Virtualization and Cloud Technology

Unit-1

Introduction to Virtualization

- What is Virtualization?
- Why You Need Virtualization?
- Virtualization in Current IT scenario
- Comparing Virtualized and Non- Virtualized Environment.
- Understanding Virtualization Technologies:
    - Server Virtualization
    - Operating system Virtualization
    - Hardware Emulation and Para-virtualization
    - Client Virtualization
        - Application Packaging
        - Application Streaming
    - Storage Virtualization

History of Virtualization

- The virtualization concept is believed to have its origins in the mainframe days in the late 1960s and early 1970s.
- IBM invested a lot of time and effort in developing robust time-sharing solutions.
- Due to virtualization, the cost of providing computing capability dropped considerably and it became possible for organisations, and even individuals, to use a computer without actually owning one.
- The capacity of a single server is so large that it is almost impossible for most workloads to effectively use it. The best way to improve resource utilization and at the same time simplify data centre management is through virtualization.
- Datacenters today use virtualization techniques to make abstraction of physical hardware, create large aggregated pools of logical resources consisting of CPUs, memory, disks, file storage, applications, networking and offer those resources to users or customers in the form of agile, scalable and consolidated virtual machines.

Why virtualization is required in IT industry?

- IT enterprises are implementing the concept of virtualization over the recent years due to its size, budget, staffing and resource constraints. Out of which, the budget and resource utilities have lead to heavy impediments for their exponential growth.
- IT challenges, such as, low server utilization, complex server-storage migration, inefficient server deployment, increased total cost of ownership, server sprawl, high-availability requirements, disaster recovery complexity, green IT requirements, automation and policy driven management have led to the innovation called virtualization.
- Virtualization is a technology to run multiple same or different operating systems which is completely isolated from each other. For instance, Run both Windows and Linux operating systems on the same machine.

Why you need Virtualization?

Following are the reasons for virtualization:

- Server Consolidation and Infrastructure Optimization
- Physical Infrastructure Cost Reduction
- Improved Operational Flexibility and Responsiveness
- Increased Application Availability and Improved Business Continuity
- Improved Desktop Manageability and Security

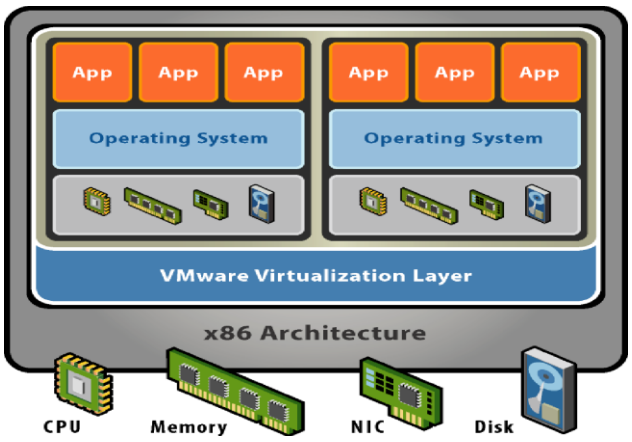
Factors that justify the need for virtualization Following justifies the need for virtualization:

- Energy Management
- Hardware and Operating Costs
- Availability of Resources
- Uninterrupted Business Continuity
- Disaster Recovery Plans

What is Virtualization?

Initially the computer hardware was designed to run a single operating system and a single application as shown in the following Figure 1, leaving most machines vastly underutilised.

- Virtualization is one of the hardware reducing, cost saving and energy saving technology that is rapidly transforming the IT landscape and fundamentally changing the way that people compute.
- In computing, virtualization means to create a virtual version of a device or resource, such as a server, storage device, network or even an operating system where the framework divides the resource into one or more execution environments.
- Virtualization is a proven software technology that is rapidly transforming the IT landscape and fundamentally changing the way people compute.
- Today's powerful x86 computer hardware (x86 is a generic name for the series of Intel microprocessor families that began with the 80286 microprocessor) was originally designed to run only a single operating system and a single application, but virtualization breaks that bond, making it possible to run multiple operating systems and multiple applications on the same computer at the same time, increasing the utilisation and flexibility of hardware.
- Virtualisation is a technology that can benefit anyone who uses a computer, from IT professionals, commercial businesses and government organisations.
- Join millions of people around the world who use virtualization to save time, money and energy while achieving more with the computer hardware they already own.



Virtualization Architecture

How does Virtualization Work?

- In essence, virtualization lets you transform hardware into software
- Use software, such as, VMware ESX to transform or "virtualize" the hardware resources of an x86-based computer including the CPU, RAM, hard disk and network controller — to create a fully functional virtual machine that can run its own operating system and applications just like a "real" computer
- Multiple virtual machines share hardware resources without interfering with each other so that one can safely run several operating systems and applications at the same time on a single computer

Virtual Machine

- A virtual machine is a tightly isolated software container that can run its own operating systems and applications as if it were a physical computer
- A virtual machine behaves exactly like a physical computer and contains its own virtual (that is, software-based) CPU, RAM hard disk and network interface card (NIC)
- An operating system can't tell the difference between a virtual machine and a physical machine, nor can applications or other computers on a network. Even the virtual machine thinks it is a "real" computer
- Nevertheless, a virtual machine is composed entirely of software and contains no hardware components whatsoever. As a result, virtual machines offer a number of distinct advantages over physical hardware

Benefits of Virtual Machines:

- Compatibility: They are compatible with all standard x86 computers.
- Isolation: They are isolated from each other as if physically separated.
- Encapsulation: They encapsulate a complete computing environment.
- Hardware independence: They run independently of underlying hardware.

