

CO1507 Virtualisation

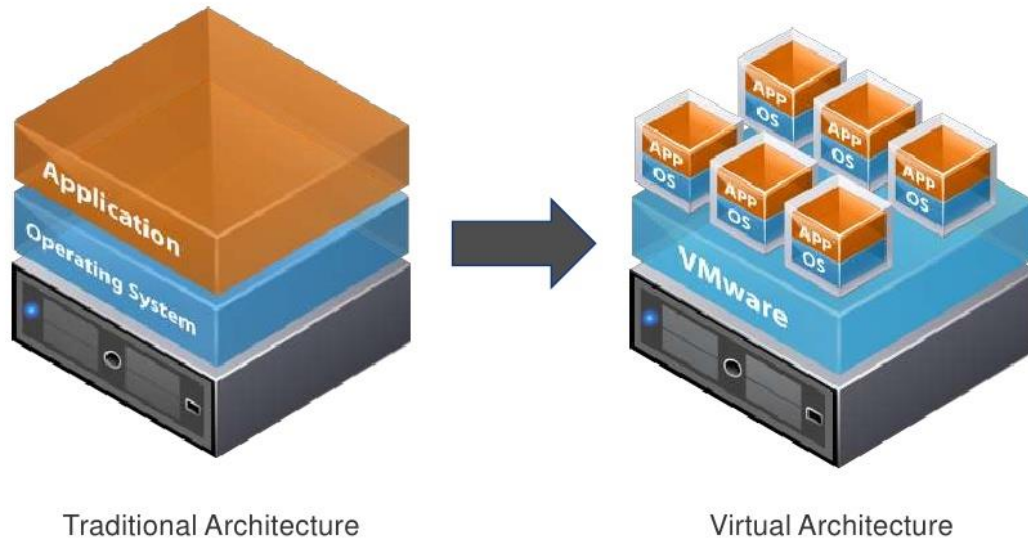
Jonathan Edwards 2024

What is Virtualisation?

- A computer is generally designed to run a **single** operating system
- On an industrial scale this may lead to machines being under utilised
- Virtualisation allows you run to **multiple** virtual machines on a **single** physical machine
- Each virtual machine shares resources of the one physical computer
- Different operating systems can be run simultaneously on the same hardware

Virtualization Defined

For those more visually inclined...



Virtualisation

Benefits

Partitioning

- Multiple OSs or multiple instances of the same OS can be run on only one physical machine
- A system's resources can be divided between different virtual machines according to the requirements

Benefits

Isolation

- Faults can be isolated at the hardware level
- Security considerations are isolated
- Resources controls to preserve performance

Benefits

Encapsulation

- The entire state of a virtual machine can be captured on file
 - A 'state' includes more than just the virtual disc, but a dump of the current memory (RAM) contents
- Can move and copy a virtual machines just like copying a file between physical machines

Benefits

Hardware independence

- You can migrate any virtual machine to a similar, or a different physical machine
- However, you cannot migrate a virtual machine that has more resources than the physical machine you are moving it to

Why use Virtualisation at university?

- Students can have their own VM separate from others
- Multiple VMs can run simultaneously on one host
- If a VM gets damaged/ infected/ corrupted etc... dump it and use a fresh copy

Why use Virtualisation at university?

- 'Snapshots' can be used to allow VMs to be easily restored to a previous state
- Useful for testing with different operating systems
- We can run services and or write software that might normally interfere with the hardware and/or campus network

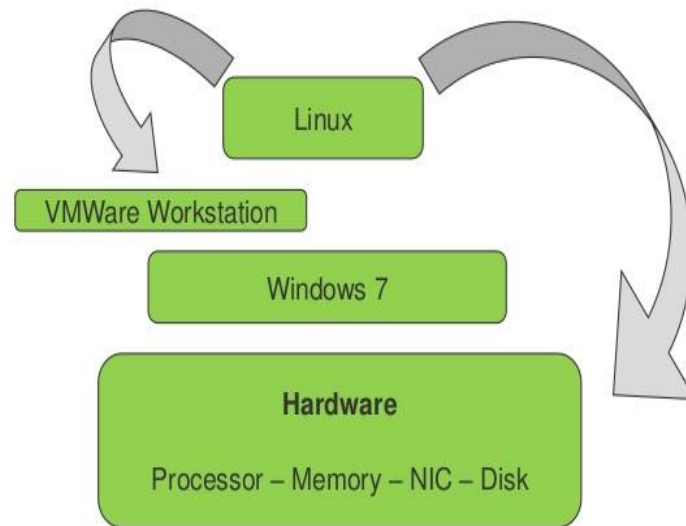
Virtualisation in industry

- Multiple 'servers' can run in parallel on the same physical machine
- These servers can also be replicated on different physical machines
- The servers may be owned and accessed by different clients remotely
- None of the servers are *aware* that they are sharing a resource
- None of the servers are *aware* of any of the others (though they both independently may probably have internet connections)

For Some Modules We Run Linux as a Virtual Machine on a Windows Host

Operating System Virtualization(contd.)

