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About The Book

Companies may store as well as manage data on a cloud, allowing for increased scalability in delivery of the applications as well as software as a service. Cloud computing also provides data transport but also storage via the internet or via a direct connection that ensures continuous data flow between the devices, apps, as well as the cloud.

In the Internet of Things (IoT), we know that the sensors, machines, various gadgets create a tremendous quantity of data each second. Cloud computing aids in the storing and analysis of this data in order to maximise the benefits of an IoT infrastructure for the organization. Cloud computing plays an important role in fostering this kind of cooperation so that the IoT solution has a high degree of visibility. And the things become more easy for you to understand the basics and significance of Cloud computing& IoT and also how it greatly influence the task of our daily life from individual to corporate level.

The book is composed of the total five chapters which introduces you the basics of cloud computing and Internet of things with their significant applications. The very first chapters give through introduction to cloud computing and Internet of things. Second chapter highlights the cloud services and the cloud service providers .The concept of collaborating with cloud services is included in the chapter three and Fourth chapter provides the details about the virtualization of clouds and the very last chapter contains the security standards and the application of cloud computing & IoT.

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FIRST EDITION

Cloud Computing & Internet of things For Beginners

Dr. Sourabh Bhattacharya
Dr. Arvind Kumar Shukla
Dr. Dilip R
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by

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2022

Cloud Computing & Internet of things : For Beginners

Dr. Sourabh Bhattacharya, Dr. Arvind Kumar Shukla, Dr. Dilip R and Dr. Veeresh Rampur

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Robotics Signal Conditioning & Automation, and Internet of Things.

Preface

Cloud is an enormous, linked network of powerful computers that provides services for companies and individuals. The cloud Interconnected computers, mechanical as well as digital machinery, animals, objects, and people are all part of Internet of Things (IoT), the system that allows data to be exchanged between the devices without any human intervention or human-to-computer contact. As the amount of data generated by IoT devices has increased, the technology has changed.

As a result, IoT Cloud Service generates extreme communication between low-cost sensors in the IoT that results in even more connectivity. Humans will soon be joined by billions of other linked gadgets and machines. This data is generated via the Internet of Things (IoT) while the cloud computing facilitates its movement. In this book, we focus on cloud service providers who offer a pay-as-you-go model in which customers only pay for resources they consume. IoT startups can also benefit from cloud hosting as a service because it provides economies of scale that reduce overall costs.

From a tech perspective, the cloud computing revolution has the potential to affect a wide range of industries all

around world. When anything in your home or business is ready to go down for the count, you may thank the cloud for alerting you ahead of time. By using a cloud-based application, the major medical equipment corporations are able to provide real-time information to the field system engineers who are responsible for maintaining health equipment. The cloud also makes it simpler to repair things when they break. The cloud will not only provide you with just-in-time training but will also aid you in making better decisions.

Table of Content

Introduction

Helping to transmit and send data as well as files to data centres through the Internet, cloud is a centralized system. A centralized cloud system makes it simple to access a wide range of data and software.

In this context, the term "Internet of Things" describes the set of interconnected gadgets. Real-time and historical data are both kept in the Internet of Things. Analysis and instructions for devices may be provided by the IoT, which can also monitor the results of particular activities.

1.1. Introduction

Cloud Computing is a helpful tool for Internet of Things. Cloud computing allows people to utilise services supplied through the Internet to conduct computer activities. The combination of Internet of Things with the cloud computing has become the catalyst: the two technologies are now intertwined. These are cutting-edge innovations that will have a significant impact in the years to come.

Data storage, processing, and retrieval has become a major issue because of the fast expansion in technological

innovation. The combination of Internet of Things with cloud computing is a major advance. Sensory data streams can be processed in sophisticated ways, as well as the new monitoring services may be implemented. You may utilise the cloud to store sensor data for later use as the intelligent monitoring as well as activation by the other devices, for instance. The objective is to turn data into actionable information that is both cost-efficient as well as productive.

IoT Because of the several ways to connect to the cloud, a huge network is implied. Users may access cloud computing services through a variety of devices, including smartphones, tablets, and computers. As a result, the necessity for the network access points must be addressed.

On-demand IoT cloud computing is available to developers. In other words, it is the web service that may be accessed without the need for specific authorization or support. Only an Internet connection is needed.

The service may be scaled up or down depending on user's requirement. Expanding storage, changing program settings, and working with many users are all possible thanks to a system that is fast and adaptable. This feature makes it feasible to deliver high levels of computation and storage depth.

The term "Cloud Computing" refers to the concept of sharing resources. It encourages a greater sense of community and fosters tight ties between users.

Security problems arise as number of the IoT devices as well as automation in use rises. Companies may rely on the cloud solutions to deliver strong authentication as well as encryption.

Finally, the benefit of IoT cloud computing is that you get precisely what you paid for. As a result, your rates will fluctuate based on how often you use the service, which is determined by the supplier. To connect to Internet and transmit data across network components, a developing network of the objects with "IP addresses" is required.

The Internet of Things and cloud computing work together to make ordinary chores more efficient. Whereas the Internet of Things creates enormous amounts of data, cloud computing focuses on making sure the data gets to where it needs to go.

1.2. Cloud-definition

Definition: "*The cloud refers to servers that are accessed over the Internet, and the software and databases that run on those servers.*"

All throughout the globe, data centers house cloud servers. As long as a company or individual is utilizing cloud computing, they are free from the burden of maintaining and operating their own physical servers.

Computing as well as the storage take place at data center rather than on user's device, so they may access same files

and programmes from nearly any device. When the Instagram user's old mobile breaks, they can just log in with new phone as well as their old account will be there, complete with their previous photographs as well as videos and chat history. Gmail, "Microsoft Office 365", and other popular cloud-based email as well as storage services operate in the same manner.
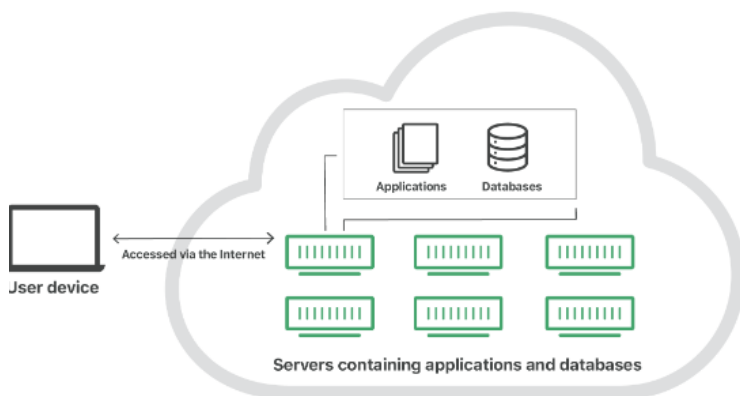
*Figure 1.1 The Cloud**

Businesses may save money on IT expenses by adopting the cloud, such as not having to upgrade as well as maintain their own servers, which the cloud provider would take care of for them. That's the big deal for small enterprises, who might not be able to purchase their internal infrastructure and could now outsource those requirements to the cloud. Companies may function more effectively

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* https://www.cloudflare.com/en-in/learning/cloud/what-is-the-cloud/

throughout the world since their workers and customers have access to same files and apps from any place.

1.3. Benefits

Because cloud computing is a hot new technology, we should all be aware of this. Almost every business has moved its services to cloud in an effort to boost business growth.

Here, we'll go through some of the most significant benefits of the cloud computing-
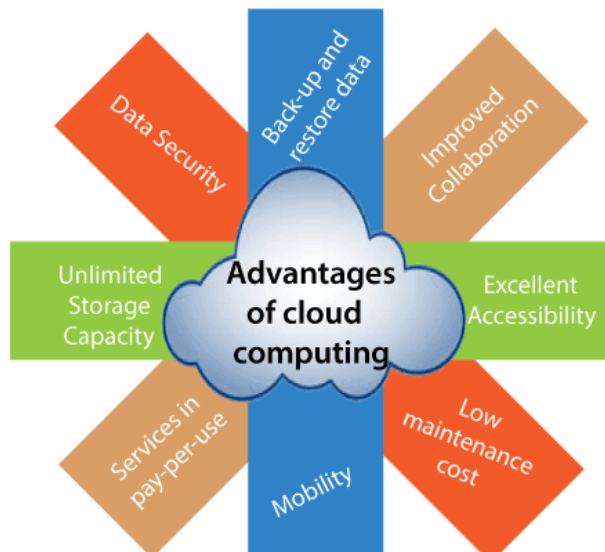
Figure 1.2 Advantages of cloud computing[*]

[*]https://www.cloudflare.com/en-in/learning/cloud/what-is-the-cloud/

1) Back-up and restore data

Having the data saved in a cloud means that it is easy to recover and back up that data.

2) Improved collaboration

The use of cloud apps facilitates teamwork by enabling users to rapidly as well as easily access and also share data on cloud.

3) Excellent accessibility

Using the internet connection, we may quickly and conveniently retrieve stored information from almost any location through the cloud. Our data is constantly available thanks to the internet cloud architecture, which boosts productivity as well as efficiency in the workplace.

4) Low maintenance cost

Cloud computing cuts the expenses of both hardware as well as software upkeep for businesses.

5) Mobility

With cloud computing, we can effortlessly access all of our cloud data from anywhere, at any time, on any device.

6) IServices in the pay-per-use model

Users may use cloud services using Application Programming Interfaces (APIs) provided by cloud computing, with costs based on usage.

7) Unlimited storage capacity

Our most critical material, such as papers, photographs, music, and video, may all be stored in one place on the cloud.

8) Data security

One of the most significant benefits of the cloud computing is the protection of user data. Cloud computing has several sophisticated security mechanisms that help to keep data safe while it is being stored and processed.

1.4.　Usage scenarios

By reducing costs, boosting flexibility, elasticity, as well as optimizing resource use, cloud computing has indeed been widely credited with enhancing competitiveness. Here are some examples of how cloud computing may help businesses reach their objectives.

1. Infrastructure-as-a-Service (IaaS) and Platform-as-a-Service (PaaS)

Using the internet as well as a pay-as-you-go billing model, "infrastructure-as-a-service "provides computing, networking, and storage capabilities to users on demand. Companies looking to save money on IT infrastructure acquisition, management, and maintenance can consider using the existing infrastructure on pay-per-use basis.

When it comes to creating, operating, as well as managing applications for clients, PaaS eliminates the need to construct and manage your own platform on-premises by providing a comprehensive platform which includes all of the necessary components—hardware, software, as well as infrastructure. PaaS might very well be used for the same purposes as IaaS, but it can also be used to speed up application development on the ready-to-use platform.

2. Hybrid cloud and multicloud

Using a combination of "on-premises private cloud services" as well as the "third-party public cloud services", a corporation may create a scalable computing environment for executing its own applications as well as workloads. Organizations have the freedom to pick the best cloud for every application or task and move workloads between the public & private clouds as conditions change. Compared to public or private cloud alone, the technical and commercial goals are met more successfully and cost-effectively.

Multicloud enables you to access two or more cloud services from the different providers at the same time. Infrastructure, Platform, or Software as a Service may all be included. As a result of multicloud, you may choose the most appropriate cloud depending on your specific needs and prevent vendor lock-in.

3. Test and development

A test as well as development environment is an excellent use case for cloud. Setting up the environment requires major resources and effort, as well as obtaining a budget. After that, you'll need to set up and customise your platform. All of this adds time to the project and makes it harder to meet goals.

Cloud computing has made it possible for you to have an environment adapted to your specific demands at any time. Virtualized and real resources may be provisioned through automated means.

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Cloud computing has made it possible for you to have an environment adapted to your specific demands at any time. Virtualized and real resources may be provisioned through automated means.

4. Big data analytics

One of the advantages of using cloud computing is indeed the ability to employ the big data analytics to access huge amounts of both structured as well as unstructured data and also extract commercial value from it.

Retailers as well as suppliers are increasingly using data gleaned from customers' purchasing habits to focus their advertising as well as marketing efforts to a certain demographic. For the first time, corporations are adopting social networking platforms as foundation for behavioural analytics.

5. Cloud storage

You may access, save, and retrieve your files from any web-enabled interface using cloud storage. Web services often have straightforward user interfaces. You can rely on the environment to be highly available, fast, scalable, and secure at all times. When it comes to the cloud storage, companies only have to pay for an amount of space that they use, and they don't have to worry about the day-to-day upkeep of their storage infrastructure.

Based on legal requirements, data might be stored on- or off-premises as well. A third party hosts virtualized storage pools that are customized to meet the needs of the user.

6. Disaster recovery

An additional advantage of adopting a cloud service is that it may offer a "disaster recovery" solution which is more cost-effective than a typical "disaster recovery" site that has fixed assets, strict processes and a significantly greater cost.

7. Data backup

In the past, backing up data was the time-consuming and

difficult task. This meant maintaining the set of tapes or discs, manually collecting them, and sending them to the backup facility with all attendant difficulties that can arise in the process. However, this method does not guarantee that all of your data will be saved in the event of the problem or that you will be able to recover it in the event of the malfunction or human mistake.

There is little doubt that cloud-based backup, although not panacea, has improved significantly over the last several years. You may now send data to any point over a wire with knowledge that security, availability, and capacity are not a concern at all.

As said, there are many additional reasons to choose cloud computing over more conventional methods for increasing IT infrastructure flexibility and taking use of the big data analytics as well as mobile computing.

1.5.   History of Cloud Computing

Server-side client-side architecture was utilised in the early days of the computing before computers were invented. To obtain access to certain data, a user must first connect to a server and then be granted permissions. However, there are several drawbacks to this method. As a result, with the rise of the client-server computing, the Distributed Computing emerged, allowing users to pool their computing resources as required. Also, there are certain drawbacks to it. As a result, cloud computing has evolved

as a solution to the restrictions inherent in dispersed systems.

CLIENT SERVER COMPUTING

↓

DISTRIBUTED COMPUTING

↓
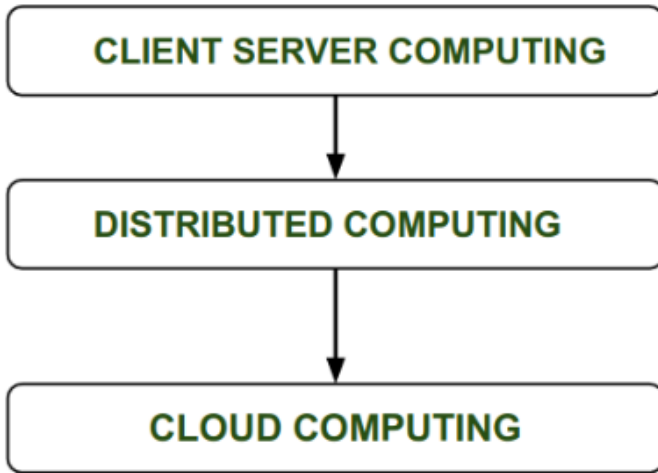
CLOUD COMPUTING

Figure 1.3 Evolution of Cloud Computing[*]

Computers may be marketed like water as well as electricity, according to John MacCharty's address at MIT in 1961. It was a wonderful concept, as per John MacCharty. People, on the other hand, were reluctant to accept this new technology at the time. For them, they believed that the technology they were using was enough for their needs. So, this idea of the computing was not widely accepted, and very little study would be done on it. However, as time passed, technology seized on the concept and realised it within a short period of time. Thus, Salesforce.com adopted this in 1999.

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[*]https://www.geeksforgeeks.org/history-of-cloud-computing/

Cloud computing was born as a result of this company's decision to start distributing a business application via the internet.

As of 2002, Amazon launched Amazon Web Services (AWS), a cloud computing service that provides storage and processing through the internet. The commercial service called "Elastic Compute Cloud" would be launched by Amazon in the year 2006, and it will be available to everyone.

For the first time since the growth of the cloud computing began in the year 2009, Google Play also started offering the "Cloud Computing Enterprise Application". As a result, Microsoft Azure was launched in 2009, and other firms such as Alibaba, Oracle, IBM, and HP followed suit with their own Cloud Services offerings. Cloud computing has grown in popularity and importance in today's world.
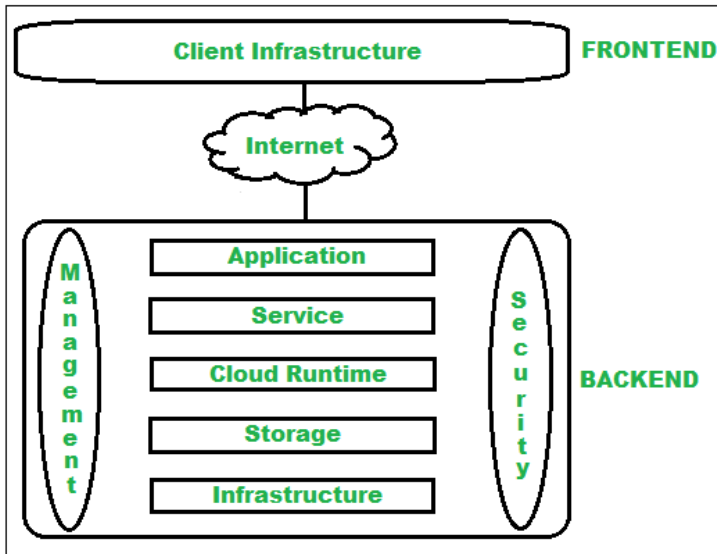
1.6.   Cloud Architecture

Small and big businesses alike are taking use of cloud computing to store their data as well as access it at any time over the internet.

It is a blend of "service-oriented architecture" as well as "event-driven architecture" that make up the cloud computing architecture.

The following are the two major components of the cloud computing architecture: –

1. Frontend
2. Backend

Figure 1.4 Architecture of Cloud Computing[*]

Cloud computing architecture is the blend of "Service Oriented Architecture" and "Enterprise Driven Architecture". The components of the cloud computing architecture include client infrastructure, service, runtime cloud, application, storage, infrastructure, and administration, as well as security.

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*https://www.geeksforgeeks.org/architecture-of-cloud-computing/

1. **Frontend**

The term "frontend" relates to side of "cloud computing system" that is accessible to the user. All user interfaces and apps used by client to access the "cloud computing services" or "resources' are included in cloud management platform. For instance, the cloud platform may be accessed using the web browser.

Client Infrastructure – It's the part of front-end component. It includes the software as well as user interfaces needed to connect to the cloud.

A GUI (Graphical User Interface) is provided for cloud-based interaction.

2. **Backend**

The cloud itself, as utilised by service provider, is referred to as the "backend." It holds, administers, and offers security procedures for the resources. Also included are large amounts of storage, virtual computers, virtual applications, traffic management techniques, and other types of implementation strategies.

- **Application**

Software or platform that a client may access in the backend is called an application. It means that the service is provided at the backend according to the client's specifications.

- **Service**

 PaaS, SaaS, and IaaS are three of the most common cloud-based service models. The user's access to the service is also controlled by the system.

- **Runtime Cloud**

The virtual machine's execution as well as Runtime platform or environment are provided by Runtime cloud.

- **Storage**
  Backend storage offers a wide range of options for storing data, as well as the ability to manage it.
- **Infrastructure**
  In backend, the cloud infrastructure relates to the servers, network devices, storage, virtualization software, and other cloud hardware as well as software components.
- **Management**
  Backend management pertains to the administration of the backend components such as applications, services, runtime clouds, infrastructure, storage, and the other security methods, amongst other things.
- **Security**
  Securing cloud resources, systems, data, as well as infrastructure at backend means putting in place a variety of security measures behind the scenes.

- **Internet**

  In order to create interaction as well as communication in between frontend and backend, the internet connection is required.

Architecture for the cloud computing having some benefits are as follows:

- Simplifies the whole cloud computing infrastructure.
- Enhances the needs for data processing.
- Assists in ensuring maximum safety.
- Increases the degree of modularity.
- Improves the ability to recover from disasters.
- Good accessibility for the end user.
- Streamlines the IT infrastructure.

1.7. Types of Clouds

You may choose from the following four kinds of cloud to meet the demands of your organisation-

1. Public cloud
2. Private cloud
3. Hybrid cloud
4. Community cloud
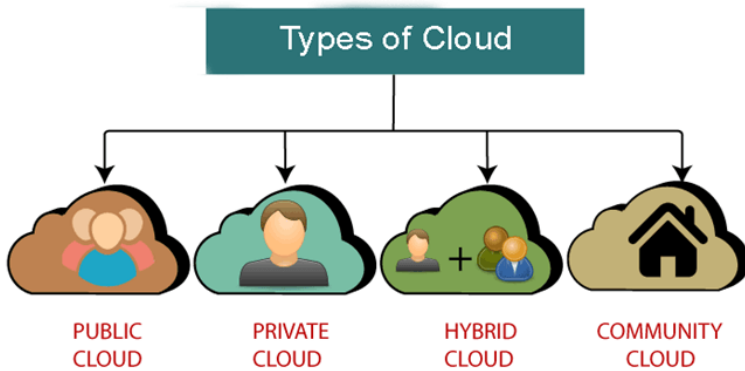
Figure 1.5 Types of Cloud[*]
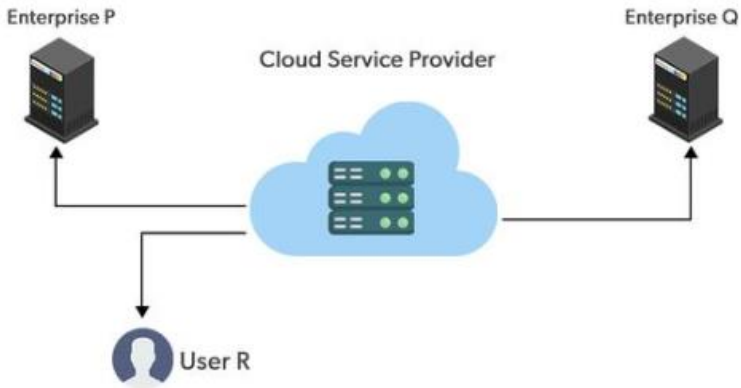
Public Cloud

Public cloud services are provided by the third parties and may be paid for on a pay-as-you-go basis, making them accessible to the general public.

They provide ways to reduce IT infrastructure expenses and are a viable choice for managing peak demands on local infrastructure. For small organizations, public clouds are indeed the best solution since they don't need a huge initial investment and can be used for all of their IT requirements.

Multitenancy is one of the most important features of the public clouds. In the public cloud, there are many users, not just one. A user needs a distinct and also most likely segregated virtual computing environment.
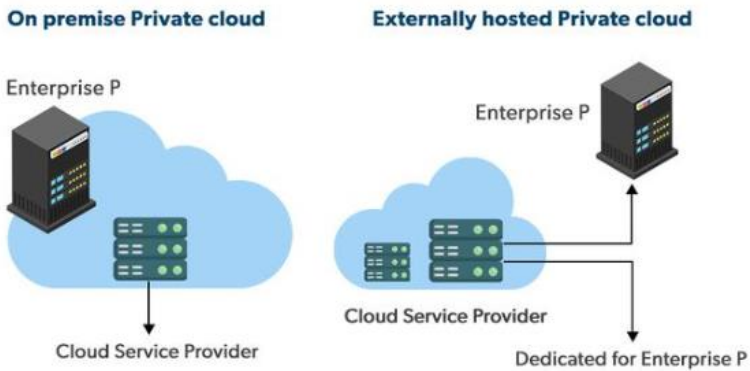
*https://www.javatpoint.com/types-of-cloud

Figure 1.6 **Public cloud**[*]

Private cloud

Figure 1.7Private Cloud[†]

Distributed systems that function on the private infrastructure and allow for the dynamic provisioning of computer resources are known as "private cloud". When using private clouds, there may be alternatives to "a pay-as-you-go model" which manage cloud consumption and charge the various departments or portions of a company accordingly.

