



GALGOTIAS  
UNIVERSITY

**School of Computing  
Science and Engineering**

Program: Btech

Course Code: CSCC3050

Course Name: Cloud Organization &  
Architecture



## Course Prerequisites

- **Basic understanding of computer architecture, Operating systems, networking and databases**



## Course Outcomes :

### CO1

- To provide a brief introduction to general issues, benefits, challenges , and architectural framework in Cloud Computing

### CO2

- Specify the need of transition from classic data center to virtual data center.

### CO3

- Find out when and in which situation virtualization technology needs to be applied and at what levels.

### CO4

- Students will get the ability to design applications in Cloud considering the best practices in Cloud.

### CO5

- Students will have the knowledge to make informed decisions about migrating to cloud infrastructure.

### CO6

- Critically analyze case studies to derive the best practice model to apply when developing and deploying cloud based applications



## SYLLABUS

### **Unit I – Introduction to Cloud Computing**

This unit focuses on the business drivers, definition, essential characteristics and phases of journey to the cloud. Business drivers for Cloud computing, Definition of Cloud Computing, Characteristics of Cloud computing as per NIST, Steps involved in transitioning from Classic data center to Cloud computing environment.

### **Unit II - Classic Data Center (CDC)**

Key elements of CDC-compute, storage and network, with focus on storage networking, business continuity and data center management. Application , DBMS, Compute, Storage and Networking, Object based and Unified storage technologies, Business continuity overview and backup, Replication technologies, CDC management.

### **Unit III - Visualized Data Center (VDC)**

This unit focuses on the visualization of core technologies in a data center, leading to Virtualized Data Center (VDC). It explains the fundamental concepts of compute, storage, networking, desktop and application visualization. Concepts and techniques employed for ensuring business continuity in a virtualized data center. Compute, Storage, Network virtualization techniques, Virtual machine(VM) components and process of converting physical to VMs, Block and file level storage virtualization, Virtual provisioning and automated storage tiering, Virtual LAN (VLAN) and Virtual SAN (VSAN) and their benefits, Key network traffic management techniques in VDC. VM replication and migration technologies, recovery options from total site failure due to a disaster.

### **Unit IV - Cloud Computing and Infrastructure**

Essential characteristics of Cloud Computing, the different Cloud services and deployment models, the economics of Cloud, Cloud infrastructure components and Cloud service creation processes. Cloud service management processes that ensure that the delivery of cloud services is aligned with business objectives and expectations of cloud service consumers. Cloud service models, Cloud deployment models, Economics of Cloud, Cloud infrastructure components, Cloud service creation processes, Cloud service management processes.

### **Unit V - Cloud Security and Migration to Cloud**

Security concerns and migration considerations to cloud. Key security concerns and threats and details Cloud model suitable for different categories of users. Security concerns and counter measures in a VDC and Cloud environment, Governance, Risk, and Compliance aspects in Cloud, Cloud security best practices, Cloud models suitable for different categories of uses, Consideration for choosing applications suitable for Cloud, Different phases to adopt the Cloud.

### **Unit VI: Advances and the Latest Trends**

The advances and the latest trends in the course as well as the latest applications of the areas covered in the course. The latest research conducted in the areas covered in the course. Discussion of some latest papers published in IEEE transactions and ACM transactions, Web of Science and SCOPUS indexed journals as well as high impact factor conferences as well as symposiums.



## **Recommended Books**

### **Text books**

- “Anthony T., Velte, “Cloud Computing: A Practical Approach”, Tata McGraw Hill Education Pvt. Ltd., 2009, ISBN: 0070683514
- Halper Fern, Kaufman Marcia, Bloor Robin, Hurwit Judith, “Cloud Computing for Dummies”, Wiley India Pvt. Ltd., 2009, ISBN: [8126524871](#)

### **Reference Book**

- Gautam Shroff, “Enterprise Cloud Computing Technology Architecture Applications”,
- Cambridge University Press; 1 edition, [ISBN: 978-0521137355], 2010
- Toby Velte, Anthony Velte, Robert Elsenpeter, “Cloud Computing, A Practical Approach” McGraw-Hill Osborne Media; 1 edition [ISBN: 0071626948], 2009.



## Cloud Computing

- ON- Premise IT Infrastructure
  - Customer has to Procure HW and SW – **Provider**
  - Provision it in their Data Center – **Provider**
  - People – Manage
    - **Hardware – Provider**
    - **Service – Provider / Customer**



