



# Virtualisation



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The Cloud is Virtualisation



- Virtualisation is the creation of a virtual computer called a Virtual Machine (VM) that acts like a real computer with an OS.
- Software executed on these virtual machines is separated from the underlying hardware resources.



# Virtualisation



Menu [Taskbar icons] Oracle VM VirtualB... Windows 7 (20131... [System tray: 1 2 ^ \* 99% Mon Oct 14, 14:34]

Windows 7 (20131010-Snapshot) [Running] - Oracle VM VirtualBox

Machine View Devices Help

Recycle Bin

Google Chrome

EN 14:34 14/10/2013 Right Ctrl



A row of application icons on the taskbar, including an anchor, a notepad, a paint palette, a document, a spreadsheet, a browser, a presentation, a music player, a camera, and a trash can.

# Hypervisor

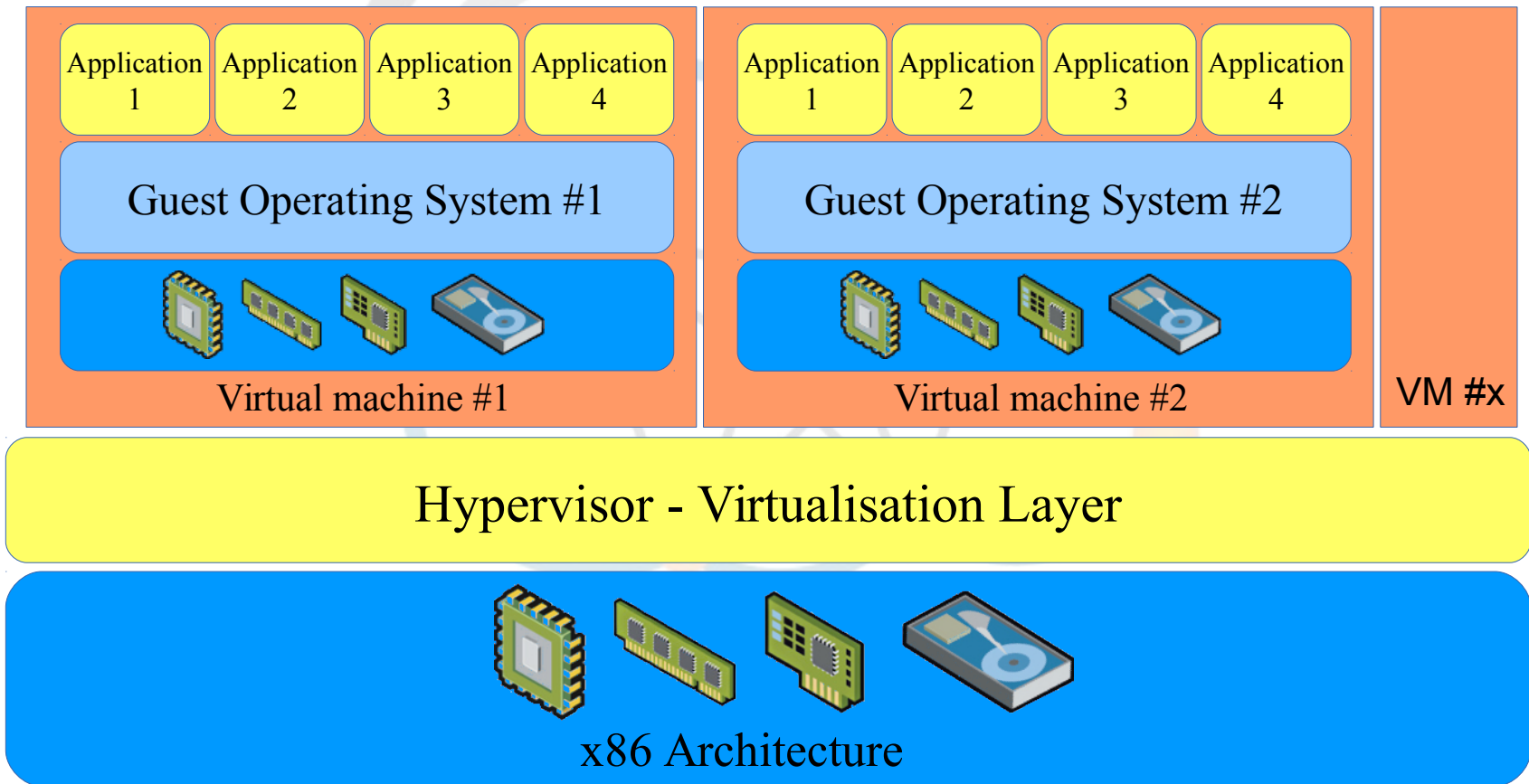


- A Hypervisor is a Virtual Machine Manager, which is software that permits multiple OSs to share a single hardware host computer.
- Each OS appears to have the host's processor, memory, and other resources all to itself.
- The hypervisor is actually controlling the host processor and resources, allocating what is needed to each OS in turn and making sure that the guest OSs (VMs) cannot disrupt each other.

