

CC

MODULE -1

CHAPTER -1 → Introduction to CC

&
chapter - 3 → Virtualization

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Cloud Computing

Q1] What is the innovative characteristic of cloud computing?

The innovative characteristic of CC is "I don't care where my servers are, who manages them, where my documents are stored, or where my applications are hosted. I just want them always available & access them from any device connected through Internet. And am willing to pay for this service for as long as I need it."

Q2] Which are the technologies on which CC relies?

Cloud computing turns IT services into utilities. CC is composition of several technologies. ^① Web 2.0 technologies play a central role in making CC an opportunity for building computing s/m. CC serves complex needs.

② Service Orientation:- It allows CC to deliver its capabilities with abstractions.

③ Virtualization → It is the necessary technique for customization, control & flexibility for building production & enterprise s/m.

Q3] Give a brief characterization of a distributed s/m.

A distributed s/m is a collection of independent computers and forms as a single coherent s/m to its users.

computing technologies that led to cc?

The primary purpose of distributed s/m is to share resources & utilize them better. Distributed s/m exhibit properties such as heterogeneity, openness, scalability, transparency, concurrency, continuous availability and independent failures.

Q] Explain → Three major milestones have led to cc: (Distributed Computing Technologies)

① Mainframe computing:

Mainframes are powerful, highly reliable computers specialized for data movement & massive I/O operations.

App's/uses: (i) Used in large organisation for bulk data processing.

ii) Online Transactions

iii) Enterprise resource planning online

iv) Transaction processing ex:- banking, airline ticket booking, super market, govt services etc.

Features:

(i) Highly reliable computers.

Always "on" & capable of handling failures transparently.

ii) No s/m shut down required to replace failed components.

iii) Batch processing

iv) Large computational power, uses multiple processors.

② Cluster computing: low cost alternative to mainframes & super computers.

Technology advancement has created faster & more powerful mainframes with less cost & increased availability.

No. of machines are connected with each other to a high-bandwidth n/w & are controlled by sw tools. and were called commodity m/cs.

Advantage/features

Commodity m/cs can be low cost & manageable than expensive super computers.

③ Grid computing: It is an evolution of cluster computing. The need for to access large computational power, huge storage facilities has led to Grid computing.

~~Grid~~ ~~is~~ cluster belonged to different organisations were aggregated to form Grid which was geographically connected by Internet.

Many clusters were formed as a large cluster called a Grid to share the computational power & storage.

Q5] Define cloud computing.

Users access devices based on the requirements without regard to where the devices are hosted. This model is referred to as cloud computing. CC allows renting infrastructure, runtime environment & services on pay-per-use basis.

Q6] What is virtualization?

It is a technology that allows creation of different computing environments. Environments are called virtual because

they emulate the interface that is expected by a guest.

Ex: #/w virtualization.

a) 7) What is the major revolution introduced by Web 2.0?

Web 2.0 apps are dynamic. Web is the primary interface through which cloud computing delivers its services.

Web 2.0 provides interactivity & flexibility into web pages. Technologies such as XML, AJAX, web services etc. allows to build apps. These provided new opportunities & markets for the web, the services can be accessed by any devices: mobile ^(smart) phones, car dashboards, TV sets etc.

a) 8) Give some examples of web 2.0 apps.

Google Documents, Google Maps, Flickr, Facebook, YouTube, Twitter, Wikipedia etc.

a) 9) Describe the main characteristics of a service orientation.

Service Orientation is the core reference model for CC S/MS. Two main characteristics/concepts :-

(i) Quality of Service (QoS) :-

It identifies set of functional & non-functional attributes such as performance metrics i.e. response time, scalability, reliability & availability. QoS requirements are established b/w client & provider to identify response time.

ii) Concept of SaaS:- New delivery model for app^s. Here ASP (Appⁿ Service Provider) plays the important role. ASP is responsible for maintaining the infrastructure.

