

MET's Institute of Engineering

Bhujbal Knowledge City, Adgaon, Nashik.

Computer Engineering

“Introduction of Cloud Computing”

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Syllabus

Importance of Cloud Computing, Characteristics, Pros and Cons of Cloud Computing, Migrating into the Cloud, Seven-step model of migration into a Cloud, Trends in Computing. Cloud Service Models: SaaS, PaaS, IaaS, Storage. **Cloud Architecture:** Cloud Computing Logical Architecture, Developing Holistic Cloud Computing Reference Model, Cloud System Architecture,

History of Cloud Computing

- Before emerging the cloud computing, there was Client/Server computing which is basically a centralized storage in which all the software applications, all the data and all the controls are resided on the server side.
- If a single user wants to access specific data or run a program, he/she need to connect to the server and then gain appropriate access, and then he/she can do his/her business.
- Then after, distributed computing came into picture, where all the computers are networked together and share their resources when needed.
- On the basis of above computing, there was emerged of cloud computing concepts that later implemented.

History of Cloud Computing

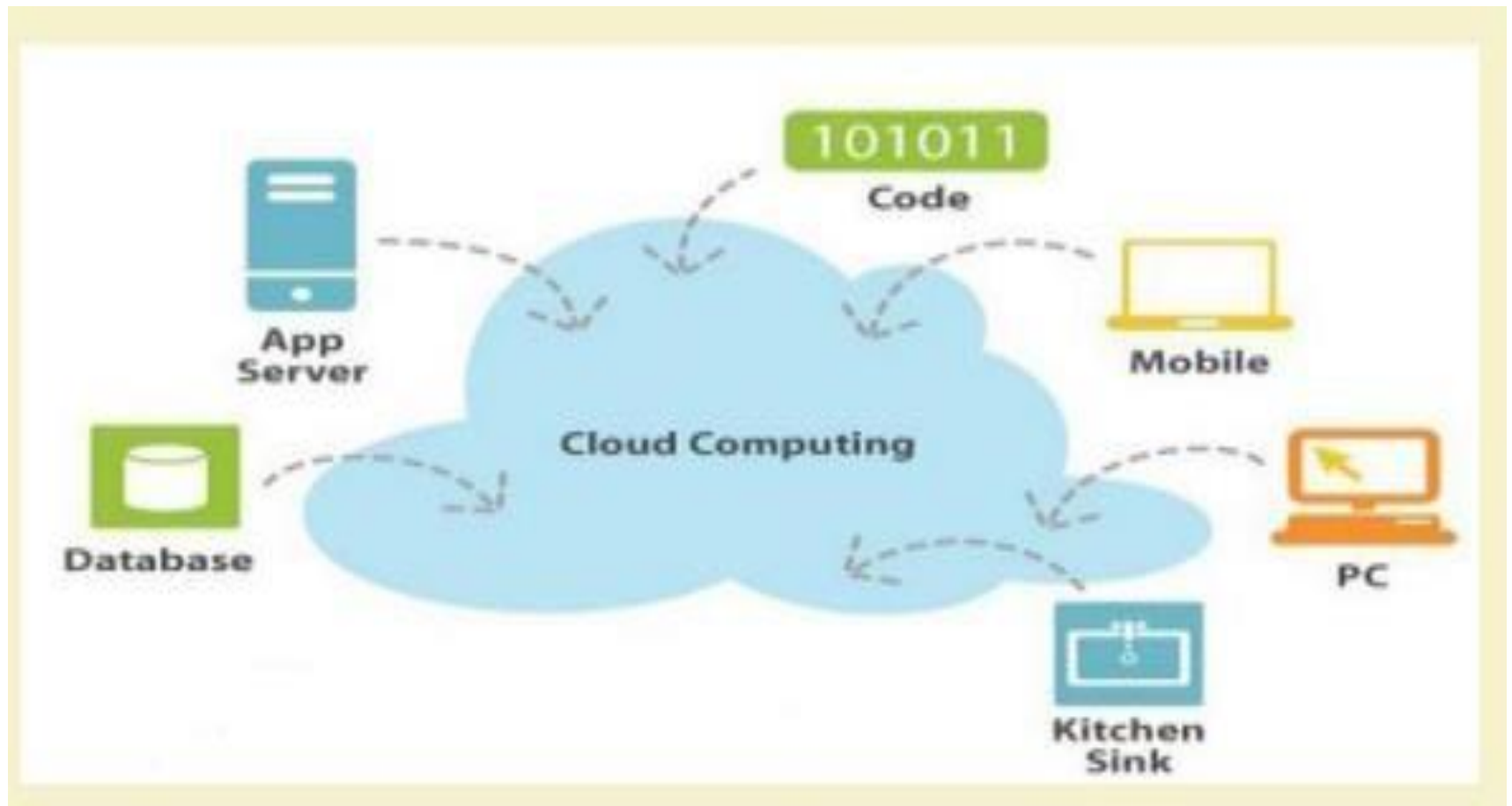
- At around in 1961, John MacCharly suggested in a speech at MIT that computing can be sold like a utility, just like a water or electricity. It was a brilliant idea, but like all brilliant ideas, it was ahead of its time, as for the next few decades, despite interest in the model, the technology simply was not ready for it.
- But of course time has passed and the technology caught that idea and after few years we mentioned that:
- In 1999, Salesforce.com started delivering of applications to users using a simple website. The applications were delivered to enterprises over the Internet, and this way the dream of computing sold as utility were true

History of Cloud Computing

- In 2002, Amazon started Amazon Web Services, providing services like storage, computation and even human intelligence. However, only starting with the launch of the Elastic Compute Cloud in 2006 a truly commercial service open to everybody existed.
- In 2009, Google Apps also started to provide cloud computing enterprise applications.
- Of course, all the big players are present in the cloud computing evolution, some were earlier, some were later. In 2009, Microsoft launched Windows Azure, and companies like Oracle and HP have all joined the game. This proves that today, cloud computing has become mainstream.

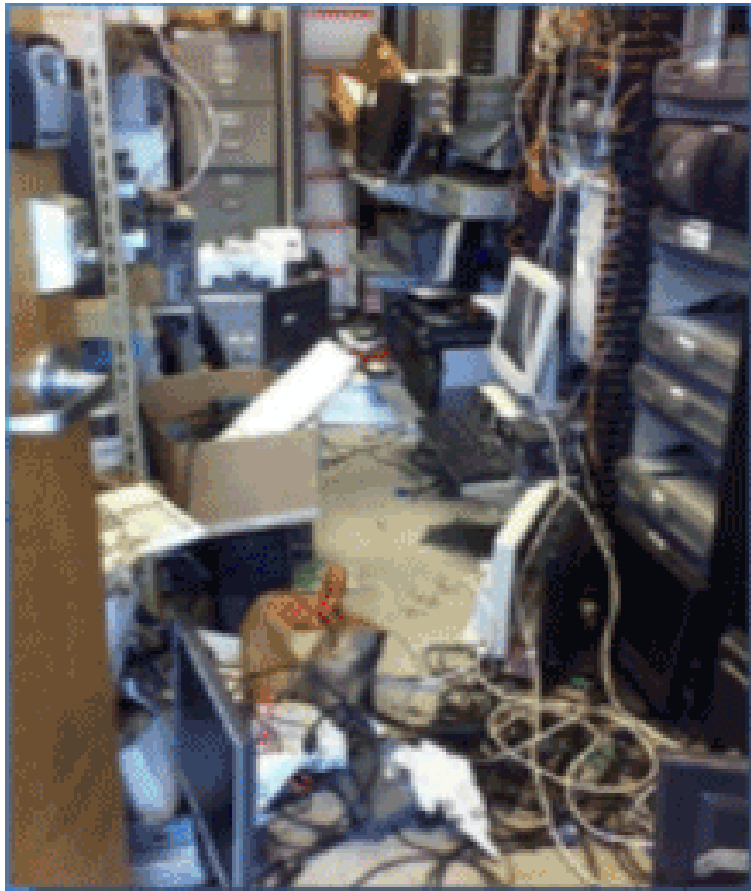
Introduction of Cloud Computing

“ Cloud computing is a model for enabling ubiquitous, 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. ”

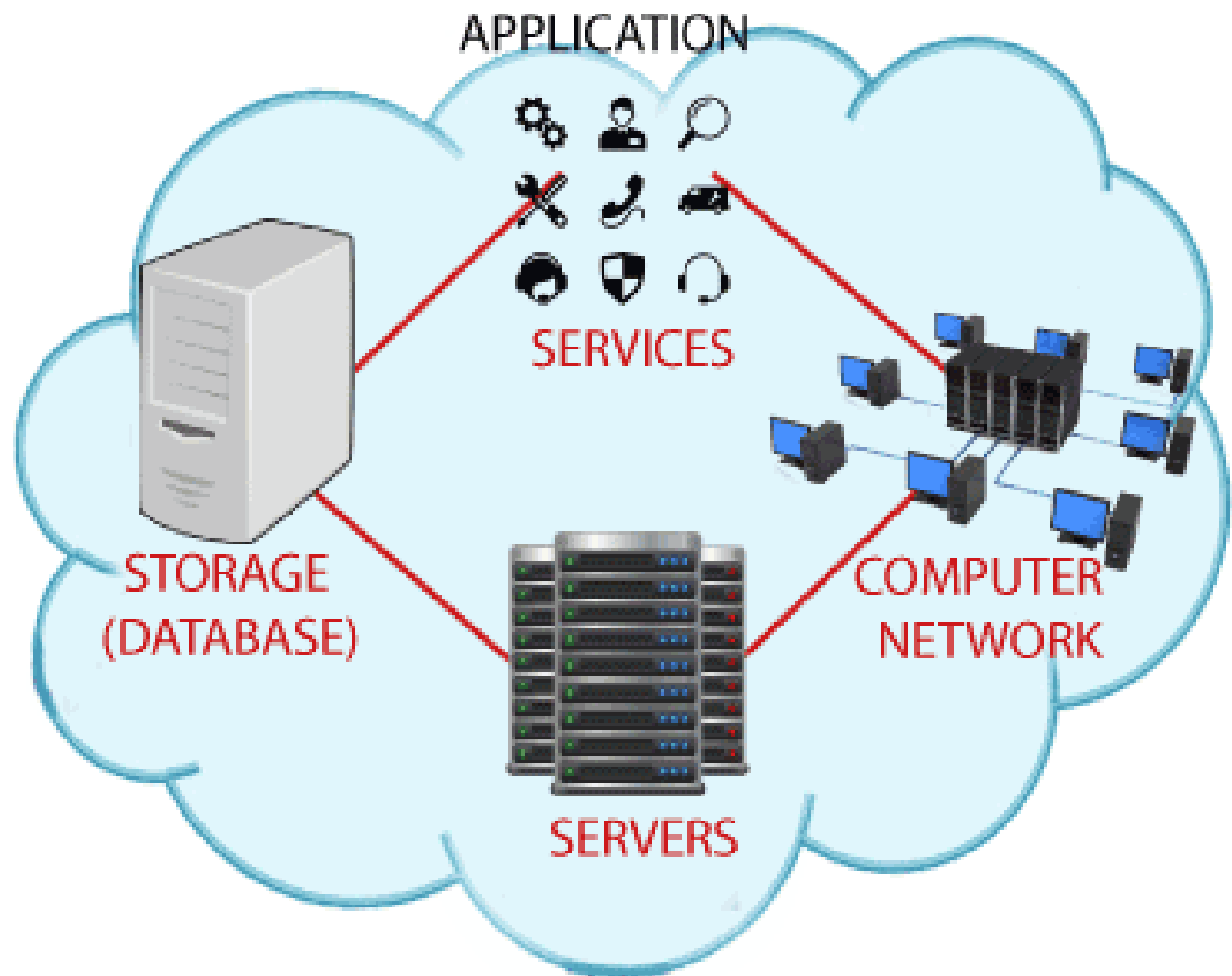


Introduction of Cloud Computing

Before
Cloud Computing



After
Cloud Computing





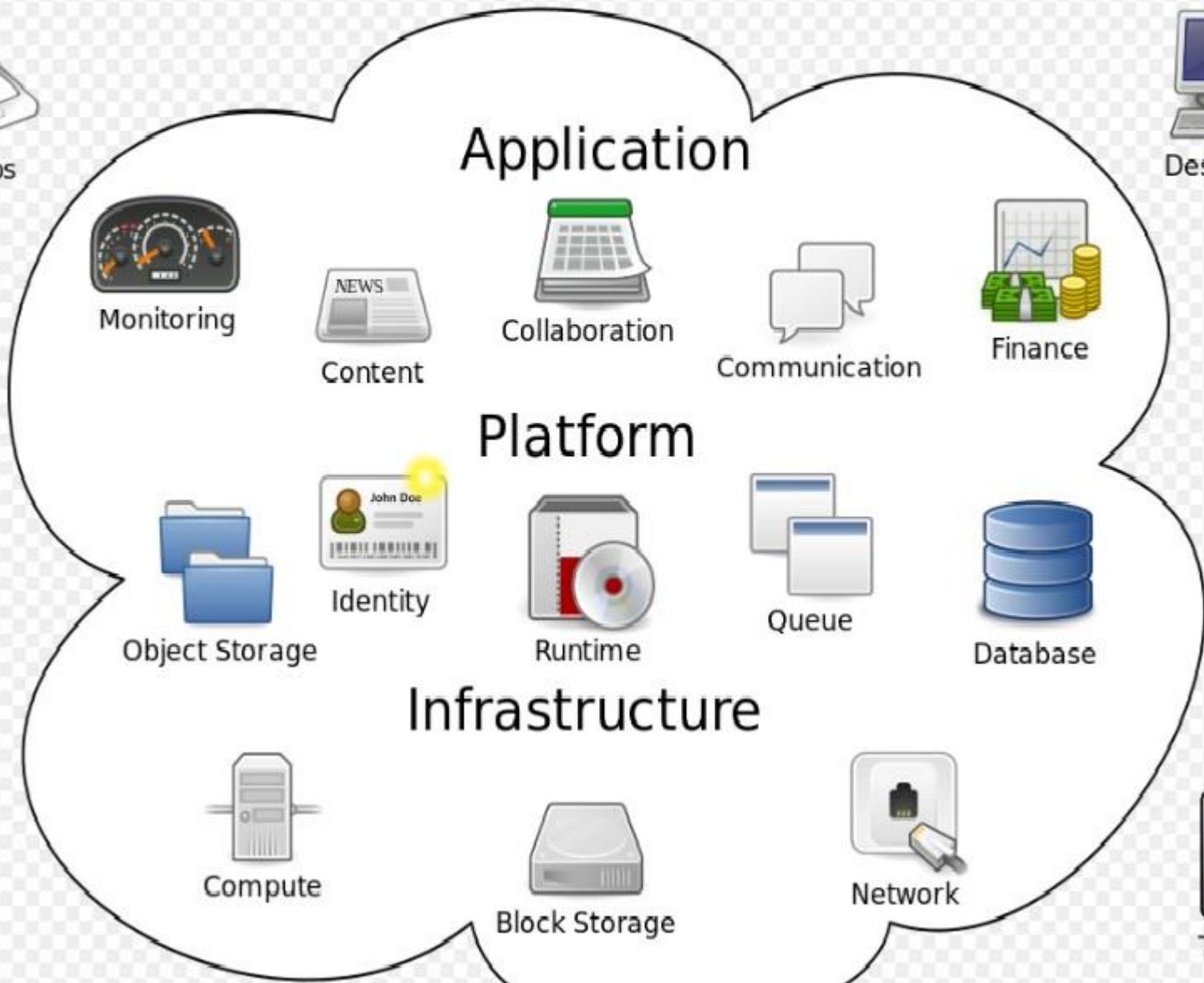
Servers



Laptops



Desktops



Application



Monitoring



Content



Collaboration



Communication



Finance

Platform



Object Storage



Identity



Runtime



Queue



Database

Infrastructure



Compute



Block Storage



Network



Phones



Tablets

Importance of Cloud Computing

- Reduction in Total Cost Ownership [TCO]
- Implementation of IT with increased flexibility
- Increased Collaboration
- Flexibility in time like work from anywhere at anytime
- Increased competitiveness
- Go-to-Market in a lesser time

Significance of Cloud Computing

- The applications are made available to everyone through the cloud as and when they are available.
- The IT costs have been reduced due to the reduction in the number of servers, software cost, and the staff.
- The investment costs have become more flexible as compared to traditional methods.
- Increased reliability as anyone could get connected anytime.
- The data and the applications are mobile and easily made available to the employees across the globe.

Significance of Cloud Computing

- The increased collaboration has reduced the time to market and product enhancement.
- The facility could be turned up, down or off as per the demand and the circumstances.
- The cloud computing delivers an appreciable integration with Mergers and Acquisitions [M&A] activity.
- The cloud computing has increased the ‘green’ credentials as the solutions have the lesser environmental impact.

Importance of Cloud Computing

- Cloud computing is so important because it offers flexibility, data recovery, little to no maintenance, easy access and a higher level of security.

1. Flexibility :

Does your business experience fluctuating bandwidth requirements? Some months are busier, while others are not as intense. With cloud computing, managing resources is easier than ever. Simply pay for the resources you are using each month, and nothing more. Cloud storage and cloud VPS providers offer flexible packages, where you can easily add or decrease the amount of storage and bandwidth you are paying to use.

2. Data Recovery :

Recovering data from damaged physical servers and hard drives can be fairly problematic. If the physical device is badly damaged, recovery may not be possible. These issues can result in businesses losing vital data, especially when it is not adequately backed up. With cloud computing, these issues are not as relevant.

Importance of Cloud Computing

3. No Maintenance :

- When running a traditional server setup, companies must worry about the maintenance of the entire system. Not only are regular checks mandatory, but parts constantly need replacing as they stop working or become outdated.
- A cloud computing solution eliminates the need for any maintenance. There is no cost or effort required by companies that use cloud solutions, as everything is handled by the provider. That removes a massive headache off your shoulders, and ensures the monthly expenditure is limited to what is paid for the cloud services being used.

4. Easy Access :

- Access to documents, backend files, software and the company website is much easier with cloud computing. It is effortless for employees to work remotely, while the entire company is connected through its cloud interface. All your employees will require is a device to access the network, and the correct security protocols.