# Virtualisation – Type 1



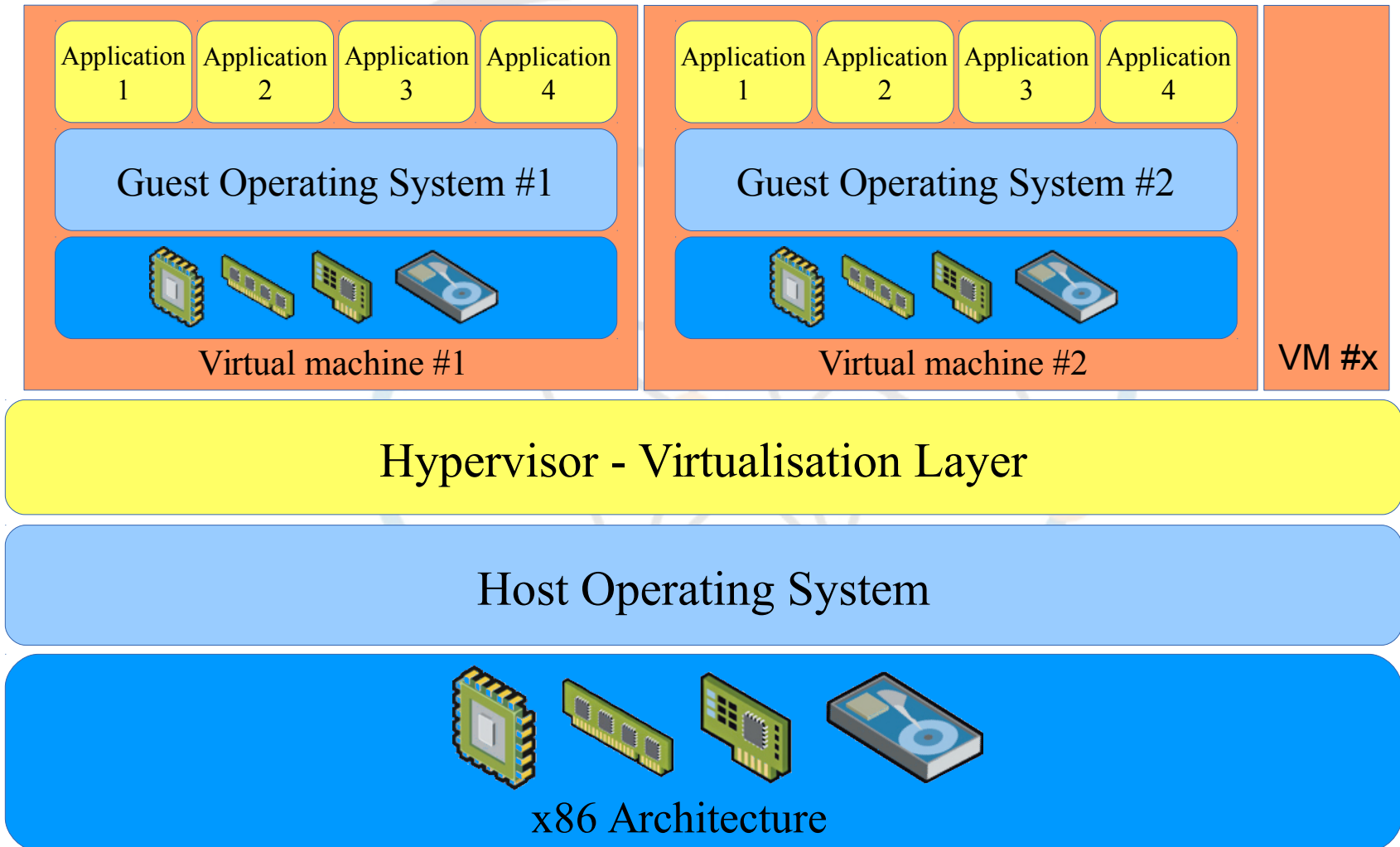
- VMware vSphere (ESX), Xen and Microsoft Hyper-V.



# Virtualisation – Type 2



- Oracle VirtualBox, VMware GSX, Microsoft Virtual Server.





# Type-1 -vs- Type-2 hypervisor



- Type-1 advantage due to independence from the OS.
  - High performance.
  - Return on Investment (ROI).
  - Scalability a Type-1 hypervisor is far superior to a Type-2. This is due to the independence of the Type-1 hypervisor from the operating system.
- Type-2 advantage is hypervisor is identical on every OS.
  - Common file formats.
  - Common image formats.
  - VMs from one host transferable to another OS no matter the OS.



- The Xen Project
  - Open source
  - Hypervisor,
  - Linux ParaVirtual OPerationS (PVOPS) framework
  - Xen Cloud Platform (XCP)
  - Xen Advanced RISC Machine (ARM).
- Xen (zɛn) has its origins in the ancient greek term Xenos, which can be used to refer to guest-friends whose relationship is constructed under the ritual of xenia 'guest-friendship'

# Xen hypervisor



- Type-1 or baremetal hypervisor
- Run many instances of different OSs in parallel on a single host.
- The hypervisor is used for open source applications:
  - Server virtualisation.
  - Infrastructure as a Service (IaaS).
  - Desktop virtualisation.
  - Security applications.
  - Embedded and hardware appliances
- It enables users to:
  - Increase server utilisation.
  - Consolidate server farms.
  - Reduce complexity.
  - Decrease total cost of ownership.
- Xen is the basis of some of the worlds largest Clouds:
  - Amazon Web Services (AWS).
  - Citrix XenServer.