Hypervisor

If virtualization is defined as the enabling multiple operating systems to run on a single host computer, then the essential component in the virtualization stack is the hypervisor.

This hypervisor, also called Virtual Machine Monitor (VMM), creates a virtual platform on the host computer, on top of which multiple guest operating systems (a guest OS is the software installed on either a virtual machine or partitioned disk that describes an operating system that is different from the host operating system) are executed and monitored. This way, multiple operating systems, which are either multiple instances of the same operating system, or different operating systems, can share the hardware resources offered by the host.

Hypervisors are commonly classified as one of the following two types:

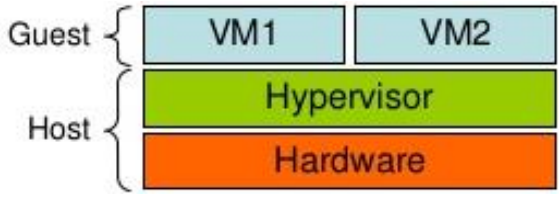
Type 1: Native or Bare Metal

Type 2: Hosted

Type 1 or Bare Metal Hypervisor

- A bare-metal virtualization hypervisor does not require admins to install a server operating system first
- Bare-metal virtualization means the hypervisor has direct access to hardware resources, which results in better performance, scalability and stability

- One disadvantage of a bare-metal virtualization hypervisor is that hardware support is typically more limited, because the hypervisor usually has limited device drivers built into it



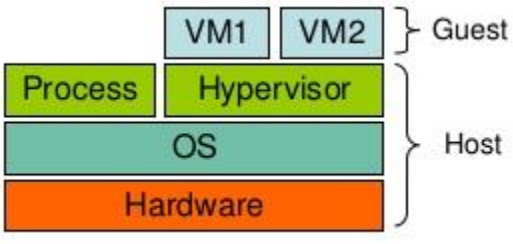
- Bare-metal virtualization is well suited for enterprise data centres, because it usually comes with advanced features for resource management, high availability and security. Admins can centrally manage this kind of virtualization hypervisor, which is critical when you one have has many hosts in their virtual infrastructure

The most popular bare-metal virtualization hypervisors are:

- VMware ESX and ESXi
- Microsoft Hyper-V
- Citrix Systems XenServer

Type 2 or Hosted Hypervisor

- Unlike the bare-metal virtualization hypervisor, a hosted hypervisor requires you to first install an OS. These hypervisors are basically like applications that install on a guest OS. This approach provides better hardware compatibility than bare-metal virtualization, because the OS is responsible for the hardware drivers instead of the hypervisor
- There are some disadvantages with bare-metal hypervisor; a hosted virtualization hypervisor does not have direct access to hardware and must go through the OS, which increases resource overhead and can degrade virtual machine (VM) performance



- Hosted hypervisors are common for desktops, because they allow you to run multiple operating systems. These virtualization hypervisor types are also popular for developers to maintain application compatibility on modern operating systems

The most popular hosted virtualization hypervisors are:

- VMware Workstation, Server, Player and Fusion
- Oracle VM VirtualBox
- Microsoft Virtual PC
- Parallels Desktop

Characteristics of Virtualization

Virtualization has three characteristics that make it ideal for cloud computing:

Partitioning:

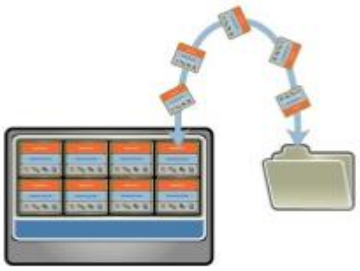
- Runs multiple operating systems on one physical machine
- Utilises server resources completely
- Supports high availability by clustering virtual machines

Isolation:

- Isolates faults and security at virtual machine level
- Dynamically controls CPU, memory, disk and network resources per virtual machine

Encapsulation:

- Encapsulates the entire state of the virtual machine in hardware independent files
- Saves the virtual machine state as a snapshot in time
- Re-uses or transfers whole virtual machines with a simple file copy

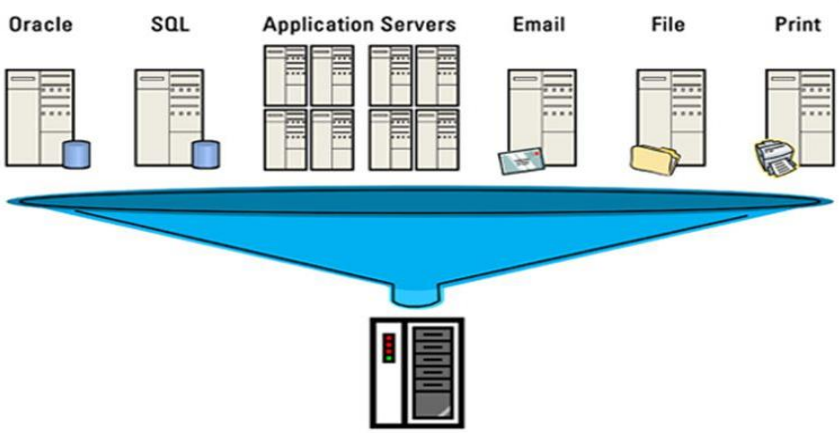


Different types of virtualization

- Server Virtualization
- Desktop Virtualization
- Application Virtualization
- Network Virtualization
- Storage Virtualization

