Cloud Computing Deployment Model

This is a new model concept that can be divided into the following four famous models (but there might be other models that can be drawn from them)

•Public:
Services and resources are reachable to the public by using the internet. This environment emphasises the advantages of rationalization (as a user has the ability to utilize only the needed services and pay only for their use), operational simplicity (as the system is organized and hosted by a third party) and scalability. The main concern in this type of cloud environment is the security; since this environment is accessible to the public and user data in one stage is hosted by a third party.

•Private:
Services and resources are reachable within a private institute. This environment emphasises the advantages of integration, optimization of hardware deals and scalability. The main concern is the complexity, as this environment is organized and hosted by internal resources. Security is not a main issue compared to the public cloud as the services are reachable only through private and internal networks.

•Community:
Services and resources of this type are shared by various institutes with a common aim. It may be organized by one of the institutes or a third party

•Hybrid:
This type combines the methods from the private and public clouds, where resources can be used either in a public or a private cloud environment. The advantages and the concerns are a mixture of the earlier type. Another cloud technology which has become very popular recently is called Green Cloud Computing. Its aim is to reduce resource consumption and yet fulfil qu ality of service needed and hold the resources switched off as long as possible. “The advantages of such technology are lower heat production and power saving by employing server consolidation and virtualization technologies; since active resources (servers, network elements, and A/C units) that are idle lead to energy waste”

IaaS

Public Infrastructure as a Service providers commonly offer virtual servers containing one or more CPUs, running several choices of operating systems and a customized software stack. In addition, storage space and communication facilities are often provided.

IaaS provides virtual machines, virtual storage, virtual infrastructure, and other hardware assets as resources that clients can provision. The IaaS service provider manages all the infrastructure, while the client is responsible for all other aspects of the deployment. This can include the operating system, applications, and user interactions with the system.

Examples of IaaS service providers include:

• Amazon Elastic Compute Cloud (EC2)

• Eucalyptus

• GoGrid

• FlexiScale

• Linode

• RackSpace Cloud

• Terremark

Features

In spite of being based on a common set of features, IaaS offerings can be distinguished by the availability of specialized features that influence the cost—benefit ratio to be experienced by user applications when moved to the cloud. The most relevant features are: (i) geographic distribution of data centers; (ii) variety of user interfaces and APIs to access the system; (iii) specialized components and services that aid particular applications (e.g., load- balancers, firewalls); (iv) choice of virtualization platform and operating systems; and (v) different billing methods and period (e.g., prepaid vs. post-paid, hourly vs. Monthly).

Geographic Presence. To improve availability and responsiveness, a provider of worldwide services would typically build several data centers distributed around the world. For example, Amazon Web Services presents the concept of “availability zones” and “regions” for its EC2 service. Availability zones are “distinct locations that are engineered to be insulated from failures in other availability zones and provide inexpensive, low-latency network connectivity to other availability zones in the same region.” Regions, in turn, “are geographically dispersed and will be in separate geographic areas or countries.”

User Interfaces and Access to Servers. Ideally, a public IaaS provider must provide multiple access means to its cloud, thus catering for various users and their preferences. Different types of user interfaces (UI) provide different levels of abstraction, the most common being graphical user interfaces (GUI), command-line tools (CLI), and Web service (WS) APIs. GUIs are preferred by end users who need to launch, customize, and monitor a few virtual servers and do not necessary need to repeat the process several times. On the other hand, CLIs offer more flexibility and the possibility of automating repetitive tasks via scripts (e.g., start and shutdown a number of virtual servers at regular intervals). WS APIs offer programmatic access to a cloud using standard HTTP

requests, thus allowing complex services to be built on top of IaaS clouds.

Advance Reservation of Capacity. Advance reservations allow users to request for an IaaS provider to reserve resources for a specific time frame in the future, thus ensuring that cloud resources will be available at that time. However, most clouds only support best-effort requests; that is, users requests are server whenever resources are available.
Amazon Reserved Instances is a form of advance reservation of capacity, allowing users to pay a fixed amount of money in advance to guarantee resource availability at anytime during an agreed period and then paying a discounted hourly rate when resources are in use. However, only long periods of 1 to 3 years are offered; therefore, users cannot express their reservations in finer granularities—for example, hours or days.

Automatic Scaling and Load Balancing: As mentioned earlier in this chapter, elasticity is a key characteristic of the cloud computing model. Applications often need to scale up and down to meet varying load conditions. Automatic scaling is a highly desirable feature of IaaS clouds. It allow users to set conditions for when they want their applications to scale up and down, based on application-specific metrics such as transactions per second, number of simultaneous users, request latency, and so forth.
When the number of virtual servers is increased by automatic scaling, incoming traffic must be automatically distributed among the available servers. This activity enables applications to promptly respond to traffic increase while also achieving greater fault tolerance.

Service-Level Agreement. Service-level agreements (SLAs) are offered by IaaS providers to express their commitment to delivery of a certain QoS. To customers it serves as a warranty. An SLA usually include availability and performance guarantees. Additionally, metrics must be agreed upon by all parties as well as penalties for violating these expectations.
Most IaaS providers focus their SLA terms on availability guarantees, specifying the minimum percentage of time the system will be available during a certain period. For instance, Amazon EC2 states that "if the annual uptime Percentage for a customer drops below 99.95% for the service year, that customer is eligible to receive a service credit equal to 10% of their bill.[1]"

Hypervisor and Operating System Choice. Traditionally, IaaS offerings have been based on heavily customized open-source Xen deployments. IaaS providers needed expertise in Linux, networking, virtualization, metering, resource management, and many other low-level aspects to successfully deploy and maintain their cloud offerings. More recently, there has been an emergence of turnkey IaaS platforms such as VMWare vCloud and Citrix Cloud Center (C3) which have lowered the barrier of entry for IaaS competitors, leading to a rapid expansion in the IaaS marketplace.

Case Studies
In this section, we describe the main features of the most popular public IaaS clouds. Only the most prominent and distinguishing features of each one are discussed in detail. A detailed side-by-side feature comparison of IaaS offerings is presented in Table 1.2.

Amazon Web Services. Amazon WS[2] (AWS) is one of the major players in the cloud computing market. It pioneered the introduction of IaaS clouds in 2006. It offers a variety cloud services, most notably: S3 (storage), EC2 (virtual servers), Cloudfront (content delivery), Cloudfront Streaming (video streaming), SimpleDB (structured datastore), RDS (Relational Database), SQS (reliable messaging), and Elastic MapReduce (data processing).

1

2

The Elastic Compute Cloud (EC2) offers Xen-based virtual servers (instances) that can be instantiated from Amazon Machine Images (AMIs). Instances are available in a variety of sizes, operating systems, architectures, and price. CPU capacity of instances is measured in Amazon Compute Units and, although fixed for each instance, vary among instance types from 1 (small instance) to 20 (high CPU instance). Each instance provides a certain amount of nonpersistent disk space; a persistence disk service (Elastic Block Storage) allows attaching virtual disks to instances with space up to 1TB.

Elasticity can be achieved by combining the CloudWatch, Auto Scaling, and Elastic Load Balancing features, which allow the number of instances to scale up and down automatically based on a set of customizable rules, and traffic to be distributed across available instances. Fixed IP address (Elastic IPs) are not available by default, but can be obtained at an additional cost.
In summary, Amazon EC2 provides the following features: multiple data centers available in the United States (East and West) and Europe; CLI, Web services (SOAP and Query), Web-based console user interfaces; access to instance mainly via SSH (Linux) and Remote Desktop (Windows); advanced reservation of capacity (aka reserved instances) that guarantees availability for periods of 1 and 3 years; 99.5% availability SLA; per hour pricing; Linux and Windows operating systems; automatic scaling; load balancing.

Flexiscale. Flexiscale is a UK-based provider offering services similar in nature to Amazon Web Services. However, its virtual servers offer some distinct features, most notably: persistent storage by default, fixed IP addresses, dedicated VLAN, a wider range of server sizes, and runtime adjustment of CPU capacity (aka CPU bursting/vertical scaling). Similar to the clouds, this service is also priced by the hour.
In summary, the Flexiscale cloud provides the following features: available in UK; Web services (SOAP), Web-based user interfaces; access to virtual server mainly via SSH (Linux) and Remote Desktop (Windows); 100% availability SLA with automatic recovery of VMs in case of hardware failure; per hour pricing; Linux and Windows operating systems; automatic scaling (horizontal/vertical).

Joyent. Joyent's Public Cloud offers servers based on Solaris containers virtualization technology. These servers, dubbed accelerators, allow deploying various specialized software-stack based on a customized version of Open- Solaris operating system, which include by default a Web-based configuration tool and several pre-installed software, such as Apache, MySQL, PHP, Ruby on Rails, and Java. Software load balancing is available as an accelerator in addition to hardware load balancers.

A notable feature of Joyent's virtual servers is automatic vertical scaling of CPU cores, which means a virtual server can make use of additional CPUs automatically up to the maximum number of cores available in the physical host.
In summary, the Joyent public cloud offers the following features: multiple geographic locations in the United States; Web-based user interface; access to virtual server via SSH and Web-based administration tool; 100% availability SLA; per month pricing; OS-level virtualization Solaris containers; Open- Solaris operating systems; automatic scaling (vertical).

GoGrid. GoGrid, like many other IaaS providers, allows its customers to utilize a range of pre-made Windows and Linux images, in a range of fixed instance sizes. GoGrid also offers "value-added" stacks on top for applications such as high-volume Web serving, e-Commerce, and database stores.
It offers some notable features, such as a "hybrid hosting" facility, which combines traditional dedicated hosts with auto-scaling cloud server infrastructure. In this approach, users can take advantage of dedicated hosting (which may be required due to specific performance, security or legal compliance reasons) and combine it with on-demand cloud infrastructure as appropriate,

taking the benefits of each style of computing.
As part of its core IaaS offerings, GoGrid also provides free hardware load balancing, auto-scaling capabilities, and persistent storage, features that typically add an additional cost for most other IaaS providers.

Rackspace Cloud Servers. Rackspace Cloud Servers is an IaaS solution that provides fixed size instances in the cloud. Cloud Servers offers a range of Linux-based pre-made images. A user can request different-sized images, where the size is measured by requested RAM, not CPU.
Like GoGrid, Cloud Servers also offers hybrid approach where dedicated and cloud server infrastructures can be combined to take the best aspects of both styles of hosting as required. Cloud Servers, as part of its default offering, enables fixed (static) IP addresses, persistent storage, and load balancing (via A-DNS) at no additional cost.

Platform as a Service:

PaaS provides virtual machines, operating systems, applications, services, development frameworks, transactions, and control structures.

The client can deploy its applications on the cloud infrastructure or use applications that were programmed using languages and tools that are supported by the PaaS service provider. The service provider manages the cloud infrastructure, the operating systems, and the enabling software. The client is responsible for installing and managing the application that it is deploying.

In addition to infrastructure-oriented clouds that provide raw computing and storage services, another approach is to offer a higher level of abstraction to make a cloud easily programmable, known as Platform as a Service (PaaS). A cloud platform offers an environment on which developers create and deploy applications and do not necessarily need to know how many processors or how much memory that applications will be using. In addition, multiple programming models and specialized services (e.g., data access, authentication, and payments) are offered as building blocks to new applications .

Google AppEngine, an example of Platform as a Service, offers a scalable environment for developing and hosting Web applications, which should be written in specific programming languages such as Python or Java, and use the services' own proprietary structured object data store. Building blocks include an in-memory object cache (memcache), mail service, instant messaging service (XMPP), an image manipulation service, and integration with Google Accounts authentication service.

A PaaS service adds integration features, middleware, and other orchestration and choreography services to the IaaS model. Examples of PaaS services are:

• Force.com

• GoGrid CloudCenter

• Google AppEngine

• Windows Azure Platform

Software as a Service:

SaaS is a complete operating environment with applications, management, and the user interface.

In the SaaS model, the application is provided to the client through a thin client interface (a browser, usually), and the customer's responsibility begins and ends with entering and managing its data and user interaction. Everything from the application down to the infrastructure is the vendor's responsibility.
A client using an SaaS service might—as is the case for Quickbooks online—log into the service from his browser, create an account, and enter data into the system. Intuit.com has a service agreement thatnot only covers the performance of the hardware and software, but extends to protecting the data that they store for clients, and other fundamental characteristics.

Other good examples of SaaS cloud service providers are:

• GoogleApps

• Oracle On Demand

• SalesForce.com

• SQL Azure

VIRTUAL MACHINE TECHNOLOGY

We begin with an overview of virtual machine technology: In general, anymeans by which many different users are able simultaneously to interact with a computing system while each perceiving that they have an entire ‘virtual machine’ to themselves, is a form of virtualization. In this general sense, a traditional multiprogramming operating system, such as Linux, is also a form of virtualization, since it allows each user process to access system resources oblivious of other processes. The abstraction provided to each process is the set of OS system calls and any hardware instructions accessible to user level processes. Extensions, such as ‘user mode Linux’ offer a more complete virtual abstraction where each user is not even aware of other user’s processes, and can log in as an administrator, i.e. ‘root, ’to their own see mingly private operating system. ‘Virtual private servers’ are another such abstraction .

At a higher level of abstraction are virtual machines based on high-level languages, such as the Java virtual machine (JVM) which itself runs as an operating system process but provides a system-independent abstraction of the machine to an application written in the Java language. Such abstractions, which present an abstraction at the OS system call layer or higher, are called process virtual machines. Some cloud platforms, such as Google’s App Engine and Microsoft’s Azure, also provide a process virtual machine abstraction in the context of a web-based architecture.

More commonly, however, the virtual machines we usually refer to when discussing virtualization in enterprises or for infrastructure clouds such as Amazon’s EC2 are system virtual machines that offer a complete hardware instruction set as the abstraction provided to users of different virtual machines. In this model many system virtual machine (VM) instances share the same physical hardware through a virtual machine monitor (VMM), also commonly referred to as a hypervisor. Each such system VM can run an independent operating system instance; thus the same physical machine can have many instances of, say Linux and Windows, running on it simultaneously.

The system VM approach is preferred because it provides complete isolation between VMs as well as the highest possible flexibility, with each VM seeing a complete machine instruction set, against which any applications for that architecture are guaranteed to run. It is the virtual machine monitor that enables a physical machine to be virtualized into different VMs. Where does this software itself run? A host VMM is implemented as a process running on a host operating system that has been installed on the machine in the normal manner. Multiple guest operating systems can be installed on different Vms that each run as operating system processes under the supervision of the VMM. A native VMM, on the other hand, does not require a host operating system, and runs directly on the physical machine (or more colloquially on ‘bare metal’). In this sense, a native VMM can be viewed as a special type of operating system, since it supports multiprogramming across different Vms,with its‘ system calls’being hardware instructions!

VIRTUALIZATION APPLICATIONS IN ENTERPRISES

A number of enterprises are engaged in virtualization projects that aim to gradually relocate operating systems and applications running directly on physical machines to virtual machines. The motivation is to exploit the additional VMM layer between hardware and systems software for introducing a number of new capabilities that can potentially ease the complexity and risk of managing large data centers. Here we outline some of the more compelling cases for using virtualization in large enterprises.

1) Security through virtualization

Modern data centers are all necessarily connected to the world outside via the internet and are thereby open to malicious attacks and intrusion. A number of techniques have been developed to secure these systems, such as firewalls, proxy filters, tools for logging and monitoring system activity and intrusion detection systems. Each of these security solutions can be significantly enhanced using virtualization.

For example, many intrusion detection systems (IDS) traditionally run on the network and operate by monitoring network traffic for suspicious behavior by matching against a database of known attack patterns. Alternatively, host based systems run within each operating system instance where the behavior of each process is monitored to detect potentially suspicious activity such as repeated login attempts or accessing files that are normally not needed by user processes.Virtualization opens up the possibility of building IDS capabilities into the VMM itself, or at least at the same layer, i.e. above the network but below the operating system. The Livewire and Terra research projects are examples of such an approach which has the advantage of enabling greater isolation of the IDS from the monitored hosts while retaining complete visibility into the host's state. This approach also allows for complete mediation of interactions between the host software and the underlying hardware, enabling a suspect VM to be easily isolated from the rest of the data center.

Virtualization also provides the opportunity for more complete, user-group specific, low-level logging of system activities, which would be impossible or very difficult if many different user groups and applications were sharing the same operating system. This allows security incidents to be be more easily traced, and also better diagnosed by replaying the incident on a copy of the virtual machine.

End-user system (desktop) virtualization is another application we cover below that also has an important security dimension. Using virtual machines on the desktop or mobile phones allows users to combine personal usage of these devices with more secure enterprise usage by isolating these two worlds; so a user logs into the appropriate virtual machine (personal or enterprise), with both varieties possibly running simultaneously. Securing critical enterprise data, ensuring network isolation from intrusions and protection from viruses can be better ensured without compromising users' activities in their personal pursuits using the same devices. In fact some organizations are contemplating not even considering laptops and mobile devices as corporate resources; instead users can be given the flexibility to buy whatever devices they wish and use client-side virtual machines to access enterprise applications and data.

2) Desktop virtualization and application streaming

Large enterprises have tens if not hundreds of thousands of users, each having a desktop and/or one or more laptops and mobile phones that are used to connect to applications running in the enterprise's data center. Managing regular system updates, such as for security patches or virus definitions is a major system management task. Sophisticated tools, such as IBM's Tivoli are used to automate this process across a globally distributed network of users. Managing application roll-outs across such an environment is a similarly complex task, especially in the case of 'fat-client' applications such as most popular email clients and office productivity tools, as well some transaction processing or business intelligence applications.