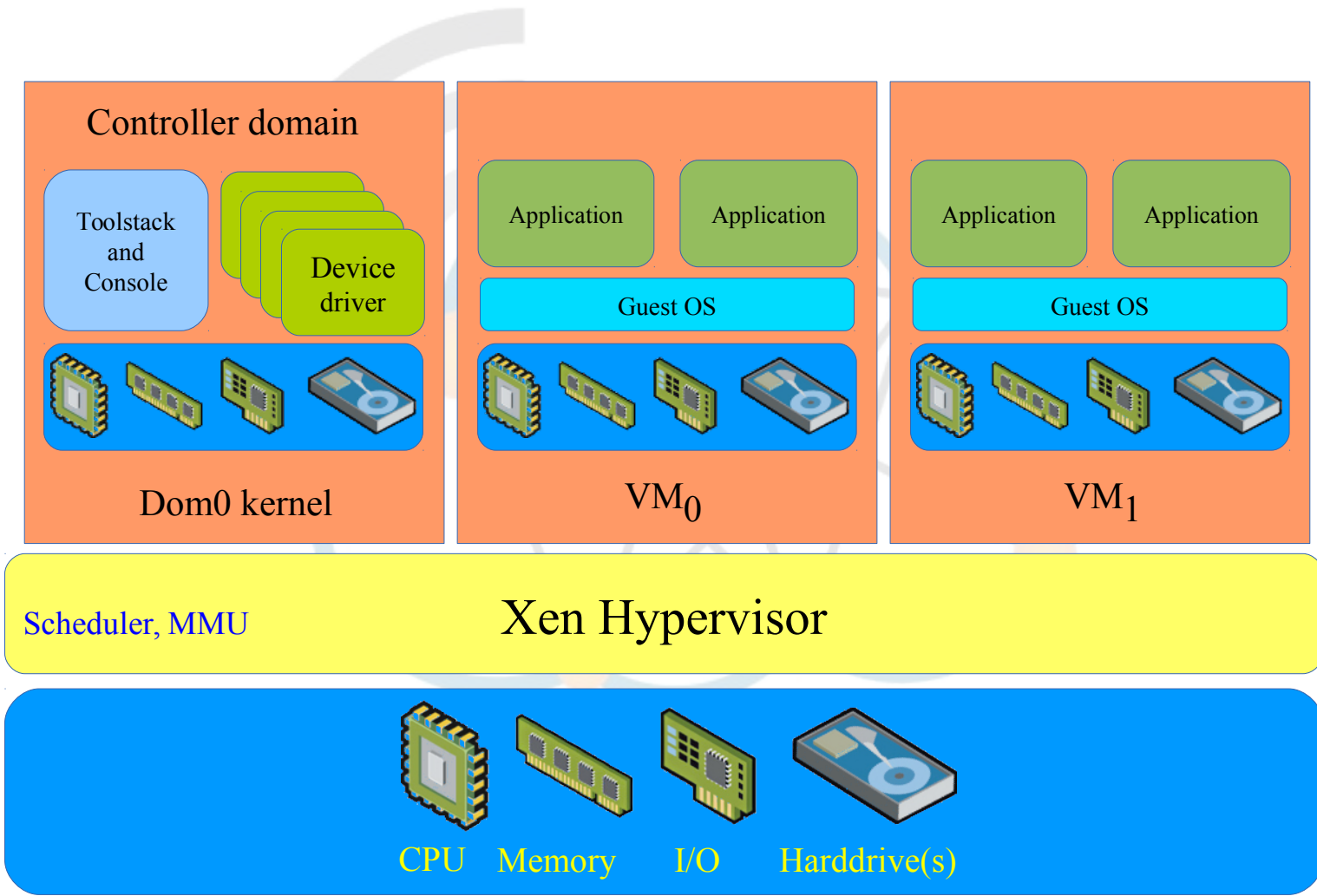
# Xen hypervisor features



- Small footprint and interface (~ 1 MB)
  - Microkernel.
  - Robust and secure.
- OS Agnostic
  - Install on Linux or Unix as Domain0 (Dom0).
  - All guest OS, GNU/Linux, Unix, Microsoft Windows ...
- Driver Isolation
  - Drivers run in VM, if VM crashes does not impact other VMs.
- Para-virtualisation (PV)
  - Guests can run faster.



# Xen Architecture





- **Xen Hypervisor**
  - Runs directly on the hardware
  - Handles CPU, Memory and interrupts.
- **Virtual Machines**
  - Virtualised environments, each running their own OS and applications.
- **Control Domain (Dom0)**
  - Specialised VM with special privileges like the capability to access the hardware directly.
  - Handles all access to the system's I/O functions and interacts with the other VMs.
  - Exposes a control interface for system control.
- **Toolstack and Console**
  - Dom0 contains a toolstack that allows a user to manage VM creation, destruction, and configuration.
  - Exposes an interface that is either driven by a command line console, by a Graphical User Interface (GUI) or by a cloud orchestration stack like OpenStack or CloudStack.
- **Xen-enabled OS**
  - A Xen Dom0 requires a Xen-enabled kernel.



- **Paravirtualisation (PV)**

- Efficient and lightweight virtualisation technique.
- Does not require virtualisation extensions from the host CPU.
- Require a Xen-PV-enabled kernel and PV drivers, so the guests are aware of the hypervisor and can run efficiently without emulation or virtual emulated hardware.
- Linux kernels have been Xen-PV enabled from 2.6.24 using the Linux PVOPS framework.

- **Full Virtualisation (HVM)**

- Uses virtualisation extensions from the host CPU to virtualise guests.
- Requires Intel VT or AMD-V hardware extensions.
- **Qemu** processor emulator to emulate PC hardware, including BIOS, IDE disk controller, VGA graphic adapter, USB controller, network adapter etc.
- Virtualisation hardware extensions are used to boost performance of the emulation. Fully virtualised guests do not require any kernel support. This means that Windows OSs can be used as Xen HVM guest. HVM guests are usually slower than PV guests, because of the required emulation.



- **PV on HVM (PVHVM)**

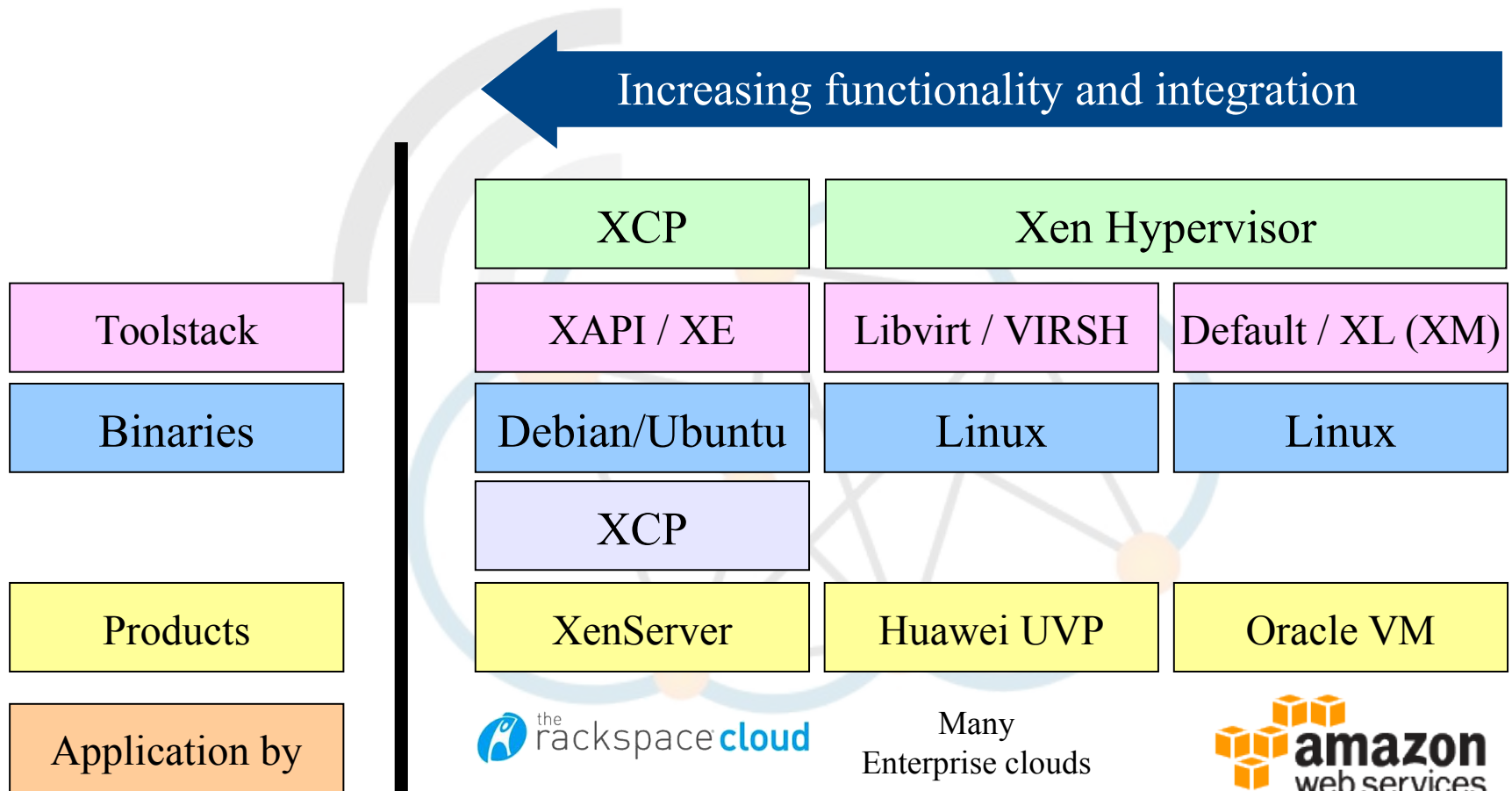
- To boost performance, HVM guests can use special PV device drivers (PVHVM).
- Optimised PV drivers for HVM environments plus bypass the emulation for disk and network I/O, thus giving PV like (or better) performance on HVM systems.