Server Virtualization

- Server virtualization is the most active segment of the virtualization industry featuring established companies, such as VMware, Microsoft and Citrix
- Server virtualization allows for more than one server to operate on the same piece of hardware.
- With server virtualization one physical machine is divided into many virtual servers
- At the core of such virtualization is the concept of a hypervisor (virtual machine monitor)
- A hypervisor is a thin software layer that intercepts operating system calls to hardware. Hypervisors typically provide a virtualized CPU and memory for the guests running on top of them. The term was first used in conjunction with the IBM CP-370



Benefits of Server Virtualization

- Increased Hardware Utilisation
- Security
- Development

Desktop Virtualization

- Desktop virtualization is a virtualization technology that separates an individual's PC applications from his or her desktop
- Virtualized desktops are generally hosted on a remote central server, rather than the hard drive of the personal computer
- The client-server computing model is used in virtualizing desktops, desktop virtualization is also known as client virtualization

Benefits of Desktop Virtualization include:

- A lower total cost of ownership (TCO)
- Increased security
- Reduced energy costs
- Reduced downtime and centralised management

Application Virtualization

- Application virtualization is running an application on a thin client (a thin client is a lightweight computer built to connect to a server from a remote location; the server does most of the work, which can include crunching numbers and storing information for the thin client)
- In application virtualization, a given application is a single platform that can be executed on virtually any other machine.
- A terminal or a network workstation with few resident programs and accessing most programs residing on a connected server
- The thin client runs in an environment separate from, sometimes referred to as being encapsulated from, the operating system where the application is located

Benefits to application virtualization include:

- Requiring fewer resources compared to using a separate virtual machine
- Allowing incompatible applications to run on a local machine simultaneously
- Maintaining a standard, more efficient and cost-effective OS configuration across multiple machines in a given organisation, independent of the applications being used

Network Virtualization

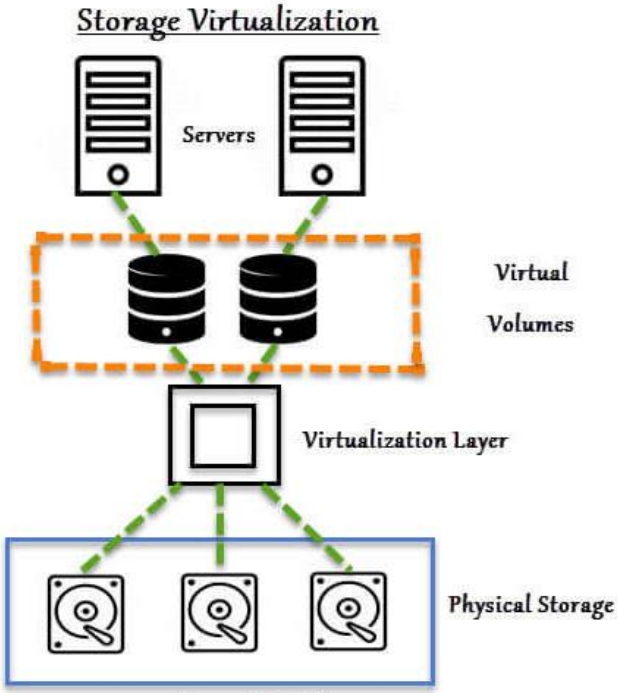
- Network virtualization refers to the management and monitoring of an entire computer network as a single administrative entity from a single software-based administrator's console
- Network virtualization is using network resources through a logical segmentation of a single physical network.
- Network virtualization is designed to allow network optimization of data transfer rates, flexibility, scalability, reliability and security

Benefits of Network Virtualization include:

- Customisation of Access: Administrators can quickly customise access and network options, such as, bandwidth throttling and quality of service
- Consolidation: Physical networkscan be combined into one virtual network for overall simplification of management

Storage Virtualization

Storage virtualization is the process of grouping the physical storage from multiple network storage devices so that it looks like a single storage device. The process involves abstracting and covering the internal functions of a storage device from the host application, host servers or a general network in order to facilitate the application and network-independent management of storage.



Benefits of Storage Virtualization include:

- Migration: Data can be easily migrated between storage locations without interrupting live access to the virtual partition with most technologies.
- Utilization: Similar to server virtualization, utilisation of storage devices can be balanced to address over and underutilisation.
- Management: Many hosts can leverage storage on one physical device that can be centrally managed.

Overall Benefits of Virtualization

- Virtualization can increase IT agility, flexibility and scalability while creating significant cost savings
- Workloads get deployed faster
- Performance and availability increases
- Operations become automated, resulting in IT that's simpler to manage and less costly to own and operate
- Reduce capital and operating costs
- Minimise or eliminate downtime
- Increase IT productivity, efficiency, agility and responsiveness
- Provision applications and resources faster
- Enable business continuity and disaster recovery
- Simplify datacenter management
- Build a true software-defined datacenter

Virtualization vendors in IT industry

VMware

- VMware dominates the server virtualization market
- Its domination doesn't stop with its commercial product, VMware vSphere
- VMware also dominates the desktop-level virtualization market and perhaps even the free server virtualization market with its VMware Server product

- VMware remains in the dominant spot due to its innovations, strategic partnerships and rock-solid products

