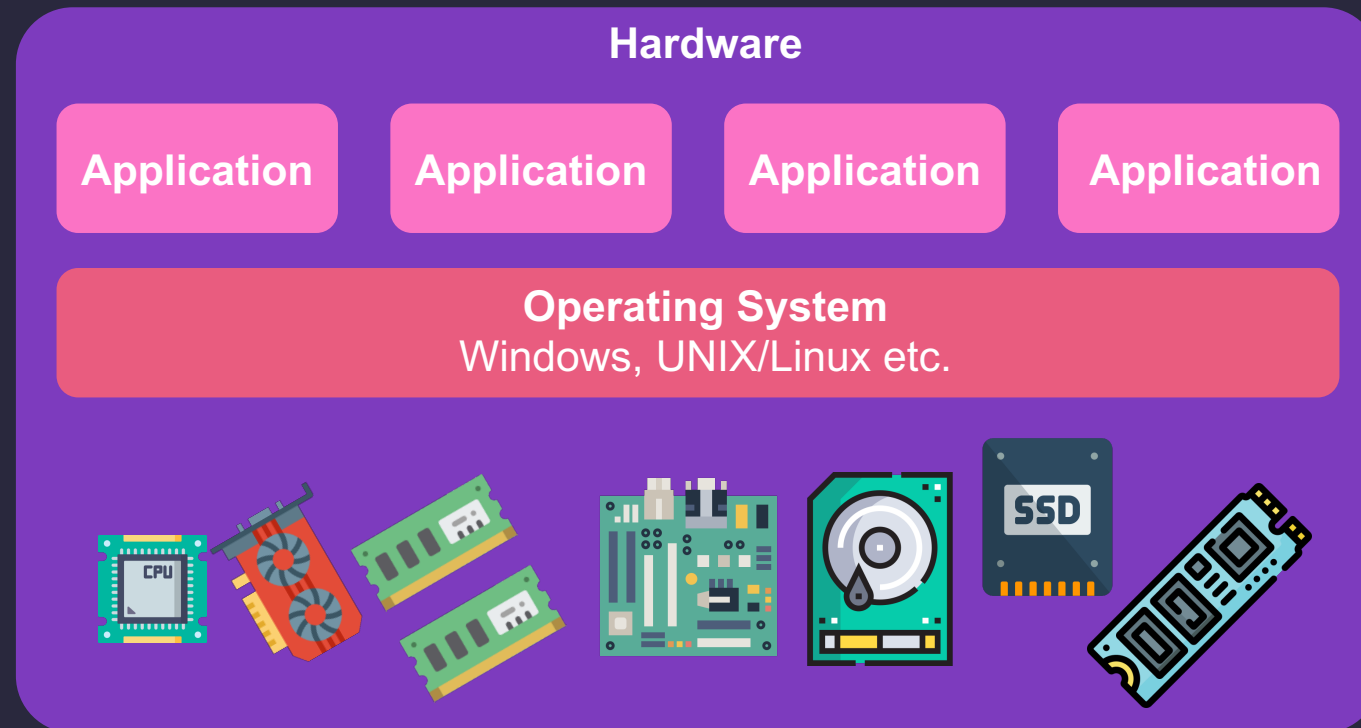
/HYPERVISOR

Software or hardware that is used to create, manage and run virtual machines.

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COMPONENTS OF A COMPUTER SYSTEM

A computer system generally consists of:
  o Hardware — **CPU, RAM, hard dri**ve etc.
  o An Operating System (OS)
  o Applications to support the users' needs

Hardware

| Application | Application | Application | Application |

Operating System
Windows, UNIX/Linux etc.

LIMITATIONS

Hardware is accessed by a **single operating system**
- When various operating systems are needed, additional machines are required

Failure of an application may interfere with other applications by:
- Excessive CPU or memory usage
- Causing operating system failure
- Servers often dedicated to single applications
- Isolate applications for security
- Results in underutilised hardware resources

VIRTUALISATION 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.

Virtualization **creates a simulated, or virtual, computing environment** as opposed to a physical environment. Virtualization often includes computer-generated versions of hardware, operating systems, storage devices, and more.

This allows organizations to **partition a single physical computer or server into several virtual machines**.

