VIRTUALIZATION IN CLOUD COMPUTING

I) what is Virtualization?

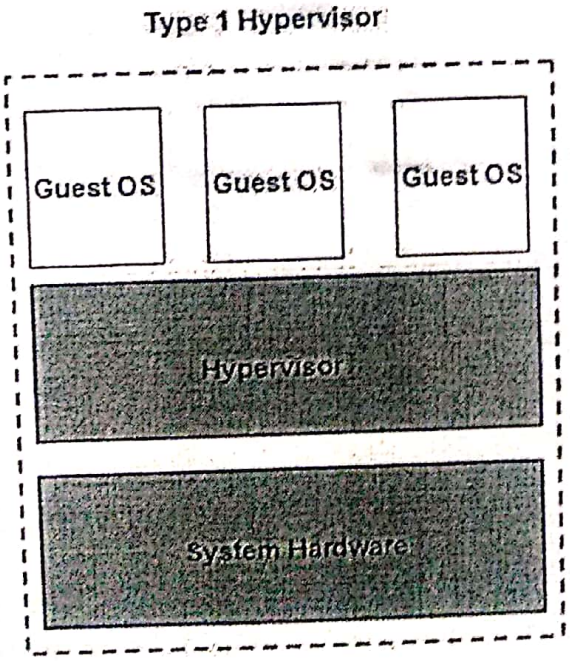
Virtualization is a technique, which allows sharing single physical instance of an application or resource among multiple organizations or tenants (customers). It does so by **assigning a logical name** to a physical resource and providing a **pointer to that physical resource** on demand.

Creating a virtual machine over existing operating system and hardware is referred as **Hardware Virtualization.** Virtual Machines provide an environment that is logically separated from the underlying hardware.

The machine on which the virtual machine is created is known as **host machine** and **virtual machine** is referred as a **guest machine.** This virtual machine is managed by a software or firmware, which is known as **hypervisor.**

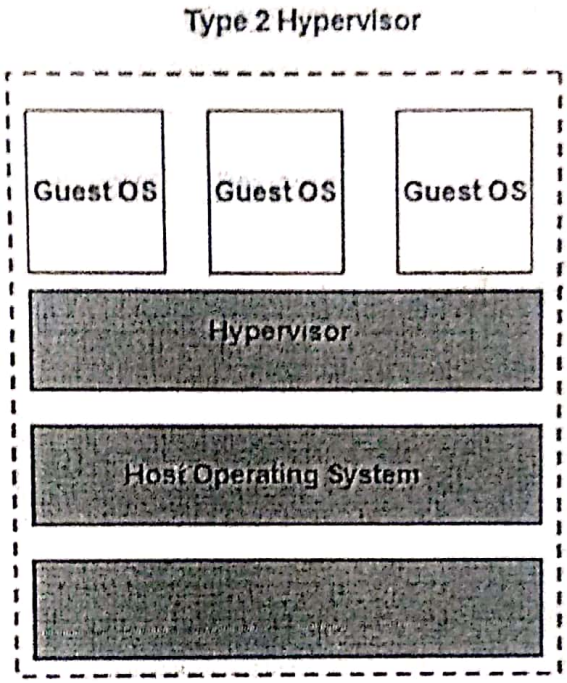
i) Hypervisor: The **hypervisor** is a firmware or low-level program that acts as a Virtual Machine Manager. There are two types of hypervisor:

- **Type 1 hypervisor** executes on bare system. LynxSecure, RTS Hypervisor, Oracle VM, Sun xVM Server, VirtualLogic VLX are examples of Type 1 hypervisor. The following diagram shows the Type 1 hypervisor.



The **type1 hypervisor** does not have any host operating system because they are installed on a bare system

- **Type 2 hypervisor** is a software interface that emulates the devices with which a system normally interacts. Containers, KVM, Microsoft Hyper V, VMWare Fusion, Virtual Server 2005 R2, Windows Virtual PC and **VMWare workstation 6.0** are examples of Type 2 hypervisor. The following diagram shows the Type 2 hypervisor.