Importance of Cloud Computing

5. Increased Security :

With cloud computing, everything you are accessing and saving is on the cloud. Even if a laptop is lost or damaged, the company interface is accessible through another device. And since all your documents save on the cloud, there is no concern about losing important documents because they were saved on a now lost or damaged laptop hard drive.

Since information is no longer contained on your physical hard drives or servers, it also becomes a lot harder for anyone to steal. With a comprehensive encryption and login security system, company data is much safer with cloud computing.

The cloud is here, and it is already transforming how many companies operate. Businesses may be reluctant to change up existing operations, but the benefits of the cloud means the transition is worth it.

Characteristics of Cloud Computing

- **On-demand self-service**

A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.

- **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 phones, tablets, laptops, and workstations).

- **Resource pooling**

The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand

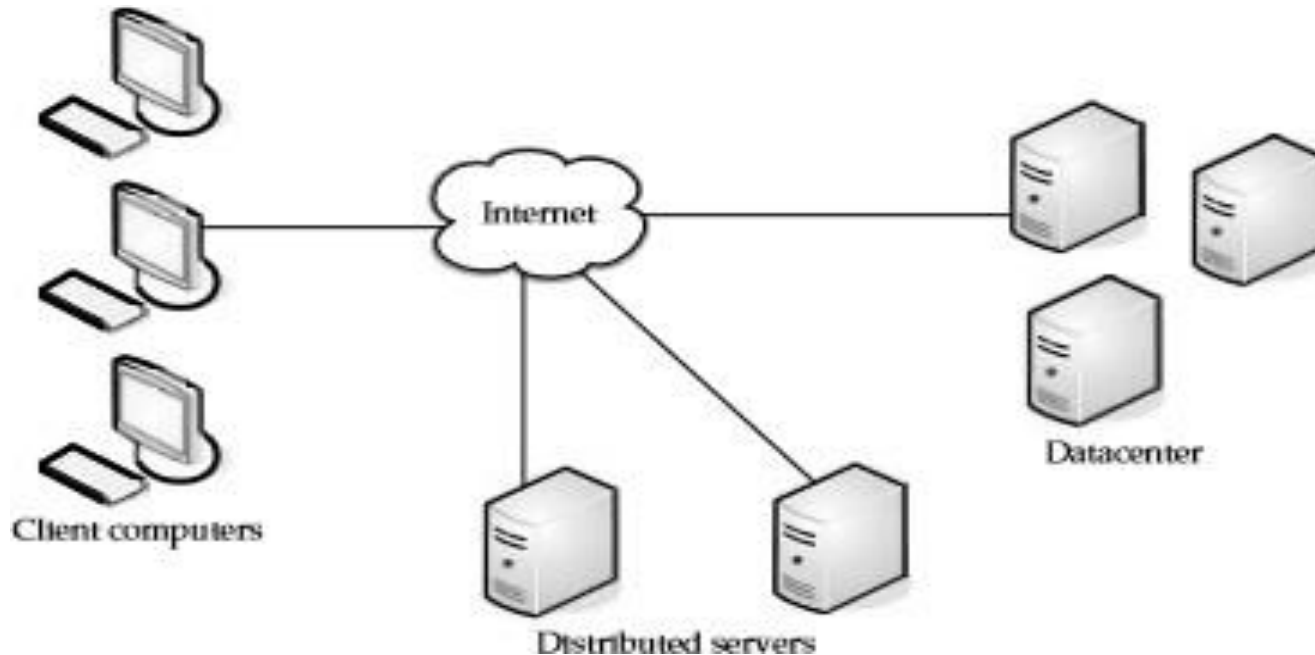
- ***Measured Service:***

Cloud systems *automatically control and optimize* resources used by leveraging a metering capability at some level of abstraction appropriate to the type of service.

- ***It will provide analyzable and predictable computing platform.***

Cloud Components

- Cloud computing solution is made up of several elements: clients, the datacenter, and distributed servers
- As shown in figure, these components make up the three parts of a cloud computing solution.
- Each element has a purpose and plays a specific role in delivering a functional cloud- based application,



Clients

- Clients are, in a cloud computing architecture, the exact same things that they are in a plain, old, everyday local area network (LAN).
- They are, typically, the computers that just sit on your desk. But they might also be laptops, tablet computers, mobile phones, or PDAs—
- Clients are the devices that the end users interact with to manage their information on the cloud. Clients generally fall into three categories:

Mobile Mobile devices include PDAs or smartphones, like a Blackberry, Windows Mobile Smartphone, or an iPhone.

- Thin Clients are computers that do not have internal hard drives, but rather let the server do all the work, but then display the information.

Thick This type of client is a regular computer, using a web browser like Firefox or Internet Explorer to connect to the cloud.

- **Datacenter**:-The datacenter is the collection of servers where the application to which you subscribe is housed. It could be a large room in the basement of your building or a room full of servers on the other side of the world that you access via the Internet.
- **Distributed Servers**-But the servers don't all have to be housed in the same location. Often, servers are in geographically disparate locations

Basic Concepts and Terminologies:-

- **IT Resource**:- An IT resource is nothing but an IT related artefact which may be either physical or virtual. For eg. Physical server, virtual server, software program, service, storage device, network device
- **On premise**:- when IT resources are hosted within an IT enterprise's organizational boundary, it is considered to be located at the premises of that enterprise. It is known as on-premise.
- **Scaling**- Scaling is the ability of an IT resource to handle continuously increasing or decreasing demands of usage.

Horizontal Scaling- scaling out and scaling down

Vertical Scaling- scaling up and scaling down

- **Cloud Service**:- A cloud service can be considered as any IT resource which can be accessed remotely via a cloud. It is a totally different and broad concept than the other IT fields.

A cloud service can be a simple web-based software application which is invoked with the help of a messaging protocol or a virtual server.

- **Cloud service consumer**:- a cloud-based web service is accessed by the consumers which are outside the range of the cloud.

Vertical scaling

- Veers to adding more resources (CPU/RAM/DISK) to your server (database or application server is still remains one) as on demand.
- Vertical Scaling is most commonly used in applications and products of middle-range as well as small and middle-sized companies. One of the most common examples of Virtual Scaling is to buy an expensive hardware and use it as a Virtual Machine hypervisor (VMWare ESX).
- Vertical Scaling usually means upgrade of server hardware. Some of the reasons to scale vertically includes increasing IOPS (Input / Output Operations), amplifying CPU/RAM capacity, as well as disk capacity.
- However, even after using virtualization, whenever an improved performance is targeted, the risk for downtimes with it is much higher than using horizontal scaling.

Horizontal Scaling

- Horizontal Scaling is a must use technology – whenever a high availability of (server) services are required
- Scaling horizontally involves adding more processing units or physical machines to your server or database. It involves growing the number of nodes in the cluster, reducing the responsibilities of each member node by spreading the key space wider and providing additional end-points for client connections. Horizontal Scaling has been historically much more used for high level of computing and for application and services.
- Although this does not alter the capacity of each individual node, the load is decreased due to the distribution between separate server nodes.
- Some of the reasons why organizations should choose to scale horizontally include increasing I/O concurrency, reducing the load on existing nodes, and increasing disk capacity.
- The Internet and particular web services have boosted the use of Horizontal Scaling. Most giant companies that provide well known web services like Google (Gmail, YouTube), Yahoo, Facebook, EBay, Amazon etc. are using heavily horizontal scaling.

Horizontal Vs vertical scaling

Parameter	Horizontal Scaling	Vertical Scaling
Cost	Less expensive	More expensive
Availability	Usually all the time,IT resources are available instantly	Not all the time,IT resources are available instantly
Additional setup	Resource replication	Additional setup is normally needed
Additional Resources	required	Not required
Limitation	Not limited capacity of hardware	limited capacity of hardware

Applications

- Online file storage
- Photo editing software
- Digital video software
- Finding a way on the map
- Presentation software
- Word Processing software

Cloud
Computing
Application



Intranets and the Cloud

- While your operation is not big as amazon s3 cloud computing, you can use the same sorts of principles within your organization to develop your IT infrastructure.
- By setting up thin clients to run applications and services on a local server, rather than on their desktops, you ease the costs of deployment and maintenance, as well as reducing power costs.
- Components:- There are two main components in client/server computing: servers and thin or light clients. The servers house the applications your organization needs to run, and the thin clients—which do not have hard drives—display the results.
- Hypervisor Applications:-
 - Applications like VMware or Microsoft's Hyper-V allow you to virtualize your servers so that multiple virtual servers can run on one physical server.
 - These sorts of solutions provide the tools to supply a virtualized set of hardware to the guest operating system. They also make it possible to install different operating systems on the same machine.
 - For example, you may need Windows Vista to run one application, while another application requires Linux. It's easy to set up the server to run both operating systems

Cloud Services Provided by number of Vendors:-

Cloud services are provided by number of vendors.

•**Amazon**:- one of the prior company offer cloud services services offered by Amazon:

1. Elastic compute cloud(EC2)
2. Simple Storage service(S3)
3. Simple queue service(SQS)
4. SimpleDB

1.EC2:- This service provides virtual machines as well as extra CPU cycles

2. S3:- This service provides facility to store items up to size five GB in virtual storage

3. SQS:- This service lets the machines of an organization to talk to each other with the help of message passing API.

4. SimpleDB:- This service works in combination with Amazon S3 as well as Amazon EC2.

- **Google**

Google's app engine is considered as contrast to amazon offerings.

App engine does not give facility to users to write a file in their own directory.

Online documents and spreadsheets are provided by google to encourage

developers to build features for online software with the help of app engine

- **Microsoft:-**

Windows Azure is a cloud computing solution provided by microsoft. It is an OS which helps organizations to execute windows application and save files as well as data using Microsoft's datacenters.

Azure services platform is also provided by microsoft.

- 1. Windows Azure:-** provides scalable storage, computation and networking
- 2. Microsoft SQL services:-** offers database services as well as reporting
- 3. Microsoft .NET services:-** offers service based implementation
- 4. Live services:-** These services help to share, store, and synchronize several types of elements such as documents, photos and files across Pcs, phone etc

Your Organization and Cloud Computing

- Cloud computing is not a one-size-fits-all affair. Just as the hardware and software configuration you use in your organization is different from the enterprise's regular affair; the needs of cloud computing needs will be different.
- When you can use cloud computing consider following no of factors
 - Cost/benefit ratio
- Speed of delivery
- How much capacity you will use
- Whether your data is regulated
- Your organization's corporate and IT structure
- There may be times when the need you have is a perfect match for cloud computing. But there may also be times when cloud computing is simply not a good match for your needs.

- Scenarios:-There are three different major implementations of cloud computing. How organizations are using cloud computing is quite different at a granular level, but the uses generally fall into one of these three solutions.
- 1. Compute Clouds:- An access is given to highly scalable, inexpensive, on demand computing resources by the compute cloud which execute the code given to them. eg. Amazon's EC2, Google App Engine
- 2. Cloud Storage:-cloud storage was one of the initial offerings by cloud and it still remains a popular solution. cloud storage is considered as a big world.
- 3. Cloud Applications:-There is difference between cloud applications and compute clouds in that cloud applications use software applications which are basically rely on cloud infrastructure.

Some cloud applications include:

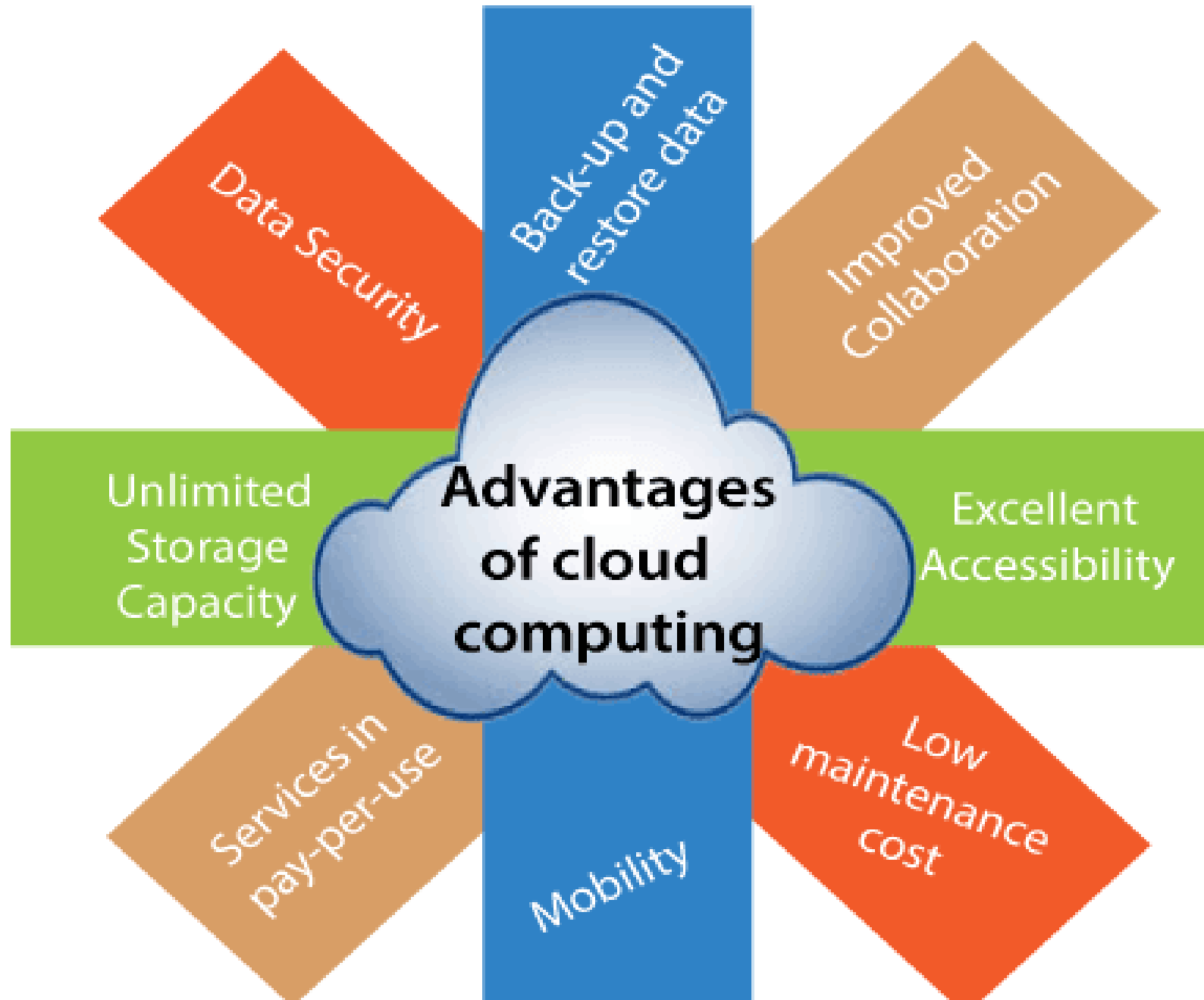
Peer to peer computing such as BitTorrent, Skype etc.

Web applications such as Myspace, YouTube, etc

SaaS such as Google Apps

Software plus services such as Microsoft online services

Cloud computing:-Advantages



Cloud computing:-Benefits

- **Increased Scalability:-**

If you are anticipating a huge upswing in computing need (or even if you are surprised by a sudden demand), cloud computing can help you manage. Rather than having to buy, install, and configure new equipment, you can buy additional CPU cycles or storage from a third party.

Since your costs are based on consumption, you likely wouldn't have to pay out as much as if you had to buy the equipment.

Once you have fulfilled your need for additional equipment, you just stop using the cloud provider's services, and you don't have to deal with unneeded equipment. You simply add or subtract based on your organization's need.

- **Simplicity/Reduced investments and proportional costs:-**

Again, not having to buy and configure new equipment allows you and your IT staff to get right to your business.

The cloud solution makes it possible to get your application started immediately, and it costs a fraction of what it would cost to implement an on-site solution.

- **Knowledgeable Vendors:-**

Typically, when new technology becomes popular, there are plenty of vendors who pop up to offer their version of that technology. This isn't always good, because a lot of those vendors tend to offer less than useful technology.

By contrast, the first comers to the cloud computing party are actually very reputable companies. Companies like Amazon, Google, Microsoft, IBM, and Yahoo! have been good vendors because they have offered reliable service, plenty of capacity, and you get some brand familiarity with these well-known names.

- **Security :-**

There are plenty of security risks when using a cloud vendor, but reputable companies strive to keep you safe and secure.

- **Increased availability and reliability:-**

For improving its reliability so as to decrease the effect of various runtime failure conditions.

A cloud based IT resource can be accessible for longer periods of time. for eg. 24 hours about 22 hours in a day.

Cloud computing:-Limitations

There are other cases when cloud computing is not the best solution for your computing needs.

- **Your Sensitive Information**

We've talked about the concern of storing sensitive information on the cloud, but it can't be understated. Once data leaves your hands and lands in the lap of a service provider, you've lost a layer of control.

- **Protect Your Data**

That doesn't mean you can't maintain your data on a cloud; you just need to be safe.

The best way is to encrypt your data before you send it to a third party.

Programs like PGP (www.pgp.com) or open-source TrueCrypt (www.truecrypt.org) can encrypt the file so that only those with a password can access it

Encrypting your data before sending it out protects it. If someone does get your data, they need the proper credentials or all they get is gibberish.

- **Applications Not Ready**

In some cases the applications themselves are not ready to be used on the cloud. They may have little quirks that prevent them from being used to their fullest abilities, or they may not work whatsoever.

First, the application might require a lot of bandwidth to communicate with users.

The application might also take a lot of effort to integrate with your other applications. If you try to relocate it to a cloud, you may find that the savings are erased by the additional effort required to maintain the integration. In this case it may end up being more cost- effective to continue to host it locally.

This helps you avoid the service cost of having to transfer to and from the cloud. It's also more efficient, because the application can talk to the database without having to reach out across the network to do so.

Some applications may not be able to communicate securely across the Internet. If they cannot communicate securely or through a tunnel, then your data is at risk.

Security Concerns:-

- Privacy Concerns with a Third Party

The first and most obvious concern is for privacy considerations. That is, if another party is housing all your data, how do you know that it's safe and secure? You really don't. As a starting point, assume that anything you put on the cloud can be accessed by anyone.