- **PV in an HVM Container (PVH)**

- PV guest using PV drivers for boot and I/O.
- Otherwise it uses HW virtualisation extensions, without the need for emulation.
- PVH combines the best trade-offs of all virtualisation modes.



# Toolstack, APIs and Console



# Toolstack comparison

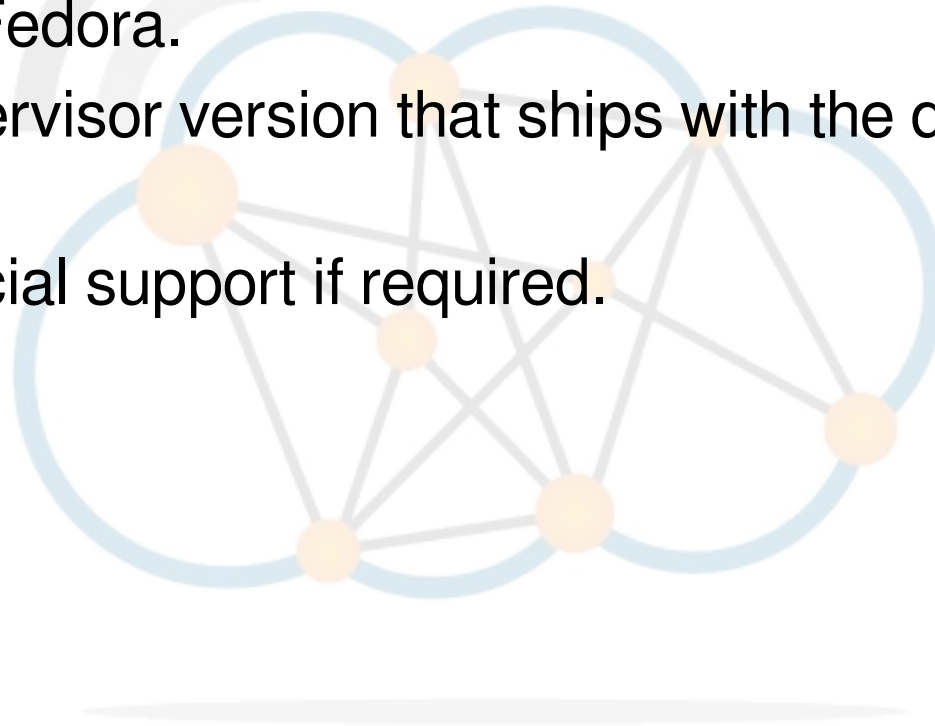


FEATURES	XL	XAPI	LIBVIRT
Purpose-built for Xen	✓	✓	✗
Basic VM Operations	✓	✓	✓
Managed Domains	✗	✓	✓
Live Migration	✓	✓	✓
PCI Passthrough	✓	✓	✓
Host Pools	✗	✓	✗
Flexible, Advanced Storage Types	✗	✓	✗
Built-in advanced performance monitoring (RRDs)	✗	✓	✗
Host Plugins (XAPI)	✗	✓	✗

# Control domain (Dom0)



- Xen requires a kernel as control domain. The choice of Dom0 comes down to:
  - Familiarity with a specific distribution, BSD Unix, Debian, Fedora.
  - Xen Hypervisor version that ships with the distribution of choice.
  - Commercial support if required.





# Kernel Virtual Manager (KVM)

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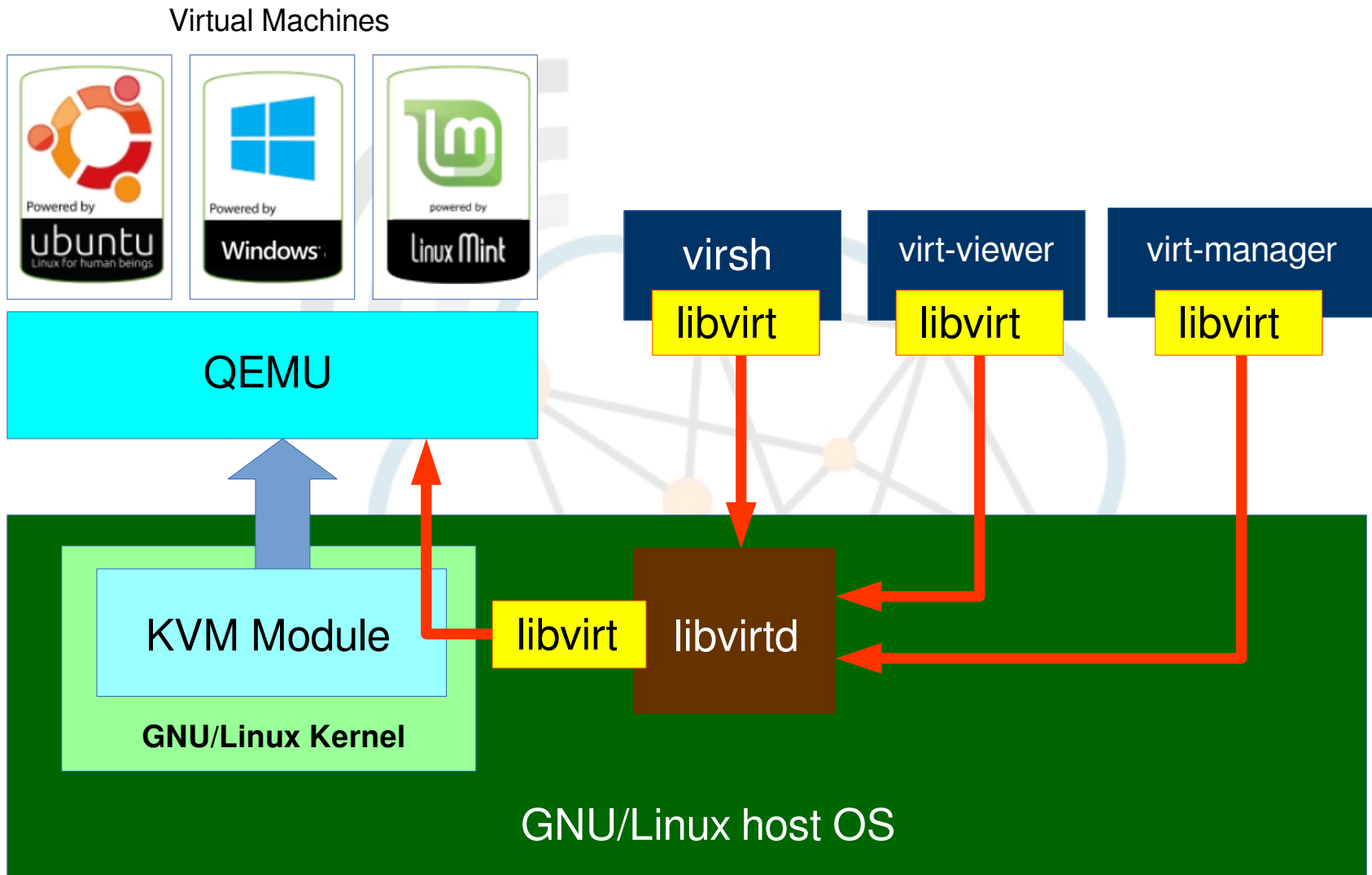