- How does Guest OS get to Hardware?



Virtualisation Terminology

○ **'Host'**

Refers to the physical computer on which the virtual machine software ("VMware", "VirtualBox" etc...) is installed

○ **'Virtual machine', a 'VM', or a 'Guest OS'**

The virtual machine has similar things to a physical machine e.g. CPU, RAM, hard disc Network interface

The host OS runs within the virtual machine and can be the same or a different OS to the host

Virtual machine is comprised of configuration files, and disc images

Virtualisation Terminology

- **'Virtual disk'**

One or more files on the host computer which make up the virtual hard disc

- **'Virtual network'**

The network configuration of the virtual machine has several options

Bridged, NAT, Host only etc.

A VM can behave just like any other computer on a physical network

Virtualisation Terminology

- **'Snapshot'**

A **copy** of a VM at a particular moment in time which can be **restored** later

- **'Hypervisor'** or **'Virtual Machine Monitor'** (VMM)

This refers to the software which creates, and runs a virtual machine

The hypervisor manages the guest operating system(s)

Networking with Virtual Machines

Bridged mode

“Bridged mode” in a VM **replicates** another node on the **physical network**

Your VM will receive its own **IP address** if DHCP is enabled in the physical network.

Each VM (virtual) adaptor has its own **IP** and **physical address**

The VM behaves just like a real PC on the network

You may get access to the same resources as the [physical machine (e.g. internet access) depending on DNS and other config

Networking with Virtual Machines

Network Address Translation (NAT)

NAT mode will mask all network activity as if it came from your Host OS, although the VM can access external resources (including the internet)

Host computer acts like router and firewall – providing a passthrough to internet access

Other computers cannot access the VM directly

Networking with Virtual Machines

Host only mode

Host-only ONLY permits network operations with the Host OS.
Ideal if activities may interfere with classroom network

No network mode

Very secure, useful only if no interaction with any other physical or virtual machine is needed

Other Considerations When Configuring a Virtual Machine

- How many **CPU** cores to allocate (can't be more than the host)
- How much virtual **RAM** to allocate (whilst leaving the host with enough)
- How much **hard drive** space to allocate – can be done dynamically
- Enable advanced CPU features which are supported by newer host hardware (intel VT -x/ETP AMD-V/RVI) – may have to be enabled in host computer **BIOS** setup.

VM Software

- There are many different pieces of virtualisation software
- Examples include VMWare, VirtualBox, (Open source) Hyper-V (Microsoft) , and Parallels (macOS)
- In the lab work for CO1507 we will be using **VMware workstation**
- VMware is a commercial product but there is a free version (limited to non-commercial usage) available to download if you wish to use it elsewhere: it is called 'VMWare workstation player'

The Roles of an Operating System

- Manage resources (CPU, memory, disc drives, network)
 - Share CPU time (time slicing)
 - Allocate and de-allocate memory
- Provide an interface for the user
- Execute software processes
- Modern OSs are multi-tasking
 - ..feature rich graphical interfaces, and focus on ease of use
 - ..It wasn't always this way.
 - ..Generally servers still don't!

OS History (1980 and beyond)

- Historically different computer manufacturers had their own software. There was very little compatibility between manufacturers.
- e.g.
 - Acorn BBC Micro Computer (1981)
 - The Commodore 64 (1982)
 - Sinclair ZX Spectrum (1983)
- Some early operating systems spread cross-platforms such as "CP/M"; this was available on many **Z80** CPU based machines in the early 1980s (ancient history for most of you..)
- The original IBM PC (1981) evolved over a long time to become the "defacto" standard for what we call a "PC" today.
- Other machines have come and long gone in the same time frame (e.g. the Amiga)



Microsoft Windows (1985)