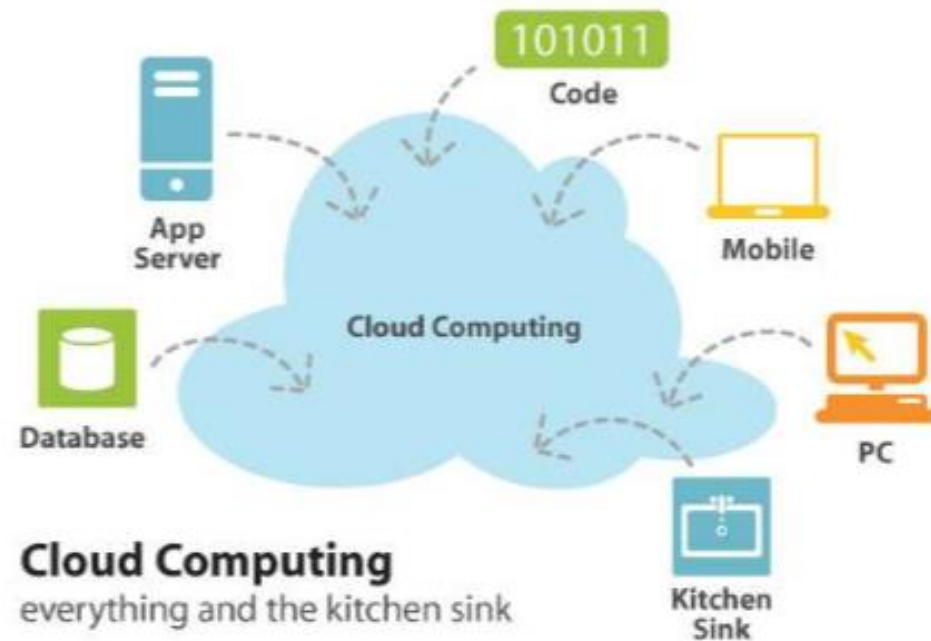
## Benefit for Customer

- No Upfront Costs - Monthly Rental  
- Subscription
- Pay for what you use
- Data Center
- No HW maintenance



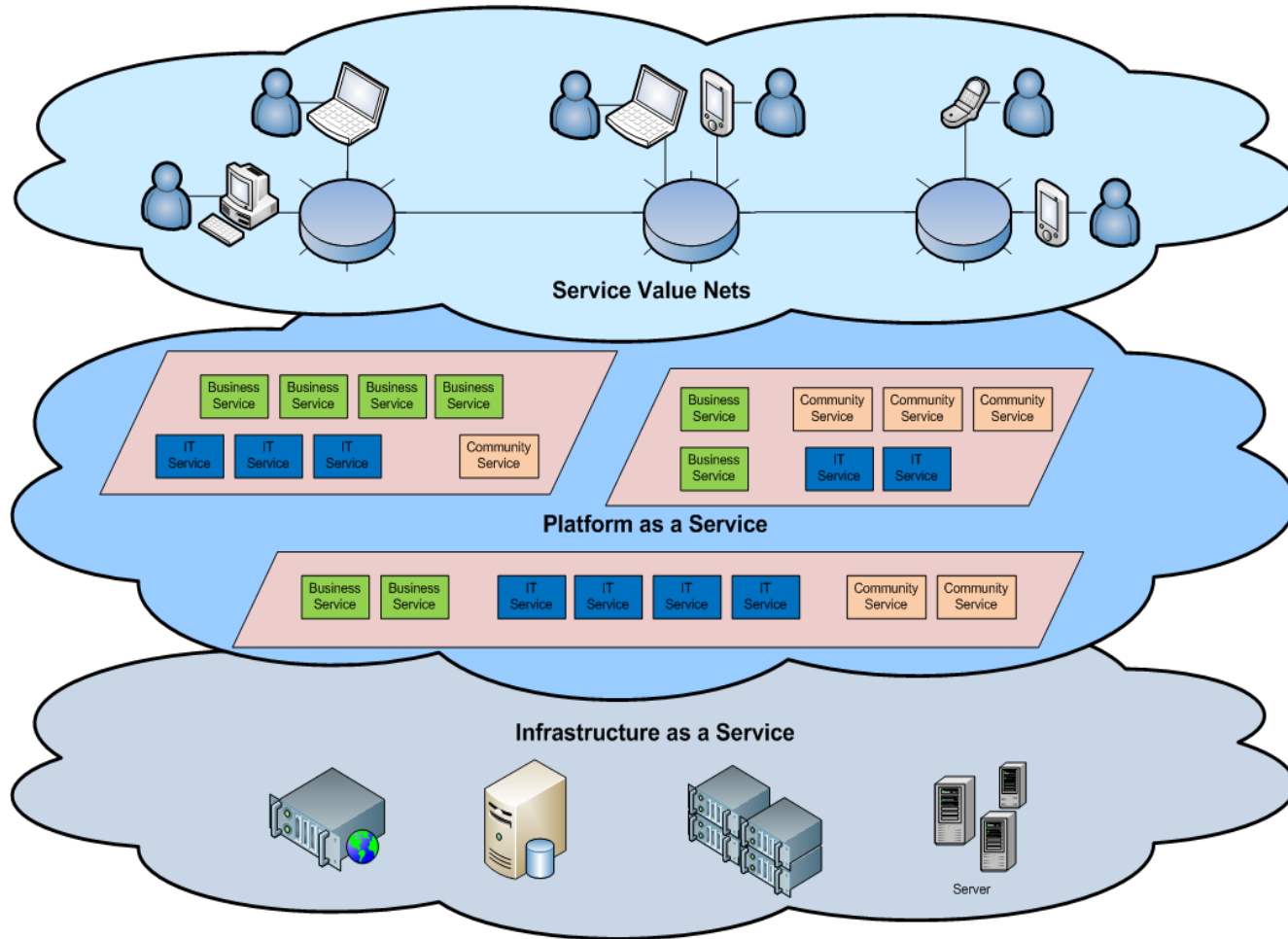
## Introduction to Cloud Architecture

Cloud computing allows computer users to conveniently rent access to fully featured applications, to software development and deployment environments, and to computing infrastructure assets such as network-accessible data storage and processing.