There are also concerns because law enforcement has been better able to get at data maintained on a cloud, more so than they are from an organization's servers.

- Hackers

Hackers Hackers aren't the nice people that Hollywood has made them out to be. Most aren't just sitting around, drinking Mountain Dew and trying to break into a secure network just because they can. They want something.

Either way, hackers are a real concern for your data managed on a cloud. Because your data is held on someone else's equipment, you may be at the mercy of whatever security measures they support.

- Are They Doing Enough to Secure It?

Before signing on with a reputable vendor, keep in mind, also, that they are doing all they can to protect your data. Now, there is a school of thought that says, in fact, that vendors will be going above and beyond to ensure that your data is secure. This is a simple matter of doing business. If word gets out that they don't protect the data they house, then no one will want to do business with them.

There's also an issue of performance and efficiency. Since you pay as you go, if you spend an inordinate amount of time on CPU cycles using their security tools, you'll go looking to the competition.

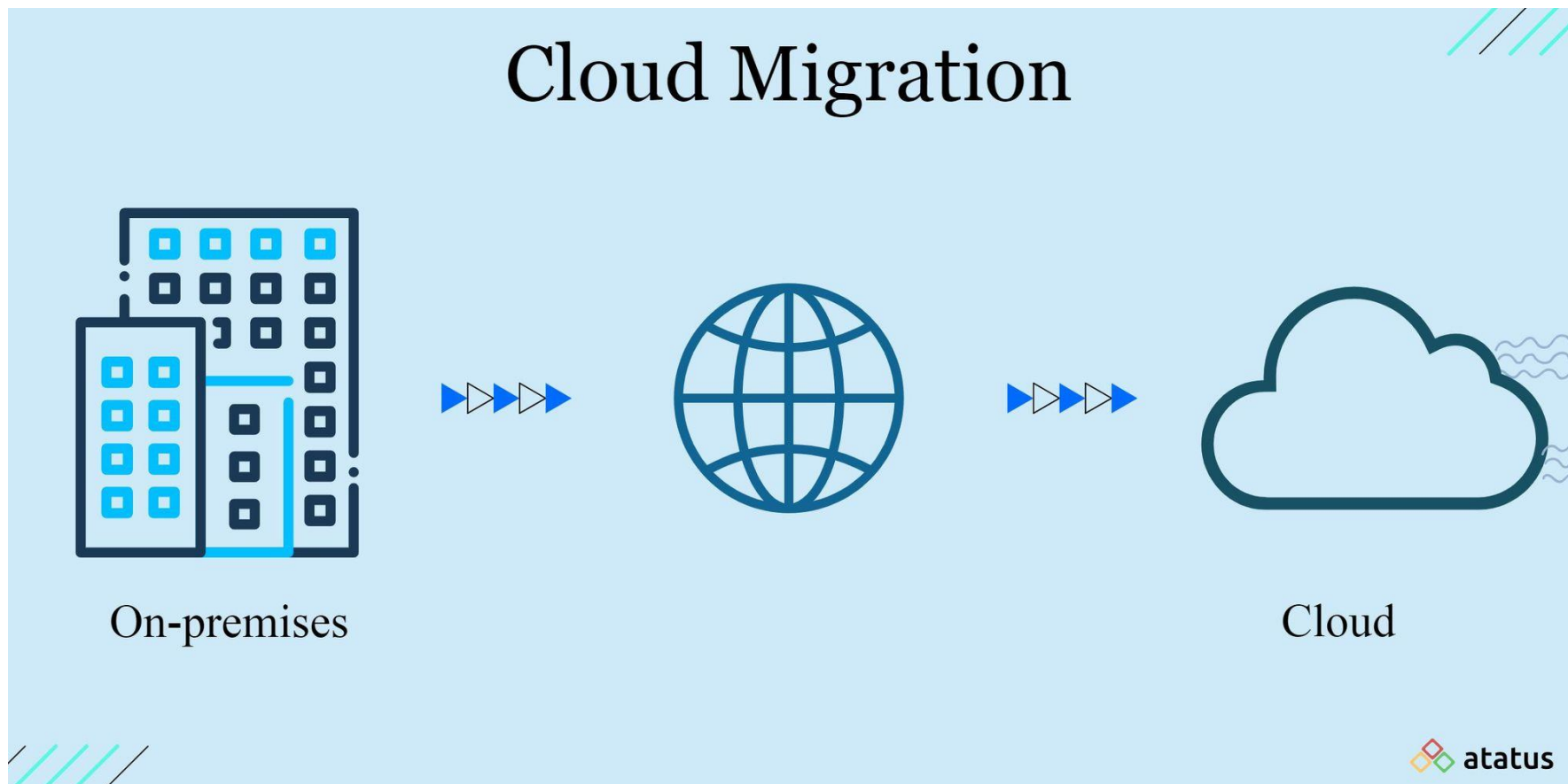
Ultimately, while we like to think that they're doing their best, their best simply might not be good enough. There are a lot of ways that their cloud and your data can be compromised.

- Bot Attackers

In a commonly recognized worst-case scenario, attackers use botnets to perform distributed denial of service (DDOS) attacks. In order to get the hackers to stop attacking your network, you face blackmail.

Migrating into Cloud

A cloud migration is when a company moves some or all of its data center capabilities into the cloud, usually to run on the cloud-based infrastructure provided by a cloud service provider such as AWS, Google Cloud, or Azure.

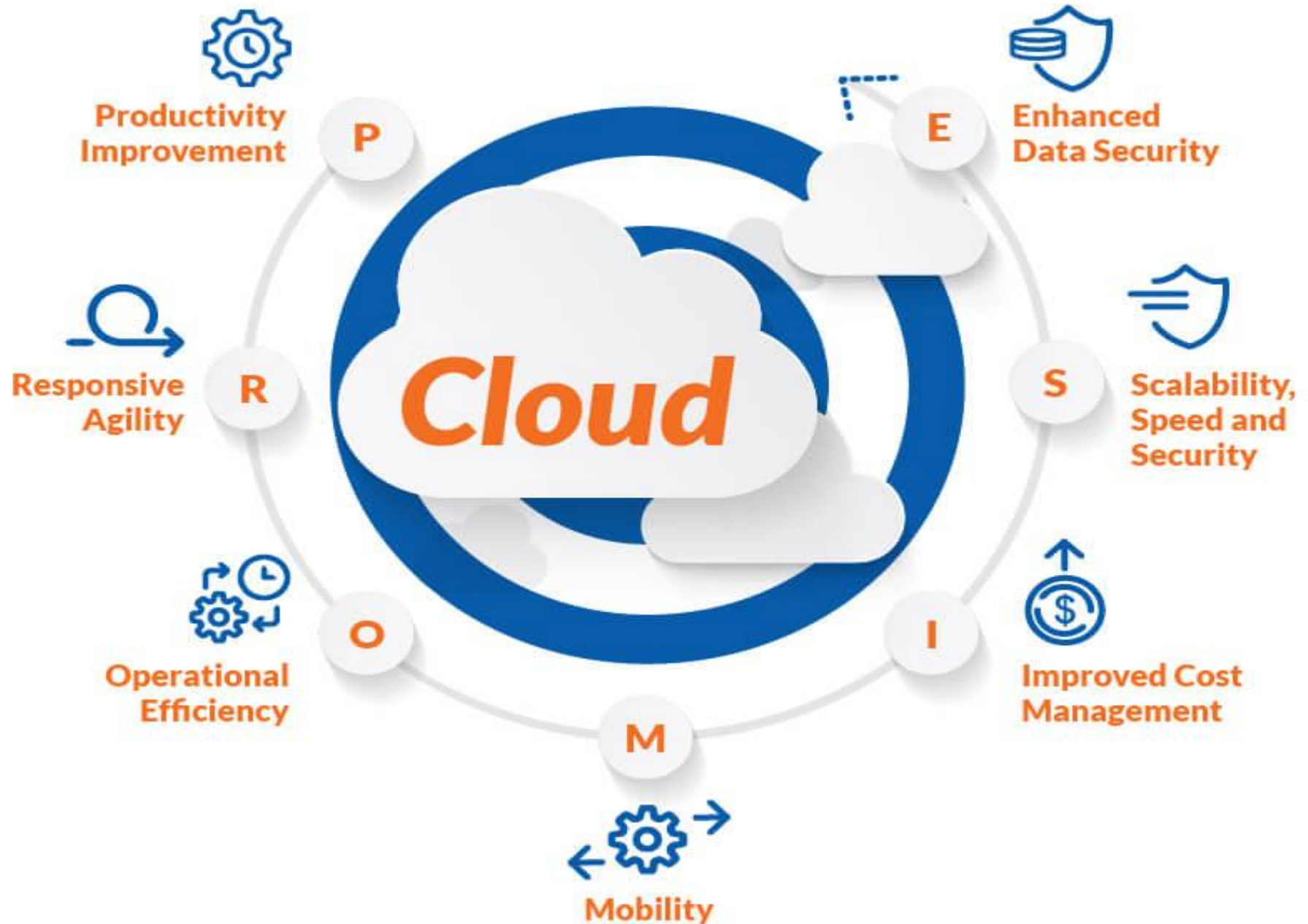


Migrating into Cloud

Cloud migration is the process of moving digital business operations into the [cloud](#). Cloud migration is sort of like a physical move, except it involves moving data, applications, and IT processes from some data centers to other data centers, instead of packing up and moving physical goods. Much like a move from a smaller office to a larger one, cloud migration requires quite a lot of preparation and advance work, but usually it ends up being worth the effort, resulting in cost savings and greater flexibility.

Most often, "cloud migration" describes the move from on-premises or legacy infrastructure to the cloud. However, the term can also apply to a migration from one cloud to another cloud

Benefits of Migrating into Cloud



Benefits of Migrating into Cloud

1. Scalability: Cloud computing can scale up to support larger workloads and greater numbers of users far more easily than on-premises infrastructure, which requires companies to purchase and set up additional physical servers, networking equipment, or software licenses.

2. Cost: Companies that move to the cloud often vastly reduce the amount they spend on IT operations, since the cloud providers handle maintenance and upgrades. Instead of keeping things up and running, companies can focus more resources on their biggest business needs – developing new products or improving existing ones.

Benefits of Migrating into Cloud

3. Performance: For some businesses, moving to the cloud can enable them to improve performance and the overall user experience for their customers. If their application or website is hosted in cloud data centers instead of in various on-premises servers, then data will not have to travel as far to reach the users, reducing latency.

4. Flexibility: Users, whether they're employees or customers, can access the cloud services and data they need from anywhere. This makes it easier for a business to expand into new territories, offer their services to international audiences, and let their employees work flexibly.

Challenges of Migrating into Cloud

1. Migrating large databases: Often, databases will need to move to a different platform altogether in order to function in the cloud. Moving a database is difficult, especially if there are large amounts of data involved. Some cloud providers actually offer physical data transfer methods, such as loading data onto a hardware appliance and then shipping the appliance to the cloud provider, for massive databases that would take too long to transfer via the Internet. Data can also be transferred over the Internet. Regardless of the method, data migration often takes significant time.

2. Data integrity: After data is transferred, the next step is making sure data is intact and secure, and is not leaked during the process.

Challenges of Migrating into Cloud

3. Continued operation: A business needs to ensure that its current systems remain operational and available throughout the migration. They will need to have some overlap between on-premises and cloud to ensure continuous service; for instance, it's necessary to make a copy of all data in the cloud before shutting down an existing database. Businesses typically need to move a little bit at a time instead of all at once.

Strategies of Migrating into Cloud

1. Rehost - Rehosting can be thought of as "the same thing, but on cloud servers". Companies that choose this strategy will select an IaaS (Infrastructure-as-a-Service) provider and recreate their application architecture on that infrastructure.

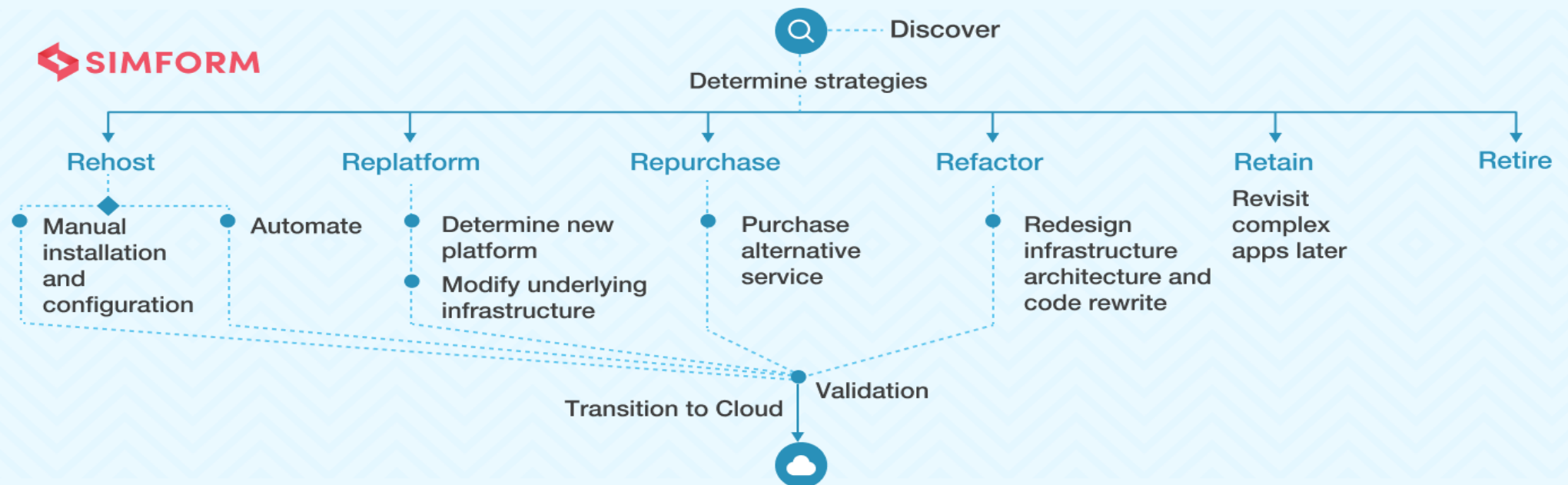
2. Refactor - Companies that choose to refactor will reuse already existing code and frameworks, but run their applications on a PaaS (Platform-as-a-Service) provider's platform – instead of on IaaS, as in rehosting.

3. Revise - This strategy involves partially rewriting or expanding the code base, then deploying it by either rehosting or refactoring

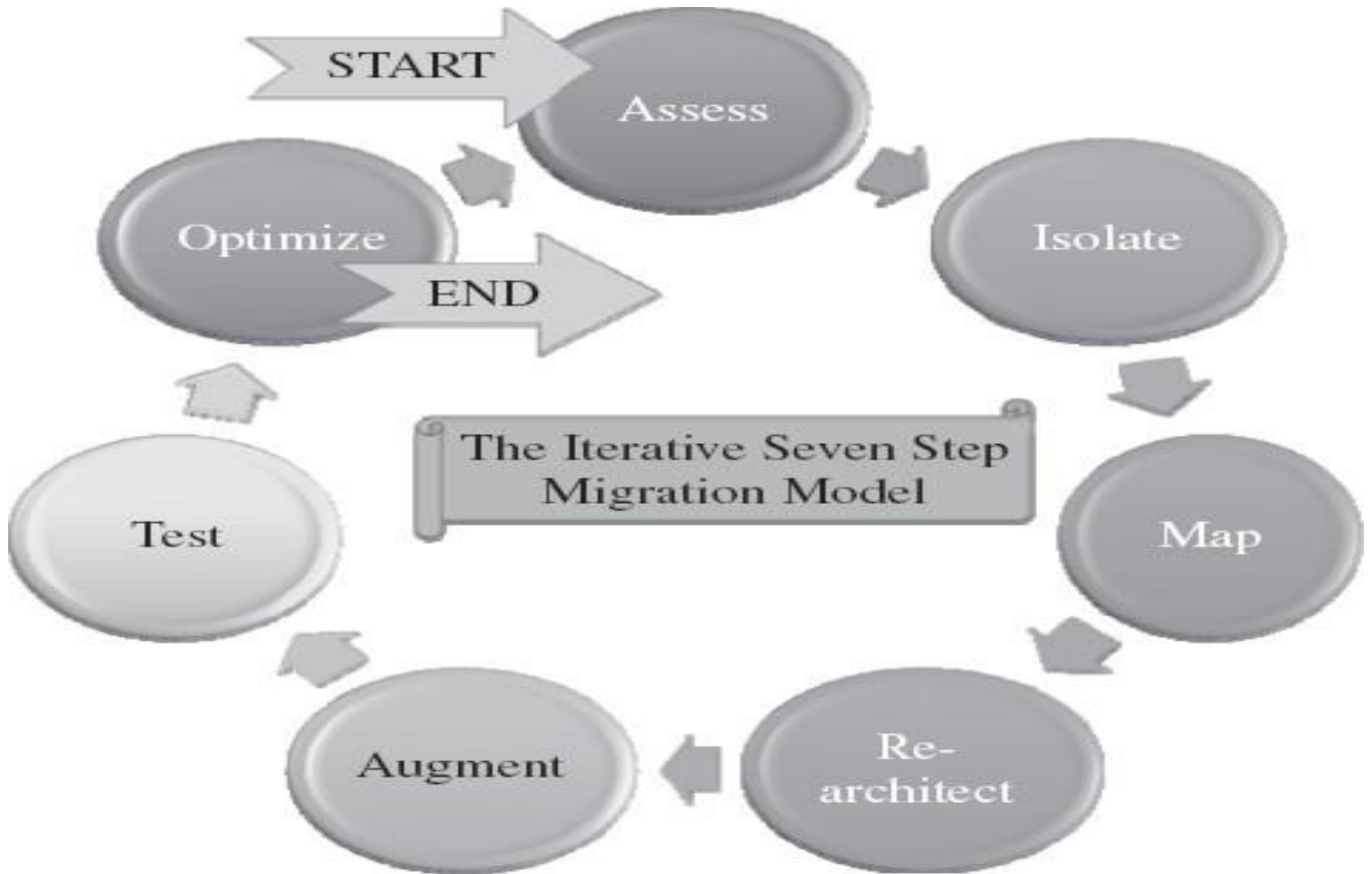
Strategies of Migrating into Cloud

4. Rebuild - To "rebuild" means rewriting and re-architecting the application from the ground up on a PaaS provider's platform. This can be a labor intensive process, but it also enables developers to take advantage of modern features from PaaS vendors.