II) Need of Virtualization (Benefits) and Limitations:

i) Benefits:

- **Reduced Infrastructure Cost:** Depending on your solution, you have a cost free data center. If the physical server cost is more, but there is an option for free virtualization software and free operating systems. We can use the free software like Microsoft virtual server and VMware server but we would like to go the support of software license to be purchased. For an instance, if you decided to use 10 instances of windows server on physical server, then we require to buy a license, if u use free version Linux for Host operating system.
- **Administration:** Administration become very easy if all servers are hosted at one location, which reduces the administration burden, VMware server allows you to manage your virtual machines remotely. Any machine that can connect to your VMware server host over an IP network can interact with virtual machines running on it. VMware, you can reduce your administrative burden from 1:10 to 1:30.

- **Fast Deployment:** Every virtual guest server is just file on a disk and it is very easy to copy (or clone) a system to create a new one within few minutes. To create a copy of the existing server, you just need a copy the entire directory of the virtual server you are copying from. The new Just-in time management Platform integrates VMware app volumes, Instant Clone and user Environment manager to simplify end-user profile management and boost performance. The platform enables real-time application delivery, up to 30 time's faster imaging, speeder desktop provision etc.
- **Better Disaster Recovery:** Data backups are much simpler in a virtualized environment. In a traditional system, you could create an "image" backup of your server — complete with operating system, applications and system settings. But it could be restored to a computer only with the exact same hardware specifications.

  With virtualization, images of your servers and workstations are much more uniform and can be restored to a wider array of computer hardware setups. This is far more convenient and much faster to restore compared to more traditional backups.

ii) Limitations:

- **Machine turn up time:** VMs run a fully-fledged OS. Every time a machine needs to be started, restarted, or shut down it involves running the full OS life cycle and booting procedure. Every time you wish to deploy your application you also have to ensure application specific software requirements such as web servers, database servers, runtimes, and any support software such as plugin drivers are installed on the machine. With teams obliged to deliver at light speed, the current VM virtualization will create more friction and latency.
- **Low resource utilization:** The preceding problem can be partially solved by using the cloud platforms, which offer on-demand resource provisioning, but again public cloud vendors come up with a predefined set of VM configuration and not every application utilizes all allocated compute and memory.
- **Software licensing Considerations:** The preceding problem can be partially solved by using the cloud platforms, which offer on-demand resource provisioning, but again public cloud vendors come up with a predefined set of VM configuration and not every application utilizes all allocated compute and memory.
- **Learn the new Infrastructure:** Implementing and managing a virtualized environment will require IT staff with expertise in virtualization. On the user side, a

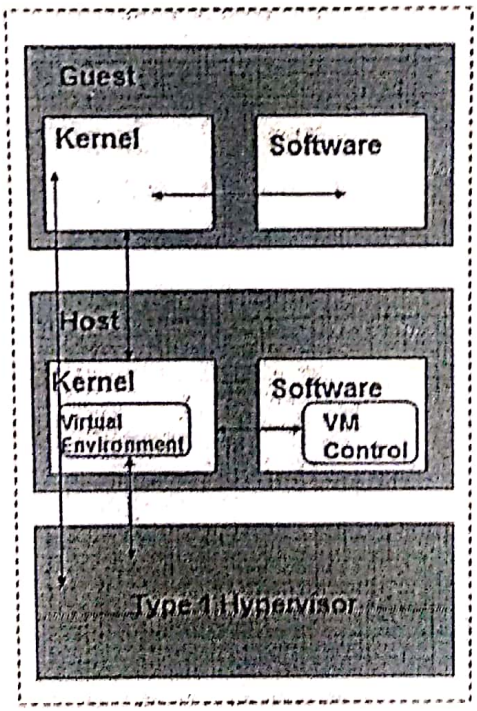
typical virtual environment will operate similarly to the non-virtual environment. There are some applications that do not adapt well to the virtualized environment.

III) Types of Hardware Virtualization

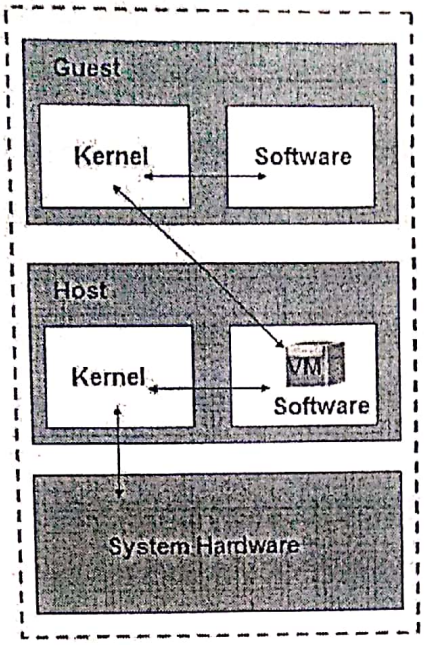
Here are the three types of hardware virtualization:

- Full Virtualization
- Emulation Virtualization
- Paravirtualization

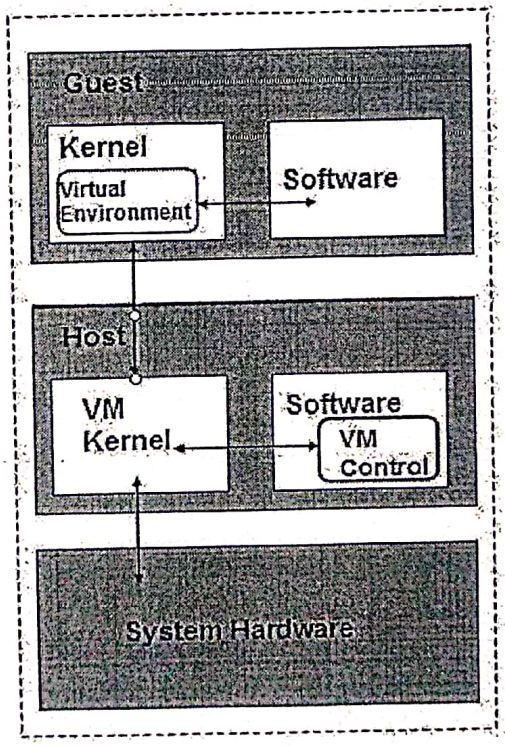
1) **Full Virtualization:** **Full virtualization** is a common and cost-effective type of **virtualization**, which is basically a method by which computer service requests are separated from the physical hardware that facilitates them. With **full virtualization**, operating systems and their hosted software are run on top of virtual hardware.



2) Emulation Virtualization: In **Emulation**, the virtual machine simulates the hardware and hence becomes independent of it. In this, the guest operating system does not require modification.



3) ParaVirtulization: Paravirtualization is a virtualization technique that provides an interface to virtual machines that are similar to their underlying hardware. In paravirtualization, the guest operating system is explicitly ported before installing a virtual machine because a non-tailored guest operating system cannot run on top of a virtual machine monitor (VMM).



Desktop Virtualization

I) Software Virtualization:

Software **Visualization in Cloud Computing** allows the single computer server to run one or more virtual environments. The software virtualizations are basically used to emulate a complete computer system and it further allows the operating system to run. Some of the examples are VMware software, Virtual Box etc.

Types of Software Virtualization:

- Operating System Virtualization
- Application Virtualization
- Service Virtualization

a) **Operating System Virtualization**: In operating system virtualization, the hardware is used which consists of software on which different operating systems work. Here, the operating system does not interfere with each other so that each one of them works efficiently.

b) **Application Virtualization:** Application virtualization is a technology, encapsulates the computer program within the operating system. It can say that application virtualizations refer to running an application on a thin client.

c) **Service Virtualization:** In the service virtualization, the Developers team can use the virtual servers rather than the physical one. It emulates the behavior of essential components which will be present in the final production environment. With the help of service virtualization, the complex application can go through testing much earlier in the development process.

Software Virtualization benefits:

i. **Backup: With** the help of software virtualization, the entire **operating system** or server installation can be backed up. This also benefits in a way that if the new server hack just restoring the previous version will allow running the server.

ii. **Run multiple operating systems:** The different operating system can use in a single computer with the partition in the hard drive. The only thing to keep in mind is to keep a snapshot of everything. If the data drowns, it can retrieve from some other place.

iii. **Running a different version of applications**: With the help of software virtualization new as well as the old operating system can use. So a program, if it is not working on a particular operating system, we can check it on another one.