Using the private cloud has the following benefits:

Customer information protection: There are less security issues with the private cloud since client data and the other sensitive information does not leave private infrastructure.

Infrastructure ensuring SLAs: Data replication, monitoring, as well as maintenance, as well as disaster recovery and the other uptime services are provided by the private cloud.

Compliance with standard procedures and operations: When implementing as well as executing applications in accordance with the third-party compliance requirements, certain processes must be implemented. In a public cloud, it is not feasible.

Hybrid cloud

The hybrid cloud is the distributed heterogeneous system made up of both public as well as private cloud resources. Because of this, they are referred to as the "heterogeneous clouds".

Private installations have the disadvantage of not being able to grow on-demand and effectively deal with peak demands. Here, the public cloud services are required. Hence, it is possible to use both public as well as private clouds in the hybrid cloud environment.
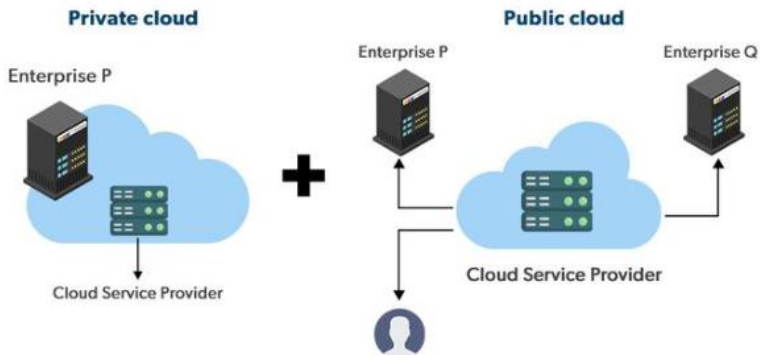
Figure 1.8 Hybrid cloud[*]

The following are some of the benefits of using the hybrid cloud:-

- Organizations that demand a higher level of security than what is provided by public cloud might benefit from a hybrid approach.
- You can launch new goods as well as services more rapidly using hybrid cloud.
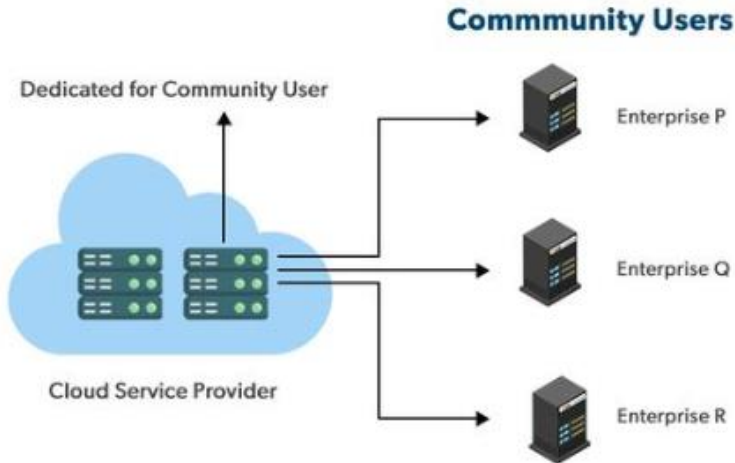- Hybrid cloud is a great method to lessen the danger.

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[*]https://www.geeksforgeeks.org/architecture-of-cloud-computing/

- Flexible as well as secure resources are provided by public as well as private clouds, respectively, in hybrid cloud.

Community cloud

Figure 1.9 **Community Cloud**[*]

In order to meet the special demands of the industry, the community, or the business sector, the community clouds integrate services of many clouds.

Infrastructure is shared among companies with common concerns or duties in community cloud. An organisation or the third party might be in charge of looking after the cloud.

[*]https://www.geeksforgeeks.org/architecture-of-cloud-computing/

Community Cloud has the following benefits:-

- In the community cloud, the entire cloud is shared by the number of organisations or groups.
- If you're an organisation that needs the cloud with additional security features than the "public cloud", the "community cloud" is the best option.
- In terms of security, it is superior than public cloud.
- It creates an atmosphere that encourages sharing and collaboration.
- Using a "community cloud," many firms may pool their cloud resources, infrastructures, as well as other capabilities.

1.8. Major Players in Cloud Computing

Among the many services offered by CSPs are "Software as a Service "(SaaS), "Platform as a Service (PaaS), Infrastructure as a Service" (IaaS), and "Network Services" (NS). In the data centre, cloud service providers keep such services, and customers may access them over the Internet via cloud provider firms.

The following are examples of this Service Providers of Cloud Computing Solutions-

1. **VMware Cloud**

In Hybrid Cloud, VMware cloud serves as a unifying platform for the "Software-Defined Data Centers". With the

use of this technology, the cloud service providers may construct nimble, scalable, and resilient cloud services.

Figure 1.10 VMware cloud[*]

Features of VMware

- Cloud computing services from VMware may be paid for on the per-use or monthly basis.
- A better customer experience is achieved by securing the user's personal information.
- A RESTful API may be used to quickly construct the new VMware SDDC cluster on AWS cloud.
- It has a wide range of storage choices available. Our application storage may be managed on the per-app basis.
- It enables multicast networking and offers a separate the high-performance network for handling application traffic.

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[*]https://www.javatpoint.com/cloud-service-provider-companies

- You don't have to worry about time and money issues anymore.

2. Oracle cloud

The Oracle Corporation makes its cloud platform available. For example, it integrates the cloud architecture of "Platform as a Service" with the infrastructure of "Infrastructure as a Service". Moving apps to cloud, administering a cloud-based development environment, and optimising connection performance are just some of the activities that may be accomplished with this tool.

Figure 1.11 Oracle cloud[*]

Features of Oracle cloud

- There are a variety of tools available on Oracle cloud to help you design and manage your apps.
- Java, PHP, Ruby, and Node.js are some of the languages that make up its infrastructure.
- In addition, it may be used in conjunction with Docker as well as the other DevOps technologies.
- Additionally, Oracle database delivers exceptional interoperability across on-premises and cloud-based platforms to enhance operational efficiencies.

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[*]https://www.javatpoint.com/cloud-service-provider-companies

- IT investments are maximised.

Private networks may be protected via a combination of "Virtual Cloud Networks", "firewall", and "IP addresses", all of which can be customised.

3. Red Hat

Red Hat's virtualization technology, Red Hat virtualization, is the open standard for the desktop virtualization. Linux is widely used for the virtualized servers and technical workstations to offer a variety of the infrastructure solutions. Red Hat is the operating system of choice for the majority of small as well as medium businesses. Higher density, improved performance as well as agility are provided to resources. In addition, it lowers the cost of doing business for the corporation by making administration more straightforward and less time consuming.

***Figure 1.12 Red Hat**[*]

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[*]https://www.javatpoint.com/cloud-service-provider-companies

Features of Red Hat

- With the help of "Red Hat Container" catalogue, customers may access safe, certified, and up-to-date container images.
- It features OpenShift, the platform which enables developers to access, upgrade, as well as deploy programmes in the cloud.
- There are 16 virtual computers, each with 256GB of RAM that it may run at the same time.
- In terms of availability, ease of maintenance, and dependability, it's superior.
- LVMs offers high availability as well as support for the rollback in addition to extremely big SAN-based storage.
- LVMs offer high availability as well as support for the rollback in addition to extremely big SAN-based storage.
- The new on-screen keyboard", "GNOME software "that enables us to install apps and update applications, and also increased device compatibility are all included in Desktop environment.

4. DigitalOcean

DigitalOcean is only company that provides the cloud computing services to businesses. "Moisey Uretsky" and "Ben" started it in 2011. The finest cloud service for managing and deploying web apps is this one.

Figure 1.13 DigitalOcean[*]

Features of Digital Ocean

- Allocate physical resources for virtual servers through KVM hypervisor.
- It is capable of delivering excellent results.
- As the digital community platform, it enables to answer questions and collect comments.
- Developers may swiftly generate new "virtual machines" for their applications by using cloud servers.
- It provides droplet applications with only a single click of the mouse. Apps like Docker, Wordpress, LAMP stack, MongoDB, PhpMyAdmin, as well as Machine Learning are included in this collection.

5. Rackspace

Servers as well as databases, as well as the cloud backup

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[*]https://www.javatpoint.com/cloud-service-provider-companies

and cloud block storage are all available with Rackspace. For Rackspace, the primary goal was to make managing private as well as public cloud installations simple. The company has data centres in the United States, United Kingdom, Hong Kong, as well as Australia.

Figure 1.14 Rackspace[*]

Features of Rackspace

- Rackspace offers a variety of technologies to facilitate better communication and collaboration inside enterprises.
- Using the device, we may access data saved on Rackspace's cloud storage at any time.
- Six data centres are available across the world.
- In same network, it may administer both virtual as well as dedicated physical servers.

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[*]https://www.javatpoint.com/cloud-service-provider-companies

- It is more cost-effective while yet delivering greater results.
- Cloud computing service provider Alibaba Cloud is number ten.

6. Alibaba Cloud

Using Alibaba Cloud, developers create data management as well as cloud computing services that can be scaled up and down at will. Elastic Computing, Security, Networking, "Database Services, Storage", "Media Services", "Cloud Communication", "Application Services", and also the Internet of Things are just some of the services that it provides.

Figure 1.15 Alibaba Cloud[*]

Features of Alibaba Cloud

- A wide range of the cloud computing services are available to both overseas consumers and the e-commerce ecosystem of "Alibaba Group".

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[*]https://www.javatpoint.com/cloud-service-provider-companies

- Pay-per-use is the only way to utilise its services.
- It handles 14 data centres throughout the world.
- Storage of data is scalable as well as dependable.

1.9. Issues in Clouds

Cloud computing has a number of serious drawbacks:

1. Privacy: With or without authorization, the host corporation may access the user's data. Data in cloud might well be accessed at any moment by service provider. They have the ability to add, remove, or edit data, whether intentionally or inadvertently.

2. Compliance: There are several rules and guidelines governing the storage and transmission of data. The customer may be forced to employ costly deployment methods in order to comply with requirements ("Federal Information Security Management Act", "Health Insurance Portability and Accountability Act", etc.).

3. Security: Third-party storage as well as security are essential components of the cloud-based services. It is possible to presume that the cloud-based corporation would safeguard as well as secure one's data if one is utilizing their services at low, free rate. There is a possibility that they would disclose the personal data of their customers to other parties. The cloud's security is seriously jeopardized.

4. Sustainability: The goal here is to prevent cloud

computing from having a negative impact on environment. As a result, nations with climates that promote natural cooling and easily accessible renewable power are competing with one another to attract the cloud computing data centres. Such countries include Sweden, Finland, and Switzerland.

5. Abuse: While providing the cloud services, it really should be discovered that the customer also isn't purchasing the services of the cloud computing for the malevolent reason. Amazon was unlawfully utilized as the command and also the control channel for the banking Trojan in 2009 which sent dangerous instructions to compromised PCs. As a result, hosting businesses as well as servers should include sufficient safeguards to prevent these problems from occurring.

6.Higher Cost: There are two things you need to have in order to utilize cloud services without interruption: a robust network and a huge business that doesn't fit into the typical subscription model for cloud services. If you're working on a complicated project or application, you may have difficulties using a conventional cloud service. This is a huge difficulty confronting small enterprises that inhibits them from diving into the cloud technology for their company.

7. Recovery of lost data in contingency: In order to make sure that their services meet your needs and are supported by the well-maintained resource infrastructure and

adequate maintenance, every cloud service provider should thoroughly review all of its standards and also documentation before accepting a subscription. When you sign up for the service, you're practically handing up control of your personal information to the third party. You won't have to worry about the data recovery in a future if you select the right cloud service now.

8. Upkeeping(management) of Cloud: The upkeep of a cloud architecture is a herculean undertaking, since it entails not only managing a massive infrastructure of resources, but also dealing with a variety of additional issues, such as customer happiness. As consumers normally pay for how much they've utilised the resources. Thus, often it becomes challenging to determine how much should really be paid in case the consumer wishes scalability and expand the services.

9. Lack of resources/skilled expertise: One of the primary difficulties that firms as well as enterprises are going through nowadays is the shortage of the resources and trained people. Every second firm is looking intrigued or has already been switched to the cloud services. As a result, the burden in a cloud is expanding, which necessitates quick innovation for cloud service providers. Organizations are having a difficult time keeping up with latest technology because of these concerns. As new tools as well as technologies are developing every day therefore more skilled or trained personnel need to increase. More training

for IT and development employees is necessary for mitigating these issues completely.

10. Pay-per-use service charges: On-demand services are the hallmark of cloud computing. Users may expand or compress volume of resource according to their need. Thus you paid for amount of resources you used. It is difficult to set a predetermined price for certain amount of services, since there are many variables to consider. The installation of the cloud computing is complicated and complex because of the highs and lows and also price changes that it is subject to. The owner of a business has a difficult time keeping track of demand and how it changes with seasons and other occurrences. So it's difficult to estimate the cost of a service which may eat up months of the budget in a matter of days.
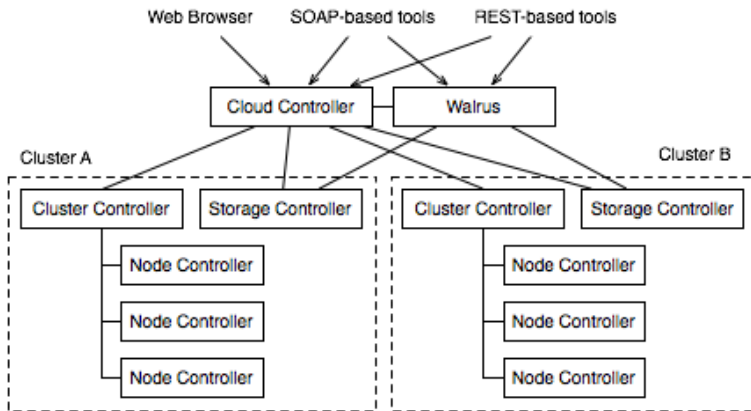
1.10. Eucalyptus

Linux-based Eucalyptus is the open source cloud computing as well as cloud storage technology that is "EC2" and "S3" compatible. It integrates private as well as hybrid clouds with the organization's IT infrastructure, making them more efficient, scalable, and secure. With it, you may create a cloud-hosted infrastructure that can be accessed over the internet. Commodity hardware may be used by users.

Developed to assist the high-performance computing, Eucalyptus was created . It's possible to use Eucalyptus on

any of the main Linux distributions, includes Ubuntu, opens USE, RHEL/CentOS, and Debian, without having to make any changes.

*Figure 1.16 Eucalyptus Fundamental Architecture**

Components of Eucalyptus:

1. Cluster Controller (CC) The "Cluster Controller" is responsible for deploying as well as managing instances on one or even more Node Controllers. It is in constant communication with both the Node Controller and the Cloud Controller. Under some Eucalyptus networking options, CC controls the networking for executing instance as well.

2. Cloud Controller (CLC) All of the other components of the ecosystem may be accessed via the Cloud Controller.

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*https://mdshaonimran.wordpress.com/2011/11/26/eucalyptus-and-its-components/

When it comes to interacting with Eucalyptus infrastructure, CLC does so using an "Amazon EC2/S3" compliant web services interface for client tools.

3. Node Controller (NC) It is the most fundamental part of a Node. Every node's instance life cycle is managed by node controller. The node controller is the software component that communicates with many systems at once: hypervisor, OS, and cluster controller.

4. Walrus Storage Controller (WS3) Controller for Walrus Storage (WS3) it's a basic "file storage system" called "Walrus Storage Controller". Image as well as snapshot storage is handled by WS3. It also uses S3 APIs to store but also serve files.

5. Storage Controller (SC) Snapshots may be taken of volumes using "Storage Controller" (SC). Persistent block storage is provided to instances through "AoE" or "iSCSI".

1.11. Nimbus

When a computer cluster is converted into a cloud-based infrastructure, it may be used by scientists to do computations. Virtual machines may be deployed on distant resources and configured to reflect the required environment by user.

To put it simply, Nimbus consists of two parts:

- **Nimbus Infrastructure** To further serve the scientific community's needs, "Nimbus

infrastructure" provides EC2/S3 compatibility, proxy credentials support, best-effort allocations, batch schedulers, and the other "infrastructure-as-a-service" capabilities.

- **Nimbus Platform** In the multi-cloud context, the "Nimbus Platform" provides scientific users with the flexibility and capability of the infrastructure clouds. Cloud resources may be deployed, scaled, and managed using the Nimbus Platform.

The "Elastic Compute Cloud" (EC2) service of Amazon is used as the basis for the "Nimbus cloud" client's leasing mechanism, which gives the user complete control over the workspaces they create.

Using the "Nimbus cloud computing" architecture, scientists may establish and utilise virtual machines with the cloud provider for data-intensive research.

Multiple virtual machines for specialised computing tasks may be created using Nimbus but also deployed anywhere in cloud as long as they cooperate. It is possible to set up the virtual machine and then link it to the resources on the cloud, no matter who is supplying the cloud.

Many data-intensive research initiatives, such as those in the experimental as well as theoretical physics, need this level of adaptability and instantaneous processing capability. The "STAR nuclear physics experiment" at "Brookhaven National Laboratory's" Relativistic Heavy-Ion Collider has previously been supported by Nimbus.

Nimbus was used to construct virtual machines which were operated on the commercial cloud computing suppliers when the researchers there wanted to transform large volumes of data into feasible simulations for the international conference.

The two primary goals of Nimbus-supported Science Clouds are as follows:

- As a way to make it easier for researchers in science as well as education to try out cloud computing, and
- Cloud computing is a wonderful tool for scientific community to understand how to utilize.

1.12. Open Nebula

In order to operate virtualized data centres, OpenNebula is the feature-rich, simple, and adaptable solution. It allows for public, private, as well as hybrid cloud computing environments. Here are the few facts concerning this answer.

Figure 1.17 OpenNebula

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*https://www.opensourceforu.com/2017/02/an-introduction-to-opennebula/

OpenNebula is indeed an "open source cloud middleware" system that handles heterogeneous distributed data centres. While it has many features, it is intended for ease of use by the administrators as well as end-users, making it an ideal choice for building and managing corporate clouds. OpenNebula is a virtualization platform that incorporates the latest advances in the multi-tenancy, provisioning automation, as well as elasticity. It's possible to map virtual networks to actual ones thanks to an integrated virtual network management. OpenNebula has already been included into distributions like as "Ubuntu" as well as "Red Hat Enterprise Linux".
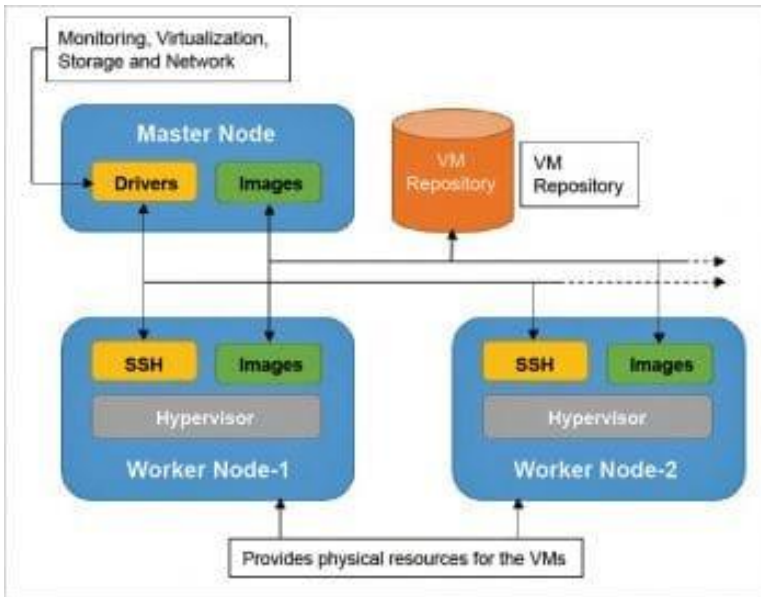
The OpenNebula deployment model

The OpenNebula deployment approach is based on the traditional cluster design. OpenNebula's deployment methodology is shown in Figure1.18.

Master node: The queueing, scheduling, and submission of tasks to cluster are all handled by the single gateway or the front-end computer, sometimes known as master node. OpenNebula services include the following:

- The user may submit virtual machines as well as track their progress using this interface.
- Monitoring and managing the cluster's VMs.
- It serves as the repository for virtual machines and also manages the transfer of the virtual machine images to relevant worker nodes through the transfer service.

- Setup of cloud-based virtual networks is made simple with this tool.
- As a last feature, you may add additional computers to your cluster using the front-end.

Figure 1.18 **OpenNebula deployment model**[*]

Worker node: The other workstations in a cluster, called as 'worker nodes,' offer the raw computational power needed to process the tasks provided. Virtualization hypervisors like Xen, VMware, or KVM run on cluster's worker nodes.

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[*]https://www.opensourceforu.com/2017/02/an-introduction-to-opennebula/

1.13. Cloud Sims

In order to model cloud computing infrastructures and services, CloudSim is the open-source framework. Programming is done completely in Java by the CLOUDS Lab, a non-profit company. In order to test the hypothesis prior to construction of software, it's being used to model and simulate the cloud computing system.

The application or website might be tested and optimised for the performance before the deployment on cloud by creating the simulation of that environment and using the multiple versatile and also scalable classes given by the "CloudSim package", for instance. Such assessments could well be performed using the free of charge "CloudSim package" to test and optimise the product before deployment.

Benefits of Simulation over the Actual Deployment

CloudSim has the following advantages:

- There is no capital expenditure required. There are no upkeep or installation costs when using a simulation programme like CloudSim.
- Scalable as well as easy to utilise. The few lines of the code may drastically alter the system's needs, like the number of the resources required.
- At an early stage, the risks may be assessed. In Cloud Computing, the use of actual testbeds restricts the tests to the size of testbed and

also makes the repetition of findings an exceedingly challenging endeavour. With simulation, you could run your product through a variety of scenarios and fix any faults before it goes into production.

- There's no need to experiment and see what works. With CloudSim, you could test your services in the repeatable as well as controlled environment for free rather than depending on the theoretical and inaccurate assessments that may lead to poor service performance as well as revenue creation.