Virtualization has been proposed as a possible means to improve the manageability of end-user devices in such large environments. Here there have been two different approaches. The first has been to deploy all end-client systems as virtual machines on central data centers which are then accessed by 'remote desktop' tools, such as Citrix Presentation Server, Windows Terminal Services (WTS), or VNC (Virtual Network Computer). At least theoretically this is an interesting solution as it (a) eases management of updates by 'centralizing' all desktops (b) allows easierrecovery from crashes by simply restarting a new VM (c) enables security checks and intrusion detection to be performed centrally and (d) with all user data being central, secures it as well as enables better data sharing and potential reduction of redundant storage use. However, this approach has never really become popular, primarily because of the need for continuous network connectivity, which in spite of the advances in corporate networks and public broadband penetration, is still not ubiquitous and 'always on.' Additionally, this approach also ignores the significant computing power available on desktops, which when added up across an enterprise can be very costly to replicate in a central data center.

The second approach is called 'application streaming.' Instead of running applications on central virtual machines, application streaming envisages maintaining only virtual machine images centrally. An endpoint client, such as a desktop, runs a hypervisor that also downloads the virtual machine image from the server and launches it on the end point client. In this manner the processing power of the end point is fully exploited, a VM image can be cached for efficiency and only incrementally updated when needed, and finally user data, which can be large, need not be centrally maintained but mounted from the local disk as soon as the virtual machine boots.

Such a solution is implemented, for example, in the XenApp product from Citrix (incorporating technology from Appstream, which was acquired by Citrix). Application streaming additionally allows the isolation of personal and corporate spaces for security purposes as mentioned in theprevious section.

Similarly in the field of Server Consolidation & Automated Infrastructure management the use of virtualization is increasing.

PITFALLS OF VIRTUALIZATION

Virtualization is critical for cloud computing and also promises significant improvements within in-house data centers. At the same time it is important to be aware of some of the common pitfalls that come with virtualization:

1. Application deployments often replicate application server and database instances to ensure fault tolerance. Elastic provisioning results in two such replicas using virtual servers deployed on the same physical server. Thus if the physical server fails, both instances are lost, defeating the purpose of replication.

2. We have mentioned that virtualization provides another layer at which intrusions can be detected and isolated, i.e., the VMM. Conversely however, if the VMM itself is attacked, multiple virtual servers are affected. Thus some successful attacks can spread more rapidly in a virtualized environment than otherwise.

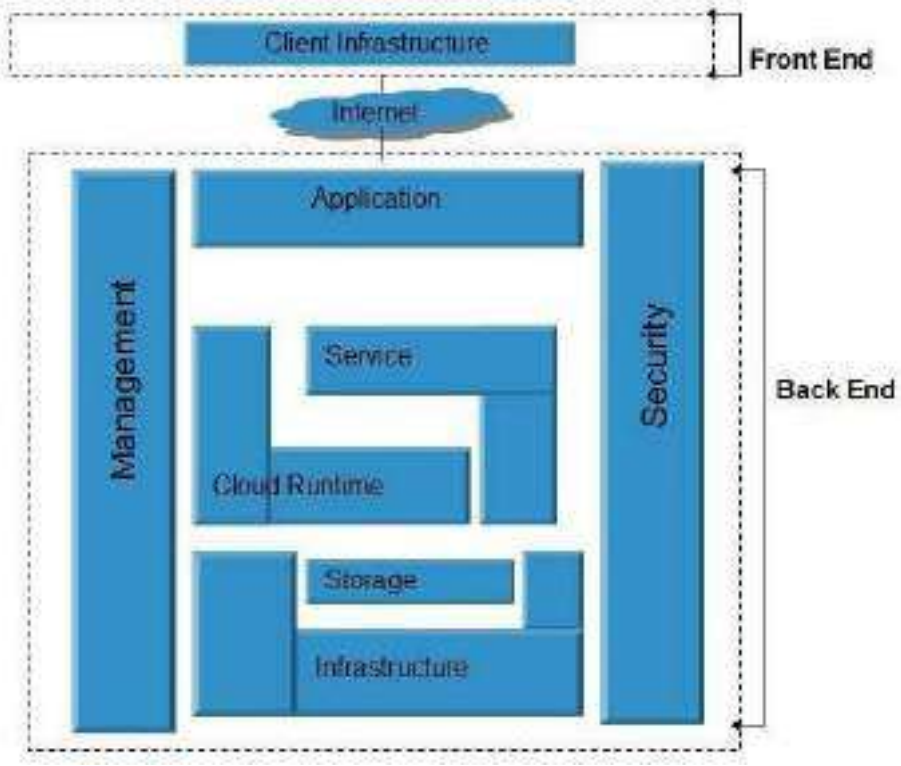
3. If the ‘server sprawl’ that motivated the building of a virtualized data center merely results in an equally complex ‘virtual machine sprawl,’ the purpose has not been served, rather thesituation may become even worse than earlier. The ease with which virtual servers and server images are provisioned and created can easily result in such situations if one is not careful.

4. In principle a VMM can partition the CPU, memory and I/O bandwidth of a physical server across virtual servers. However, it cannot ensure that these resources are made available to each virtual server in a synchronized manner. Thus the fraction of hardware resources that a virtual server is actually able to utilize may be less than what has been provisioned by the VMM.

Architecture of Cloud Computing

Cloud Computing architecture comprises of many cloud components, which are loosely coupled. We can broadly divide the cloud architecture into two parts:

- Front End
- Back End



Front End

1.The **front end** refers to the client part of cloud computing system.

2.It consists of interfaces and applications that are required to access the cloud computing platforms, Example - Web Browser.

3.The interaction is done through middleware or via web-browser or virtual sessions.

Back End

1.The **back End** refers to the cloud itself.

2.It consists of all the resources required to provide cloud computing services.

3.It comprises of huge data storage, virtual machines, security mechanism, services, deployment models, servers, etc.

4.It is the responsibility of the back-end to provide the security of data for cloud users along with the traffic control mechanism. The server also provides the middleware which helps to connect devices & communicate with each other.

Components of Cloud Computing:

i. Hypervisor

The hypervisor is also known as *Virtual Machine Monitor*. This consists of the software, hardware, and firmware which makes and runs the virtual machines. The Hypervisor provides a user with a platform which is known as *Virtual Operating Platform*. This allows us to manage the guest's operating system to use the cloud. This can be also known as the traditional term of the kernel in an operating system.

ii. Management Software

Management software consists of various plans and the strategies which help to increase the performance of the cloud. This management software provides many features such as on-time delivery of storage, proper security, all-time access, and many other facilities. This is one of the important parts of Cloud Computing architecture. One of the important features of this is the compliance auditing, management of overseeing disaster, and contingency plans.

iii. Deployment Software

Cloud deployment simply means *to initiate the working of the SaaS, PaaS, and IaaS*. This initiates the solutions that can access by the users or the customers. This deployment consists of all the mandatory installations and configurations of the cloud. This emerges from the back end and implements before the provisioning occurs.

iv. Route of Connectivity

It is an important part of the Cloud Computing architecture, through which the whole cloud gets connected. The speed of transfer depends on the network which is the internet connection. There are many cloud servers present which connects with the help of this virtual route. This also provides a facility to the user by allowing them to customize the route and protocol.

v. A server of the Cloud

A cloud server is a virtual server running in cloud computing premises. It's engineered, hosted and delivered via a cloud computing platform via the web. It can be accessed from anywhere.Cloud servers are stable, quick and secured.

vi. Storage of the Cloud

Cloud storage service, construct to produce applications, services and organizations with access to offsite storage capability that may provision instantly are versatile in scaling automatically at runtime and is globally accessible. An Infrastructure as a Service (IaaS) service model delivers scalable, flexible and redundant storage capability through net services API, online interfaces and thin client applications.

Service models provided in cloud computing:IaaS,PaaS,SaaS/Services provided by cloud computing/Cloud Computing Stack

The service models are categorized into three basic models:

1) Software-as-a-Service (SaaS)
2) Platform-as-a-Service (PaaS)
3) Infrastructure-as-a-Service (IaaS)

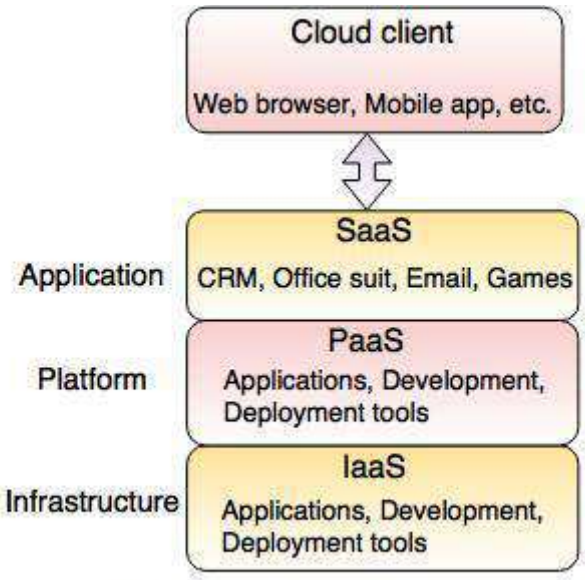


Fig. - Categories of Cloud Computing

1) Software-as-a-Service (SaaS)

- SaaS is known as **'On-Demand Software'.**
- It is a software distribution model. In this model, the applications are hosted by a cloud service provider and publicized to the customers over internet.
- In SaaS, associated data and software are hosted centrally on the cloud server.

- User can access SaaS by using a thin client through a web browser.
- CRM, Office Suite, Email, games, etc. are the software applications which are provided as a service through Internet.
- The companies like Google, Microsoft provide their applications as a service to the end users.

Advantages of SaaS

- SaaS is easy to buy because the pricing of SaaS is based on monthly or annual fee and it allows the organizations to access business functionalities at a small cost, which is less than licensed applications.
- SaaS needed less hardware, because the software is hosted remotely, hence organizations do not need to invest in additional hardware.
- Less maintenance cost is required for SaaS and do not require special software or hardware versions.

Disadvantages of SaaS

- SaaS applications are totally dependent on Internet connection. They are not usable without Internet connection.
- It is difficult to switch amongst the SaaS vendors.

2) Platform-as-a-Service (PaaS)

- PaaS is a programming platform for developers. This platform is generated for the programmers to create, test, run and manage the applications.
- A developer can easily write the application and deploy it directly into PaaS layer.
- PaaS gives the runtime environment for application development and deployment tools.
- Google Apps Engine(GAE), Windows Azure, SalesForce.com are the examples of PaaS.

Advantages of PaaS

- PaaS is easier to develop. Developer can concentrate on the development and innovation without worrying about the infrastructure.
- In PaaS, developer only requires a PC and an Internet connection to start building applications.

Disadvantages of PaaS

- One developer can write the applications as per the platform provided by PaaS vendor hence the moving the application to another PaaS vendor is a problem.

3) Infrastructure-as-a-Service (IaaS)

- IaaS is a way to deliver a cloud computing infrastructure like server, storage, network and operating system.
- The customers can access these resources over cloud computing platform i.e Internet as an on-demand service.
- In IaaS, you buy complete resources rather than purchasing server, software, datacenter space or network equipment.
- IaaS was earlier called as Hardware as a Service(HaaS). It is a Cloud computing platform based model.
- HaaS differs from IaaS in the way that users have the bare hardware on which they can deploy their own infrastructure using most appropriate software.

Advantages of IaaS

- In IaaS, user can dynamically choose a CPU, memory storage configuration according to need.
- Users can easily access the vast computing power available on IaaS Cloud platform.

Disadvantages of IaaS

- IaaS cloud computing platform model is dependent on availability of Internet and virtualization services.

Deployment model. various deployment models of Cloud

i) Public cloud
ii) Private cloud
iii) Hybrid cloud
iv) Community cloud

i) Public cloud

- In the public cloud, systems and services are accessible to the general public. **For example,** Google, IBM, Microsoft etc.
- Public cloud is open to all. Hence, it may be less secure.
- This cloud is suitable for information which is not sensitive.

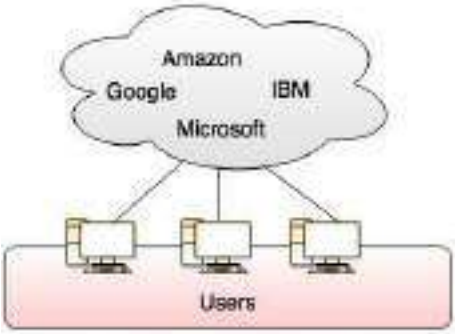


Fig.- Public cloud

Advantages of Public cloud:

- Public cloud is less expensive than the private cloud or hybrid cloud because it shares same resources with many customers.
- It is easy to combine public cloud with private cloud so it gives the flexible approach to the customer.
- It is reliable because it provides large number of resources from various locations and if any resource fails, another is employed.

ii) Private cloud

- In the private cloud, systems and services are accessible within an organization.
- This cloud is operated only in a particular organization. It is managed internally or by third party.

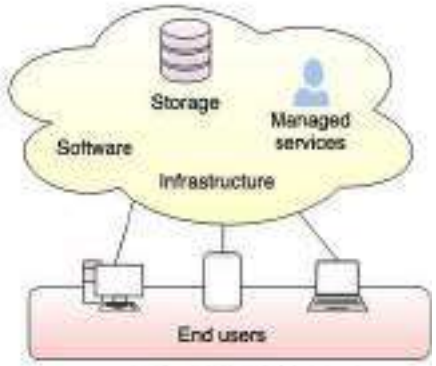


Fig.- Private cloud

Advantages of Private cloud:

- Private cloud is highly secured because resources are shared from distinct pool of resources.
- As compared to the Public cloud, Private cloud has more control on its resources and hardware because it accessed only in the boundary of an organization.

Disadvantages of Private Cloud:

- Private cloud is very difficult to deploy globally and it can be accessed locally only.
- Private cloud's cost is more than that of Public cloud.

iii) Hybrid cloud

- Hybrid cloud is a mixture of public and private cloud.
- In hybrid cloud, critical activities are conducted using Private cloud and the non-critical activities are conducted using Public cloud.

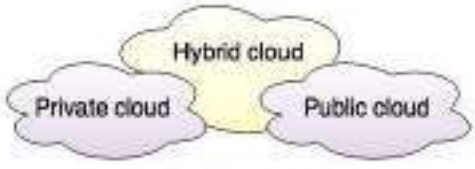


Fig.- Hybrid cloud

Advantages of hybrid cloud model:

- It is scalable because it gives the features of both public and private cloud.
- It gives secure resources because of Private cloud and scalable resources because of Public cloud.
- The cost of the Hybrid cloud is less as compared to Private cloud.

Disadvantages of hybrid Cloud:

- In hybrid cloud, networking becomes complicated because both Private and Public cloud are available.

iv) Community cloud

- Community cloud enables the system and services which are accessible by group of organizations.
- It shares the infrastructure between several organizations from a specific community.
- It is managed internally and operated by several organizations or by the third party or combination of them.

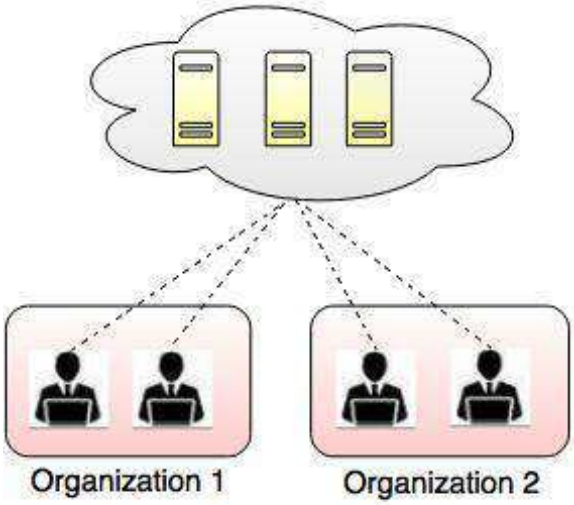


Fig.- Community cloud

Advantages of Community Cloud model:

- In Community cloud, cost is low as compared to Private cloud.
- Community cloud gives an infrastructure to share cloud resources and capabilities between several organizations.
- This cloud is more secure than the Public cloud but less secured than the Private cloud.

Compare Cloud Computing with traditional computing architecture/Client Server.

Characteristic	Cloud Computing	Traditional	Comments
Time before service can be accessed	Minutes/ Hours	Days/Weeks	Once the cloud computing environment is set up initially, you can gain access faster than in traditional environments where lead time is needed for installation, set-up, and configuration.
Capital Expenditure (CAPEX)	Pay-as-you-go, Variable	Upfront cost, Fixed	The pay-as-you-go model for cloud computing reduces or eliminates the large upfront costs incurred in procuring hardware and software and standing up traditional environments.
Economies of scale	Yes, for all organizations	For large organizations only	Cloud computing not only provides cost advantages in procurement of hardware and software, it also provides cost advantages from improved productivity. Traditionally, lessons learned from one environment must be duplicated in other environments but, with cloud computing, once the best practices are applied they benefit all consumers.
Multi-tenancy	Yes	Generally no, but can be found in application hosting	Multi-tenancy properly applied to cloud computing services allows providers to host multiple consumers effectively across shared resources. While it is more readily enabled in IaaS through the use of virtualization, PaaS and SaaS providers may need to undertake significant re-architecting of their platforms or applications to apply multi-tenancy to these elements as well as to infrastructure. Where this has not been undertaken, consumers may find that their platforms and applications are not as elastic or cost-effective as anticipated.
Scalability	Elastic and Automatic	Manual	Cloud computing resources can often be scaled up or down automatically, whereas human intervention is usually needed to add hardware and software in traditional environments.
Virtualized	Usually	Sometimes	Cloud computing environments are usually virtualized, whereas traditional environments include a mix of physical and virtualized infrastructure.