II) Memory Virtualization:

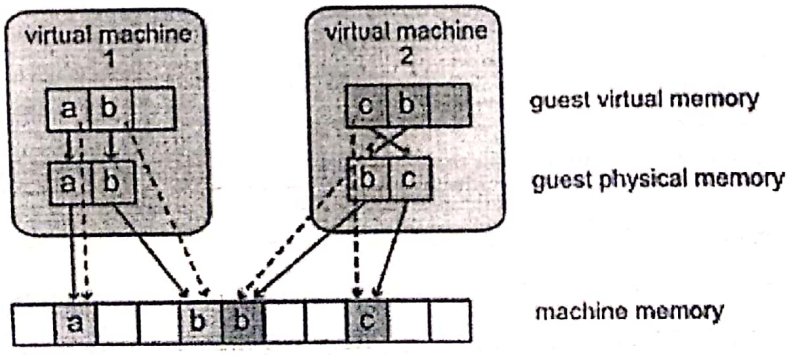
Memory required in every digital machine; switches, routers, appliances and servers. Each containsphisycal memory alongside the logic that manipulate the 1's and 0's. Memory is closely coupled with compute logic, and when performance gains are needed enterprises typically add more memory, which can be very expensive.

Memory Virtualization introduces a way to decouple memory from the processor, and from the server to provide shared, distributed or networked function. This is not more addressable memory but virtualized memory shared between multiple machines.

It is important to keep in mind that memory and storage are not synonymous. Memory virtualization is focused in application performance and has direct touch point with end users. The CPU actively and directly uses data from memory. On the other hand, storage is persistent store the data. Storage is static, regardless of whether it is spinning disk, SSD or RAM disk. Data is retrieved from disk and put into memory before the processor can transform data to information.

The VM Kernel manages all machine memory. The VM kernel dedicates part of this managed machine memory for its own use. The rest is available for use by virtual machines. There are 2 types of Memory Virtualization: **Software-based** and **hardware assist** memory Virtualization.

The Following Diagram shows ESXi implementation of memory Virtualization.



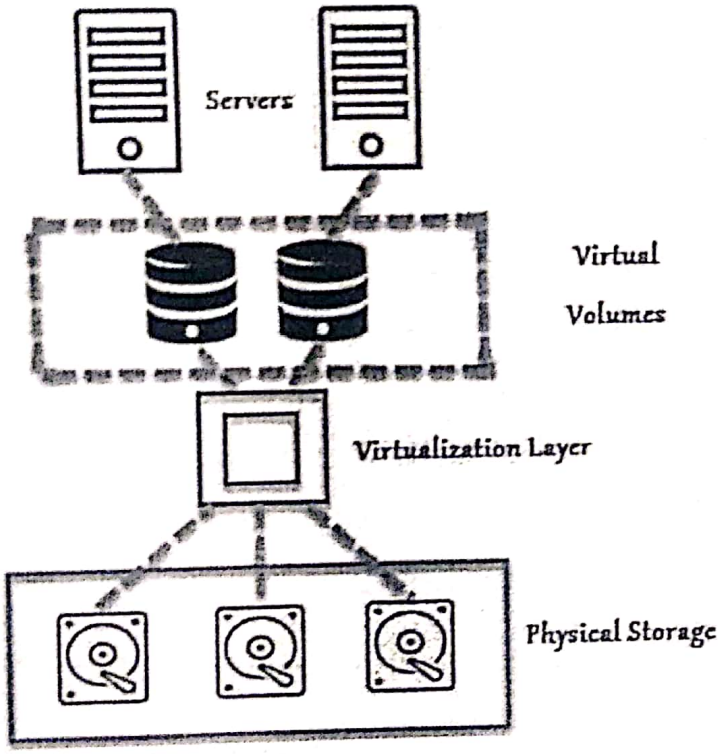
Form the above diagram, the boxes represent pages, and the arrows show the different memory mappings. The arrows from guest virtual memory to guest physical memory show the mapping maintained by the page tables in the guest operating system. The arrows from guest physical memory to machine memory show the mapping maintained by the VMM.

The dashed arrows show the mapping from guest virtual memory to machine memory in the shadow page tables also maintained by the VMM. The underlying processor running the virtual machine uses the shadow page table mappings.

III) Storage Virtualization:

Storage virtualization is the pooling of physical storage from multiple storage devices into what appears to be a single storage device -- or pool of available storage capacity -- that is managed from a central console. The technology relies on software to identify available storage capacity from physical devices and to then aggregate that capacity as a pool of storage that can be used in a virtual environment by virtual machines (VMs).

The virtual storage software intercepts I/O requests from physical or virtual machines and sends those requests to the appropriate physical location of the storage devices that are part of the overall pool of storage in the virtualized environment. To the user, virtual storage appears like a standard read or write to a physical drive.