Web Services are also most popular in service orientation that works on HTTP.

Q10] What is utility computing?

Utility computing is a vision of computing that defines a service provisioning model for compute services in which resources such as storage, compute power, app^s & infrastructure are packaged & offered on a pay-per-use basis.

Q11] Briefly explain different computing platforms & technologies.

i] Amazon web Services (AWS):- AWS offers cloud IaaS services. It has services such as

- * Elastic compute Cloud (EC2)
- * Simple Storage Service (S3)

EC2 → It provides users with customizable virtual h/w. It allows users to create their own templates for deploying s/w.

AWS is a cloud service provider. It is used for backup & sharing across different devices.

~~EC2~~ S3 provides organization of objects in ~~buckets~~ binary form. Users can store objects of any size, from simple files to entire disk images.

iii] Microsoft Azure:

It is a cloud Operating system & platform for developing apps in the cloud. Here there are apps organised into 3 types of Roles.

↳ Web Role

↳ Worker Role

↳ Virtual machine Role

Web Role → Designed to host a web app.

Worker Role → Container of apps for workload processing.

Virtual m/c Role → It provides virtual environment for applications to run.

iii] Hadoop:

Apache Hadoop is a open source framework for processing large data.

Hadoop is developed by Google, an app programming model which uses the algorithm called MapReduce which performs basic operations for data processing: map & reduce

Map → This transforms & synthesizes i/p data given by user.

Reduce → Aggregates the o/p obtained by the map operations.

iv] Manjrasoft Aneka:

It is a slw platform for developing cc apps. Aneka is a pure PaaS solution. It has scalable cloud middleware & has models such as - Task, Thread & MapReduce.

Q12] Discuss a closer look / bird's eye view of CC.

Fig 1.3 page 10

We have 3 models in CC environment

↳ Private / Enterprise cloud.

↳ Public cloud

↳ ~~Private cloud~~

↳ Hybrid clouds

Public clouds :- s/ms & services easily accessible to general public.

Ex: email.

It is less secure because of its openness.

Private cloud: It allows s/m services accessible within an organisation.

IBM cloud

Hybrid cloud: Combination of public & private cloud. Public cloud is used for non-critical operations. Private cloud is used for critical operations.

Telco cloud solution

Business or non-private cloud public

Cloud Manager → who manages the cloud & also other services.

Q13] With a neat diagram explain CC reference model.

Fig 1.5 in page - 12

Cloud computing services can be organised into layered view.

1) SaaS → Software as a Service.

It allows to use software applications as a service to end users.

Ex: Google Docs, Facebook, Flickr etc.

It provides multi-tenant environment for use of software by different users.

2) PaaS → Platform as a Service.

It provides run-time environment for application development tools.