5. Replace - Businesses can also opt to discard their old applications altogether and switch to already-built SaaS (Software-as-a-Service) applications from third-party vendors.



7 Step of Migrating model in Cloud



7 Step of Migrating model in Cloud

1. Assessment:-

The first step of the iterative process of the seven-step model of migration is basically at the assessment level. These assessments are about the cost of migration as well as about the ROI that can be achieved in the case of production version.

2. Isolating:-

The next process step is in isolating all systemic and environmental dependencies of the enterprise application components within the captive data center. This, in turn, yields a picture of the level of complexity of the migration.

7 Step of Migrating model in Cloud

3. Mapping:-

After isolation is complete, one then goes about generating the mapping constructs between what shall possibly remain in the local captive data center and what goes onto the cloud.

4. Re-Architect:-

Perhaps a substantial part of the enterprise application needs to be re-architected, redesigned, and re-implemented on the cloud. This gets in just about the functionality of the original enterprise application. Due to this migration, it is possible perhaps that some functionality is lost.

7 Step of Migrating model in Cloud

5. Augment:-

In the next process step we leverage the internal features of the cloud computing service to augment our enterprise application in its own small ways.

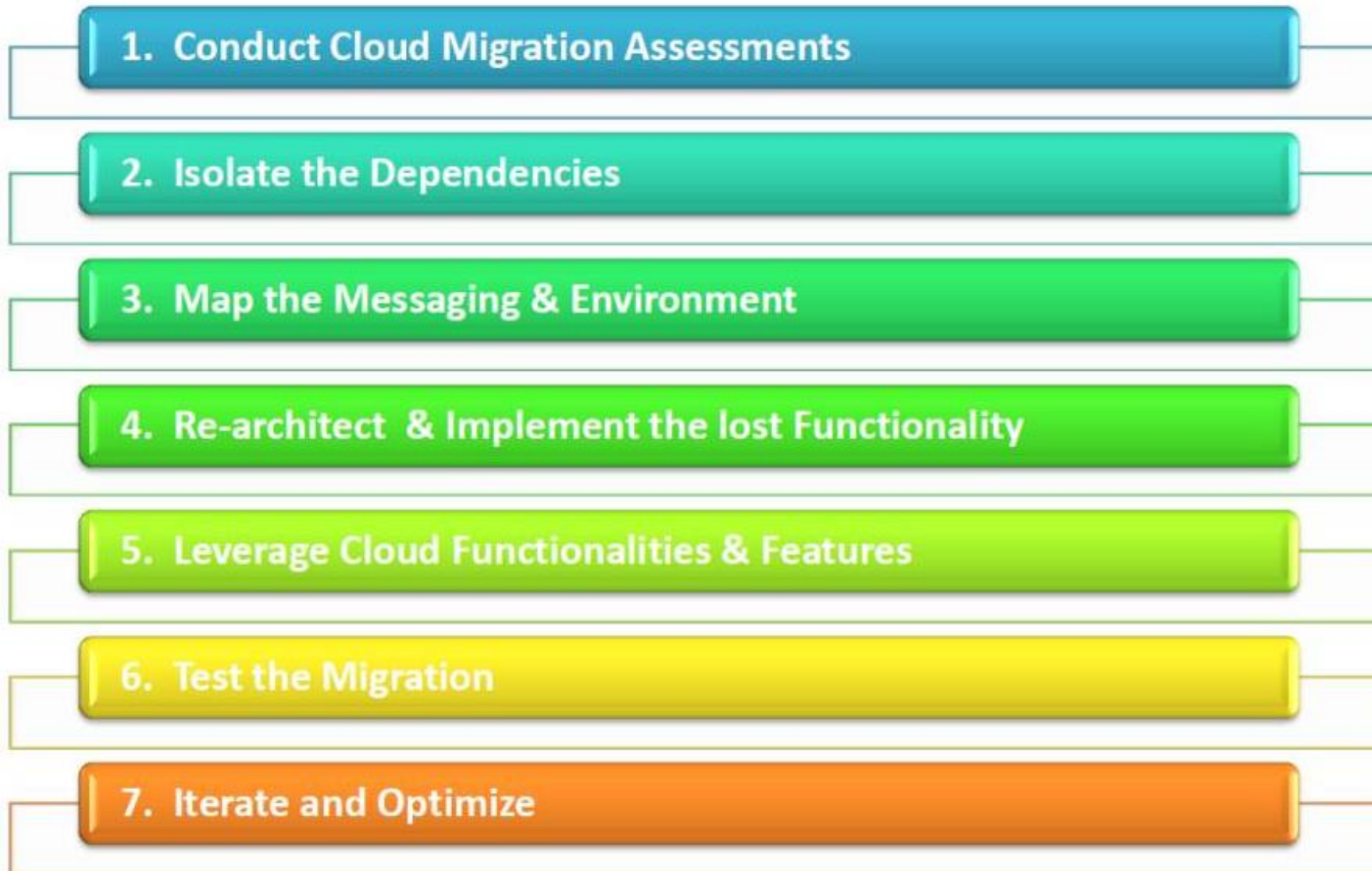
6. Validate:-

Having done the augmentation, we validate and test the new form of the enterprise application with an extensive test suite that comprises testing the components of the enterprise application on the cloud as well. These test results could be positive or mixed.

7 Step of Migrating model in Cloud

7. Optimization:-

In the latter case, we iterate and optimize as appropriate. After several such optimizing iterations, the migration is deemed successful.



Trends in Cloud Computing



Future of Cloud Computing

Increase
Storage Capacity

IoT Along With
Cloud Computing

Security

Enhanced
Performance
of Internet

Data Shows
How Future
Changes

Modular Software

Modular
Software Will
Be Priority

Improvement
in Cloud Services

Economic

Trends in Cloud Computing



As a service offerings

Industry trends

Cloud Growth:
4 Key Areas

Investment trends

Big 3 cloud providers

Cloud Computing Service Provider

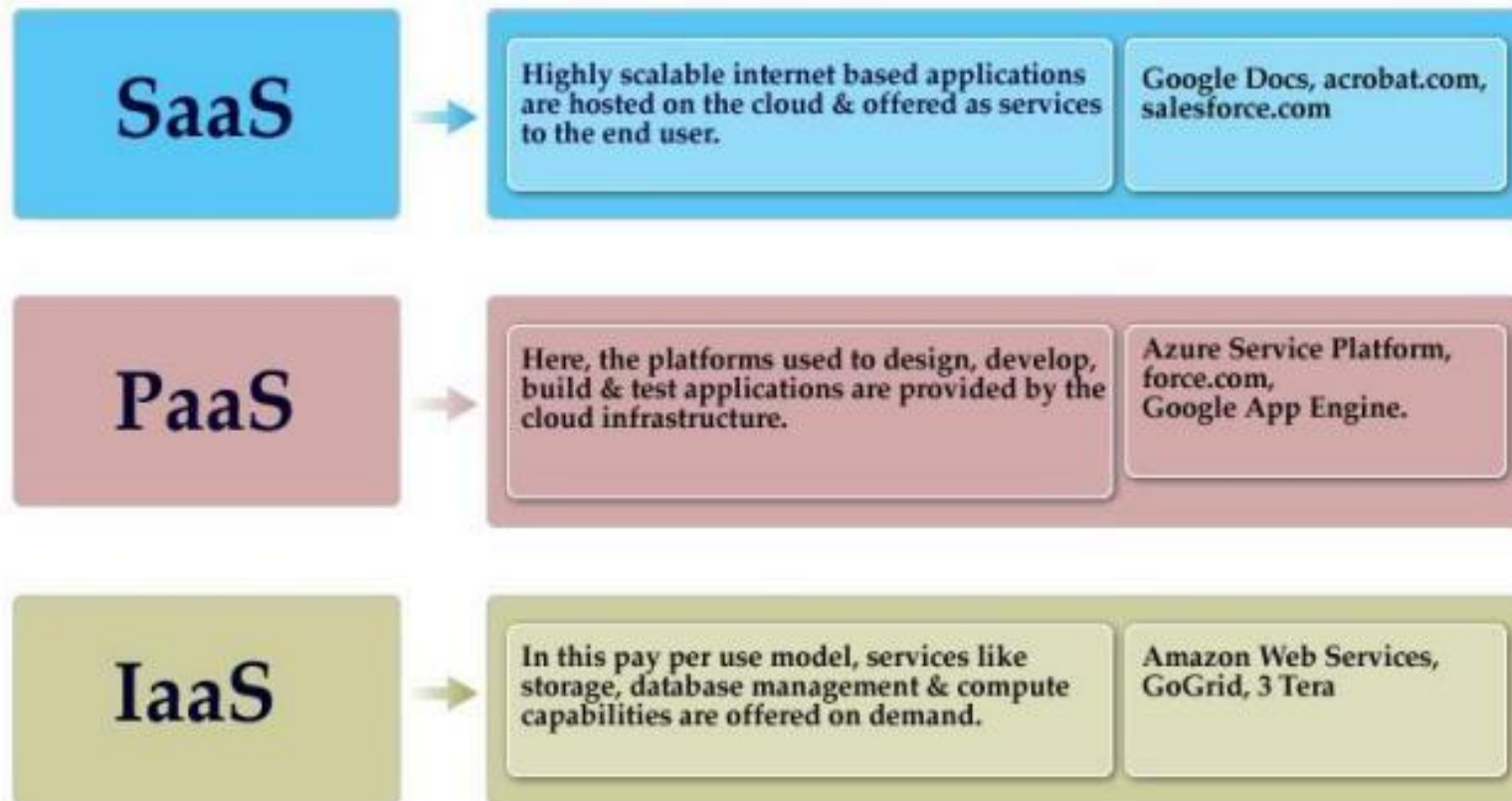
A few of the most popular cloud computing service providers include:

1. Microsoft Azure
2. Amazon Web Services (AWS)
3. Google Cloud
4. Alibaba Cloud
5. IBM Cloud
6. Oracle
7. Salesforce
8. SAP
9. Rackspace Cloud
10. VMWare

Cloud Delivery Models

There are three types of cloud delivery models which are also known as Cloud computing services.

1. Software as a service(SaaS)
2. Platform as a service(PaaS)
3. Infrastructure as a service(IaaS)



Software as a Service(SaaS)

SaaS is also known as "On-Demand Software". It is a software distribution model in which services are hosted by a cloud service provider. These services are available to end-users over the internet so, the end-users do not need to install any software on their devices to access these services.

There are the following services provided by SaaS providers -

Business Services - SaaS Provider provides various business services to start-up the business. The SaaS business services include ERP (Enterprise Resource Planning), CRM (Customer Relationship Management), billing, and sales.

Document Management - SaaS document management is a software application offered by a third party (SaaS providers) to create, manage, and track electronic documents
Example: Slack, Samepage, Box, and Zoho Forms.

Social Networks - As we all know, social networking sites are used by the general public, so social networking service providers use SaaS for their convenience and handle the general public's information.

Mail Services - To handle the unpredictable number of users and load on e-mail services, many e-mail providers offering their services using SaaS.

Software as a Service(SaaS)

In SaaS, an application is hosted by a service provider and then accessed via the World Wide Web by a client.

SaaS (Software as a Service) is an application hosted on a remote server and accessed through the Internet.

An easy way to think of SaaS is the web-based email service offered by such companies as Microsoft (Hotmail), Google (Gmail), and Yahoo! (Yahoo Mail).



This is a simple explanation of SaaS, but the same architecture can be applied to a broad variety of applications, used either by businesses or individual end users. SaaS can be divided into two major categories:

1. **Line of business services** These are business solutions offered to companies and enterprises. They are sold via a subscription service. Applications covered under this category include business processes, like supply-chain management applications, customer relations applications, and similar business-oriented tools.
2. **Customer-oriented services** These services are offered to the general public on a subscription basis. More often than not, however, they are offered for free and supported by advertising. Examples web mail services, online gaming, and consumer banking, among others.

- **Characteristics of SaaS:-**

SaaS makes available various types of software over the internet.

Vendor has the responsibility to maintain the software.

They Can scale up or down on demand.

They are anytime anywhere available on demand.

• Advantages of SaaS:-

1. Modest software tools:- No installation at client side
2. Efficient use of software licenses:- no need of license of software
3. Centralized management and data: data is saved centrally by the cloud provider
4. Platform responsibilities managed by providers:-All platform responsibilities are performed by the cloud provider.
5. Multitenant solutions:- Multitenant solutions enable several users to share single instance of multiple resources in virtual isolation.

Disadvantages of SaaS:-

Browser based risks

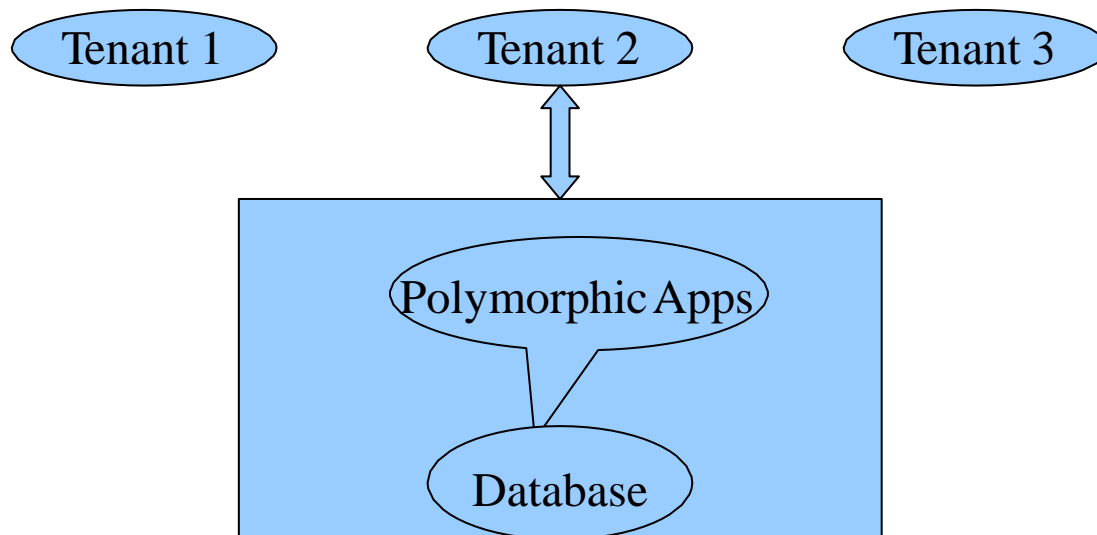
Network dependance

Lack of portability between SaaS clouds.



Understanding Multitenant nature of SaaS Solutions

- In order to achieve cost efficiencies in delivering same applications to various sets of users it is a vital and obvious choice that an increasing number of applications are multi-tenant instead of single tenant.
- A Multi-tenant application should be able to satisfy the needs of multiple sub organizations or sections within the organization using the single shared stack of software and hardware resources and staff needed to manage.
- A Multi-tenant application shares a single stack of resources both hardware and software to cater multiple tenants(organizations,sub organizations,sections etc)



- Meta-Data-Driven Reference Architecture

A Traditional static application is not capable of addressing unique challenges of multi-tenancy.

A Multi tenant application should be dynamic in nature or polymorphic to fulfil the specific expectations of various tenants and their users.

Application components need to be generated at runtime from meta-data.i.e.data about the application itself.

It should be a well defined meta data driven architecture with a separate component for:

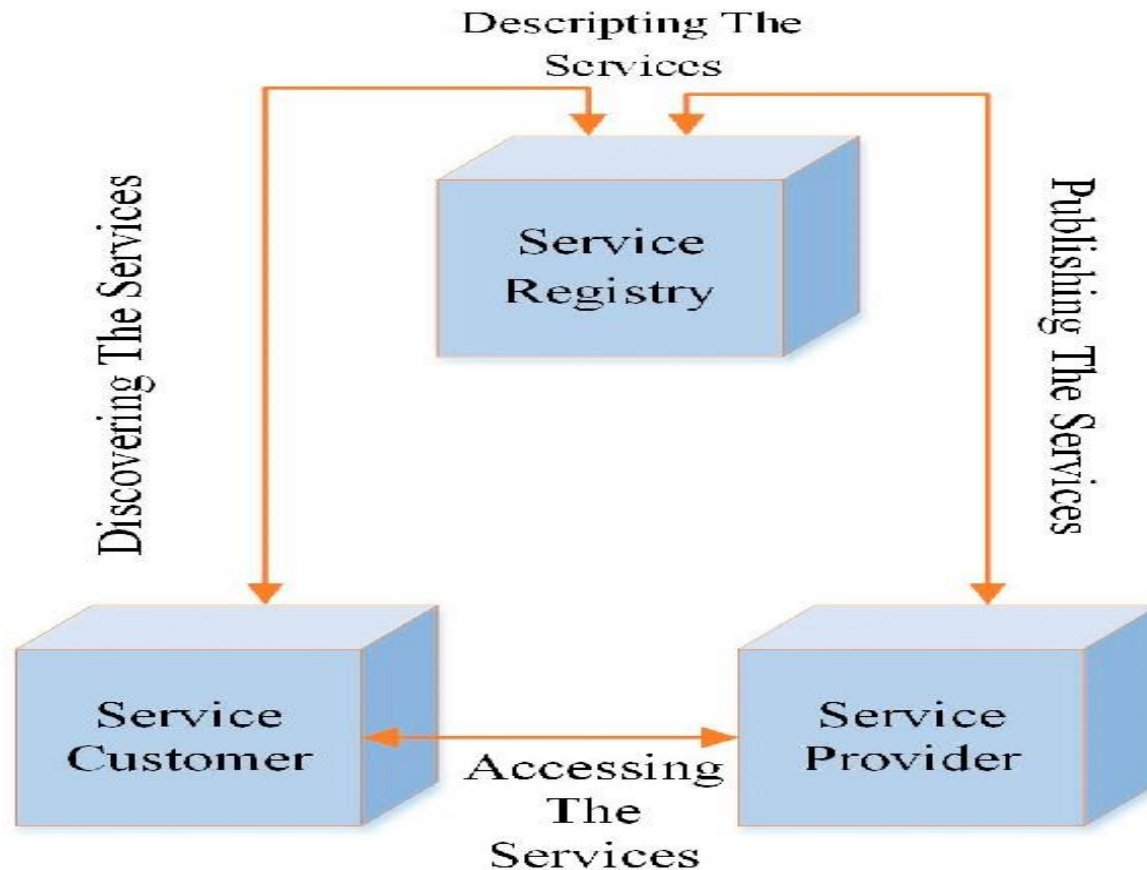
Runtime application data

Meta data that describes the base functionality of an application

Meta data that corresponds to each tenant specific data and customization

Understanding SOA

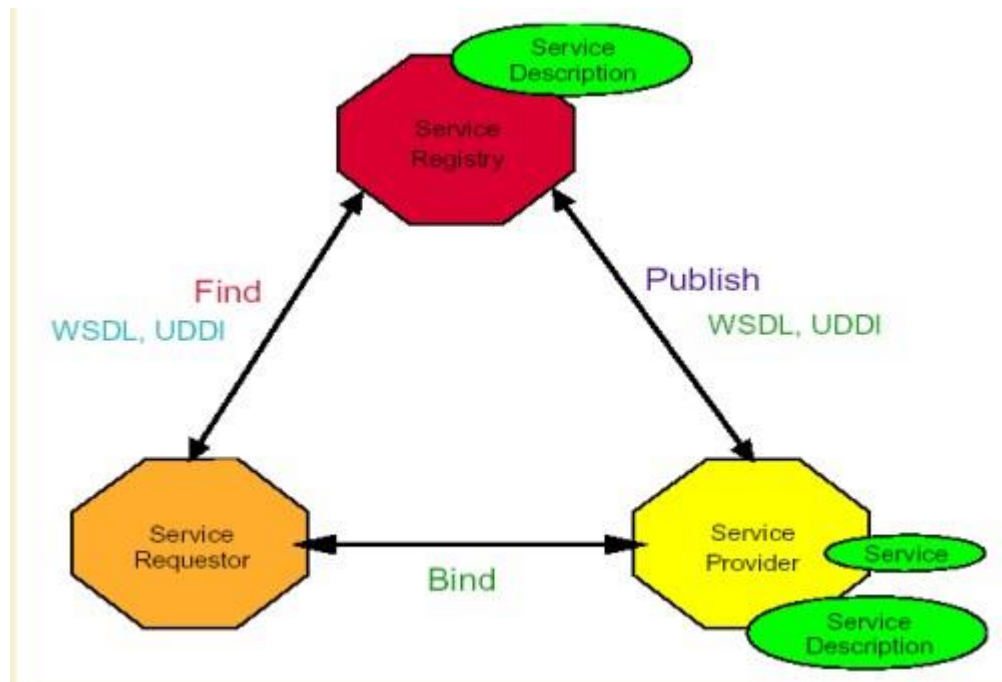
- A service oriented architecture is basically a group of services that interact with each other. The interaction can engage either transfer of data or synchronization of one or more services into particular action,



- **Service**: A service is defined as a function which is definite and independent of framework or condition of other services.
- **Architecture**: SOA is defined as architecture useful for constructing business application as a set of freely joined black box units arranged to convey a well defined level of service by connecting different business processes together.
- A service is a task which is precise, self-sufficient and does not require any context or state of other services.
- **Each SOA consists of three building blocks are as follows:**
 - **Service provider:-** Owner of the service
Platform that hosts access to the service
 - **Service requestor:-** Business that requires certain functions to be satisfied
Application looking for and invoking an interaction with a service
 - **Service registry:-** Searchable registry of service descriptions where service providers publish their servicedescriptions

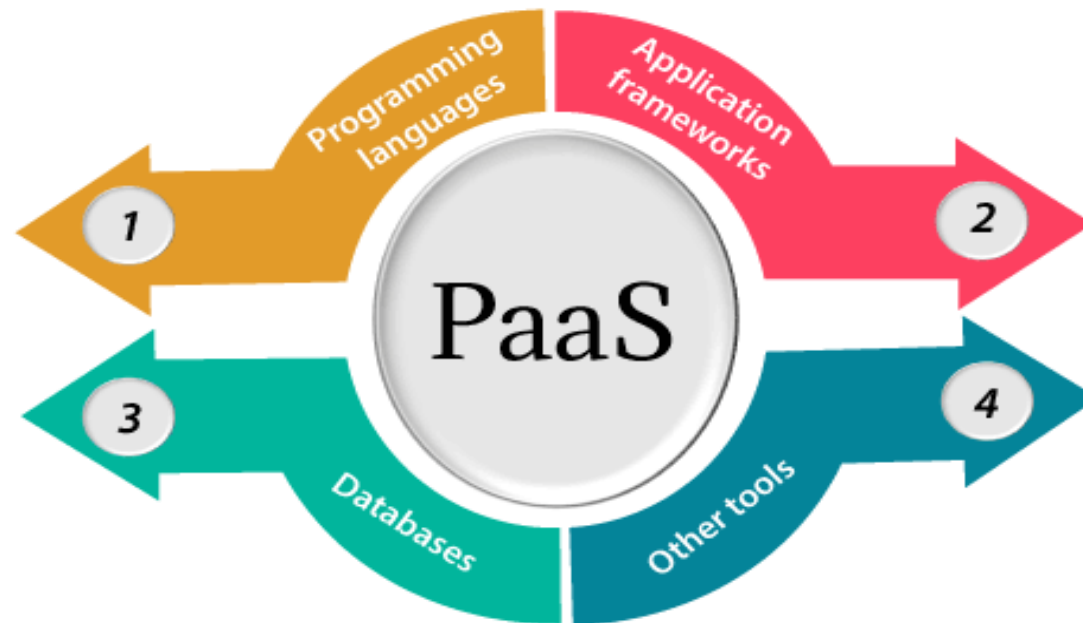
• Operations in a SOA:-

- Publish:- Service descriptions need to be published in order for service requestor to find them
- Find/Discovery:- Service requestor retrieves a service description directly or queries the service registry for the service required
- Bind/Access service:- Service requestor invokes or initiates an interaction with the service at runtime



Platform as a service(PaaS)

- Platform as a Service (PaaS) provides a runtime environment. It allows programmers to easily create, test, run, and deploy web applications. You can purchase these applications from a cloud service provider on a pay-as-per use basis and access them using the Internet connection. In PaaS, back end scalability is managed by the cloud service provider, so end- users do not need to worry about managing the infrastructure.
- PaaS includes infrastructure (servers, storage, and networking) and platform (middleware, development tools, database management systems, business intelligence, and more) to support the web application life cycle.
- Example: Google App Engine, Force.com, Joyent, Azure.



Platform as a service(PaaS):-IT Evolution Leading to the cloud

- Platform as a service provides a readymade runtime environment for different types of applications.
- It also offers various tools regarding development and deployment which are necessary to develop applications.
- PaaS provides a very important feature of point and click tools which is very useful for the non-developers to create various types of web applications as per their requirements.

- Example as PaaS offering vendors:

App Engine of Google

App Engine of Force.com

- Developer can log on these websites to take help of built in API for the creation of web based applications.

PaaS Providers

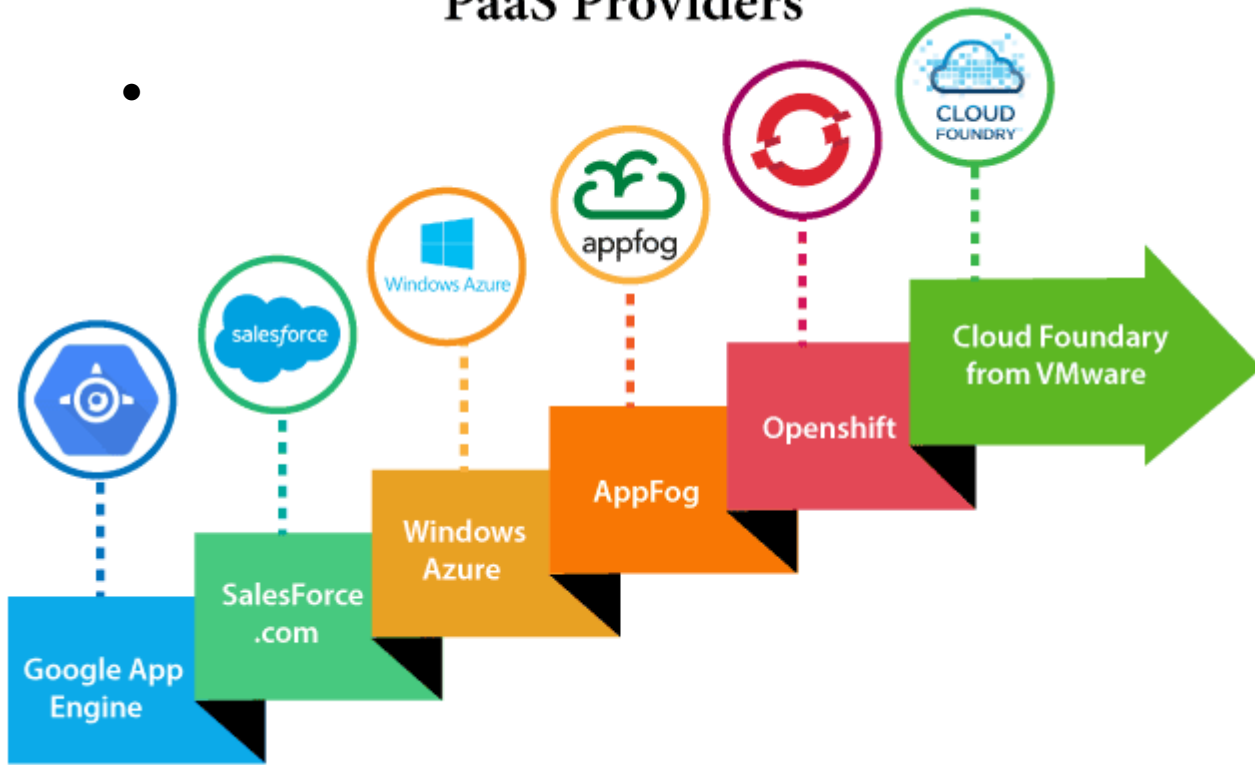


Fig.PaaS

- **Benefits of PaaS Solutions:-**

1. **Low Overhead of Administration:-** As administration is the responsibility of cloud provider, it is not a headache of customer.
2. **Less Ownership Cost:-** For the customer there is no need to purchase expensive hardware, servers, data storage and power.
3. **Scalable Solutions:-** It is very simple and flexible to scale the available resources up or down automatically, depending on their requirement.
4. **Latest System Software:-** It is the responsibility of the cloud provider to maintain and keep advanced and latest software versions.

- **Disadvantages of PaaS solutions:-**

1. **Lack of Portability:-** lack of portability between PaaS clouds.
2. **Resources constraints:-** Event based processor scheduling which constitutes resource constraints on the application i.e. time limitation to answer a request.
3. **Dependency on Network:-** PaaS applications are completely reliant on network, hence they have to explicitly use cryptography and manage the upcoming security exposures.

Infrastructure as a service(IaaS)

IaaS is also known as Hardware as a Service (HaaS). It is one of the layers of the cloud computing platform. It allows customers to outsource their IT infrastructures such as servers, networking, processing, storage, virtual machines, and other resources. Customers access these resources on the Internet using a pay-as-per use model.



- **Compute:** Computing as a Service includes virtual central processing units and virtual main memory for the Vms that is provisioned to the end- users.
- **Storage:** IaaS provider provides back-end storage for storing files.
- **Network:** Network as a Service (NaaS) provides networking components such as routers, switches, and bridges for the Vms.
- **Load balancers:** It provides load balancing capability at the infrastructure layer.

Infrastructure as a service(IaaS)-Understanding IaaS

- Infrastructure as a service is a model which provides access to primary resources like physical machines virtual storage etc.
- In addition to these resources,the IaaS also provides following facilities:

Virtual machine disk storage

Software bundles

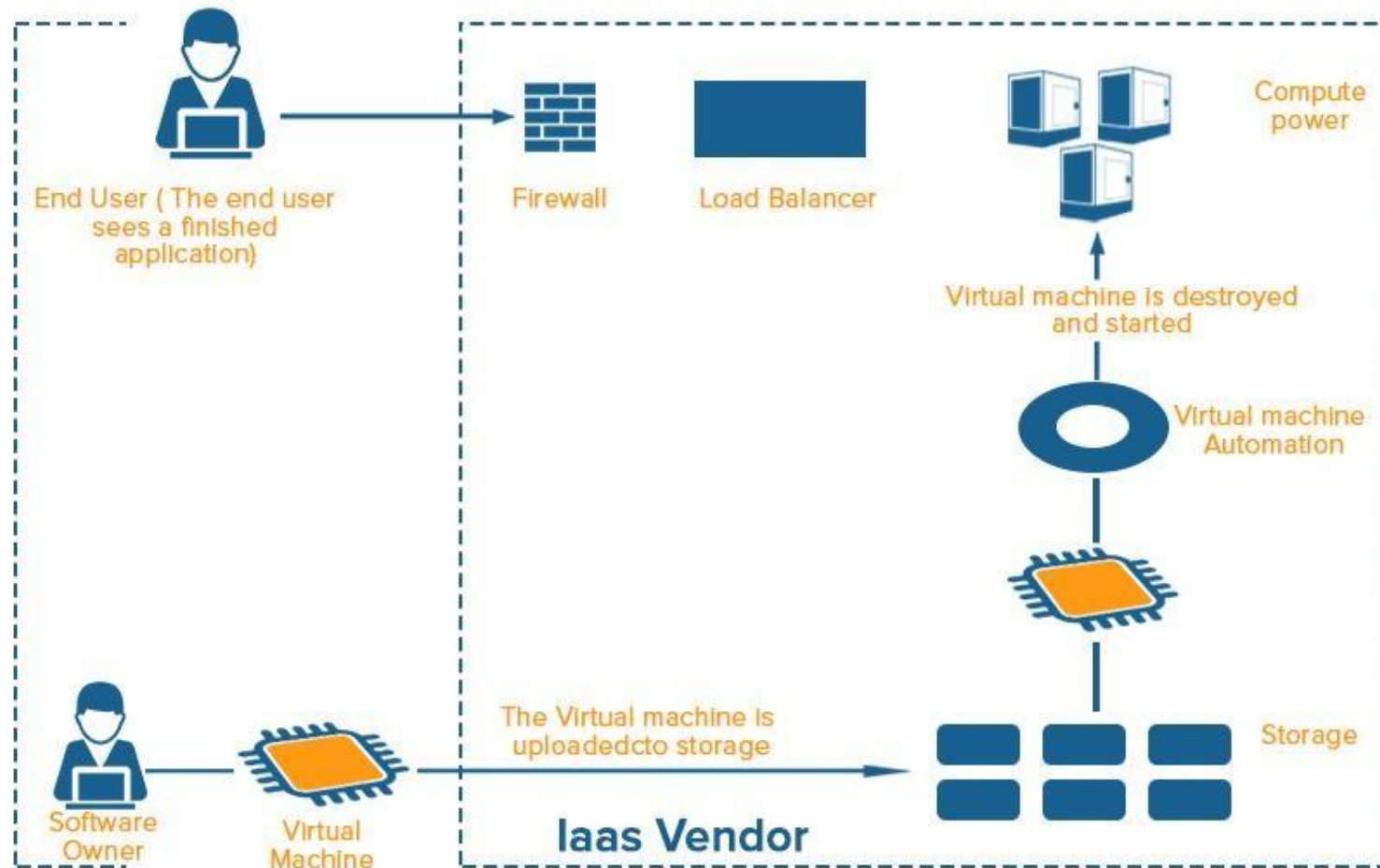
Virtual local are network(VLANs)

IP addresses

Load balancers

- The concept of server virtulization is used to make available these resources to the user.The extent of access rights gives feeling of owner of these resources to the end user.

How IaaS Works



Source: SlideShare.net

• Advantages of IaaS:-

1. Allows IT to shift focus:- with fast accessibility of IaaS

Utility Service:- pay per use/subscription based model

2. Dynamic Scaling:- Scales up and down the infrastructure services

Multiple tenants:- multiple users accessing the identical infrastructure

3. Investment cap:- Highly beneficial for businesses with limited capital to invest in hardware and infrastructure.

4. Flexible offering:- Access infrastructure from any location, any place and on any device.



Infrastructure as a service(IaaS)

- **Disadvantages of IaaS:-**

- 1. Security :**

Security is one of the biggest issues in IaaS. Most of the IaaS providers are not able to provide 100% security.

- 2. Maintenance & Upgrade :**

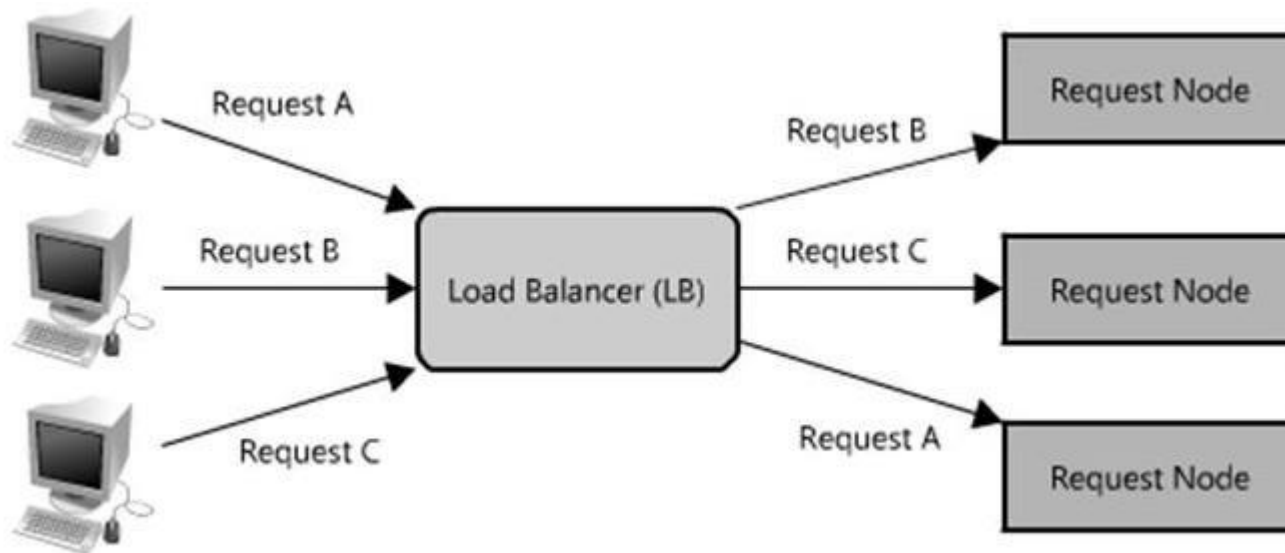
Although IaaS service providers maintain the software, but they do not upgrade the software for some organizations

- 3. Interoperability issues :**

It is difficult to migrate VM from one IaaS provider to the other, so the customers might face problem related to vendor lock-in.

