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Welcome to:

Server and Storage Virtualization

Unit Objectives

After completing this unit, you should be able to:

- Identify the types of server virtualization
- Explain hardware assisted virtualization
- Define and describe Hypervisors
- Explain Desktop virtualization
- Differentiate between the types of desktop virtualization
- Understand Storage Virtualization
- Identify the types of Storage virtualization

What this unit is about

- This unit provides the concept of Hypervisors.

Types of server virtualization (1 of 3)

- Full virtualization

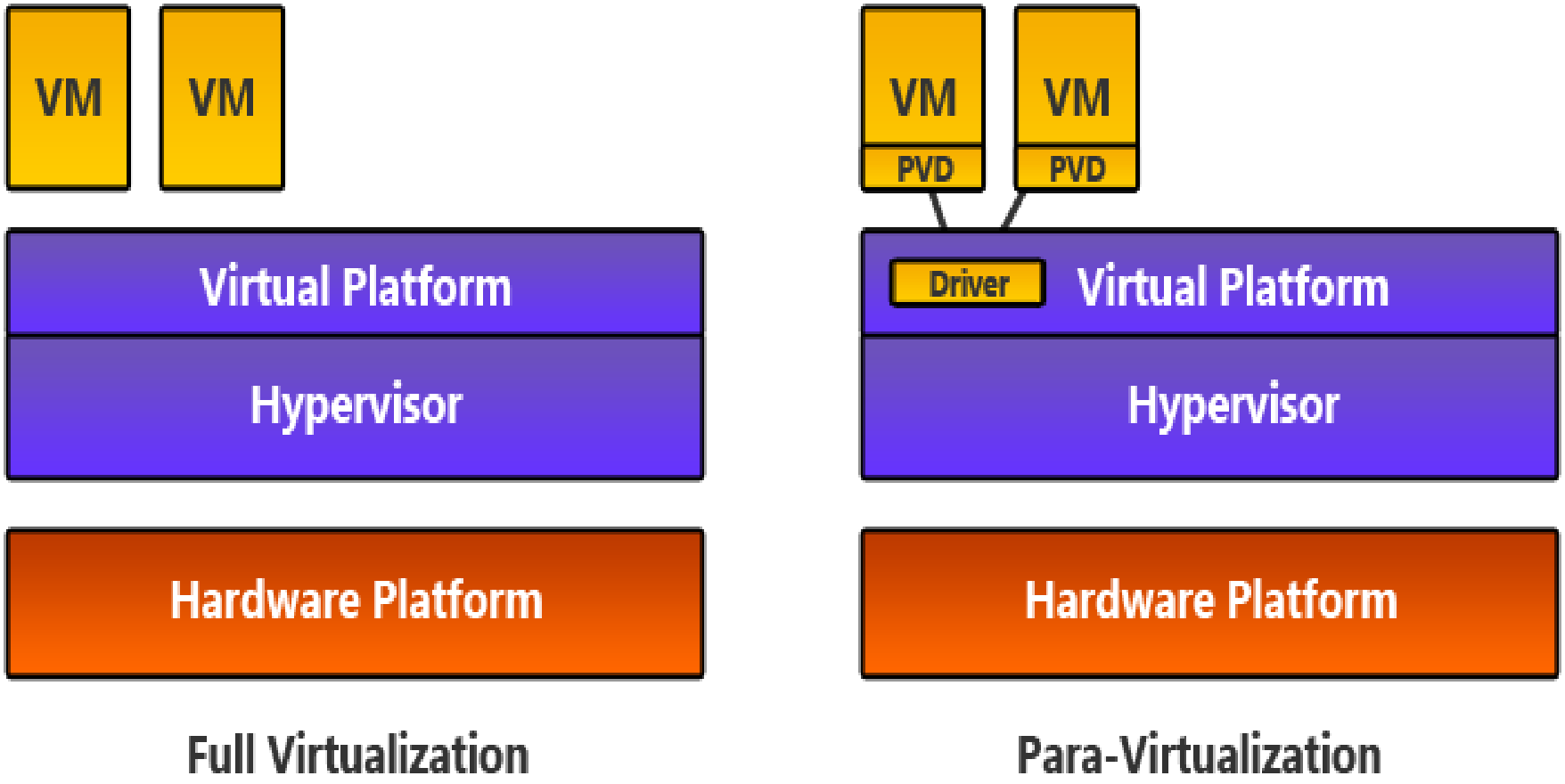


Figure: Types of server virtualization

Types of server virtualization (2 of 3)
Para virtualization

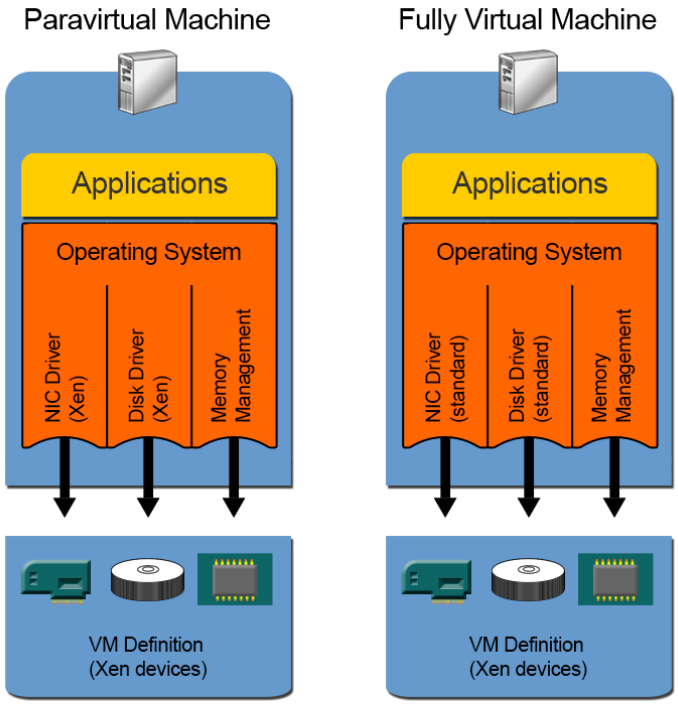


Figure: Types of server virtualization

- Para-Virtualization requires specialized hypervisor support in the form of an Application Programming Interface (API) that could be used by virtual machines to request services from the hypervisor.
- This specialized support from the hypervisor is known as the Hyper-call or Para-API.
- The most common example of a Para-virtualized machine is a Xen-VM running in Para-virtualized mode.
- A specialized version of the Linux kernel is required for installation and the boot up of the Linux OS on Xen VM.

