UNIT 2 CLOUD SERVICE MODELS :

Software as a Service (SaaS) - Infrastructure as a Service (IaaS)- Platform as a Service (PaaS)-Service Oriented Architecture (SoA) - Elastic Computing - On Demand Computing.

Software-as–a-Service (SaaS)

- SaaS is defined as the software distribution model that is deployed on the internet in which a cloud service provider provides applications.
- It is also known as "on-demand software" or "pay-as-you-go application". Here the customer licenses their product via SaaS-providers
- . SaaS market is a rapid-growing one, and with this fast-growing service, SaaS will soon become an active cloud service technology for every organization and companies.
- So it's important to understand those users and or buyers the usage of SaaS and why it is suitable.

Software-as–a-Service (SaaS) model allows to provide software application as a service to the end users. It refers to a software that is deployed on a host service and is accessible via Internet. There are several SaaS applications listed below:

- Billing and invoicing system

- Customer Relationship Management (CRM) applications

- Help desk applications

- Human Resource (HR) solutions

Some of the SaaS applications are not customizable such as **Microsoft Office Suite.** But SaaS provides us **Application Programming Interface (API),**which allows the developer to develop a customized application.

Characteristics
Here are the characteristics of SaaS service model:

- SaaS makes the software available over the Internet.

- The software applications are maintained by the vendor.

- The license to the software may be subscription based or usage based. And it is billed on recurring basis.

- SaaS applications are cost-effective since they do not require any maintenance at end user side.

- They are available on demand.

- They can be scaled up or down on demand.

- They are automatically upgraded and updated.

- SaaS offers shared data model. Therefore, multiple users can share single instance of infrastructure. It is not required to hard code the functionality for individual users.

- All users run the same version of the software.

Benefits

Using SaaS has proved to be beneficial in terms of scalability, efficiency and performance. Some of the benefits are listed below:

- Modest software tools

- Efficient use of software licenses

- Centralized management and data

- Platform responsibilities managed by provider

- Multitenant solutions

Modest software tools

The SaaS application deployment requires a little or no client side software installation, which results in the following benefits:

- No requirement for complex software packages at client side

- Little or no risk of configuration at client side

- Low distribution cost

Efficient use of software licenses

The customer can have single license for multiple computers running at different locations which reduces the licensing cost. Also, there is no requirement for license servers because the software runs in the provider's infrastructure.

Centralized management and data

The cloud provider stores data centrally. However, the cloud providers may store data in a decentralized manner for the sake of redundancy and reliability.

Platform responsibilities managed by providers

All platform responsibilities such as backups, system maintenance, security, hardware refresh, power management, etc. are performed by the cloud provider. The customer does not need to bother about them.

Multitenant solutions

Multitenant solutions allow multiple users to share single instance of different resources in virtual isolation. Customers can customize their application without affecting the core functionality.

Issues

There are several issues associated with SaaS, some of them are listed below:

- Browser based risks
- Network dependence
- Lack of portability between SaaS clouds

Browser based risks

If the customer visits malicious website and browser becomes infected, the subsequent access to SaaS application might compromise the customer's data.

To avoid such risks, the customer can use multiple browsers and dedicate a specific browser to access SaaS applications or can use virtual desktop while accessing the SaaS applications.

Network dependence

The SaaS application can be delivered only when network is continuously available. Also network should be reliable but the network reliability cannot be guaranteed either by cloud provider or by the customer.

Lack of portability between SaaS clouds

Transferring workloads from one SaaS cloud to another is not so easy because work flow, business logics, user interfaces, support scripts can be provider specific.
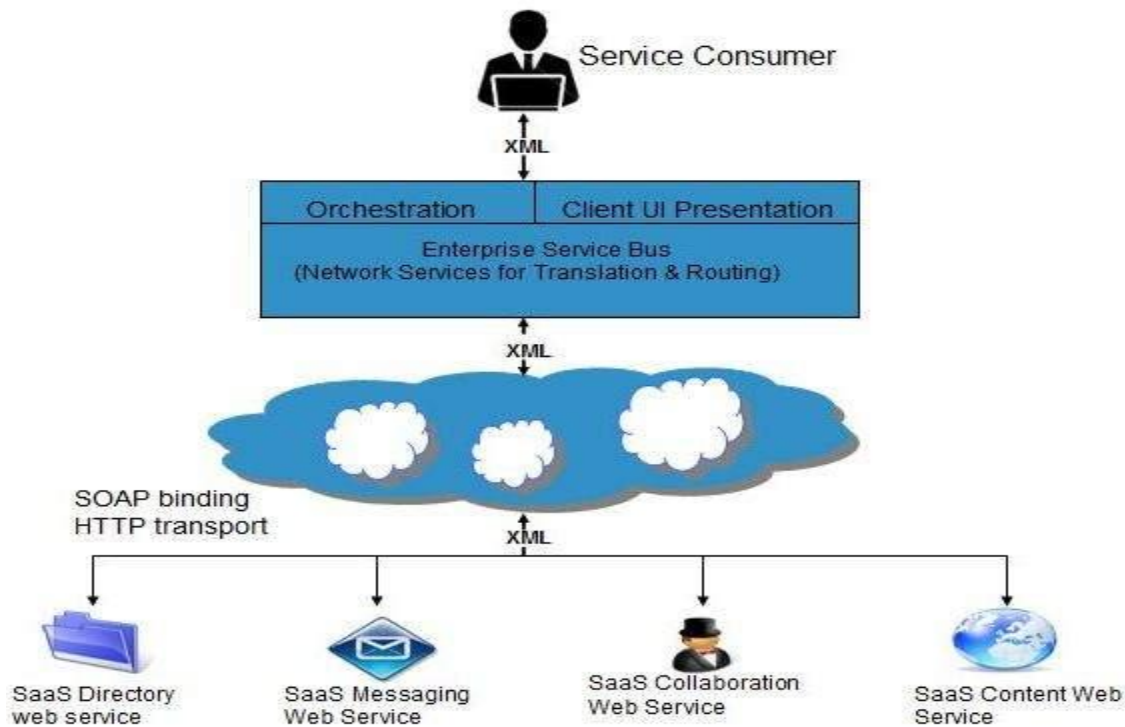
The SaaS provides various applications such as:

- CRM applications
- Solution to Human Resource (HR)
- Pre-existing Billing & Invoicing systems
- Other daily usable application suites

Infrastructure-as-a-Service

IaaS, as the name suggests, is a way of providing Cloud computing infrastructure such as virtual machines, storage drives, servers, operating systems & networks, which is also an on-demand service like that of SaaS. Rather than purchasing servers or developing software, clients buy those resources as a fully outsourced service based on their requirement. "Public cloud" is considered as an infrastructure that consists of shared resources, based on a self-service over the Internet. In one word, it is the only layer of the cloud where the customer gets the platform for their organization to outsource IT infrastructure on a pay-per-use basis.

Infrastructure-as-a-Service provides access to fundamental resources such as physical machines, virtual machines, virtual storage, etc. Apart from these resources, the IaaS also offers:

- Virtual machine disk storage
- Virtual local area network (VLANs)

- Load balancers

- IP addresses

- Software bundles

All of the above resources are made available to end user via **server virtualization.** Moreover, these resources are accessed by the customers as if they own them.
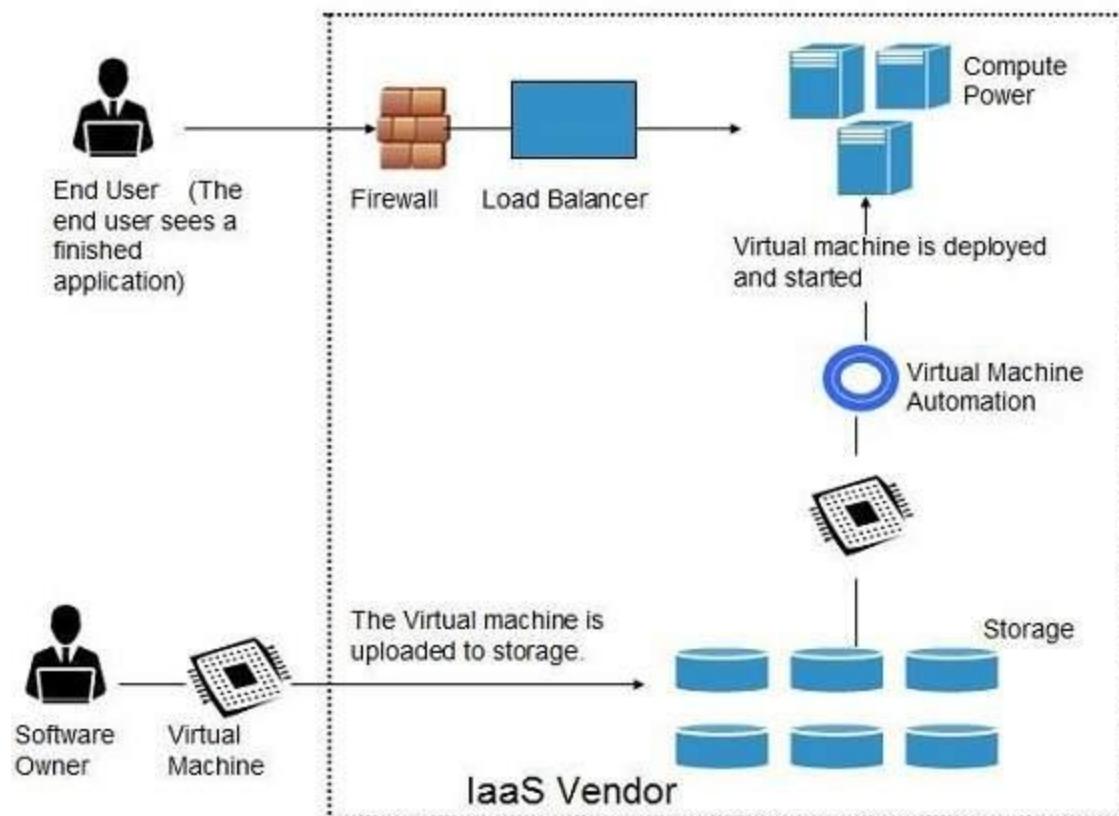
Issues

