# 2.1t: Machine virtualisation

What is a virtual machine?

A virtual machine is an emulation of a computer system. Virtual machines are based upon a computer architecture. For example, we may have an Intel or ARM based architecture which would behave much like a native fully-fledged computer system. There are many different virtual machine environments that can be used to install virtualised environments such as VMware workstation ESXi, Proxmox/KVM.

Virtual machines support many computer architectures, the most common of these is Intel x86/x64 architecture. For the purpose of these subsequent lectures and labs we will focus on the x86/x64 architecture.

What is required to run a virtual machine?

Virtual machines require a host operating system so that the virtual machine environment can be installed within it. Without an underlying host operating system, virtualised environments cannot operate. Most modern machines seen today are capable of running virtual machines and the hardware requirements can be relatively modest, but this depends on how many virtual machines you intend to run and the actual specifications of your host machine. Within enterprise environments, there may be many virtual machines running simultaneously and these will be clustered together to share resources from both the processor and memory of the host computer to ensure that each virtual machine has adequate resources assigned to them. Within enterprise environments, the server host will likely contain a lot of memory, numerous CPUs and very fast redundant storage space that enable quick recovery and read and write speed, each containing many processor cores that will be assigned to virtual machines on an as-needed basis.

Types of virtual machines

Type I Hypervisors

When dealing with the underlying operation of virtualisation, it is referred to as a hypervisor. A hypervisor is the computer software, firmware and hardware that runs the virtual machines. The computer that runs the hypervisor is known as the host machine and each virtual machine installed within the virtual environment is known as a guest operating system. It is important to consider the type of hypervisors that can be used for virtualization. A type I hypervisor, commonly known as a native or bare–metal hypervisor is run directly on the host and controls the underlying hardware and management of the guest operating systems. In general, type I hypervisors offer superior performance to type II hypervisors because there is less overhead, i.e. one less layer of abstraction between the hardware and the guest operating system, this means that there is no requirement for the guest operating system to contend with device drivers installed within a fully-fledged operating system and there is no performance degradation through using the operating system’s own hardware abstraction layer. Type I hypervisors generally do not run an operating system that can be operated by the end user to achieve tasks, they are designed to be minimalistic in terms of how much resource usage they consume, because those resources need to be available for the guest operating systems. Generally, type I hypervisors are remotely managed and accessed via a web interface but this is not always a rule of thumb. Microsoft hyper-V environment within Windows server uses a graphical user interface within the Windows server environment, however it is classed as a type I hypervisor and therefore is able to take advantage of bare-metal performance.

Type II Hypervisors

Type II hypervisors rely on a host operating system to run virtual machines. This adds an extra layer of performance loss to the guest operating systems due to device drivers and the lower level operating system affecting system resources. Type II hypervisors are cost-effective and are designed to be integrate alongside the host operating system, offering flexibility. In many cases, Type II hypervisors are useful for testing but not as useful in server environments.

What are the advantages of using virtual machines?

The most significant benefit is being able to use multiple operating systems simultaneously on the same host machine, whilst maintaining a level of isolation between each machine. The other advantage is offering diversity of computer architectures to that of the host machine. Another significant benefit to using virtual machines is quick maintenance, provisioning and recovery of virtual machines. Virtual machines use the same virtual hardware provided by the virtualisation environment, therefore can be templated for quick deployment.

What are the disadvantages?

If a virtual machine is not given sufficient resources then performance degradation can occur. It is important that guest virtual machines are assigned appropriate resources to ensure optimum performance. Virtual machines can be assigned a specified number of processor cores and memory to ensure that each VM has a fair access to available resources from the host machine to prevent resource contention across multiple VM’s. There is also security issues to be aware about, compromising a host computer may potentially compromise the guest VMs running within it.