CloudSim Architecture

- Interfaces for managing resources like virtual machine (VM), memory, as well as bandwidth are provided by the "CloudSim Core Simulation Engine".
- Virtual machines (VMs), hosts, cloudlets, etc. are all managed by CloudSim. It also handles the network-related execution, as well as the provisioning and administration of resources.
- It is the layer that the user controls. This layer may be used by the developer to provide the hardware characteristics for a certain situation.
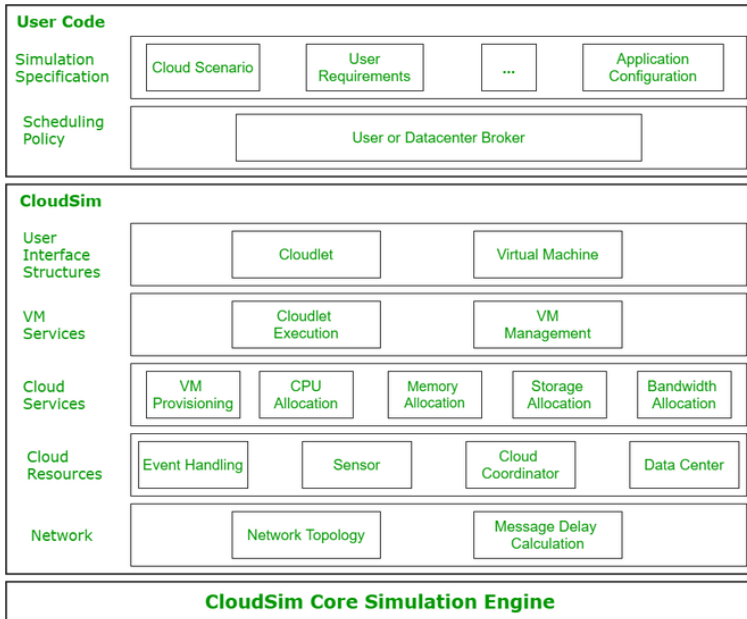
Figure 1.19 **Cloud Sim Layered Architecture**[*]

The following classes are often used in simulations:

- **Datacenter**: Modeling the underlying hardware of every cloud system, the Datacenter. Additionally, it offers ways for specifying the Datacenter's functional needs and VM allocation rules, among other things.

- **Host**: This class is responsible for carrying out tasks associated with the administration of the virtual machines. It also specifies rules for assigning CPU

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[*]https://www.geeksforgeeks.org/what-is-cloudsim/

cores to the virtual machines as well as allocating memory and also the bandwidth to them.

- **VM**: It depicts the virtual machine by providing setters and getters for attributes like RAM, bandwidth, million instructions per second, and size.

- **Cloudlet**: As an example, the file updating job may be represented by the cloudlet class, which is a kind of task that is executed on a virtual machine. In addition to giving methods for specifying the task's length, size, as well as million instructions, this class also contains methods for describing the task's status, cost, as well as history.

- **DatacenterBroker**: DatacenterBroker acts as an intermediary When it comes to virtual machines, it's in charge of everything from their construction and maintenance to their eventual demise as well as the submission of any cloudlets they contain to the VM.

- **CloudSim**: In order to start as well as end simulation environment once all the relevant cloud entities have indeed been created, this class is responsible for initializing and creating them.

Cloud services

Cloud computing services as well as technology have revolutionised the procurement and management of infrastructure. All of the main companies in the public cloud training have worked with Exit Certified, including Amazon Web Services, Google Cloud, Microsoft Azure, IBM, and Oracle.

In a public as well as private sectors, cloud computing services are revolutionizing the use of information technology. A wide range of the cloud computing services are now available to meet almost any IT need. Because they only pay for cloud services they really use, businesses may save money and improve the efficiency of their infrastructure by only paying for what they actually use.

As more and more businesses go to cloud, it's critical to know what kinds of services cloud can provide. Even though there are the wide variety of the cloud computing services, such services all have some similar characteristics, benefits, and may be divided into four main cloud service offers. These four kinds of the cloud computing services allow organizations of all sizes to fly their operations to the cloud.

2.1. Types of Cloud services

As far as the cloud computing models are concerned, there are the three primary ones: "Infrastructure as a Service", "Platform as a Service", and "Software As a Service" (SaaS). Despite their distinct distinctions, the three may work together to build a single cloud computing paradigm that provides a wide range of storage as well as resource sharing options.

Database as a Service, Monitoring as a Service, Communication as services are also the types of the cloud service explained here.

2.1.1. Software as a Service

SaaS, or "On-Demand Software," is another term for SaaS. It is the software distribution paradigm wherein cloud service providers host services. The end-users may use such services without installing the software on any devices since they are made accessible through the internet to them.

Services offered by SaaS vendors include the following:

Business Services

In order to get a firm off the ground, SaaS providers provide a wide range of support services. Software as a service solutions for businesses includes CRM, ERP, billing, as well as sales management.

Figure 2.1 Dashboard of SaaS[*]

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[*]https://www.simplekpi.com/KPI-Dashboard-Examples/SaaS-Dashboard-Example

Document Management

There are several SaaS document management applications that may be used to produce, manage, and monitor electronic documents from a third-party supplier.

Samepage, Slack, Box, and Zoho Forms are just a few examples.

Social Networks

Social networking sites are widely utilized by general public, and as a result, the companies that offer these services rely on SaaS to make their operations more efficient and to protect the data of their users.

Figure 2.2 SaaS[*]

[*]https://www.javatpoint.com/software-as-a-service

Example: Slack, Samepage, Box, and Zoho Forms.

Mail Services

Several email service providers now provide their products as a service in order to manage the fluctuating number of the users and the resulting pressure on their systems.

Using cloud computing as a SaaS layer has several advantages:

1. SaaS is easy to buy

For businesses, SaaS pricing is more affordable than licenced apps since it is dependent on the monthly or yearly subscription charge.

Instead of charging a one-time price for conventional software, SaaS suppliers charge a monthly or yearly subscription fee that is often paid up front (and frequently includes optional continuing maintenance fees).

2. One to Many

The "one-to-many model" of SaaS services implies that the single instance of the application being shared by a number of customers at the same time.

3. Less hardware required for SaaS

Because software is centrally hosted, enterprises are spared the expense of purchasing new hardware.

4. Low maintenance required for SaaS

For the enterprises, software as a service eliminates the need for the installation as well as daily maintenance. SaaS often has a lower start-up cost than the enterprise software. There are several use criteria, like number of the users that SaaS companies utilize to price their apps. Because of this, SaaS is simple to use and always up to date.

5. No special software or hardware versions required

Access to the program will be through web browser, as well as all users would have access to same version. Outsourcing hardware as well as software upkeep and also support to IaaS provider lowers the cost of SaaS.

6. Multidevice support

It is possible to use SaaS services on any device, including desktops, tablets as well as laptops.

7. API Integration

Standard APIs make it simple to connect SaaS services with the other applications or services.

8. No client-side installation

A web connection is all that's needed to access the SaaS services, thus no software has to be installed on your computer.

2.1.2. Platform as a Service

It's the runtime environment provided by Platform-as-a-Service. It makes it easy for developers to construct, test, execute, and publish web applications. Pay-per-use options are available from the cloud service providers, so you could get these apps and utilise them from wherever you have the Internet connection. Users don't have to worry about the infrastructure management while using PaaS since the cloud service provider takes care of the back-end scalability.

Web application lifecycle support is made possible by PaaS, which consists of infrastructure (such as data storage, web servers, and also networking) and platform (such as middleware, database management systems, software development tools, as well as business intelligence).

Example: Azure,Force.com, Google App Engine, Joyent.

Programming languages, databases, frameworks, the and other tools are all provided as part of the PaaS service:
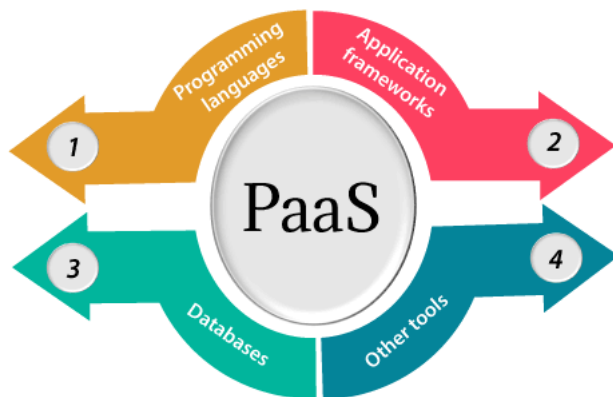
1. Programming languages

Developers may use a variety of programming languages provided by PaaS providers to create their apps. PHP, Java, Perl, Ruby, and Go are just a few of the prominent programming languages supported by PaaS companies.

2. Application frameworks

The frameworks provided by PaaS providers make it easier for developers to grasp application development process. It is common for the PaaS providers to provide a wide range of frameworks for their customers to choose from.

3. Databases

In order to connect with the apps, PaaS providers offer numerous databases like PostgreSQL, MongoDB, ClearDB, and Redis.

4. Other tools

Other tools necessary for application development, testing, and deployment are provided by PaaS providers.

Advantages of PaaS

PaaS has the following benefits:-

1) Simplified Development

Allowing developers to concentrate on innovation as well as development, PaaS removes the burden of managing infrastructure.

2) Lower risk

There's no need to buy hardware or software up front. To get started creating apps, all developers need is a computer and the internet connection.

3) Prebuilt business functionality

A number of PaaS providers additionally provide pre-defined business functionality such that customers don't have to start from the scratch and could instead begin working on their projects right away.

4) Instant community

The majority of PaaS providers provide developer forums where they may exchange ideas, learn from others' mistakes, and obtain guidance.

5) Scalability

It is possible to grow apps from 1 to1000 of users without modifying the code.

2.1.3. Infrastructure as a Service

"Hardware as a Service" is another name for Iaas . In cloud computing platform, this is one of the levels An IT service provider may provide clients with a service that enables them to outsource their IT infrastructures. Pay-as-you-go models are used by customers to access such resources on an Internet.

IT infrastructure was hired for a fixed length of time, with the pre-determined hardware configuration in conventional hosting services. Irrespective of whether or not the service was actually used, the customer was charged for the setup and time. Using the IaaS cloud platform layer, users may adjust the configuration as needed and only pay for the resources they really utilise.

Organizations are freed from the burden of maintaining their own IT infrastructure thanks to IaaS cloud computing platform layer.

In addition to public as well as private cloud, IaaS is also available as a hybrid cloud. The term "private cloud" refers to a cloud service which is hosted on a customer's premises. The vendor's data centre is the location of public cloud, whereas the hybrid cloud combines best features of both the public and private clouds for the benefit of the client.

IaaS provides the following services :-

Advantages of IaaS cloud computing layer

1. **Compute:** Computing as a Service comprises the provisioning of virtual machines to end customers using the virtual central processing units as well as "virtual main memory".
2. **Storage:** Storage for the files is provided by an IaaS provider.

3. **Network:** Network as a Service offers virtual machines (VMs) access to networking hardware like switches, routers, and bridges.

4. **Load balancers:** At the infrastructural level, it offers load balancing.

Figure 2.3 Services provided by IaaS[*]

IaaS computing layer has the following benefits:

1. Shared infrastructure

Sharing the very same physical infrastructure is possible with IaaS.

2. Web access to the resources

Access to "IT resources" may be obtained through the internet via IaaS.

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[*]https://www.javatpoint.com/infrastructure-as-a-service

3. Pay-as-per-use model

It is common practise for IaaS providers to bill customers on a per-use basis. The users must pay for what they consumed.

4. Focus on the core business

Instead than concentrating on IT infrastructure, IaaS companies put the needs of their customers first.

5. On-demand scalability

IaaS provides scalability on need, which is a major benefit. When using IaaS, consumers don't have to be concerned about performing software upgrades or resolving hardware-related difficultiess.

2.1.4. Database as a Service

The self-service, on-demand database consumption model that also incorporates operational automation is known as "DBaaS." Cloud computing services are often paid for on the per-use basis, and this is the case with DBaaS as well. "Traditional" as well as "relational database models" may be used in the same way as this DBaaS. Therefore, enterprises may avoid the setup, administration, upgrade, as well as security issues associated with data bases by using DBaaS.

There is an information manager which manages all of the underlying data instances through an API in the DBaaS service. Using the management console, such as a web

application, the user may manage as well as assemble the data and even provide or deprovision information instances.

Key Characteristics of DBaaS :

- The fully managed information service helps to organise, manage, as well as administer your information in cloud, as well as providing services for the hardware provisioning as well as backup.
- Customers from various backgrounds and levels of IT knowledge may easily access database information thanks to DBaaS.
- Offers a wide range of services that may be requested at any time.
- Supported by the resources available, it provides a flexible information platform which adapts to current needs of environment.
- The Databases are always being monitored by a group of professionals at your disposal.
- Automates the management and monitoring of information.
- Makes use of current hardware and storage.

Advantages of DBaaS :

- In the case of DBaaS, the information provider is responsible for managing and maintaining the information hardware as well as code.
- Electricity costs for cooling and ventilating the servers have been reduced significantly

- A company that uses DBaaS does not have to employ information developers or build an information system in-house.
- With today's automation, simple cloud exits are now available at minimal cost and in little time.
- Elimination of the requirement for system maintenance personnel.
- For one thing, because DBaaS is hosted off-site, there is no need to worry about power or network outages.
- Check out Oracle's information as a service offering.

2.1.5. Monitoring as a Service

Businesses that depend on IT infrastructure might benefit greatly from the security features offered by "Monitoring as a Service" (MaaS). The firm needs, however, have up-to-date technology, professionals with extensive technical capabilities, as well as scalable security procedures in order to monitor effectively and efficiently. These requirements come at a significant cost.

Human resources were utilised to monitor such operations prior to introduction of technological devices, but they were ineffectual.

This issue can be solved using MaaS, which is an excellent solution. It offers round-the-clock monitoring, notifies any problems with security infrastructure, and protects the critical data of its clients.

MaaS outperforms the conventional security operations centre in the two key ways:

1. The conventional security operations centre had the higher total cost of the ownership.
2. There is a lack of effectiveness in the traditional security operations.

Features of MaaS

1. Protection Against External and Internal Threats

24/7, the real-time monitoring of security device alarms is carried out by security monitoring services. Data from numerous security devices is collected by security analyst in order to identify dangers and, as a result, to suggest appropriate countermeasures.

2. Delivering Business Values

It's common for customers to believe that a selection between building or buying is better than assessing the ROI for their investment.

MaaS service providers, however, are less expensive to run than developing your own security monitoring infrastructure and employing an in-house security staff.

The MaaS providers have a full security architecture, as well as a staff of experts which are always up to speed on the most recent technological developments. Customers benefit from scalable services offered by MaaS suppliers. To build

the security infrastructure in-house, a corporation has to pay attention to employee turnover, technology upgrades and operational scheduling as well as discovering and resolving vulnerabilities. All of these difficulties may be avoided by using MaaS services provided by a third party.

3. Real-Time Log Monitoring Enables Compliance
In order to better understand how the system or the application is being used, the log messages are recorded and stored in the log file. Errors, failed processes, as well as services may all be quickly identified with the aid of the real-time log monitoring.

It also sends out notifications in the event of network or protocol errors. It serves as a warning to programmers about potential infrastructure issues. This tedious procedure may be made more efficient with the use of MaaS.

Advantages of MaaS

- MaaS provides its customers with "ready-to-use monitoring" solution at a very low cost.
- With MaaS, the client can concentrate on their business rather than worrying about safety of their company's data.
- If you have a problem with MaaS, you may report it and receive rapid help from MaaS team.

2.1.6. Communication as services.

CaaS service providers provides customers with a popular service known as "communication as a service", which is based on the cloud computing. In today's corporate world, effective communication has risen to the top of the priority list. The company's growth may be accelerated with the use of a comprehensive communication solution.
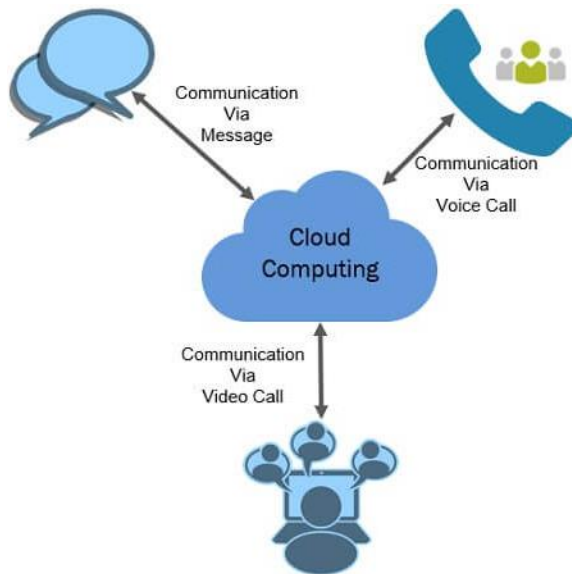
Figure 2.4 Communication as a service[*]

Communication as a service (CaaS) is the cloud-based solution supplied by cloud suppliers. CaaS is the customised form of "Software as a Service" (SaaS) that is among 3 major services supplied by cloud computing

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[*]https://binaryterms.com/communication-as-a-service-caas.html

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technology. When we speak about the communication, recollect, in how many areas we may communicate with people. Well, we could converse by text message, phone call as well as video call.

CaaS providers handle the hardware as well as software that really are crucial for providing "Voice over IP" for the voice communication service, and additional services such as "Instant Messaging" (IM) to give text communication service as well as "video conferencing" to give visual communication service.

CaaS concept delivers affordable services since the service consumers do not have to suffer the cost of purchasing and operating communication equipment. CaaS is ideal for the small IT organisations are on the edge of expanding. Let us explore the characteristics of CaaS.

Features of CaaS

1. Integrated and Unified Communication

The sophisticated unified communication capabilities includes Chat, Real-time presence, Microsoft Outlook integration, Video calls, Multimedia conferencing, "Soft" phones , Unified messaging as well as mobility.

Presently, CaaS provider delivers new features to its CaaS services considerably quicker than ever before. It has become inexpensive for providers to offer the new feature to CaaS application quicker since the end-users are profiting from provider's scalable platform architecture and

eventually the several end-users utilising provider's service shares the cost of improvement.

2. No Investment Required

As we have discussed above it is exclusive obligation of CaaS provider to manage the hardware as well as software installed to deliver communication service to the clients. The consumer just needs to pay for a service he is receiving from CaaS provider, not for the communication features implemented to deliver communication services.

3. Flexibility & Scalability

The consumer might outsource communication services from CaaS suppliers. The clients "pay for what they have demanded". It's up to the consumer to decide how much service they need. Communication services benefit from increased adaptability and scalability, as well as lower costs.

4. No Risk of Obsolescence

As the needs of the industry change, CaaS suppliers are always improving their hardware as well as software to match those needs. There's no need for customers to be concerned about the services becoming obsolete.

5. No Maintenance Cost Incurred

In the CaaS model, the client doesn't have to worry about keeping up with the equipment that is used to provide communication services.

6. Ensure Business Continuity

How long could you keep running your company if the area where it is located is devastated by a natural disaster? Across ensure data redundancy and speedy recovery after the catastrophic catastrophe, corporations are increasingly distributing their data to geographically distant data centres.

The same capability is accepted and applied by CaaS providers in order to maintain communication continuity in case of a catastrophic disaster.

2.2. Service providers

Companies which create, administer, or give on-demand access to public, private, or hybrid clouds are known as the cloud service providers. Businesses may save money by using cloud services instead of on-premise IT.

2.2.1. Google

Google Cloud Platform

As the product of Google, the "Google cloud platform" is known as "Google cloud". Virtual machines, hard discs, computers, and other physical equipment are all part of it. It also makes it easier for companies to migrate to a new platform.
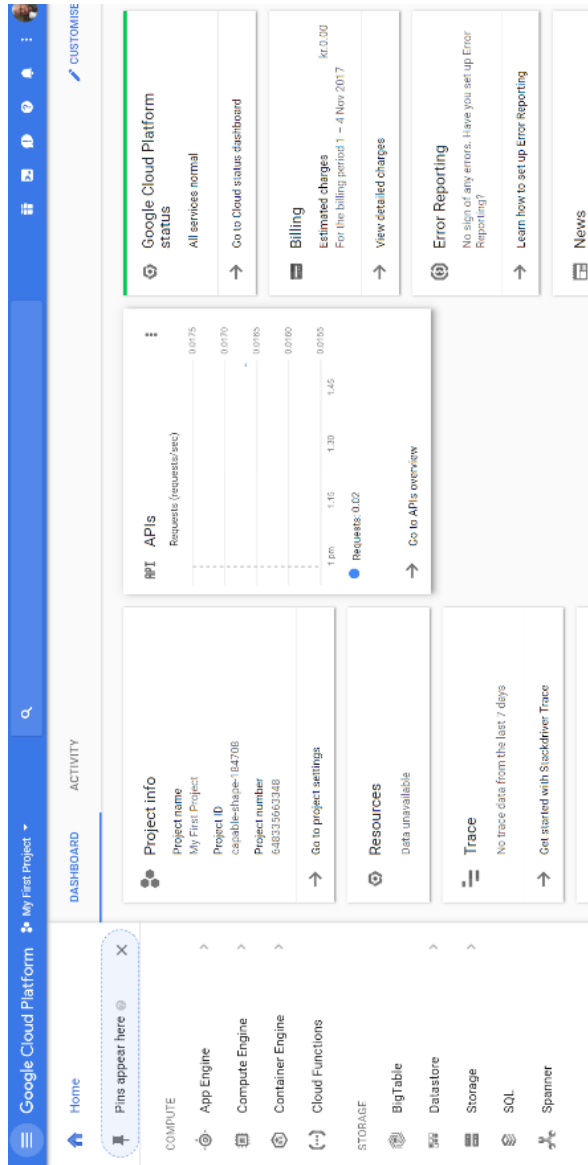
Figure 2.5 Google cloud platform Dashboard[*]

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[*]https://klauselk.com/2017/11/04/google-onboard/

Figure 2.6 Google cloud platform[*]

Features of Google Cloud

- There are many large data services in the Google Cloud, including "Google CloudDataproc", "Google BigQuery", "Google CloudDatalab", as well as "Google Cloud Pub/Sub".
- In addition, it offers a variety of networking services, includes Google 'Virtual Private Cloud" (VPC), "Content Delivery Network", "Google Cloud Load balancing", and "Google Cloud Interconnect".
- It has a wide range of the high-performance as well as scalable options.
- GCP offers a wide range of serverless services, including data warehouse, data processing,

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[*]https://www.javatpoint.com/cloud-service-provider-companies

messaging, compute, database, storage, as well as machine learning.

- The free "cloud shell environment" with the Boost Mode is provided by the service.