IaaS shares issues with PaaS and SaaS, such as Network dependence and browser based risks. It also has some specific issues, which are mentioned in the following diagram:
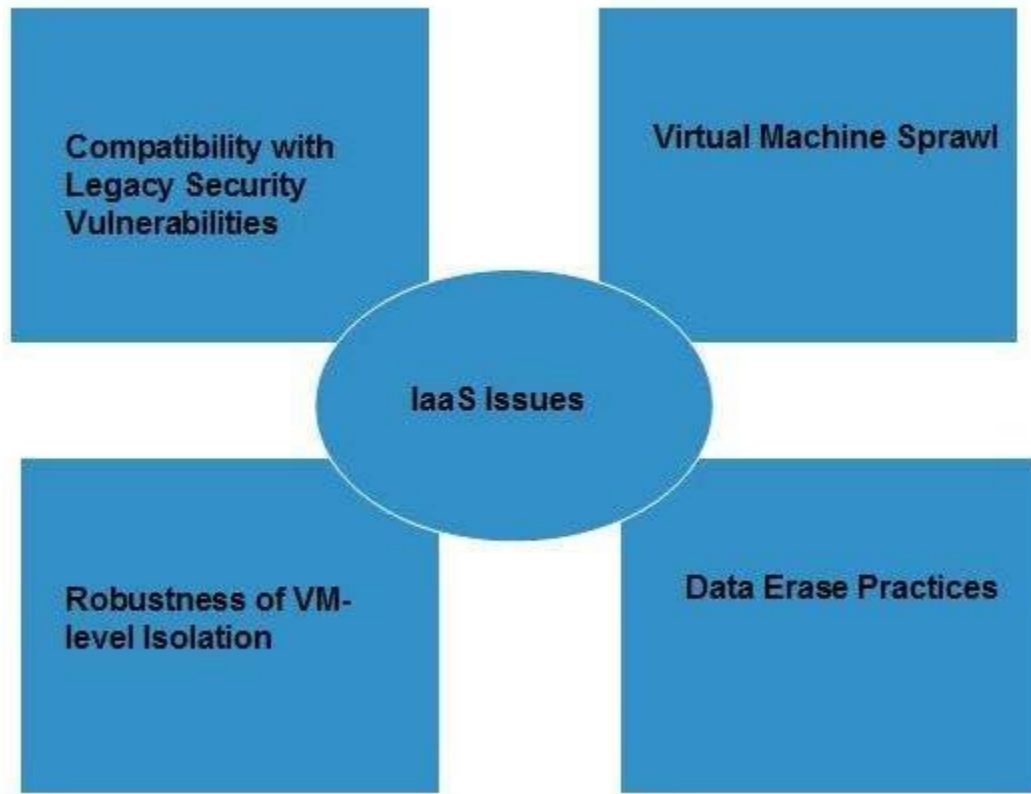
Compatibility with legacy security vulnerabilities

Because IaaS offers the customer to run legacy software in provider's infrastructure, it exposes customers to all of the security vulnerabilities of such legacy software.

Virtual Machine sprawl

The VM can become out-of-date with respect to security updates because IaaS allows the customer to operate the virtual machines in running, suspended and off state. However, the provider can automatically update such VMs, but this mechanism is hard and complex.

Robustness of VM-level isolation

IaaS offers an isolated environment to individual customers through hypervisor. Hypervisor is a software layer that includes hardware support for virtualization to split a physical computer into multiple virtual machines.

Data erase practices

The customer uses virtual machines that in turn use the common disk resources provided by the cloud provider. When the customer releases the resource, the cloud provider must ensure that next customer to rent the resource does not observe data residue from previous customer.

Characteristics

Here are the characteristics of IaaS service model:

- Virtual machines with pre-installed software.

- Virtual machines with pre-installed operating systems such as Windows, Linux, and Solaris.

- On-demand availability of resources.

- Allows to store copies of particular data at different locations.

- The computing resources can be easily scaled up and down.

Advantages of IaaS are:

- Dynamic: Users can dynamically opt & configure devices such as CPU, storage drive, etc.
- Easy Access: Users can easily access the vast cloud computing power.
- Renting: Flexible and efficient while renting IT infrastructures.
- Full control of computer resources along with portability.

Disadvantages of IaaS are as follows:

- Internet connection is a must.
- IaaS depends on virtualization services.
- This service restricts the user-privacy & customization.

PaaS is a platform for programming developers and brings the benefits - SaaS is used for but from the software development point. It is the computer platform that provides the facility to use web applications quickly and with ease, without buying & maintaining web-development PaaS has a similarity with that of SaaS except that SaaS deliver software over the web, whereas PaaS provides a platform for the creating of software, delivered over the web. PaaS has a feature of point-and-click tool that allows non-programmers to develop web applications. App-Engine of Google & Force.com, Windows Azure, AppFog, Openshift and VMware Cloud Foundry are examples of PaaS.

Platform-as-a-Service offers the runtime environment for applications. It also offers development and deployment tools required to develop applications. PaaS has a feature of **point-and-click** tools that enables non-developers to create web applications.