There are two basic methods of virtualizing storage: **file-based** or **block-based.**

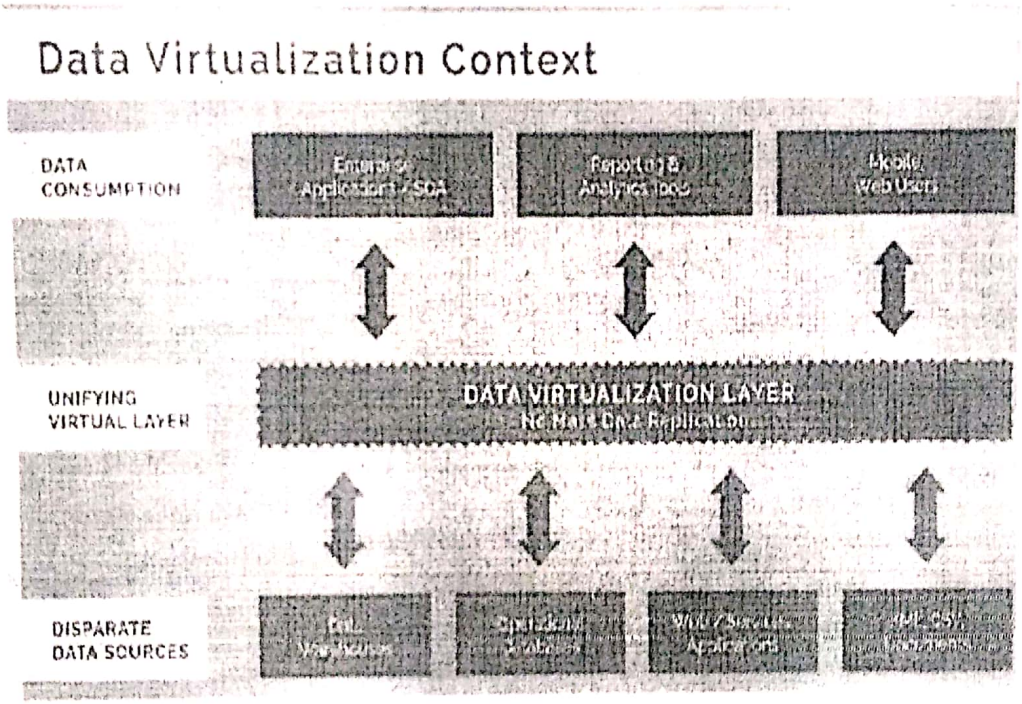
File-based storage virtualization is a specific use case, applied to network-attached storage (NAS) systems. File-based storage virtualization breaks the dependency in a normal NAS array between the data being accessed and the location of physical memory.

Block-based or block access virtual storage is more widely applied in virtual storage systems than file-based storage virtualization. Block-based systems abstract the logical storage, such as a drive partition, from the actual physical memory blocks in a storage device, such as a hard disk drive (HDD) or solid-state memory device.

IV) Data Virtualization:

Data virtualization is any approach to data management that allows an application to retrieve and manipulate data without requiring technical details about the data, such as how it is formatted at source, or where it is physically located, and can provide a single customer view (or single view of any other entity) of the overall data.

Data Virtualization enables distributed databases, as well as multiple heterogeneous data stores, to be accessed and viewed as a single database. Rather than physically performing ETL on data with transformation engines, Data Virtualization servers perform data extract, transform and integrate virtually."