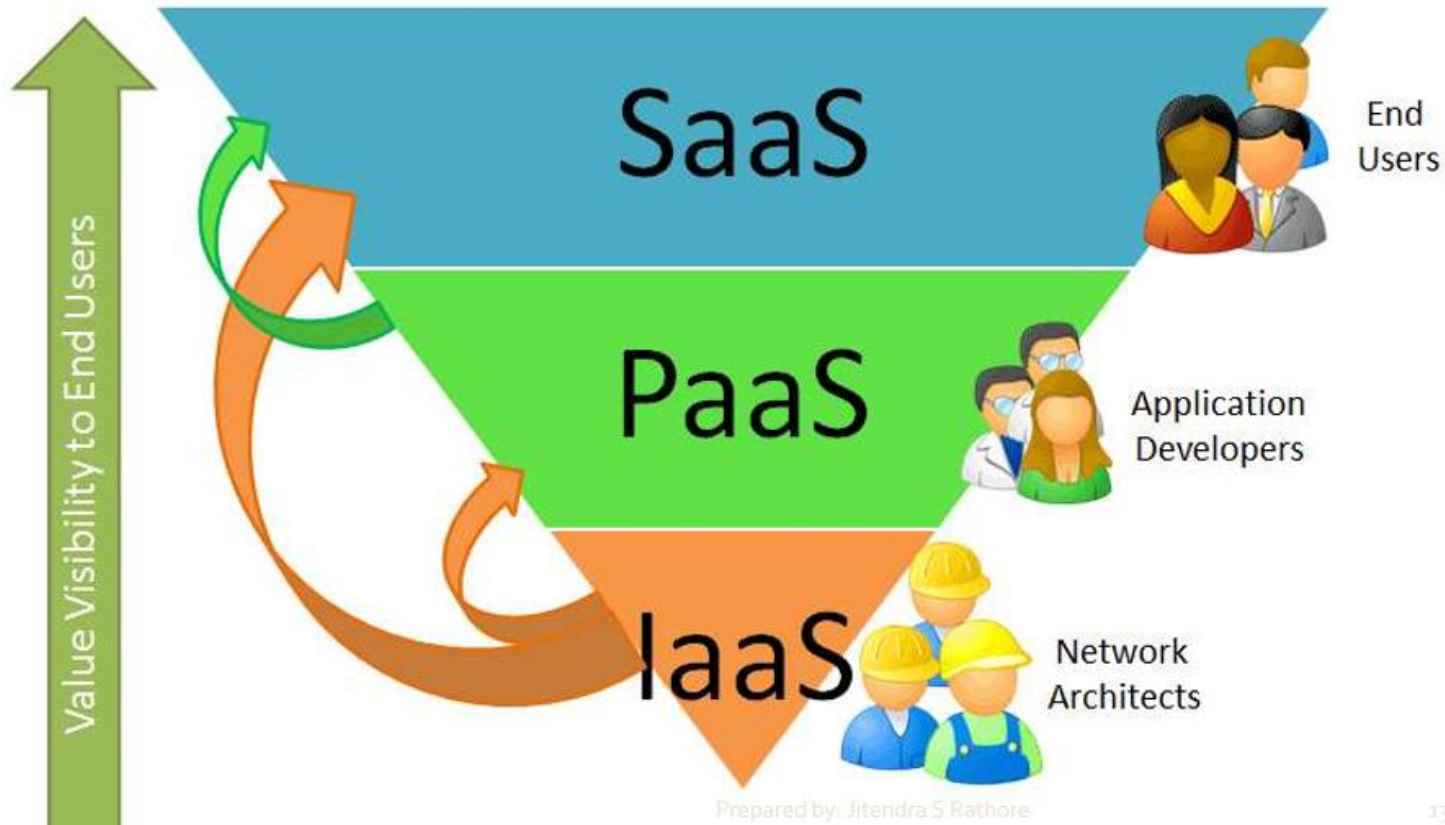




# Introduction to Cloud Architecture



## Service Models



Prepared by: Jitendra S Rathore

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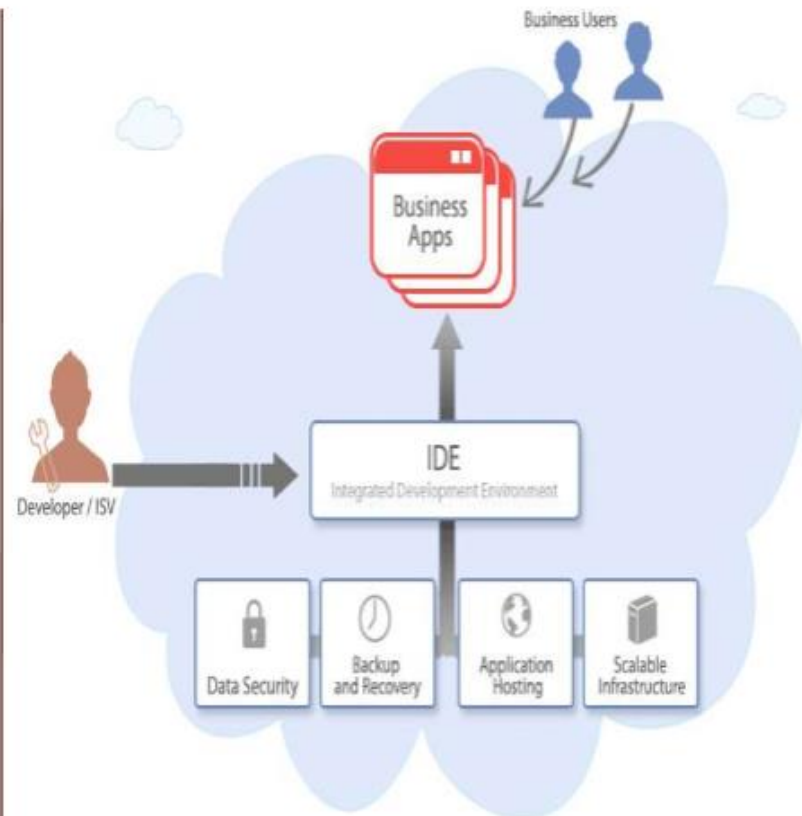
## Service Models

▪ **Software as a Service (SaaS)** - The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a Web browser (e.g., Web-based email). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.