Table 1.1: Practical differences between cloud computing and traditional environments

Load Balancing and Virtualization?Define Server Virtualization

Load Balancing

Cloud load balancing is defined as the method of splitting workloads and computing properties in a cloud computing. It enables enterprise to manage workload demands or application demands by distributing resources among numerous computers, networks or servers. Cloud load balancing includes holding the circulation of workload traffic and demands that exist over the Internet.

As the traffic on the internet growing rapidly, which is about 100% annually of the present traffic. Hence, the workload on the server growing so fast which leads to the overloading of

servers mainly for popular web server. There are two elementary solutions to overcome the problem of overloading on the servers-

- First is a single-server solution in which the server is upgraded to a higher performance server. However, the new server may also be overloaded soon, demanding another upgrade. Moreover, the upgrading process is arduous and expensive.
- Second is a multiple-server solution in which a scalable service system on a cluster of servers is built. That's why it is more cost effective as well as more scalable to build a server cluster system for network services.

Load balancing is beneficial with almost any type of service, like HTTP, SMTP, DNS, FTP, and POP/IMAP. It also rises reliability through redundancy. The balancing service is provided by a dedicated hardware device or program. Cloud-based servers farms can attain more precise scalability and availability using server load balancing.

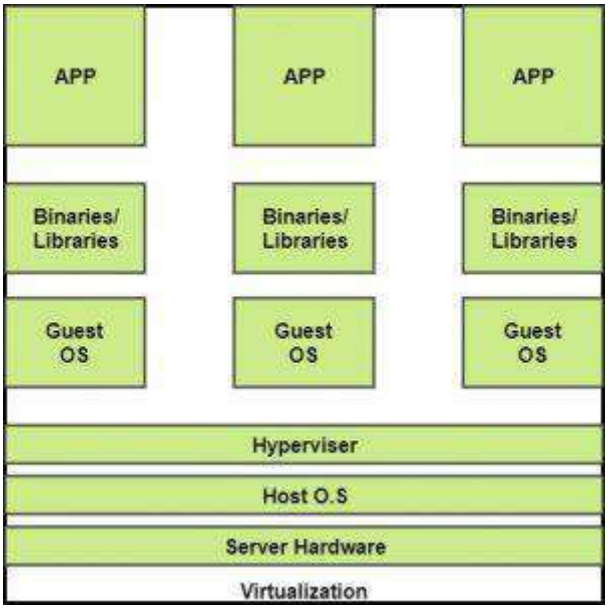
Load balancing solutions can be categorized into two types –

1. **Software-based load balancers:** Software-based load balancers run on standard hardware (desktop, PCs) and standard operating systems.
2. **Hardware-based load balancer:** Hardware-based load balancers are dedicated boxes which include Application Specific Integrated Circuits (ASICs) adapted for a particular use. ASICs allows high speed promoting of network traffic and are frequently used for transport-level load balancing because hardware-based load balancing is faster in comparison to software solution.

Virtualization In Cloud Computing and Types

Virtualization is a technique how to separate a service from the underlying physical delivery of that service.It is the process of creating a virtual version of something like computer hardware.It was initially developed during the mainframe era.It involves using specialized software to create a virtual or software-created version of a computing resource rather than the actual version of the same resource. With the help of Virtualization multiple operating systems and applications can run on same Machine and its same hardware at the same time increasing the utilization and flexibility of hardware.

In other words,One of the main cost effective,hardware reducing,energy saving techniques used by cloud providers is virtualization.Virtualization is a technique, which allows to share a single physical instance of a resource or an application among multiple customers and organizations at one time. It does by assigning a logical name to a physical storage and providing a pointer to that physical resource on demand.The term virtualization is often synonymous with hardware virtualization, which plays a fundamental role in efficiently delivering Infrastructure-as-a-Service (IaaS) solutions for cloud computing.Moreover, virtualization technologies provide a virtual environment for not only executing applications but also for storage, memory, and networking.



The machine on which the virtual machine is going to be build is known as Host Machine and that virtual machine is referred as a Guest Machine.

BENEFITS OF VIRTUALIZATION

1.More flexible and efficient allocation of resources.
2.Enhance development productivity.
3.It lowers the cost of IT infrastructure.
4.Remote access and rapid scalibility.
5.High availability and disaster recovery.
6.Pay per use of the IT infrastructure on demand.
7.Enables running multiple operating system.

Definition of Server Virtualization : Server virtualization is a virtualization technique that involves partitioning a physical server into a number of small, virtual servers with the help of virtualization software. In server virtualization, each virtual server runs multiple operating system instances at the same time.

Q.What is the role of networks in cloud computing.[S-17](4M)[W-16][S-18][S-16]

Ans:

1.Emerging capabilities of network have enabled cloud to successfully provide on-demand services which can unilaterally provision computing capabilities such as servers, network, OS and storage.

2.Further, it allows resource pooling where multiple users through multiple tenant model (multiple customer utilizing the same facility) can access different physical and virtual resources. Additionally, virtualization permits applications, compute and network resources

to reside anywhere, which are then accessed through the network, thus allowing these resources to be flexible and scalable.

3.Cloud computing also has the capability to measure the services being offered through the usage of charge back or metering where it can control and optimize resource usage.
4.The network plays a key role in the delivery of cloud-based services as it provides a means to connect every IT system and has the ability to provision and scale these resources to meet application and end-user requirements.
5.It also is one of strategic element used for management of security objectives in the cloud as it:

- Enables infrastructure enhancements by supporting server consolidation, virtualized environment, automated infrastructure and support application mobility.
- Addresses access requirements emerging from thin clients or organization mobility requirements which may extend to any device at any time from any place.
- Offers application analytics by clustering requirements and enabling remote usage or community services
- Supports varied traffic patterns through location independent endpoints while ensuring automated provisioning and orchestration.

Overview of Cloud Computing & Virtualization

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Prerequisites

- Fundamentals of Computers and Internet
- Basics of Database and Networking
- Virtualization and Computing concepts

Course Objectives

- To introduce the concepts of cloud computing with brief history and evolution
- To understand the cloud service models and the different cloud deployment models
- To understand the relevance, benefits and challenges of cloud computing
- Cloud computing and Virtualization – Industry perspective

References

- Barri Sosinsky, “Cloud Computing Bible” , Wiley Publishing Inc. 2011
- Hurwitz, Robin Bloor, Marcia Kaufman, Dr. Fern Halper, “Cloud Computing for Dummies” , Wiley Publishing Inc, 2009

Session Plan

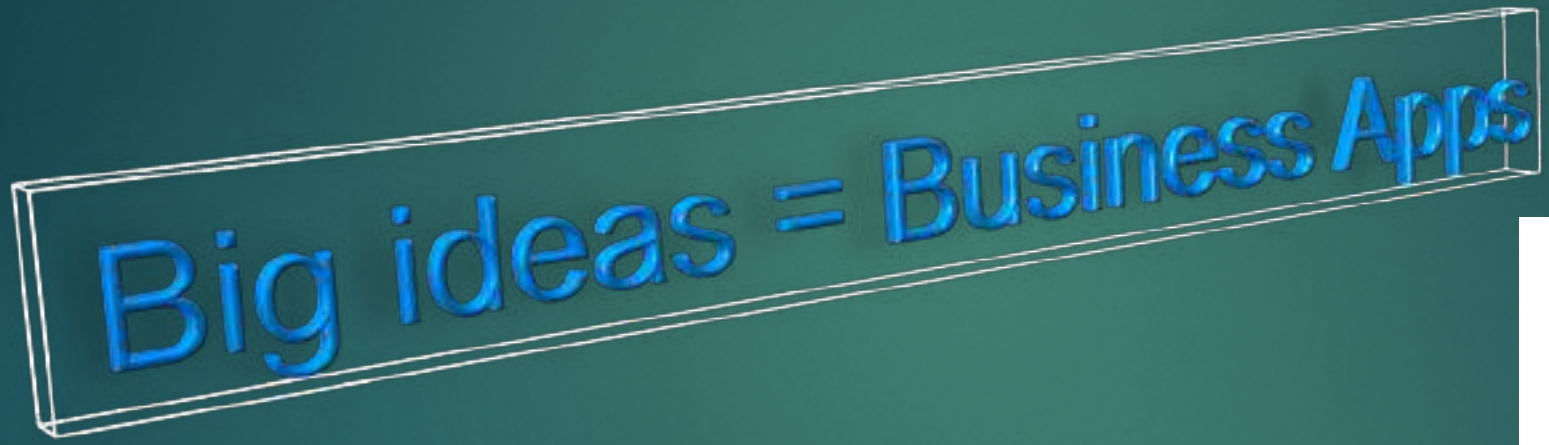
- Problems in managing the traditional IT and hence the overcoming of Cloud Computing
- Introduction to Cloud Computing and its Benefits
- Cloud Model Architecture and base technologies
- Cloud Computing Deployment Models
- Cloud Computing Service Models
- Data center transformation
- Virtualization definition & history
- Virtualization technologies
- Role of virtualization in cloud computing
- Myths and Challenges observed in Cloud Computing

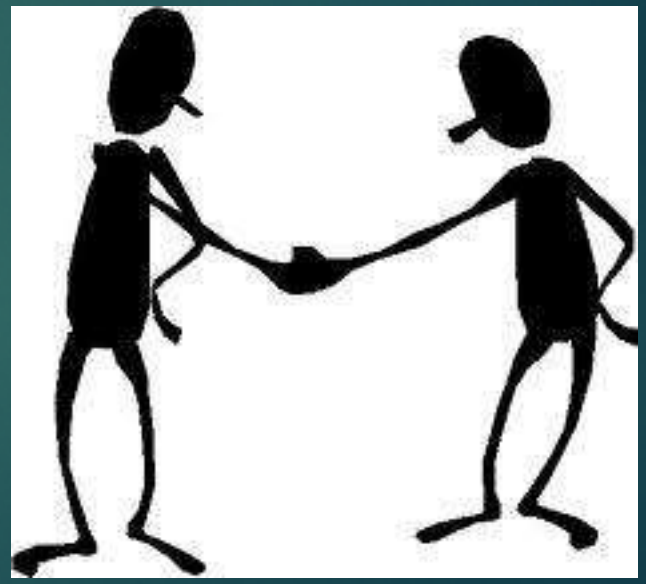
NIST describes Cloud Computing

(NIST) defines cloud computing as “a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.”

Source: www.**nist**.gov/itl/csd/**cloud**-102511.cfm

The Application and its IT infrastructure





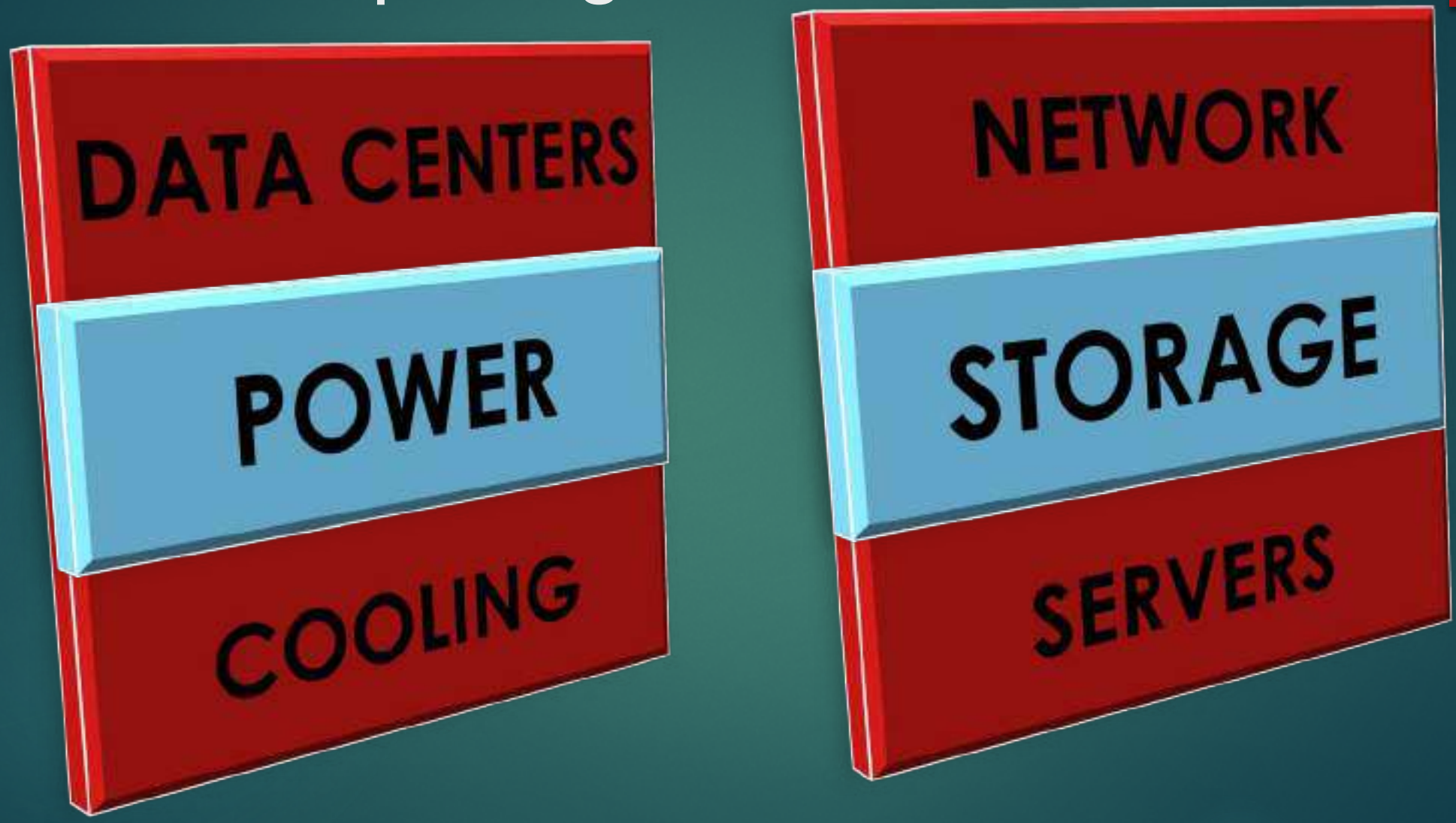
Steps involved in traditional Infrastructure

- Spend a couple of minutes in writing down the steps which you may follow putting the *Enterprise IT Infrastructure* in place*.

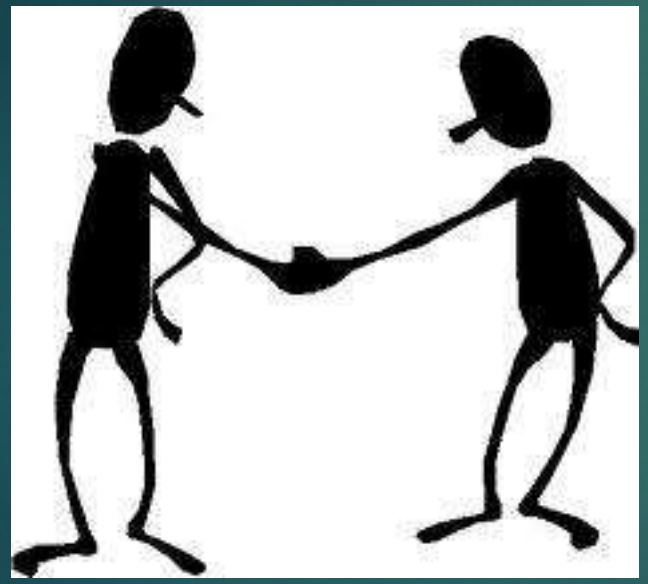
* Assuming that you have got land, building and necessary approvals.
* Enterprise IT Infra may contain PCs, networks, servers, misc. hardware and software to start with.