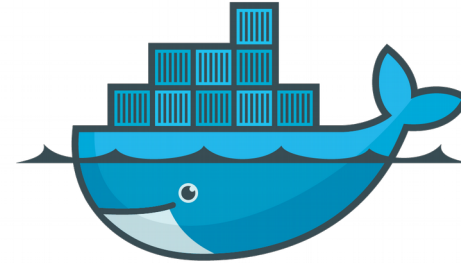
# Kernel Virtual Manager (KVM)



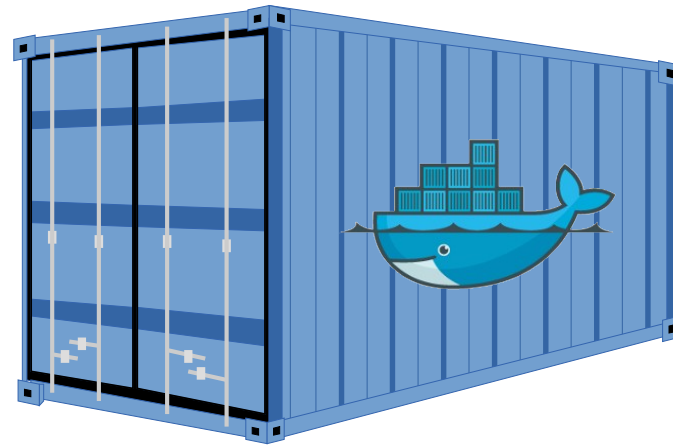
- KVM is a Type-1 hypervisor that runs directly on x86 hardware.
- Included in major GNU/Linux releases today
- Hypervisor of choice within the GNU/Linux community.
- Uses the Quick EMUlator (QEMU) machine emulator and virtualiser for I/O hardware emulation.
- QEMU combined with the KVM kernel module can approach native speeds.
- Managed via the libvirt API and tools:
  - virsh
  - virtinstall
  - virt-clone
  - virt-viewer
  - virt-manager.

# KVM Architecture





docker



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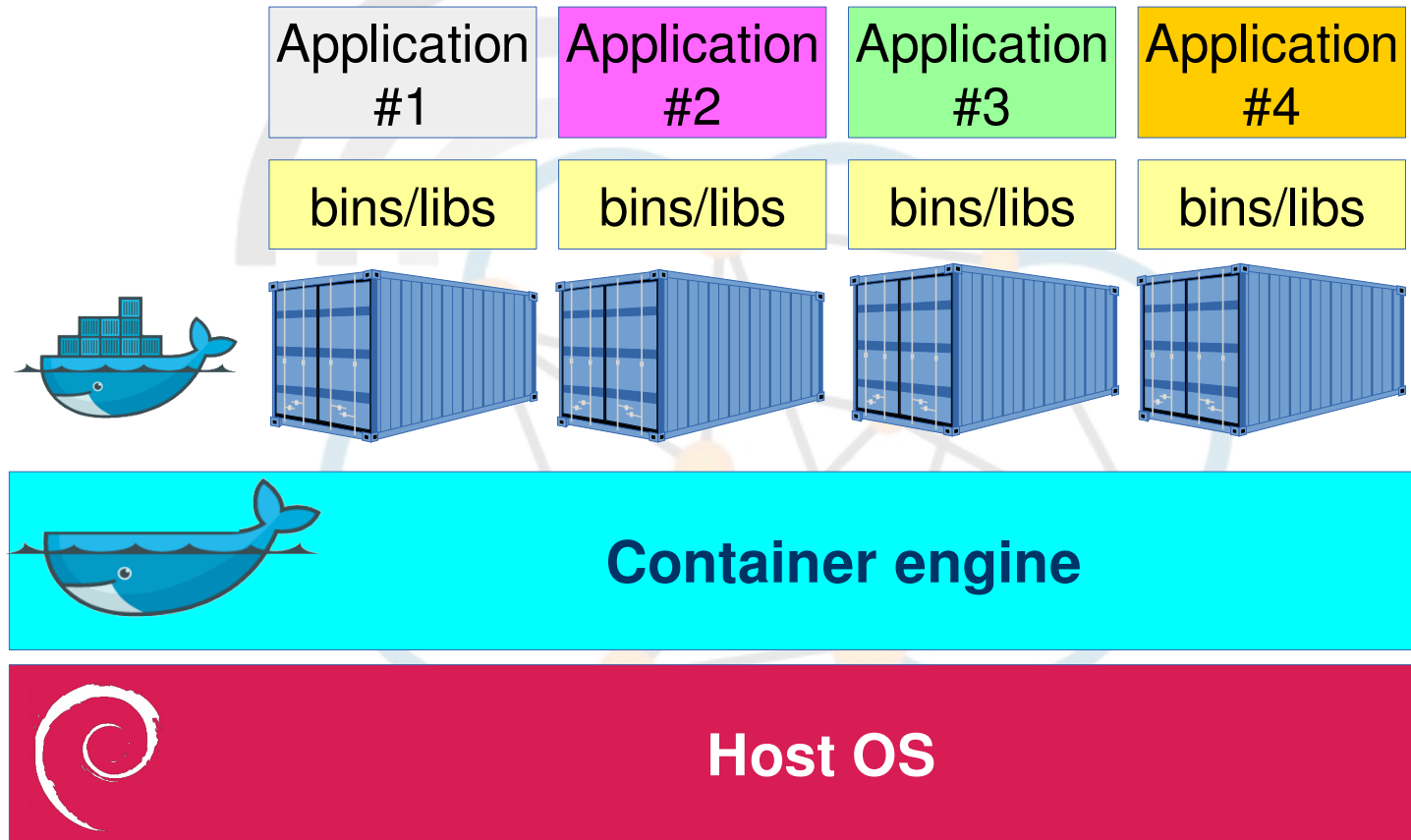
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# Container Architecture