2.2.2. Amazon

This cloud service platform is supplied by Amazon, and is called "Amazon Web Services". Among the many features it provides is the ability to store and retrieve data from a variety of sources, as well as the ability to process large amounts of data.
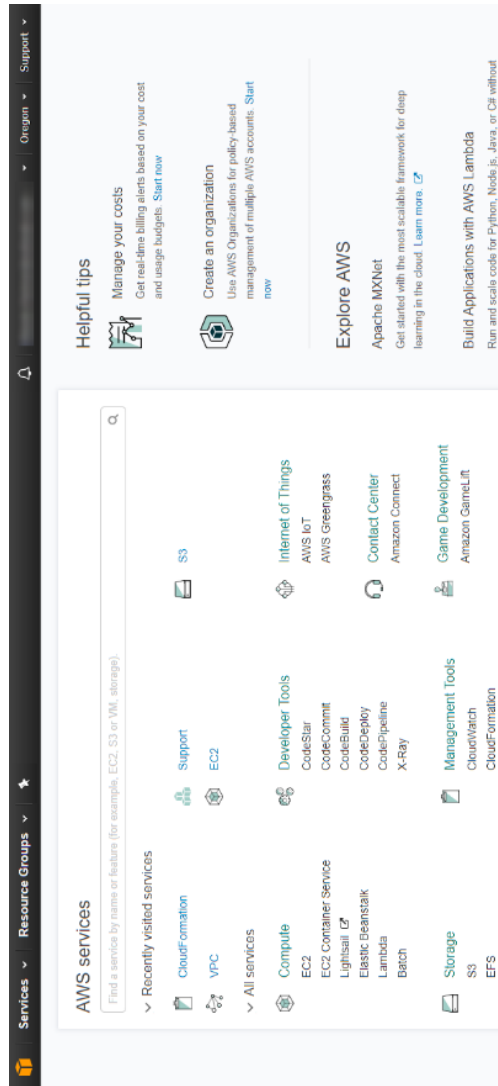

Figure 2.7 Amazon Web Services[*]

Features of AWS

Many strong capabilities are provided by AWS for creating scalable, cost efficient, and enterprise-level software. Listed below are some of the most notable AWS features:-

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[*]https://www.javatpoint.com/cloud-service-provider-companies

Figure 2.8 Amazon Web service dashboard[*]

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[*]https://subscription.packtpub.com/book/virtualization-and-cloud/9781787125629/2/ch02lvl1sec27/aws-dashboard

- AWS is scalable since the computer resources may be scaled up or down to meet the needs of the enterprise.
- The "pay-as-you-go" pricing mechanism of AWS makes it cost-effective.
- Flexible storage choices are provided.
- Penetration testing as well as DDoS("Distributed Denial-of-Service") assaults are just a few of the services it provides, along with infrastructure security as well as data encryption.
- Manages and secures Windows workloads with ease.

2.2.3. Microsoft Azure

Windows Azure is another name for Microsoft Azure. It has a broad range of operating systems, programming languages, databases, and frameworks which make it easy for IT professionals to design, deploy, including manage applications around the globe. It also provides the ability to establish separate groups for various utilities.

*Figure 2.9 Microsoft Azure**

Features of Microsoft Azure

- Microsoft Azure offers a service that is scalable, adaptable, and affordable.
- It makes it easier for programmers to maintain websites and apps.
- It was in charge of all of the resources on its own.
- Using its cloud architecture, we may run the general-purpose virtual machine on Windows or Linux.
- Imagery, video, as well as audio files may all be sent using "Content Delivery System" (CDS).

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*https://www.javatpoint.com/cloud-service-provider-companies
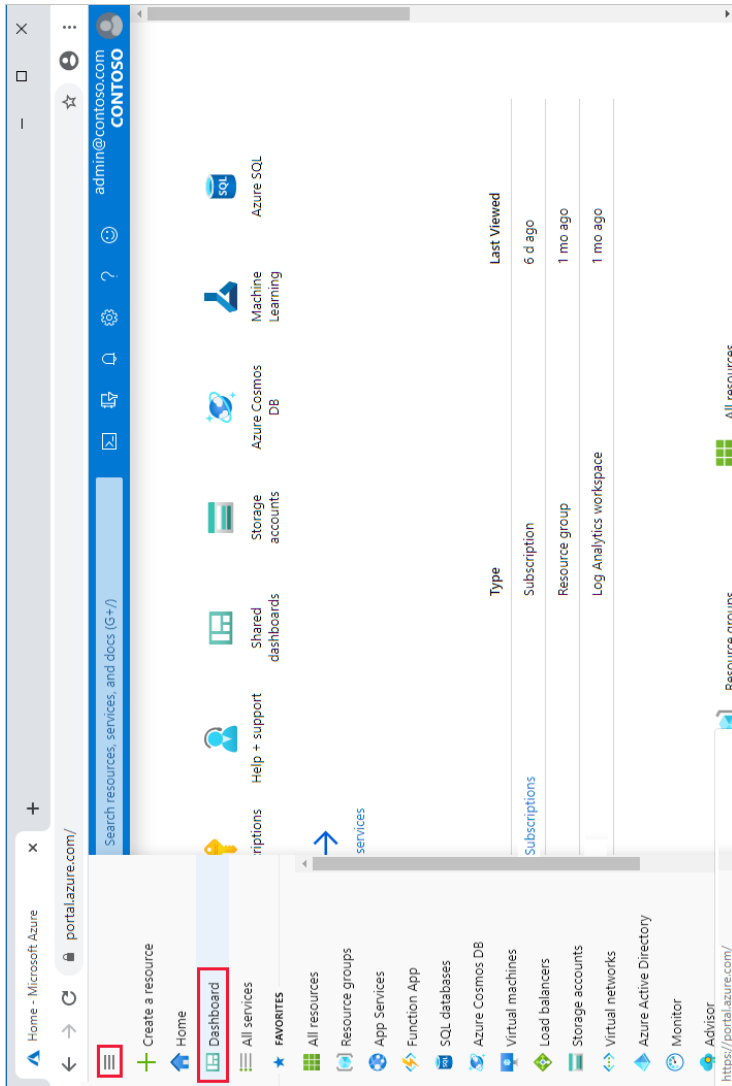
*Figure 2.10 Microsoft Azure Dashboard**

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*https://docs.microsoft.com/en-us/azure/azure-portal/azure-portal-dashboards

2.2.4. IBM

*Figure 2.11 IBM Cloud**

There are several advantages to using IBM Cloud over other platforms. Advanced data as well as AI techniques are used to build it. As a result of its wide range of offerings, it may be used for anything from infrastructure to the software to the platform. With an internet connection, you may leverage its services including computational power, cloud use cases, cloud data analytics, and storage networking.

Feature of IBM Cloud

- Operational efficacy is increased thanks to the IBM cloud.
- The customer's pleasure is boosted by its quickness and agility.

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*https://www.javatpoint.com/cloud-service-provider-companies

- There are three types of services available: "Infrastructure", "Platform" and "Software as a Service"
- It provides our IT environment with a variety of the cloud communication options.

2.2.5. Sales force

Using Salesforce Sales Cloud, businesses may expand their customer base. It is able to give customers with relevant information and conclude agreements more swiftly. Increased productivity and income may be achieved thanks to the Salesforce Sales Cloud, which provides superior insights to help you make better choices.

Salesforce Sales Cloud offers the following features and functions:

- **Lightning for Gmail**

Lightning for Gmail is the natural connection of "Salesforce CRM" with Gmail.

Using it, you'll be able to examine all of the relevant data associated with each email.

When you use Gmail, you may add additional applications to the sidebar. Finally, and perhaps most crucially, you can now use Gmail's Lightning-enabled features in your Salesforce conversations.

- **Lightning Dialer Voicemail Drop**

It's one of the Salesforce's best-known functionalities. With the single click, you may leave voicemails for a group of linked prospects. Move on to a next call after pre-recording a generic message.

- **Einstein Automated Contacts**

To keep data clean and correct, use Einstein Automated Contacts. Emails and calendar events are also analysed by it. In addition, Einstein Automated Contacts recognises new contacts and offers ideas for the addition of new entries by boosting your CRM system.

- **Lightning Contact Hierarchy**

An easy-to-understand visual representation of 2,000 records is provided by "Lightning Contact Hierarchy". You may configure and customise columns with ease with this tool.

- **Lightning Report Builder**

Multiple reports may be created using the intuitive "Salesforce Lightning Report Builder". The info you need is at your fingertips within minutes.

Salesforce Service Cloud

Service Cloud allows you to provide flawless customer service at your fingertips. Call-center, live discussions,

knowledge base, as well as product help are just few of the services it offers.

The following features are available via Salesforce Service Cloud:

- **Lightning Service Console:** Optimize your case hovers, case feed, split view, as well as keyboard shortcuts to get the most out of them.
- **Lightning Service Setup:** Video tutorials may be used to establish up lightning communities and knowledge bases.
- **Snap-ins for Lightning Communities:** Allows for the provision of the real-time live chat customer assistance with a focus on individual needs.
- **Lightning Field Service Preventative Maintenance:** Product breakdown may be prevented by keeping track of work orders.
- **Lightning Field Service Parts Requests and Transfers:** Access to tracking and parts requests via mobile devices.

Marketing Cloud

In addition to online and mobile apps, "Salesforce Marketing Cloud" delivers social channels and lets marketers deliver appropriate message at right time across both the channels. Salesforce's AI suite and Einstein's vision are both integrated within the Social Studio. Intelligent social media analytics are provided by "Salesforce Einstein Vision" through the Salesforce Einstein platform. Salesforce

Marketing Cloud" also aids in determining the most effective "social media campaigns" and understanding user uptake.

A key feature of "Salesforce Marketing Cloud", Einstein helps to segment market to locate the correct audience.

A "Center Sales Leaderboard" inside social studio allows you to get a holistic view of your client's experience.

Commerce Cloud

Customers may enjoy the collaborative shopping experience using the Salesforce Commerce Cloud's IT solutions.

- **Einstein Predictive Sort**: Customized items are developed by analysing data from the customer base.
- **Order Management**: Returned goods and exchanges are handled by this department.
- **Mobile-First Reference Architecture**: It aids in the development of mobile apps for both businesses and consumers alike.
- **Commerce Cloud Reports and Dashboards**: Easy dashboards as well as reports let you keep tabs on income and performance.
- **Android Pay:** Integrates mobile commerce with Android transaction security.

Community Cloud

The "Salesforce Community Cloud" links partners, customers, and workers by creating a community that is relevant to their businesses. A CRM system may be used to populate communities with material. As an added benefit, Salesforce Community Cloud provides agents with a view of the material that their contacts have most recently interacted with. In addition, the dashboard provides easy access to key performance indicators.

Health Cloud

To improve patient-provider as well as hospital-administration interactions, Salesforce Health Cloud was developed.Patients' clinical records, medical gadgets, as well as wearables may all be incorporated into a single patient profile.

Analytics Cloud

By using Salesforce Analytics Cloud, users can quickly and iteratively explore large amounts of data using dynamic visualisations over the underlying data sets. Data visualisation and mobile access are optimised in this "business intelligence" platform.

Financial Service Cloud

Create a community tailored to your business's requirements with the "Salesforce Financial Service Cloud". A direct connection with the "independent investors" and

the sharing of client data with them is facilitated by this tool. On a safe gateway, you may exchange consumer information such as financial objectives, accounts, and current client connections.

In addition to online and mobile apps", Salesforce Marketing Cloud" delivers social channels and lets marketers deliver an appropriate message at right time across both the channels. Salesforce's AI suite and Einstein's vision are both integrated within the Social Studio. Intelligent social media analytics are provided by Salesforce Einstein Vision through the Salesforce Einstein platform. Salesforce Marketing Cloud also aids in determining the most effective social media campaigns and understanding user uptake.

A key feature of Salesforce Marketing Cloud, Einstein assists to segment market to locate the correct audience.

A "Center Sales Leaderboard" in a social studio allows you to get a holistic view of your client's experience.

Collaborating using cloud services

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CHAPTER

3

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Employees may collaborate on documents as well as the other data types which are kept outside of company's firewall using cloud collaboration, a sort of corporate collaboration. There are the cloud-based collaboration tools that allow teams of employees to collaborate on projects.

Work may be done in real time by two or more persons using Cloud Collaboration. One person generates the file or the document and then shares it with others; for instance, the link to a project which enables others to see and modify this might be shared by the project author.

Editing the document is possible at any moment, even if other people have access to document. To ensure all users see same version of project at any one time, all changes are synchronized.

As providers compete for clients, cloud collaboration has evolved. Project participants may see who else is looking at the page and interact with one another as they work, like as via comments or the chat option, with most collaboration tools. When the file is modified, several tools enable users to get email notifications. These and the other features aid

in enhancing the effectiveness and also productivity of employees.

Features

- **Access files anytime through the internet:** Anyone with an internet connection or mobile device may use the cloud collaboration program whenever they want. Offline functionality is also needed so that users may make modifications to files saved in cloud, even though they won't be visible to others until they re-connect to internet.
- **Real-time communication:** Instant chat, team communication channels, message boards, and even the comments should be included in cloud collaboration platform you pick. Even if you're working on the same project, you must have the ability to make comments for your colleagues right in app, rather than having to contact them individually.
- **Setting custom permission levels:** Not all firm information should be disclosed in the same manner. Using view-only access, for example, you may prevent unauthorized modifications to essential project rules and briefings. Custom permission levels must be possible in the collaborative tool. Who may see, modify, and also comment on papers must be up to you to determine, as they must be.

- **Version control:** Any modifications made to documents must be synced in the real-time by cloud collaboration platform, ensuring that users only have access to most recent version of files. While providing access to all prior versions, it must also be able to monitor document modifications. You must be able to see exactly who made what modifications to what documents and at when point in time they were done.

- **Centralized file storage**: An essential cloud collaboration tool features is the ability to save entire of the work-related data in the online repository. As the enterprise storage solution, it provides a safe and convenient way for your company's staff members to locate and use critical documents.

3.1. Email Communication over the Cloud

Cloud email provides you with a wide range of powerful email features that can be accessed over the internet. Using the vendor's cloud-based email hosting service is quite similar to using any other cloud-based service.

The "cloud-based email service" has several advantages over a standard on-premises email server, including the following.

- **Convenience**: You may view your emails from any connected device with the cloud-based email

hosting. You're good to go as long as you have the internet and the connected device.

- **Cost**: There are a lot of advantages to running the in-house email server for your business, but the costs may quickly mount up over time. Not only will you need the operating system as well as the email platform, but you'll also need to buy a rack and also pay for energy, cooling and also employees to maintain it.
- **Up-to-date security**: Cloud computing security has become a top focus for most of the world's largest email service providers. The cloud-based email hosting provider will likely keep you safer than relying on a single member of your staff to maintain the email server up to date, thanks to the latest technologies, the team of security specialists, and extensive processes.
- **Scalability**: Having the cloud email service means that you don't have to worry regarding scaling your data centre to keep up with your expanding business. Your service provider would bear the full weight of the responsibility. In the midst of the growth boom, this frees up more time for your team to work on quality control.
- **Easier disaster recovery**: Recovering lost data from a virus-infected or dead email server is tough. It's not always feasible to get back on track. A cloud-based email service includes built-in redundancy. That implies that you may quickly as well as easily

retrieve all of your contacts, emails, and other data saved in the email system.

3.2. CRM Management

Managing all of your company's contacts and connections with consumers and future customers is the goal of "customer relationship management". The end aim is clear: To enhance business connections. CRM systems assist businesses to better communicate with and serve their consumers while also streamlining internal operations.

The CRM system, the tool which assists with the sales management, contact management, productivity and much more, is generally what people mean when they speak about CRM.

Customers, coworkers, and suppliers all benefit from a CRM solution's ability to keep track of your interactions with them during the lifespan of their connection with your company.

Use of CRM

An integrated customer relationship management (CRM) system improves the management of the external contacts and connections that are critical to a company's long-term success. In a CRM solution, you can store customer but also prospect information, discover sales possibilities, record service concerns, and also manage marketing campaigns everything in one central area – and also make information

about each customer encounter accessible to everyone at your firm who may need it!
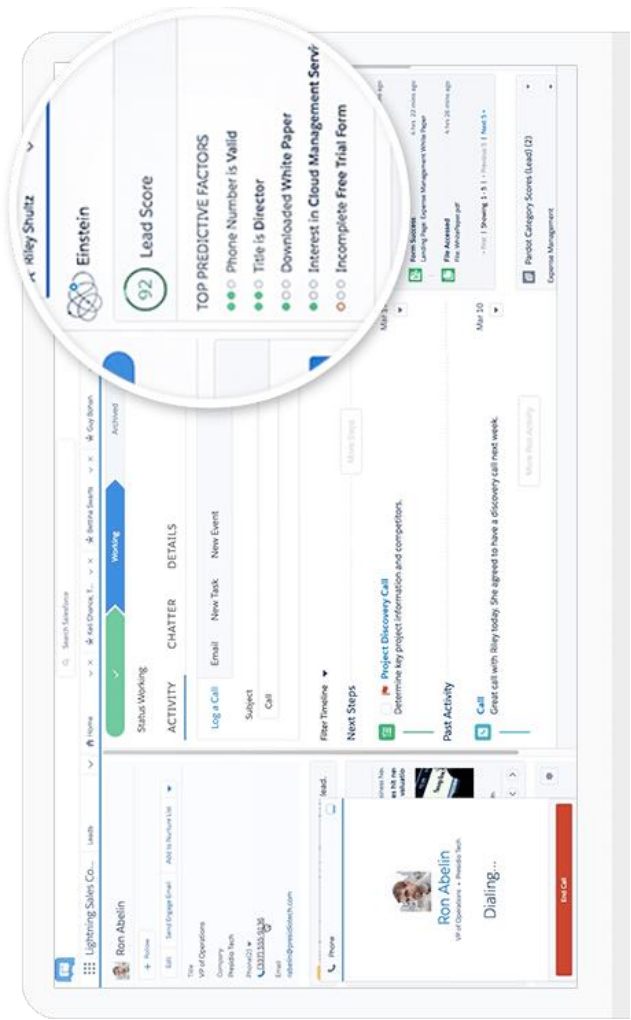
Figure 3.1 An example of CRM[*]

Collaboration and productivity may be improved with more visibility and availability of data. It is possible for everyone in your firm to see how as well as when consumers have indeed been communicated with and also what they have purchased, as well as when as well as how much they paid for it all. Companies of various sizes may benefit from CRM systems, but small businesses in particular can benefit from CRM since they are typically faced with the challenge of doing more with less.

Here's What a CRM system could do for your company.

1. Make improvements to your bottom line.

When a CRM platform is implemented, it has been shown to have a positive impact on the bottom line.

2. Identify and categorise leads.

A CRM system may make it simple and fast to find and also add new leads, as well as precisely classify them. Concentrating on the proper prospects enables marketing but also sales to uncover possibilities which will complete transactions and nurture those leads to become quality leads.

Sales and marketing teams may better target their efforts and resources on the correct customers when they have access to up-to-date, accurate, but also centrally stored information on them.

3. Increase referrals from existing customers.

In order to get new consumers, you must better understand current clients so that you may identify cross-selling as well as upselling prospects.

You'll be able to provide greater service to your clients if you have better visibility. Recurring consumers spend up to 33% more money when they are satisfied, according to certain surveys.

4. Offer better customer support.

If you don't have a 24-hour helpline, you're out of business. Customer relationship management (CRM) software may help you provide the high level of service your clients expect. The record of every client contact is available to your agents to help them provide consumers with answers immediately.

5. Improve products and services.

A strong CRM system would collect data from a wide range of sources throughout your organization and the world at large. So you can better understand your clients and also what they think about your company, as well as seeing potential issues before they become major issues, so you can fix them before they become major issues.

3.3. Project Management

Using the "cloud-based project management software",

the project is planned, collaborated, monitored, and delivered.

Figure 3.2 An example of project management Software[*]

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[*]https://www.scoro.com/blog/best-project-management-software-list/

Instead of utilizing a simple whiteboard as well as sticky notes, the project managers and their teams may use a network of the tools accessible in the program to get the work done. Business-to-business—and team-to-team—use of the project management software is on the rise. However, the overall goal is to make it simpler and more productive to manage projects as well as deadlines. For the last several years, cloud-based solutions seem to be the most popular trend in the commercial world. It's becoming more challenging for enterprises to discover the correct software solution because of the constant stream of new and enhanced offerings.

3.4.   Event Management

On-premises or in a cloud, the Cloud Event Management may accept events from numerous monitoring sources. The event is a signal indicating an applications, services, or the other monitored object has experienced a change.

An incident is created when attribute values which match are used to connect unrelated occurrences. Monitoring tool alerts and notifications are regarded to be part of the very same incident if they include the same data in a certain attribute.

In the case that a same event happens many times, only the most recent one is included in incident it is linked to. But instead is updated to reflect how several times the very same event has happened. As long as the resource bundle

as well as the event type are identical, the event is duplicated.

Figure 3.3 An example of Event Management software[*]

[*]https://blog.capterra.com/free-event-management-software/

The Cluster characteristics are initially checked by "Cloud Event Management". In case the cluster values are all the same, then incidents are linked. There is no association in case Cluster values are different.

A Cloud Event Management system checks to see whether the values in Application property match when no value has been set in a Cluster attribute for any of events that have been processed. There is a correlation between events if their application values would be the same. There is no connection in case the Application values are dissimilar.

Hostname values are also checked in case there is no value for Application property in any of events in "Cloud Event Management". Unless one of attribute values matches throughout events as well as none of the prior attributes contain values, the procedure iterates down the list, checking attribute values. "Cloud Event Management" creates an issue when the very same event characteristic is used in more than single event.

3.5.   Task Management

You can think of the task management as keeping track of the project's tasks as they progress through their numerous stages. Your final aim is to successfully complete your activities, which means actively making choices for the tasks to accommodate changes which might occur in the real-time.

Many duties are carried out by cloud service providers to guarantee that cloud resources are used effectively. We'll go through a few of them here:

➢ **Audit System Backups**

Auditing the backups on a regular basis is necessary to verify that various users' data may be restored at random. There are many methods for creating backups:

- A company's on-site computers are used to back up data to remote drives in cloud.
- The cloud service provider is in charge of data backup.

When using a cloud service, it's critical to understand if data is protected, who really has access to it, and where the backups are being stored.

➢ **Data Flow of the System**

The manager is in charge of creating a thorough process flow chart. An organization's data travels via this process flow as it traverses the cloud solution.

➢ **Vendor Lock-In Awareness and Solutions**

Managers should understand how to discontinue using a certain cloud provider's services. To allow cloud administrators to move an organization's data to the another cloud provider, certain protocols should be developed.

➤ **Knowing Provider's Security Procedures**

For the following functions, managers must be familiar with the provider's security measures:

- Multitenant usage
- processing of E-commerce
- Screening of Employee
- Encryption policy

➤ **Monitoring Capacity Planning and Scaling Capabilities**

Managers need to be aware of the cloud provider's capacity planning in order to determine whether or not they are fulfilling their business's future capacity needs.

It is the responsibility of the management to guarantee that services may be scaled up or down according to the requirements of the users.

➤ **Monitor Audit Log Use**

It is necessary for managers to conduct routine log audits in order to detect systemic mistakes.