## Service Models

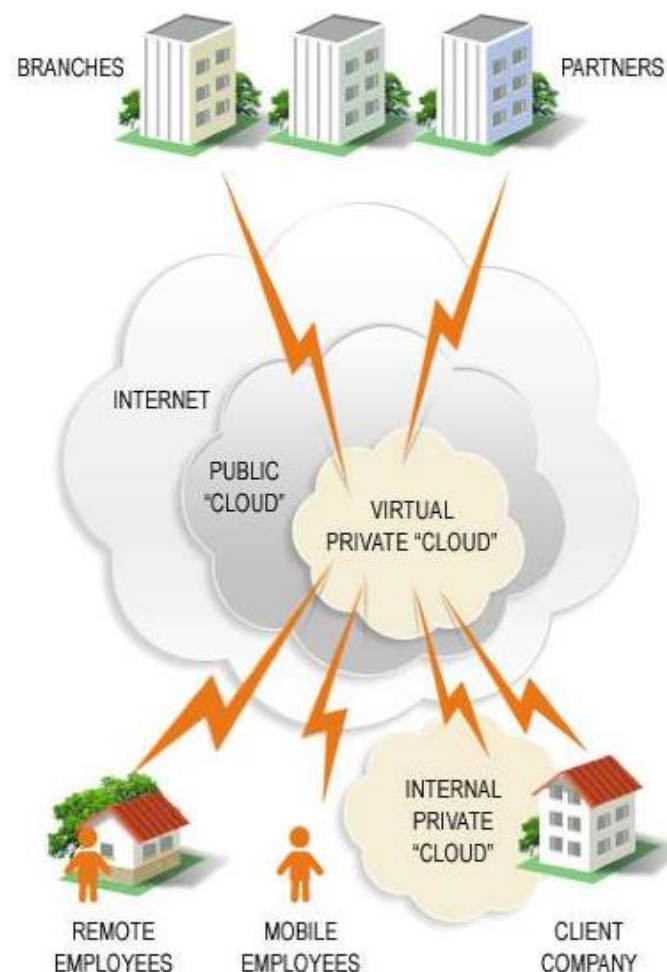
▪ **Platform as a Service (PaaS)** - The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or -acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.



## Service Models

### ▪Infrastructure as a Service (IaaS) -

The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).



# Cloud Service Models

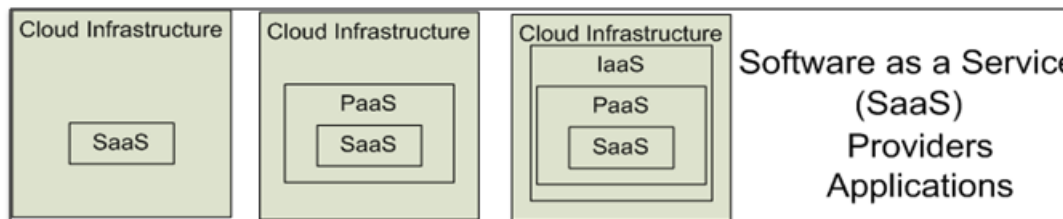
Software as a Service (SaaS)

Platform as a Service (PaaS)