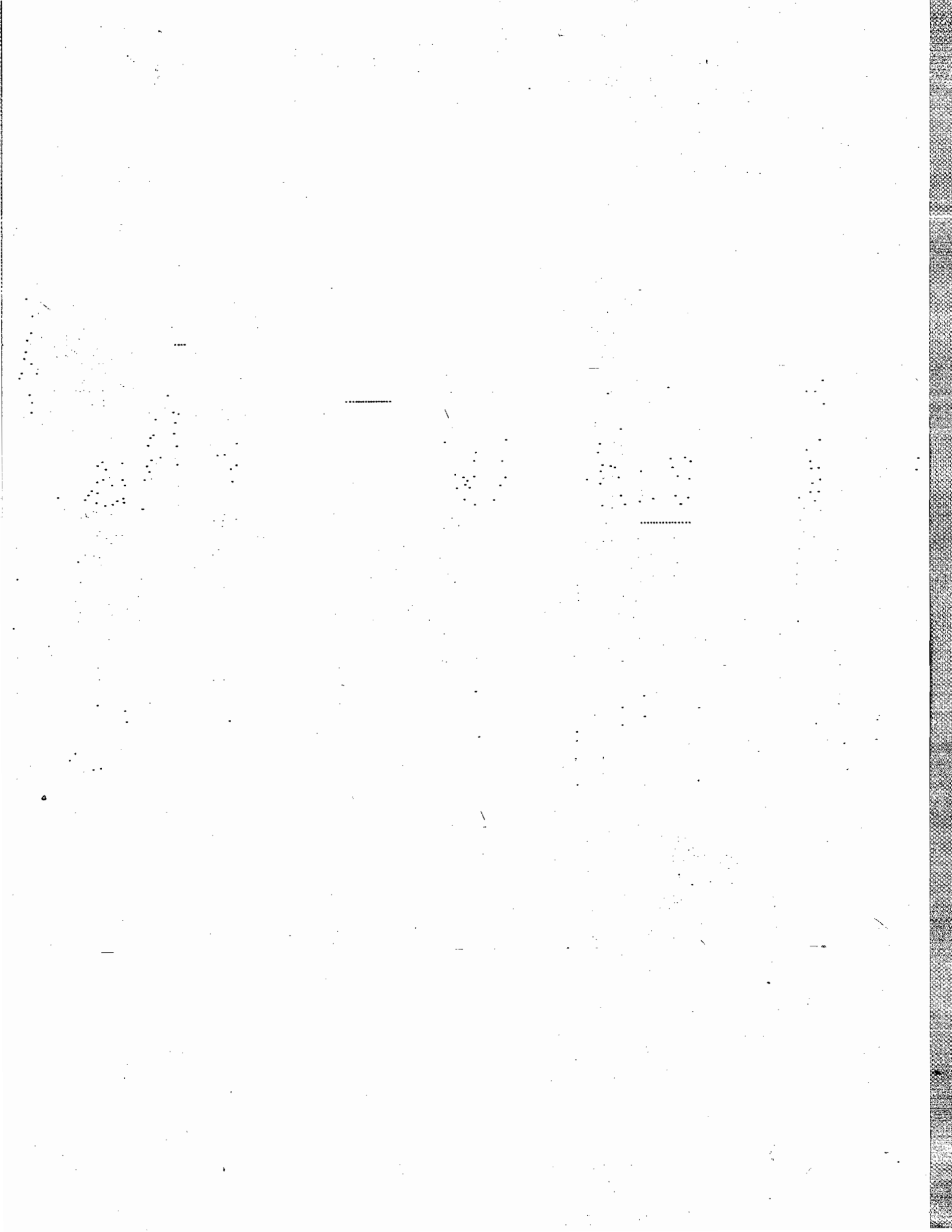
It provides all facilities required to support the complete lifecycle of building web applications & services from internet.

Ex: Aneka, AWS, Windows Azure, Hadoop
- Google App Engine etc.

3) IaaS → Infrastructure as a Service.

It provides infrastructure & allows access to fundamental resources such as physical machine, virtual machine, virtual storage & network.

Ex: AT & T cloud, NTT commⁿ
- Amazon EC2, S3 etc.



1] What is virtualization and what are its benefits?

Virtualization is a broad concept that refers to the creation of a virtual version of hardware, a software environment, storage or a n/w. In a virtualized environment there are 3 major components: guest, host & virtualization layer. Guest represents sm component such as appⁿ. Host represents the original environment such as physical h/w. The virtualization layer is responsible for recreating the same or a different environment where the guest will operate.) same ans for 2nd question

Advantages/Benefits:

1] Increased Security:

Virtual machine manager controls & filters the activity of the guest, thus preventing some harmful operations from being performed. Resources exposed by host can be hidden or protected from the guest.

Ex: applets downloaded from Internet are run on JVM, which provides limited access to the ^{host} operating sm resources.

2] Managed Execution:

It has features such as
 i) Sharing :- Fully utilizing the resources of guest which were underutilized.

ii) Aggregation: A group of separate hosts can be tied together & can be represented as a single virtual host.

iii) Emulation: Guest programs are executed by virtualization layer, emulates the different environment in the physical host. It can be useful for testing also.

iv) Isolation: Isolation provides or allows multiple guests to run on the same host without interfering with each other.