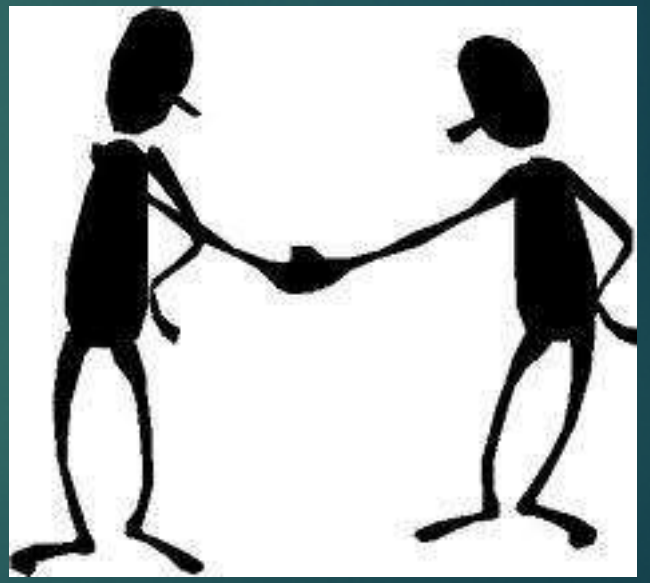
i. Business Apps Examples

ii. The Computing environment



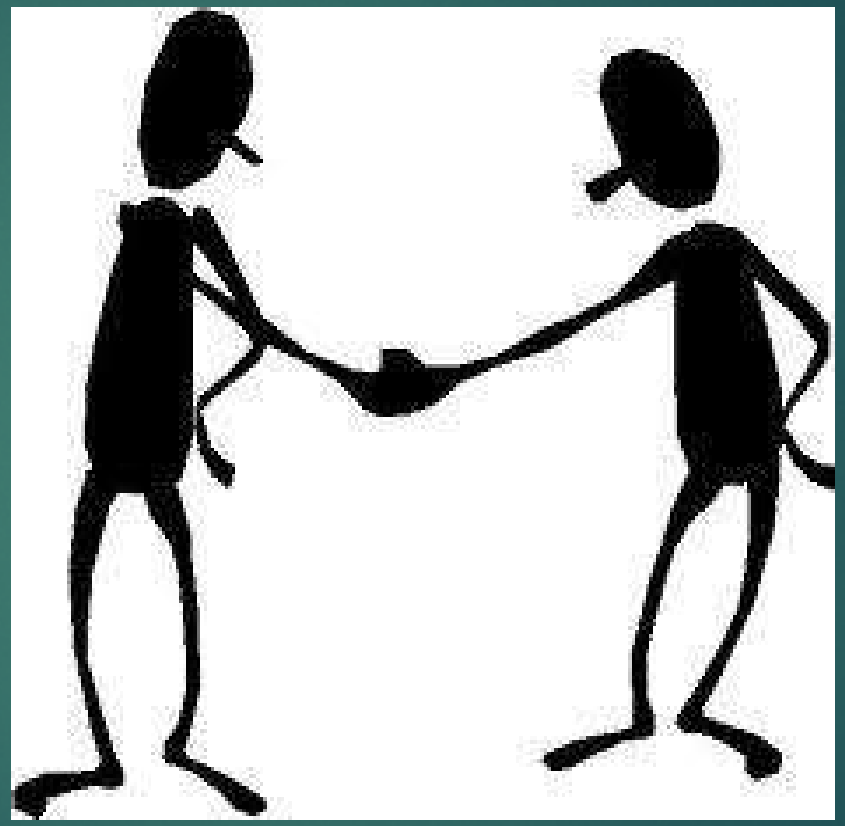
iii. Software environment and Experts team





iv. The Software Cycle

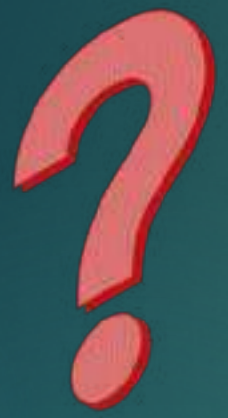
Now finally we have the app and the IT infrastructure !!



Problems in managing IT infrastructure

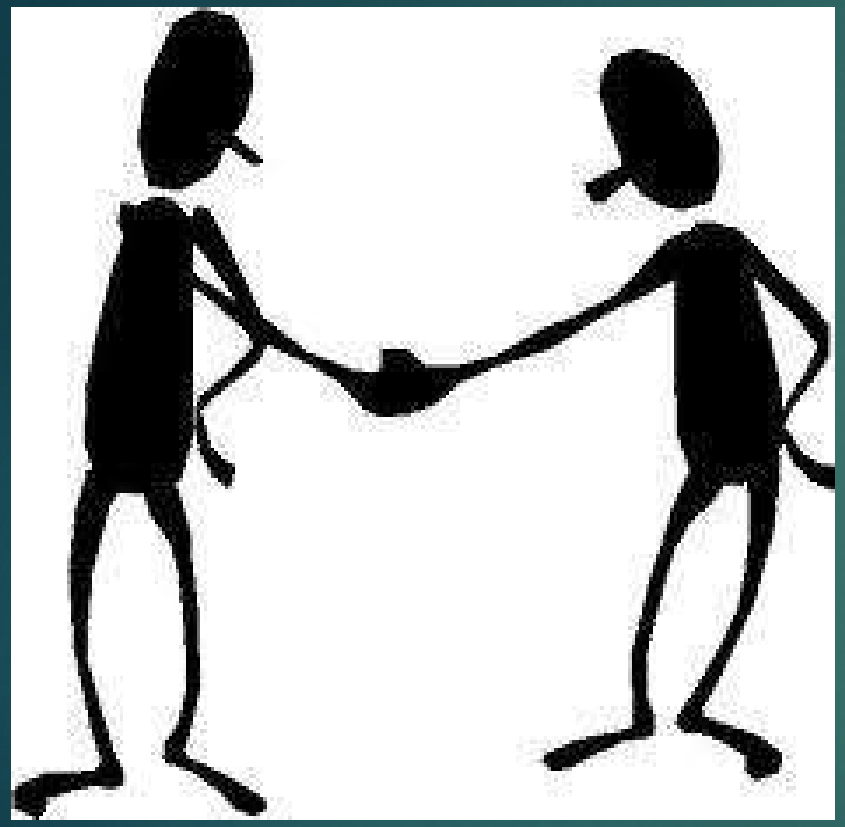
- **New Versions Upgrades**
- **Increase in employee base at diverse locations**
  - Upturn the IT infrastructure (Increase in Office Infra, LAN, WAN, secure access)
- **Support increased customer demand**
- Upturn the IT infrastructure (Increase in load capacity, Web Front-End servers, App Servers, DB Servers)
- **Welcome the Recession**
  - Cut down employee staff and release unused IT infra

Analyze the Problems



- **Uneven business**
- **Over Cost Expenditure**
- **Very Unstable Work Environment**
- **Uneven requirement of hardware**
- **Loads of apps with these many headaches**

What could be a Solution?



- **Outsourcing**
- **Rent the IT infrastructure**
- **Someone maintains the IT infrastructure**

Conclusion:

Rent infrastructure on demand as a service, paying for what is being used; just like a Utility.

Power of Utility- is the Power of Cloud Computing

- Utility Model in real world:
  - Water Service
  - Electricity
  - LPG

- **Computing as a UTILITY !!!!** (e.g. Server, Storage, Network, Platform, Software)

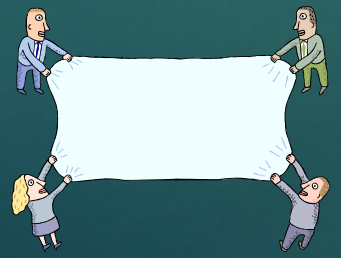
Cloud Computing- a Solution

Access information from anywhere; through secure APIs

Multi-tenant environment

Focus on Business than IT

Dynamically scale up the available resources ; Instantly; on-demand



Reliable

Monthly online subscription – Pay per use Model

Cloud Service Providers Today – Glance

Cloud Computing – in a Nutshell

- **Focus on Business than IT**
- **On Demand Service**
- **Instant**
- **Rapidly Elastic**
- **Simple APIs accessible anywhere**
- **Pay for what you use**
- **Reliable**

Cloud Computing Architecture (1 of 2)

- A Client-Server architecture
- **A Multi-tenant environment (**also termed as Shared approach)**:** The multi-tenancy allows multiple tenants to use an application running on shared system
  - One single instance for all customers
  - One copy of all resources user within an application is shared by all customers.
  - Upgrade needs to happen only in a single instance, as a result costs and time can be saved

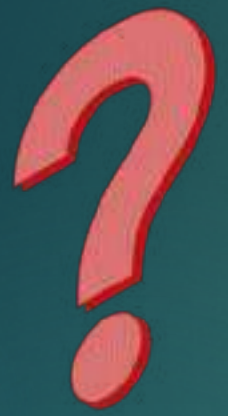
Cloud Computing Architecture (2 of 2)

- **Virtualization:**
  - It 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.
- **Grid Computing:**
  - Grids enable the sharing and aggregation of a wide variety of geographically distributed computational resources (such as supercomputers, compute clusters, storage systems, data sources, instruments, people) and presents them as a single, unified resource for solving large-scale compute or data intensive computing applications
  - E.g. molecular modelling for drug design, brain activity analysis, and high energy physics

So far???

- What is Cloud Computing?
- What is the need of Cloud Computing?
- What are benefits of using Cloud Computing over Traditional IT?
- List some examples of Cloud Service Providers!

A Concern

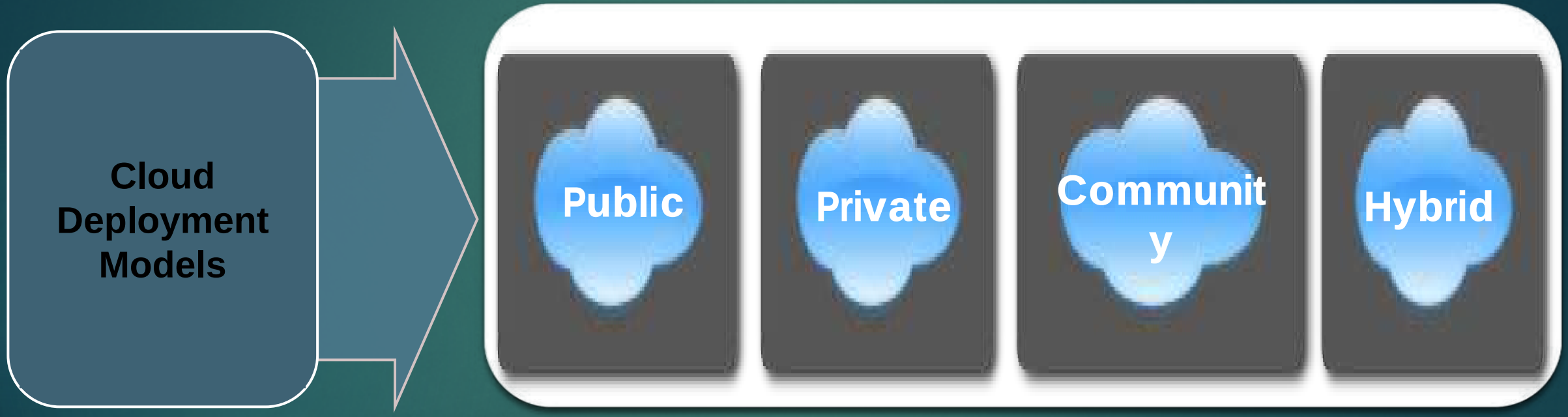


Cloud computing would require you to expose your data to the outside world..

Its is a Myth……!! ☺

Fact: Using a private cloud deployment model; you need not expose the data to outside world

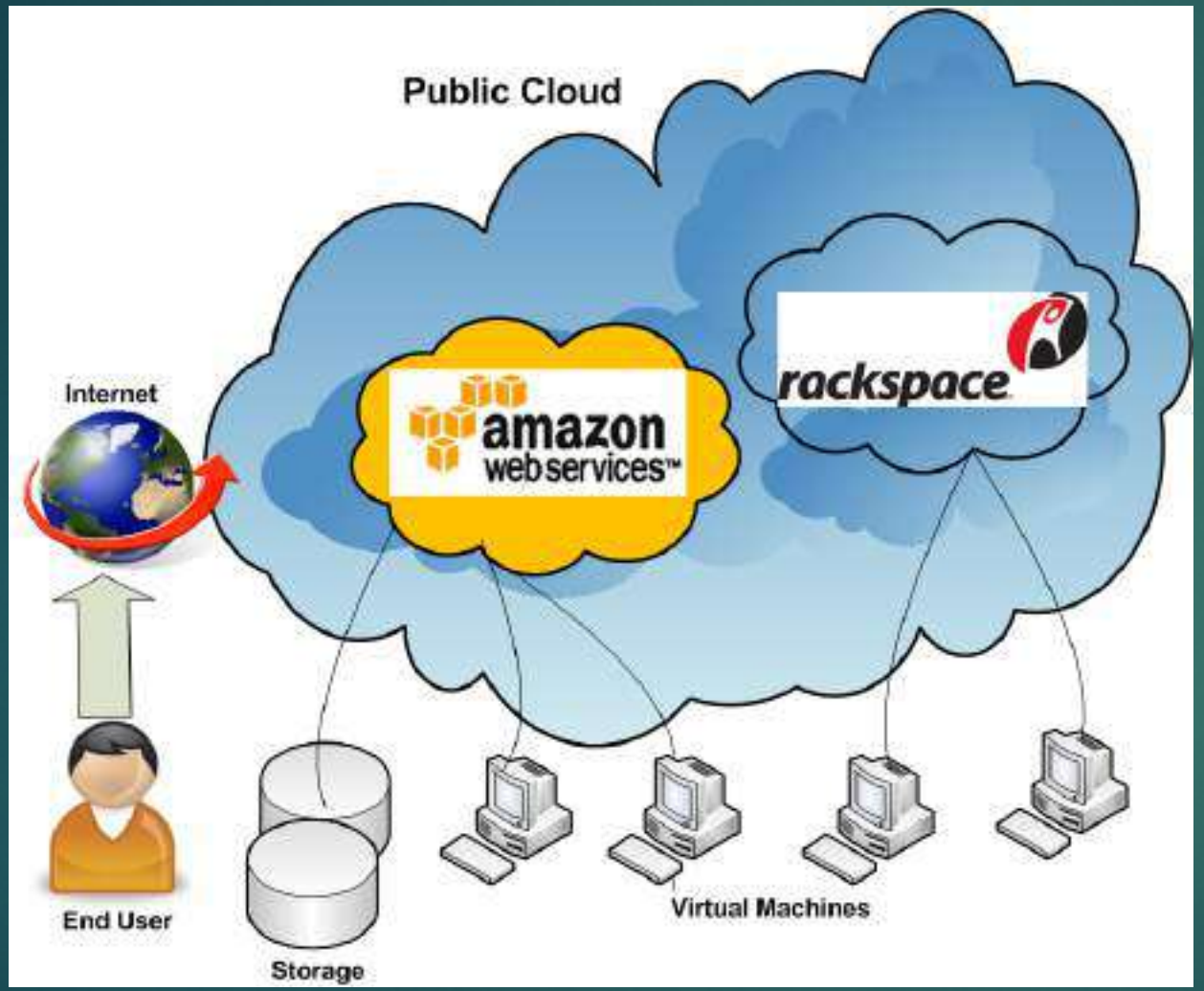
Cloud Computing Deployment Models



Public Cloud

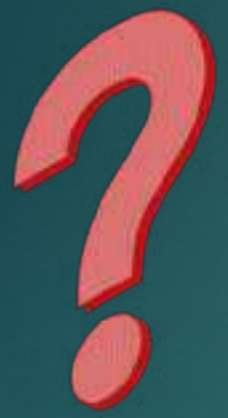
User 1

User 2



- Open for General Public
- Free and Paid Models - Register yourself at CSP's website
- Highest level of efficiency
- Owned by a user, an industry, a government organization
- Shared Data Center- Security is a big concern

When Public Cloud



- For startups to grow fast instantly
- For periodic processing at certain period of times
- For pre-defined burst events which demands high utilization
- For unpredictable utilizations by users

Public Cloud Service Providers

Public Cloud Issues

- Public Cloud Security concerns:
  - Data existence
  - Data ownership
- Limited Customization and control on infrastructure

- Private Cloud- a better choice than Public Cloud when Security or control is a concern

Private Cloud

- For exclusive use by a single organization
- Exists on or off premises
- Owned, managed, and operated by the organization, a third party

User

On-premises and Off-premises

- **On-premises** means the IT resources are installed and run on computers on the premises (i.e. in the network or firewall) of the person or organization. E.g. Mycloud in Infosys is an on-premises cloud
- **Off-premises** means the IT resources are installed and run on computers outside of the the firewall of the organization. E.g. Citrix WorkX cloud

Private Cloud Service Providers

Challenges with private cloud

- Greater initial cost
- Management (greater skills)
- Reliability (uptime)
- Your security is entirely your responsibility

Community Cloud

- For exclusive use by a group of users
- Users share mission or regulation w.r.t mission, security requirements, policy, and compliance considerations
- Owned, managed, and operated by one or more of the organizations in the community, a third party
- It may exist on or off premises

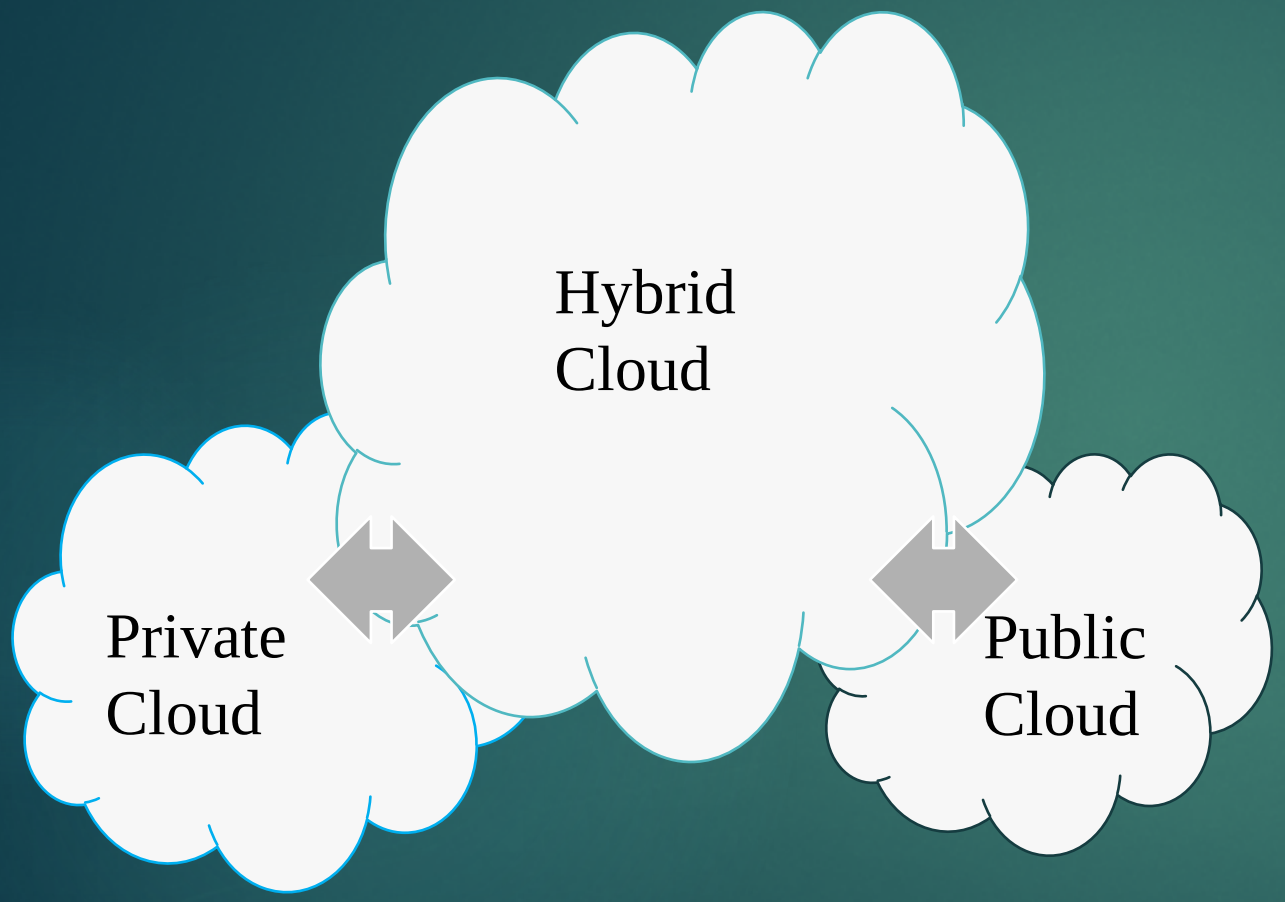
Examples of Community Cloud

- Healthcare community cloud:
  - To provide specific security and regulatory requirements compliant with let's say HIPAA, the Health Insurance Portability and Accountability Act
- Financial services community cloud:
  - To provide ultra-low latency for stock traders to execute financial transactions
- Other examples adopting Community Model: Education, Energy, Gaming.

