

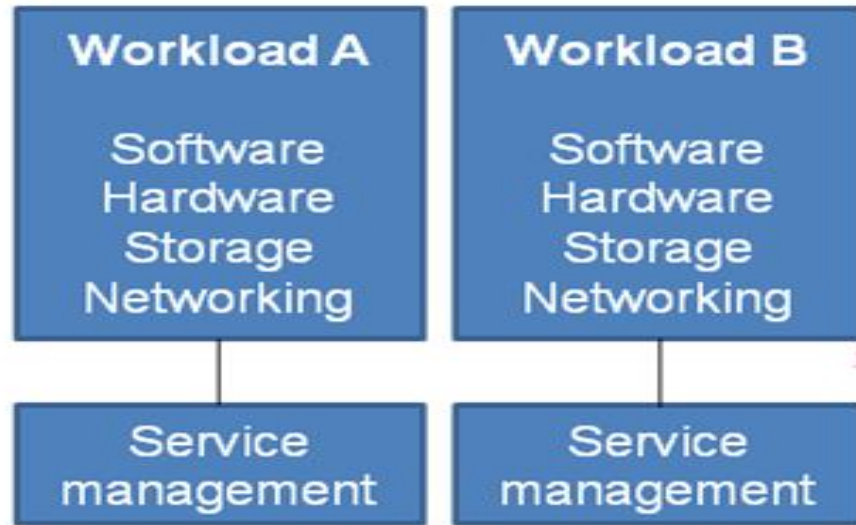
Cloud computing

What is cloud computing?

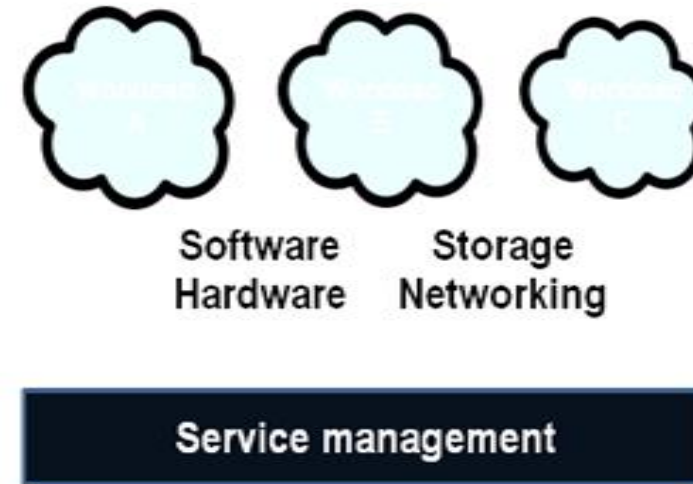
- Any IT company needs a server room, database server, mail server, networking, firewalls, routers, model, switches, configurable system, high net speed and the maintenance engineers as basic need for it.
- To establish such infrastructure the company has to spend a lot of money.
- To overcome all these problems and reduce the cost involved, cloud computing comes into existence.
- **Cloud computing** means *on demand delivery of IT resources* via the internet with pay-as-you-go pricing. It provides a solution of IT infrastructure in low cost.
- Cloud Computing can be defined as delivering computing power(CPU, RAM, Network Speeds, Storage OS software) a service over a network (usually on the internet) rather than physically having the computing resources at the customer location.

Scenario without and with cloud computing

Without cloud computing



With cloud computing



Understanding Cloud Computing

- Automated service management
- Standardized services
- Location independent
- Rapid scalability
- Self-service

The need for a cloud computing



Cloud computing essential characteristics

Broad network access

- Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms(e.g mobile, labtops, PDA etc)

Resource pooling

- **Resource:** Any kinds of resources *to be shared* to compose *cloud services*,including *computing power, storage, network, database, and applications*.
- The CSP's computing resources are *pooled to serve multiple users* using a *multi-tenant model*, with *different physical* and *virtual resources* that are dynamically assigned and reassigned according to user demand.
- There is a sense of *location independence* in that the customer generally has *no control or knowledge over the exact location* of the provided resources, but *may be able to specify the location at a higher level of abstraction* (e.g.,country, state, data centre).
- Examples of resources include:
 - Storage (typically on hard or optical disc drives),
 - Processing,
 - Memory (typically on DRAM),
 - Network bandwidth,
 - and Virtual machines (VM).

Cloud computing essential characteristics- cont..

Rapid elasticity

- Rapid elasticity: Capabilities can be rapidly and elastically provisioned, in some cases automatically, to ***quickly scale out***, and rapidly released to ***quickly scale in***.
- To the CSU, the capabilities available for provisioning often appear to be ***unlimited*** and ***can be purchased in any quantity at any time***.

Measured service

- Measured service: Cloud systems ***automatically control*** and ***optimize resource use*** (e.g., storage, processing and bandwidth) by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., the number of active user accounts).
- ***Resource usage can be monitored, controlled, and reported***, providing transparency for both the CSP and CSU of the utilized service.

Resiliency:

- Resilient computing is a form of failover that distributes redundant implementations of IT resources across physical locations. IT resources can be pre-configured so that if one becomes deficient, processing is automatically handed over to another redundant implementation. Within cloud computing, the characteristic of resiliency can refer to redundant IT resources within the same cloud (but in different physical locations) or across multiple clouds

Characteristic of cloud computing – cont..

- 1. Agility – as the cloud works in the distributed computing environment, it shares resource among users and work very fast
- 2. High availability and reliability (ubiquitous access)- Availability of servers is high and more reliable, because **chances of infrastructure failure are minimal.**
- 3. high scalability- Means "**on-demand**" **provisioning of resources on a large scale**, without having engineers for peak loads.
- 4. Multi-sharing or multi-tenancy- **multiple users and applications can work more efficiently** with cost reductions by sharing common infrastructure.
- 5. Device and location independence- web browser and internet connection is enough. Geographical and device is not a matter.
- 6. Maintenance- Easier, as they **do not need to be installed on each user's computer and can be accessed from different places.** So, it reduces the cost also.
- 7. Low cost- **IT company need not to set its own infrastructure** and pay-as-per usage of resources
- 8. Services in pay-per-use mode – Users **can access services on the cloud by using the APIs(Application Programming Interfaces) provided by the clouds and pay the charges as per the usage of services**

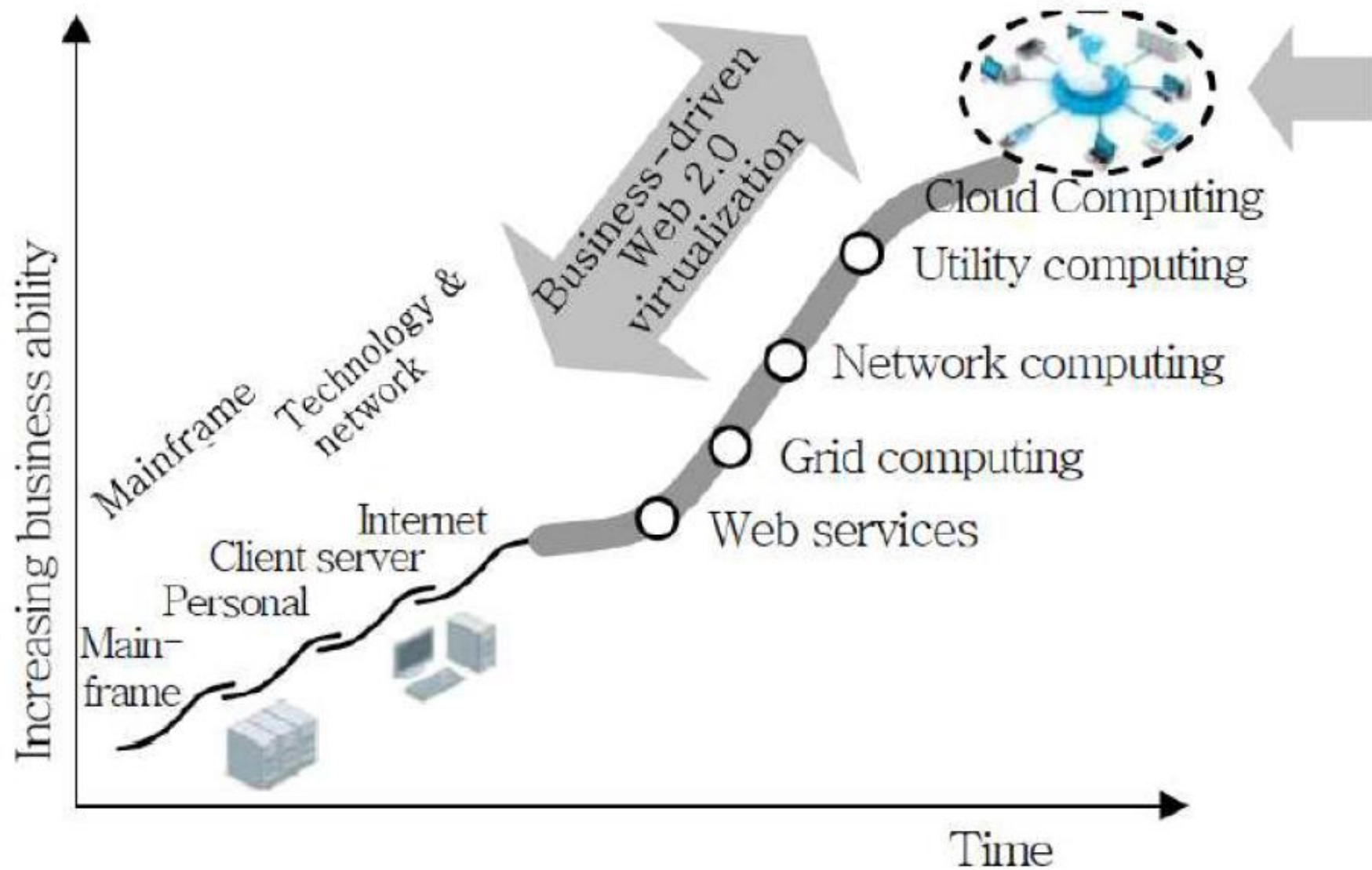
Advantages of cloud computing

- Lower cost computer for users- no need for high-powered computer to run cloud based applications, because the apps run on cloud not on PCs
- Lower IT infrastructure cost- no need to invest in large number of powerful servers. No need for IT staff
- Fewer maintenance cost – as the cloud provider look into maintenance no need for companys to take care.
- Lower Software cost- no need to purchase the software packages for each computer in the organization.
- Instant software updates-users no need to care about obsolete s/w and high upgrade costs. Updates happen automatically and always available
- Increased computing power- high powered servers
- Unlimited storage capacity- they provide high storage space
- Data is free from accidental erasure or h/w crashes. Because it is duplicated across multiple physical machines. So even if one machine fails, they other machine starts functioning , so the user don't feel the failure of crash

Disadvantage of cloud computing

- Require a constant internet connection
- Require high speed internet connection
- Stored data might not be secure
- Lock In- it is very difficult for the customers to switch from one **Cloud Service Provider (CSP)** to another. It results in dependency on a particular CSP for service.