Types of server virtualization (3 of 3)

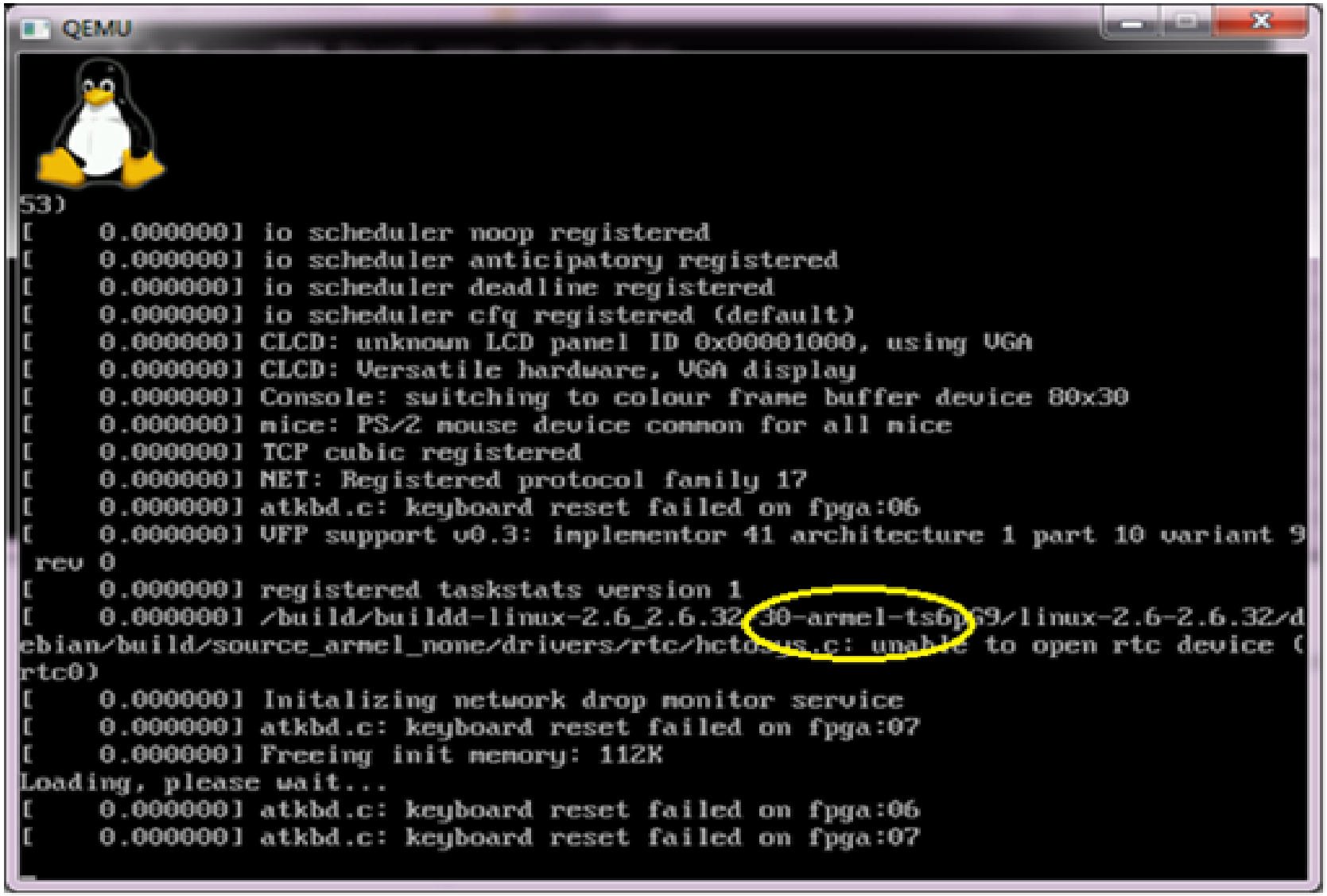


Figure: Types of server virtualization

Simulation

- Simulation refers to techniques that create an exact virtual footprint of the underlying hardware for the purpose of virtualization.

- The main reason for virtualization-by-simulation is isolation and consolidation of OS and applications.

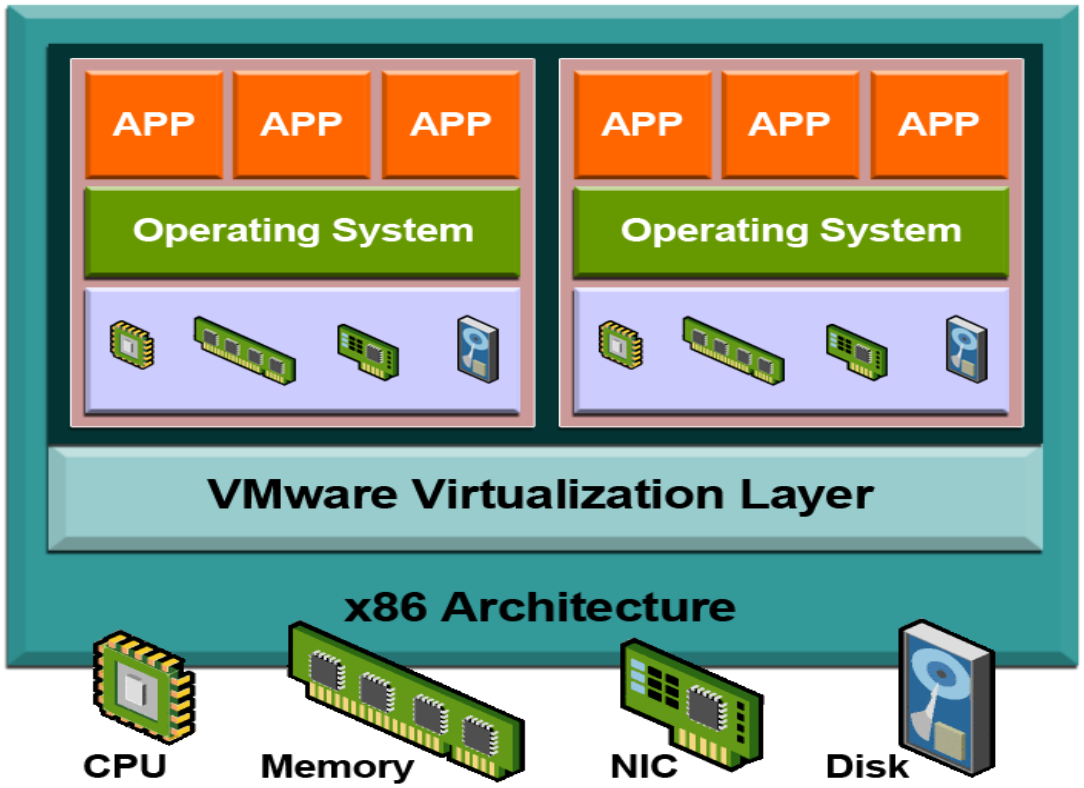


Figure: Simulation

Hardware assisted virtualization (1 of 2)

- Hardware Assisted Virtualization (HAV) uses features provided by the hardware to improve the performance of the simulated virtual machines.
- The approach uses features provided by the host physical processor to improve the efficiency of virtualization thereby improving the performance of the virtual machines.
- Intel and AMD implemented the hardware features required for HAV in their latest processors. The hardware features were named Intel VT-x and AMD-V respectively.