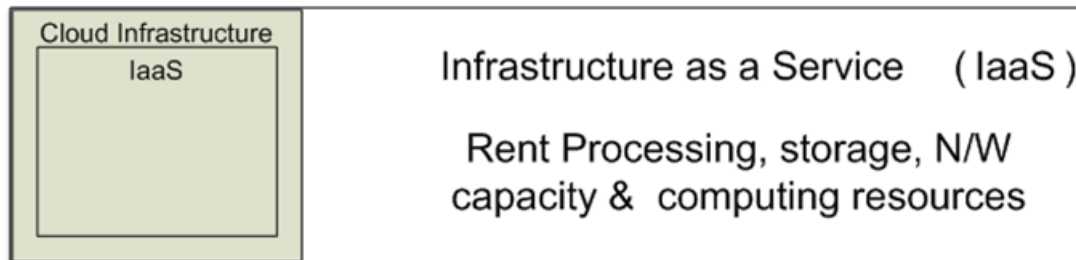
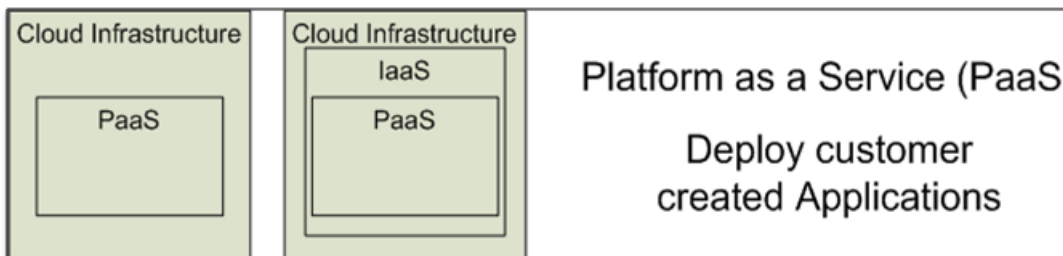
Infrastructure as a Service (IaaS)

SalesForce CRM

LotusLive



Google App



## Deployment Models

▪ **Private cloud** - The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.

▪ **Community cloud** - The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.

▪ **Public cloud** -The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.

▪ **Hybrid cloud** - The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).



# Cloud Computing Service Layers

	Services	Description
<b>Application Focused</b>	<b>Services</b>	Services – Complete business services such as PayPal, OpenID, OAuth, Google Maps, Alexa
	<b>Application</b>	Application – Cloud based software that eliminates the need for local installation such as Google Apps, Microsoft Online
	<b>Development</b>	Development – Software development platforms used to build custom cloud based applications (PAAS & SAAS) such as Salesforce
<b>Infrastructure Focused</b>	<b>Platform</b>	Platform – Cloud based platforms, typically provided using virtualization, such as Amazon ECC, Sun Grid
	<b>Storage</b>	Storage – Data storage or cloud based NAS such as CTERA, iDisk, CloudNAS
	<b>Hosting</b>	Hosting – Physical data centers such as those run by IBM, HP, NaviSite, etc.



# Basic Cloud Characteristics

- The “**no-need-to-know**” in terms of the underlying details of infrastructure, applications interface with the infrastructure via the APIs.
- The “**flexibility and elasticity**” allows these systems to scale up and down at will
  - utilising the resources of all kinds
    - CPU, storage, server capacity, load balancing, and databases
- The “**pay as much as used and needed**” type of utility computing and the “**always on!, anywhere and any place**” type of network-based computing.

# Advantages of Cloud Computing

- Lower computer costs:
  - You do not need a **high-powered and high-priced computer** to run cloud computing's web-based applications.
  - Since applications run in the cloud, not on the desktop PC, your desktop PC does not need the processing power or **hard disk space demanded by traditional desktop software**.
  - When you are using web-based applications, your PC can be **less expensive, with a smaller hard disk, less memory, more efficient processor...**
  - In fact, your PC in this scenario **does not even need a CD or DVD drive, as no software programs have to be loaded** and no document files need to be saved.

# Advantages of Cloud Computing

- Improved performance:
  - With **few large programs hogging your computer's memory**, you will see better performance from your PC.
  - Computers in a cloud computing system boot and run faster because they have fewer programs and processes loaded into memory...
- Reduced software costs:
  - Instead of **purchasing expensive software applications**, you can get most of what you need for free-ish!
    - most cloud computing applications today, such as the **Google Docs** suite.
  - better than paying for similar commercial software
    - which alone may be justification for switching to cloud applications.

# Advantages of Cloud Computing

- Unlimited storage capacity:
  - Cloud computing offers **virtually limitless storage**.
  - Your computer's current 1 Tbyte hard drive is small compared to the hundreds of Pbytes ( $10^{15}$  bytes of data or 1,000 terabytes) available in the cloud.
- Increased data reliability:
  - Unlike desktop computing, in which if a hard disk crashes and destroy all your valuable data, a computer crashing in the cloud should not affect the storage of your data.
    - if your personal computer crashes, all your data is still out there in the cloud, still accessible
  - In a world where few individual desktop PC users back up their data on a regular basis, cloud computing is a data-safe computing platform!

# Advantages of Cloud Computing

- Universal document access:
  - That is not a problem with cloud computing, because you do not take your documents with you.
  - Instead, they stay in the cloud, and you can access them whenever you have a computer and an Internet connection
  - **Documents are instantly available from wherever you are**
- Latest version availability:
  - When you edit a document at home, that edited version is what you see when you access the document at work.
  - The cloud always hosts the latest version of your documents
    - as long as you are connected, you are not in danger of having an outdated version

# Advantages of Cloud Computing

- Easier group collaboration:
  - Sharing documents leads directly to better collaboration.
  - Many users do this as it is an important advantages of cloud computing
    - multiple users can collaborate easily on documents and projects
- Device independence.
  - You are no longer tethered to a single computer or network.
  - Changes to computers, applications and documents follow you through the cloud.
  - Move to a portable device, and your applications and documents are still available.