History of cloud computing



History of cloud

Client/server computing:

- Data & applications reside in central mainframes.
- After getting access the users can access the data, that to in round-robin technique only. If somebody is using they have to wait till they release the respective resource.
- Dump computer with no intelligence, master/slave concept

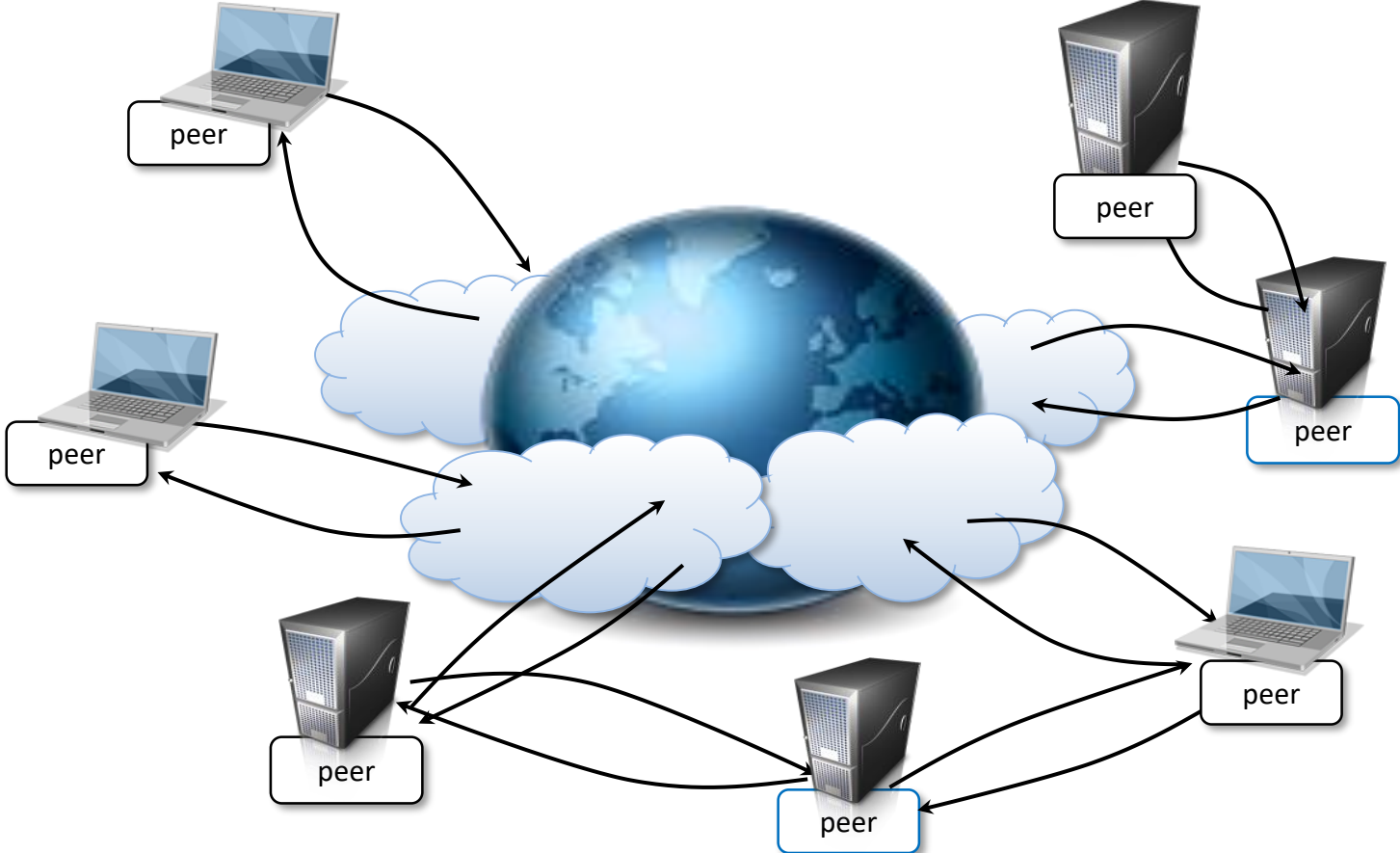
Peer-to-peer computing

- Each computer is a client as well as servers
- Intelligent, exchange data between two PC's without intervention of servers
- No master slave concept
- Decentralizing concept adopted
- Eg internet

Distributed computing

- Various computers tries to solve a problem of project which if run in single PC may take more days. But using various computers will solve within a short duration

P2P

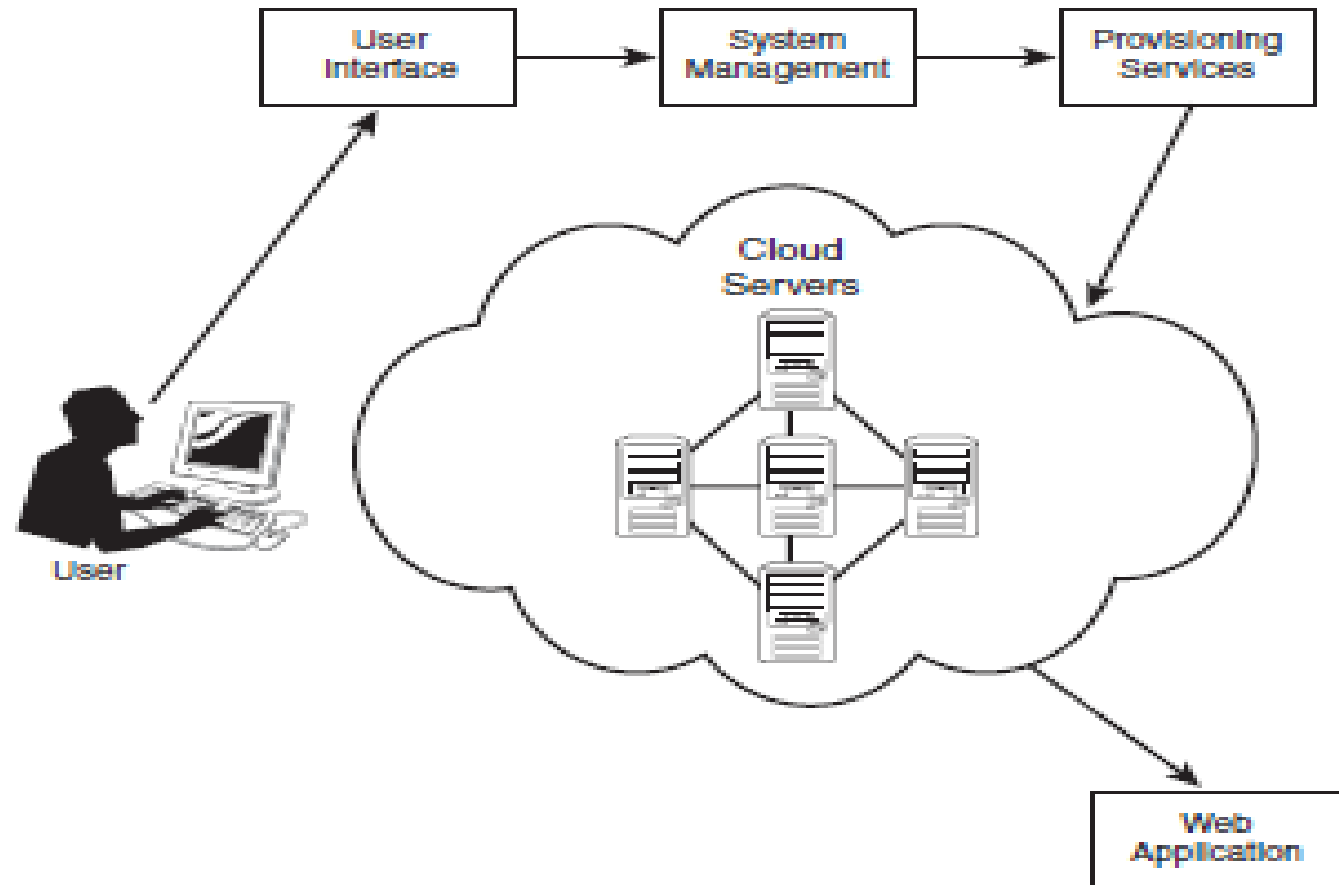


Collaborative computing: working as a group

- There has been a desire for multiple users to work simultaneously on the same computer-based project
- To enable this users must be able to share files and communicate through audio/video conferencing etc
- The next step is cloud computing in this scenario

Cloud architecture

- Cloud is a collection of computers and servers that are publicly accessible via the internet. This h/w is owned by a third party. The machines on any operating system.
 - The cloud is seen as a single computer to users
 - The h/w is invisible
 - Automated mgt for allocation of resources
- No intervention of humans



Understanding of cloud storage

- Dynamic- the cloud storage location may differ from day to day even minute to minute based on available storage as the cloud dynamically manages the space. The user sees a virtual server- that is it appears as if the data is stored in a particular space with a specific name to the user. The users sees a “static” location for his data as if it is in his PC.

Who benefit from cloud ?