➤ **Solution Testing and Validation**

It's critical to test any solution provided by the cloud provider to verify that it works as expected and is free of

errors. For the system to be stable and dependable, this is a need:

The advantages of utilizing a task management software

- To assist you with task management, color coding is used
- Using Gantt charts, you can keep track of project's progress and highlight important milestones.
- You may define objectives, monitor deliveries, as well as manage deadlines using this tool.
- Provides flexible, configurable timetables to ensure smooth operations.
- It removes need to keep track of all your duties and reminds you of them at the right moment.
- Working with what you are most familiar with is made easier with the customizable choices.

3.6. Calendar

The "web-based calendar service" allows you to view your calendars from the computer with the Internet connection. Even if the office assistant has added the new appointments while you left, you may still check your calendar while you're on a road. Web-based calendars" may also be easily shared with the other users from any place, making them ideal for the collaborative projects. Google, Windows Live, Yahoo!, and Apple's MobileMe calendars are among the most famous "web-based calendars", as well as calendars

hosted on other sites such as 30Boxes, Hunt Calendars, e-Studio Calendar, Trumba and Calendars Net.

There are the calendars that need payment and also the calendars that are free and also just as useful for the group members to use. Google Calendar is by far the most widely used web-based calendar nowadays. Google Calendar is the free, feature-rich, and user-friendly calendaring service. In addition to personal as well as shared calendars, it is great for managing family business group, and community schedules.

In a calendar, you may see the appointments (that Google calls "events") in either monthly, weekly, daily, or formats. You may also see your weekly schedule on the single page, if you really like. Other of your events are kept on cloud, not on the computer, as is the case with all the "web-based calendars". Thus, your calendar will be available from any computer, no matter where you are. It's as simple as logging into the Google Calendar account and seeing all of your events.

In order to utilise Google Calendar to build the public calendar for the business or group, you must have the web-based account. Set up a web-based calendar that can be accessed by all workers or attendees. It's simple to invite guests to the public or the private event with the help of special invitation capabilities. Google enables you to build a variety of calendars, each with a particular purpose.
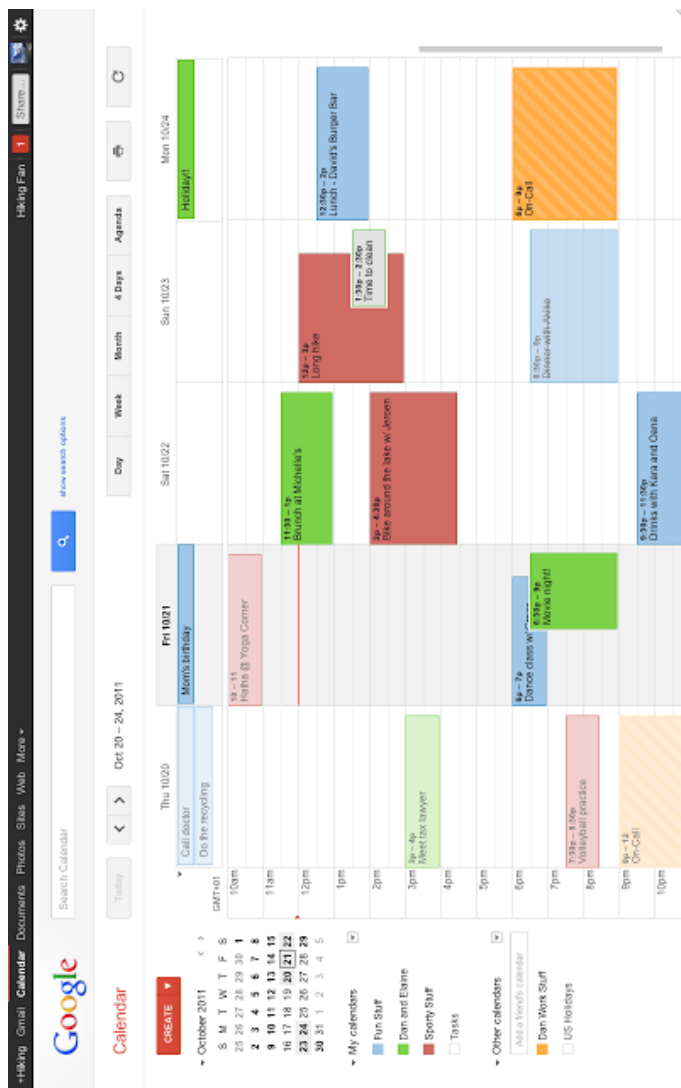
*Figure 3.4 Google Calendar**

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*https://www.schudio.com/embed-google-calendar/google-calendar-screenshot/

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Google Calendar lets you build a variety of various kinds of calendars, including the following:

1. Personal calendars, such as the one you use as the default calendar, are a kind of the personal calendar.
2. Calendars that are available to public via internet.

3.7. Schedules

To put it another way, the cloud computing scheduling relates to the procedure of assigning virtual machines (VMs) to execute on the available resources so that customers may meet their needs.

Improve system performance and load balancing, optimize resource usage, conserve energy, decrease expenses, and minimize overall processing time are the goals of scheduling approaches in cloud environments. Since virtualized resources and user-required limitations must be considered by the scheduler, it is critical that it do so. There must be at least one strategy behind every scheduling approach. For the most part, the most typical strategies or goals are time as well as cost; energy consumption; quality of service; but also fault tolerance.

Scheduling Types

Different types and categories of scheduling in cloud computing system are shown in Fig.
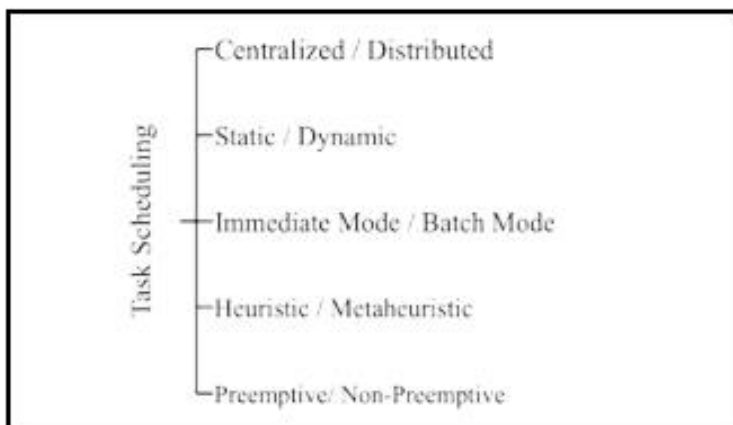
Figure 3.5 Task scheduling types [*]

Centralized / decentralized scheduling

Decisions on scheduling usually made at a single location. It ensures resource economy and simplicity. However, the problem is that it lacks scalability as well as fault tolerance. Despite its inefficiency, distributed or decentralized scheduling is becoming common in actual cloud environments.

Static / Dynamic scheduling

Before performing any job, all the task timing information is accessible in the static scheduling, therefore the execution schedule of every task is calculated. It works well in situations when the requirements are predetermined. The customer as well as the cloud provider agree on the services

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[*]http://paper.ijcsns.org/07_book/201802/20180214.pdf

in advance, and also the cloud provider sets up all necessary resources before service begins.

At runtime, timing information for jobs is unknown in the dynamic scheduling. As a result, the user's wishes may influence the task's execution timeline. In comparison to the static scheduling, the dynamic scheduling has a higher runtime cost. The cloud service provider cannot foresee consumption in the dynamic scheduling. To the extent necessary, it distributes and removes resources from the system.

Preemptive / Non-Preemptive scheduling

Preemptive scheduling enables tasks to be interrupted and moved to another resource while they are being executed. When a job is more important than another and must be completed even if it is executing in the virtual computer, this is an instance of high priority. Consequently, if limitations like deadline, priority, and cost are to be enforced, this scheduling method must be used. Virtual machines can't be removed from the non-preemptive scheduling until the job executing on them completes. It prevents the execution of the job from being interrupted.

Immediate mode / Batch mode scheduling

When working in "immediate mode," also known as the "online mode," tasks are assigned to resources right away, with no pause. Tasks may be scheduled once and can't be modified beyond that point. Batch mode, on the

other side, gathers jobs into a collection and performs mapping checks at predetermined periods. Offline mode is another name for this mode.

Heuristic / metaheuristic scheduling

Scheduling methods based on heuristics may tackle certain difficulties. Known as "master methods" for solving universal issues, metaheuristic procedures are the high-level problem-independent techniques which may be applied to the wide variety of situations. A good answer isn't guaranteed, but it's an excellent solution whenever compared to amount of the time spent on computing.

3.8.   Word Processing

The term "word processor" refers to a device that performs word processing on documents that include pages as well as paragraphs of text. Electronic, mechanical, and software-based word processors all exist.

The word processor is the device which offers input, editing, formatting, and also output of provided text with certain extra functions, while word processor is being used to apply fundamental editing as well as design.

It's either a piece of software or a piece of technology. When it comes to modern computers, word processor has evolved into the word-processing software or applications.
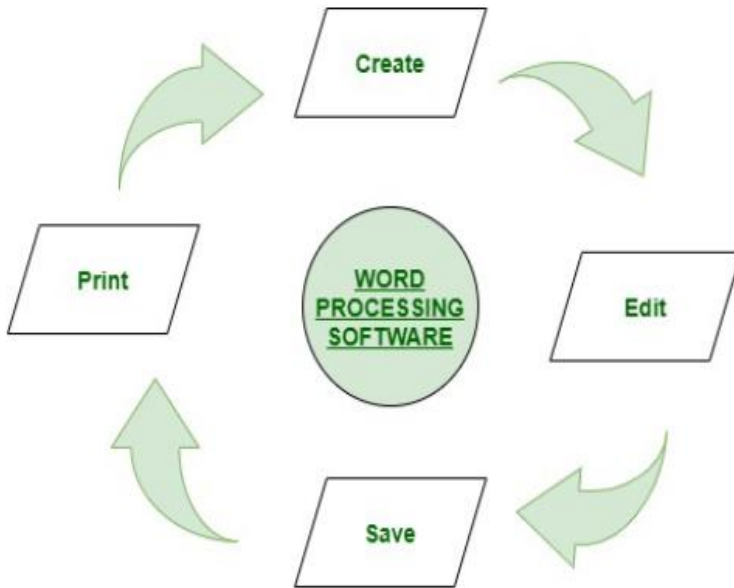
*Figure 3.6Word processor software**

Features:

- General-purpose computers are being used to execute their software.
- It is simple to use.
- Allows you to alter paragraph's character structure as well as style
- It can handle the most basic editing tasks, such as adding headers and bullets, footers, and numbers.
- Mail merge as well as preview are both possible with this software program.

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*https://www.geeksforgeeks.org/word-processing-software/

Functions:

- It aids in the improvement of the sentence's grammar as well as spelling.
- In a novel approach, the typed documents may be stored and created.
- In addition to creating documents, this application allows for the basic editing and storing as well as printing of those documents or same.
- Using this feature, you may easily copy text, move it around, delete it, and then paste it somewhere else in your document.
- You may use it to change the font size and style of your text.
- It has the ability to create and modify table formats.
- Inserting diverse pieces from other program kinds is made easier with its assistance.

Advantages:

- It helps environment by minimizing the quantity of documentation that has to be printed out.
- Paper and mail waste are becoming less expensive.
- It's a tool for working with text in documents, such reports.
- It has a number of useful features, such as the ability to copy, delete, and format data.
- It aids in the identification of a feature of user interface.

- Your pages will have a consistent look and feel thanks to this tool.
- Repetitive chores can be done more easily using this tool.
- Desktop publishing software is included in the package.
- It saves time.
- The data exchange is dynamic in nature.
- There are no errors in the papers it generates.
- Ensure the safety of our files.

3.9. Presentation Spreadsheet

It has been almost the decade since the cloud-based spreadsheets were first introduced. There are the few web-based spreadsheets available, but the market for them is rapidly dwindling. This kind of the cloud-based service is now available, and we'll go through a few examples in the next sections. Google Inc.'s first big supplier of SaaS spreadsheet and the other office apps, Google Sheets1 is an online and the cloud-based spreadsheet.

Google's initial release was in 2006, and the company's capabilities have continued to grow ever since. Multi-user simultaneous editing, the cloud-based availability as well as storage, several export or import options as well as the REST API for the developers are some of its key features. A free version of the service is available, but there are also a few premium options.

Features of Google Sheets

1. Editing

With Google Sheets, spreadsheets can be edited in the real-time by several people. One document may be accessed by many persons and modified at the same time, instead of sending each person a copy of it. All modifications are immediately saved to the Google servers and may be seen by other participants.

Collaborators may also use Google Sheets' sidebar chat to discuss changes in the real-time and give suggestions. The Revision History function allows you to keep track of any changes made by your colleagues. The editor has the ability to go back and undo any modifications that were made in the past.

2. Explore

In September 2016, the Google Sheets debuted Explore feature, which utilises machine learning to provide new features. Data entered into the spreadsheet is used to power this function, which may then automatically update itself relying on new information.

There are a variety of options available in the Explore section of the spreadsheet for the users to manipulate their data. If you're putting out the monthly budget and have already entered all of your spending into spreadsheet, you may utilise the Explore function to find out how much food, transportation, clothes, and other relevant items will cost.

Toward the bottom of the page, there is the box where you may write in the question and it would return answer. Additionally, if you go deeper into the Explore panel, you'll find a list of recommended charts based on your spreadsheet's data and the option to switch between various types of the pivot tables and also the pie charts and bars charts as you see fit.

3. Offline editing

With Google Sheets' offline editing feature, users may make changes to their spreadsheets even when they are not connected to a computer or mobile device. Google Sheets and the other Google apps can only be edited offline using "Chrome browser" and "Google Docs Offline" Chrome plugin, both of which are available for free from Chrome web store. When utilizing Google Sheets on a mobile device, users must download Google Sheets mobile app for the Android and iOS.

4. Supported file formats

A wide variety of spreadsheet file types as well as formats are supported by the Google Sheets. It is possible to import spreadsheets and documents into the Google Sheets, modify them, save them, or export them. You can view and convert.xlsx,.xls,.xlsm,.xlt, and.xltx files in Google Sheets, among other formats.

5. Integration with other Google products

As the Google product, Google Sheets may be connected with a wide range of the other products and services. Using Google Forms, you may build a poll or questionnaire, for instance, before importing the data into the Google Sheets.

3.10. Databases

The term "cloud database" refers to the database service provided by the cloud computing provider. The advantages of the cloud computing outweigh the disadvantages of a conventional database. In order to use the database, users must install software on the cloud infrastructure.

Key features:

- A cloud-based database service that may be accessed through the web browser
- Hosts databases without the need for specific hardware
- User-managed or service-managed, depending on the supplier.
- NoSQL databases as well as conventional databases (like MySQL as well as PostgreSQL) are supported (including MongoDB as well as the Apache CouchDB)
- Utilizes the web interface or an API offered by the provider.

Benefits:

- **Ease of access**

Access to the cloud databases may be done using the vendor's API or the web interface, from any location, at any time.

- **Scalability**

The storage capacity of cloud databases may be increased in real time to meet changing demands. Organizations only pay for the services they utilize.

- **Disaster recovery**

Backups on distant servers provide data security in the case of the natural catastrophe, equipment failures, or power loss.

Considerations for cloud databases

- **Control options**

Users may choose between a regular database and the service provider's "Database as a Service"(DBaaS).

- **Database technology**

However, SQL databases are widely used, making them challenging to scale. NoSQL databases are more scalable, however certain applications do not operate with them.

- **Security**

It's important to explore the cloud database providers to find the best fit for your organization's needs.

- **Maintenance**

Make sure that IT employees could maintain virtual machine image's underlying architecture before employing it.

3.11. Desktop

End-user computing through the cloud desktops is a method in which the virtual desktops and apps are stored in cloud instead of in a company's on-premises data centre.

Cloud desktops working

Desktop virtualization technologies typically enable users to access the Windows desktops or apps operating in a separate physical location. This is made possible by a system that includes mostly of the following components:

- Datacenter-hosted server with one or even more instances of Microsoft's operating system
- Configuration as well as user assignment are handled by the "desktop virtualization infrastructure".
- Access from outside the data center may be secured using this gateway.

- Accessing the user's virtual desktop or the application from the endpoint device. The desktop, laptop, or the mobile device may be used for this. If you like, you may use it to access the virtual desktops and programmes as the "thin client" or just as the web browser.
- Video, keyboard, audio, and mouse data are sent between user's endpoint as well as desktop through the remote protocol.

Once remote protocol establishes the connection with gateway and the desktop virtualization infrastructure, user's endpoint device is routed to "virtual desktop" or application that's also allotted to them.

However, desktop virtualization as well as the datacenter resources are hosted and also managed by the third-party supplier using Cloud Desktops.

Benefits of the Cloud desktops.

For both enterprises as well as end users, the cloud desktops provide a wide range of advantages that are worth considering. Because cloud desktops are the virtual, the single virtual machine (VM) may handle a large number of users, resulting in cost savings. As a result, businesses don't have to spend time and money acquiring new laptops for their staff.

Businesses benefit from economies of the scale by spreading the expense of instance among numerous users, which is

made possible by Windows' ability to run multiple users on the single instance. "Multi-session" or "Remote Desktop Session Host" (RDSH) are other names for this feature. Virtual Desktop Infrastructure" may also be used for a one user to one instance strategy if necessary.

By using the cloud, clients will only be charged for resources that they really use at any given moment in time. It is not necessary for companies to purchase physical computers in order to quickly create fresh desktops for their workers. As soon as such resources are no longer required, the consumer is no longer billed for them. Other pricing structures exist, but the Cloud Desktops' use of the consumption-based pricing sets them apart.

Some further advantages of using cloud desktops may be found here:

Increased productivity. Workers may execute business-critical operations from anyplace they have an internet-enabled mobile device — at home, in airport lounge kiosk, in coffee shop, or nearly anywhere else they have access to the mobile device.

Savings. Cloud desktops may save organisations money in a variety of ways. As long as workers could access their desktop from any device, there is no need for the IT to spend CAPEX on providing them with pricey, "high-performance desktops or laptops" for work. Due to the fact that all of the hard work of computing is performed at cloud host, current client devices may have their lifespans

extended. Many firms discover that they may cut down on IT support costs on the month-to-month basis by reducing IT activities.

Enhanced security. Even most security-conscious enterprises can't match the physical protection offered by the hyper scale cloud providers. As a result, a lost or damaged device being used for accessing the "cloud hosted desktop" has no effect on data and programmes already saved in cloud.

Self-service simplicity. In seconds or minutes, the cloud desktops may be created, accessed, as well as de-provisioned. It's possible to deploy the cloud-hosted desktop while new hires are filling out the paperwork and then have it ready for the use by time they arrive at their workstation.

Increased agility. It is unnecessary to 'push' updates to the individual users when using the cloud desktops since they automatically get updates for apps and utilities. This implies that regardless of their preferred operating system, customers can access their virtual desktops and programmes from nearly any device but also have them at their fingertips where ever and whenever it is convenient for them.

3.12. Social Networks and Groupware

Social Networking

Grouping people and organisations together over a common medium, such as the Internet, to exchange ideas, thoughts, as well as activities is known as the social networking.

Facebook, LinkedIn, Twitter, Google+, and other "web-based social network services" are accessible to connect with individuals across the nation and across the world through the easy-to-use and engaging interface. Apps like Whatsapp, hike, Line, and others are also available for the mobile social networking.

3.12.1. Where Social Networking Helps

Facebook, Twitter, and Instagram are the most famous social media platforms in the following areas:

- **Online Marketing**

It is possible to develop an online presence for any product, group, or organisation using social networking sites like Facebook.

- **Online Jobs**

It is possible to connect with experts and obtain the job depending on someone's unique skill set by using the website such as LinkedIn.

- **Online News**

People also submit daily news on the social networking sites that helps us stay up to date.

- **Chatting**

As a result of social media, we are able to stay in touch with our loved ones. We're able to text back and forth with them.

- **Share Picture, Audio and video**

Images, music, and video may all be shared through social media sites like Facebook and Twitter.

It's unlikely that the social network group will satisfy for huge organizations. Collaborative technologies that allow the team members interact with one other and manage their group tasks are what you need alternative.

When it's hosted in cloud, this sort of solution is referred to as "online groupware". Collaboration software for the workgroups is referred to as groupware. With the online groupware, members of an organization may access group's assets no matter where they are in a world.

Significance of Groupware

- All of your group conversations (and, in certain circumstances, files) may be found in one place, available to the members of group from any location with the Internet connection, making it easier for everyone to participate in the group discussion.

- It must be possible to minimize number of the meetings and also the conference calls including the email traffic by using groupware.
- As a result, your group's productivity and that of its members must rise. That's all there is to it.
- Let's say you're in charge of a non-profit organization in your neighborhood. Use "online groupware" to link management and volunteers from throughout the community. You may use groupware to request and receive bids and bills from vendors, as well as to exchange plans, proposals, as well as the other documents with all the members. Because this could be done from own computer, you won't have to travel, that means less time as well as less money spent on useless meetings and also the phone calls, both of which are crucial for charity.

Some of the most widely used online collaboration tools are:

AirSet

It's possible to build up the website for your organisation using AirSet (www.airset.com). Group announcements, contact lists, web calendars, to-do lists, as well as the instant messaging may all be included in the AirSet site, as could wikis that allow users to work together on content creation, blogs that allow users to post their own content, and even picture albums and also the music playlists. With all of

these technologies, each modification made by one member of the group is immediately visible to the rest of the group.

ContactOffice

Figure 3.7 Contact Office[*]

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[*]https://alternativeto.net/software/contactoffice/about/

It's possible to exchange documents, appointments, contacts, emails, tasks, and more with the other members of the group using "Contact Office" ("www.contactoffice.com"). You may set up groups both inside and across companies, the latter of which allows you to engage with individuals outside of the immediate workplace, such as clients as well as suppliers. Additional features include online calendar, message forum, address book, and live chat. "Virtual office" dashboard page is seen in "ContactOffice dashboard" figure 3.7.

Huddle

It is the hosted environment which integrates project management, online collaboration, including document sharing with "social networking principles". A single dashboard manage the network of collaborative workplaces for your team. It is now possible to use all of Huddle's collaboration capabilities such as online file storage as well as the project calendar as well as RSS feeds and email alerts.