The Benefits of Data Virtualization

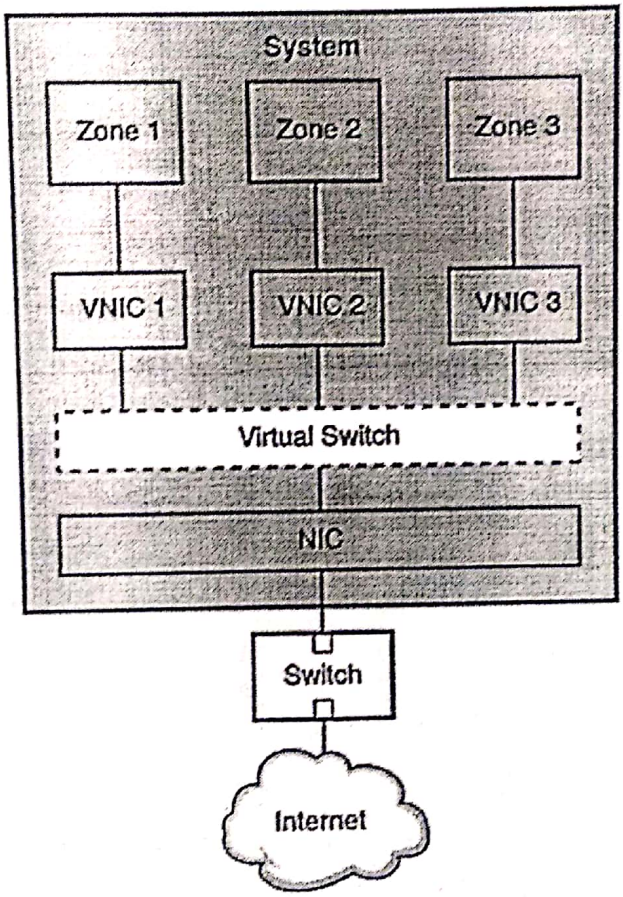
- Connection to More **Data. Data virtualization** allows business users to access internal and external **data** without the need to know how or where the **data** is stored.
- Experimentation. **Data virtualization** allows users to experiment with new ideas to gain and use **data.**
- Quick Response Times.
- Fewer Risks.
- Improved Decision Making.

V) Network Virtualization:

Network virtualization is a process of abstraction which separates logical network behavior from the underlying physical network resources. virtualization allows network aggregation and provisioning, combining different physical networks into a single virtual network, or breaking a physical network into multiple virtual networks that are isolated from each other. This is sometimes called "external network virtualization." Network virtualization can also be applied within virtual servers to create synthetic networks between virtual machines (VMs); this is often called "internal network virtualization."

Components of Network Virtualization:

Figure: VNIC Configuration for a Single Interface



The following are the basic components of network virtualization in Oracle Solaris:

1. Virtual network interface cards (VNICs)
2. Virtual switches
3. Etherstubs

1) VNICs are virtual network devices with the same data link interfaces as a physical NIC. You configure VNICs over an underlying data link. When VNICs are configured, they behave like physical NICs. VNICs are virtual network devices with the same datalink

interfaces as a physical NIC. You configure VNICs over an underlying datalink. When VNICs are configured, they behave like physical NICs.

2) A **virtual switch** is automatically created. In accordance with Ethernet design, if a switch port receives an outgoing packet from the host connected to that port, that packet cannot go to a destination on the same port.