- Collaborators: the people who works on a project, from different geographical locations
- Road warriors : the people who keep moving from one place to another
- Cost-conscious users : in colleges, instead of buying Microsoft office, google docs, spreadsheets etc can be used free of costs.
- Cost-conscious IT depts: where more server and more computing power is needed can go for cloud computing

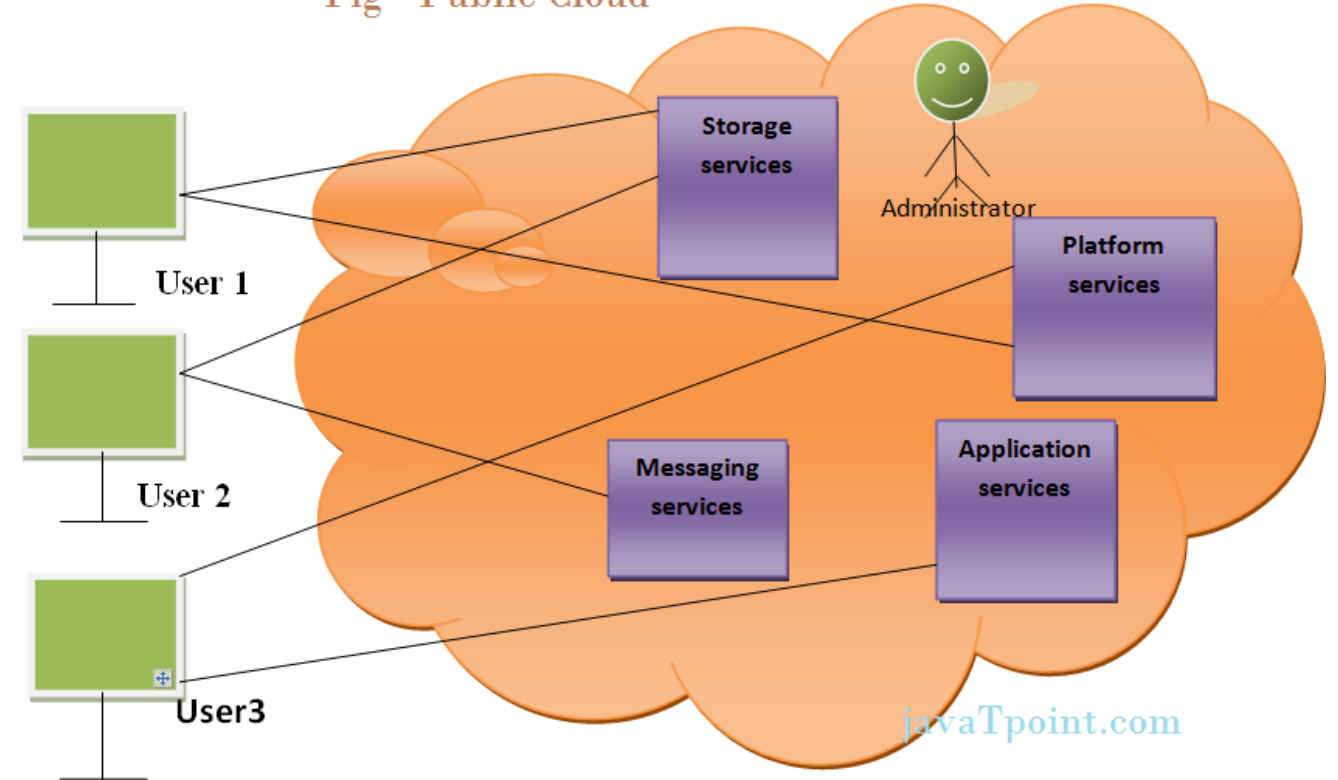
Deployment models and types of cloud

- Deployment models define the type of access to the cloud. Based on this the clouds are of the following types:
- Public cloud – allows systems and services to be easily accessible to the general public. It is less secure because of its openness.
- Private cloud – allows systems and services to be accessible within an organization. More secured
- Community cloud- allows systems and services to be accessible by a group of organizations.
- Hybrid cloud – is a mixture of public and private cloud, in which the critical activities are performed using private cloud while the non-critical are performed using public cloud.

Public cloud

- A *public cloud* is a publicly accessible cloud environment owned by a third-party cloud provider
- Public cloud allows the accessibility of systems and services easily to general public. Eg: Amazon, IBM, Microsoft, Google, Rackspace etc.

Fig - Public Cloud



Advantages of public cloud

- Low cost: as it shares resources with large number of consumers.
- Reliable: provides large number of resources from different locations, if any of the resource fail, public cloud can employ another one.
- Flexible: easy to integrate with private and hybrid clouds
- Location independent: because of internet.
- High scalability: as per the demand the resources are available. That is when need more or less it is allocated accordingly.

Disadvantage of public cloud

- Low security : as the resources are shared publicly, the data may not be secure.
- Less customizable:

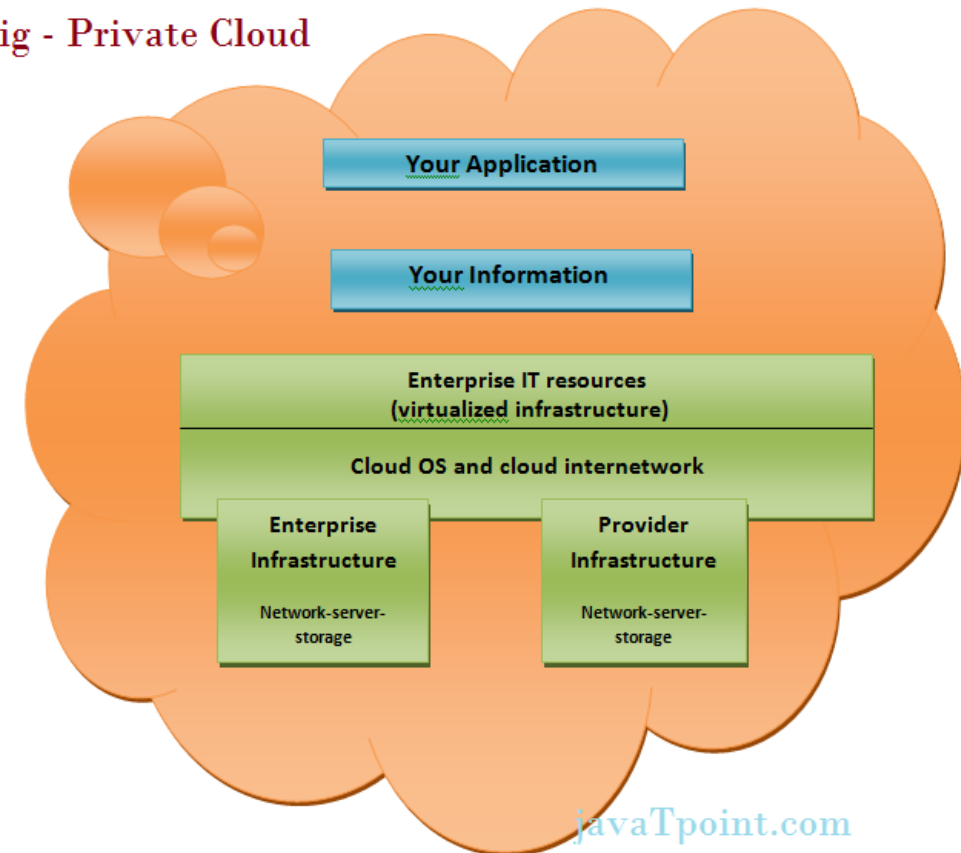
Private cloud

- Allows accessibility of systems and services within the organization. But it will be managed internally or by third party

With a private cloud, the same organization is technically both the cloud consumer and cloud provider. In order to differentiate these roles:

- a separate organizational department typically assumes the responsibility for provisioning the cloud (and therefore assumes the cloud provider role)
- departments requiring access to the private cloud assume the cloud consumer role

Fig - Private Cloud



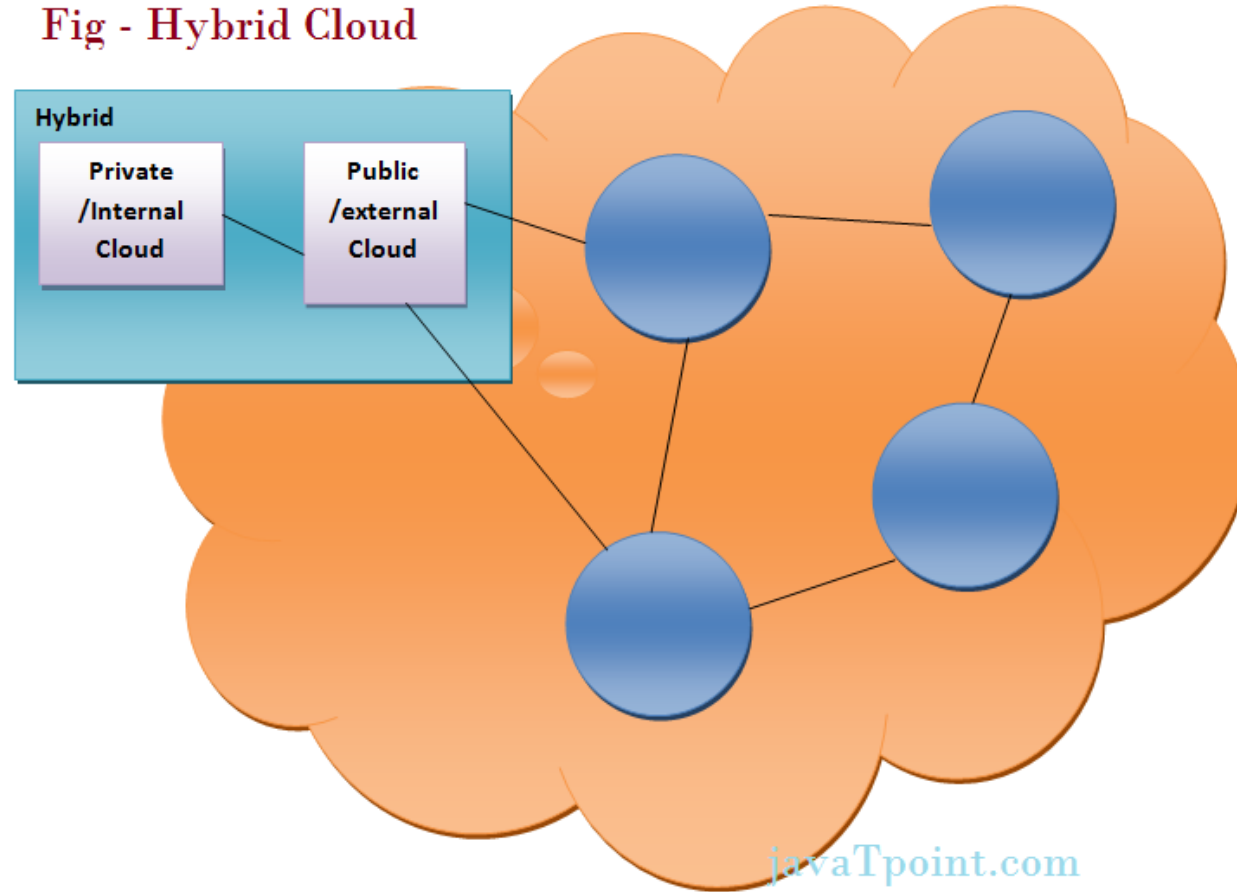
Advantages of private cloud model

- High security and privacy – shared from distinct pool of resources and hence highly secured.
- More control- control over its resources than public cloud.
- Restriction - Private cloud is only accessible locally and it is very difficult to deploy globally.
- More cost
- Inflexible price- In order to fulfill demands, purchasing new hardware is very costly.
- Less scalability-Private clouds are scaled only within capacity of internal hosted resources.