# Disadvantages of Cloud Computing

- Requires a constant Internet connection:
  - Cloud computing is impossible if you cannot connect to the Internet.
  - Since you use the Internet to connect to both your applications and documents, if you do not have an Internet connection you cannot access anything, even your own documents.
  - A dead Internet connection means no work and in areas where Internet connections are few or inherently unreliable, this could be a deal-breaker.

# Disadvantages of Cloud Computing

- Does not work well with low-speed connections:
  - Similarly, a low-speed Internet connection, such as that found with dial-up services, makes cloud computing painful at best and often impossible.
  - Web-based applications require a lot of bandwidth to download, as do large documents.
- Features might be limited:
  - This situation is bound to change, but today **many web-based applications simply are not as full-featured as their desktop-based applications.**
    - For example, you can do a lot more with Microsoft PowerPoint than with **Google Presentation's web-based offering**



# Disadvantages of Cloud Computing

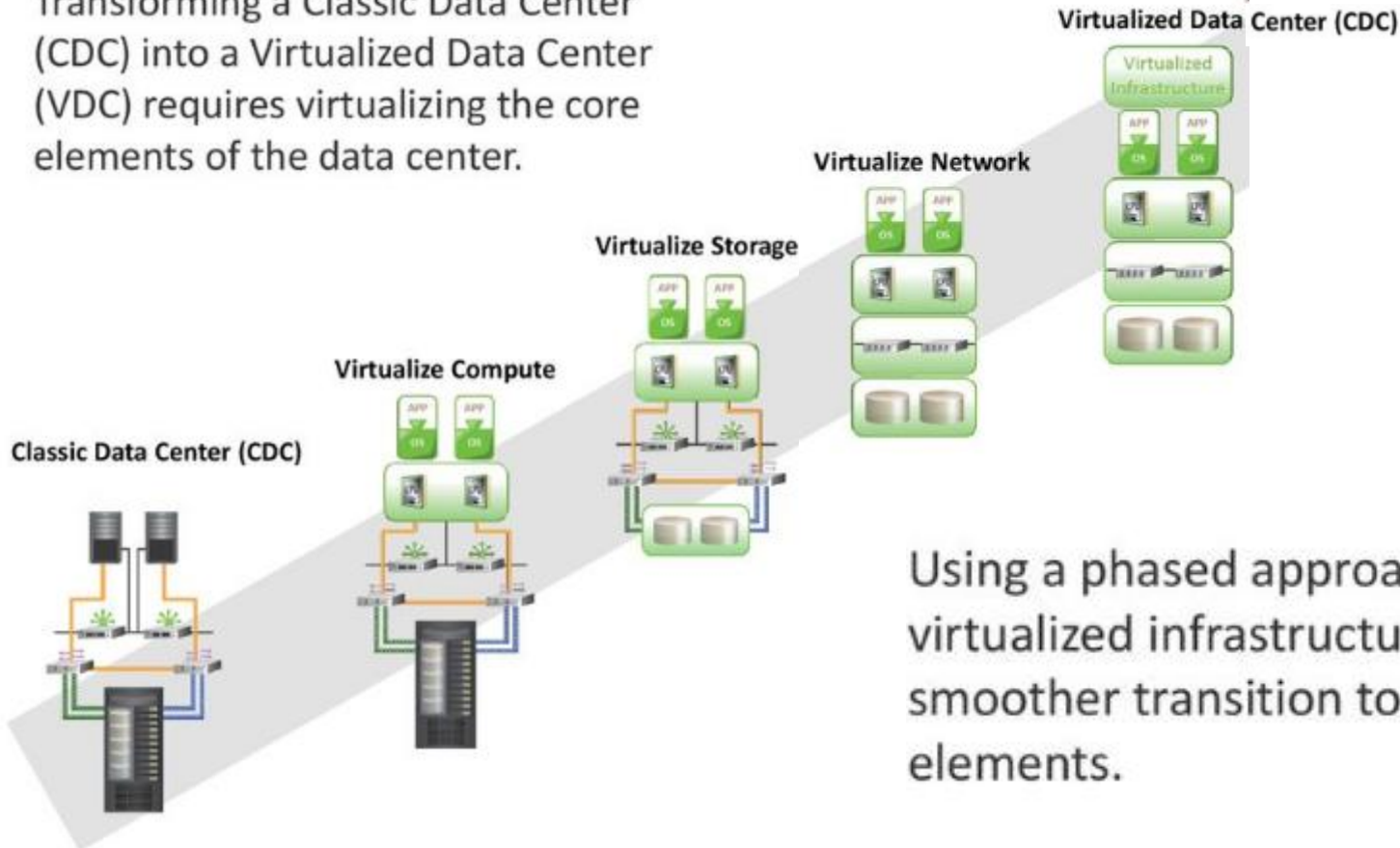
- Can be slow:
  - Even with a fast connection, web-based applications can sometimes be slower than accessing a similar software program on your desktop PC.
  - Everything about the program, from the interface to the current document, has to be sent back and forth from your computer to the computers in the cloud.
  - If the cloud servers happen to be backed up at that moment, or if the Internet is having a slow day, you would not get the instantaneous access you might expect from desktop applications.