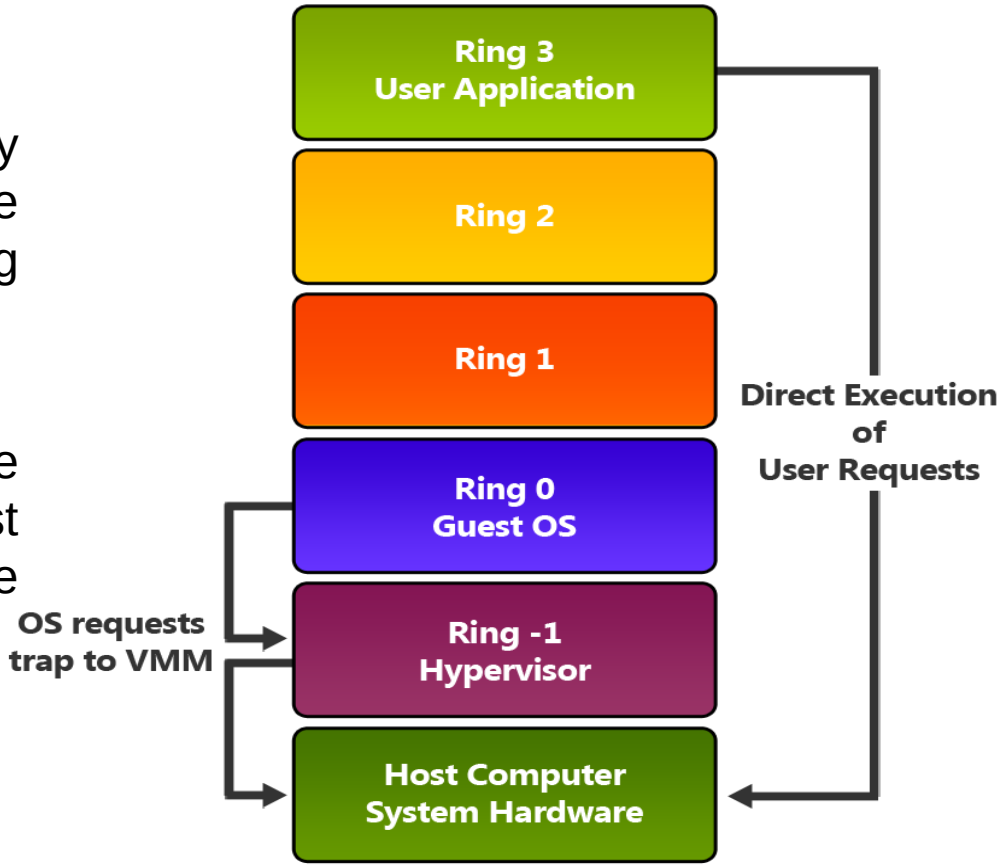


Figure: Hardware assisted virtualization

Hardware assisted virtualization (2 of 2)

- The following example is of a KVM Virtual Machine running Linux 32-bit in Full Virtualization mode with Hardware Assisted Virtualization.

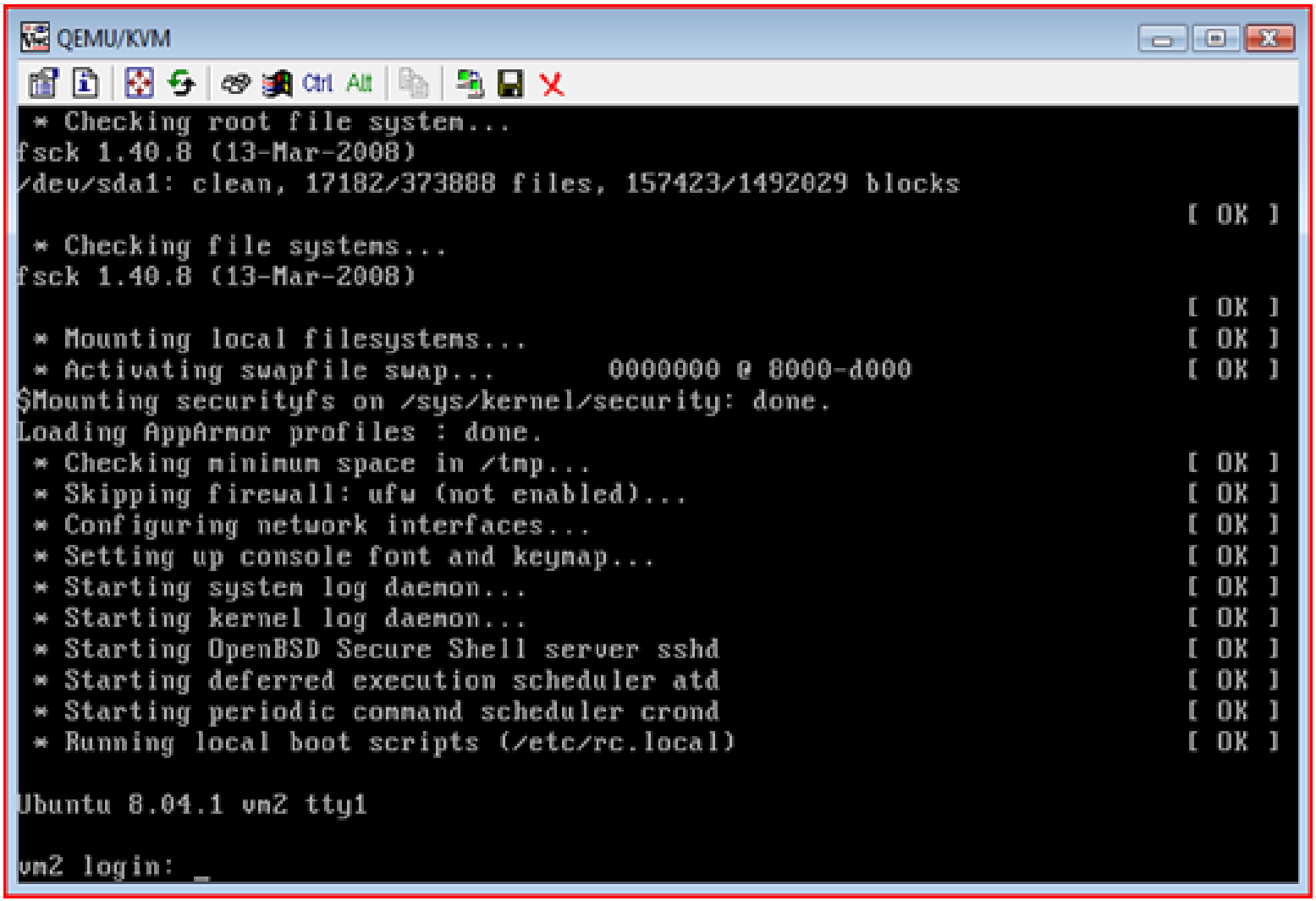


Figure: Hardware assisted virtualization

Purpose of hypervisors

- Hypervisors may be described as a layer in software or firmware handling the execution of virtual machines. It may reside on bare-metal hardware or be a module in a standard operating system.

- The primary purpose of a hypervisor is to share the underlying hardware resources by presenting a virtual hardware platform to the guest operating systems. The hypervisor also maintains strict isolation and ensures non-interference between virtual machines.

- Hypervisors are commonly designed to run on bare-metal and in most cases use the Hardware-Assisted Virtualization techniques, if supported by the underlying hardware.