Improving Performance through load Balancing

- There are number of famous sites such as google,yahoo,Amazon which experience millions of user hits per day.
- A technique known as **load balancing** is used by those sites to manage the huge web requests.
- It helps to share the requests across multiple servers.
- Simply the browser working at client side send request of an HTML page first and then the associated graphics,CSS and Javascript files from the web server as shown fig.



- When the demand regarding the server increases in huge manner, the organization has choice of placing a load balancing server with two or more servers to which the web requests are distributed by the load balancer.
- For simple applications the load balancing is considered as quite straightforward since either server may be handle all requests.
- When there is complexity in server based applications regarding various aspects such as accessing data within a database then the developers has to provide shared access to the database.
- To avoid any single point of failure, companies make replicas of the database on more than one server.
- The database software further should do the process of synchronization of data updates across the systems, all the database, will send data updates to other for maintaining data synchronization among the servers.
- The organization may select to simplify the solution with the help of cloud-based database or a cloud based network attached storage device.
- There is no need to the applications to worry about the data synchronization and replication since this work is handled within the cloud.

System and Storage Redundancy

- Cloud based computing does not have any problem regarding the location of the physical computing resources as well as data storage devices.
- Hence companies often use the process of collocation through which duplicate off-site servers or disk storage devices are employed.
- The process of employing duplicate resources, systems can transfer control from one location to another or they can easily utilize the duplicate systems for the purpose of load balancing.

• In this manner, the collocated resources perform the following tasks:

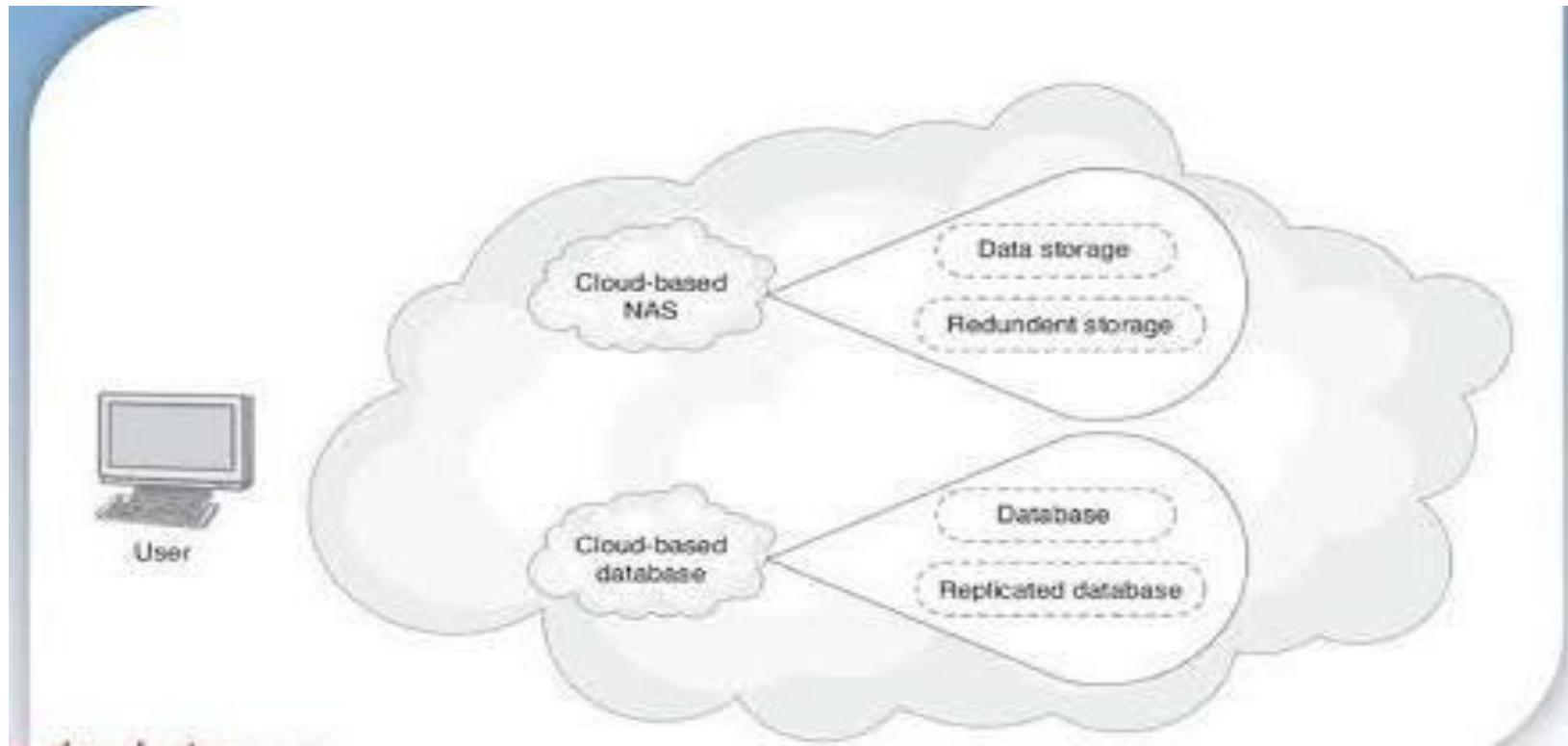
Makes the organization less susceptible to fire, natural disasters or terrorism

Increase the performance by distributing workload

Makes the organization less susceptible to downtime because of power loss from a blackout or brownout.

- Since last some years the cheap options provided by IaaS providers have made hardware redundancy a compulsory element for organization which depends upon the availability of key applications and data.

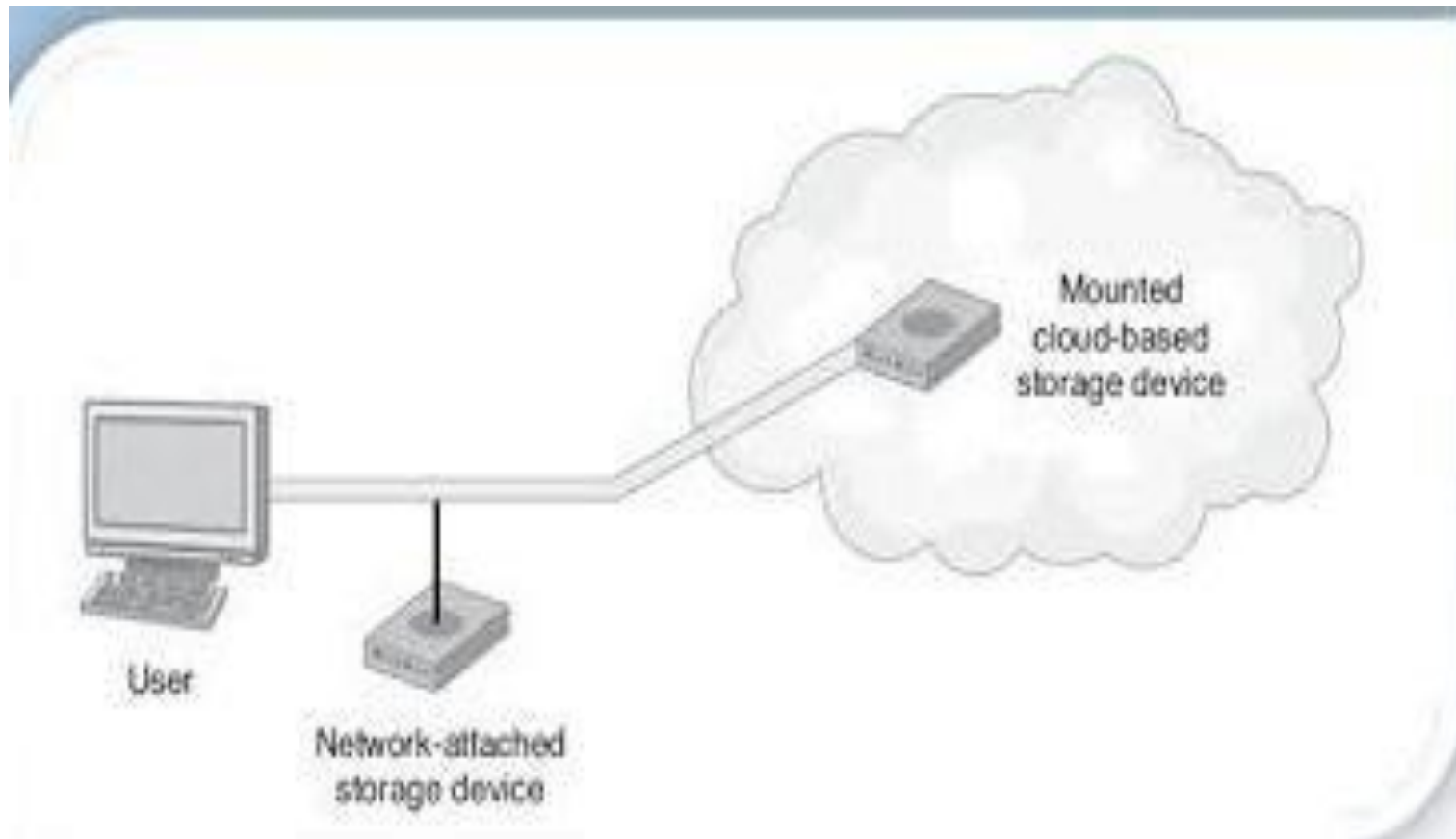
- Similarly, by employing cloud based NAS –(Network Attached Storage)devices and cloud based database systems it becomes easy for companies to replicate their data.
- IaaS providers give facility to the organizations to add servers, processors and RAM in their applications as per requirement.
- It is also possible for IaaS providers to automatically scale resource allocation up or down.



Utilizing Cloud Based NAS Devices

- A NAS unit is a computer connected to a network that provides only file based data storage to other devices on the network.
- Although it may technically be possible to run other software on a NAS unit, it is usually not designed to be a general purpose server.
- For eg. NAS units usually do not have a keyboard or display, and are controlled and configured over the network often using a browser.
- A full featured OS is not needed on a NAS device, so often a stripped down OS is used.
- NAS systems contain one or more hard disk drives, often arranged into logical, redundant storage containers or RAID.
- There are number of ways for companies to shift their data storage solution is to use cloud based NAS devices which present devices as well as applications as mountable drives and file system.
- Usually users are able to scale their cloud based storage on demand and pay just regarding the storage space which they consume.

- As shown in fig. some of the cloud based NAS devices offer behind the scenes data replication for data redundancy requirements.
- Nirvanix offers a wide range of cloud solutions, from public, private and hybrid clouds to backup and off-site storage and cloud NAS which is a cloud based NAS solution.



- Advantages of IaaS Solutions:-

Simply IaaS is considered as a mechanism to provide the hardware necessary for execution of an application.

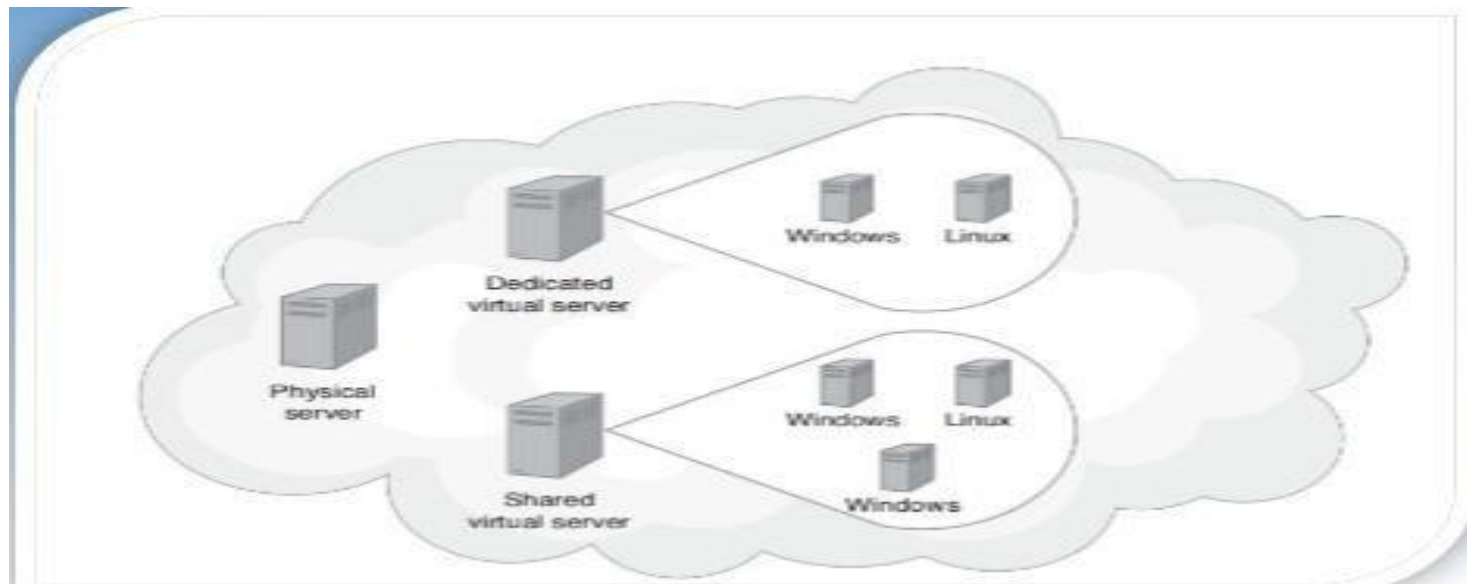
The use of IaaS solutions helps companies to eliminate the necessity to data warehouse as well as maintain expensive data centers.

No need of an expensive as well as staff intensive data center.

- ✓ Hardware scalability is easy and flexible.
- ✓ Reduced hardware cost.
- ✓ On demand pay as go scalability.
- ✓ Need of less IT staff.
- ✓ Ad hoc test environment suitability.
- ✓ Absolute system administration and management.

Server Types Within an IaaS Solution

- In the environment of IaaS customers have facility to acquire one or multiple servers.
- Physical Server: Allocation of actual hardware is made for dedicated use of customer.
- Dedicated virtual server: A virtual server is allocated to customer that runs on a physical sever which may or may not contain other types of virtual servers.
- Shared virtual server: Customer is given facility to access a virtual server on a device which is shared with multiple customer.



Identity as a Service(IDaaS)

- Identity as a service(IDaaS) is a cloud based service that provides a set of identity and access management functions to target a systems on customers premises and/or in the cloud.
- Identity as a Service refers to the identity and access management service which serve through the cloud by subscribing into it. It can be purchased as a subscription-based managed service.
- IDentity as a Service (IDaaS), is a cloud-oriented third-party authentication service.
- It offers services that allow users to securely access their sensitive data.
- Employees are facing several login problems such as remembering the username and password to access the data.
- If the employee resigns, the data stored on the computer must be completely erased. This can be done with the help of IDaaS, which also used for electronic transactions.
- ID management is considered as tedious,time consuming,and expensive.since last decade,organizations have started to emerge to provide identity as a service or cloud based ID management.

Difference between IaaS, PaaS and SaaS

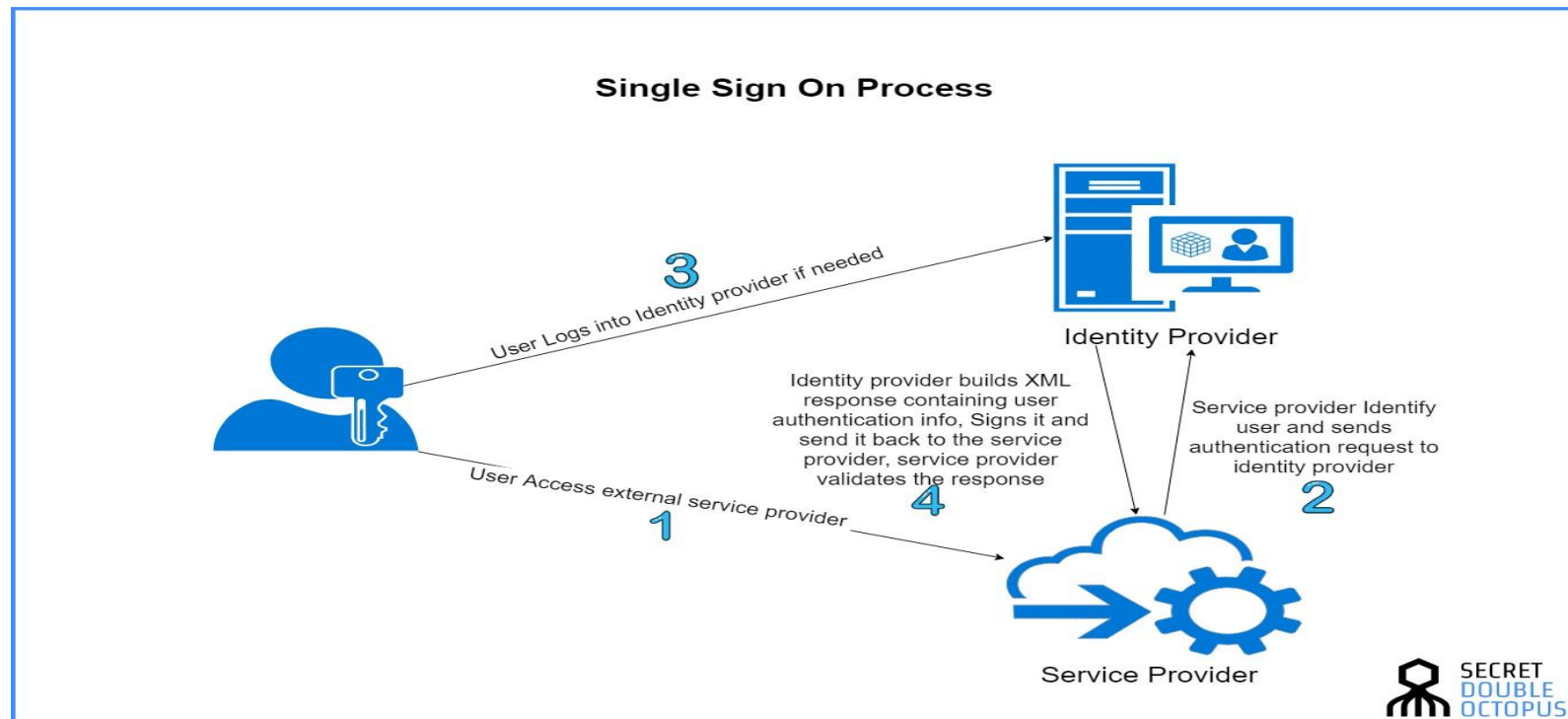
IaaS	PaaS	SaaS
It provides a virtual data center to store information and create platforms for app development, testing, and deployment.	It provides virtual platforms and tools to create, test, and deploy apps.	It provides web software and apps to complete business tasks.
It provides access to resources such as virtual machines, virtual storage, etc.	It provides runtime environments and deployment tools for applications.	It provides software as a service to the end-users.
It is used by network architects.	It is used by developers.	It is used by end users.
IaaS provides only Infrastructure.	PaaS provides Infrastructure+Platform.	SaaS provides Infrastructure+Platform +Software.