## Oracle VirtualBox



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# Getting VirtualBox



- <https://www.virtualbox.org/wiki/Downloads>
- Pre-built binaries pre-existing on Linux or BSD Unix distributions.
- Debian based Linux
  - `debian~# apt-get install virtualbox-5.0`
- Fedora/Redhat based Linux
  - `fedora~# yum install virtualbox-5.0`

# Build a VM



File Machine Help

New Settings Discard Start

Details Snapshots

### Welcome to VirtualBox!

The left part of this window is a list of all virtual machines on your computer. The list is empty now because you haven't created any yet.

In order to create a new virtual machine, click the **New** button on the main tool bar located at the top left of the window.

You can press the **F1** key to open the help file for the latest information about VirtualBox.

### Name and operating system

Please choose a descriptive name for the new virtual machine and select the type of operating system you intend to install on it. The name you choose will be used throughout VirtualBox to identify this machine.

Name:

Type:  

Version:

Expert Mode < Back Next > Cancel

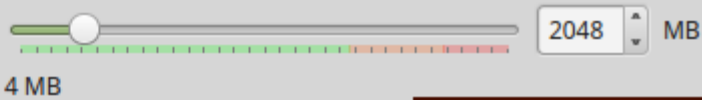
# Build a VM



## Memory size

Select the amount of memory (RAM) in megabytes to be allocated to the virtual machine.

The recommended memory size is **256 MB**.



< Back

## Hard disk

If you wish you can add a virtual hard disk to the new machine. You can either create a new hard disk file or select one from the list or from another location using the folder icon.

If you need a more complex storage set-up you can skip this step and make the changes to the machine settings once the machine is created.

The recommended size of the hard disk is **8.00 GB**.

- Do not add a virtual hard disk
- Create a virtual hard disk now
- Use an existing virtual hard disk file

Empty

< Back

Create

Cancel

# Build a VM



## Hard disk file type

Please choose the type of file that you would like to use for the new virtual hard disk. If you do not need to use it with other virtualization software you can leave this setting unchanged.

- VDI (VirtualBox Disk Image)
- VMDK (Virtual Machine Disk)
- VHD (Virtual Hard Disk)
- HDD (Parallels Hard Disk)
- QED (QEMU enhanced disk)
- QCOW (QEMU Copy-On-Write)

Expert Mode

< Back

## Hard disk file type

Please choose the type of file that you would like to use for the new virtual hard disk. If you do not need to use it with other virtualization software you can leave this setting unchanged.

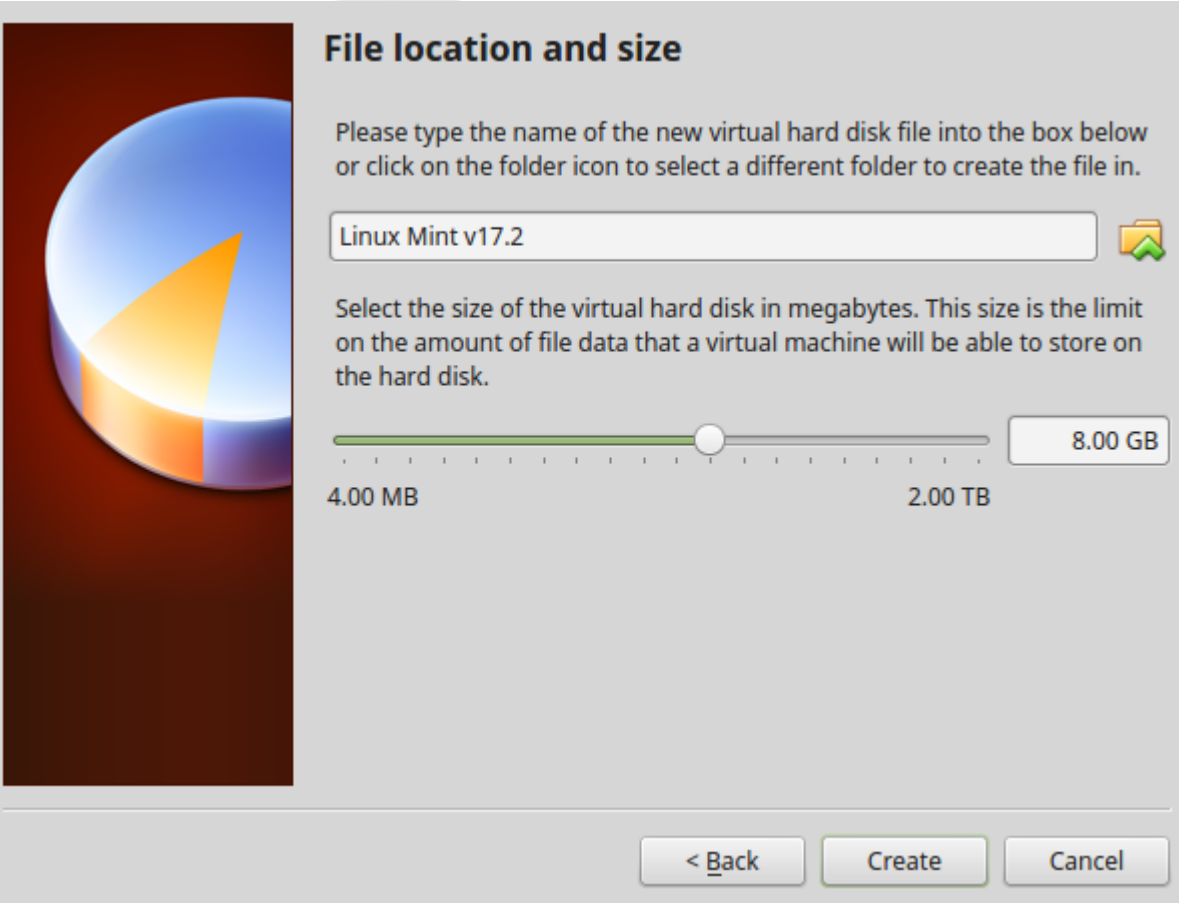
- VDI (VirtualBox Disk Image)
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- VHD (Virtual Hard Disk)
- HDD (Parallels Hard Disk)
- QED (QEMU enhanced disk)
- QCOW (QEMU Copy-On-Write)

Expert Mode

< Back


Next >

Cancel




**File location and size**

Please type the name of the new virtual hard disk file into the box below or click on the folder icon to select a different folder to create the file in.