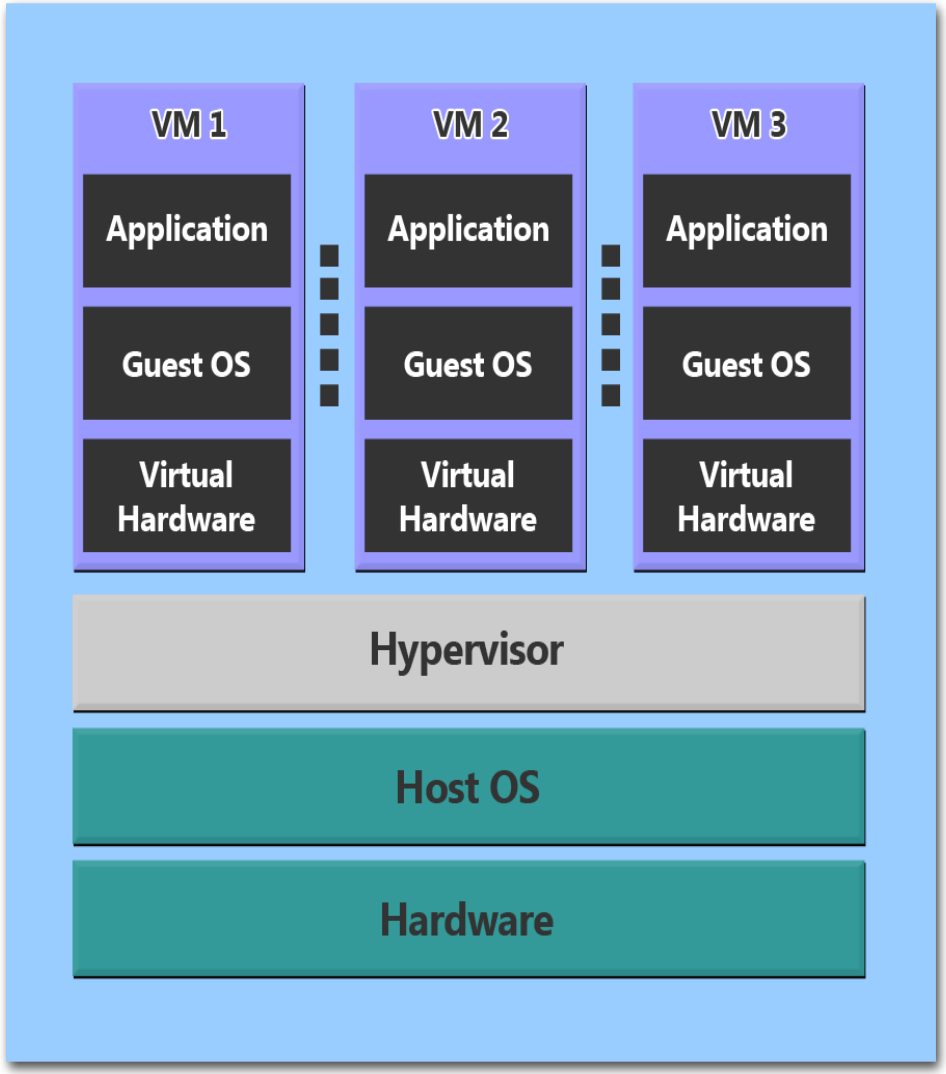


Figure: Purpose of hypervisors

Ring levels on x86 processors

- X86 processors have built-in execution domains called rings. On an x86 processor, there are four ring levels –0, 1, 2 and 3.
- Level 0 is the highest privileged ring level. Highly privileged instructions on x86require ring level 0 to run. Operating systems, like Linux and Microsoft Windows, run in ring level 0. The user space applications are run in Ring Level 3. Other levels are not used.