Community Cloud aims:

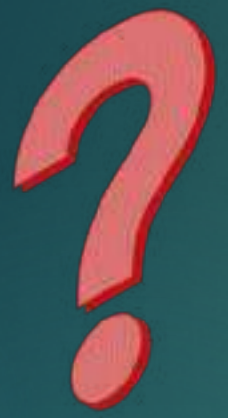
- To offer a subgroup of public clouds to meet common desires of a specific vertical industry
- To work on a shared cloud platform with some common regulations than demanding separate space in a public cloud
- To allow multiple clients plug into their environment and subdivide their sessions on a logical approach

Hybrid Cloud



- Composition of two or more distinct cloud infrastructures
- Entities are bound together by standardized technology that enables data and application portability
- Leverage multiple providers

When Hybrid Cloud



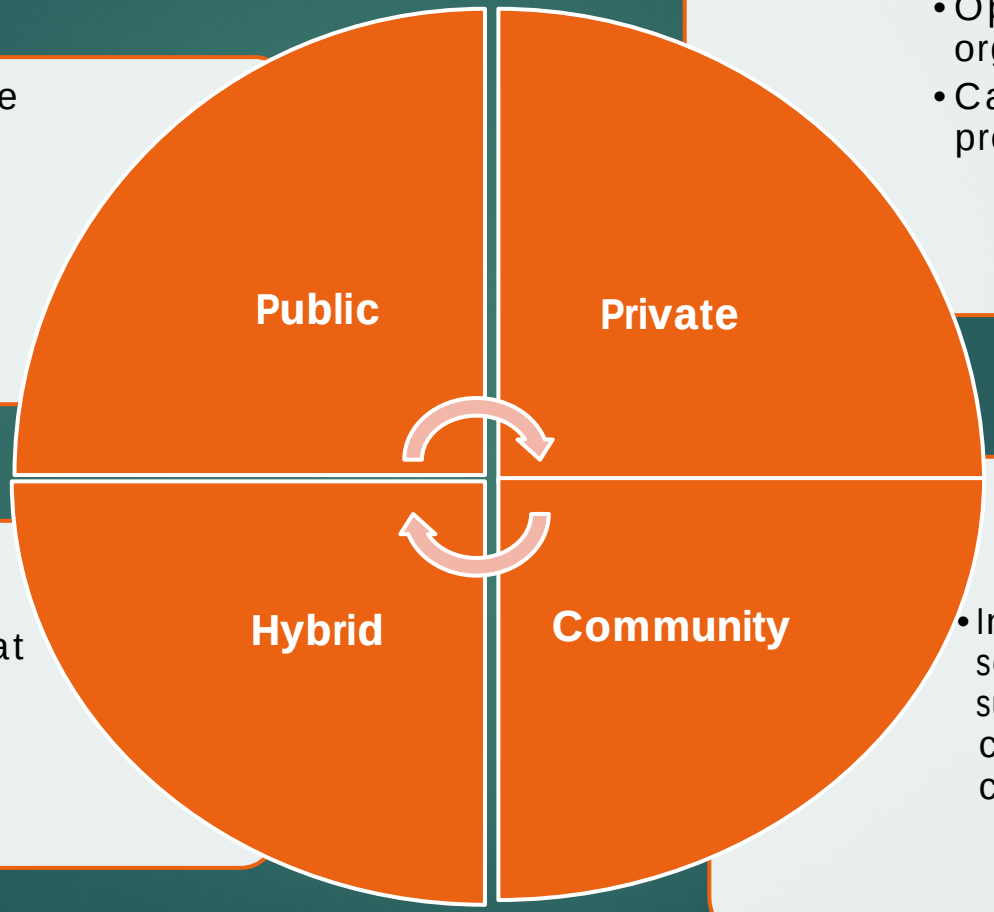
- Public and Private Cloud together w.r.t applications areas as per sensitivity or usage
- Cloud bursting for Load Balancing
- Instant on-demand provisioning of resources
- A lower cost model or capital expenditures

Hybrid Cloud Service Providers

Cloud Deployment Models in Conclusion

- Infrastructure available to public
- Owned by Cloud Service Provider

- Operated solely for an organization
- Can exist either on-premise or off premise



- Two or more clouds that interoperate or federated through technology

- Infrastructure shared by several organizations supporting specific community that have common concerns

Self- Review… So far???

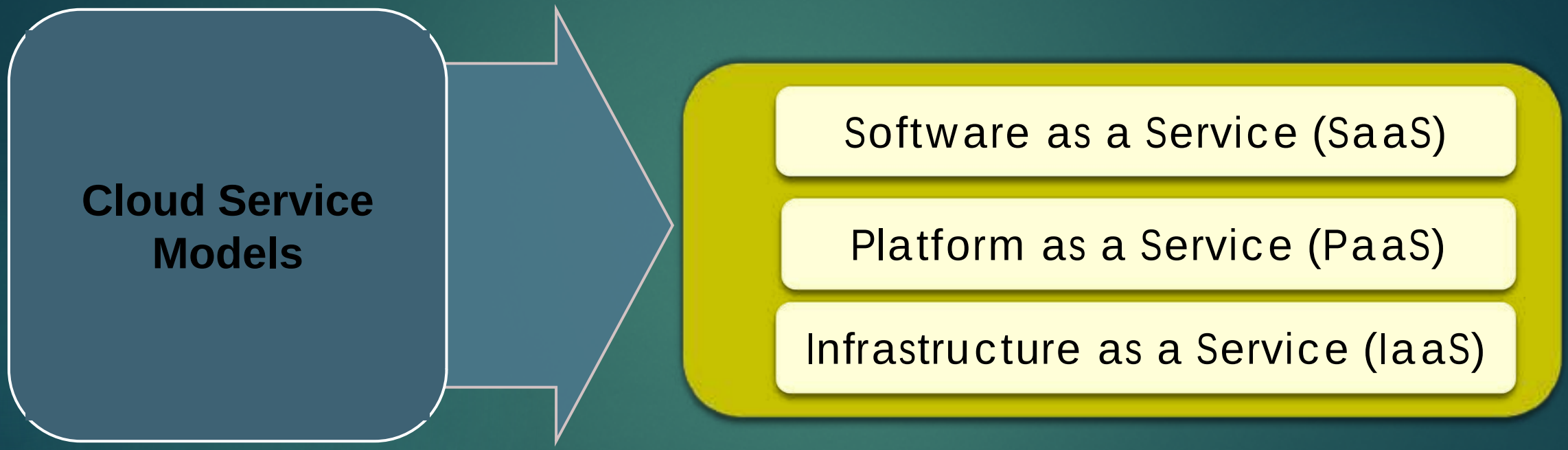
- What are the different Deployment Models in Cloud Computing?
- What is Public Cloud and when could it be used?
- What are the benefits of using Private Cloud over Public Cloud?
- When is a Community Cloud used?
- What is a Hybrid Cloud and when could it be used?

Resources available in Cloud

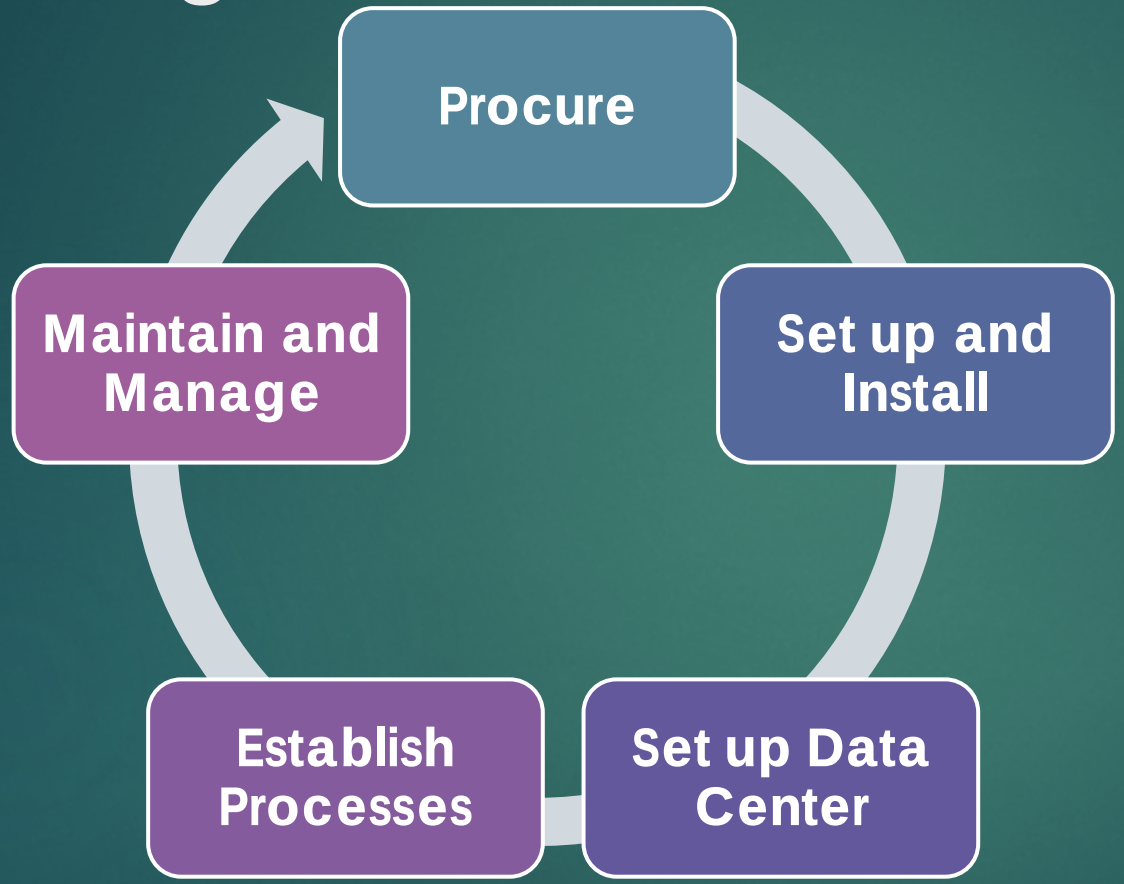
- Infrastructure components- Storage, Computing, RAM, Processor, Network etc.
- Platform or environment components: Languages, software supporting or IDEs, runtime environments etc.
- Software: SAP, CRM, HRD etc.

Let's defines these different layers of resources.

Cloud Service Models



Infrastructure Model – Traditions, Challenges



- Infrastructure calls for on-going maintenance
- Costly
- Risky
- Maintenance is Troublesome

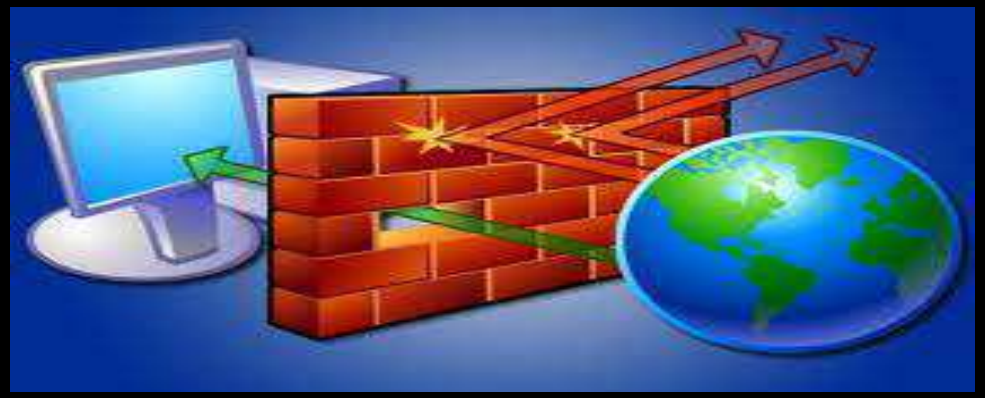
Infrastructure as a Service

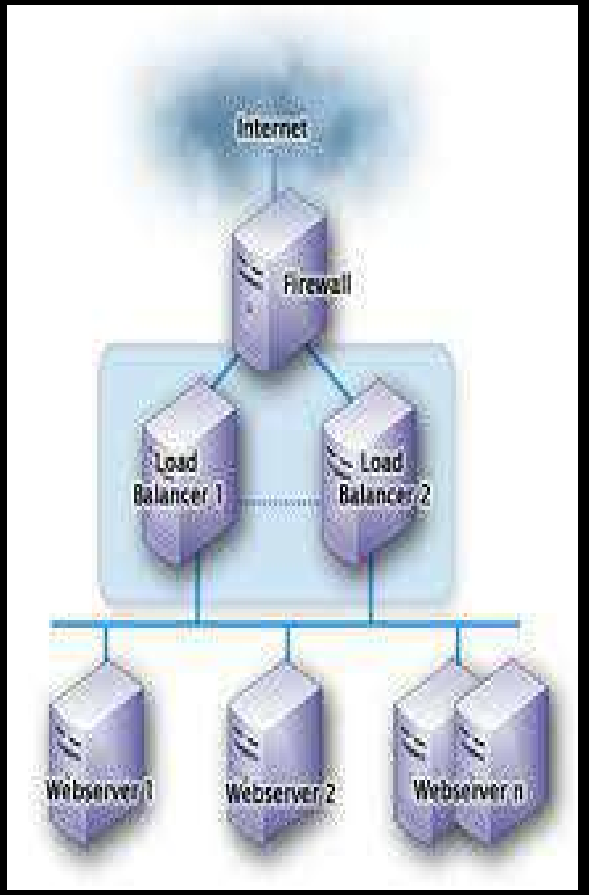
- Infrastructure services :
  - Renting storage space, network resources, processing and other computing resources required by an organization
- You need not manage or control the underlying cloud infrastructure
- You have some limited control to select the networking components like host, firewalls etc.
- The CSP here is called an IaaS provider

IaaS Delivery Model

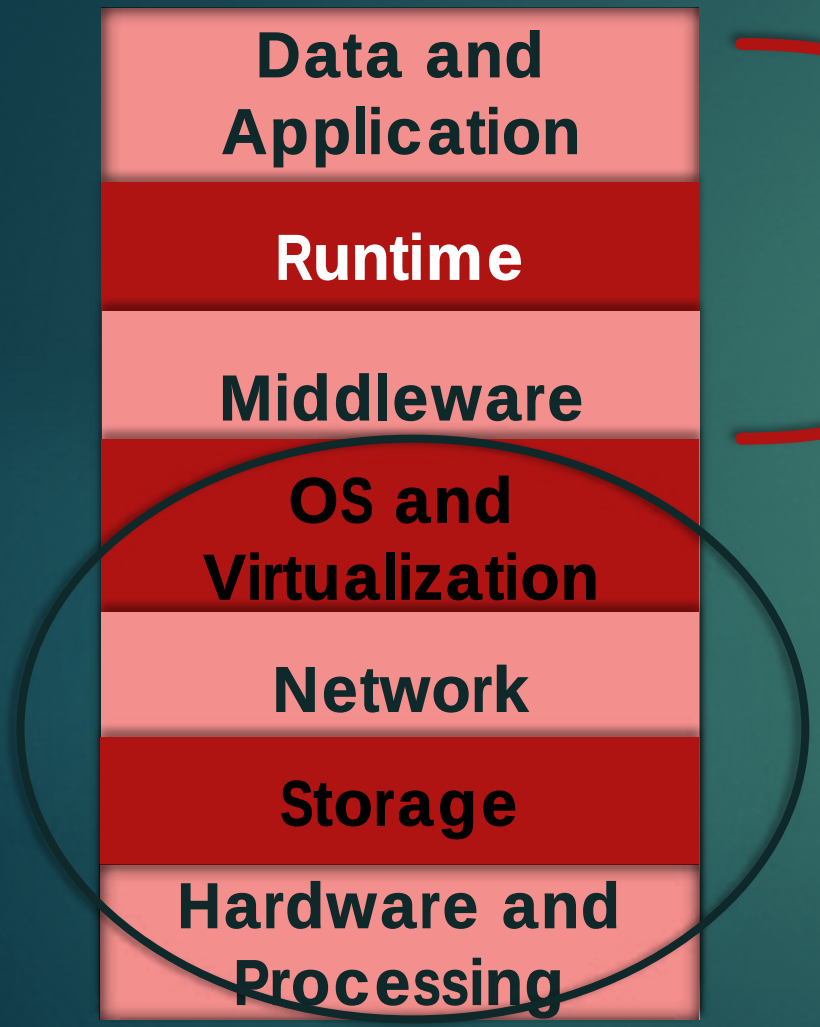
Pick your...