Google Sites

You may establish the group web page hosted by the Google using "Google Sites" ("sites.google.com"), which was formerly referred as "Jotspot". Your choice of the announcements, file uploads, mailing lists, task/project management, and like may be found on this page. "Google Calendar", "Gmail", "Google Docs", as well as "Google Talk" are just a few of the online services that are integrated

with the Google Sites. It's also absolutely free, as is the case with the most Google products.
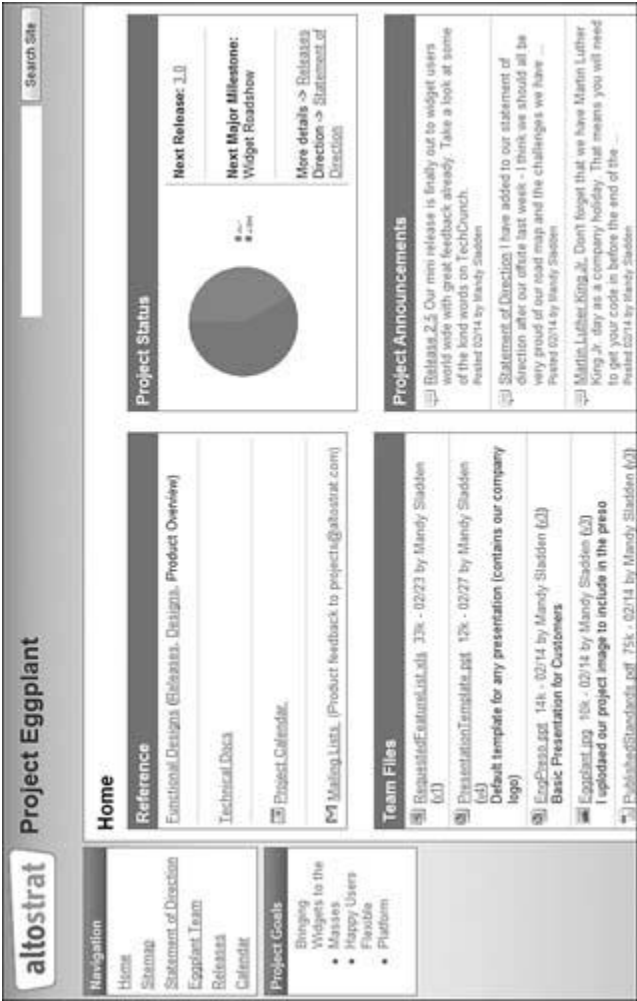
Figure 3.8 A typical Google Sites group page[*]

[*]https://www.wmlcloud.com/internet/collaborating-via-social-networks-and-groupware-evaluating-online-groupware/

Nexo

Create the free group website with Nexo (www.nexo.com). Photos, forums, videos, calendars, message boards, polls, and also to-do lists may all be included into the website's design. Nexo primarily serves families, friends, and communities, although it might be used by certain less-demanding corporate organisations. (Figure 3.8 depicts a young sports team's practise facility.

Figure 3.9 A Nexo group site for a youth sports team[*]

[*]https://www.wmlcloud.com/internet/collaborating-via-social-networks-and-groupware-evaluating-online-groupware/
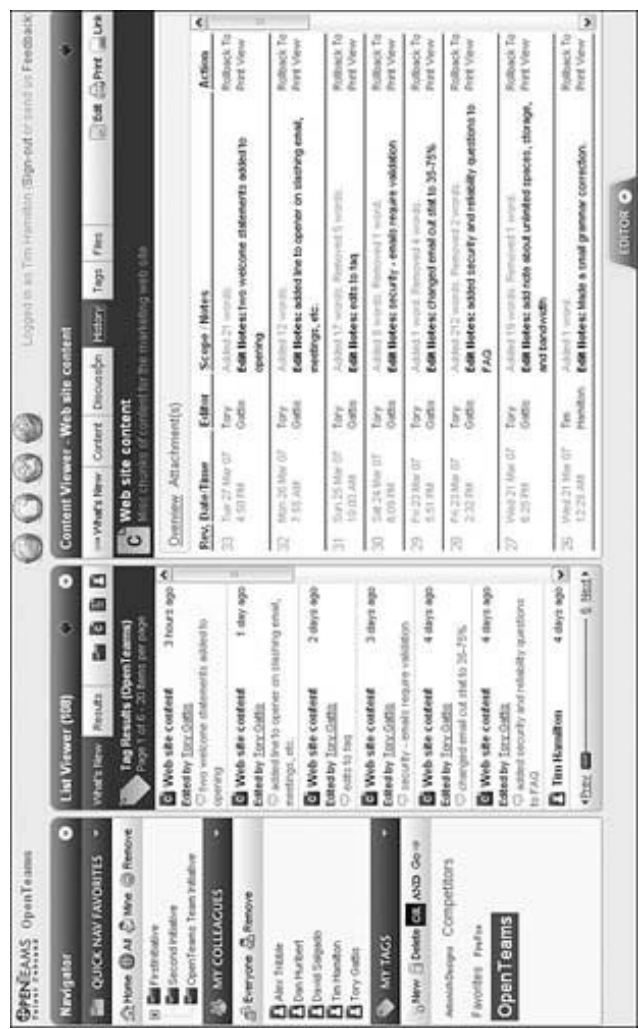
OpenTeams

Figure 3.10 The OpenTeams Navigator[*]

It is best suited for big enterprises to use Open Teams ("www.openteams.com"). Figure 4 shows the customizable Navigator page, which provides access to team files, blogging, including wiki-like collaborative sites. Keep tabs on important team members, tag resources, engage in threaded conversations, and also monitor new information submitted by the team members from this page.

ProjectSpaces

There is a web-based workspace available called ProjectSpaces (www.projectspaces.com) that is specifically developed for collaborative collaboration. As a group member, you will have access to the shared document library, the shared calendar, the shared email discussion list, the task management capabilities as well as email and RSS group notifications.

Virtualization for cloud

4.1.   Virtualization for cloud

There are many ways to describe virtualization: a desktop, a server, the operating system are all examples of things that may be "virtualized."

Virtualization is a technology that enables numerous consumers and organizations to share the single physical instance of the resource or the application. Assigning a virtual name to an actual storage location and enabling access to that location when needed is how it does this.

Separating a service from its underlying physical delivery through virtualization is the common practice in the IT industry. It's a method for making a digital replica of a physical object, such as a piece of the computer hardware. In the beginning, it was developed using mainframe computers. When a computer resource is produced using software, instead of real resource, it is known as the "virtual" resource. It is possible to run many operating systems as well as applications at once, boosting the usage and also the flexibility of the hardware, thanks to virtualization.

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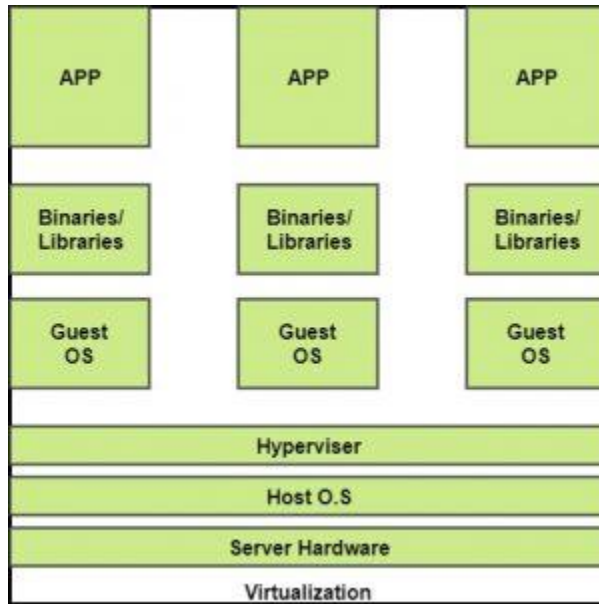
Figure 4.1 Virtualization[*]

In other ways, cloud providers employ virtualization as a key cost-saving, hardware-reducing, as well as the energy-saving strategy. Multi-user and multi-organization access to resources and applications is made possible by virtualization. It does this by giving the physical storage device the logical name and then on-demand supplying the reference to that resource. Many people use the word "virtualization" as the synonym for the "hardware virtualization," which really is critical to the successful delivery of the cloud computing "infrastructure as a

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[*]https://www.geeksforgeeks.org/virtualization-cloud-computing-types

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service" solutions. As a result, virtualization technologies offer the virtual environment for not only running programmes, but also for storing, storing, as well as networking data.

It's Host Machine which is going to host "virtual machine"; virtual machine" itself is considered to as "Guest Machine".

4.2. Need for Virtualization

The following are the 5 most important reasons for using virtualization:
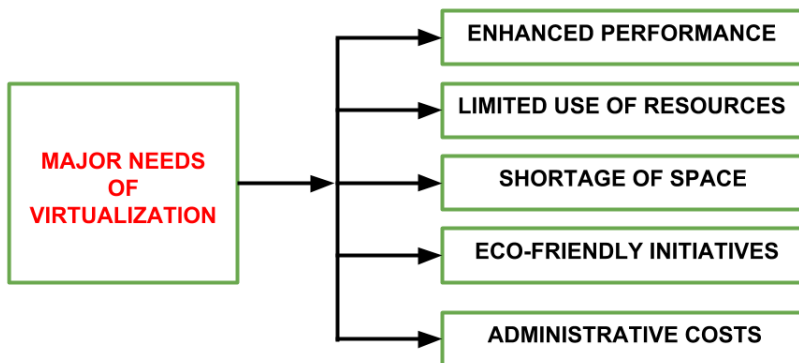
Figure 4.2 Need for Virtualization[*]

1. Enhanced performance

End-user systems, i.e., personal computers, are now powerful enough to meet all of user's fundamental

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[*]https://www.geeksforgeeks.org/need-of-virtualization-and-its-reference-model/

processing needs, as well as a number of optional features that are seldom utilized. Most of their systems are capable of running the virtual machine manager as well as executing the virtual machine with reasonable speed.

2**. Limited use of hardware and software resources-** Hardware as well as software are being underutilised because of inefficient usage. Several of user's computers are often utilised since they are capable of being used 24 hours a day, seven days a week, without any interruption. It is possible to boost the efficiency of the "IT infrastructure" by using such resources outside of normal business hours. Virtualization makes it feasible to achieve this environment.

3. Shortage of space

Data centres are expanding at a fast pace due to the constant need for more memory storage and processing power. Microsoft, Google, and Amazon, for example, create their own data centres to meet their own requirements. Businesses that can't afford to expand their data centres are the most common. This leads to the widespread use of the technology known as the "server consolidation".

4. Eco-friendly initiatives

Currently, businesses are actively looking for new ways to reduce the amount of electricity their systems use. Data centres are major users of electricity, and they need a constant supply of power and also a substantial quantity of energy to stay cool. Because a number of the servers is

reduced, the amount of electricity as well as cooling required is reduced as a result of the server consolidation. Virtualization is a powerful tool for reducing the number of servers in a network**.**

5. Administrative costs-

In addition, the need for additional servers in the data centre, which results in the increase in administrative expenses, is also to blame. Common system administration responsibilities includes server setup, hardware monitoring, and upgrades, server resource monitoring, faulty hardware replacement, and backups. These really are operations that need a lot of people. As number of the server's increases, so does the administrative expense. Because fewer servers are needed to handle the given workload when using virtualization, administrative costs are reduced.

4.3. Pros and cons of Virtualization

4.3.1. Pros of Virtualization in Cloud Computing

Utilization of Hardware Efficiently –

Virtualization helps both the customer and cloud service provider get the most out of their hardware. As a consequence, the user's reliance on the physical hardware system is reduced, resulting in lower costs. Hardware virtualization may be used by service providers to reduce the amount of hardware they need to purchase from

vendor, hence reducing the amount of the hardware they need to deliver to end user. As a result of virtualization, the companies and organizations no longer need their own servers, engineers to monitor their performance, and additional hardware costs; instead they can use Cloud vendors to provide the Physical Services without any need for the physical hardware systems to be set up or maintained.

Availability increases with Virtualization –

Advance capabilities in virtualization make it possible to keep the virtual instance running 24 hours a day, every day. A difficult and dangerous activity in the server-based system is moving the virtual instance through one virtual server to the other. It safeguards data as it is being transferred through one server to the other. In addition, we may access the information from any place and also at any time, using any device.

Disaster Recovery is efficient and easy –

Using virtualization to do tasks such as backup, data recovery, and duplication is a breeze. If server system is destroyed in some way due to a catastrophe, data recovery is unlikely using the usual technique. Virtualization, on the other hand, makes the real-time data backup, recovery, including mirroring a simple procedure that guarantees zero data loss.

Virtualization saves Energy –

Virtualization would save energy since number of the server's drops while shifting from the physical servers to the virtual servers, resulting in a reduction in the monthly power & the cooling costs. As the cost of cooling falls, so does the amount of carbon dioxide emitted by equipment, resulting in a cleaner, more open atmosphere.

Quick and Easy Set up –

Setting up the physical system as well as servers the old-fashioned way takes a long time. To begin, place bulk orders and then patiently await delivery. After shipment is completed, wait for setup and afterwards spend time installing necessary software and etc. This is going to take a long time. As a consequence, the whole procedure may be completed in a short period of time, resulting in an efficient setup.

Cloud Migration becomes easy –

Shifting to a cloud is a concern for many businesses that have already been invested heavily in server infrastructure. Cloud services, however, are more cost-effective since all of the data which is now on company's servers could be quickly transferred into cloud server as well as save money in the form of the power consumption and the cooling costs, as well as the cost of the server maintenance engineers.

4.3.2. Cons of Virtualization

Data can be at Risk

Working with virtual instances on the shared resources implies that our data is stored on the third-party resource, putting it at risk. Our data is vulnerable to assault by any hacker who wants to get access to it. If we don't have the security solution, the data we have is at risk**.**

Learning New Infrastructure

As the company transitioned from on-premises servers to the cloud. They needed people who are comfortable working on the cloud. The corporation must either acquire new IT employees with the required competence or give training on that ability, which increases the expense of the organisation.

High Initial Investment

Although virtualization would save firms money, the initial outlay for cloud computing is higher. It offers a slew of other services that aren't essential, and companies that aren't tech-savvy end up paying for them when they attempt to set up in cloud.

4.4. Types of Virtualization

Various methods of virtualization implementation are used based on the applications involved. There are 7 basic forms of the virtualization.

Figure 4.3 Types of Virtualization[*]

1. OS (Operating System) Virtualization

The operating system is a word you've probably heard before. This is the well-known phrase among the computer users, and it has even made its way onto smartphones. In order to run properly, our computers need operating systems. Why do technicians sometimes say that the operating system is faulty? Because they believe that you can't do anything because it isn't working, and etc? Businesses construct and also visualize operating systems for the variety of reasons. Enterprises benefit from this since it reduces the costs and time associated with creating their own operating systems from scratch.

These operating systems being virtualized and hence accessible to anyone throughout the globe. Typically, the operating system is offered to customers for a one-time

[*]https://www.jandjtech.com/managed-service/virtualization/seven-different-types-of-virtualization/

price. Upgrades are routinely carried out by the OS's creators, who then notify you that you should do the same.

2. Application-Server Virtualization

Since the beginning of the virtualization, Application-Server Virtualization has indeed been around. Developed servers are relocated to virtual environment, like the other forms of the virtualization, to serve many users. In order to do this, the physical server is partitioned into many unique and isolated virtual servers. In most cases, the software program is used to do this. After that, every virtual server runs the operating system on its own virtual machine. This reduces the complexity of the server, improves application performance, and speeds up the deployment of new workloads.

Web hosting firms mostly use Application-Server Virtualization to deliver fast as well as the secure web hosting services. In the absence of virtualization, servers are only able to use a small portion of their power. The outcome of this is that the server would be idle since burden is divided across a limited number of the servers on a network. Also, data centers will become overcrowded with the servers that are not being used.

3. Application Virtualization

Make no mistake: This is not the same as virtualizing an application server. When we execute virtualized apps, they seem to be stored on the computer's hard drive as if they

were the natural part of the operating system. There is a server behind all of these apps. Despite the fact that they function off of your computer's RAM as well as CPU, all of the data is really kept on a remote server. Such apps include "Microsoft Terminal Services" as well as "cloud-based software". Such applications may be installed on the device, but you have no control over them; the creator, for example, might update them from their servers, which you are unaware of.

4. Administrative Virtualization

This kind of virtualization is used to distribute administrative responsibilities across a variety of the system users. Most often, it's utilised in data centres to establish user roles. As a result, certain files, servers, and other resources may be accessible to one user but not accessible to another. Application or the server user policies are used to do this. A user's ability to read files as well as other data is limited, but they can't make any changes.

5. Network Virtualization

Virtualization, as you may already be aware, is the process of putting a previously built software that performs a certain function into the purely virtual environment, namely the internet. In terms of the network virtualization, all of the actual networking equipment is combined into the single piece of software. This software is then made available to the broader public as a service on the internet. As part of the network virtualization process, servers and

other devices are given their own dedicated channels of bandwidth.

Network virtualization may help enterprises with a big number of users which need to maintain their systems functioning at all times benefit from the technology. It aids in the efficient delivery of services by speeding up networks.

6. Hardware Virtualization

OS virtualization is a good analogy for this. A hypervisor, also known as the virtual machine manager, is used to achieve hardware virtualization. The hypervisor creates virtual machines as well as operating systems and merges them into the single physical server. In this way, hardware resources may be better used. Users may also run several operating systems simultaneously on the same machine.

7. Storage Virtualization

Storage virtualization includes combining physical hard discs into the single application as well as pushing to internet for the virtual access. This may be the simplest and most cost-effective kind of the virtualization to install. Cloud storage systems are feasible because of virtualization. It offers safe data storage as well as the data backup as well as recovery. Dropbox. Instances of the cloud storage services include Google Drive, Dropbox, and so forth.

4.5. System Vm

Using such sorts of the virtual machines, we have a full operating system platform and also the ability to run it. An OS may be installed in its entirety using system virtual machine, just as it does with the virtual box. For example, we could see in the figure below how the two "simulated operating systems" are running on the "Real Machine hardware". Then, in a distributed hardware of the simulated computers, various applications and also the processes are running.
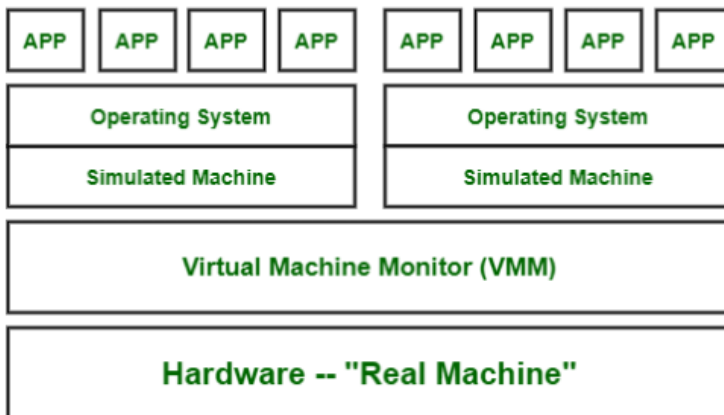
Figure 4.4 System VM[*]

4.6. Process VM

Unlike "system virtual machines", which allow us to install the "virtual operating system" entirely, process the "virtual

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[*]https://www.geeksforgeeks.org/types-of-virtual-machines/

machines" do not. While utilising the app or program, it generates the virtual environment of that OS, which would be deleted as soon as we quit the app. There are certain programmes running on primary operating system, and also number of virtual machines that may be used to run other applications. This demonstrates that for time being, these applications are executing since the process virtual machine supplied them with a distinct operating system.

Example

Linux users may use Wine to run the Windows programmes.
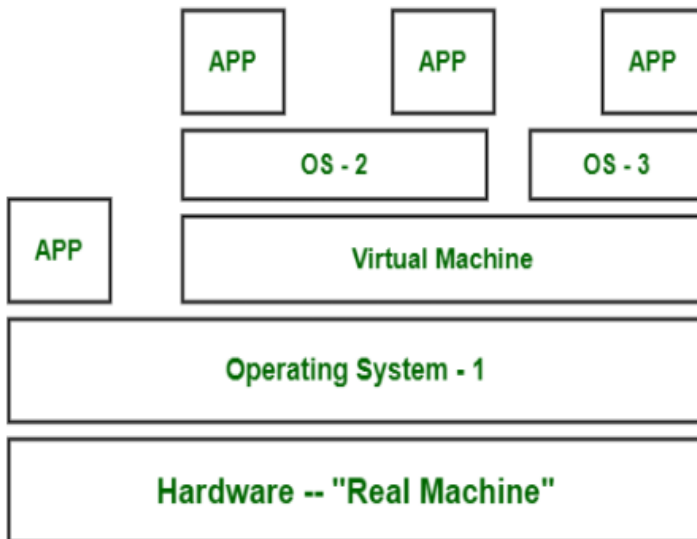
Figure 4.5 Process Virtual Machine[*]

4.7. Virtual Machine monitor

In order to create, administer, and control virtual machines (VMs), the "virtual machine monitor" is the piece of software which runs on the top of the real host system.

"Virtual Machine Manager" (VMM) and "Hypervisor" are other names for VMM. Vendor products, on the other hand, provide varying degrees of architectural execution and service.

When it comes to virtualization setups and implementations, VMM is the go-to program. VMM allows the construction of virtual machines, every with its own operating system and set of apps, on top of a host computer. VMM allocates the appropriate processing, storage, memory, and the other input/output resources to such virtual machines.

VMs that are deployed on the single server or distributed across many and linked hosts may also be managed using VMM's centralized interface.

Virtual machine properties

1. Increased Security –

Controlling the guest program's execution in the totally transparent way provides new opportunities for creating secure, controlled execution environments. A virtual machine is used to accomplish all of guest programs'

activities that are subsequently translated and applied to the host applications.

It is possible for the virtual machine manager to monitor as well as filter all of the guest applications' activities, preventing potentially hazardous ones from taking place. The resources that the host has made available to the visitor might be concealed or merely safeguarded. When working with the untrusted code, increased security is must.

Example-1:

Cuckoo sandboxes may be used to examine untrusted programmes.

The isolated execution environment wherein the instructions may be screened and stopped before they are translated and performed in actual execution environment is referred to as a sandbox.

Example-2:

The term "sandboxed" relates to a certain configuration of "Java Virtual Machine" in which instructions which are deemed potentially hazardous may be prohibited via the use of security policies.

2. Managed Execution –

The most important aspects are aggregation, sharing, emulation, as well as isolation.
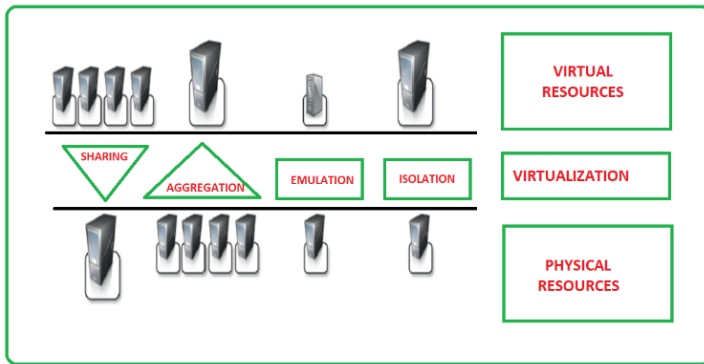
Figure 4.6 **Functions enabled by a managed execution**[*]

3. Sharing

Using virtualization, it is possible to create many computing environments on a single host computer. In order to minimize the number of the servers in operation as well as reduce the power consumption, this functionality is employed.

4. Aggregation

Sharing the physical resources across several guests may be done, but the virtualization also permits aggregation, which would be the reverse. The single virtual host may represent a collection of several hosts who have been linked together. With the "cluster management software", a homogenous set of computers' physical resources may be tapped and represented as the single resource.

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[*]https://www.geeksforgeeks.org/characteristics-of-virtualization/

5. Emulation

Guest applications run in the "virtual environment controlled" by "virtualization layer", a program. Another advantage of virtualization is the ability to run guest applications that need special qualities that are not available on the physical host.