Linux Mint v17.2 

Select the size of the virtual hard disk in megabytes. This size is the limit on the amount of file data that a virtual machine will be able to store on the hard disk.

 8.00 GB

4.00 MB 2.00 TB

< Back Create Cancel



# Build a VM

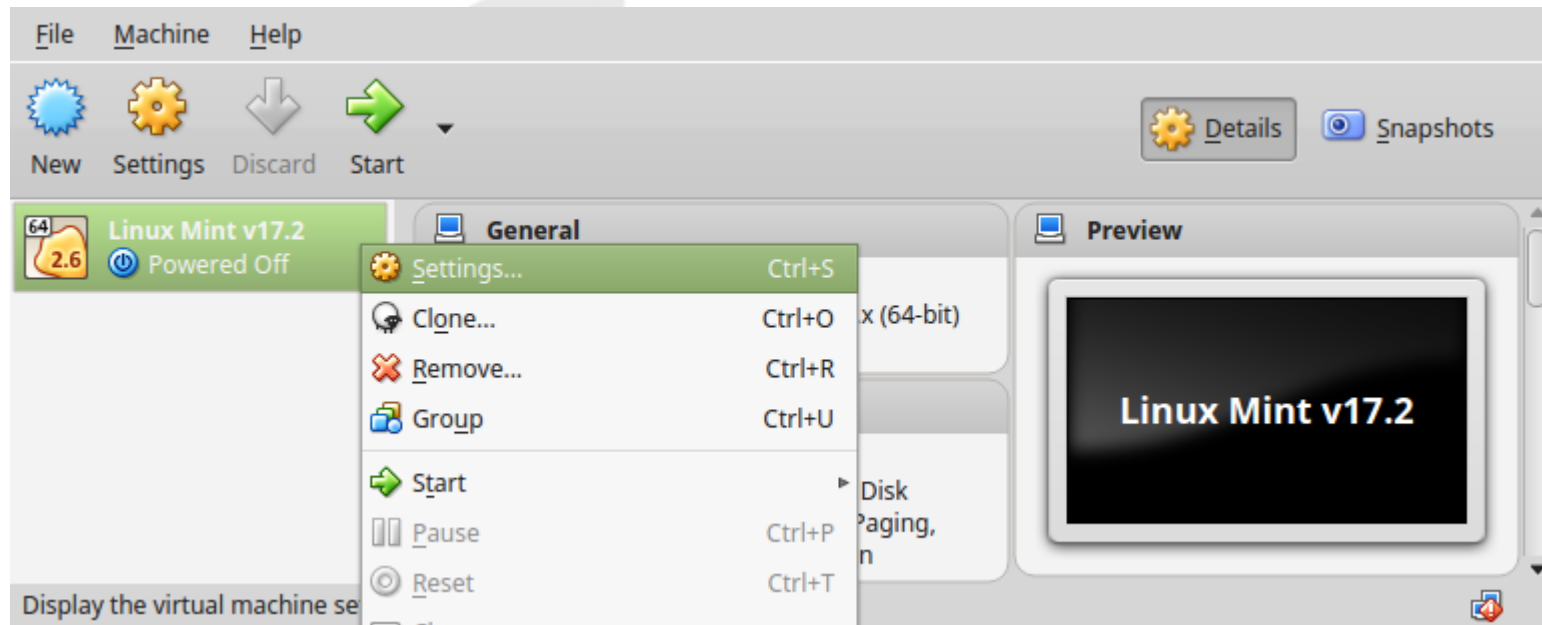


The screenshot shows a virtual machine management interface. At the top, there is a menu bar with 'File', 'Machine', and 'Help'. Below the menu is a toolbar with icons for 'New' (blue starburst), 'Settings' (yellow gear), 'Discard' (grey arrow), and 'Start' (green arrow). To the right of the toolbar are buttons for 'Details' (yellow gear) and 'Snapshots' (blue camera). The main area is divided into three sections: a left sidebar, a 'General' tab, and a 'Preview' window. The sidebar shows a VM named 'Linux Mint v17.2' with a '64 2.6' icon and a 'Powered Off' status. The 'General' tab displays the following information:

<b>General</b>	
Name:	Linux Mint v17.2
Operating System:	Linux 2.6 / 3.x / 4.x (64-bit)
<b>System</b>	
Base Memory:	2048 MB
Boot Order:	Floppy, Optical, Hard Disk
Acceleration:	VT-x/AMD-V, Nested Paging, KVM Paravirtualization

The 'Preview' window shows a black screen with the text 'Linux Mint v17.2' in white.

# Install an OS on a VM



# Install an OS on a VM



**Storage**

Storage Tree

- Controller: IDE
  - linuxmint-17.2-cinnamon-64bit.iso
- Controller: SATA
  - Linux Mint v17.2.vmdk