Hybrid cloud

- The Hybrid cloud is the mixture of public and private cloud. Non-critical activities are performed by public cloud while critical activities are performed by private cloud

Fig - Hybrid Cloud



Advantages of hybrid cloud

- Scalable -It provides both the features of public and private cloud scalability.
- Flexible and secure-It provides secure resources because of private cloud and scalable resources because of public cloud
- Cost effective-It is having less cost as compared to private cloud.

Disadvantage of hybrid cloud

- Networking issues-Networking becomes complex because of private and public cloud.
- Security Compliance-It is necessary to ensure that cloud services are compliant with the security policies of an organization.

Community cloud

Community Cloud allows system and services to be accessible by group of organizations. It shares the infrastructure between several organizations from a specific community. It may be managed internally by organizations or by the third-party.

Advantage of community cloud

Cost effective : same as private cloud

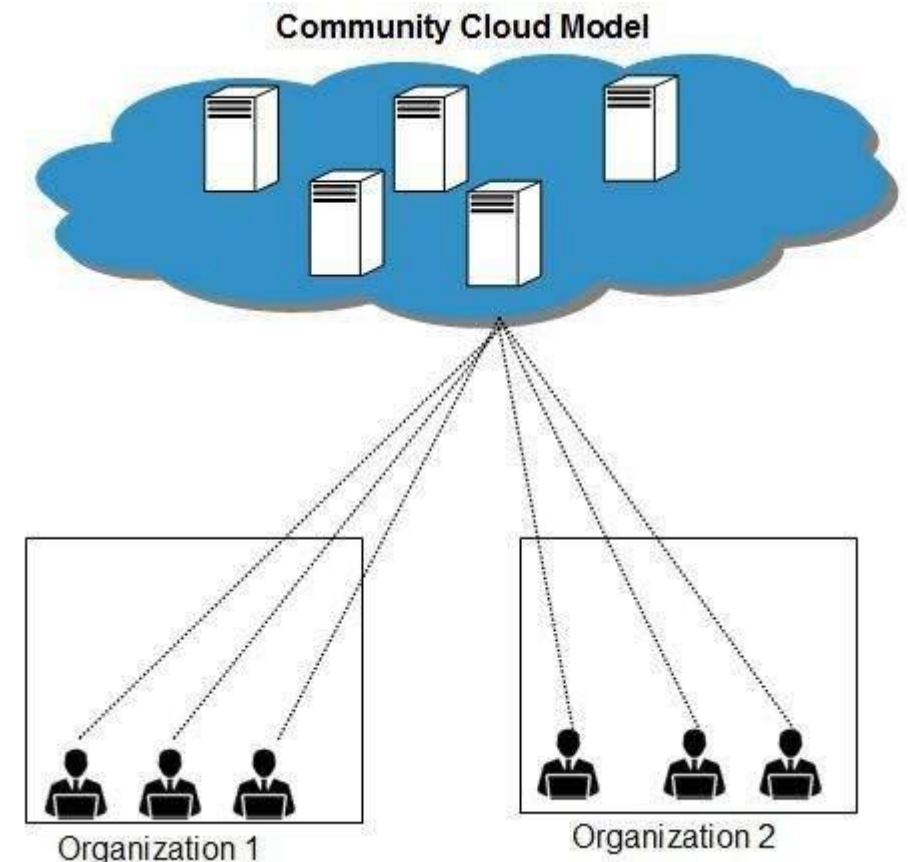
Sharing among organizations

Security: more secure than public cloud

Issues

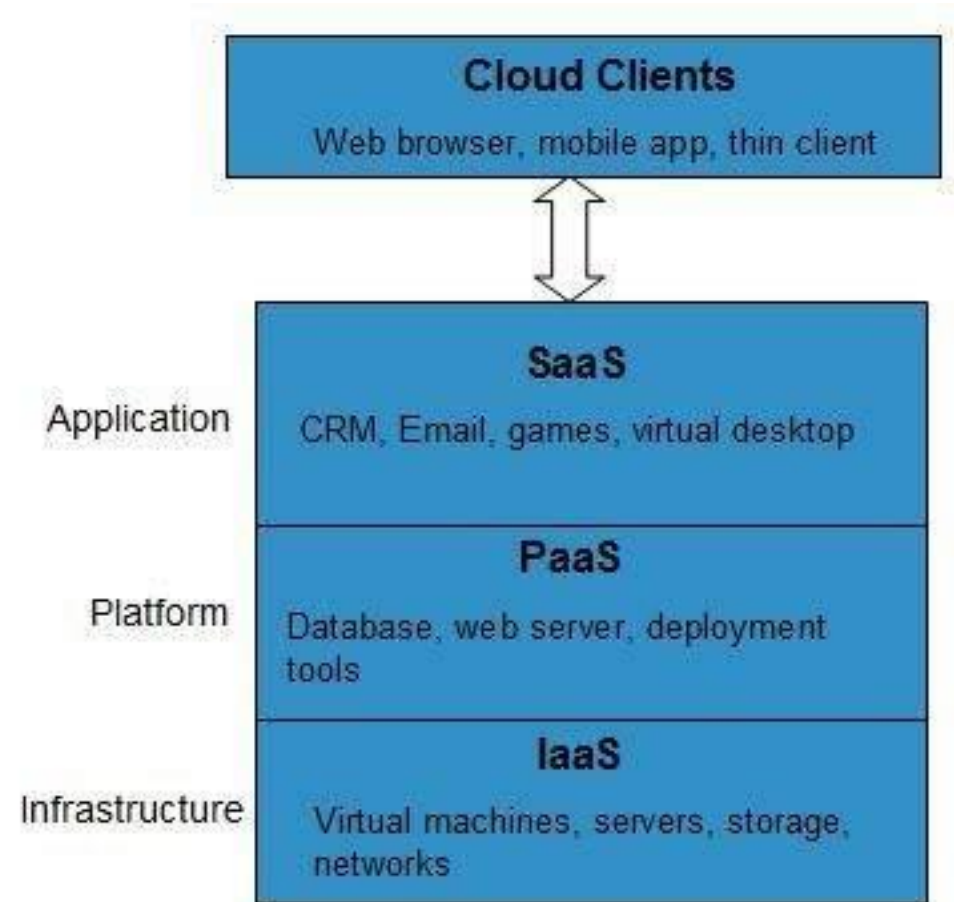
Since all data is located at one place, one must be careful in storing data in community cloud because it might be accessible to others.

It is also challenging to allocate responsibilities of governance, security and cost among organizations.

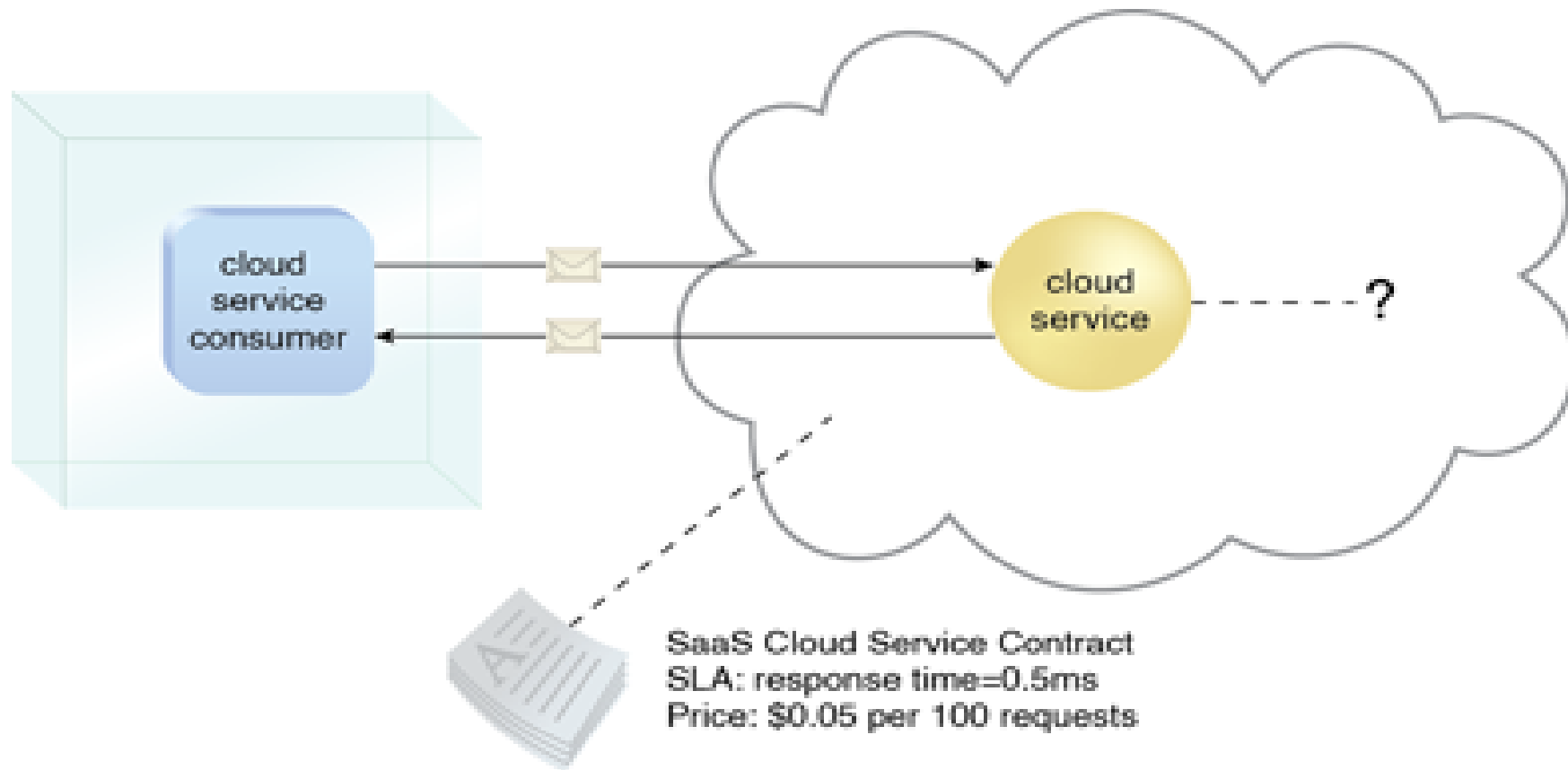


Cloud computing services

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



Software as a Service(SaaS)