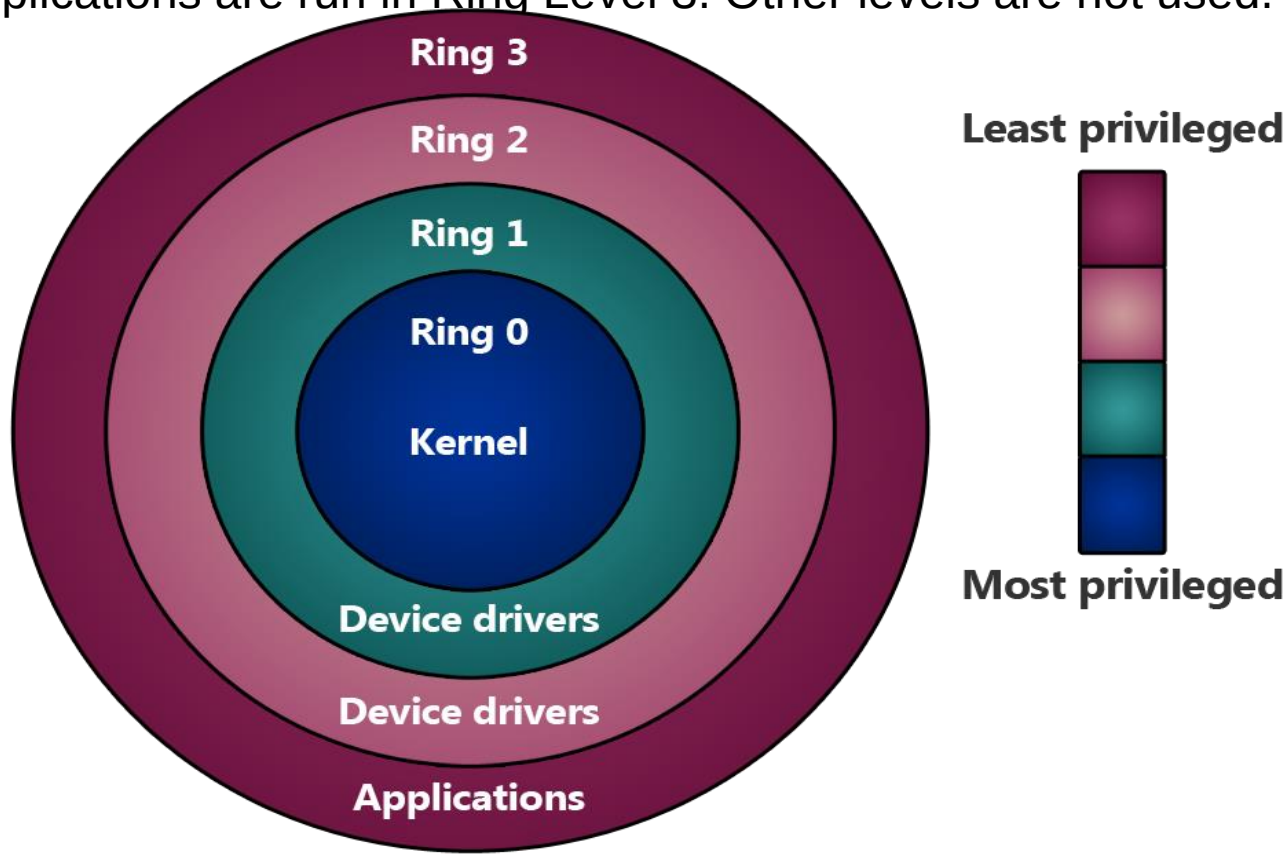


Figure: Ring levels on x86 processors

Types of hypervisors

- Type 1 Hypervisors

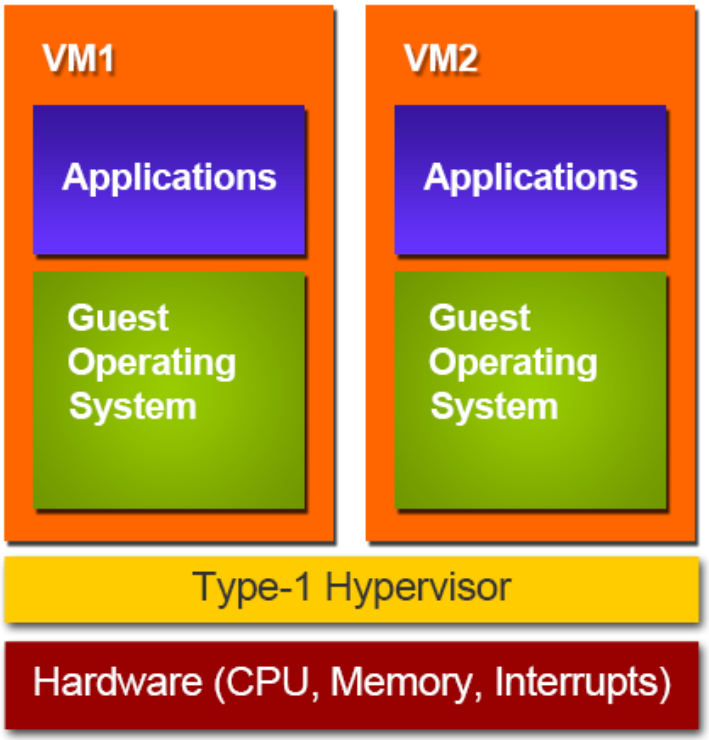


Figure: Types 1 hypervisors

- Type 2 Hypervisors

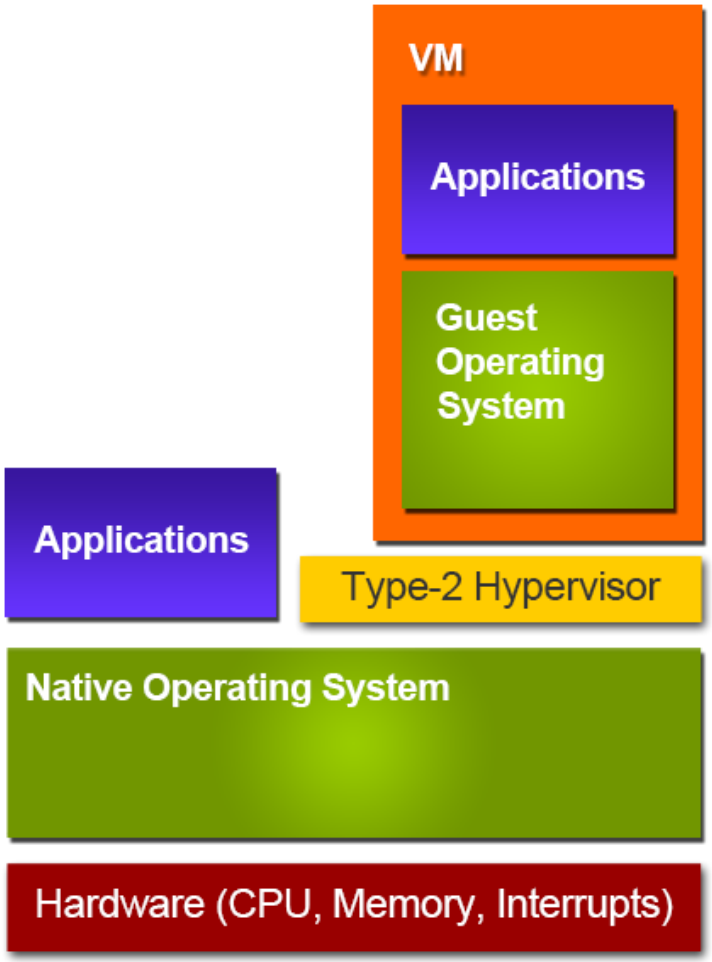


Figure: Types 2 hypervisors

IBM powervm hypervisors

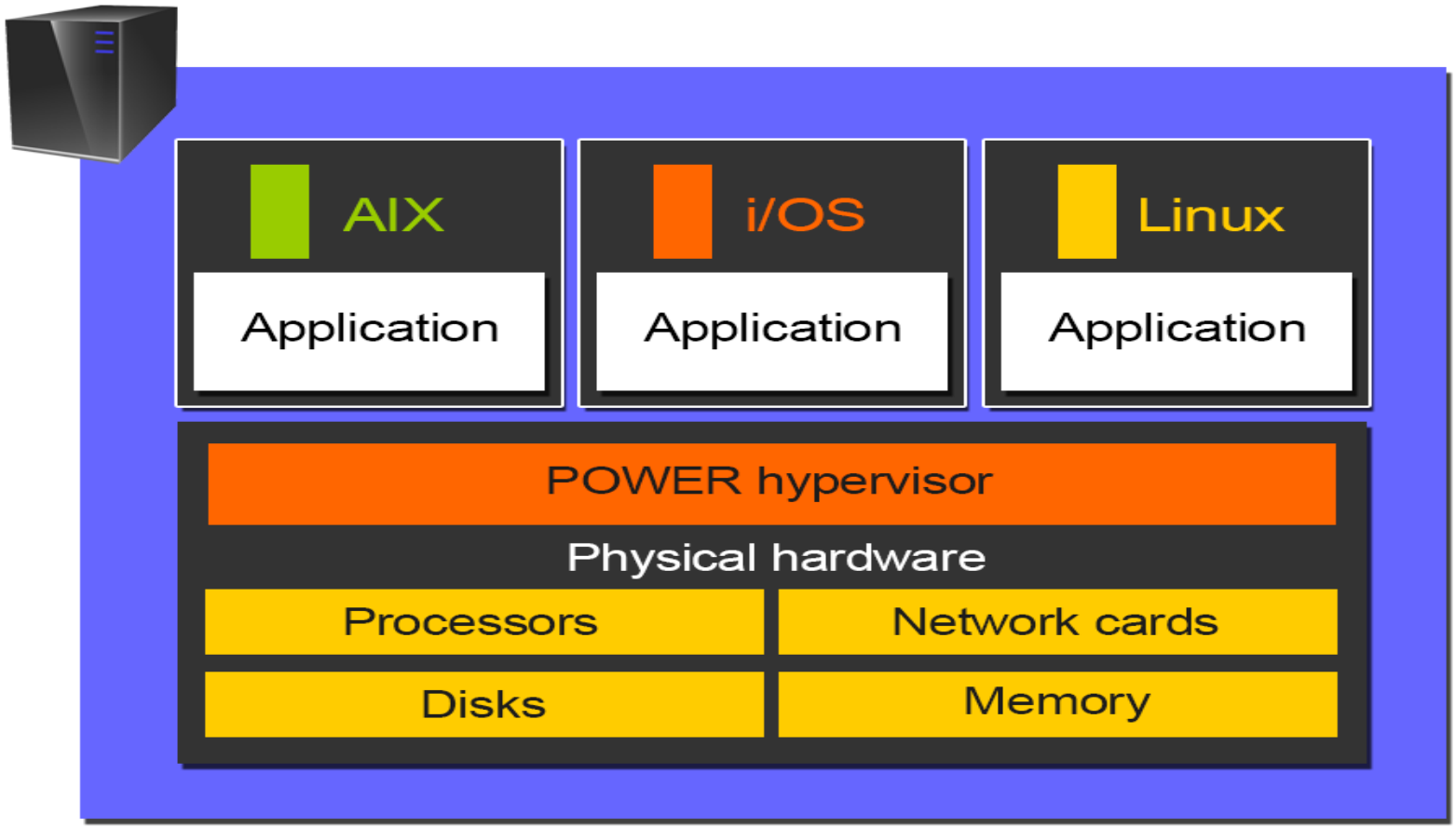


Figure: IBM powervm hypervisors

Common considerations in server virtualization

- SPOF in server virtualization:
  - Patch management.
  - Migration of existing IT infrastructure.
  - Licensing.
  - Legacy/Proprietary Applications.

Desktop virtualization

- Desktop virtualization refers to the technique of creating an abstraction of desktop clients or end-user computing equipment.

- This is not very different from virtualizing a physical server.
  - The process involves creating a logical abstraction or a virtual image of the desktop and placing it on a centralized physical server.

Figure: Desktop virtualization

How desktop virtualization works?

- The concept of desktop virtualization works around a server-client model. An end-user using a thin client can access their respective desktop environment on the centralized server.

- The centralized server is designed to host desktop environments (virtual machines) for multiple end-users.
  - Each desktop environment is a virtual machine hosted on the hypervisor of the centralized server.

- The desktop environment can be provisioned or de-provisioned on demand.
  - Desktop virtualization is achieved using a set of hardware-software technologies and systems commonly termed as VDI (Virtual Desktop Infrastructure).

Figure: Desktop virtualization

Benefits of Desktop Virtualization

- Easy management of remote desktop instances Easy snapshots enable easier backup of desktop environments.
- Easy to power-up or power-down desktops based on need and usage trends.
- Improved desktop availability.
- Application deployment and Licensing.
- Easy of application access.
- Sharing of performance-intensive applications.