- OS
- Firewalls
- Routers
- Load Balancing





IAAS control



- You manage Data, Application, Runtime and middleware environments.
- You might require additional staff to manage your applications.

Compare to a real-world example:

- Owning a Car: Traditional IT on-premises
- Renting a Car: IAAS

IaaS Delivery Model – Benefits

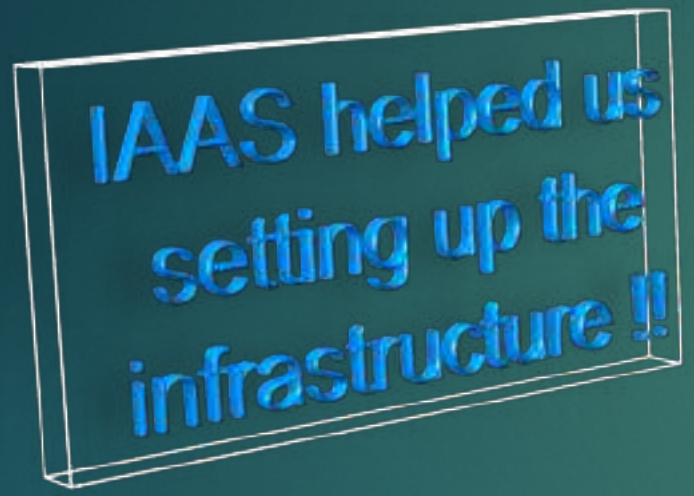
- Rent Infrastructure components either in public or in private.
  No location dependence.
- Pay as you Use model, cost-efficient
- Reduced or no infrastructure maintenance headaches
- Ability to scale from a single server up to entire data centers
- Meet your infrastructure demands dynamically with fast and reliable services

IaaS Delivery Model – Challenges

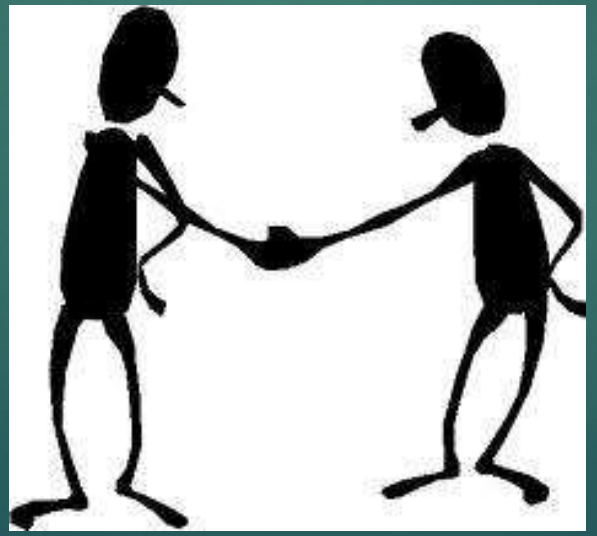
- Integration issues while consuming resources outside company's firewall
- Application deployment and migration issues
- Potential reliability and security risks

IAAS Vendors

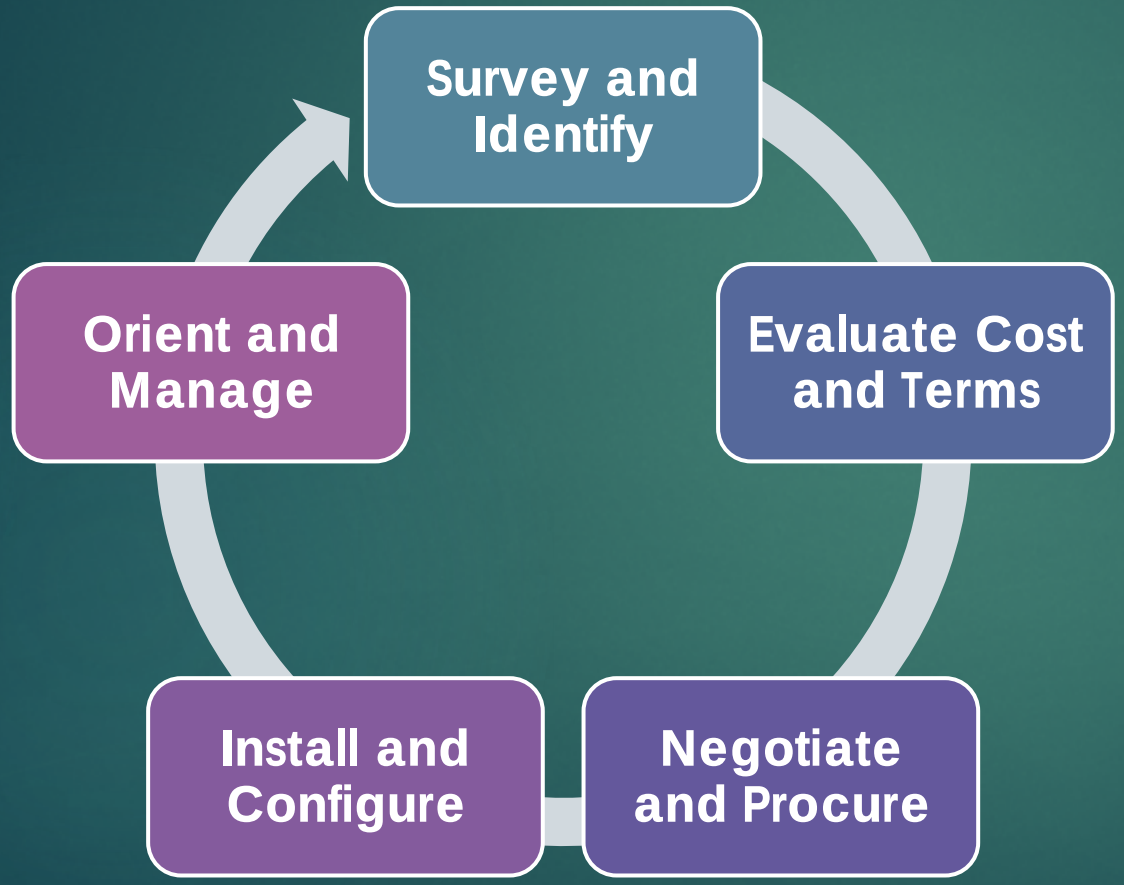
A Scenario- Retail Business Company



- A heterogeneous customer base:
  - Customers connect with the company through internet, using their desktops or laptops, smart phones, PDAs etc.
- The company setup different environments for development, testing and production



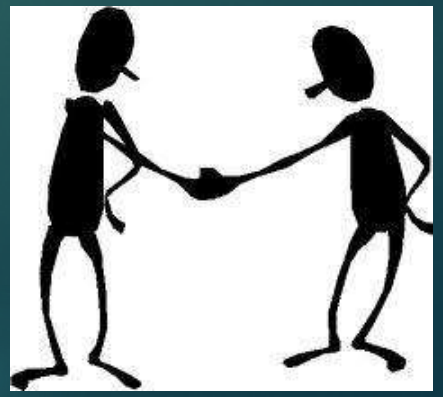
Platform Model – Traditions & Challenges



- Different software, IDEs (Integrated Development Environment
- A lot of licensed software, an expensive option
- A team should take care of the platform management without any delay
- Compatibility issues between the hardware infrastructure and various different software
- Too much software or platform vendor dependence which becomes very risky

A better solution to meet the challenges !!

- Outsource all the system software instead !!
- “Someone” to supply software along with their licenses.
- “Someone” should own the all software licenses along with their maintenance.
- Company would pay to this “someone” based upon “pay per use”.
- This “someone” is a service provider who provides “Platform as a Service” (PaaS)



Platform as a Service

- Here the CSP provides programming languages, libraries, services, and various other tools to the consumer
- You can just focus on developing the application and once done, deploy it onto the cloud
- You not worry about the underlying cloud infrastructure including network, servers, operating systems, or storage

Platform Delivery Model

Pick your...

- App Server
- Web Server
- Database Server
- Middleware
- Development Environments

Enterprise Service Bus (ESB)

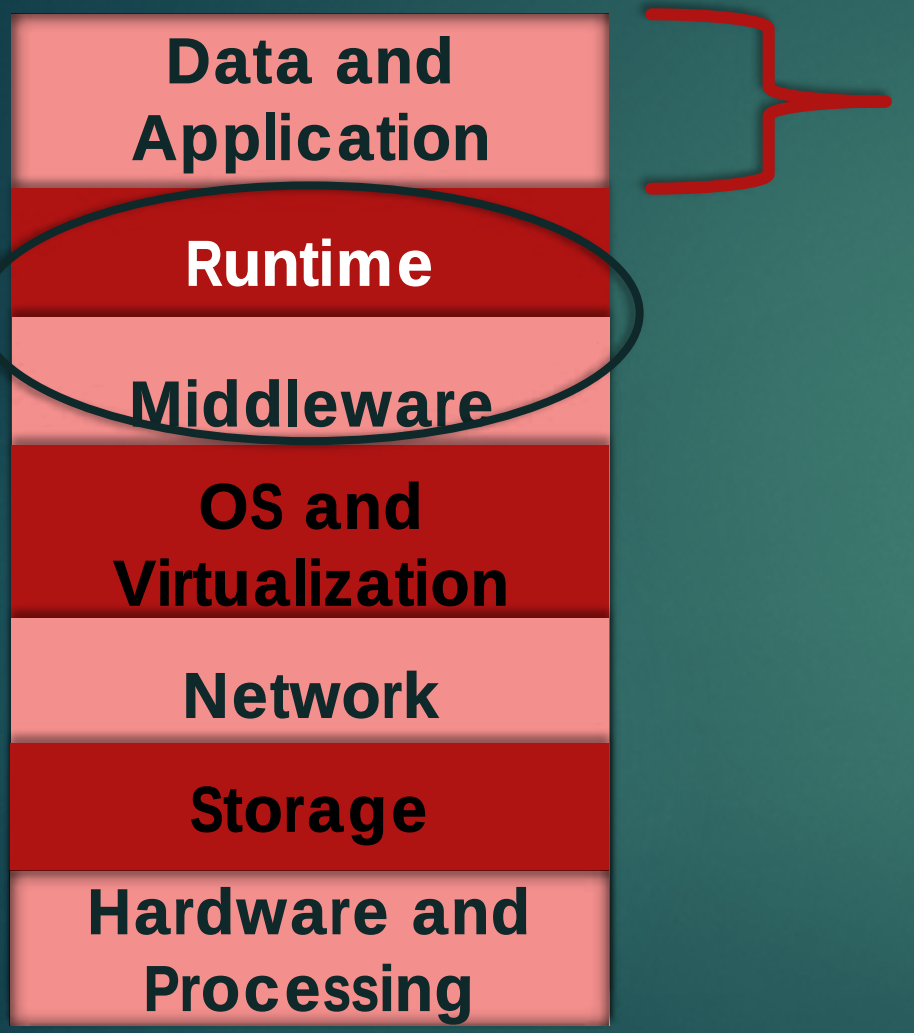
Enterprise Application Integration

Data Integration

Message Oriented Middleware (MOM)

Object Request Brokers (ORBs)

PAAS control



- You manage the Data and Application alone.
- You control the deployed applications and some configuration settings for the application-hosting environment.

Platform Delivery Model – Benefits

- Reduced complexity in hardware and software compatibility issues
- Increased focus for developers on application development logic
- Natural choice for development, testing and production environments
- Dynamic provisioning and scalable services

Platform Delivery Model – Challenges

- Connectivity, interoperability or synchronization issues
- Potential reliability, control and security risks
- Risks of vendor lock-in in case of migration requirements (Platform or Provider)

PAAS Providers

IBM BlueMix

LONGJUMP
CLOUD APPLICATIONS PLATFORM

CORDYS

Next stage of the Scenario…

- Retail company is fully focused on application development
- Company is creating tools for business and operational productivity at workplace; for better suitability

Software Model – Traditions, Challenges

- **In-house development at times**
- **Trained Skill**
- **Testing, Quality Check and Deployment**
- **Trending with market**

- Difficult to develop and use office productivity tools in quick time
- Reliability and security issues with applications
- Keeping ahead of the competition with latest versions

Think of a better Solution..

- Company wants “someone” to provide software solutions HR and Finance package, CRM package etc.
- Company wants this “someone” to maintain the software solutions also along with providing regular upgrades and enhancements.
- Also, if company wants to migrate from one solution to the other, this “someone” should provide it instantaneously and without extra cost of development.
- This “someone” is termed as service provider who provides “Software as a Service” (SaaS).

Software as a Service

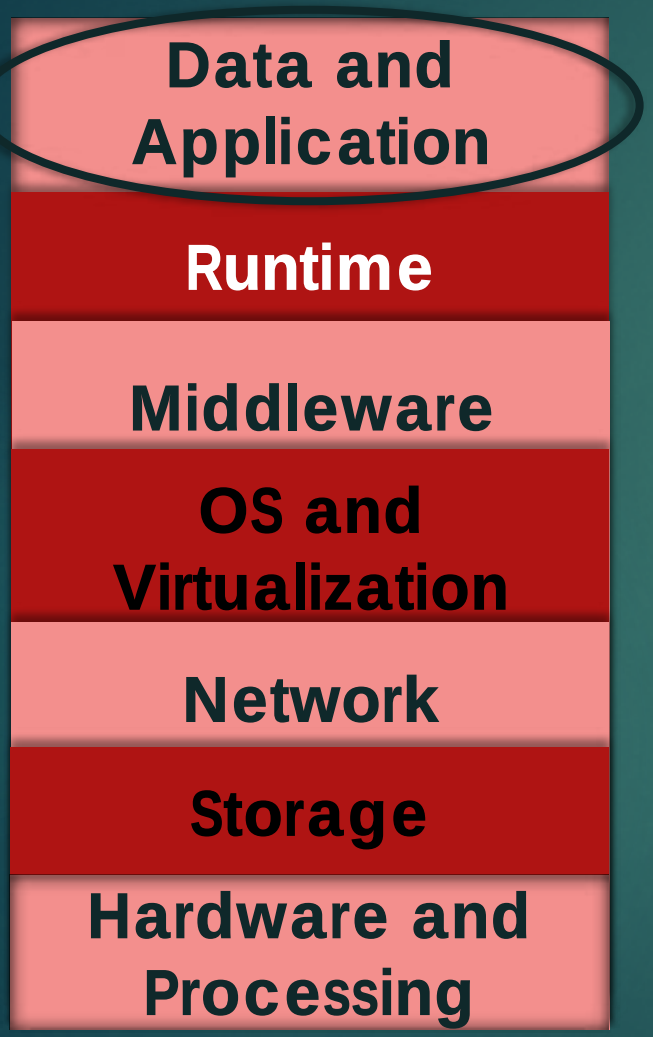
- SAAS provides ready to use existing online applications running on a cloud infrastructure
- Free or paid model via subscription
- E.g. a web-based mail like Yahoo Mail, Gmail
- Applications are accessible from various client devices through either a thin client interface, such as a web browser or some program interface

SaaS Delivery Model

Pick your...