The following diagram shows how PaaS offers an API and development tools to the developers and how it helps the end user to access business applications.
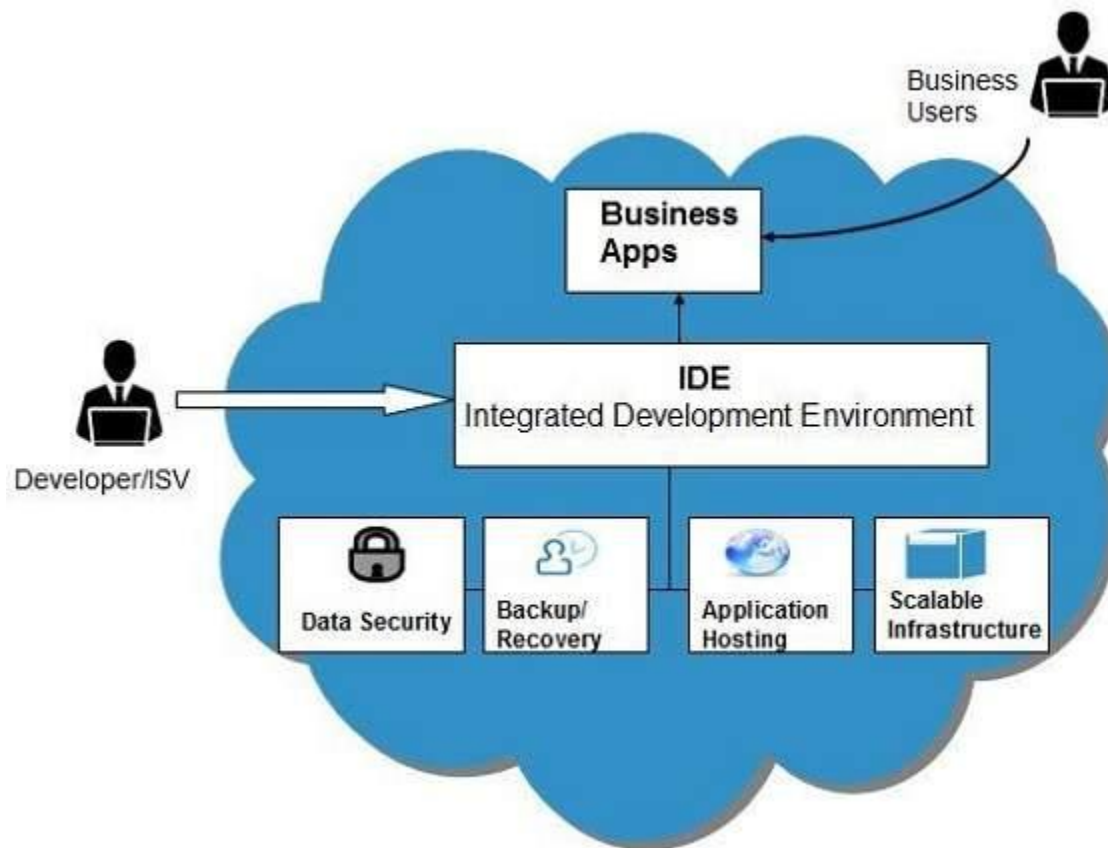
Issues

Like **SaaS, PaaS** also places significant burdens on customer's browsers to maintain reliable and secure connections to the provider's systems. Therefore, PaaS shares many of the issues of SaaS. However, there are some specific issues associated with PaaS as shown in the following diagram:
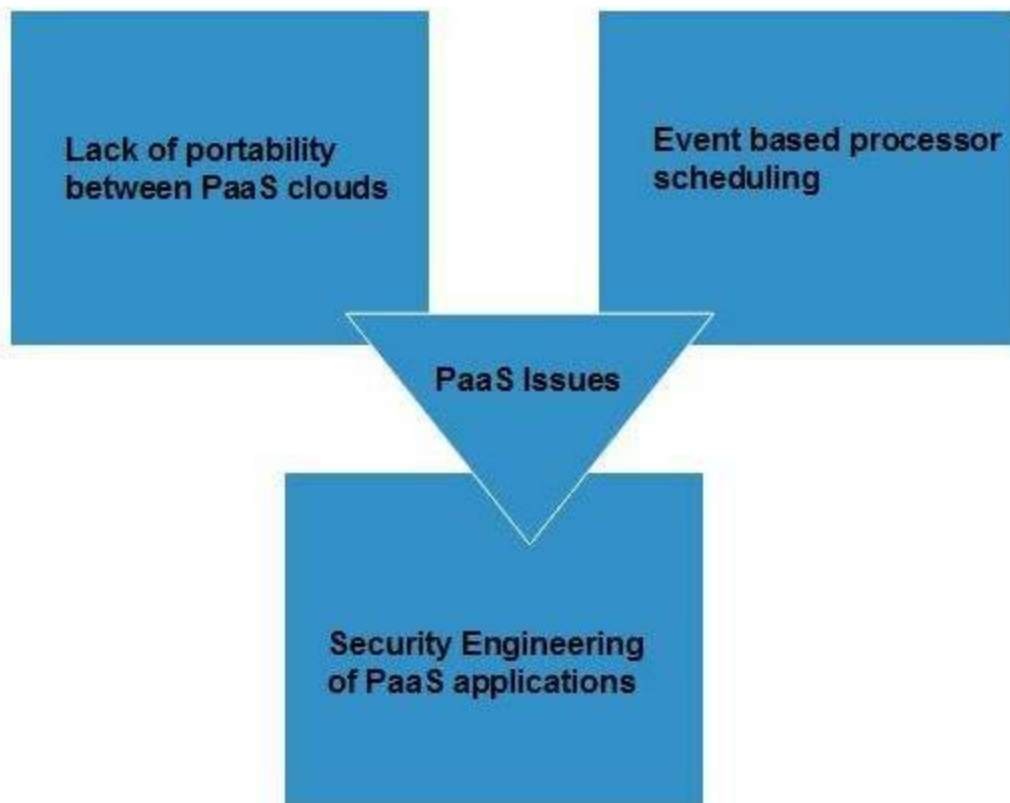
Lack of portability between PaaS clouds

Although standard languages are used, yet the implementations of platform services may vary. For example, file, queue, or hash table interfaces of one platform may differ from another, making it difficult to transfer the workloads from one platform to another.