# Disadvantages of Cloud Computing

- Stored data might not be secure:
  - With cloud computing, all your data is stored on the cloud.
    - The questions is How secure is the cloud?
  - Can unauthorised users gain access to your confidential data?
- Stored data can be lost:
  - Theoretically, data stored in the cloud is safe, replicated across multiple machines.
  - But on the off chance that your data goes missing, you have no physical or local backup.
    - Put simply, relying on the cloud puts you at risk if the cloud lets you down.

## Virtualized Data Center

Transforming a Classic Data Center (CDC) into a Virtualized Data Center (VDC) requires virtualizing the core elements of the data center.



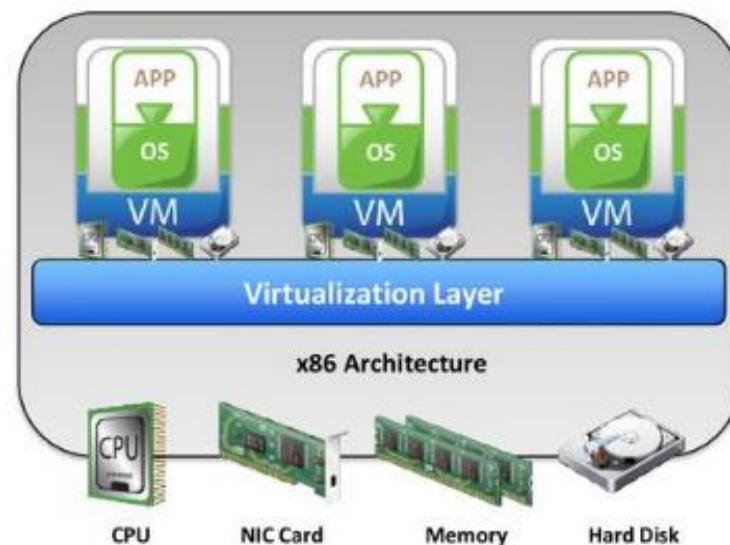
Using a phased approach to a virtualized infrastructure enables smoother transition to virtualize core elements.

## Compute Virtualization

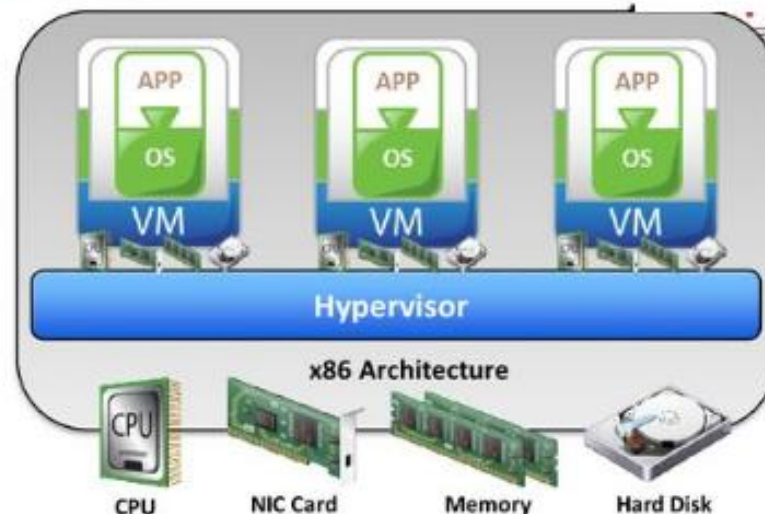
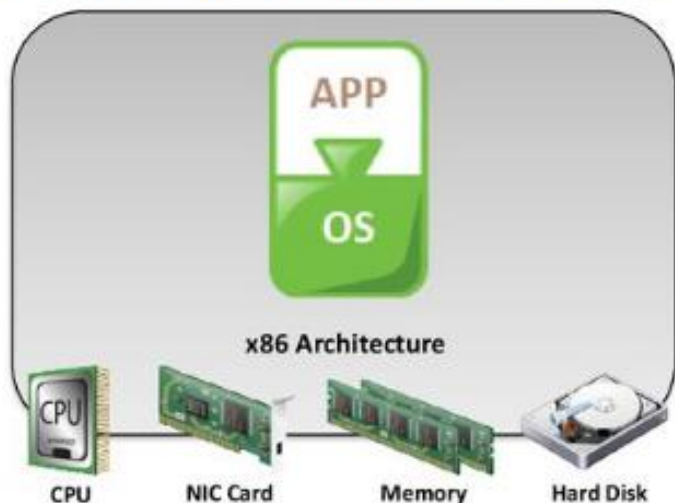
### Compute Virtualization

It is a technique of masking or abstracting the physical compute hardware and enabling multiple operating systems (OSs) to run concurrently on a single or clustered physical machine(s).