3] Portability: Guest is packed into a virtual image & can be safely moved & executed on top of different virtual machines.
Ex: binary code (jars or assemblies) can be run without recompilation on any virtual machine.

2] What are the characteristics of virtualized environment.

Refer figure 3.01 in Text book

Page No. 74

Virtualization Reference model.

(1st Question ⇒ Ans in Brackets) (Introduction)

(contd)

(i) In the case of hardware virtualization, the guest is represented by a s/m image consisting of OS & installed app's. App's are installed on top of virtual h/w that is controlled & managed by the Virtualization layer, also called virtual machine manager. Host is represented by physical h/w & in some cases OS, defines the environment where the virtual m/c manager is running.

② In case of virtual networking,
Guest i.e. appⁿs & users interact
with a virtual n/w, such as VPN
(Virtual Private N/w). VPNs are useful
for creating the illusion of being within
a different physical n/w & accessing the
resources in it.

3] Discuss the machine reference model of
Execution Virtualization.

Fig: 3.4 in Text Book 79

A machine reference model:

Modern computing s/ms can be expressed
in terms of reference model.

At the Bottom layer, we have ISA (Insⁿ
Set Architecture), it defines the instruction
set for the processor, registers, memory &
interrupt management. ISA is an ~~interface~~
interface b/w h/w & s/w.

Then we have ABI (Appⁿ Binary Interface)
It separates the OS layer from the
appⁿs & libraries, managed by the OS.
ABI deals with low level data types &
defines format for executable programs.
s/m calls are defined in this layer.

Highest level of abstraction is represented
by API (Appⁿ Programming Interface)
API's interface appⁿs to libraries and
underlying OS.

The high-level abstraction is converted into m/c level insⁿs to perform the actual operations supported by the processor.

H7] Explain with figure, security rings & privilege modes.

Fig 3.5 page 80 in Textbook.

Privileged insⁿs are those that are executed under specific restrictions & used for sensitive operations such as operation of I/O & altering the state of CPU registers.

Non-Privileged insⁿs are those that can be used without interfering with other tasks because they do not access shared resources.

Ring Security → We have Ring 0, 1, 2 & 3.

Ring 0 is the most privileged level.

Ring 3 is the least privileged level.

Ring 0 is used by the kernel of OS.

Ring 3 is used by ~~host~~ user.

⇒ Ring 1 & 2 are used by OS level services.

All s/m's have different execution modes: supervisor mode & user mode.

(supervisor) An execution mode in which all insⁿs can be executed without any restriction is called the master mode or kernel mode. It is used by Hypervisor to perform sensitive opⁿs on h/w.

A mode where insⁿs are executed with restriction is called user mode.

Q5]

Discuss h/w level virtualization.

Fig 3.6 in page 81

H/w-level virtualization is also called s/m virtualization. It provides execution environment in terms of computer h/w on top of which guest OS can be run.

In this model, guest is \rightarrow OS

Host is \rightarrow Physical h/w

Virtual m/c is by emulation

Virtual m/c manager \rightarrow Hypervisor.

Hypervisor:- (VMM)

It recreates a h/w environment in which guest OS are installed. There are 2 major types of Hypervisor:

\rightarrow Type I :- These hypervisors run directly on top of the h/w. It means they take place of OS & interact directly with ISA interface in h/w. Then ISA interface is emulated to manage guest OS. They are also called native virtual machine because they run natively on h/w.

\rightarrow Type II \rightarrow These hypervisors require the support of OS to provide virtualization services. Here ABI interface is present through which programs are interacted. ISA interface is then emulated for guest OS.

They are also called hosted virtual machine, because they are hosted within an OS.