Event based processor scheduling

The PaaS applications are event-oriented which poses resource constraints on applications, i.e., they have to answer a request in a given interval of time.

Security engineering of PaaS applications

Since PaaS applications are dependent on network, they must explicitly use cryptography and manage security exposures.

Characteristics

Here are the characteristics of PaaS service model:

- PaaS offers **browser based development environment.** It allows the developer to create database and edit the application code either via Application Programming Interface or point-and-click tools.

- PaaS provides **built-in security, scalability,** and **web service interfaces.**

- PaaS provides built-in tools for defining **workflow, approval processes,** and business rules.

- It is easy to integrate PaaS with other applications on the same platform.

- PaaS also provides web services interfaces that allow us to connect the applications outside the platform.

PaaS Types

Based on the functions, PaaS can be classified into four types as shown in the following diagram:
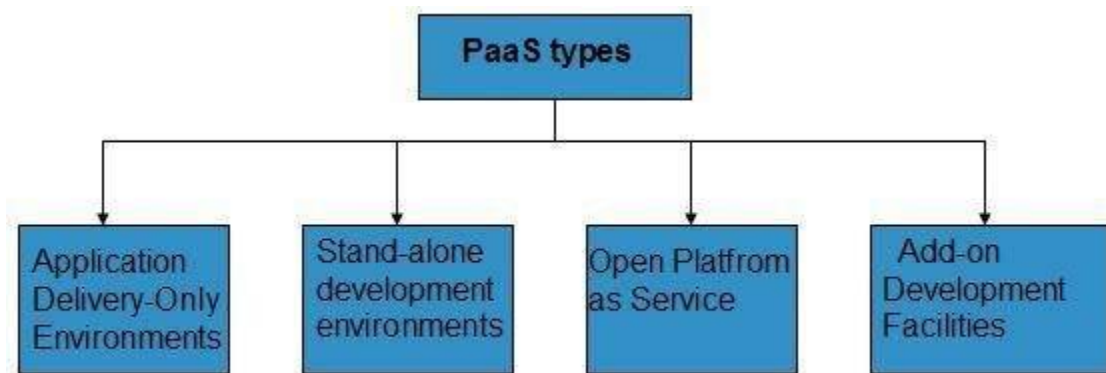
Stand-alone development environments

The **stand-alone PaaS** works as an independent entity for a specific function. It does not include licensing or technical dependencies on specific SaaS applications.

Application delivery-only environments

The **application delivery PaaS** includes **on-demand scaling** and **application security.**

Open platform as a service

Open PaaS offers an **open source software** that helps a PaaS provider to run applications.

Add-on development facilities

The **add-on PaaS** allows to customize the existing SaaS platform.

<u>Advantages of PaaS:</u>

- Scalability: of users ranges from hundreds to thousands.
- Prebuilt Business Plan: PaaS vendors provide pre-defined business functionality for users to directly start the project.
- Low Cost: Development via PaaS requires a computer & a good internet connection and hence less investment in hardware & software.
- Instant Community: PaaS providers facilitates user providing online communities where a developer can get new ideas & share their experience & advice.
- Simple & easy to use

<u>Disadvantages of PaaS are as follows:</u>

- Vendor Migration: Migration from one PaaS vendors' application to another PaaS vendor will create some problem.
- Data-Privacy: Privacy of data can get hamper if it is not held within the boundary of the company or organization.
- Mix-up Complexity: Some of the applications developed may be local while others are from the cloud; which may increase the complexity.

Cloud Computing depict a broad movement towards internet and the use of WAN and enable smooth interaction between IT service providers of many types and consumers. Cloud technology brings with it a large number of key benefits and risks. These includes:

- Outsourcing to cloud-providers
- Dependence on network
- Dependence on Cloud Providers
- Information Assurance

SOA (Service Oriented Architecture) is built on computer engineering approaches that offer an architectural advancement towards enterprise system. It describes a standard method for requesting services from distributed components and after that the results or outcome is managed. The primary focus of this service oriented approach is on the characteristics of service interface and predictable service behavior. Web Services means a set or combination of industry standards collectively labeled as one. SOA provides a translation and management layer within the cloud architecture that removes the barrier for cloud clients obtaining desired services. Multiple networking and messaging protocols can be

written using SOA's client and components and can be used to communicate with each other. SOA provides access to reusable Web services over a TCP/IP network, which makes this an important topic to cloud computing going forward.