Microsoft

- Microsoft came up with the only non-Linux hypervisor, Hyper-V, to compete in a tight server virtualization market that VMware currently dominates
- Not easily outdone in the datacenter space, Microsoft offers attractive licensing for its Hyper-V product and the operating systems that live on it

- For all Microsoft shops, Hyper-V is a viable solution that has only gotten more competitive in the virtualization space with each new Windows' Server release
- Microsoft has also been steadily gaining traction with enterprises looking to leverage the company's Azure cloud services as well as those interested in managing both onpremises Hyper-V services and Azure service

Citrix

- Citrix was once the lone wolf of application virtualization, but now it also owns the world's most-used cloud vendor software called Xen (the basis for its commercial XenServer)
- Amazon uses Xen for its Elastic Compute Cloud (EC2) service and so do Rackspace, Carpathia and SoftLayer

Red Hat

- For the past 15 years, everyone has recognised Red Hat as an industry leader and open source champion
- Hailed as the most successful open source company, Red Hat entered the world of virtualization in 2008 when it purchased Qumranet and with it, its own virtual solution: KVM and SPICE (Simple Protocol for Independent Computing Environment)
- Red Hat released the SPICE protocol as open source in December 2009.

- The company's renowned Red Hat Enterprise Virtualization (RHEV) desktop and server virtualization platform is based on the KVM hypervisor and Red Hat's Enterprise Linux (RHEL) server operating system
- RHEV is based on open standards and works with Linux and Windows, as well as enterprise applications, such as, SAP, SAS and Oracle

Oracle

- If Oracle's world domination of the enterprise database server market doesn't impress you, its acquisition of Sun Microsystems has made it an impressive virtualization player.
- Additionally, Oracle owns an operating system (Sun Solaris), multiple virtualization software solutions (Solaris Zones, LDoms and xVM) and server hardware (SPARC). What happens when you pit an unstoppable force (Oracle) against an immovable object (the Datacenter)? You get the Oracle-centred Datacenter.

Google Ganeti

The company's open source Google Ganeti cluster virtual server management software tool is built on top of existing virtualization technologies, such as, Xen or KVM and essentially serves as a wrapper around these hypervisors to help system admins set up clusters.

Virtualization in Current IT scenario

- Virtualization usage has soared to great heights in IT. Thanks to hypervisors (such as, Hyper-V and VMware ESXi) and their ability to run multiple operating systems on a single computer, IT departments have reached new levels of efficiency and better usage of precious compute, storage and memory resources.
- In fact, according to the 2016 Spiceworks State of IT report, more than 76% of organisations are taking advantage of virtualization today and that number will continue to grow in the future. Now let us take a closer look at operating systems and virtualization.

Comparing Non-Virtualized and Virtualized Environment

Non-Virtualized

- Single OS image per machine
- Software and hardware tightly coupled
- Running multiple applications on same machine often creates conflict
- Inflexible and costly infrastructure

Virtualized environment

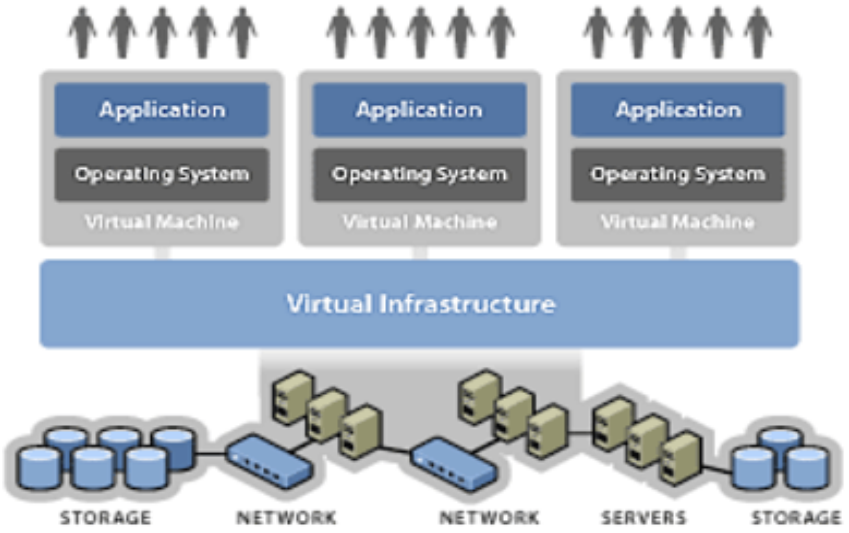
- Hardware-independent operating system and applications
- Virtual machines can be provisioned to any system
- Can manage operating system and application as a single unit by encapsulating them into virtual machines