Each virtual machine can then interact **independently** and run **different operating systems** or applications while **sharing the resources** of a single **host machine**.

https://azure.microsoft.com/en-gb/resources/cloud-computing-dictionary/what-is-virtualization/

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VIRTUALISATION OF COMPUTERS

o Virtualisation software enables physical computer resources to be partitioned and shared among more than one virtual machine.
   o Each virtual machine has its own virtual set of resources
   o Each runs in complete isolation from other virtual machines

o Software that manages the virtualisation is known as hypervisor
   o **Two types of hypervisor available**
      o **Type 1** (native hypervisor) – runs directly on machine hardware
      o **Type 2** (hosted hypervisor) runs on conventional operating system

o Virtualisation of computers is not a new concept
   o Mainframe computers have always done this
   o Computational power of PCs now makes this possible on lower-cost machines

HYPERVISORS

○ 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**.
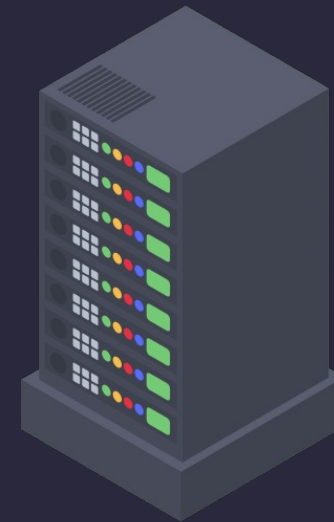
HYPERVISORS – TYPE 1

Type 1 hypervisor, known as native/bare metal hypervisors are installed directly on bare-metal hardware. It doesn't require an additional OS, it is the OS. Examples of type-1 hypervisors are **KVM** and **Citrix/Xen** Server

Advantages:
- System is thin
- The hypervisor has direct access to the HW
- Higher density hardware

Disadvantages:
- HW used to build the server should support virtualization technology
- Costs more compared to Type-2 HVs (specialist hardware)
- Un-user friendly console interface

HYPERVISORS – TYPE 2

Type 2 is more of an application installed on an operating system and not directly on the bare-metal. Examples of type-2 hypervisors are VirtualBox and VMWare Workstation/Player.

Advantages:
- Run on a greater array of HW because the underlying Host OS is controlling HW access
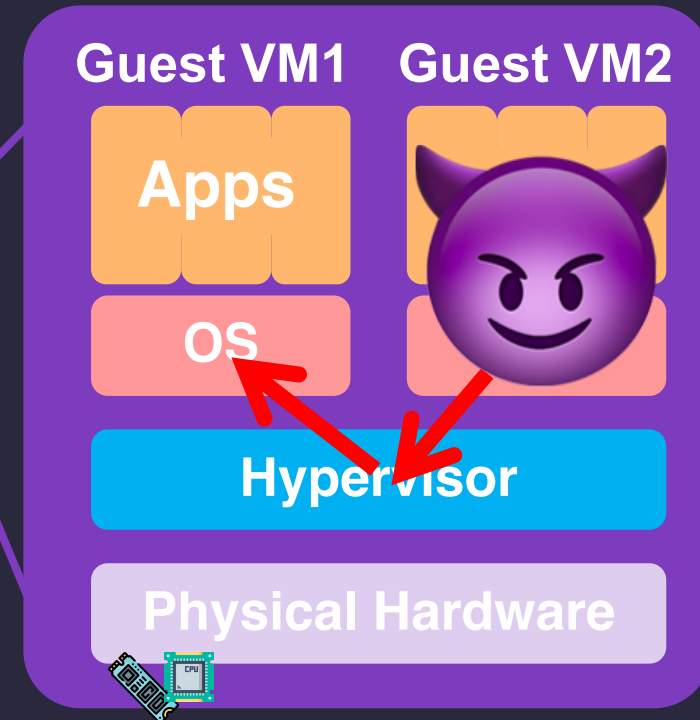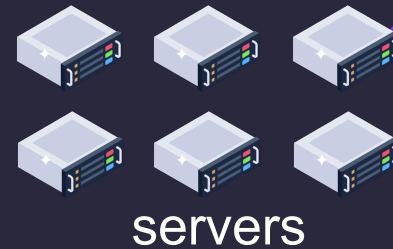- Easy user interface
- Data can be secured on the desktop

Disadvantages:
- Decreased security,
- Loss of Centralized Management,
- Lower VM Density,
- Cannot support as many VMs are the first type (OS bloat).