• What is Single Sign-On (SSO)?

Single Sign-on is an authentication process, with a user can access multiple applications. This requires only one set of log-in information. With the help of LAN, the client can access multiple resources.

Through SSO, a user doesn't have to log in again and again.

The mechanism of SSO varies from application to application. Single Sign-On can use with other authentication techniques which can be either smart cards or OTP tokens.



Step 1:- User logs into the authentication server by entering the valid username and password.

Step 2:- Users ticket is returned by the authentication server

Step 3:- The ticket is sent to the intranet server by the user

Step 4:- The ticket is sent to the authentication server by the intranet server.

Step 5:- User's security credentials for the server are sent by authentication server back to the intranet server.

- Whenever an employee leaves the organization the user should be disabled by the IT Staff at the authentication server which will disable the users access to all systems.

- Advantages of SSO

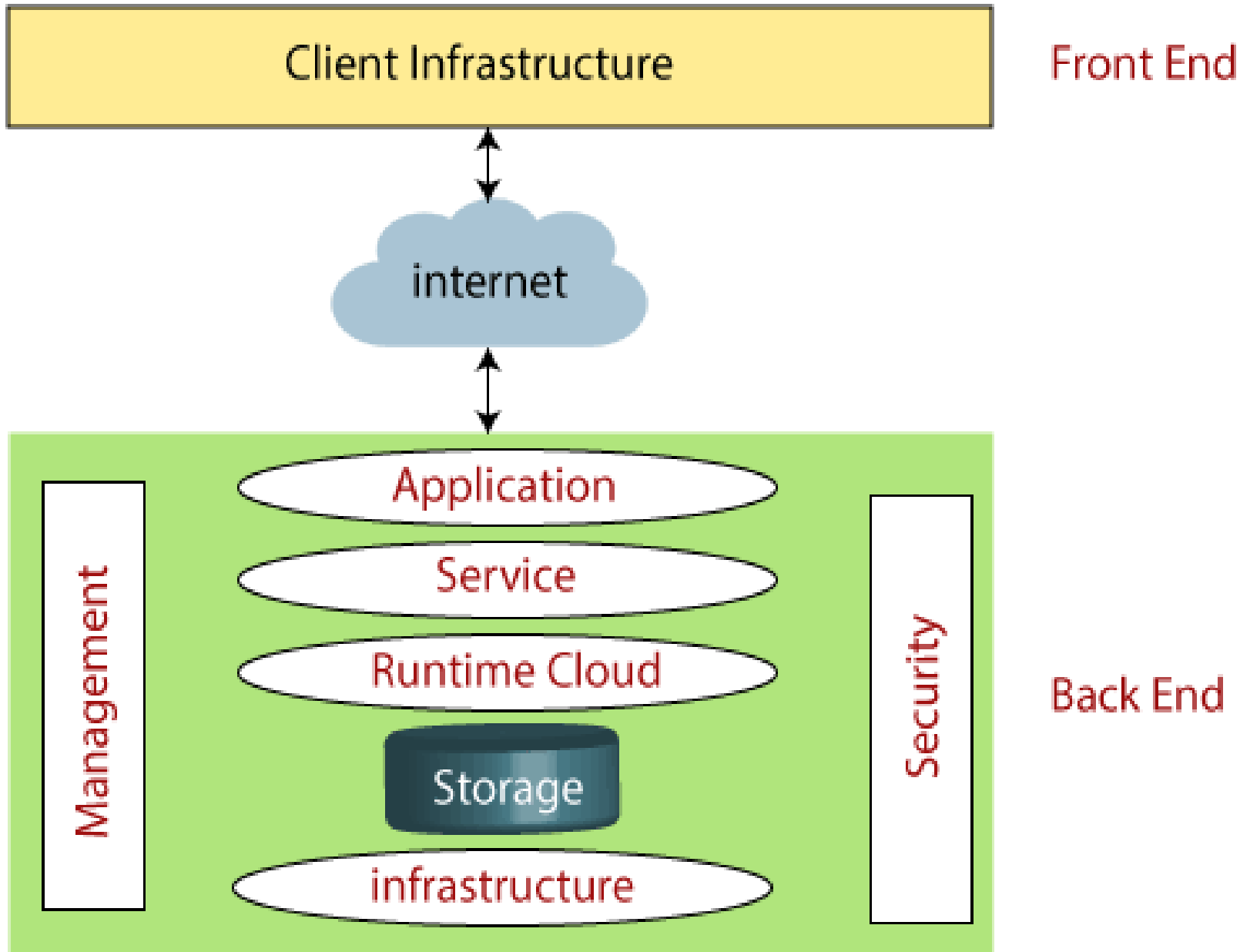
- It's time to list down all the benefits of SSO in Identity as a Service:
- Manages local and remote applications along with the desktop flow.
- Removes re-authentication and improves productivity.
- The database is user-friendly and flexible which benefits in many ways.
- Serves detailed user access reporting

Cloud Computing Architecture

- As we know, cloud computing technology is used by both small and large organizations to store the information in cloud and access it from anywhere at anytime using the internet connection.
- Cloud computing architecture is a combination of service-oriented architecture and event-driven architecture.
- Cloud computing architecture is divided into the following two parts -
 - Front End
 - Back End
- The below diagram shows the architecture of cloud computing -

Cloud Computing Architecture

Architecture of Cloud Computing



Cloud Computing Architecture

- **Front End**

- The front end is used by the client. It contains client-side interfaces and applications that are required to access the cloud computing platforms. The front end includes web servers (including Chrome, Firefox, internet explorer, etc.), thin & fat clients, tablets, and mobile devices.

- **Back End**

- The back end is used by the service provider. It manages all the resources that are required to provide cloud computing services. It includes a huge amount of data storage, security mechanism, virtual machines, deploying models, servers, traffic control mechanisms, etc.-

Cloud Computing Architecture

- **Application –**

Application in backend refers to a software or platform to which client accesses. Means it provides the service in backend as per the client requirement.

- **Service –**

Service in backend refers to the major three types of cloud based services like SaaS, PaaS and IaaS. Also manages which type of service the user accesses.

- **Cloud Runtime –**

Runtime cloud in backend refers to provide of execution and runtime platform/environment to the virtual machine

Cloud Computing Architecture

- **Storage –**

Storage in backend refers to provide flexible and scalable storage service and management of stored data.

- **Infrastructure –**

Cloud Infrastructure in backend refers to hardware and software components of cloud like it includes servers, storage, network devices, virtualization software etc.

- **Management –**

Management in backend refers to management of backend components like application, service, runtime cloud, storage, infrastructure, and other security mechanisms etc.

Cloud Computing Architecture

- **Security** –

Security in backend refers to implementation of different security mechanisms in the backend for secure cloud resources, systems, files, and infrastructure to end-users.

- **Internet** –

Internet connection acts as the medium or a bridge between frontend and backend and establishes the interaction and communication between frontend and backend.

Benefits of Cloud Computing Architecture

1. Makes overall cloud computing system simpler.
2. Improves data processing requirements.
3. Helps in providing high security.
4. Makes it more modularized.
5. Results better disaster recovery.
6. Gives good user accessibility.
7. Reduces IT operating costs.

Components of Cloud Computing Architecture

Some of the important components of Cloud Computing architecture that we will be looking into are as follows:

1. Hypervisor
2. Management Software
3. Deployment Software
4. Network
5. Cloud Server
6. Cloud Storage



Components of Cloud Computing Architecture

1. Hypervisor :

- It is a virtual machine monitor which provides Virtual Operating Platforms to every user
- It also manages guest operating systems in the cloud
- It runs a separate virtual machine on the back end which consists of software and hardware
- Its main objective is to divide and allocate resources

2. Management Software :

Its responsibility is to manage and monitor cloud operations with various strategies to increase the performance of the cloud.

Some of the operations performed by the management software are:

1. compliance auditing
2. management of overseeing disaster
3. contingency plans

Components of Cloud Computing Architecture

3. Deployment Software :

- It consists of all the mandatory installations and configurations required to run a cloud service
- Every deployment of cloud services are performed using a deployment software
- The three different models which can be deployed are the following:

SaaS - Software as a service hosts and manages applications of the end-user.

Example: Gmail

PaaS - Platform as a service helps developers to build, create, and manage applications.

Example: Microsoft Azure

IaaS - Infrastructure as a service provides services on a pay-as-you-go pricing model.

Components of Cloud Computing Architecture

4. Network :

- It connects the front-end and back-end. Also, allows every user to access cloud resources
- It helps users to connect and customize the route and protocol
- It is a virtual server which is hosted on the cloud computing platform
- It is highly flexible, secure, and cost-effective.

5. Cloud Storage :

Here, every bit of data is stored and accessed by a user from anywhere over the internet

It is scalable at run-time and is automatically accessed

Data can be modified and retrieved from cloud storage over the web

Virtualization and Cloud Computing

The main enabling technology for Cloud Computing is Virtualization. Virtualization is the partitioning of a single physical server into multiple logical servers. Once the physical server is divided, each logical server behaves like a physical server and can run an operating system and applications independently. Many popular companies like VMware and Microsoft provide virtualization services. Instead of using your PC for storage and computation, you can use their virtual servers. They are fast, cost-effective, and less time-consuming.

For software developers and testers, virtualization comes in very handy. It allows developers to write code that runs in many different environments for testing

Virtualization and Cloud Computing

Virtualization is mainly used for three main purposes: 1) Network Virtualization, 2) Server Virtualization, and 3) Storage Virtualization

Network Virtualization: It is a method of combining the available resources in a network by splitting up the available bandwidth into channels. Each channel is independent of others and can be assigned to a specific server or device in real time.

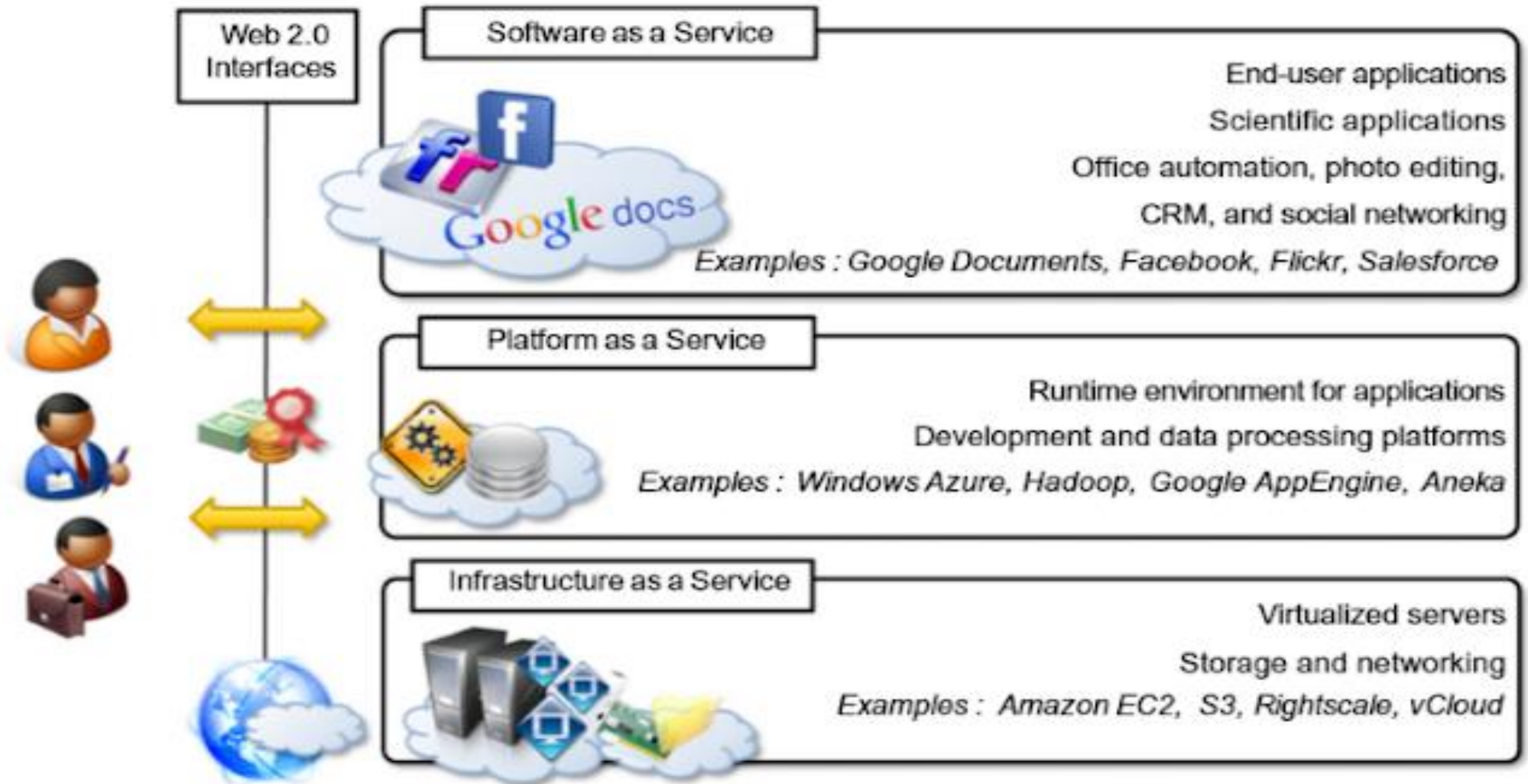
Storage Virtualization: It is the pooling of physical storage from multiple network storage devices into what appears to be a single storage device that is managed from a central console. Storage virtualization is commonly used in storage area networks (SANs)

Virtualization and Cloud Computing

Server Virtualization: Server virtualization is the masking of server resources like processors, RAM, operating system, etc., from server users. Server virtualization intends to increase resource sharing and reduce the burden and complexity of computation from users.

Developing Holistic Cloud Computing Reference Model

The reference model for cloud computing is an abstract model that characterizes and standardizes a cloud computing environment by partitioning it into abstraction layers and cross-layer functions.



Developing Holistic Cloud Computing Reference Model

If we look in to the reference model as seen in above image we will find classification of Cloud Computing services:

1. Infrastructure-as-a-Service (IaaS),
2. Platform-as-a-Service (PaaS), and
3. Software-as-a-Service (SaaS).
4. Web 2.0

1. Infrastructure as a service (IaaS) :

Infrastructure as a service (IaaS) is a cloud computing offering in which a vendor provides users access to computing resources such as servers, storage and networking. To read more about IaaS [click here](#).

Developing Holistic Cloud Computing Referene Model

2. Platform as a service (PaaS) :

Platform as a service (PaaS) is a cloud computing offering that provides users with a cloud environment in which they can develop, manage and deliver applications. To read more about PaaS [click here](#).

3. Software as a service (SaaS) :

Software as a service (SaaS) is a cloud computing offering that provides users with access to a vendor's cloud-based software. Users do not install applications on their local devices. Instead, the applications reside on a remote cloud network accessed through the web or an API. Through the application, users can store and analyze data and collaborate on projects.

Developing Holistic Cloud Computing Reference Model

4. Web 2.0 :

Web 2.0 is the term used to describe a variety of web sites and applications that allow anyone to create and share online information or material they have created. A key element of the technology is that it allows people to create, share, collaborate & communicate.

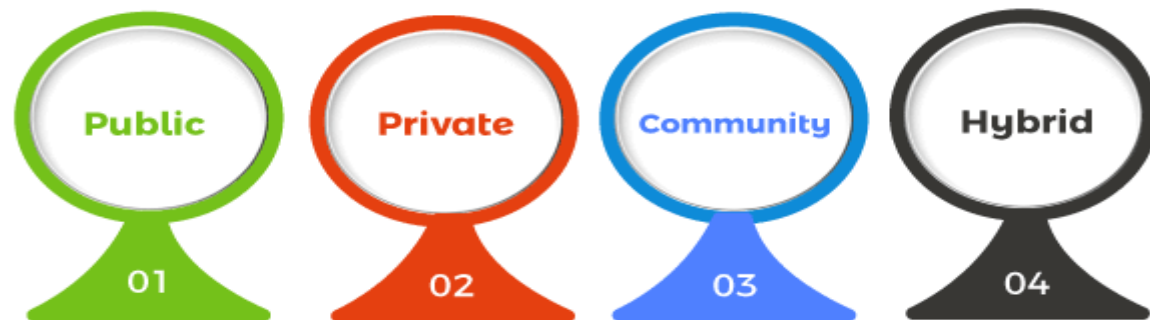
Cloud Deployment Model

It works as your virtual computing environment with a choice of deployment model depending on how much data you want to store and who has access to the Infrastructure.