Constraints in desktop virtualization

- Network bandwidth.
- Security of the network.
- Graphics intensive applications.
- The application requires direct access to peripherals or embedded debuggers/programmers used in the hardware design sector that in turn require direct access to host connected serial, USB ports are not well tested on VDI.

Types of desktop virtualization

- Desktop virtualization may be classified based on the back-end VDI technology, methods used and the extent of virtualization.
  - Centralized server method.
  - Shared load method.
  - Client hosted method.

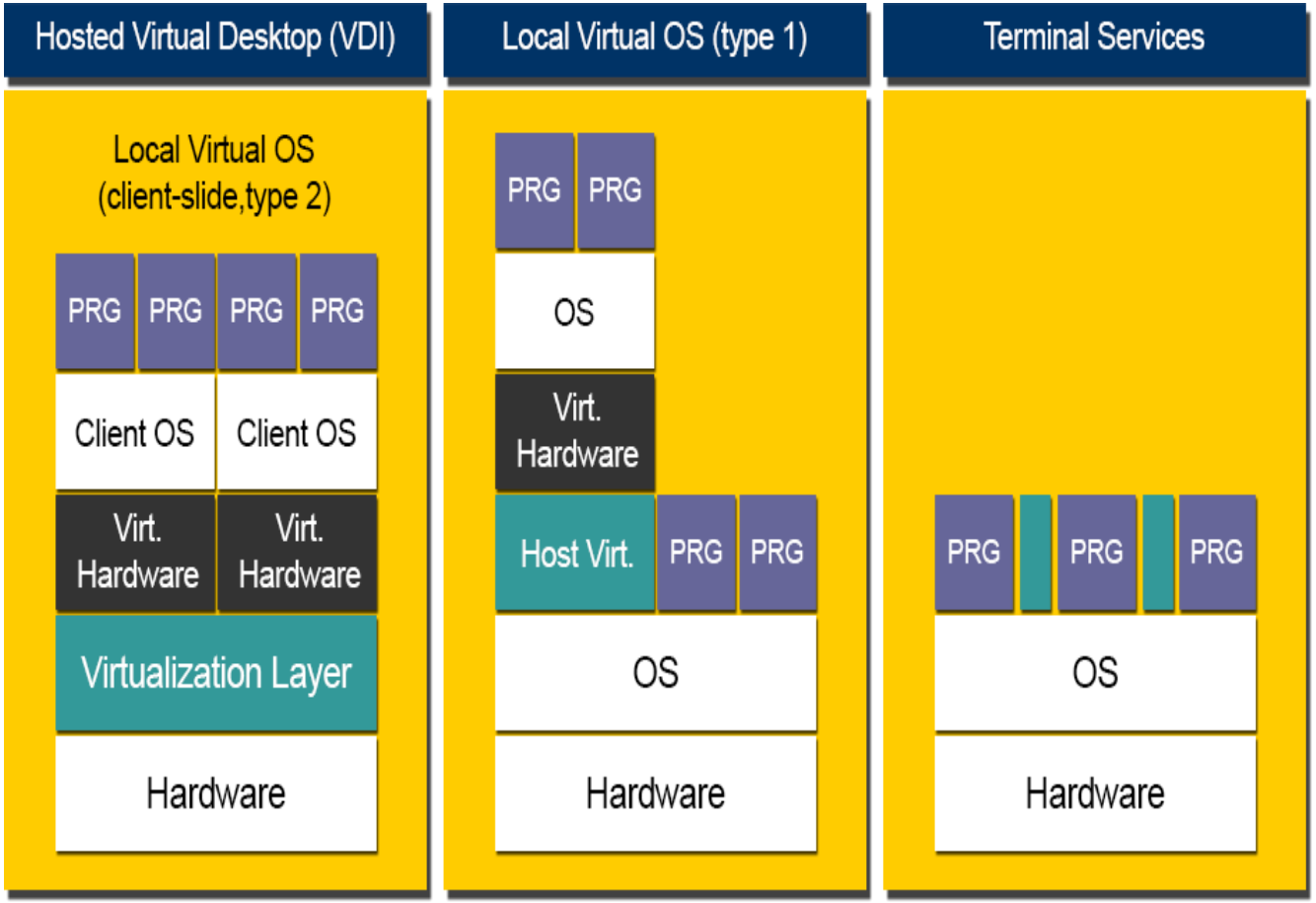


Figure: Types of desktop virtualization

Anatomy of server virtualization

- In this section, we'll take an example to understand the internals of a standard. Server Virtualization solution. For our purpose, we'll be referring to an open-source Virtualization product called XenServer Virtualization.

- Xen Server allows multiple guest Sesto run on virtual machines managed by an underlying layer called the Hypervisor.

- Xen Server provides bare-metal server virtualization. This basically means that the hypervisor resides over the hardware.

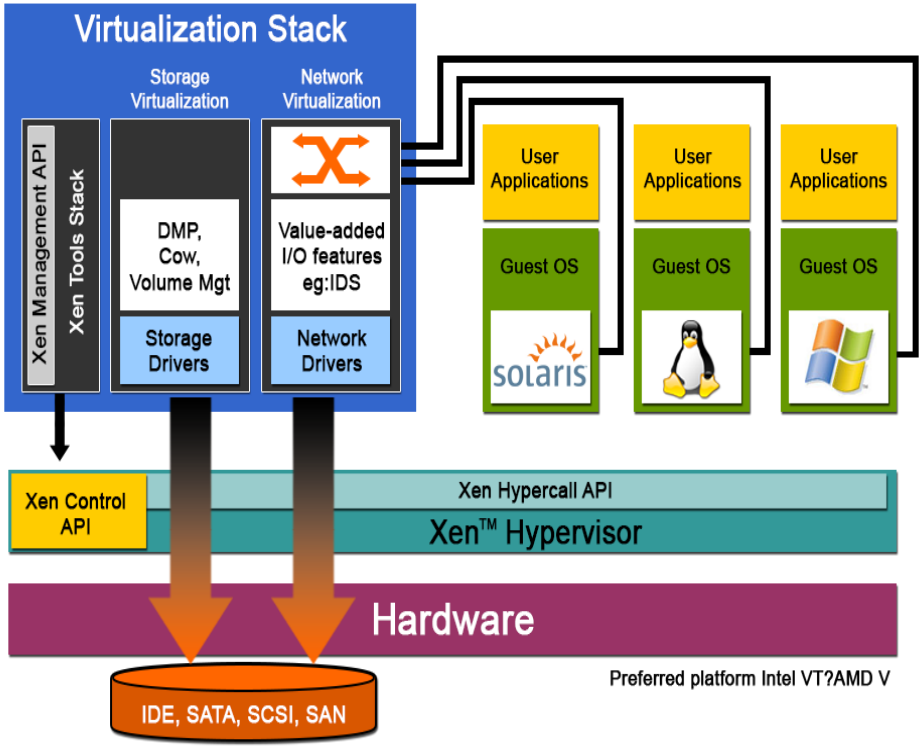
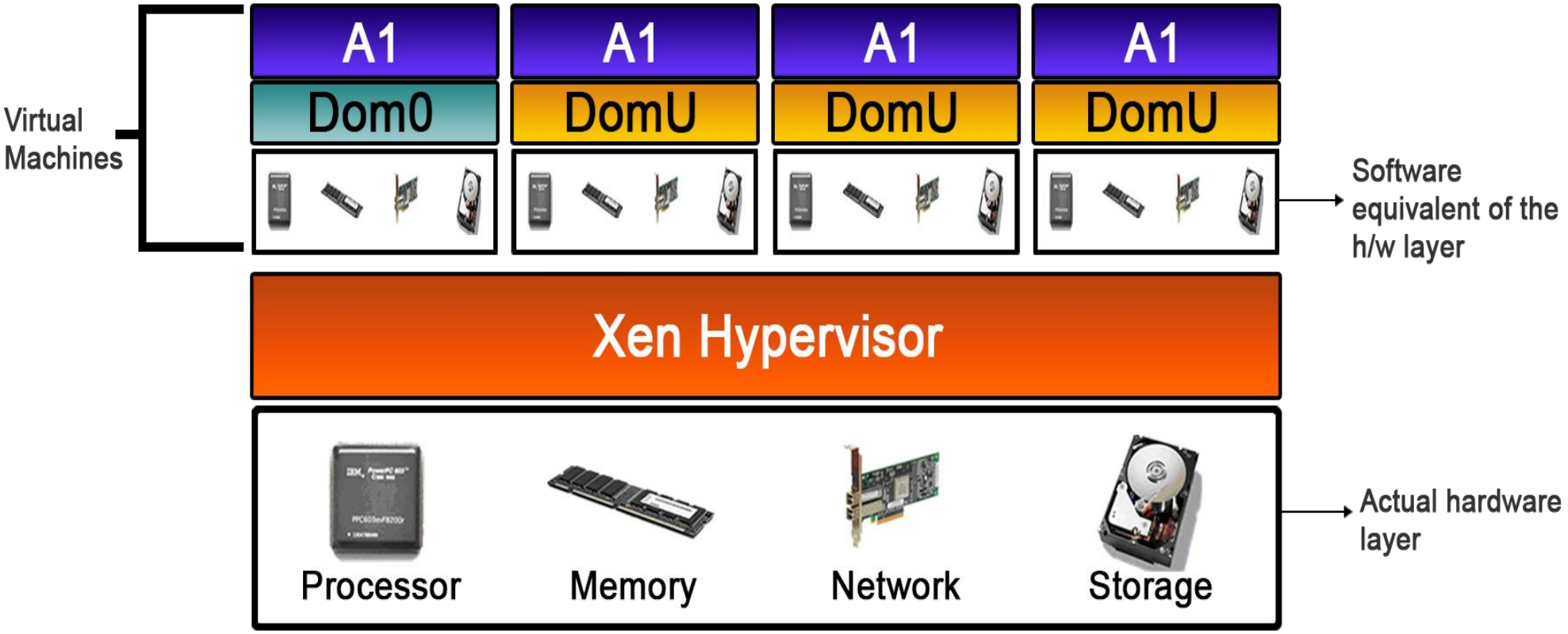