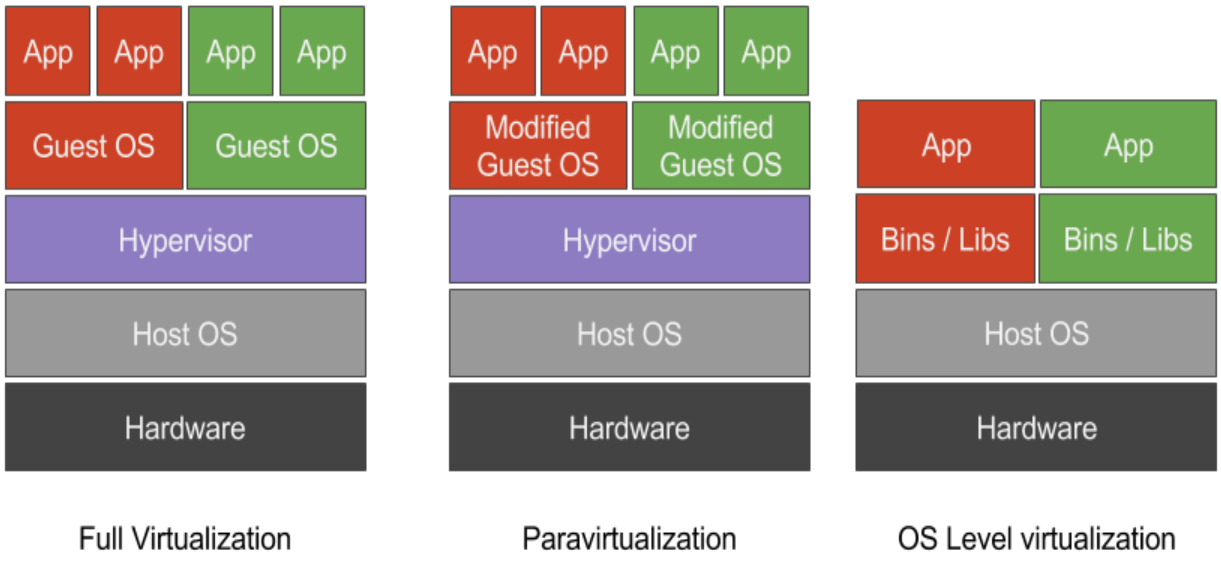
Case Studies Showing Benefits of Virtualization in Enterprises

- Over the past few years, virtualization has transformed the traditional datacenter
- Countless businesses have reduced energy and hardware costs as more IT professionals realise the benefits of virtualization
- For companies that demand more computing power, virtualization can help deliver improved performance without the need for an expanded facility or additional cooling infrastructure

What is Server Virtualization?

- In creating a virtual server, the process is also known simply as server virtualization. It means partitioning a physical server into smaller virtual servers to maximise the resources of the dedicated server.
- Through server virtualization, the resources of the server itself are hidden or masked from users each of who have their own separate and independent virtual machine to utilise.
- The server administrator uses software that divides the physical server into multiple isolated virtual environments while masking resources from the users, such as the number and identity of individual physical servers, processors and operating systems.





Full Virtualization | Paravirtualization | OS Level virtualization

Full Virtualization

Full virtualization uses a *hypervisor* as a special kind of software to allocate resources.

- The hypervisor interacts directly with the physical server and works as a platform for each virtual server's operating system
- The hypervisor also works to keep each virtual machine independent and unaware of other virtual servers running on the physical machine
- Each guest server runs its own OS while the hypervisor monitors the resources of the physical server and relays these resources to the appropriate virtual server

- Some of the physical server's processing power must be reserved for the hypervisor's needs

Paravirtualization

- In paravirtualization, guest operating system or virtual servers are aware of one another, unlike in the full virtualization approach.
- The hypervisor does not require as much processing power to manage the virtual servers as it would under full virtualization, which can help prevent any slowing down of the performance.
- The hypervisor does not play as big a role because each OS is already aware of the demands the other operating systems are placing on the server.
- This makes it possible for the whole system to work together as a unit rather than the hypervisor relaying resources and having to monitor what resources are available for each virtual server.

Paravirtualization has many significant performance advantages and its efficiencies offer better scaling. As a result, it is used in various areas of technology, such as:

- Partitioning development environments from test systems
- Disaster recovery
- Migrating data from one system to another
- Capacity management

Paravirtualization technology was introduced by IBM and was developed as an open-source software project. **Example:** Xen open source virtualization software

Operating System Level Virtualization

- OS (Operating System) level virtualization uses a completely different architecture than the other two.
- OS level virtualization does not even use a hypervisor at all because virtualization capability is part of the host OS which performs that kind of functions that a fully virtualized hypervisor would.
- There are limitations to this method though as all the guest or virtual servers run on the same OS.

- The virtual servers remain independent of one another, but users are not able to mix and match operating systems among them.
- This environment is known as homogeneous since all the operating systems are the same. The type of virtualization that would work best depending on the network administrator's needs.

Uses of OS Virtualization

- Used for virtual hosting environment
- Used for securely allocation of finite hardware resources among a large number of distrusting users
- System administrator uses it to integrate server hardware by moving services on separate hosts
- To improvise security by separating several applications to several containers
- These forms of virtualization don't require hardware to work efficiently.

Advantages of OS level virtualization

- Flexible Provisioning of Resources
- Support of Multiple Images per System, including Boot Menu
- Rapid Software (OS/Apps) Deployment
- Easy Implementation of Updates and Hotfixes of the Operating System and Applications
- Easy Rollback Scenarios
- After Restarting, the System is Back to a Clean State

Disadvantages OS Virtualization

- No Work offline Capability
- High-speed LAN Recommended (>100Mb)
- Not All Operating Systems are Supported

Benefits of Server Virtualization

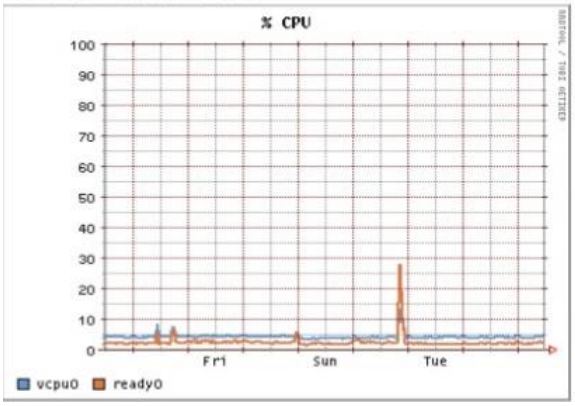
- More efficient utilisation rates
- Reduced power consumption and energy costs