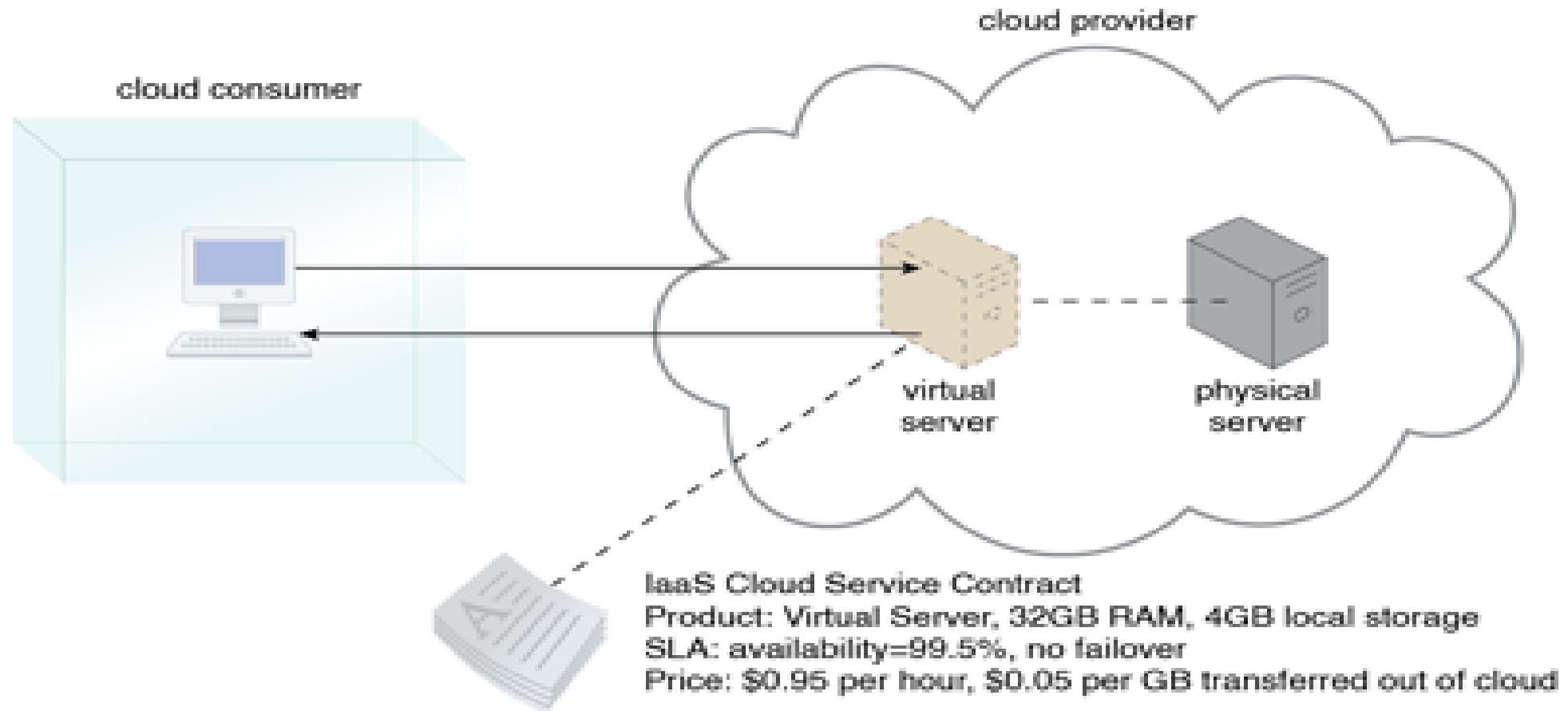
The cloud service consumer is given access the cloud service contract, but not to any underlying IT resources or implementation details.

Software as a Service(SaaS)

- Is a software distribution model in which applications are hosted by a vendor or service provider and made available to customers over a network(internet)
- Traditionally, software application needed to be purchased upfront and then installed it in the computer.(along with annual maintenance cost etc)
- But in SaaS instead of purchasing the s/w , it will be subscribed usually on monthly fees.
- As the software is hosted remotely, the organization don't need to invest in additional h/w
- Easy to monitor and automatic updates available.
- No special s/w or h/w versions required as all users get the latest same version
- Disadvantage
- Security-
- Latency issue-as the s/w are stored in cloud somewhere, there may be latency while interacting with the application than a local deployment. So the SaaS model is not good where the response time needed is in milliseconds
- Without internet nothing can be done
- Switching between SaaS vendors is difficult

Infrastructure as a Service (IaaS)

A cloud consumer is using a virtual server within an IaaS environment



Infrastructure as a Service (IaaS)

- IaaS is one of the layers of cloud computing platform wherein the customer organization outsources its IT infrastructure such as servers, networking, processing, storage, virtual machines and other resources. Customers access these resources over internet i.e. cloud computing platform, on a pay-per-use model.
- It provides access to computing resources in a virtualized environment “the cloud” on internet. It provides computing infrastructure like virtual server space, network connections, bandwidth, load balancers and IP addresses. The pool of hardware resource is extracted from multiple servers and networks usually distributed across numerous data centers. This provides redundancy and reliability to IaaS.
- IaaS is a complete package for computing. For small scale businesses who are looking for cutting cost on IT infrastructure, IaaS is one of the solutions. Annually a lot of money is spent in maintenance and buying new components like hard-drives, network connections, external storage device etc. which a business owner could have saved for other expenses by using IaaS.
- IaaS is offered in three models: public, private, and hybrid cloud. Private cloud implies that the infrastructure resides at the customer-premise. In case of public cloud, it is located at the cloud computing platform vendor's data center; and hybrid cloud is a combination of two with customer choosing the best of both worlds.

Advantages of IaaS cloud computing layer

- dynamically choose a CPU, memory and storage configuration as per your needs.
- easily access the vast computing power available on IaaS cloud platform.
- eliminate the need of investment in rarely used IT hardware.
- IT infra will be handled by the IaaS cloud computing platform vendors.

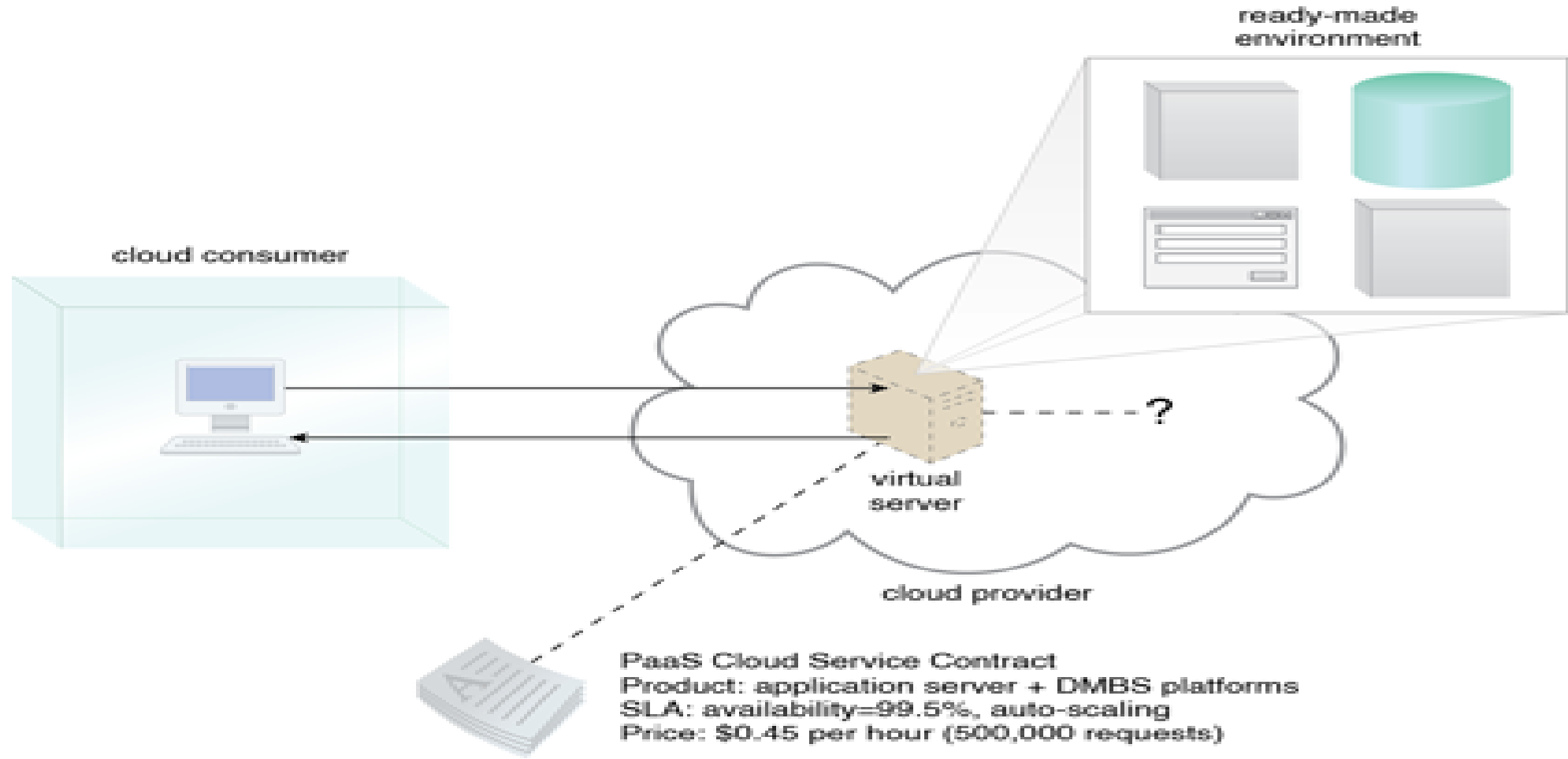
Disadvantages of IaaS cloud computing layer

- There is a risk of IaaS cloud computing platform vendor by gaining the access to the organization's data. But it can be avoided by opting for private cloud.
- IaaS cloud computing platform model is dependent on internet availability.
- It is also dependent on the availability of virtualization services.
- IaaS cloud computing platform can limit the user privacy and customization options.