Figure: Anatomy of server virtualization

Three major layers in Xen Server



- Hardware layer.
- Hypervisor.
- Domains layer.

Figure: Three major layers in Xen Server

Storage virtualization overview

- We are living in an information age. When we interact with technology, we either create new information or consume existing information.
- The amount of information that is being generated daily runs into petabytes and is growing at an exponential rate.
- There is an ever-growing demand for storage infrastructure to store, query and analyze this information.
- Traditional computers used internal or tape drives to store and backup information. Over the last few decades, specialized external storage systems have been used.
- These specialized external storage systems are known as Disk Arrays.
- One major advantage of Disk Array is that these allow sharing of the storage among several machines or over the storage network.
- Another advantage was these arrays were built with internal redundancy that allowed for mirroring of the data.
- So, more than one copy of the data could be stored in real-time. When one copy of data fails, the other copy is still available. These were known as RAID Arrays.

Benefits of storage virtualization

- Major shortcomings of the conventional storage systems.
- Interoperability.
- Manageability.
- Scalability.

Features in the logical layer

- To counter the shortcomings of conventional storage systems, new protocols and implementation mechanisms were required to build more flexibility, manageability, and interoperability into the storage systems.

- Features built into the logical layer may vary from vendor to vendor, but almost all of them ensure the following:
  - Interoperability.
  - Manageability.
  - Scalability.

Types of Storage Virtualization

Commonly used protocols for storage in the industry are classified broadly in three categories:

- Host based storage virtualization.
- Network based.
- Hybrid model.

Host level storage virtualization

- The host-based storage virtualization refers to a set of techniques that use host server OS and hardware to achieve the aims of manageability, scalability and interoperability.

- A common host-based mechanism used for virtualizing storage is Logical Volume Manager(LVM).

- Logical Volume Manager (LVM) is an important feature for virtualizing the underlying storage. Logical volume manager creates an abstraction over the disks in the form of logical volumes and volume groups.

- Logical volume management brings in flexibility in managing storage assigned to an application. It virtualizes the underlying storage by creating a logical layer and separating the physical components from the logical components.

- Any change in the physical characteristics does not impact the logical layer and is hidden from the applications.

Host based mirroring

- The abstraction created using Logical Volume Management, also allows an administrator to implement Host Based Mirroring.

- Typically, a logical volume in a volume group can be created in a mirror configuration. The logical volume, thus created will act in a RAID 1 (mirror configuration), i.e. the data written on one physical volume will get replicated on the other physical volume in real-time.

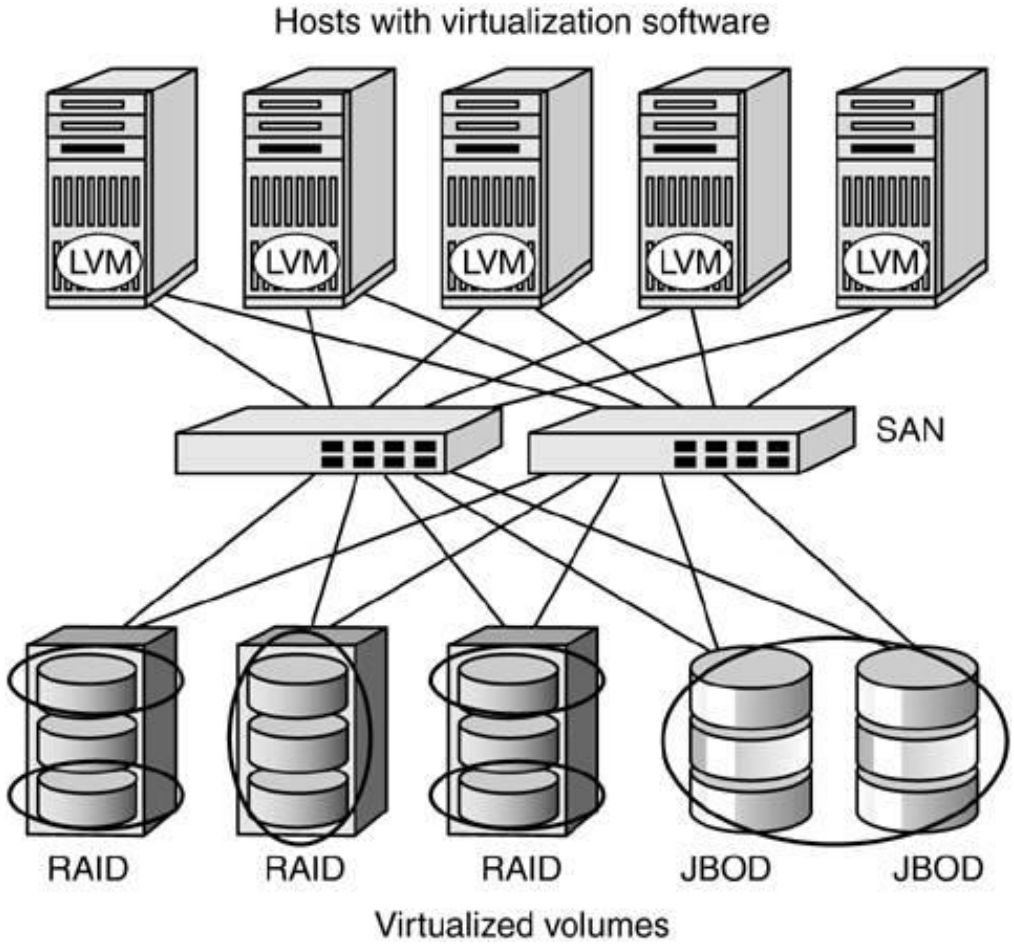


Figure: Host based mirroring

Storage level virtualization

- Storage level virtualization refers to the implementation of the logical layer in the storage array firmware.
- The logical layer separates the physical components in the storage array and provides an abstraction for access to the storage.
- The logical layer can talk to heterogeneous storage systems from multiple vendors without exposing the details to the end user host or application.
- The logical layer abstraction also enables better manageability of the storage system by allowing the storage allocation to be done in logical units rather than in actual physical units.
- The abstraction takes care of mapping the logical units to the actual physical units.