- Decreased capital expenditures
- Enhanced business continuity
- More flexible and efficient allocation of resources
- Simplified server management and security
- First step towards the cloud environment

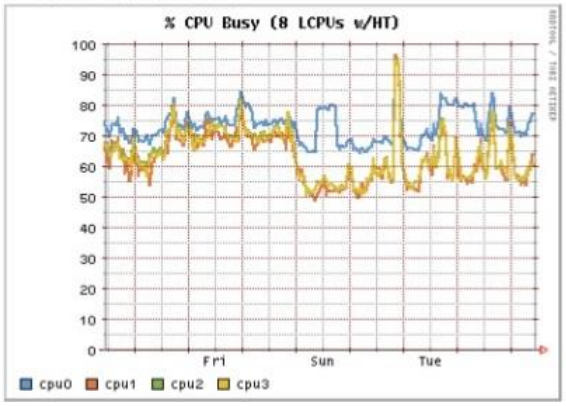
More efficient utilisation rates

- X86 servers typically run at utilisation rates of 5 to 15%
- Virtualization enables businesses to increase server virtualization rate from 60 to 80 %
- Halts to server sprawl
- Dynamic resource balancing and resulting in improved operating system and application performance

Before Virtualization



After Virtualization



Reduced Power Consumption

- **Underutilised x86 hardware** is the most significant factor contributing to excessive energy consumption in data centres
- **Gartner Report**: Even underutilised servers use high amounts of energy. Increasing utilisation levels to 60% and more requires only modest increases in power. The effective use of virtualization can **reduce server energy consumption by up to** 82**%** and floor space by 85%
- Virtualization right sizes these major contributors to excessive data centre energy consumption

- **Greener approach to IT**, enables organisations to demonstrate environmental responsibility

Decreased Capital Expenditures

- **Consolidating of servers,** enables efficient use of combined infrastructure resources and breaks away from the traditional model of one server for each application
- **Simplified migrations**, when an OS is tied directly to a piece of hardware, it is complex and costly to migrate
- Facilitates **operational expenditure savings** over a long period of time
- **Accelerates** Return On Investment **(ROI)**
- **Frees up servers** for deployment as backup system at remote site

Enhanced Business Continuity

- **Virtualization** makes it affordable and efficient to deploy a backup system at a remote site
- **Reduced Backup and recovered time**, that is, ease of backing up and restoring a file
- **Lower cost and management complexity** while enhancing efficacy of business continuity plan

More Flexible Use of Resources

- **Server Virtualization** infrastructure brings uniformity to the data centre
- **Rapid provisioning** of servers and applications within minutes, instead of weeks
- **Dynamically scale** to respond to unpredictable market changes and user demands
- **Increase in productivity** of IT administrators, enabling them to spend more time focusing on business needs
- **Lower IT costs** through increased efficiency, flexibility and responsiveness

Simplified Server Management and Security

- **Accelerated Application Testing and Deployment,** by using pre-configured VM templates and profiles
- **Centralised Resource Monitoring** (VMM) and dynamically map computing resources to the environment

- **Seamless upgrade/maintenance** of hardware with zero down time
- **Guest isolation**, one guest Virtual Machine (VM) cannot access or even address the "hardware resources" of another guest VM or the host/hypervisor

What is hardware emulation?

Hardware emulation is a specialised software, which is also known as *hypervisor*, creates hardware emulation for OS in a single server. They can host different types of OS in a single server. The OS loaded into each virtual machine works as a standalone and unmodified OS**.** When a VM is running, the hypervisor makes changes to the part of the OS that makes system calls. Hypervisor changes the OS by entering a piece of code which is known as binary translation to the OS when it is running. Binary translation takes place in four parts of the OS (memory, processor, network and storage) that interact with the hardware.

Advantage

You do not have to modify the OS and applications to run on the virtual environment.

Two types of hypervisor is used in hardware emulation:

- Type 1 hypervisor
- Type 2 hypervisor

Type 1 Hypervisor

- Type 1 hypervisor is also known as bare-metal implementation because they sit directly on the top of hardware, without needing any operating system. Since they can directly communicate with hardware resources, they are much faster than type 2 hypervisor.

Advantage of Type 1:

- If a single virtual machine crashes, it does not affect the rest of the guest operation system. Therefore, they are considered more secure than type 2. Since they generate less overhead, type 1 hypervisor is much faster than its counterpart.

Type 1 Products include **VMware ESX, Microsoft Hyper-V, and the** many Xen variants.

Type 2 Hypervisor

Type 2 hypervisor resides on top of the operating system. Since they cannot directly communicate with the hardware, they are less efficient than the type 1.

Advantage of Type 2

In type 2 hypervisor, the OS takes care of all the hardware. That is why a type 2 hypervisor can support a wide range of hardware. Besides, installing a type 2 is much easier than that of type 1.

Disadvantage of Type 2

They have more points of failure since anything that affect the stability of the base operating system can also affect the guest OS and the virtual machine. When the base OS needs a reboot, all the VM will also be rebooted.