- Enables creation of multiple virtual machines (VMs), each running an OS and application
  - ▶ VM is a logical entity that looks and behaves like physical machine
- Virtualization layer resides between hardware and VMs
  - ▶ Also known as hypervisor
- VMs are provided with standardized hardware resources



## Need for Compute Virtualization



### Before Virtualization

- Runs single operating system (OS) per machine at a time
- Couples s/w and h/w tightly
- May create conflicts when multiple applications run on the same machine
- Underutilizes resources
- Is inflexible and expensive

### After Virtualization

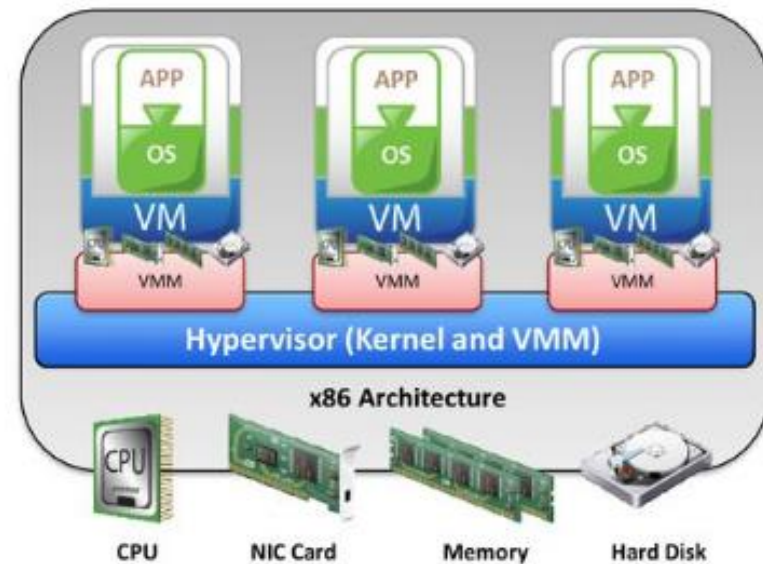
- Runs multiple operating systems (OSs) per machine concurrently
- Makes OS and applications h/w independent
- Isolates VM from each other, hence no conflict
- Improves resource utilization
- Offers flexible infrastructure at low cost

## Hypervisor

### Hypervisor

It is a software that allows multiple operating systems (OSs) to run concurrently on a physical machine and to interact directly with the physical hardware.

- Has two components
  - ▶ Kernel
  - ▶ Virtual Machine Monitor (VMM)

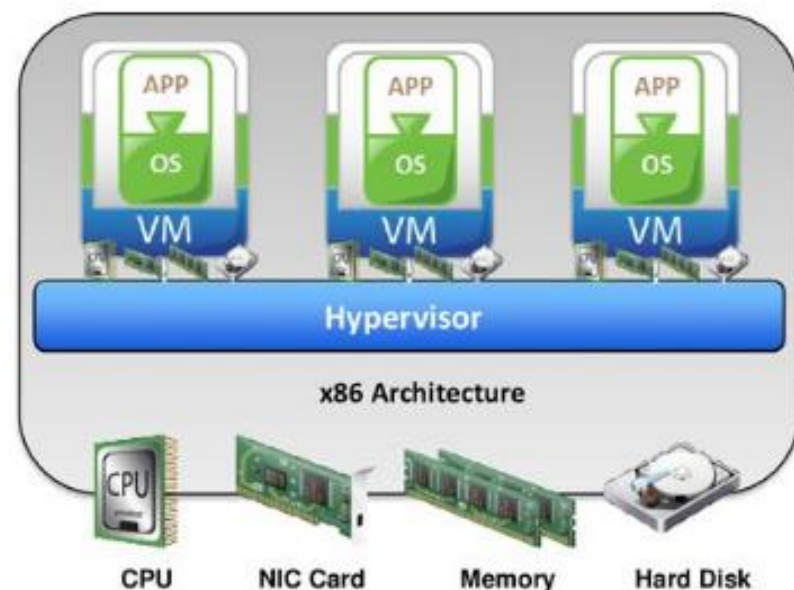


## Benefits of Compute Virtualization

- Server consolidation
- Isolation
- Encapsulation
- Hardware independence
- Reduced cost

## Virtual Machine

- From a user's perspective, a logical compute system
  - ▶ Runs an operating system (OS) and application like a physical machine
  - ▶ Contains virtual components such as CPU, RAM, disk, and NIC
- From a hypervisor's perspective
  - ▶ Virtual machine (VM) is a discrete set of files such as configuration file, virtual disk files, virtual BIOS file, VM swap file, and log file





## Virtual Machine Files

File name	Description
Virtual BIOS File	<ul style="list-style-type: none"><li>• Stores the state of the virtual machine's (VM's) BIOS</li></ul>
Virtual Swap File	<ul style="list-style-type: none"><li>• Is a VM's paging file which backs up the VM RAM contents</li><li>• The file exists only when VM is running</li></ul>
Virtual Disk File	<ul style="list-style-type: none"><li>• Stores the contents of the VM's disk drive</li><li>• Appears like a physical disk drive to VM</li><li>• VM can have multiple disk drives</li></ul>
Log File	<ul style="list-style-type: none"><li>• Keeps a log of VM activity</li><li>• Is useful for troubleshooting</li></ul>
Virtual Configuration File	<ul style="list-style-type: none"><li>• Stores the configuration information chosen during VM creation</li><li>• Includes information such as number of CPUs, memory, number and type of network adaptors, and disk types</li></ul>

## Benefits of Compute Virtualization

- Server consolidation
- Isolation
- Encapsulation
- Hardware independence
- Reduced cost



Thank You