Top vendors who are providing IaaS cloud computing platform

IaaS Vendor	IaaS Solution	Details
Amazon Web Services	Elastic, Elastic Compute Cloud (EC2) MapReduce, Route 53, Virtual Private Cloud, etc.	The cloud computing platform pioneer, Amazon offers auto scaling, cloud monitoring, and load balancing features as part of its portfolio.
Netmagic Solutions	Netmagic IaaS Cloud	Netmagic runs from data centers in Mumbai, Chennai, and Bangalore, and a virtual data center in the United States. Plans are underway to extend services to West Asia.
Rackspace	Cloud servers, cloud files, cloud sites, etc.	The cloud computing platform vendor focuses primarily on enterprise-level hosting services.
Reliance Communications	Reliance Internet Data Center	RIDC supports both traditional hosting and cloud services, with data centers in Mumbai, Bangalore, Hyderabad, and Chennai. The cloud services offered by RIDC include IaaS and SaaS.
Sify Technologies	Sify IaaS	Sify's cloud computing platform is powered by HP's converged infrastructure. The vendor offers all three types of cloud services: IaaS, PaaS, and SaaS.
Tata Communications	InstaCompute	InstaCompute is Tata Communications' IaaS offering. InstaCompute data centers are located in Hyderabad and Singapore, with operations in both countries.

PaaS (Platform as a Service)



PaaS (Platform as a Service)

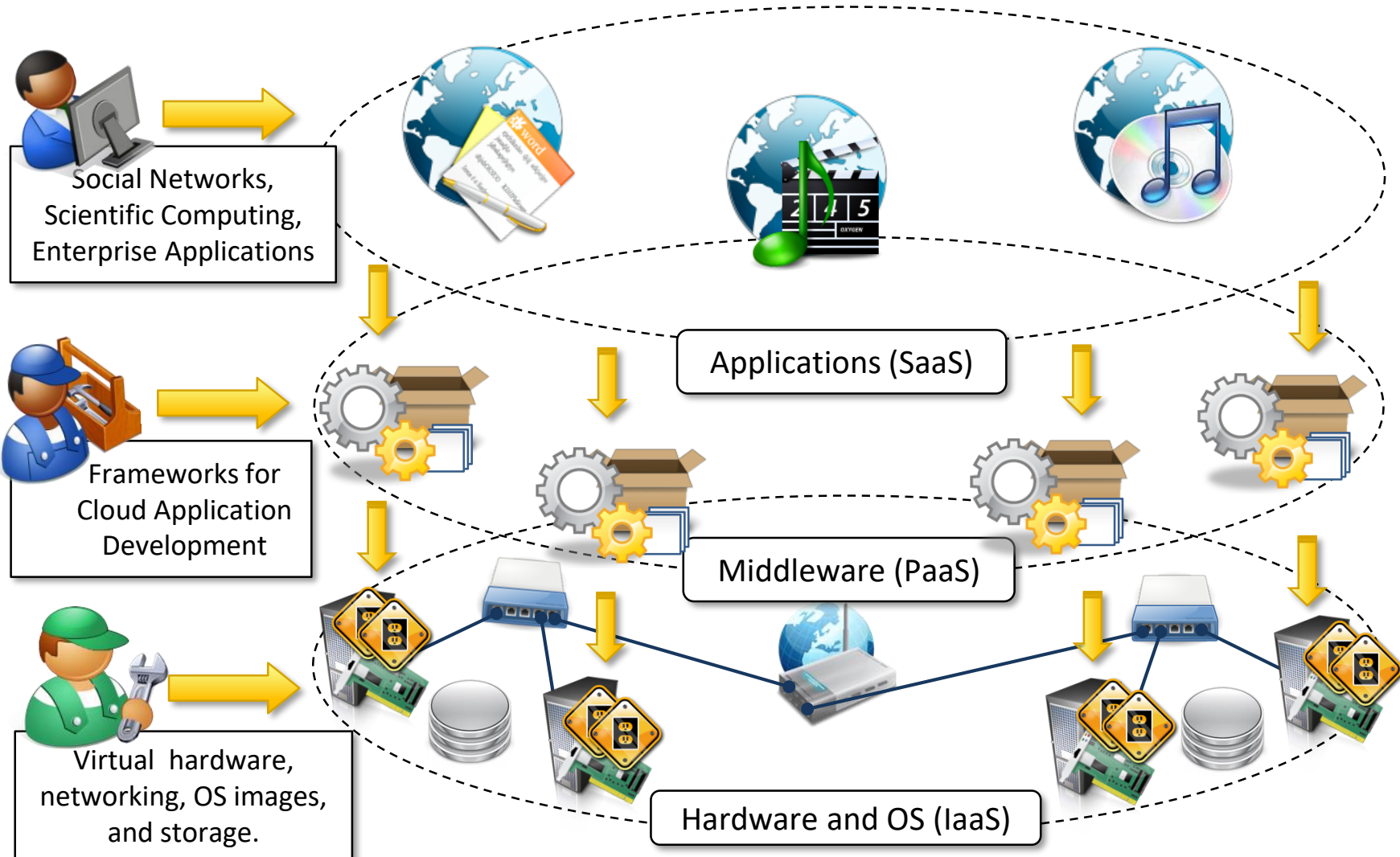
- **PaaS cloud computing platform** is a developer programming platform *which is created for the programmer to develop, test, run and manage the applications.*
- represents a pre-defined "ready-to-use" environment typically comprised of already deployed and configured IT resources
- A developer is able to write the application as well as deploy it directly into this layer easily.
- PaaS extend and abstract the IaaS layer by removing the hassle of managing the individual virtual machine.
- In PaaS cloud computing platform, back end scalability is handled by the cloud service provider and the end user does not have to worry about to manage the infrastructure.
- All the infrastructure to run the applications will be over the internet.
- PaaS products are available with different development stacks. For example, Microsoft Azure provides a .NET-based environment, while Google App Engine offers a Java and Python-based environment.

Advantages of PaaS cloud computing layer

- **Simplified development**-Developers can focus on development and innovation without worrying about the infrastructure.
- **Lower risk**-No requirements of investment in hardware and software. Developers only need a PC and an internet connection to start building applications.
- **Prebuilt business functionality**-Some PaaS vendors also provide already defined business functionality so that users can avoid building everything from very scratch and hence can directly start the projects only
- **Instant community**-PaaS vendors frequently provides online communities where developer can get the ideas, share experiences and seek advice from others.
- **Scalability**-Applications deployed can scale from one to thousands of users without any changes to the applications

Disadvantages

- **Vendor lock-in**- One have to write the applications according to the platform provided by PaaS vendor so migration of an application to another PaaS vendor would be a problem.
- **Data Privacy**-Corporate data, whether it can be critical or not, will be private so if it is not located within the walls of the company there can be a risk in terms of privacy of data.
- **Integration with the rest of the systems applications**- It may happen that some applications are local and some are in cloud. So there will be chances of increased complexity when we want to use data which in the cloud with the local data.
- **Top vendors of PaaS**- Google Apps Engine(GAE), Salesforce.com, Windows Azure, AppFog, Openshift, Cloud Foundry from VMware



Top Layer
(SaaS)

Provides ready to
use applications



Middle
Layer
(PaaS)

Provides
platform-oriented
service



Bottom
Layer
(IaaS)

Provides Infrastructure
services such as CPUs,
memory and storage



A comparison of typical cloud delivery model control levels.