Hypervisor / vmm has 3 main modules :-

1] Dispatcher → Entry point of monitor & routes the insⁿs to other modules

2] Allocator → Responsible for deciding & lm resources given by virtual m/c.

3] Interpreter → It consists of Interpreter routines which are executed whenever virtual m/c executes privileged insⁿs.

Q6] List & Explain h/w virtualization techniques

* H/w Assisted Virtualization:-

This is a term in which h/w provides architectural support for building vmm to run a guest OS.

Ex: IBM s/m/370, Xen, Hyper-V & so on.

* Full Virtualization:- It refers to run a program directly on top of virtual m/c, without any modification as though it was run on raw h/w.

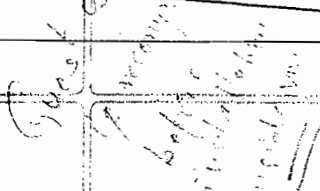
Advantages:-

* Complete Isolation

* Enhanced Security

* Different s/m on same platform.

* Para Virtualization:- Not Transparent Virtualization.



In this, sw interface is exposed to the virtual m/c that is modified from the host.

Adv:- Demand the execution of
— performance critical operation.

Ex: TRANGO, Wind River.

* Partial Virtualization:- It provides partial emulation of h/w. There is no complete execution of guest OS in complete isolation.

Adv:- Appⁿs can run transparently

— Multiple appⁿs & users
can run concurrently in separate memory.

* OS level Virtualization:-

It allows us to create different and separated execution environment for appⁿs that are managed concurrently.

Here there is no VMM/Hypervisor

Adv:-) Virtualization is done by single OS.

) It provides isolated user space.

Ex: FreeBSD, openVZ.

* Programming language level Virtualization

It is used for managing execution of appⁿs across different platforms & OS.

Here, virtual m/c will execute byte code of a program.

Ex: JVM (Java virtual m/c)

* Appⁿ level Virtualization:-

It allows appⁿs to be run in runtime environment in any platform as though they are run in same m/c.

It focus on 2 concepts

Interpretation & Binary Translation.

Ex: Wine, WABE.

allow UNIX OS to execute on windows platform

Q7] Explain other types of Virtualization

i] Storage Virtualizations

It provides physical organisation of h/w in a logical form. Using this users need not worry about location of their data, because it can be found by a logical path.

Ex: SAN (Storage Area N/w)

* Network Virtualizations

It is a combination of h/w & s/w for creating & managing virtual network. Two types of virtualization

↳ VLAN (External n/w virtualization)

→ Internal n/w virtualization

VLAN is hosts connected with each other in such a way that they look like located in same domain.

To access the n/w, NAT (N/w Address Translation) protocol is used.

* Desktop Virtualizations

Virtualization on a personal computer to provide access to client/server approach

Adv:- 1) Remotely access any host.

2) High Availability infrastructure

3) Ease of management & accessibility

* Appⁿ Server Virtualizations

It is collection of application servers that are emulated as a single virtual appⁿ server.

Adv:- Load Balancing

High Availability Infrastructure
Better Qos (Quality of Service)

Q8) What are disadvantages of virtualization

I] Performance Degradation:-

* Maintaining status of virtual processors

* Support of privileged insⁿs.

* Support of paging within VM.

* Console functions

2] Inefficiency & degraded user experience

3] Security holes & new threat

* Phishing technique.

* Malicious programs can extract sensitive info from guest.

Ex: malware such as Blue Pill
and Subvert.

Sensitive info extraction
malicious programs
detection (padding)

Q8]

What is Xen? Discuss its elements for virtualization.

Xen is an open source virtualization platform based on para virtualization.

[Fig 3.11 in page 96]

Xen based s/m is managed by the Xen hypervisor.

Xen hypervisor runs in highest privileged mode & controls access of guest OS to the underlying h/w.

Guest OS is executed within domains which are virtual machine instances.

(vm instances)

In Domain 0 → Special domain where there is a control p/w which has ^{privilege} access to host & controls ^{all} other guest OS.