Network based storage virtualization

- One of the other popular techniques to provide storage virtualization is called NAS or Network Attached Storage (NAS).
- NAS provides a file system level abstraction of the storage, i.e. the remote storage file system can be locally mounted by a host as any other file system.
- The IP network is used to manage any communication or meta-data transfer between the NAS Client and the NAS Server. NAS uses commonly used network protocols to provide access to remote file systems for example NFS.

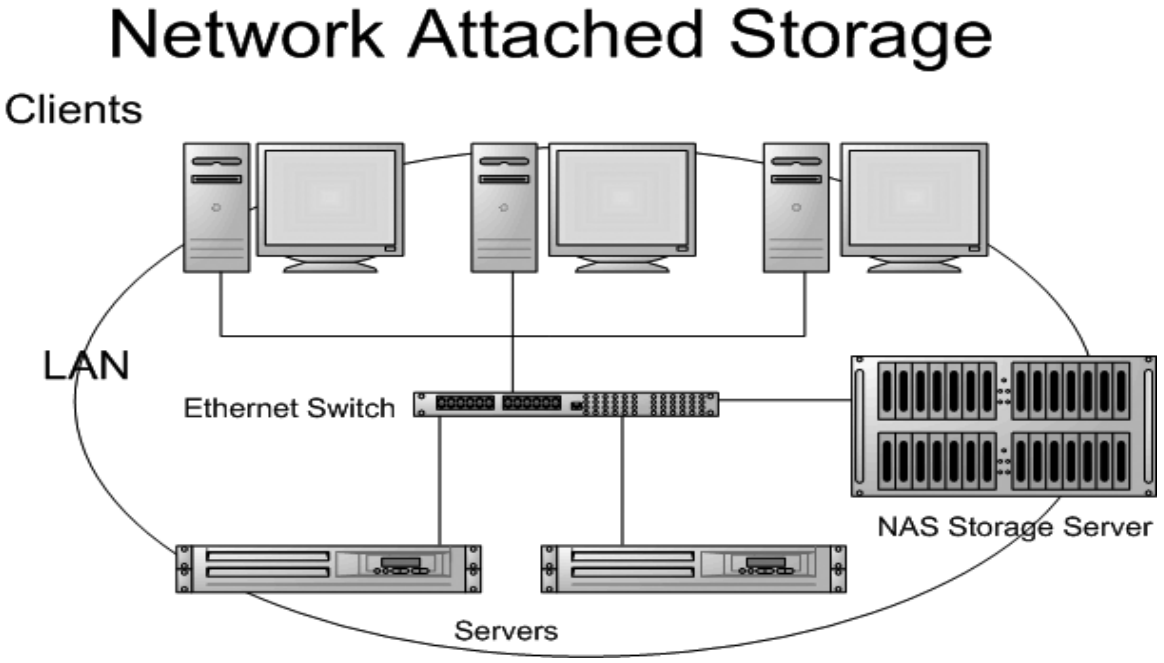


Figure: Network based storage virtualization

Checkpoint (1 of 2)

Multiple choice questions:

1. What type of storage protocols is used to access storage system in Storage based virtualization?
   a) host-dependent
   b) guest-dependent
   c) host-independent
   d) guest-independent
2. Major shortcomings of the conventional storage systems are :
   a) Interoperability, Reliability and Scalability
   b) Interoperability, Manageability and Scalability
   c) Security, Reliability and Reusability
   d) None
3. The three major layers in a Xen Server are :
   a) Software Layer, Hypervisor layer and Domains Layer
   b) Hardware Layer, Hypervisor layer and Domains Layer
   c) Hardware Layer, Hypervisor layer and Software Layer
   d) None.

Checkpoint solutions (2 of 2)

Multiple choice questions:

1. What type of storage protocols is used to access storage system in Storage based virtualization?
   a) host-dependent
   b) guest-dependent
   c) host-independent
   d) guest-independent
2. Major shortcomings of the conventional storage systems are :
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   b) Interoperability, Manageability and Scalability
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3. The three major layers in a Xen Server are :
   a) Software Layer, Hypervisor layer and Domains Layer
   b) Hardware Layer, Hypervisor layer and Domains Layer
   c) Hardware Layer, Hypervisor layer and Software Layer
   d) None.

Checkpoint (2 of 2)

Fill in the blanks:

1. _____ creates an abstraction over the disks in the form of logical volumes and volume group.
2. _____ provides a file system level abstraction of the storage, i.e. the remote storage file system can be locally mounted by a host as any other file system.
3. _____ refers to the components built into the host server operating system and the host hardware to enable storage virtualization.
4. In a _____, the desktop virtual machines are kept on a central server.

True or False:

1. KVM is enabled only in the presence of Intel VT-x hardware on Intel platforms or AMD-V feature on AMD platforms. True/False.
2. The IP network is used to manage any communication or meta-data transfer between the NAS Client and the NAS Server. True/False.
3. The abstraction created using Logical Volume Management, does not allow an administrator to implement Host Based Mirroring. True/False.

Checkpoint solutions (1 of 2)

Fill in the blanks:

1. **Logical volume manager** creates an abstraction over the disks in the form of logical volumes and volume group.
2. **NAS** provides a file system level abstraction of the storage, i.e. the remote storage file system can be locally mounted by a host as any other file system.
3. **Host based storage virtualization** refers to the components built into the host server operating system and the host hardware to enable storage virtualization.
4. In a **centralized server method** the desktop virtual machines are kept on a central server.

True or False:

1. KVM is enabled only in the presence of Intel VT-x hardware on Intel platforms or AMD-V feature on AMD platforms. **True**.
2. The IP network is used to manage any communication or meta-data transfer between the NAS Client and the NAS Server. **True**
3. The abstraction created using Logical Volume Management, does not allow an administrator to implement Host Based Mirroring. **False**.

Question bank

Two-mark questions:

1. Mention types of server virtualization.
2. Define Emulation.
3. Define IBM PowerVM Hypervisors.
4. Define Manageability.

Four-mark questions:

1. Explain in brief Desktop virtualization.
2. Explain in brief types of hypervisors.
3. Explain in brief network-based storage virtualization.
4. Explain in brief Storage level virtualization.

Eight-mark questions:

1. Explain in detail hardware assisted virtualization.
2. Explain in detail Types of server virtualization.

Unit summary

Having completed this unit, you should be able to:

- Identify the types of server virtualization
- Explain hardware assisted virtualization
- Define and describe hypervisors
- Explain desktop virtualization
- Differentiate between the types of desktop virtualization
- Understand storage virtualization
- Identify the types of storage virtualization