Different Types of Cloud Computing Model :

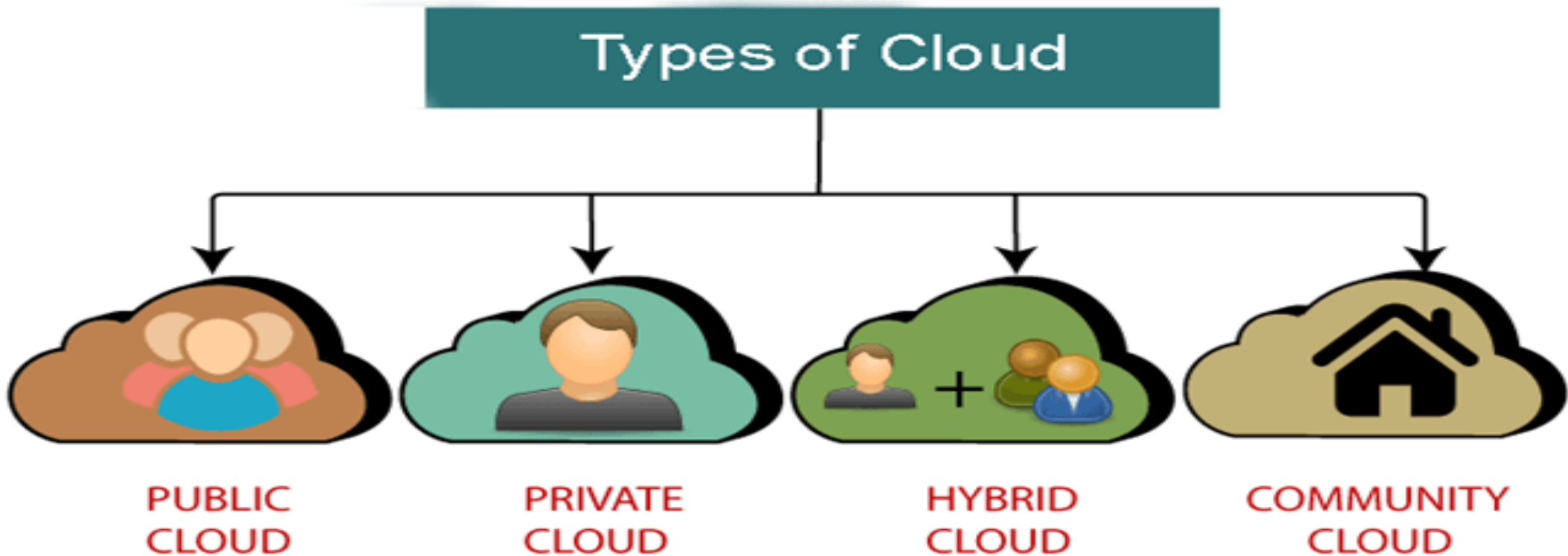
Most cloud hubs have tens of thousands of servers and storage devices to enable fast loading. It is often possible to choose a geographic area to put the data "closer" to users. Thus, deployment models for cloud computing are categorized based on their location. To know which model would best fit the requirements of your organization, let us first learn about the various types.

Types of Cloud Computing Deployment Models



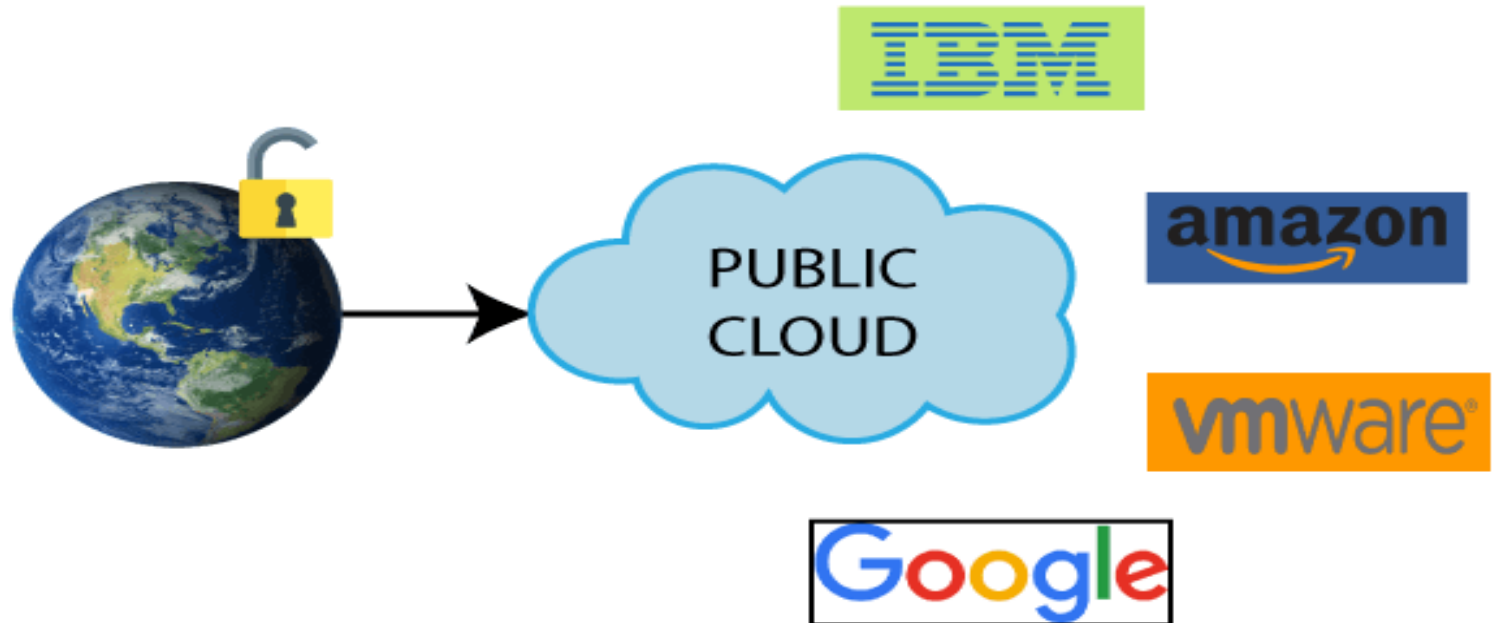
Types of Cloud

1. **Public Cloud**
2. **Private Cloud**
3. **Hybrid Cloud**
4. **Community Cloud**



Public Cloud

1. Public cloud is open to all to store and access information via the Internet using the pay-per-usage method.
2. In public cloud, computing resources are managed and operated by the Cloud Service Provider (CSP).
3. Example: Amazon elastic compute cloud (EC2), IBM SmartCloud Enterprise, Microsoft, Google App Engine, Windows Azure Services Platform.



Public Cloud

Advantages of Public Cloud

1. Public cloud is owned at a lower cost than the private and hybrid cloud.
2. Public cloud is maintained by the cloud service provider, so do not need to worry about the maintenance.
3. Public cloud is easier to integrate. Hence it offers a better flexibility approach to consumers.
4. Public cloud is location independent because its services are delivered through the internet.
5. Public cloud is highly scalable as per the requirement of computing resources.
6. It is accessible by the general public, so there is no limit to the number of users.

Public Cloud

Disadvantages of Public Cloud

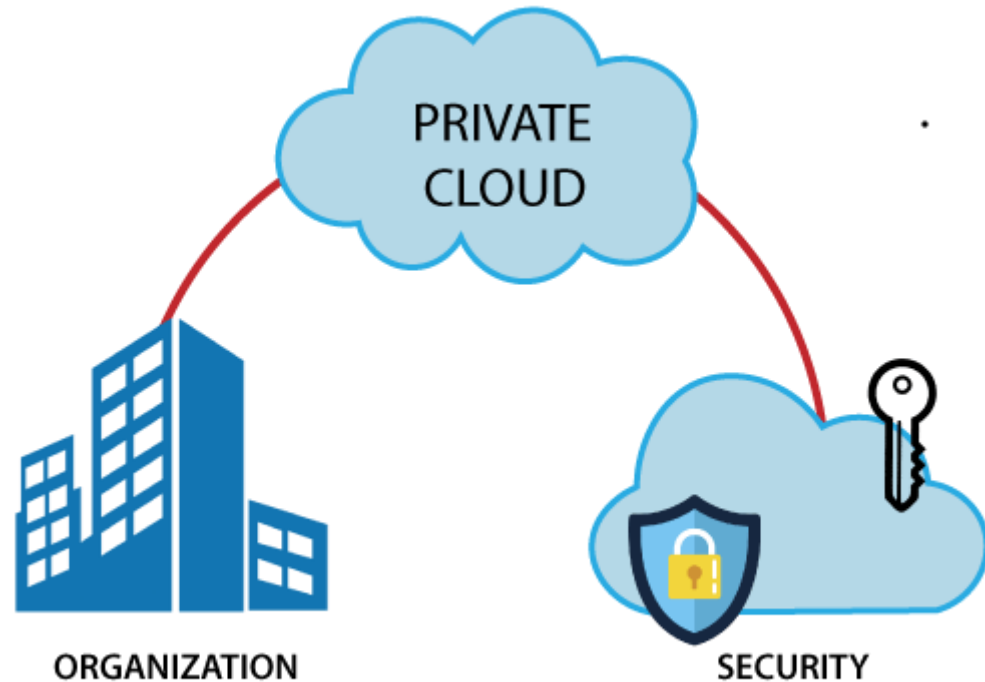
1. Public Cloud is less secure because resources are shared publicly.
2. Performance depends upon the high-speed internet network link to the cloud provider.
3. The Client has no control of data.

Private Cloud

Private cloud is also known as an internal cloud or corporate cloud. It is used by organizations to build and manage their own data centers internally or by the third party. It can be deployed using Opensource tools such as Openstack and Eucalyptus.

Based on the location and management, National Institute of Standards and Technology (NIST) divide private cloud into the following two parts-

1. On-premise private cloud
2. Outsourced private cloud



Private Cloud

Advantages of Private Cloud

1. Private cloud provides a high level of security and privacy to the users.
2. Private cloud offers better performance with improved speed and space capacity.
3. It allows the IT team to quickly allocate and deliver on-demand IT resources.
4. The organization has full control over the cloud because it is managed by the organization itself. So, there is no need for the organization to depend on anybody.
5. It is suitable for organizations that require a separate cloud for their personal use and data security is the first priority.

Private Cloud

Disadvantages of Private Cloud

1. Skilled people are required to manage and operate cloud services.
2. Private cloud is accessible within the organization, so the area of operations is limited.
3. Private cloud is not suitable for organizations that have a high user base, and organizations that do not have the prebuilt infrastructure, sufficient manpower to maintain and manage the cloud

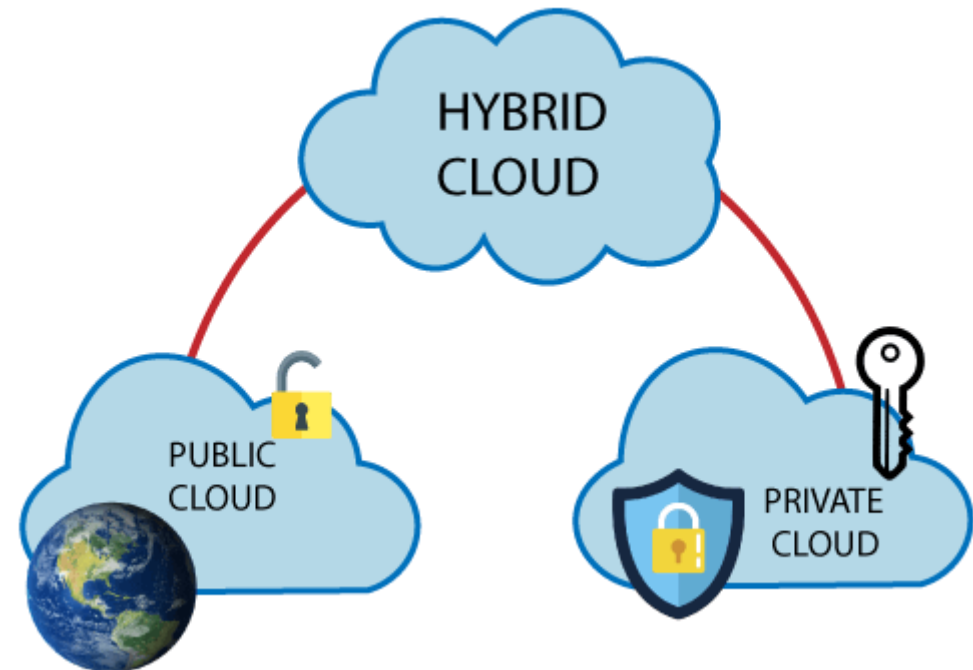
Hybrid Cloud

Hybrid Cloud is a combination of the public cloud and the private cloud. we can say:

Hybrid Cloud = Public Cloud + Private Cloud

Hybrid cloud is partially secure because the services which are running on the public cloud can be accessed by anyone, while the services which are running on a private cloud can be accessed only by the organization's users.

Example: Google Application Suite (Gmail, Google Apps, and Google Drive), Office 365 (MS Office on the Web and One Drive), Amazon Web Services



Hybrid Cloud

Advantages of Hybrid Cloud

There are the following advantages of Hybrid Cloud -

1. Hybrid cloud is suitable for organizations that require more security than the public cloud.
2. Hybrid cloud helps you to deliver new products and services more quickly.
3. Hybrid cloud provides an excellent way to reduce the risk.
4. Hybrid cloud offers flexible resources because of the public cloud and secure resources because of the private cloud.

Hybrid Cloud

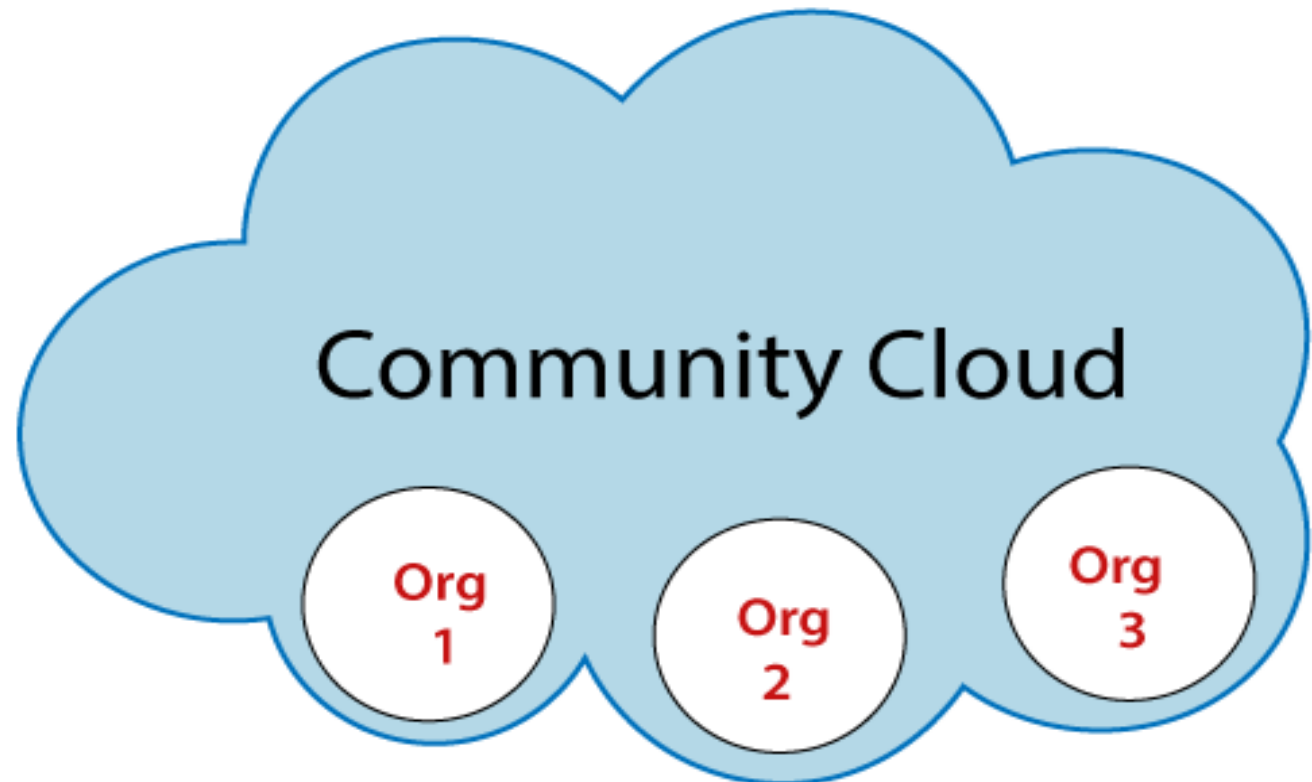
Disadvantages of Hybrid Cloud

1. In Hybrid Cloud, security feature is not as good as the private cloud.
2. Managing a hybrid cloud is complex because it is difficult to manage more than one type of deployment model.
3. In the hybrid cloud, the reliability of the services depends on cloud service providers.

Community Cloud

Community cloud allows systems and services to be accessible by a group of several organizations to share the information between the organization and a specific community. It is owned, managed, and operated by one or more organizations in the community, a third party, or a combination of them.

Example : Healthcare Community Cloud



Community Cloud

Advantages of Community Cloud

There are the following advantages of Community Cloud -

1. Community cloud is cost-effective because the whole cloud is being shared by several organizations or communities.
2. Community cloud is suitable for organizations that want to have a collaborative cloud with more security features than the public cloud.
3. It provides better security than the public cloud.
4. It provides collaborative and distributive environment.
5. Community cloud allows us to share cloud resources, infrastructure, and other capabilities among various organizations.

Community Cloud

Disadvantages of Community Cloud

1. Community cloud is not a good choice for every organization.
2. Security features are not as good as the private cloud.
3. It is not suitable if there is no collaboration.
4. The fixed amount of data storage and bandwidth is shared among all community members.

Difference between Public, Private, Hybrid and Community Cloud

Parameter	Public Cloud	Private Cloud	Hybrid Cloud	Community Cloud
Host	Service provider	Enterprise (Third party)	Enterprise (Third party)	Community (Third party)
Users	General public	Selected users	Selected users	Community members
Access	Internet	Internet, VPN	Internet, VPN	Internet, VPN
Owner	Service provider	Enterprise	Enterprise	Community

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THANK YOU!!!

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