We have security levels in the form of Rings:-

Ring 0 → Hypervisor is executed and in Domain 0.

Ring 3 Domain U → User apps are run.

Ring 0 → Highest privilege mode
(Supervisor / Kernel / Master)

Ring 3 → Lowest level privilege mode
(User mode)

All user

all apps utilize

100% loads → to each code
RING 0 & RING 3 — user apps

run by all OS mode

Advantages: It prevents access to Hypervisor mode by user apps. ~~also~~ by protecting virtualized environment with an interrupt called trap/silent fault protecting normal opⁿ of Guest OS.

Q 9) Discuss the architecture of Hyper-V.

Hyper-V supports multiple & concurrent execution of guest OS by partitions.

A partition is a completely isolated environment in which an OS is installed & run.

There are 2 types of partitions &

* Parent Partition (Root)

* Child Partition.

Parent partition has direct access to the h/w. It owns virtualization stack, it hosts the drivers that are required to configure guest OS.

Child partition - It is created by parent partition through hypervisor. Child partitions are used to host guest OS & do not have access to the h/w.

Interaction with child partition is controlled by hypervisor or parent partition.

Two types of Partitions exist.

- 1] Enlightened I/O partition
- 2] Unenlightened I/O partition.

Enlightened I/O → In this guest OS is supported by Hyper-V

UnEnlightened I/O → Guest OS is not supported by Hyper-V, instead h/w is emulated.

Parent Partition (contd) :-

Parent partition executes ^{the} host OS. Parent partition manages the execution, creation & destruction of child partitions. It is done by VID (Virtualization Infrastructure Driver).

This VID controls access to the hypervisor and allows management of virtual processors & memory.

Whenever a child partition is created VMOP is instantiated in parent process (Virtual Machine Worker Process), then child partition interacts via hypervisor through VID.

Hyper-V Hypervisor :- It has following components :-

1] Hypercalls Interface :- This interface is used by drivers in the partitioned OS to contact hypervisor. (For the exeⁿ of sensitive ins.)

2] Memory Service Routines (MSR) :- To translate virtual memory address.

3] Advanced Programmable Interrupt Controller (APIC)
It manages the signals ^{coming} from h/w when some event occurs like I/O ready, trap exception, timer expired etc.

4] Scheduler :- It schedules virtual processors to run on available physical processors.

5] Address Manager :- To manage virtual n/w address that are allocated to each of guest OS.

6] Partition Manager :- Responsible for partition creation, destruction & configurations through

of Explain Server Virtualization using VMware technology example.

VMware is based on the concept of full virtualization, where underlying h/w is replicated & made available to guest OS. VMware implements full virtualization by Type II Hypervisor for desktop environment & Type I for Server Environment.

Fig: 3.14 in page 101

Server Virtualization:-

Here we have earlier VMware GSX server, which is used to replicate for end user computers.

The architecture is designed to serve the virtualization of web servers.

There is a process called Daemon process called serverd, it controls & manages VMware appⁿ processes. Appⁿs are connected by VMware driver installed on host OS. User requests are routed from web server to vmm by serverd.

There is a base of bare metal servers & they provide services for virtual m/c management.

Ex: VMware ESX server

Q 11) Explain End user (desktop) virtualization using VMware technology.

Fig:- 3.13 page 100

VMware allows installing differ OS & app^s in a completely isolated environment called guest OS.

We use VM^{ware} software - VMware Workstation for windows OS and VMware Fusion for Mac OS X environments.

By creating virtual machines & managing their execution we can save resources of the host m/c. Resources such as (USB devices, folder sharing & GUI of OS)

We have VMM, which takes control of CPU & MMU.

Virtual m/c images are saved in a collection of files on the host file s/m.

Ex! VMware Player is a version of VMware workstation that allows creating & playing virtual m/cs in a Windows or Linux OS.

— END OF MODULE -1 —