Benefits of SOA:

With high-tech engineering and enterprise point of view, various offers are provided by SOA which proved to be beneficial. These are:

- Language Neutral Integration: Regardless of the developing language used, the system offers and invoke services through a common mechanism. Programming language neutralization is one of the key benefits of SOA's integration approach.
- Component Reuse: Once an organization built an application component, and offered it as a service, the rest of the organization can utilize that service.
- Organizational Agility: SOA defines building blocks of capabilities provided by software and it offers some service(s) that meet some organizational requirement; which can be recombined and integrated rapidly.
- Leveraging Existing System: This is one of the major use of SOA which is to classify elements or functions of existing applications and make them available to the organizations or enterprise.
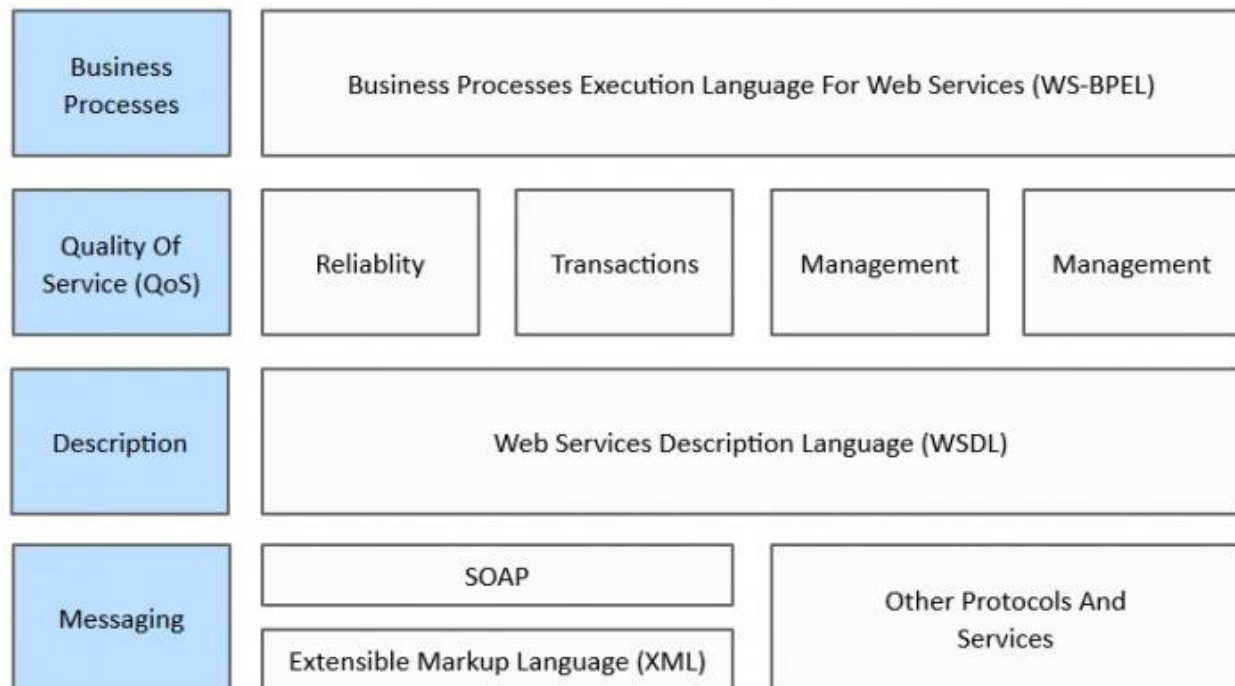
SOA architecture:

SOA architecture is viewed as five horizontal layers. These are described below:

- Consumer Interface Layer: These are GUI based apps for end users accessing the applications.
- Business Process Layer: These are business-use cases in terms of application.
- Services Layer: These are whole-enterprise, in service inventory.
- Service Component Layer: are used to build the services, such as functional and technical libraries.
- Operational Systems Layer: It contains the data model.

SOA GOVERNANCE:

It is a notable point to differentiate between It governance and SOA governance. IT governance focuses on managing business services whereas SOA governance focuses on managing Business services. Furthermore in service oriented organization, everything should be characterized as a service in an organization. The cost that governance put forward becomes clear when we consider the amount of risk that it eliminates with the good understanding of service, organizational data and processes in order to choose approaches and processes for policies for monitoring and generate performance impact.

Here lies the protocol stack of SOA showing each protocol along with their relationship among each protocol. These components are often programmed to comply with SCA (Service Component Architecture), a language that has broader but not universal industry support. These components are written in BPEL (Business Process Execution Languages), Java, C#, XML etc and can apply to C++ or FORTRAN or other modern multi-purpose languages such as Python, PP or Ruby. With this, SOA has extended the life of many all-time famous applications.

SECURITY IN SOA:

With the vast use of cloud technology and its on-demand applications, there is a need for well - defined security policies and access control. With the betterment of these issues, the success of SOA architecture will increase. Actions can be taken to ensure security and lessen the risks when dealing with SOE (Service Oriented Environment). We can make policies that will influence the patterns of development and the way services are used. Moreover, the system must be set-up in order to exploit the advantages of public cloud with resilience. Users must include safety practices and carefully evaluate the clauses in these respects.