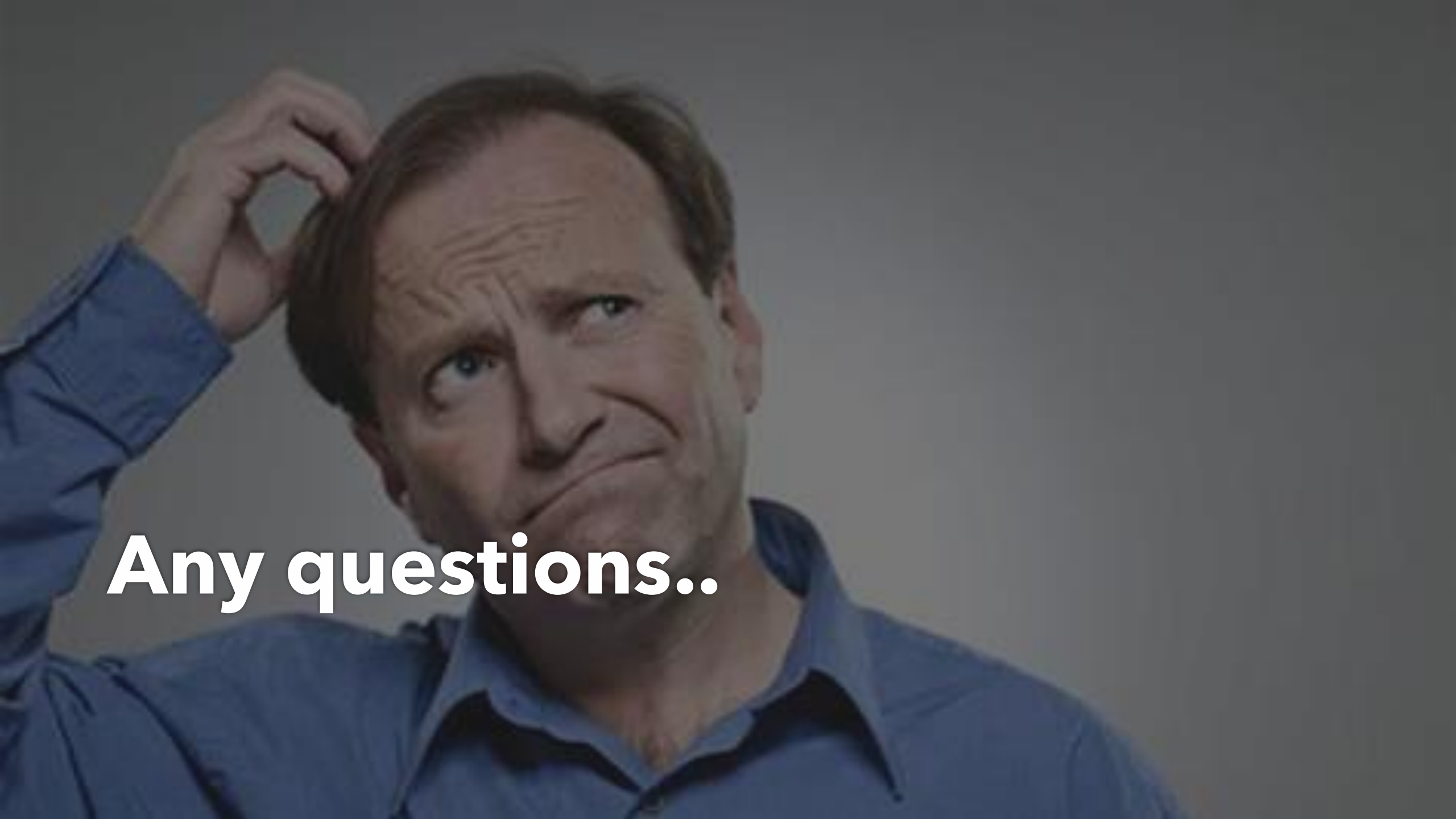
- Windows brought the concept of a GUI (graphical user interface) to DOS users on the IBM PC
 - Windows was initially installed on top of **DOS** as an add-on
 - Later versions (Windows NT and XP onward) of Windows removed DOS altogether, but still feature a command line interface reminiscent of DOS through the “command prompt” app.

Apple Macintosh (1984)

- Came with mouse and graphical user interface (GUI) from version 1
 - Apple had their own operating system purpose built (versions 1.0 – 9)
 - Until macOS (OSX), when they switched to a BSD-UNIX-like system
(FYI: BSD = Berkley Software Distribution)
 - More modern Macs use intel's x86 Architecture just like PCs (previously used Motorola 68000 and then PowerPC) – this is now changing again towards ARM with the Apple M1 chips
 - This meant users could run Windows (via Bootcamp or Virtual machine)
 - Initially Macs were mainly used for graphics and desktop publishing
 - Concentrated on the market for home users, graphic professionals and education

Linux

- Linux is a **FREE** operating system based on the commercial **UNIX** operating system
- **UNIX** is a multi-user operating system designed for large mainframes beginning in the 1970's (that's 50 years ago!)
- LINUX is heavily used in web and other types of servers
- It is heavily used in security, forensic, and networking modules
- It runs most of all mobile devices
- Apple Mac OS X while not LINUX is also a 'UNIX like' operating system thanks to its BSD underpinnings
- Suddenly then MS Windows starts to look like the odd one out for not being 'UNIX-like'

A man with a confused expression, his hand on his head, looking upwards and to the side. The image is dimmed, serving as a background for the text.

Any questions..