6. **Isolation**

Virtualization provides a fully independent environment for guests, whether they be operating systems, programmes, or the other entities. Accessibility to underlying resources is provided through the abstraction layer that is used by the guest application. Using the virtual machine's filters, it is possible to keep the host safe from attacks by the guest.

In addition to these features, virtualization also makes it possible to fine-tune performance. Because to the significant advancements in the virtualization technology and also the software, this functionality is now a reality. Fine-tuning the parameters of resources accessible by virtual environment makes it simpler to regulate performance of guest. This functionality makes it possible to create a QoS infrastructure in an efficient manner.

7. Portability

Depending on the kind of virtualization being addressed, the idea of the portability may be used in many ways.

When using hardware virtualization, the guest is packed into the virtual image that could be securely relocated and performed on top of other virtual machines in most situations.

Binary code representing the application components (jars or the assemblies) may execute without the recompilation on any implementation of relevant virtual machine when programming-level virtualization is used, as in JVM or.NET runtime.

4.8.   Interpretation and Binary translation

Binary Translation
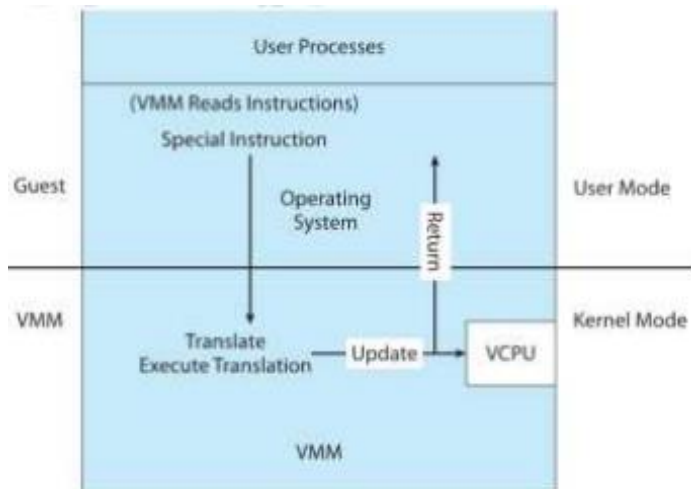
Figure 4.7 Binary Translation[*]

[*]http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000
007CS/P001073/M023262/ET/1505968591CC-mod25-Q1-eText.pdf

Hardware virtualization may be divided into the two types depending on the technology used to achieve it: "full virtualization" and "host-based virtualization". A host OS doesn't have to be modified for "full virtualization" to work. In order to catch as well as virtualize execution of some nonvirtualized instructions, it uses binary translation. Each guest OS has both the non-critical as well as the critical instructions, which make up the programmes that run on it. Host OS as well as guest OS are utilised in the host-based system. Between the "host OS" and the "guest OS", the virtualization software layer is created. Next, we'll present two types of virtual machine architecture.

1. Full Virtualization

All "non-critical instructions" are moved to VMM, where they may be mimicked by software, while the crucial ones are found as well as replaced with the traps. Full virtualization may be achieved using the hypervisor as well as the VMM. Why is the VMM only able to save essential instructions? For this reason, it's best not to employ binary translation. Unlike noncritical instructions, the critical instructions control hardware and pose a danger to system's security. Running "non-critical instructions" on the hardware not only increases efficiency, but also provides security.

Binary Translation of Guest OS Requests Using a VMM

Several software businesses, including VMware, have adopted this strategy. VMware places VMM in Ring 0 as

well as guest OS in Ring 1, as seen in Figure 4.8. The VMM analyses the stream of instructions to identify those that are sensitive too, control, privilege and behaviour. When such instructions are found, VMM emulates their behaviour by capturing them. This emulator employs a technique known as the "binary translation". As a result, "binary translation' and "direct execution" are both included in complete virtualization. The underlying hardware is totally isolated from guest OS. As a result, the virtualized operating system has no idea that it is virtualized.

Binary translation is the time-consuming process, therefore complete virtualization might not have been the best option. Particularly difficult is the complete virtualization of the I/O-intensive applications. In order to boost efficiency, binary translation uses the code cache to store translated hot instructions. However, this increases memory use. A comprehensive virtualized implementation on an x86 platform often performs between 80 and 97 percent better than the host computer.

2. Host-Based Virtualization

An alternate VM design is to build the layer of the virtualization on top of a host operating system. A hardware is still under the control of the host operating system. A virtualization layer serves as a foundation for guest operating systems, which are installed and operate on top of it. The VMs are capable of running standalone apps. It's possible that certain additional apps could run directly

on host operating system as well. The following are some of the benefits of such host-based architecture.
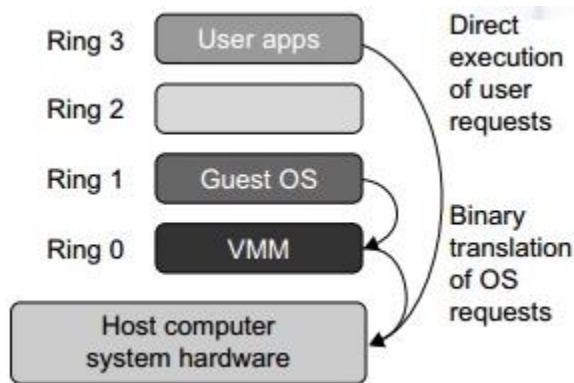
Figure 4.8 Host-Based Virtualization[*]

First, the user does not have to alter the host operating system to install such VM architecture. When it comes to device drivers and the other low-level functions, virtualizing software might depend on a host operating system. This would make it easier to create as well as deploy the virtual machine.

There are several machine configurations that are suitable for the host-based method. A host-based architecture's performance might well be inferior to that of "hypervisor" or "VMM architecture". When the application asks for the hardware access, four levels of the mapping are used, considerably slowing down performance. Binary

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[*]https://www.brainkart.com/article/Binary-Translation-with-Full-Virtualization_11335/

translation is required when ISA of the guest OS differs from ISA of an underlying hardware. A performance of host-based architecture is insufficient for practical application, notwithstanding its flexibility.

4.9. Hypervisors

This program is used in the Cloud hosting to split and distribute the resources on different pieces of the hardware. The virtualization hypervisor is a software that enables segmentation, isolation, or abstraction. It is possible to run a number of different guest operating systems on the single host computer using the hypervisor, which is the virtualization technology. The "hypervisor" is often referred to as "virtual machine manager".

Types of Hypervisors

TYPE-1 Hypervisor:

Directly on a host system, it executes the hypervisor. Native Hypervisor or the "bare metal hypervisor" is another name for this kind of operating system. It doesn't need the server operating system of any kind to run. This software has the direct access to the computer's hardware resources. The "Citrix XenServer hypervisor", "VMware ESXi hypervisor", and "Microsoft Hyper-V hypervisor" are all instances of the "Type 1 hypervisors".

Pros & Cons of Type-1 Hypervisor:

- **Pros:** Since they have the direct access to actual hardware resources, these types of hypervisors are extremely efficient (such as Memory, Cpu, Network, as well as the Physical storage). There is no 3rd resource that the attacker may utilize to compromise security as a result of this, making the system more secure.
- **Cons:** To run Type-1 hypervisors, you often require a separate computer that really can train VMs as well as manage "host hardware resources". This is a drawback of "Type-1 hypervisors".

TYPE-2 Hypervisor

An "underlying host system" serves as the foundation for the "Host operating system". Hosted Hypervisor" is another name for it. The application on the host system instead of running directly on underlying hardware is the kind of the hypervisor. The operating system is required to run the program. The hypervisor makes hardware requests to operating system. The illustration of the "Type 2 hypervisor" is "Parallels Desktop", or "VMware Player". Endpoints, such as PCs, often the "host hypervisors". It is very beneficial to engineers as well as security analysts to utilise "type-2 hypervisor".

Pros & Cons of Type-2 Hypervisor:

- **Pros:** Using a hypervisor like this, you can run the guest operating system on a separate computer while host is running. Additional functionality for the guest computers are common in such hypervisors. These technologies make it easier for the host as well as guest machines to work together.
- **Cons:** The efficiency of such hypervisors lags in comparison to "type-1 hypervisors", and possible security issues are also there, since an attacker may breach the security flaw if he has access to "host operating system", thus he could access a "guest operating system".

4.10. Xen

Xen is the para virtualization-based hypervisor that is free and open source. It is the most often used Para virtualization technique. Xen has been enhanced to work with the hardware-assisted virtualization for complete virtualization of a system. It allows the guest operating system to run at the high level of efficiency. In order to do this, it is likely that Xen will change a section of "guest operating system" it is running in order to remove any performance degradation caused by the instructions that need a considerable amount of processing. Since the majority of commodity PCs and also servers run on x86 platform, this is a must-have.

User Application
(Unmodified ABI)

User Domains
- Guest OS
- Modified codebase
- Hypercalls into Xen VMM

Privileged Instruction

Xen Hypervisor (VMM)
- Memory management
- CPU state register
- Devices I/O

Hardware TRAP

Hardware x86

Ring 3
Ring 2
Ring 1
Ring 0

Management Domain
- VM Management
- HTTP Interface
- Access to Xen Hypervisor
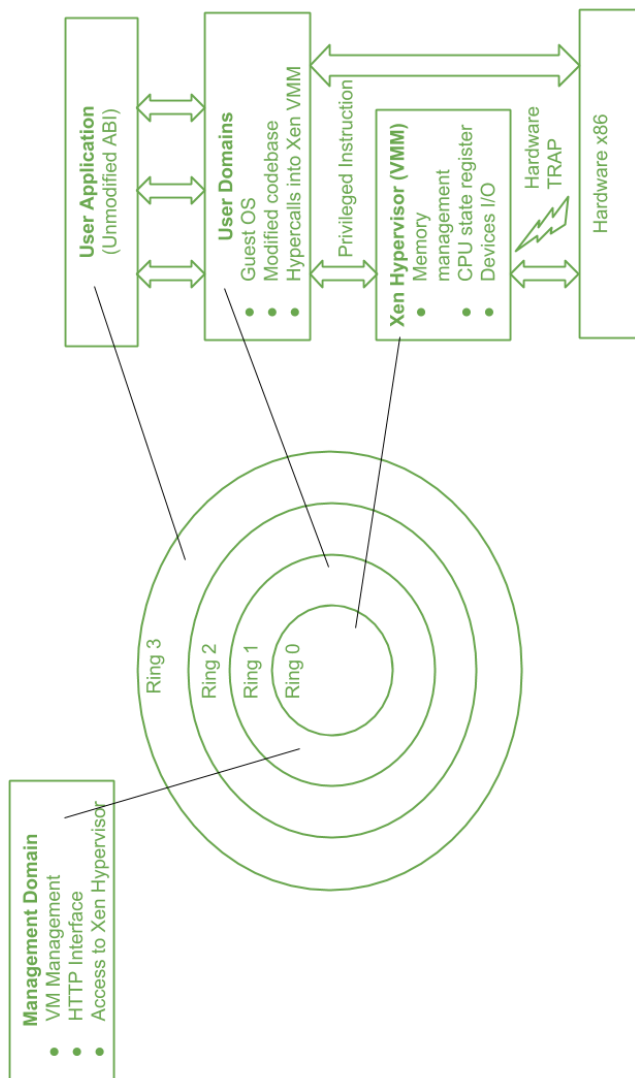
Figure 4.9 Xen Architecture and Guest OS & Management [*]

A conventional x86 privilege model is shown in the figure4.9, which shows how tXen Architecture is mapped to it. The "Xen hypervisor", which is performed in a most privileged mode as well as preserves guest operating system's access to fundamental hardware, is used in a "Xen based system". Virtual machine instances, or domains, are used to execute guest operating systems.

A unique domain called Domain 0 is reserved for control software that has access to host and manages all the other guest operating systems. "Virtual machine creation", "configuration", as well as "termination requests" are sent to HTTP server after the "virtual machine manager" has completely started up and only one loaded. With this component in place, the principal shared "virtual machine manager" for Cloud computing system that provides "Infrastructure-as-A-Service" solution may be established and maintained.

4.11. KVM

In order to run Linux on the x86-based CPU architecture, the virtualization infrastructure known as "kernel-based virtual machine" is used.

KVM is the virtualization technology as well as service created by "Red Hat Corporation" for "Linux operating system". Linux is the core operating system that KVM is built on top of.

Working of KVM

As a "type-1hypervisor", KVM transforms Linux. VMs can't operate on any hypervisor without certain operating system-level components, including the process scheduler, the memory manager, the input/output stack as well as device drivers. There are all these features in KVM since it's a "Linux kernel component". VMs are built on top of the normal Linux scheduler and have their own specialized virtual hardware, such as graphics adapter, network card, memory, CPU(s), and storage.

Implementing KVM

Finally, the operating system should have been published after 2007 and must be installed on an X86 machine with virtualization capabilities. The "host kernel module" as well as the "processor-specific module", "an emulator", and any other drivers which are needed to run multiple systems are all which is required if both of the boxes are ticked.

The Linux distribution that supports KVM, such as RHEL("Red Hat Enterprise Linux"), increases the capabilities of KVM by allowing resource swapping, sharing of libraries, speed optimization and many other things.

4.12. VMWare

Palo Alto, California-based virtualization as well as "cloud computing software" company VMware is known for its

products. VMware was founded in the year 1998 and is now part of "Dell Technologies". The "bare-metal hypervisor ESX/ESXi" in "x86" architecture is the foundation on which VMware builds its virtualization technologies. There is no requirement for a main operating system for the bare-metal embedded hypervisors. The hypervisor is placed on the actual server to enable for several virtual machines to operate on the very same physical server, using the VMware server virtualization. As each virtual machine may operate its operating system, a single physical server could host numerous operating systems. VMs on the very same physical server share the resources, like network bandwidth as well as RAM, among other functions.

Network as well as security management capabilities are included in the VMware products, as are storage solutions. For the large-scale implementation and management of VM infrastructures, "VMware vSphere" is the ideal platform. It is possible for IT organisations to deploy the application workloads on the most cost-effective computational resources available via the use of "VMware vSphere".

VMware provides desktop and the server applications. VMware's desktop software runs on Windows, Linux, and Mac OS X. VMware desktop offerings includes Fusion, Workstation, and Player. ESX, ESXi, and the VMware Server all fall under the VMware server software umbrella. When it comes to deploying Linux-based virtual machines on-premises or in a cloud, VMware has become an official SUSE Alliance Partner since the year 2004. For

both the private as well as the public clouds, "SUSE" and "VMware" have teamed to create a trustworthy data centre virtualization solution. The most recent version of vSphere is compatible with "SUSE Linux Enterprise Server".

4.13. Virtual Box

The open-source tool for virtualizing the x86 architecture, VirtualBox is free as well as open. It was created by "Oracle Corporation". As the hypervisor, it creates Virtual Machines in which a different operating system may be installed and used by the user. It's the operating system on which VirtualBox is running. It is virtual machine's "guest" OS that runs. VirtualBox can run Linux, Windows, Open Solaris, Solaris, as well as MacOS as host operating system.

Users may choose how many CPU cores and just how much RAM as well as disc space to provide to the virtual machine while setting it up. It is possible to "pause" a virtual machine while it is operating.

History of VirtualBox

To begin with, it was created by Innotek GmbH in Germany. On January 17th, 2007, the open-source software programme known as VirtualBox was made available. The firm was eventually bought by "Sun Microsystems". On January 27, 2010, "Oracle Corporation" acquired Sun Microsystems and also took over the production of VirtualBox.

Features of VirtualBox

VirtualBox has a wide range of capabilities. Listed below are a few of the most important attributes:

- **Portability**

Because it is the "Type 2 hypervisor" cross-platform OS, the Virtual Machine created on one host may operate on any number of systems that have Virtual Box installed. The Open Virtualization Format allows for the guest virtual machines to be imported as well as exported as needed.

- **Guest Addition**

Additional host system interaction as well as the communication are provided by these sets of utilities installed on Guest OS.

- **VM Groups**

VirtualBox has the ability to work in groups. As a result of this feature, users may arrange virtual computers both individually as well as collectively. If you're working with classes of virtual machines, like single virtual machines, you can generally apply actions like start, close, pause, shutdown, reset, power off, save state, and etc.

- **Hardware Support**

VirtualBox supports the multi-screen resolution, the Guest SMP, USB devices, the built-in iSCSI support, complete

ACPI compatibility as well as PXE network boot in addition to VirtualBox itself.

- **Snapshot**

A save snapshot function in VirtualBox provides guest with information about the status of the VM. We will be able to retrieve the virtual computer at some point in the future.

Working of virtual box

Oracle

There's no limit to what you can do using VirtualBox. It's not too difficult to virtualize a software application in principle. VirtualBox allows us to run a variety of the operating systems on top of it. It is possible to pause and stop any operating system individually.

As the Ring zero kernel service, hypervisor is used. vboxsrv is the device driver utility included in a kernel. For example, such device driver may load hypervisor modules for the functionality, allocate physical memory to digital guest machine, save and reload visitor technique context, among other things. A different operating system may commence execution and determine whether VT-x or AMD-V operations should be handled if the interruption occurs.

During the course of the application's execution, the user supervises OS scheduling. The user is the single process running on a host system, and is scheduled by the host. In addition, when the user allows the OS to access

the resources such as community controllers, drives, and the other devices, additional device drivers are available. Other processes are running on host to aid running guest. When the guest VM is started from "VirtualBox GUI", "VBoxSVC process" launches automatically in a background.

4.14. Hyper-V

A virtualization technology called "hypervisor" by Microsoft, "Microsoft Hyper-V" allows administrators to run different operating systems on the very same physical server at a same time.

Server operating systems inside the data centre can be virtualized, as can "Windows phone environments" on the desktop, and almost anything in between could be virtualized using Microsoft Hyper-V. Also helpful for engineers who wish to run tests in a safe environment.

Virtualization was barely taking off when "Microsoft Hyper-V" made its debut in the year 2008. Few people were aware of its existence, never alone what it might be used for. Putting it all into action and keeping it running seems dangerous and difficult from a conceptual standpoint.

A lot has happened in a short period of time. As a result, virtualization is now widely used. It is surrounded by data centres. It's a must for programmers. It is essential for cloud providers.

Microsoft's product has kept pace with the increasing demand for its services. Microsoft Hyper-V is fast catching up to VMware ESXi, the corporate the virtualization market leader.

For those of you who have been holding out for such technology to evolve before diving in, now is the moment.

Hyper-V working

To have a better understanding of how virtualization works before getting into Hyper-V, you may want to spend the few minutes familiarising yourself with the fundamentals. Hyper-V deployment and operation might be hindered by a lack of understanding of the fundamentals.

To get things started, we'll need a computer. The hardware is where you begin. The motherboard, RAM, CPU, hard drive, and display all go into making this. The first piece of software to be installed on a computer is the operating system. All that gear has to be organized, and it's up to it to keep track of it all. For example, the keyboard as well as mouse may be used to interact with it. Directing output to printers, screen, and the other devices is the closely connected function.

Regardless of whether or not you are aware of it, virtualization is taking place in the figure As a matter of fact, "virtualization" is only a synonym for "abstraction." The operating system's primary role is abstraction. Unless you have a lot of time on your hands, you won't be able to learn

how to communicate with the CPU using binary instructions as well as data. The printer abstraction is presented in this way by operating systems so that users may submit print jobs. The print job which you produced was based on the abstraction of document which you were working with. Abstractions include the desktop icons as well as mouse cursor.
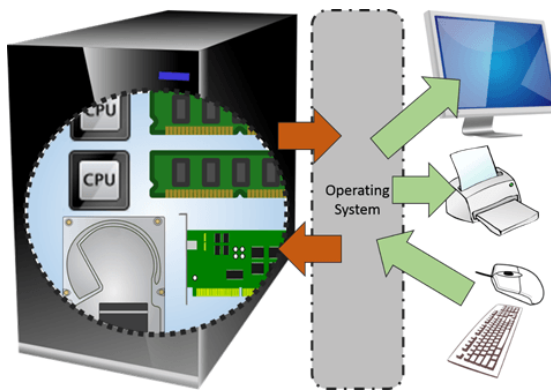
Figure 4.10Virtualization taking place [*]

This degree of abstraction is further enhanced by the use of a hypervisor. This may be seen in word's origin. What we now refer to as the "operating systems" were formerly referred to as "supervisors." Using the prefix "hyper-" in popular Western idioms has evolved to indicate "super-exceeding". That's how we came up with the name "hypervisor," which means a manager of other managers. This is how it appears on paper:

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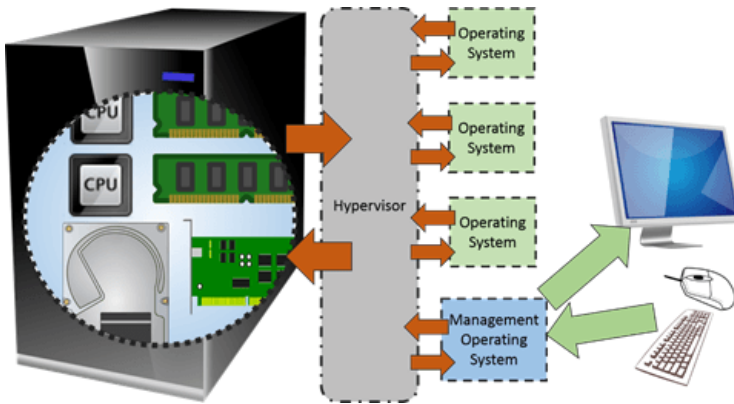
*Figure 4.11 Supervisor of supervisors**

In the Hyper-V environment, operating system is still abstracted from hardware, but now there is a new layer of abstraction between operating system as well as hardware. Multiple operating systems may now coexist on the very same hardware thanks to this extra layer.

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*https://www.altaro.com/hyper-v/what-is-hyper-v/

Security, standards and applications

5.1. Security in Clouds

In order to safeguard "cloud-based infrastructure", apps, and data, a variety of security techniques are used, together referred to as "cloud computing security." Data as well as resource access management and privacy protection are all made possible via the implementation of such security measures.

5.1.1. Cloud security working

The cloud service provider must utilise a range of the technologies, rules, and procedures to guarantee "cloud data security". Consider only the cloud service providers that adhere to worldwide security standards like "ISO 27001" and "National Institute of Standards and Technology" as well as applicable local regulations, like GDPR ("General Data Protection Regulation")as well as HIPAA("Health Insurance Portability and Accountability Act"), when selecting a service provider for your business.

Other technologies and practises which your company must follow and/or seek for in the cloud provider include the following:

File encryption. The "government-approved AES-256 strong encryption" should be used to encrypt all of the data before it is sent to cloud. Encryption is set up by your company, and also only employees who have been granted access are able to use it. Since data is kept in "encrypted cloud storage", the cloud provider must be unable to access it.

Secure communications. Data must be protected, and all administrative contact between systems as well as cloud provider must be encrypted using SSL. As a result, you can be certain that the data is safe at any given time.

Web application firewall. In order to prevent SQL injection, the cross-site scripting, unauthorised resource access, remote file insertion as well as the other OWASP ("Open Web Application Security") threats, the service provider must utilise the "web application firewall".