- Office Suites
- CRM
- Financial Planning
- Human Resources
- SCM

SAAS control



- CSP hosts the Data and Application
- The consumer have no control on the underlying cloud infrastructure
- There is some control for limited user specific application configuration settings

SaaS Delivery Model – Benefits

- Leverage anytime, anywhere access services
- Reduced operating costs
- Eliminate licensing and version compatibility problems
- Reduced hardware in premises

SaaS Delivery Model – Challenges

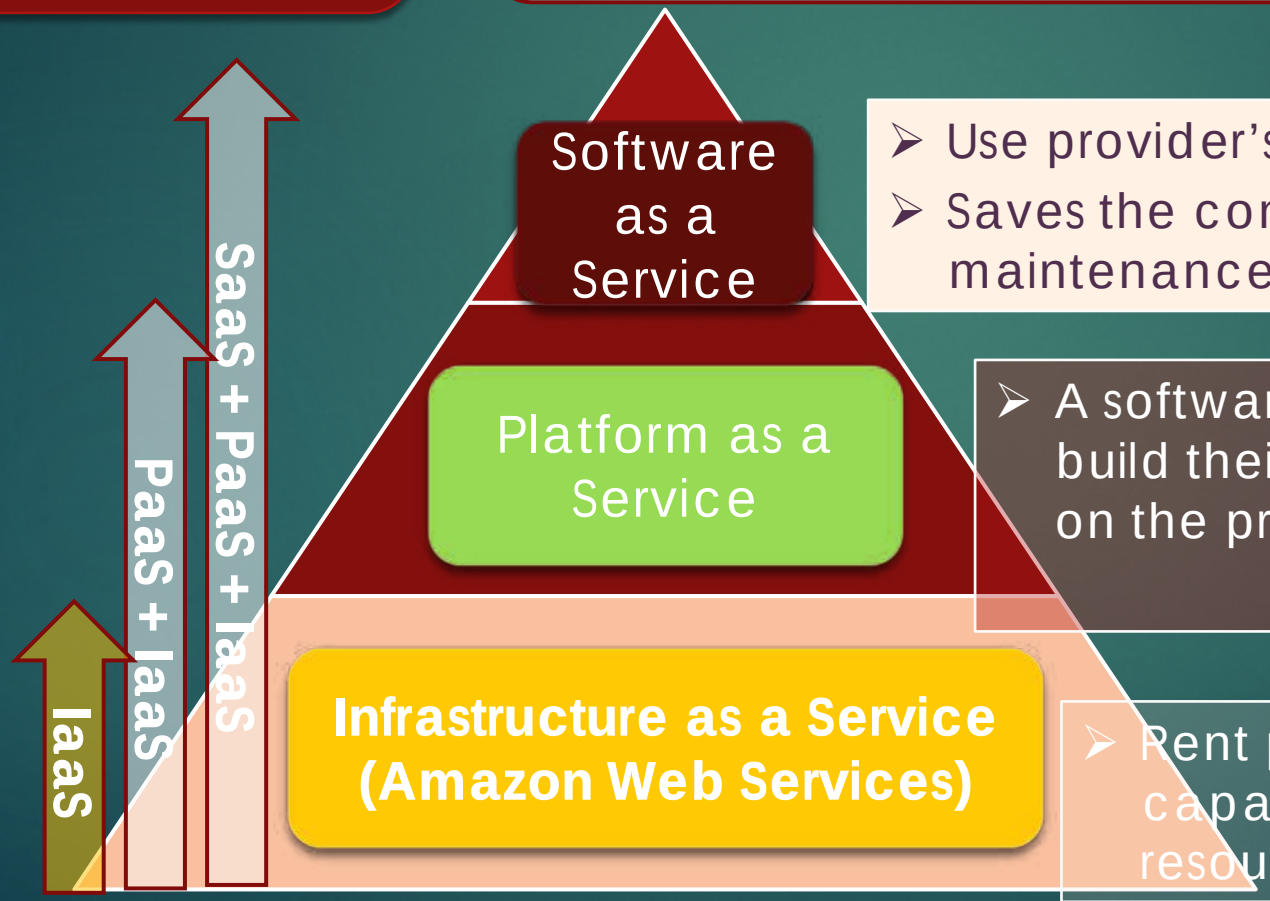
- Data privacy and ownership issues
- Governance and billing management
- Synchronization issues between client and service provider

SAAS Providers

Public Cloud – Service Models

3 Models in cloud computing

IaaS | PaaS | SaaS



- Use provider's applications over a network
- Saves the complexity of software installation, maintenance, upgrades, patches etc.

- A software platform on which users can build their own applications and host them on the provider's infrastructure

- Rent processing, storage, network capacity, and other computing resources

Self- Review… Queries so far???

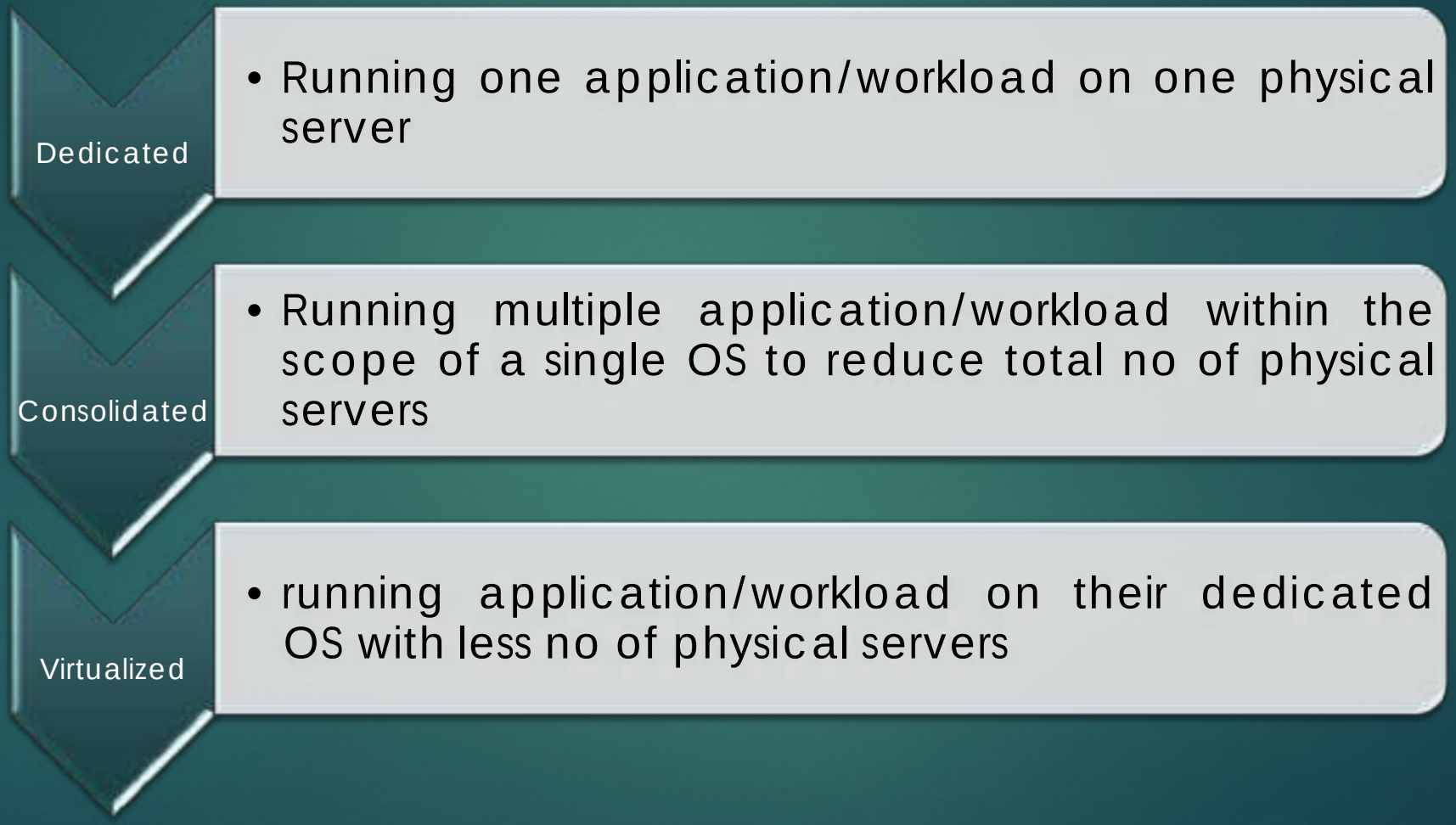
- What are the different service Models in Cloud Computing?
- What are the benefits and challenges in IAAS?
- What are the benefits and challenges in PAAS?
- What are the benefits and challenges in SAAS?

Data Center

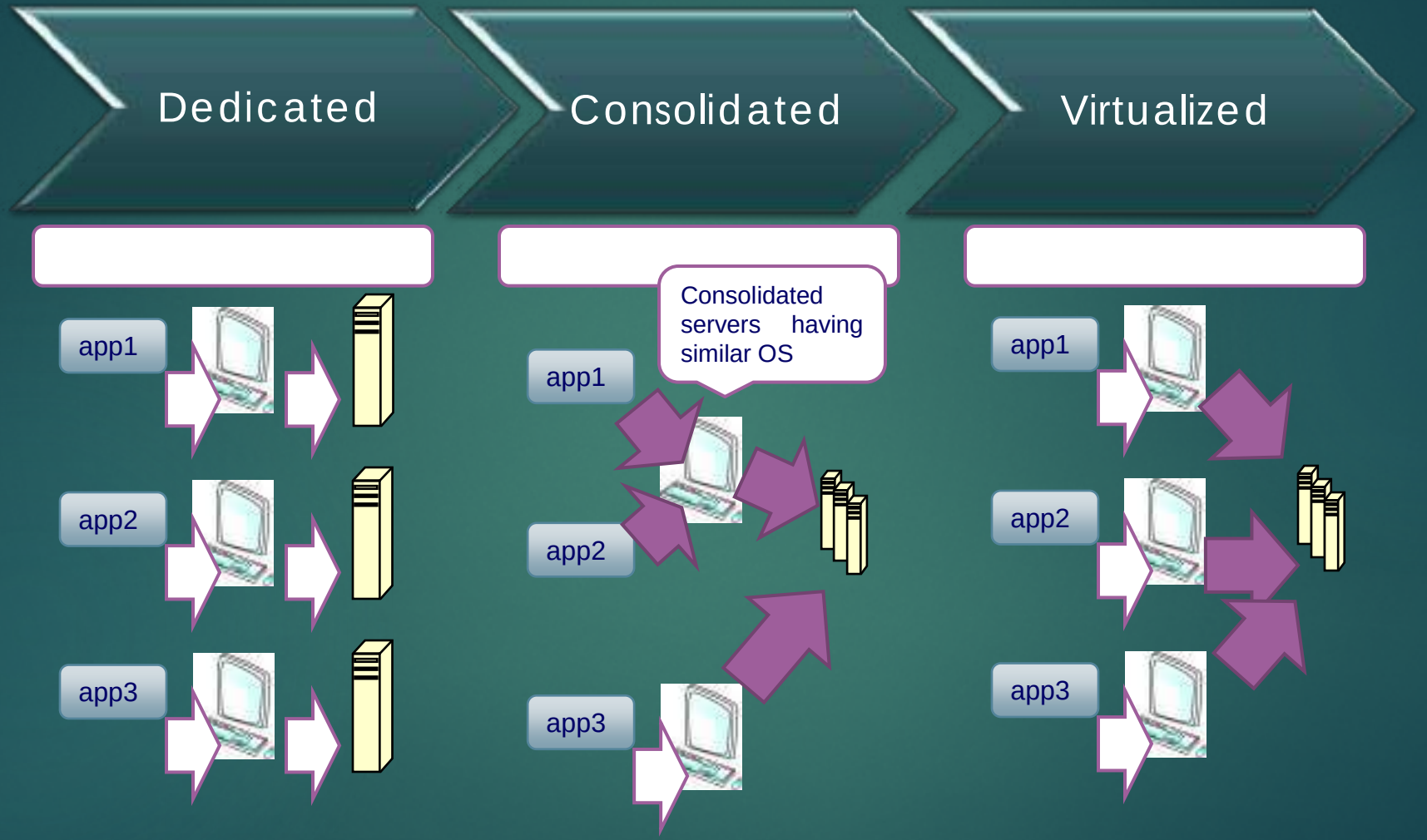
- Is a secured facility to house IT equipment for Enterprise
- Provides complete redundancy on power supply, environmental controls (e.g. AC, fire suppression, redundant data communications connections and security devices)

Image source from :
http://www.slashgear.com/

Data Center transformation



Data Center transformation



Virtualization

- Is the creation of a virtual version of something, such as an operating system, a server, a storage device or network resources

- Is a technique to provide the abstraction of physical resources

History of Virtualization

- Conventional Data Centers
  - Multiple applications
  - Multiple servers
  - Multiple OS
  - Underutilized servers

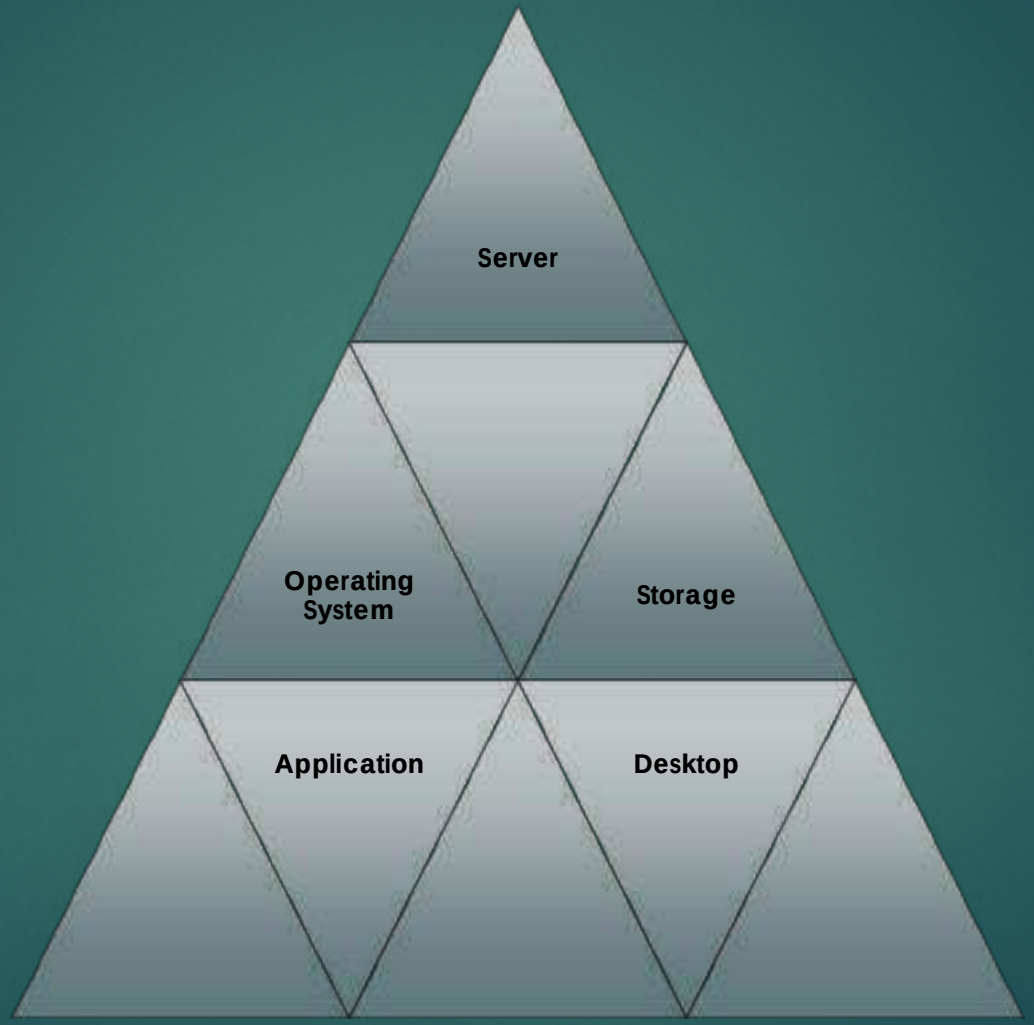
History of Virtualization

- Virtualized Data Centers
  - Multiple applications
  - Single physical servers supporting multiple virtual server
  - Single OS supporting multiple OS
  - Optimal utilization of servers

Basics of Virtualization

- Virtualization is an approach to simulate the software or hardware upon which other software/application runs
- This simulated environment is called a *virtual machine* (VM)
- An abstraction of the underlying hardware that allows a single machine to be showcased as multiple machines

Virtualization technologies



Benefits of virtualization

Optimal utilization of resources

- Hypervisors allow resource sharing
- By creating virtual machines, fewer server are required for the same no of applications
- Improved resource utilization

Reduce data center's space

- Virtual machines helps in reducing the total no of physical hardware and thus allows to reclaim data center space

Benefits of virtualization

Reduction in operation cost

- Less hardware leads to less power consumption
- Less maintenance overhead for IT staff

Reduce carbon emission

- Less servers > less carbon emission
- Data center more green compliant

Benefits of Server virtualization

Reduced scheduled downtime

- Most virtualization platforms include some iteration of live migration features
- Live migration allows to move VMs from one physical host to another to improve performance

Benefits of Server virtualization

Load balancing

- With portability, VMs can be automatically moved from one host to another without creating downtime and whenever a virtual host fails to provide the resources VMs need

High availability

- If VMs' current host fails, these virtual servers can be automatically restarted on another host

Benefits of Server virtualization

Easier backup and restore

- A hypervisor can track the blocks of a VM disk that have been changed so that only those blocks are backed up
- Plus, with snapshot functionality, virtual machines can be backed up anytime without affecting user performance

Fast provisioning

- Virtual machines can be easily and quickly cloned to create new VMs in seconds whenever needed
- This way, new enterprise applications can be brought up to run, faster than previously

Benefits of Server virtualization

Easier patch managements & upgrades

Simpler **disaster recovery** planning without disruption to the production environment

Role of virtualization in Cloud

- Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (eg. Server, storage, application) that can be rapidly provisioned and released with minimal management effort

- Virtualization is the key to unlock the door to cloud computing and to push organizations in that direction

Role of virtualization in Cloud - How?