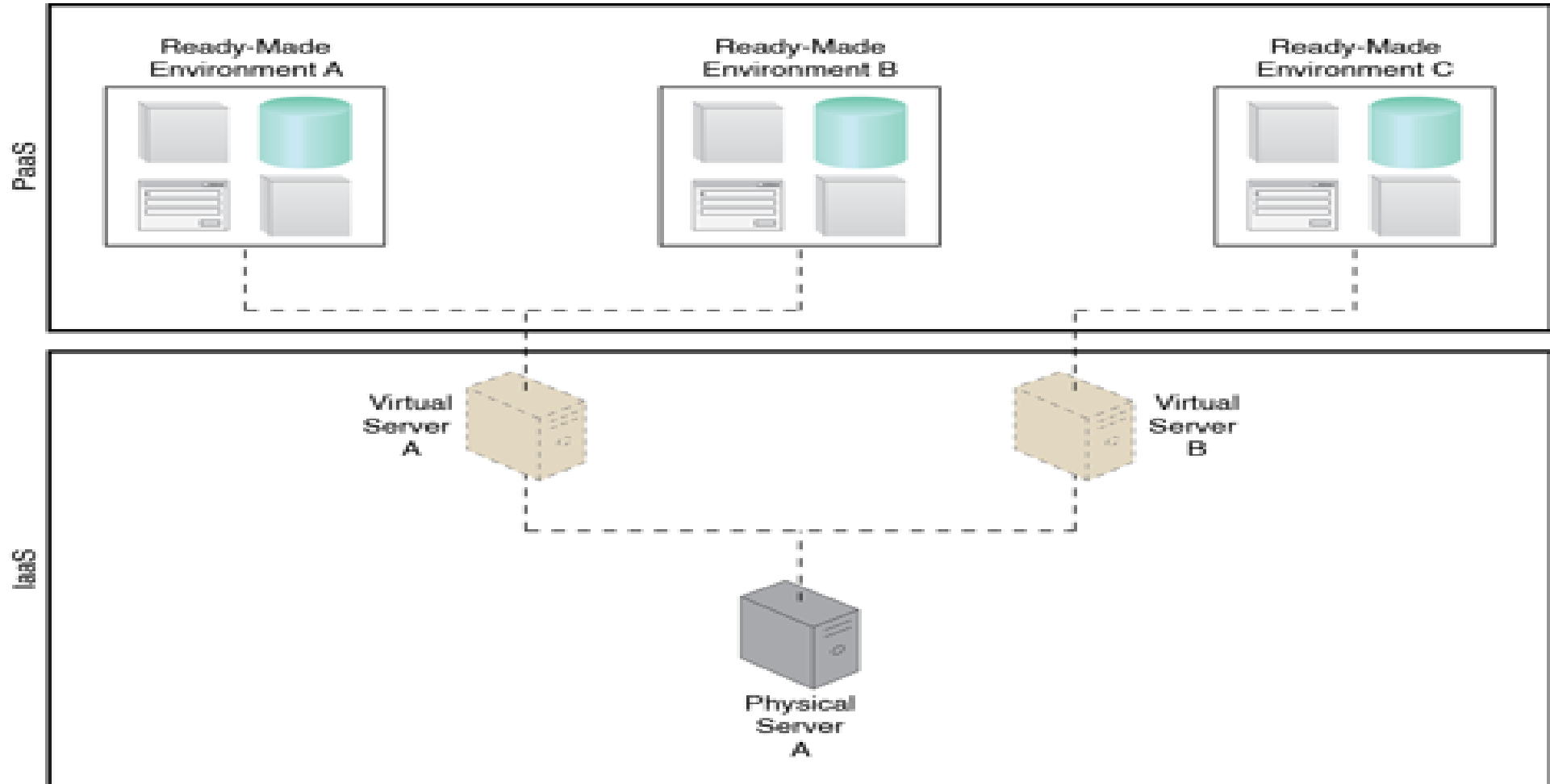
Cloud Delivery Model	Typical Level of Control Granted to Cloud Consumer	Typical Functionality Made Available to Cloud Consumer
SaaS	usage and usage-related configuration	access to front-end user interface
PaaS	limited administrative	moderate level of administrative control over IT resources relevant to cloud consumer's usage of platform
IaaS	full administrative	full access to virtualized infrastructure-related IT resources and, possibly, to underlying physical IT resources

Typical activities carried out by cloud consumers and cloud providers in relation to the cloud delivery models

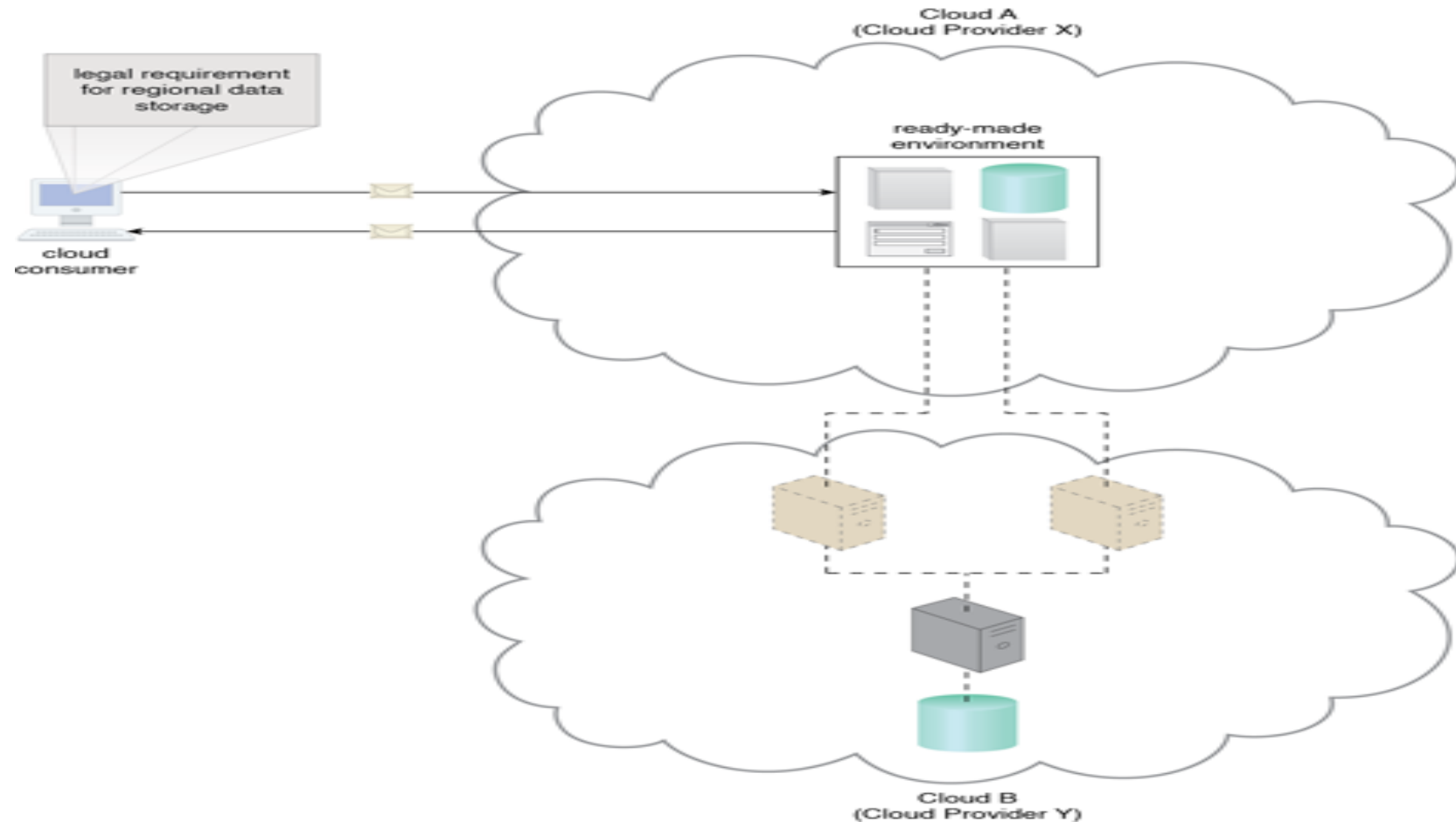
Cloud Delivery Model	Common Cloud Consumer Activities	Common Cloud Provider Activities
SaaS	uses and configures cloud service	implements, manages, and maintains cloud service monitors usage by cloud consumers
PaaS	develops, tests, deploys, and manages cloud services and cloud-based solutions	pre-configures platform and provisions underlying infrastructure, middleware, and other needed IT resources, as necessary monitors usage by cloud consumers
IaaS	sets up and configures bare infrastructure, installs, manages, and monitors any needed software	provisions and manages the physical processing, storage, networking, and hosting required monitors usage by cloud consumers

Combining Cloud Delivery Models

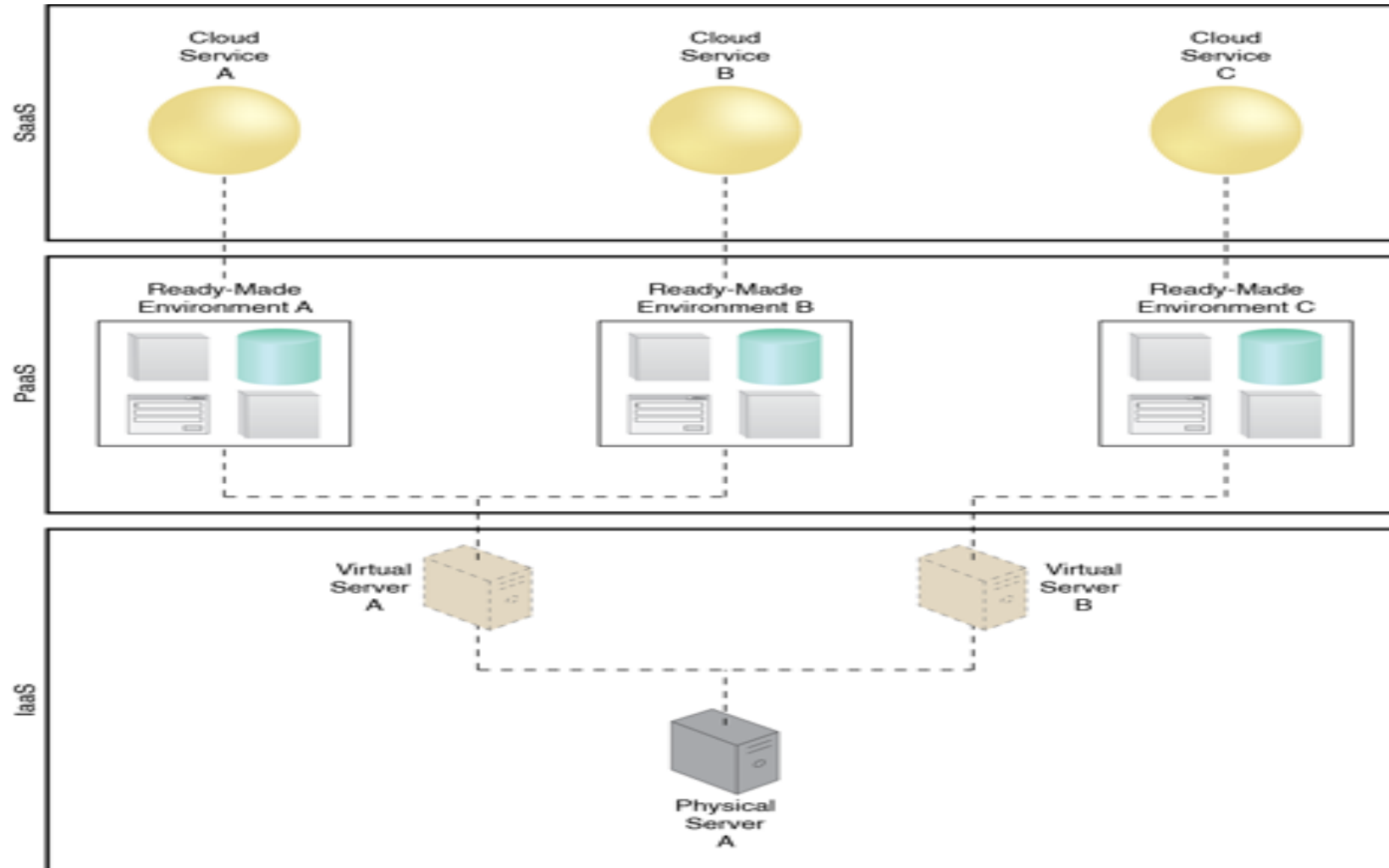
- A PaaS environment based on the IT resources provided by an underlying IaaS environment.