Example of Type 2 Hypervisor

VMware Player, VMware Workstation and Microsoft Virtual Server

What is client virtualization?

Client virtualization simulates a user's desktop experience, but separates the desktop from the hardware, OS and applications. The simulated client desktop or virtual machine (VM), runs on a physical host server which is running virtualization software called a hypervisor. Many virtual clients can run on one host server with each client having different user properties, data, applications and even operating systems. This allows users to seamlessly access their regular desktops from inexpensive low-end, thin-client or shared machines.

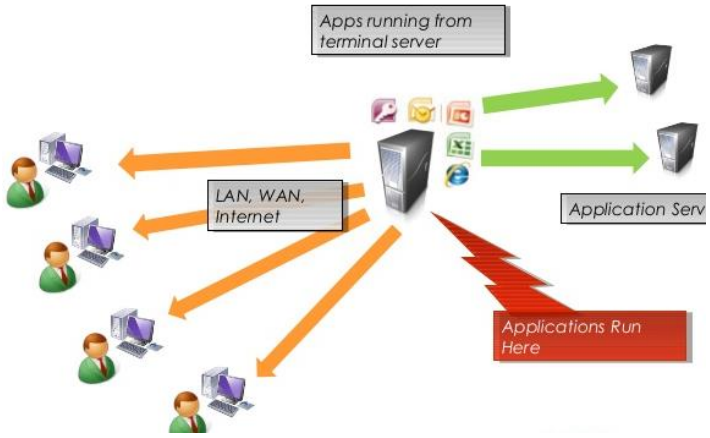
Types of Client Virtualization

- Presentation virtualization
- Virtual desktop infrastructure (VDI)
- Application virtualization

Presentation Virtualization

- As hinted in the name, it is an application delivery method that delivers desktops or applications from a shared server.
- This enables access to client applications from a central server that is connected with clients. This initiates a presentation session through a web portal while giving them access to a virtualized application instance on a shared Windows Server OS. The only resources shared with the client is the graphical user interface as well as the mouse/keyboard.
- Benefits of this presentation virtualization range from reduced user resource needs to simplicity, since applications are installed only once despite multiple users sharing

the same application instance and even server level administration since multiple users are sharing the resources of the same system.



Virtual Desktop Infrastructure (VDI)

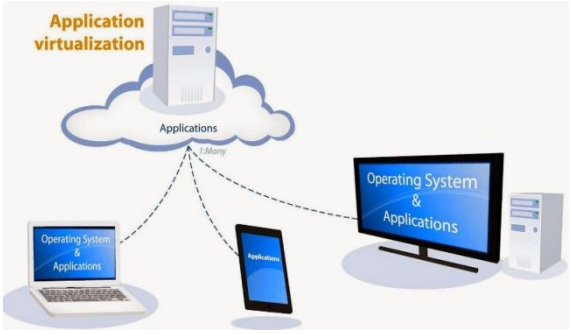
- Sharing similarities with presentation virtualization, VDI solutions are also a remote display protocol that hosts centrally-managed virtual machines (VMs) that client PCs are connected to on a one-on-one network relationship.
- Also known as desktop virtualization, this method utilises a hypervisor that is in charge of hosting a dedicated operating system VM for each client individually.
- Due to the fact that each client is totally separate from one another on the server, this option allows for flexibility, management and security.

Application Virtualization

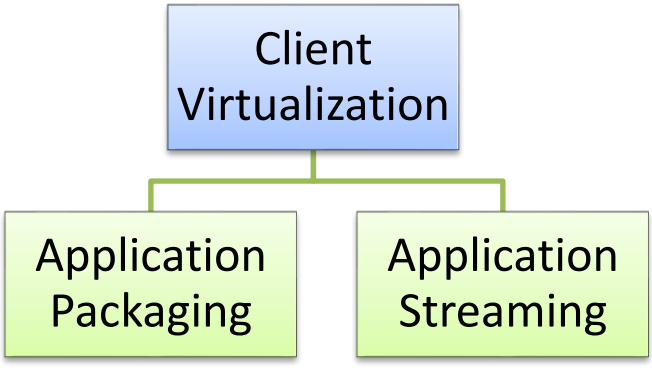
- Application virtualization is the separation of an installation of an application from the client computer accessing it.
- From the user's perspective, the application works just like it would if it lived on a user's device. The user can move or resize the application window, as well as carry out keyboard and mouse operations. There might be subtle differences at times, but for the most part, the user should have a seamless experience.
- To make this possible, IT must use an application virtualization product. Application virtualization vendors and their products include Microsoft App-V, Citrix XenApp, Parallels Remote Application Server and VMware ThinApp or App Volumes.

Benefits of Application Virtualization

- Application virtualization can be an effective way for organisations to implement and maintain their desktop applications. One of the benefits of application virtualization is that administrators only need to install an application once to a centralised server rather than to multiple desktops.



Classification of Client Virtualization with Respect to Application



Application Packaging

In application packaging, virtualized environment is packed along with the application; so that the underlying hardware and the OS resources will not be attacked with malware/virus.

Although the specifics of how application packaging is accomplished vary from one vendor to another, all the methods share a common approach, that is, isolating an application that runs on a client machine from the underlying operating system. By isolating the application from the operating system, the application is unable to modify underlying critical operating system resources, making it much less likely that the OS will end up compromised by malware.