On demand & rapid provisioning

- Virtualization enables faster provisioning of resources
- Virtualization facilitates organizations leverage on-demand access to application & infrastructure as service

Shared pool & elasticity of resources

- Virtualization provides resource pooling
- Enables to allocate resources on-demand

Enables economies of scale

- Virtualization enables efficient datacenter consolidation thereby cutting capital & operating costs

Some Myths about Cloud Computing

Myth: Cloud computing requires you to expose your data to the outside world

Fact: Using private cloud you need not expose the data to outside world

Myth: Cloud computing requires virtualization

Fact: Virtualization only speeds up the cloud deployment and is not a necessity

Virtualization v/s Cloud Computing

Factor	Virtualization	Cloud Computing
User Interaction	User needs to interact with Hypervisor to create, manage VMs and their properties	All admin activities have been outsourced by API Human factor of management have been automated
Presence	Virtualization is the foundational element of cloud computing which is mainly a part of the physical infrastructure.	Cloud computing is the delivery of shared computing resources, software or data as a service via the Internet

Some Myths about Cloud Computing

Myth: Cloud computing always saves you money

Fact: In certain circumstances of licensing and support models, you may pay significantly high amount than deploying it internally

Myth: Cloud computing is same as Grid Computing

Fact: Grid Computing is different technology which is used under Cloud Architecture

Grid Computing v/s Cloud Computing

Factor	Grid Computing	Cloud Computing
Working	In a computational grid, one large job is divided into many small portions and executed on multiple machines	The computing cloud is intended to allow the user to avail of various services without investing in the underlying architecture.
Service	It services large-scale computations, or compute-intensive operations	Cloud services include the delivery of software, infrastructure, and storage over the Internet (either as separate components or a complete platform) based on user demand

Cloud Computing – Challenges

- Data Security and Privacy
- Data Ownership and Control Options
- Reliability and Performance
- Federation concerns amongst CSP's
- Compliance to Legal standards

So just be Careful !!

- It might be unsecure
  - So, a safe and secure way of using cloud demands your real knowledge.
  - You should identify and resolve security issues, specific to public and private cloud.
  - You need to bring measures of cyber security to the cloud.
- You need to have an honest conversation with these providers
- Do they offer 100% availability SLAs, or do you get that generic "99.9 percent" availability?
- Do they offer dedicated compute resources for each partner, or are you going to end up fighting with other cloud tenants for the same resources?

Limitations of the cloud computing

- Cloud computing makes it difficult to customise applications according to the needs of different users.
- If the usage of services is excessive then costs of using services from a service provider will be much more than conventional hosting.
- The changes in the application are made without the end user's knowledge since the cloud is not being maintained by him/her.
- The freedom of the end user is limited since he/she is dependent on the cloud computing provider.

When to use Cloud – Some Scenarios

Deployment is for "green field" application, especially startup	✓ Focus on your core business without having to set up and provision your IT infrastructure, especially if it primarily involves basic elements such as e-mail, word processing, collaboration tools, and so on
IT department needs to "burst" to access additional IT resources to fulfill a short-term requirement	✓ Testing of an internally developed application to determine scalability ✓ Prototyping of "nonstandard" software to evaluate suitability ✓ The term ***cloud bursting*** is sometimes used to describe this scenario
Ramping up of a "new service offering" without completely certain about the demand	✓ It can start with a small number of resources and scale up or down according to the demand ✓ No risk of time-to-market efficiency and/ or unnecessary investment in resources

Why use cloud?

- **Competition-** 45% of business already use or plan to use cloud
- **The Green Cloud**:
  - You having a low power system can save energy at your end
  - Cloud tools allow people to collaborate without travelling
- **The Innovative Cloud**:
  - It is essential to meet next generation computing like google goggles working on various devices would be a near future.
  - In time, Visual Search (google goggles), augmented reality, online translations would be required that is entirely dependent on cloud.

Summary

- Why Cloud computing?
- Service models – IaaS, PaaS and SaaS
- Deployment models – Private, Public, Community and Hybrid
- Benefits of cloud computing and When to use cloud?
- Cloud computing challenges and Myths
- Data center & its transformation
- Virtualization definition & history
- Virtualization technologies : OS level, Storage, Application and Desktop virtualization
- Role of virtualization in cloud computing
- Differences with Grid Computing and Virtualization

Queries????

Thank You!!!

Appendix

Load Balancer

- A load balancer is a device that acts as a reverse proxy and distributes network or application traffic across a number of servers to increase capacity (concurrent users) and reliability of applications.
- They improve the overall performance of applications by decreasing the burden on servers associated with managing and maintaining application and network sessions, as well as by performing application-specific tasks.
- Load balancing can be implemented with hardware, software, or a combination of both.
- Usually, if two servers are used to balance a work load, a third server is needed to determine which server to assign the work to. Since load balancing requires multiple servers, it is usually combined with failover and backup services. In some approaches, the servers are distributed over different geographic locations.

POD

- Print On Demand (POD) services are an example of organizations that can benefit from IaaS.
- The POD model is based on the selling of customizable products.
- PODs allow individuals to open shops and sell designs on products. Shopkeepers can upload as many or as few designs as they can create.
- With cloud storage capabilities, a POD can provide unlimited storage space.

Router

- A router is a device that forwards data packets along networks.
- A router is connected to at least two networks, commonly two LANs or WANs or a LAN and its ISP's network.
- Routers are located at gateways, the places where two or more networks connect.
- Routers are small physical devices that join multiple networks together.
- By maintaining configuration information in a piece of storage called the routing table, wired or wireless routers also have the ability to filter traffic, either incoming or outgoing, based on the IP addresses of senders and receivers.

Firewall

- A firewall is a system designed to prevent unauthorized access to or from a private network.
- Firewalls can be implemented in both hardware and software, or a combination of both.
- All messages entering or leaving the intranet pass through the firewall, which examines each message and blocks those that do not meet the specified security criteria.

Firewall

Hardware and Software Firewalls

- Firewalls can be either hardware or software but the ideal firewall configuration will consist of both.
- Hardware firewalls can be purchased as a stand-alone product but are also typically found in broadband routers, and should be considered an important part of your system and network set-up.
- Software firewalls are installed on your computer (like any software) and you can customize it; allowing you some control over its function and protection features.

Thin Clients

- At times, thin may be defined as simply not needing the software or operating system installed on the user machine.
- This allows all end users' systems to be centrally managed and software deployed on a central server location as opposed to installed on each individual system.
- For this reason, thin clients are often deployed in hotels and airports, where installing software to all systems wouldn't make sense.
- To use the client, an input device (keyboard) and viewing device (display) is usually the basic requirements. Some may not even require a mouse.

Thick Clients

- In contrast, a thick client will provide users with more features, graphics and choices making the applications more customizable.
- Unlike thin clients, thick clients do not rely on a central processing server because the processing is done locally on the user system, and the server is accessed primarily for storage purposes; often not well-suited for public environments.
- To maintain a thick client, IT needs to maintain all systems for software deployment and upgrades, rather than just maintaining the applications on the server.
- Additionally, thick clients often require operating specific applications, again posing more work and limitations for deployment.

Cloud Bursting

- Cloud bursting is an application deployment model in which an application runs in a private cloud or data center and bursts into a public cloud when the demand for computing capacity spikes.

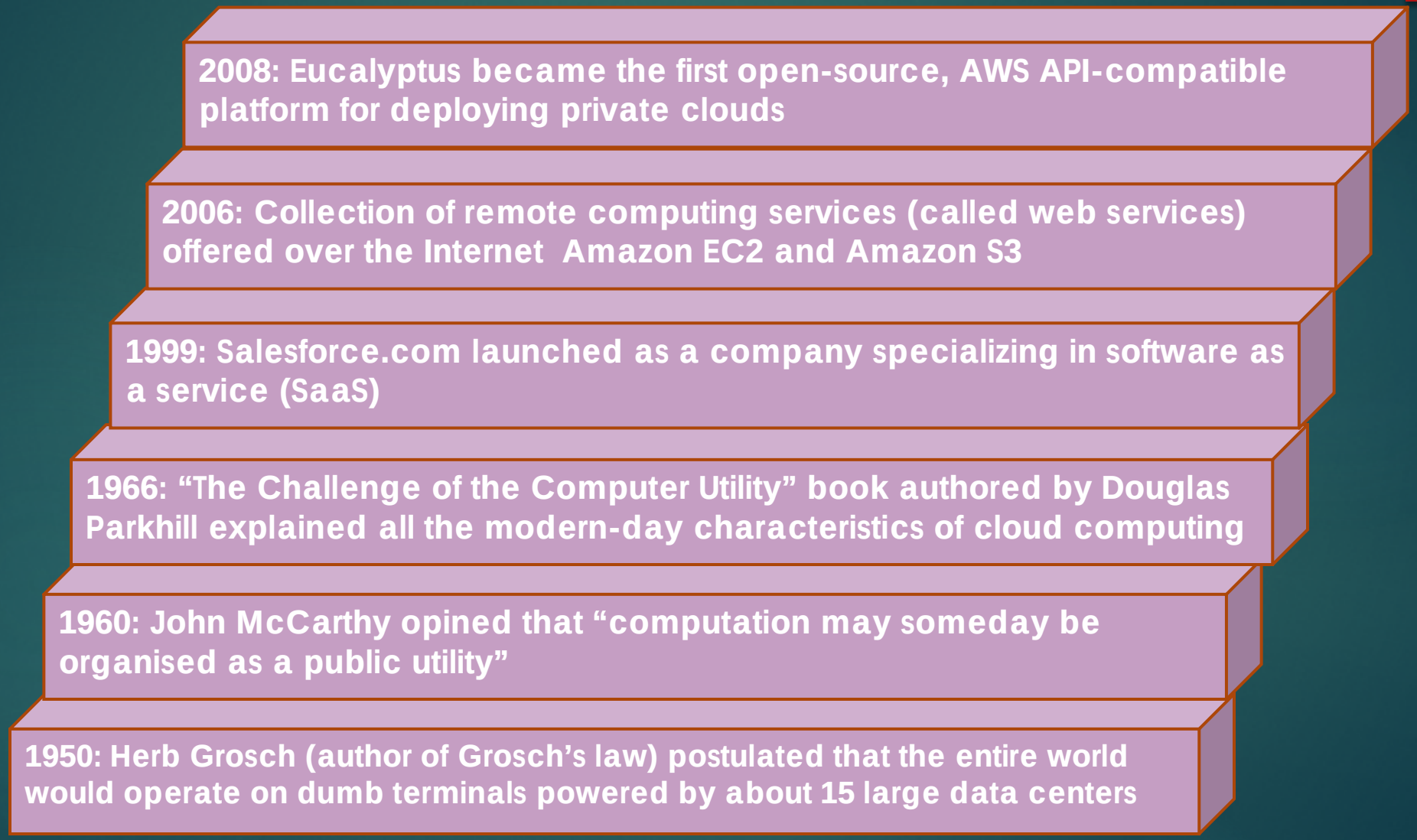
Cluster Computing v/s Grid Computing

Cluster Computing	Grid Computing
Cluster is homogenous	Grids are heterogeneous
Cluster computers all have the same hardware and OS	Run different operating systems and have different hardware
The machines in a cluster are dedicated to work as a single unit and nothing else	A grid can make use of spare computing power on a desktop computer
The computers in the cluster are normally contained in a single location or complex	Grid are inherently distributed by its nature over a LAN, metropolitan or WAN
In case of Cluster, the whole system (all nodes) behave like a single system view and resources are managed by centralized resource manager	In case of Grid, every node is autonomous i.e. it has its own resource manager and behaves like an independent entity.

Distributed Computing v/s Grid Computing

Distributed Computing	Grid Computing
Distributed computing uses a centralized resource manager and all nodes cooperatively work together as a single unified resource or a system	Grid computing utilizes a structure where each node has its own resource manager and the system does not act as a single unit

History of Cloud Computing



Traditional vs Cloud Computing

	Delivery Model	Cost	Flexibility	Provisioning Resources	Scalability
Traditional	Buy Asset	Capital Cost yearly	Manual Procure	More Time	Manual
Cloud	Buy Services	Pay as you Use	Self Service	Within Minutes	Elastic

Cloud Computing – Benefits

- Lower cost of ownership
- Rollout applications faster
- Multi-tenant environment
- Reduce infrastructure management complexity
- Allow for fluctuating resource loads

Cloud Computing in a Nutshell

Characteristics

- On Demand Service
- Metered Service
- Rapidly Elastic
- Broad Network Access
- Pooling of Resources

Service Models

- Software as a Service (SaaS)
- Platform as a Service (PaaS)
- Infrastructure as a Service (IaaS)

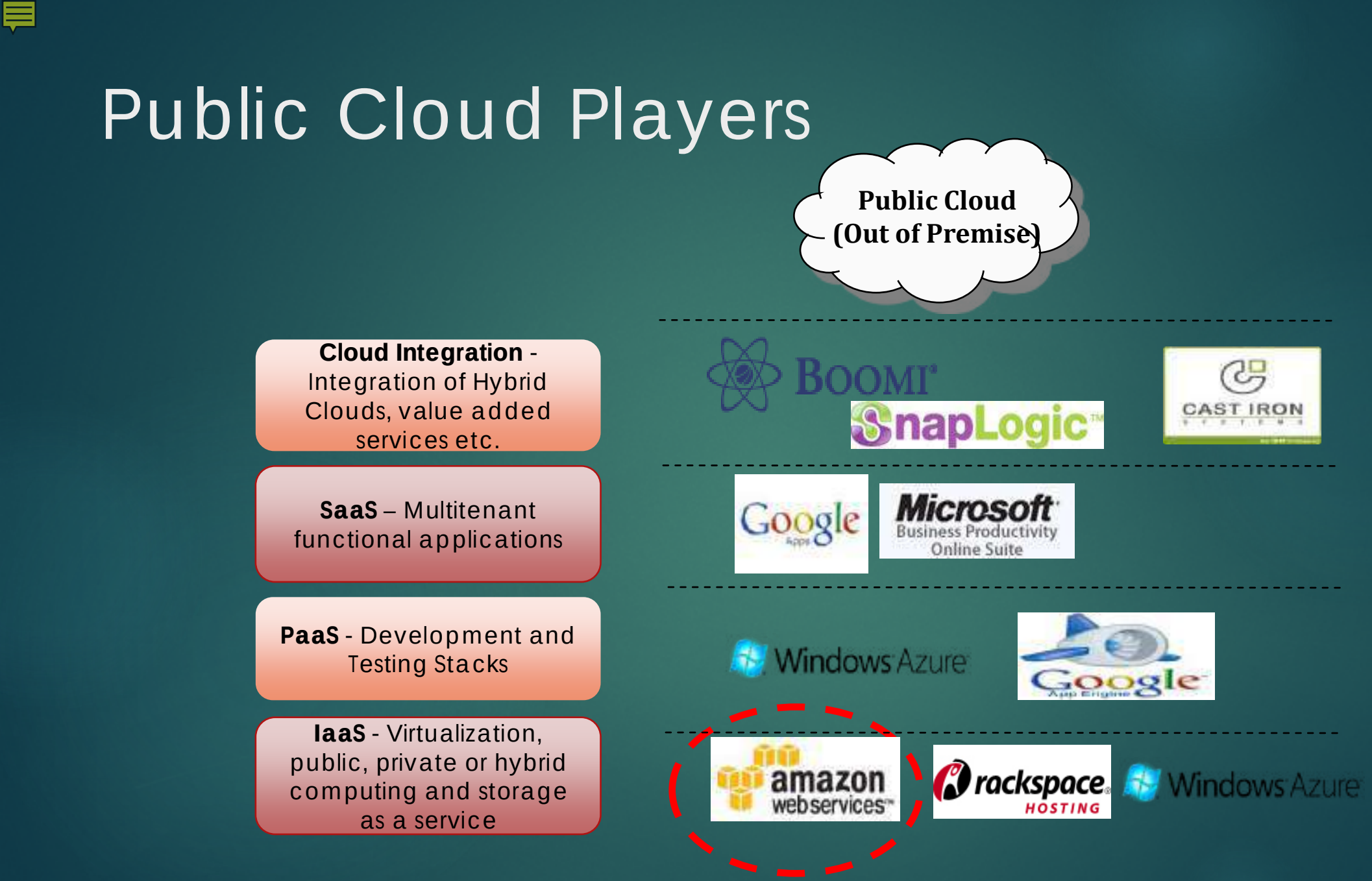
Deployment Models

- Public
- Private
- Hybrid
- Community

Cloud Computing – Service Models

IaaS	• Rent storage, network resources and other computing resources • Amazon Web Services
PaaS	• Rent platforms for application building and host them on service provider network • Google App Engine
SaaS	• Use infrastructure, platform and also applications of the service provider to save complexity • Microsoft Dynamics

Public Cloud Players



Let us evaluate ourselves...

- Mention under which service model the below scenarios fall:
- We are going to start a new project in Finance unit and client wants to setup the development, testing environment at Client campus.
  - IaaS and PaaS
- CBSE website where class 10 and class 12 results are announced
  - IaaS + PaaS. May include SaaS as needed.
- Shifting from Super Computer to Cloud Computing
  - IaaS

Let us evaluate ourselves...

- Education getting online
  - SaaS
- Rural students connect virtually to learn through Cloud
  - IaaS + PaaS + SaaS
- Gaming industry on Cloud
  - IaaS
- Product development lifecycle
  - IaaS
- Flexible conditions to SMEs to work while being mobile
  - IaaS + PaaS + SaaS