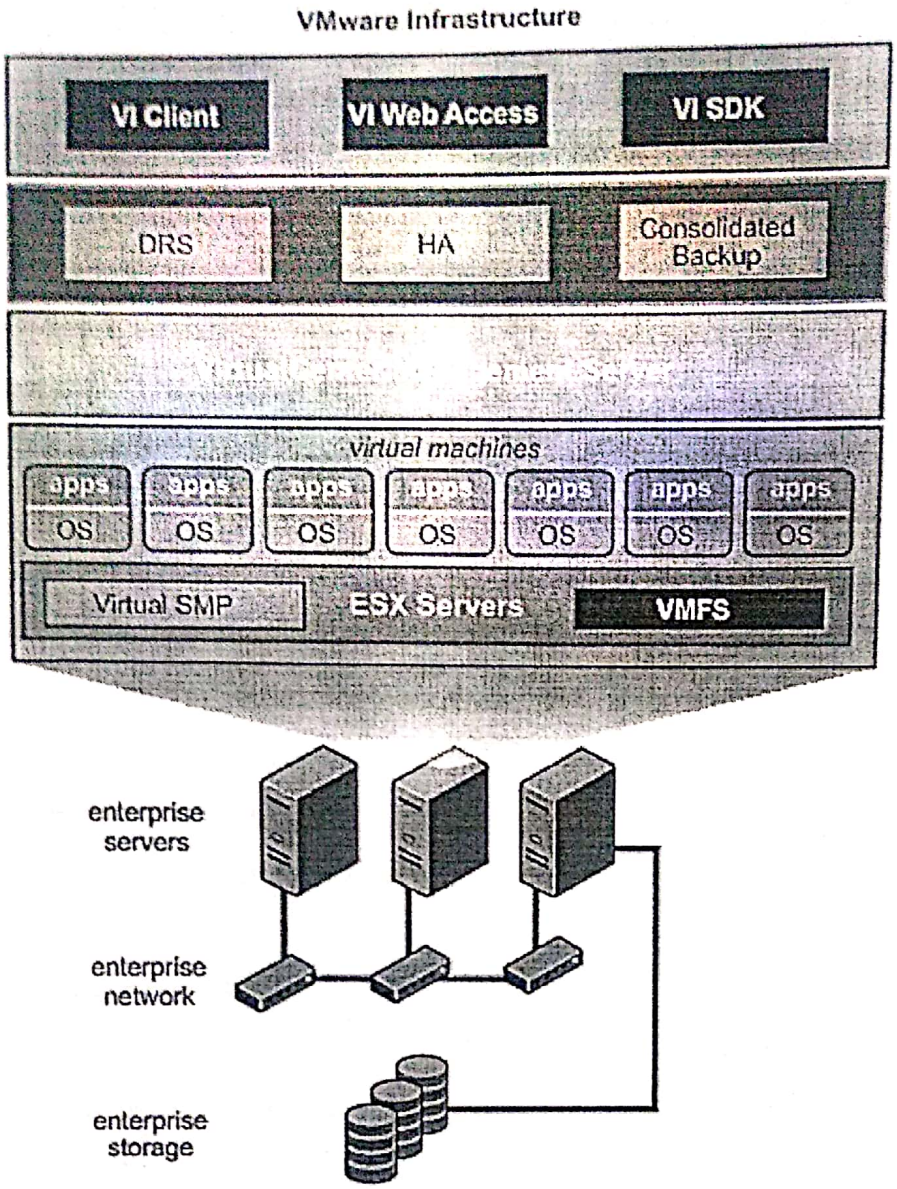
3) **Etherstubs** are pseudo Ethernet NICs. You can create VNICs over etherstubs instead of over physical links. VNICs over an etherstub become independent of the physical NICs on the system. With etherstubs, you can construct a private virtual network that is isolated both from the other virtual networks on the system and from the external network.

VI) VMware Infrastructure:

VMware Infrastructure is a full infrastructure virtualization suite that provides comprehensive virtualization, management, resource optimization, application availability, and operational automation capabilities in an integrated offering. VMware Infrastructure virtualizes and aggregates the underlying physical hardware resources across multiple systems and provides pools of virtual resources to datacenter in the virtual environment.

In addition, VMware Infrastructure brings about a set of distributed services that enables fine-grain, policy-driven resource allocation, high availability, and consolidated backup of the entire virtual datacenter. These distributed services enable an IT organization to establish and meet their production Service Level Agreements with their customers in a cost effective manner.

The relationships among the various components of the VMware Infrastructure are shown in Figure:



- **VMware ESX Server** – A robust, production-proven virtualization layer run on physical servers that abstracts processor, memory, storage, and networking resources into multiple virtual machines.
- **VirtualCenter Management Server (VirtualCenter Server)** – The central point for configuring, provisioning, and managing virtualized IT environments.
- **Virtual Infrastructure Client (VI Client)** – An interface that allows users to connect remotely to the VirtualCenter Server or individual ESX Servers from any Windows PC.
- **Virtual Infrastructure Web Access (VI Web Access)** – A Web interface that allows virtual machine management and access to remote consoles.

- **VMware Virtual Machine File System (VMFS)** – A high-performance cluster file system for ESX Server virtual machines.
- **VMware Virtual Symmetric Multi-Processing (SMP)** – Feature that enables a single virtual machine to use multiple physical processors simultaneously.
- **VMware VMotion** – Feature that enables the live migration of running virtual machines from one physical server to another with zero down time, continuous service availability, and complete transaction integrity.
- **VMware HA** – Feature that provides easy-to-use, cost-effective high availability for applications running in virtual machines. In the event of server failure, affected virtual machines are automatically restarted on other production servers that have spare capacity.
- **VMware Distributed Resource Scheduler (DRS)** – Feature that allocates and balances computing capacity dynamically across collections of hardware resources for virtual machines.
- **VMware Consolidated Backup (Consolidated Backup)** – Feature that provides an easy-to-use, centralized facility for agent-free backup of virtual machines. It simplifies backup administration and reduces the load on ESX Servers.
- **VMware Infrastructure SDK** – Feature that provides a standard interface for VMware and third-party solutions to access the VMware Infrastructure.