HYPERVISOR VULNERABILITIES

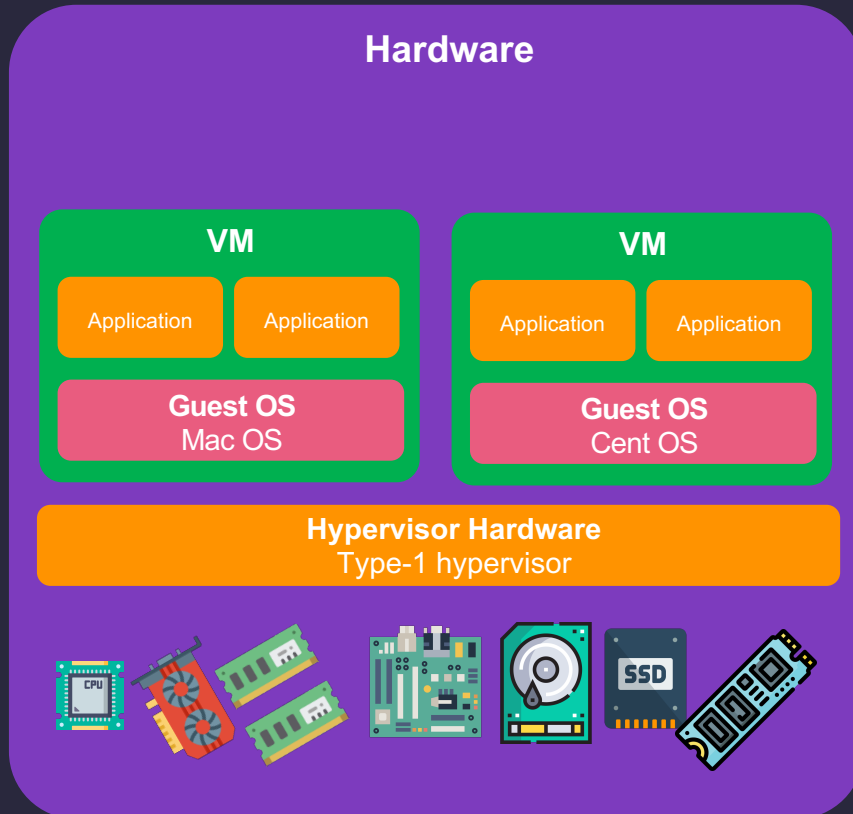Malicious software can run on the same server:
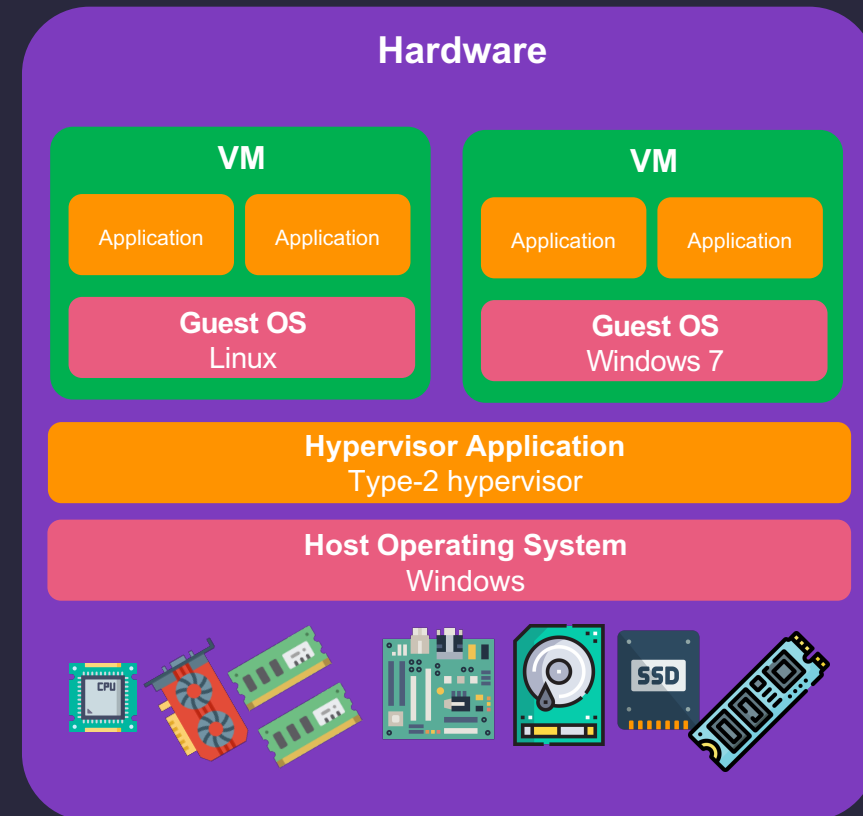○ Attack hypervisor
○ Then access/obstruct other VMs

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].

Guest VM1   **Guest VM2**

Apps

OS

Hypervisor

Physical Hardware

BENEFITS OF VIRTUALISATION

o **Decouples** applications and OS from hardware
o Easier to **upgrade** hardware
o Hardware **maintenance** easier
o **Multiple VMs** can run on **one physical machine**
o Better **resource utilisation**
o VMs run **independent** of each other
o Resources can be **dynamically** allocated
o VM **maintenance** easier
o VMs can be cloned and easily reused
o Easier to **backup and restore** (Virtual Disk)
   o Snapshots can be taken of a VM at any time

BENEFITS OF VIRTUALISATION

Cost-effectiveness – less hardware
○ Multiple virtual machines/operating systems/services on single physical machine (**server consolidation**)
○ Various forms of computation as a service