An example of a contract between Cloud Providers X and Y, in which services offered by Cloud Provider X are physically hosted on virtual servers belonging to Cloud Provider Y. Sensitive data that is legally required to stay in a specific region is physically kept in Cloud B, which is physically located in that region

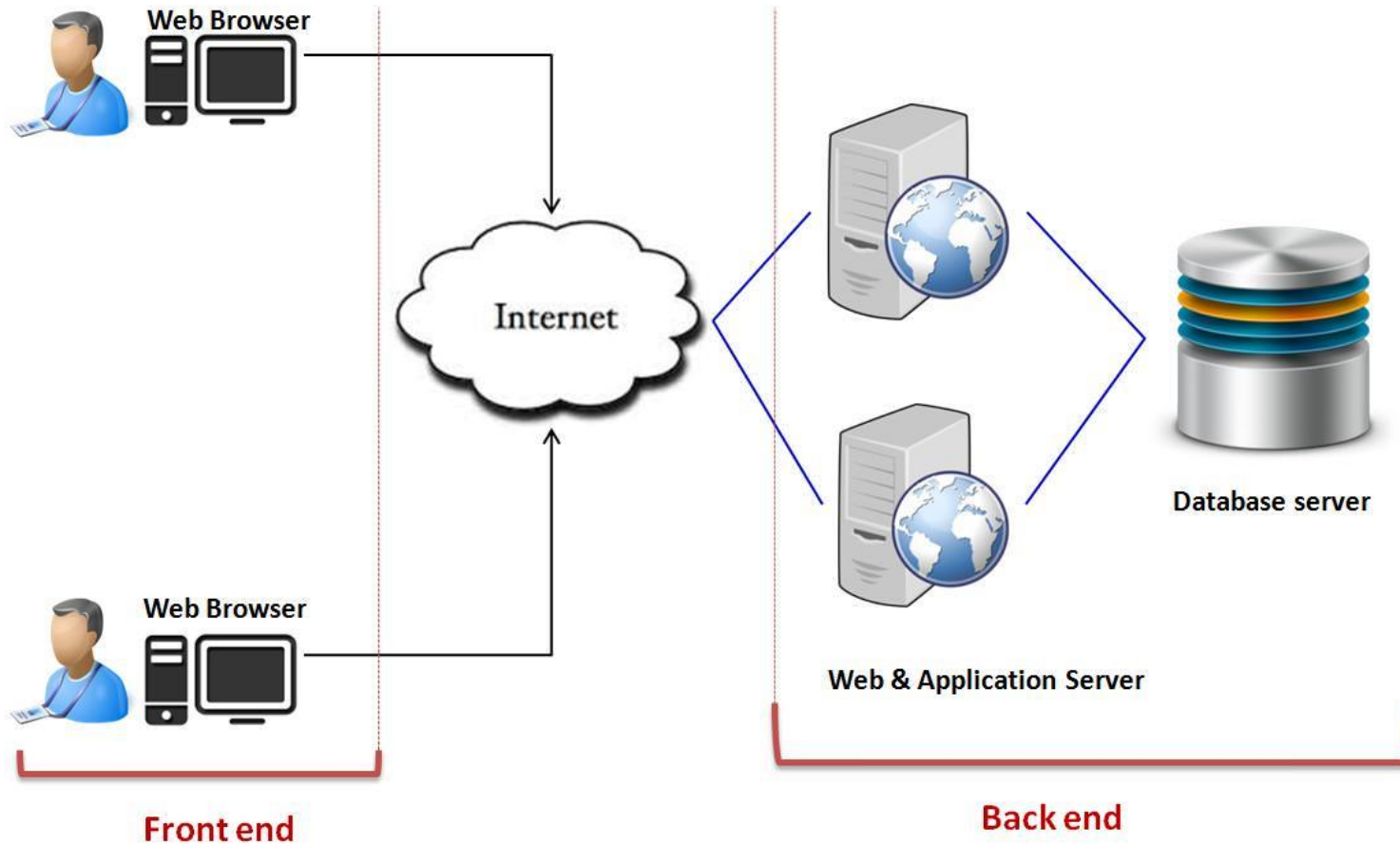


- A simple layered view of an architecture comprised of IaaS and PaaS environments hosting three SaaS cloud service implementations.



Cloud architecture

- Cloud computing comprises of two components front end and back end. Front end consist client part of cloud computing system. It comprise of interfaces and applications that are required to access the cloud computing platform.



- While back end refers to the cloud itself, it comprises of the resources that are required for cloud computing services. It consists of virtual machines, servers, data storage, security mechanism etc. It is under providers control.
- Cloud computing distributes the file system that spreads over multiple hard disks and machines.
- Data is never stored in one place only and in case one unit fails the other will take over automatically.
- The user disk space is allocated on the distributed file system, while another important component is algorithm for resource allocation.
- Cloud computing is a strong distributed environment and it heavily depends upon strong algorithm.

Cloud ecosystem

- Cloud ecosystem is a term used to describe the complex system of interdependent components that work together to enable cloud services

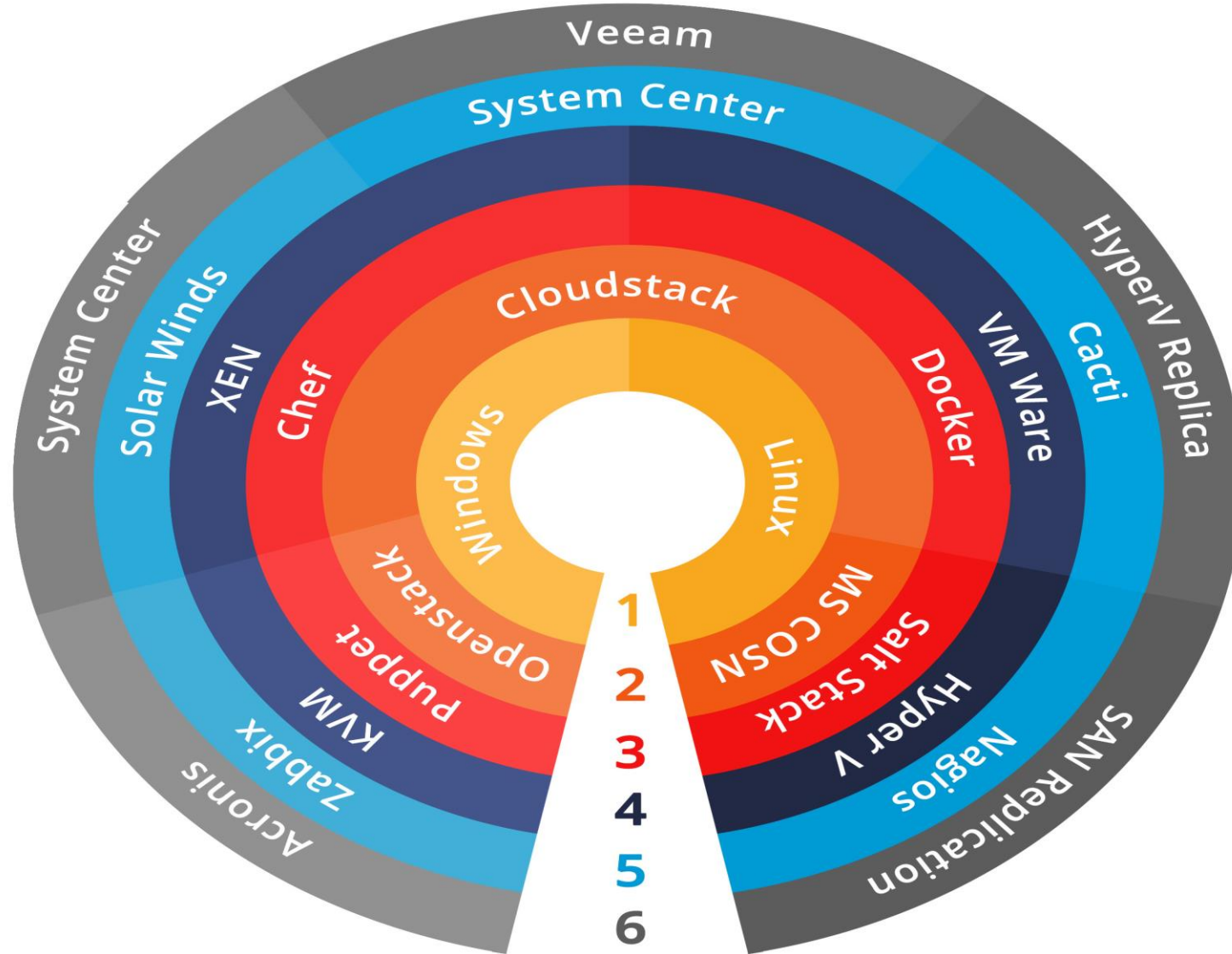
Cloud ecosystem actors

- Cloud service users (CSU)-cloud users.
- Cloud service provider(CSP)-An organization that provides and maintains delivered cloud services
- Cloud service partner(CSN) – A person or organization that provides support to the building of the service offer of a CSP.

Cloud deployment models

Cloud service categories

CLOUD ECOSYSTEM



- 1 Operating System
- 2 Cloud Provisioning OS
- 3 IT Automation Software
- 4 Hypervisor
- 5 Infrastructure Monitoring Tools
- 6 Backup and DR Planning