Application packaging is accomplished by executing the application on top of a software product that gives each application its own virtual set of system resources, such as, files and registry entries. Another approach of accomplishing application packaging is by bundling the application and the virtualization software into a single executable program that is downloaded or installed. Application packaging is a great way to isolate programs from one another and reduce virus transmission.

Products that provide application packaging include:

- SVS from Altiris
- Thinstall's Virtualization Suite
- Microsoft's SoftGrid

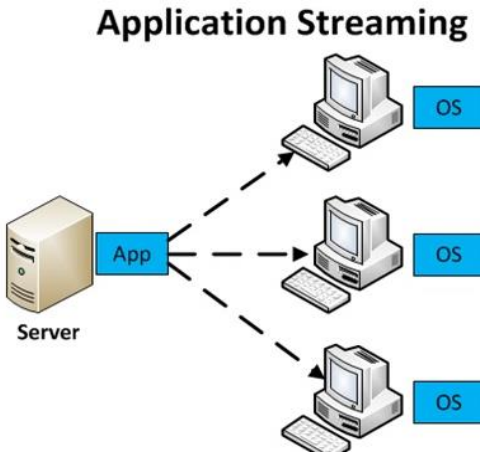
Application Streaming

It stores the proper versions of applications on servers in the data centres. Whenever an end user wants to use a particular application, it is downloaded on the fly to the end user's machine.

- Application packaging is a great way to isolate programs one another and reduce virus transmission, but it doesn't solve the problem of end users installing non-packaged software on client machines.
- Application streaming solves the problem of how to keep client machines loaded with up-to-date software in a completely different fashion than application packaging. Because it's so difficult to keep the proper versions of applications installed on client machines, this approach avoids installing them altogether. Instead, it stores the proper versions of

applications on servers in the data centre and when an end user wants to use a particular application, it is downloaded on the fly to the end user's machine.

- Examples of these situations include call centres and office environments where workers rarely leave the premises to perform work duties. This type of virtualization is offered by AppStream's Virtual Image Distribution, Softricity's SoftGrid for Desktops and Citrix's presentation server.
- Application streaming is best suited for static work environments where people don't move around much, such as, call centres and form-processing centres.



Case Study of Virtualization

Retail Chain Eases IT Manpower with Desktop Virtualization

Malaysia's supermart giant Mydin reduces the time needed to roll out new software patches from 120 man-hours to just 15 minutes and minimises the maintenance of thin-client devices due to desktop virtualization.

When it decided to deploy desktop virtualization, retail giant Mydin had the usual concerns associated with bandwidth and user resistance. So it focused most of its efforts on assuring employees about the benefits and is now reaping the rewards from better utilisation of its IT resources.

The Malaysia-based supermarket chain chalked up 2.1 billion ringgit (US$650.16 million) in revenue last year and is targeting to hit 2.5 billion ringgit (US$774 million) this year. It manages more than 200,000 items daily and is looking to open another three new hypermarkets over the next two years.

Case Study of Server Virtualization

The Challenge

Shelco had a number of servers reaching the end of their lifecycle. In today's environment, it was imperative for Shelco to find a cost-effective way to improve the end user's experience with Shelco systems. Rather than replacing hardware, Shelco was looking to virtualize on a SAN.

The Solution

AT-NET Services, Inc. installed a server virtualization solution utilising Cisco UCS Servers, VMware, and a NetApp Storage Area Network (SAN). The virtual server solution included: Physically staging the servers and SAN, configuration of the local network, servers and SAN, virtualizing seven servers, configuring backups and performing administrative training. The Impact

"The completed project has enabled Shelco to replace our aging physical servers with virtual machines. SAN performance has improved our end user experience and provided an enhanced capability for backup and disaster recovery planning. Our interaction with the ATNET team was outstanding. They did an outstanding job of understanding our needs and tailoring the initial proposal to win the job."

Case study 1: Financial Services Company Running Out of Space As computing needs continued to grow, an online financial services company faced a problem all too common in today's datacenters. The company was running out of space to house physical servers and its existing cooling infrastructure couldn't keep up.

New workloads meant addition of physical systems and valuable time was spent configuring those systems and balancing power distribution. Finally, the company turned to server virtualization technology to help solve its space problems and improve efficiency. Today, the company is 75% virtualized and runs 200 VMs on just 10 physical servers, leading to an estimated 33% savings in power use.

Case Study 2: Architectural Firm Uses Storage Area Network Technology in its Virtualization Rollout

- Storage area networks (SANs) have become commonplace in the modern data centre and are especially valuable for virtual systems. However, it is critical to plan and budget for all the technology needed to properly deploy and manage a SAN
- Planning ahead is also essential for identifying the potential costs that could surface beyond the initial SAN deployment and is key to realising the benefits of virtualization
- This case study shows what happened when an IT solution provider supported a data centre virtualization project for an architectural firm that did not budget for licensing costs and SAN management tools

Case study 3: Healthcare Provider Sees Benefits of Virtualization

- Virtualization isn't just for large datacenters supporting enterprise businesses. Even smaller organisations can use virtualization technologies to improve performance, as evidenced by this case study of a New York healthcare provider
- The company's director of IT was frustrated by frequent downtime caused by aging servers and had to manoeuvre his way through long-expired warranties and self-maintenance, and eventually turned to server virtualization software
- This case study illustrates why a well-built virtual infrastructure is often more reliable than its physical equivalent. It also demonstrates the other benefits of virtualization that can be realised, including high availability and increased reliability