Here's the diagrammatic figure showing the different elements of SOA and its subparts:

Figure - Elements Of SOA:
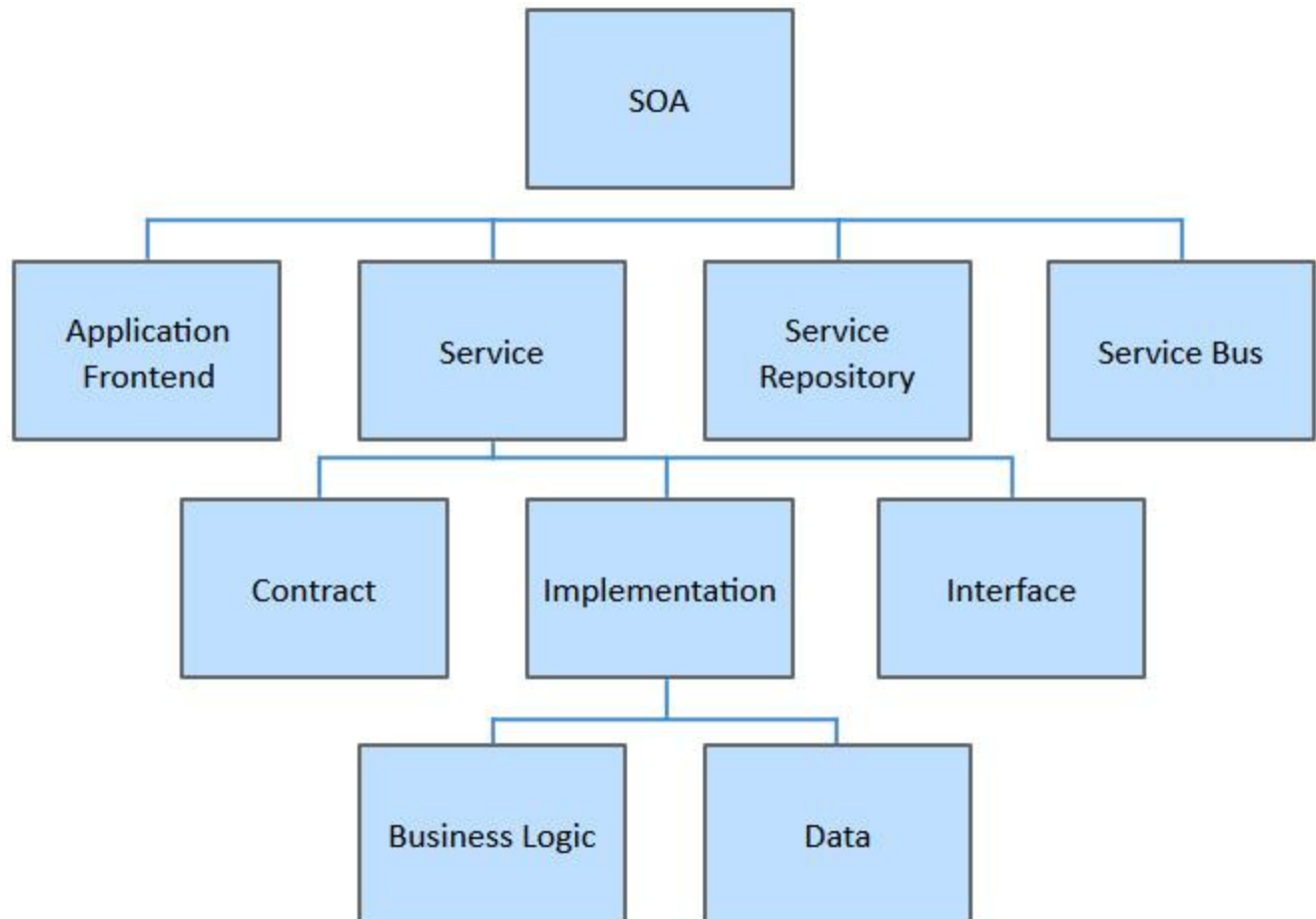
Though SOA enjoyed lots achieving the success in the past, the introduction to cloud technology with SOA, renewed the value of SOA.

ELASTIC COMPUTING:

Elastic computing is the ability to quickly expand or decrease computer processing, memory and storage resources to meet changing demands without worrying about capacity planning and engineering for peak usage. Typically controlled by system monitoring tools, elastic computing matches the amount of resources allocated to the amount of resources actually needed without disrupting operations. With cloud elasticity, a company avoids paying for unused capacity or idle resources and does

not have to worry about investing in the purchase or maintenance of additional resources and equipment.

While security and limited control are concerns to take into account when considering elastic cloud computing, it has many benefits. Elastic computing is more efficient than your typical IT infrastructure, is typically automated so it does not have to rely on human administrators around the clock and offers continuous availability of services by avoiding unnecessary slowdowns or service interruptions.

What is Elastic Cloud Computing and how it Benefits Business

Nowadays cloud computing are well known phenomenon for everyone. Most of the small and large business have switched their data to cloud storage. Moreover, organization also prefer to have elastic computing.

But before proceeding to know more about elastic computing let's have a quick outline of cloud computing. Cloud Computing or Cloud is defined as using various services such as software development platforms, servers, storage, over the Internet.

So, what does Elastic Cloud Computing mean?

Elastic computing is nothing but a concept in cloud computing in which computing resources can be scaled up and down easily by the cloud service provider. Cloud service provider gives you provision to flexible computing power when and wherever required. The elasticity of these resources depends upon the following factors such as processing power, storage, bandwidth, etc.