Attributes

Optical Drive: IDE Primary Master

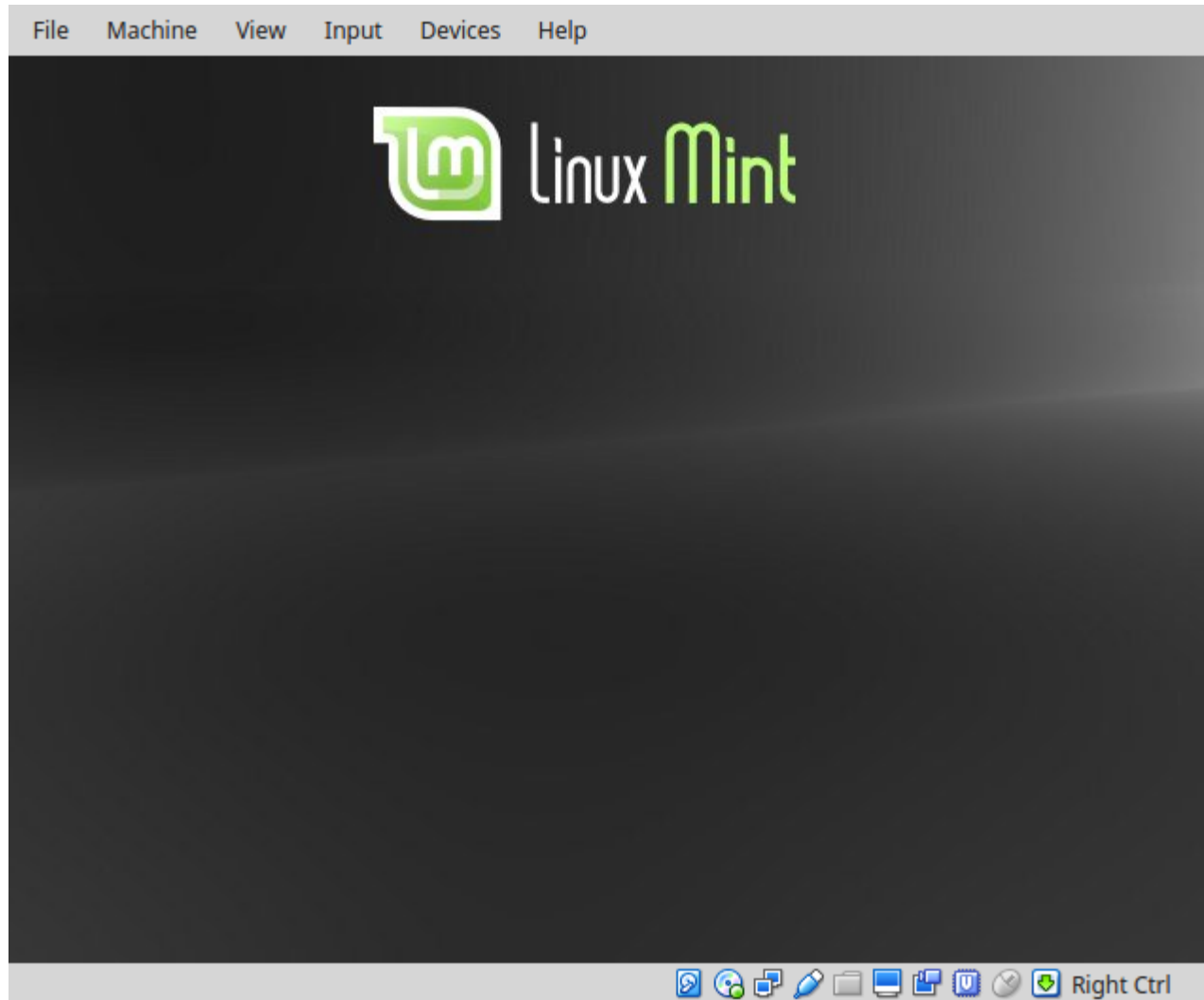
Live CD/DVD

Information

Type: Image  
Size: 1.44 GB  
Location: /home/dobriain/Dropbox/FOSS/ISO...  
Attached to: --

Help Cancel OK

# Install an OS on a VM



# Install an OS on a VM from a .vmdk file



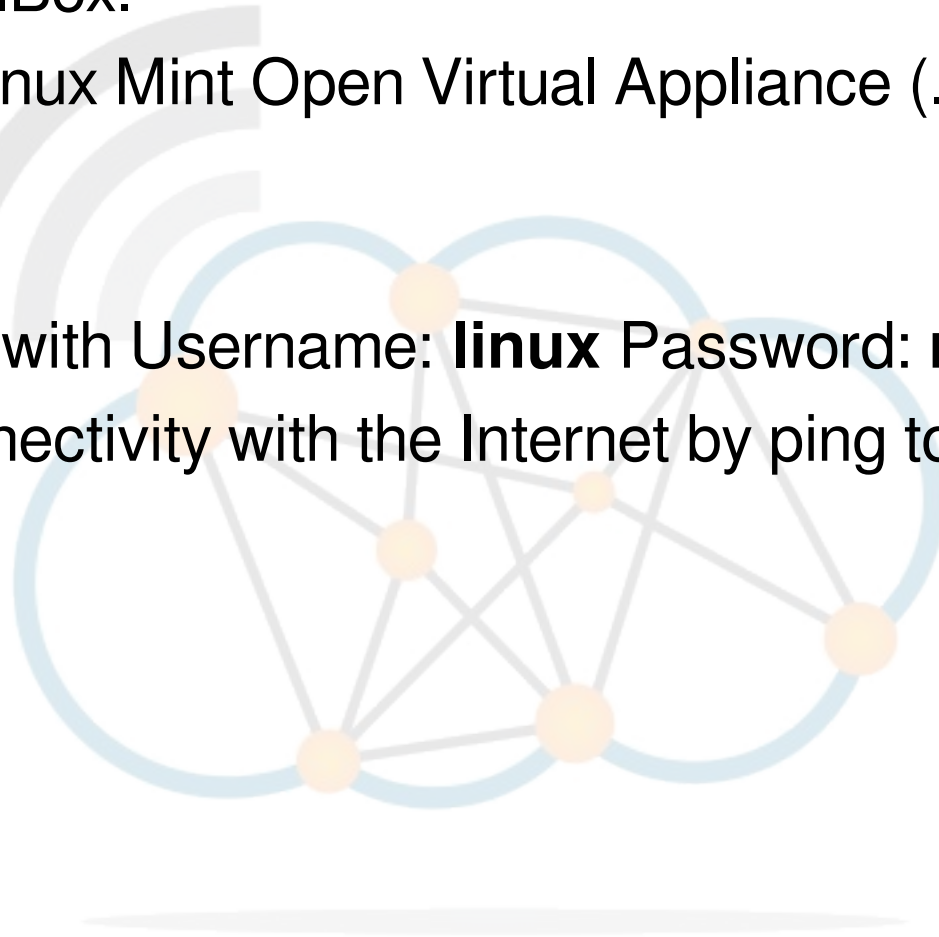
# Running the VM



The image shows a virtual machine window with a menu bar (File, Machine, Help) and a toolbar (New, Settings, Discard, Show). A list of machines shows "Linux Mint 17.2 Xfce" as "Running". The main window displays the "General" tab with the name "Linux Mint 17.2 Xfce" and operating system "Linux 2.6 / 3.x / 4.x (64-bit)". The desktop background is a sunset over a lake with tall grass in the foreground. A login dialog box is open, showing a user named "linux" with a password field and an "OK" button. The dialog box also includes a "Please enter your password" prompt and a "Right Ctrl" key indicator in the bottom right corner.



- Install VirtualBox.
- Import the Linux Mint Open Virtual Appliance (.ova) image given.
- Run VM.
- Login to VM with Username: **linux** Password: **mint**.
- Confirm connectivity with the Internet by ping to 8.8.8.8.







Thank you