Process/Application 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
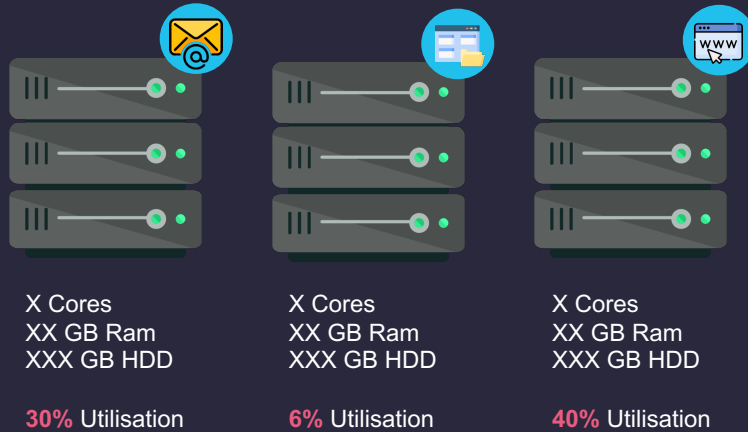○ Origins of VMware as a tool for developers

BENEFITS OF VIRTUALISATION – BUSINESS PERSPECTIVE
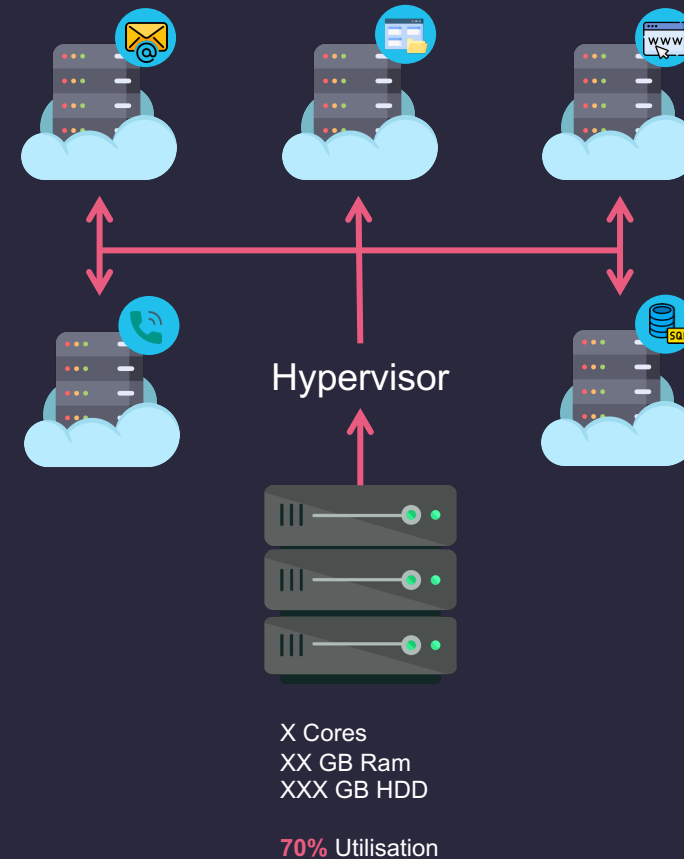
Reduce physical infrastructure costs:
- Less rack space
- Reduced power requirements
- Reduce HVAC costs
- Reduce management needs
- Easier to manage a virtual environment
- Quicker provisioning
- Lower TCO of data center and user desktops
- Increase failover and disaster protection

TRADITIONAL Vs VIRTUALISATION

Traditional

X Cores
XX GB Ram
XXX GB HDD

30% Utilisation

X Cores
XX GB Ram
XXX GB HDD

6% Utilisation

X Cores
XX GB Ram
XXX GB HDD

40% Utilisation

Virtualisation

Hypervisor

X Cores
XX GB Ram
XXX GB HDD

70% Utilisation

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VIRTUALISATION AND THE CLOUD

o Virtualisation is often used as a **foundation of cloud computing**.

o 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/server**.

o A primary driver for virtualisation is **consolidating servers**, which **provides organizations with efficiency** and potential **cost savings**.

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ROLE OF 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**

THE BIG PLAYERS IN THE CLOUD VM SPACE

VIRTUALISATION AND IaaS

o Understanding virtualisation is important when working with IaaS

o **Infrastructure delivered as a service is virtualised**

o Servers are virtual servers from providers' data centers

o Addresses allocated to servers are virtual network addresses

o Managed by virtualisation software

o Following are examples of products from IaaS provider: Amazon

TASKS

○ Implement a virtual server capable of hosting Java Web Applications.
  - ○ Ubuntu server 18.04/20.04
  - ○ JDK
  - ○ Tomcat
  - ○ LAMP Stack
  - ○ Apache
  - ○ MySQL
  - ○ PHP

We will do this locally first then transfer these skills to the cloud.