Types of Elastic Cloud Computing

Rather than various types, elastic computing have only one type i.e. Elasticity, or fully-automated scalability which removes manual labor for increasing or decreasing resources as everything is controlled by triggers by the system monitoring tools.

Is there any difference between Scalability and Elasticity?

Then answer is yes. **Scalability** refers to the ability of system to accommodate larger loads just by adding resources either making hardware stronger (scale up) or adding additional nodes (scale out).

Elasticity refers the ability to fit the resources needed to cope with loads, so that when load increase you scale up by adding more resources and when demand diminishes you shrink back and remove unneeded resources. Elasticity is mostly important in Cloud environment where you pay-per-used resources only.

Benefits/Pros of Elastic Cloud Computing

Elastic Cloud Computing has numerous advantages. Some of them are as follow:-

1. **Cost Efficiency:** - Cloud is available at much cheaper rates than traditional approaches and can significantly lower the overall IT expenses. By using cloud solution companies can save licensing fees as well as eliminate overhead charges such as the cost of data storage, software updates, management etc.

2. **Convenience and continuous availability:** - Cloud makes easier access of shared documents and files with view and modify choice. Public clouds also offer services that are available wherever the end user might be located. Moreover it guaranteed continuous availability of resources and In case of system failure; alternative instances are automatically spawned on other machines.

3. **Backup and Recovery:** - The process of backing up and recovering data is easy as information is residing on cloud simplified and not on a physical device. The various cloud providers offer reliable and flexible backup/recovery solutions.

4. **Cloud is environmentally friendly:** -The cloud is more efficient than the typical IT infrastructure and it takes fewer resources to compute, thus saving energy.

5. **Scalability and Performance:** - Scalability is a built-in feature for cloud deployments. Cloud instances are deployed automatically only when needed and as a result enhance performance with excellent speed of computations.

6. **Increased Storage Capacity:** -The cloud can accommodate and store much more data compared to a personal computer and in a way offers almost unlimited storage capacity.

Disadvantages/Cons of Elastic Cloud Computing:-

1. **Security and Privacy in the Cloud:** - Security is the biggest concern in cloud computing. Companies essentially hide their private data and information over cloud as remote based cloud infrastructure is used, it is then up to the cloud service provider to manage, protect and retain data confidential.
2. **Limited Control:** - Since the applications and services are running remotely companies, users and third party virtual environments have limited control over the function and execution of the hardware and software.
3. **Dependency and vendor lock-in:** - One of the major drawbacks of cloud computing is the implicit dependency on the provider. It is also called "vendor lock-in". As it becomes difficult to migrate vast data from old provider to new. So, it is advisable to select vendor very carefully.
4. **Increased Vulnerability:** - Cloud based solutions are exposed on the public internet therefore are more vulnerable target for malicious users and hackers. As we know nothing is completely secure over Internet even the biggest organizations also suffer from serious attacks and security breaches.

Regardless the disadvantages elastic cloud computing even remains stronger and has great potential for the future. Elastic computing offering better, more fine-tuned and easy to use services and solutions. We can only hope that the advantages will grow more and the disadvantages will be diminished as cloud is the future.

On-Demand Computing:

On-demand computing is a business computing model in which computing resources are made available to the user on an "as needed" basis. Rather than all at once, on-demand computing allows cloud hosting companies to provide their clients with access to computing resources as they become necessary.

On-demand computing is a delivery model in which computing resources are made available to the user as needed. The resources may be maintained within the user's enterprise, or made available by a cloud service provider. When the services are provided by a third-party, the term cloud computing is often used as a synonym for on-demand computing.

The on-demand model was developed to overcome the common challenge to an enterprise of being able to meet fluctuating demands efficiently. Because an enterprise's demand on computing resources can vary drastically from one time to another, maintaining sufficient resources to meet peak requirements can be costly. Conversely, if an enterprise tried to cut costs by only maintaining minimal computing resources, it is likely there will not be sufficient resources to meet peak requirements.

The on-demand model provides an enterprise with the ability to scale computing resources up or down with the click of a button, an API call or a business rule. The model is characterized by three attributes: scalability, pay-per-use and self-service. Whether the resource is an application program that helps team members collaborate or additional storage for archiving images, the computing resources are elastic, metered and easy to obtain.

Many on-demand computing services in the cloud are so user-friendly that non-technical end users can easily acquire computing resources without any help from the organization's information technology (IT) department. This has advantages because it can improve business agility, but it also has disadvantages because shadow IT can pose security risks. For this reason, many IT departments carry out periodic cloud audits to identify greynet on-demand applications and other rogue IT.

Advantages of On-Demand Computing:

The on-demand computing model was developed to overcome the common challenge that enterprises encountered of not being able to meet unpredictable, fluctuating computing demands in an efficient manner.

Businesses today need to be agile and need the ability to scale resources easily and quickly based on rapidly changing market needs.

 Because an enterprise's demand for computing resources can vary dramatically from one period of time to another, maintaining sufficient resources to meet peak requirements can be costly.

However, with on-demand computing, companies can cut costs by maintaining minimal computing resources until they run into the need to increase them, meanwhile only paying for what they use.

Industry experts predict on-demand computing to soon be the most widely used computing model for enterprises.

In fact, IBM's vice-president of technology and strategy stated, "The technology is at a point where we can start to move into an era of on-demand computing. I give it between two and four years to reach a level of maturity."