Data center security. With high walls, 24-hour security officers as well as 90-day video monitoring, the physical data centre should be exceedingly secure. Additionally, proximity key cards as well as the biometric hand-geometry scans must be needed to get entry.

Data center availability. To reduce downtime and remove single points of the failure, the infrastructure of a cloud

provider should fulfil strict service level agreements for the high availability. In addition, the data centers electrical power systems should offer continuous power to whole infrastructure, 24 hours a day, seven days a week. During the transition to "diesel generators", "automatic uninterruptible power supply" defend against power spikes and offer power assistance. At the very least, the data centers must be fueled by two separate sources of electricity.

Regular backups. To ensure that data is safe in the event of a significant outage, the cloud provider should do backups on the regular basis.

Professional best practices. An additional safeguard against malicious or unintentionally dangerous acts by insiders is implementation by provider of the "strict confidentiality policies" and codes of conduct for all the employees, including the background checks wherein appropriate, the non-disclosure agreements, and principles of separation of duties, necessity, and also the least privilege access. Security measures such as multi-factor authentication as well as widespread activity recording guarantee that only authorized users have access to critical systems.

5.1.2. Cloud security benefits

In order to safeguard their apps and also data from malicious attackers, companies must prioritise "cloud computing security". The advantages of the cloud computing are already well-known, and enterprises may

profit from them by maintaining a high level of the cloud security. Security in the cloud comes with its own benefits, like cheaper initial investment costs, decreased continuing operating expenses, simpler scalability, stronger DDoS defence, and a more reliable and available service.

The following are the most important advantages of the cloud computing in terms of security:

1. Lower upfront costs

When you use cloud computing, you don't have to buy your own gear. This is a huge benefit. Because you don't have to buy specialised hardware, you may save money up front and enhance security at the same time. Once you've engaged a CSP, they'll take care of all of your security concerns. This saves you money and reduces the danger of having to pay an internal security staff to protect specialised hardware.

2. Reduced ongoing operational and administrative expenses

You may save money on administrative as well as operational costs by using cloud-based security measures. A CSP would take care of all your security requirements, eliminating a need for you to spend money on people to do manual upgrades and setups on your own. In addition, the CSP has a team of experts that can manage all of your security concerns for you.

3. Increased reliability and availability

Accessing your data quickly and securely is critical. Cloud security guarantees that your data and apps are accessible only to those who are allowed to access them. Your cloud apps and data will always be accessible through a trusted channel, allowing you to address any possible security concerns as soon as they arise.

4. Centralized security

One place to store data as well as applications with multiple endpoints and also the devices needing security is provided by cloud computing. All your apps, devices, and data are managed by a single point of contact in the cloud. Cloud security firms are able to handle responsibilities like disaster recovery planning, network event monitoring, as well as web filtering more quickly because of their central location.

5. Greater ease of scaling

As your business grows, you may easily add additional apps and storage space using cloud computing. The security of the cloud computing services may readily grow along with your needs. The centralised structure of the cloud security enables you to simply incorporate new apps and the other features without losing the data's security as your requirements change. During times of heavy traffic, cloud security may be scaled up to provide

additional protection, then scaled down when the traffic lowers.

6. Improved DDoS protection

DDoS assaults are one of the most serious dangers to the cloud computing. The goal of such assaults is to overwhelm servers with a large volume of the traffic at once. Cloud security monitors and disperses these threats to keep your servers safe.

5.2.   Cloud security challenges

A wide range of cloud services, including PaaS, IaaS, SaaS and the models such as Private, Public, and Hybrid, are used by organizations. There are a variety of security concerns with the various types as well as administrations. A subset of the topics are addressed within every administration's demonstration. Security concerns are examined from two angles. To begin from the standpoint of a professional co-op, which ensures that the services they provide are safe and also manages client's character management. The other perspective is that of the customer, who is concerned about the security of the administration they are using.

Multi-Tenancy

Cloud service providers who tailor their security to fit the needs of high-risk clients are likely to see an increase in the security of their lower-risk customers as a result. When it

comes to malfeasants targeting music labels, a prominent producer is more likely to be the target of criminals than a music label which is currently using file-sharing services. The foundation of the gauze manufacturer might be affected by attacks directed at music brand if both wrap manufacturer and also music label share a common cloud. Cloud providers should thus explain security in order to deal with difficulties relating to music names, and this benefits gauze manufacturers.

Elasticity

For fast scaling out as well as rapid scaling in, resources may be rapidly provided and then released in the elastic manner. In the minds of customers, the capabilities that may be made available for supply often create the image of being limitless and available at any time.

Insider attacks

In the multi-tenant architecture, cloud displays are managed by the single provider. This is a problem that arises inside the organisation. Employees of the cloud are not subject to standard contractual procedures or vendors. In other words, a third-party vendor may easily access the data of one organisation and use it to degrade or pitch it to another.

Outsider attacks

This is a serious risk for any organization since it releases confidential information about a group in open. The private

system has a limited number of interfaces, whereas a cloud has many more. As a result, hackers as well as attackers have the advantage in exploiting the API's flaws and completing the association break. These attacks are less dangerous than insider attacks since we are sometimes unable to notice the attack in the latter.

Loss of control
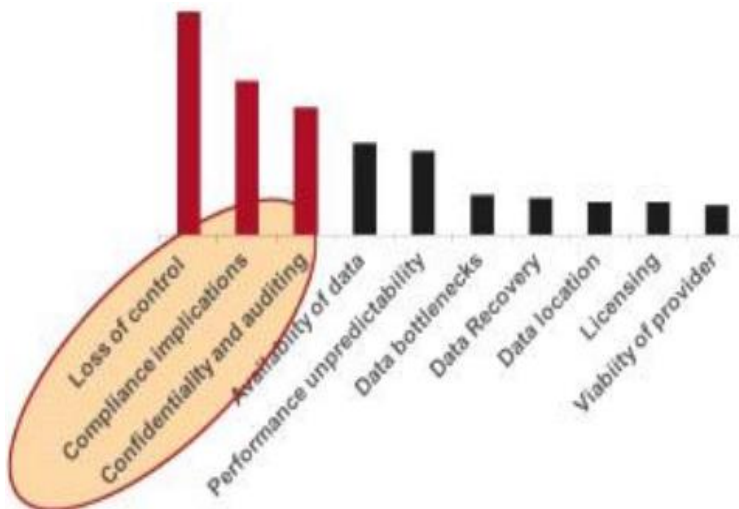
Figure 5.1 Loss of control[*]

As a result of the cloud's location transparency paradigm, organizations are no longer required to disclose the location of their services and data. Providers may access their administrations from anywhere in the cloud as a result of this development. In such a scenario, the association may be

[*]https://www.ijemr.net/DOC/CloudComputingSecurityIssuesAn dSecurityStandards.pdf

at risk of losing its data and may be unaware of provider's security instruments setup.

Data Leakage

For organizations, data leakage is becoming one of most serious security threats. Almost every legislative in the world has a set of safeguards in place for a particular sort of data. The cloud service provider must be able to define security command that customers must agree to and assess the concerns before they can use it. A minimum level of encryption must be applied to any data that is mandated by law or contractual duty. To ensure that the mitigations in place are adequate, an annual risk assessment must be conducted just for the data in concern. In addition, the cloud service provider must have a plan in place to deal with any data leaks which may occur.

Abuse of cloud services

The unparalleled storage capacity of cloud has allowed malware, illegitimate software, and the other digital assets to be hosted and disseminated by both the hackers and legitimate users. Among these risks are the hazards of distributing pirated content such as music, records, and literature. Persistently reviewing utilisation and establishing rules for what your employees have stored in cloud may reduce your exposure to chance.

Malware injection

Malware infusions are files or pieces of code which are

injected into the cloud services and continue to function as "legitimate instances" on the cloud servers. As a result, malicious code might be injected into cloud services and be detected as part of the software which is operating on servers inside cloud environment. The confidentiality of sensitive data might be jeopardized after an injection has been carried out and also the cloud has begun using it.

Denial of service attacks
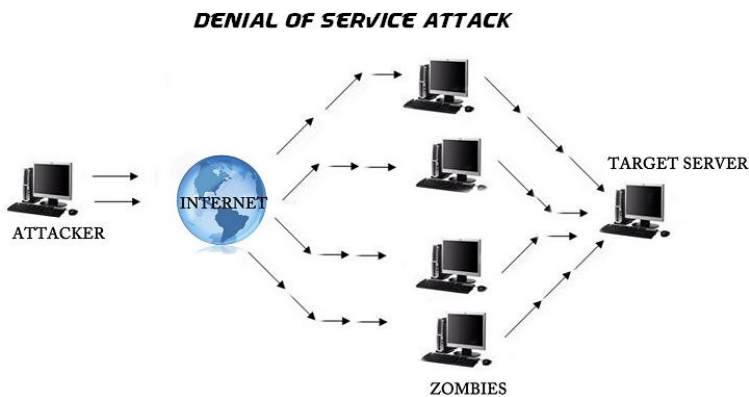
Figure 5.2 Denial of service attacks[*]

Denial of service assaults, unlike the other forms of the cyber-attacks, do not attempt to penetrate your security perimeter and steal vital information. Instead, they are attempting to prevent authorized people from accessing your servers and website. At least in some circumstances,

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[*]https://www.ijemr.net/DOC/CloudComputingSecurityIssuesAndSecurityStandards.pdf

denial-of-service attacks are also used to mask other malicious activities and to shut down security programmes such as firewalls.

5.3. Software as a Service Security

The management, monitoring, and protection of the sensitive data from the cyber-attacks are all aspects of SaaS security. Cloud-based IT infrastructures have become more efficient and scalable, but this has also made enterprises more susceptible.

SaaS security posture management, for example, ensures the privacy as well as security of the user data. A security of the SaaS applications is essential to your business, from "customer payment information" to "inter-departmental information" sharing.

5.3.1. The Anatomy of SaaS Security

Cloud-based service providers may use preventative measures like SaaS security posture management to monitor and secure their customers' sensitive data on a continual basis.

Let's take a closer look at how SaaS security works in a cloud. It's the three-tiered cake, with each layer representing a different kind of place.

SaaS security has three levels:

- Infrastructure ("server-side")

- Network ('the internet")
- Application and Software ("client-side")
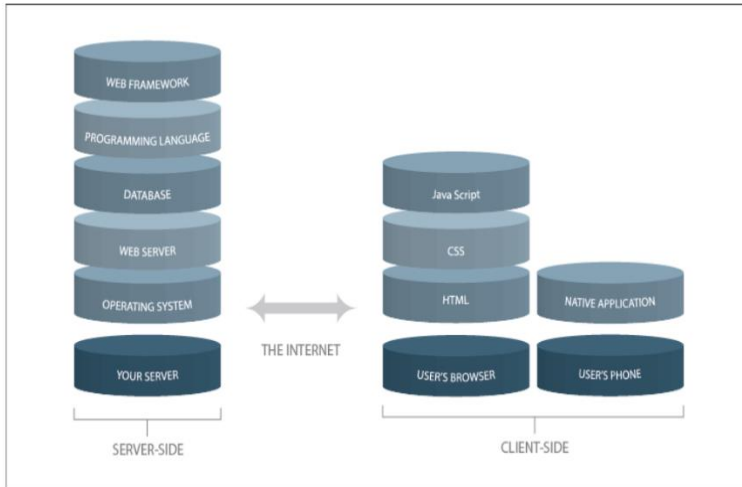
Figure 5.3 Levels of SaaS Security[*]

- **Infrastructure**

Your technological stack's server-side focuses on internal exchange of data. In the case of SaaS businesses that use "Amazon Web Services", for example, you should protect all points of data interaction between "cloud storage provider" as well as "platform".

This is where every IoP from client side begins. Additional security precautions may be required based on a kind of the storage you use.

- **Network**

The internet is used to transmit data back and forth between the server as well as client sides. This is most susceptible layer of any SaaS company. Data packets sent over the internet sometimes have inadequate encryption, which hackers might exploit to gain unauthorized access.

To ensure SaaS security, an integrity of the data encryption technologies and the real-time monitoring of the information sent over internet are critical. In today's digital age, companies are continuously exchanging as well as receiving sensitive data due to the rise of the online payment methods but also KYCs. As a result, network security becomes really critical.

- **Application and Software**

SaaS security concludes with the use of applications as well as software. As previously said, the single data leak might result in an unprecedented number of users to leave. For this reason, we need to implement impregnable SaaS security measures to keep the user data secure.

We should constantly monitor all of your third-party apps as well as software. Because client-side environment is unpredictable, more stringent security measures are needed.

5.3.2. SaaS Security Best Practices for Secure Products

As a result of the intense rivalry in every industry, SaaS

providers are forced to constantly improve their products and provide the new features as well as tools to stay competitive. Even if you're only trying to fix issues or add the new features, it's important to have the security measures in place. Now, let's look at some recommendations for your company's SaaS security:

Encryption is a must

Using the data encryption, you can rest certain that your personal and financial information is safe from hackers at all times. Your data should be encrypted at all the times, whether it's being sent internally or being communicated with customers. You may use the following forms of encryption in the SaaS product:

- Data Encryption Standard (DES)
- TripleDES
- RSA("Rivest, Shamir, Adleman")Algorithm
- Advanced Encryption Standard
- TwoFish

Encryption algorithms developed by leading experts in the field ensure that your SaaS goods are protected thanks to these various encryption kinds' built-in mathematical safety measures.

Back-up User Data in Multiple Locations

Effective data management for customers is vital for providing satisfying services. Disaster recovery guarantees that one system's failure doesn't really undermine the whole

infrastructure's capacity to function. Backups are available on a large number of the cloud platforms. As long as you're careful with your backups, you'll have no problems.

Compulsory Strong Passwords

Everything in the internet world, from the email to banking, is protected by passwords. Today's hackers are becoming more and better at breaking passwords using publicly accessible information. As a result, the strong password restrictions are essential if you want to guarantee that your users are using secure passwords which can't be guessed.

Consult a SaaS Security Firm

Whenever in doubt, seek an expert. Experts in the software monitoring, data encryption, as well as AI-based vigilance are employed by SaaS security organisations like Cloudlytics. Our testing as well as monitoring technologies can help you develop a safe as well as secure SaaS platform.

5.3.3. Prioritizing SaaS Security

Security vulnerabilities connected with the "Infrastructure-as-a Service" as well as "Platform as a Service" settings are well-understood by many enterprises. In most businesses, IT as well as security teams work together via the use of standardised business processes and software. Cloud computing security and also management technologies are also in high demand.

Organizations might benefit from SaaS apps since they function in a unique way. They are, however, more difficult to secure:

- **Complexity**— Software as a service (SaaS) application may be used by a broad range of groups inside an organization. It's common for the record systems to be utilized by sales as well as development teams for client data, and also by HR departments for the HR information. Such as SaaS apps are commonly utilized by various end-users with varying degrees of the technical expertise. For the security teams, SaaS services are challenging to comprehend because of their sheer number and complexity of use.
- **Communication**— SaaS technology selection and management are handled by the business administrators who have limited interaction with the security professionals. This makes it difficult for the security teams to comprehend how these apps will be used and how they will affect the organization's security when they are fully operational.
- **Collaboration**— Rather than securing these services, corporate teams who support SaaS apps tend to be more concerned with meeting functional as well as business objectives. Keeping business as well as security demands in balance requires constant cooperation. Organizations should devote more time and also the resources to identifying and

mitigating security threats, and approach SaaS the same way they manage bare metal, PaaS, IaaS, and the endpoint security, in order to maintain uniformity.

5.4. Common Standards

Some Common standards in Cloud computing are as follows:

5.4.1. The Open Cloud Consortium

As part of the VMAN Initiative, VMAN has developed the "Open Virtualization Format". " Virtual appliance lifecycle management" is simplified by OVF since it describes an open, portable, secure, efficient, as well as extensible standard for packaging and delivery of a single or many virtual appliances. Virtual machines' integrity may be checked using the OVF's methods as well as technologies, which are included in the distribution package. As a result, format's security is improved, and customers who utilise virtual appliances created by the third parties may relax about their security worries.

For both the independent software providers and consumers, the OVF offers methods for licencing checks for the VMs which are included in OVF. Lastly, the OVF provides information about the "host virtualization platform" and "runtime environment" to the installed VM, enabling the VM to localise its programmes and optimise its performance for specific virtualization environment. The

mobility of the virtual machine packing is an important characteristic of OVF. By design, OVF seems to be "virtualization platform-neutral", so platform-specific improvements may be recorded. A number of open virtual hard drive formats are also supported. OVF information is used to quickly and accurately describe the attributes of virtual machines.

OVF has been designed to ensure safe and secure delivery. Depending on the industry-standard public key infrastructure, it offers a simple system for managing software licence and also the content verification. The ease with which the OVG may be installed and deployed is another advantage of the technology.

Metadata is used by the OVF to evaluate the complete package but also decide whether or not the virtual appliance may be loaded automatically. Complex multitier services involving numerous interdependent virtual machines may be packaged in packages comprising of the single or the multiple VM configurations. The OVF doesn't really rely on a particular virtualization platform, host platform, or guest operating system because it is the vendor- and the platform-independent.

The Open Virtualization Framework (OVF) is designed to grow alongside the industry's adoption of virtual appliance technologies. Vendor-specific information for various vertical markets is also supported and may be encoded with the help of this software platform. During the installation of

the virtual appliance, the interactive processes may be localized as well as the user-visible descriptions in several locales are supported. Using this method, the single virtual appliance may service a variety of markets.

5.4.2. The Distributed management Task Force

In the "Distributed Management Task Force," the abbreviation "DMTF" might be used. "Standards Development Non-Profit Organization", that also develops open standards for the variety of conventional IT-based organisational structures as well as facilities, including virtualization, cloud computing services, network infrastructure, and infrastructure, servers as well as data storage to support the business ventures and also the Internet backgrounds. It also works to promote cross-industry interoperability.

The "Distributed Management Task Force" brings IT industry together to work on the creation, validation, as well as promotion of the systems management standards, making it possible for the millions of the IT systems throughout the globe to be managed more effectively. And over 4,000 people from 43 countries are involved in the association, which has 160 members and organisations from throughout the sector. Innovative, industry-leading technological businesses make up board of directors of "DMTF" or "Distributed Management Task Force". AMD ("Advanced Micro Devices"), CA, Broadcom, Inc., EMC, Dell, Fujitsu, Hitachi, HP, Ltd., Intel, Symantec Corporation,

IBM ("International Business Machines"), Microsoft, Oracle, Novell, Inc., Sun Microsystems, as well as VMware, Inc. are a few of the companies in this group. Interoperable IT management is made possible by DMTF's wide as well as deep reach. Interoperability of the multi-vendor systems, tools, as well as the solutions inside an organisation is made possible by "DMTF management standards".

The "Virtualization Management Initiative"(VMAN) was launched by the DMTF. Delivering widely approved interoperability as well as portability standards to the virtual computing environments, the VMAN unlocks virtualization's full potential by using VMAN, network administrators may quickly and easily deploy as well as manage applications across the variety of heterogeneous computing environments. The industry standards which are now the part of the VMAN are supported by a wide range of the management software products.

This reduces IT managers' support as well as training expenditures. By maximising use of the existing physical resources, virtualization has improved the IT sector by reducing number of the systems deployed and maintained. Decreases hardware costs as well as reduces the power and also cooling requirements as a result. Even while virtualization increases efficiency, it also raises IT costs because of the more difficult administration that comes with this new method.

Management tool suppliers may easily offer holistic management abilities to allow IT managers to control virtual environments in context of underlying hardware because DMTF builds on current server hardware standards. Because of this, IT professionals' learning curves are shortened, and suppliers' burdens are alleviated as well. The VMAN Initiative provides IT administrators with the tools they need to implement a standardized approach to IT management:

1. Deploy the virtual computer system
2. Locate and catalogue all of the virtual computer systems that exist.
3. In charge of the virtual computer system lifecycles and maintenance.
4. Virtual resources may be added, changed, or deleted.
5. Inspect the health and efficiency of virtual systems.

5.5. Standards for application Developers

Standards for the application development are meant to provide the high-quality software that is uniform as well as consistent across all projects. There are several reasons why programmers value programming standards. 80 percent of the piece of the software's lifetime costs are spent on maintenance, according to some experts. A further problem is that very little software is supported for the duration of its existence by original inventor. Improved readability of software helps developers learn new code quickly and

completely. Programming standards aid in this process. The quality of your product's source code should be equivalent to the quality of the competitors you are competing with. Everyone involved in creating new solutions should adhere to the criteria set out. The following sections cover Internet browser application standards for the data transfer, message transmission, including data security.

Browsers (Ajax)

To construct dynamic online apps or the rich Internet applications, web developers employ Ajax or its precursor, AJAX "Asynchronous JavaScript and XML". Web applications may get data from a server asynchronously utilizing Ajax, avoiding interference with appearance and behaviour of browser page presently presented to user. Ajax. Because to Ajax, web sites now include more interactive animation. Ajax does not need JavaScript or XML, despite the fact that it is named after both. Furthermore, asynchronous queries are not required. Because such technologies are no longer necessary, the original moniker AJAX has been renamed Ajax. Pages on the same website which seem to be unrelated can have a lot in common. Traditionally, every time the request is made, this kind of material should be re-downloaded.

Only the material that has changed may be requested by an Ajax-enabled web app. Network traffic as well as the page load times are considerably reduced as a result of this. The client browser might look more interactive and react faster

to input by utilizing asynchronous queries. Reloading particular sections of the page is possible. The program is seen by the users to be very responsive and speedier. An advantage of using Ajax is that scripts as well as style sheets are only needed once. Web applications which use Ajax may be built using an Ajax framework. On a client side, the framework enables them to create the dynamic web pages with ease. Requests, often written in JavaScript, are used to send and receive data between the client and the server. These queries may need some server-side processing, such as searching as well as storing data. The usage of the framework specifically designed to handle Ajax queries makes this task much simpler.

ICEfaces Ajax Application Framework

For Java EE developers, ICEfaces is the Ajax-integrated Ajax application framework which makes it easy to build as well as deploy the thin-client rich Internet applications. Enterprise developers may utilise ICEfaces for free to build the new or the existing Java EE apps. The most popular "open source Ajax framework" for businesses is "ICEfaces". More than 32,000 developers from 36 countries are already part of the ICEfaces development community. ICEfaces programmes need the following third-party software to be installed on the user's computer:

- Java 2 Platform
- Tomcat
- ICEfaces Web browser

- Ant
- Standard Edition

ICEfaces makes use of the full Java EE toolkit and environment, which is based on open standards. In the thin-client approach, Java-based corporate applications are designed with a wide range of functionality. There's no need for any special browser add-ons like Applets or the proprietary plug-ins. If you're already familiar with "JavaServer Faces" (JSF), you don't need to learn JavaScript in order to use ICEfaces apps.

If you're familiar with Java, you may continue to utilise ICEfaces in the same manner. They may make use of their current Java IDEs and testing tools to speed up development. Many different Java application servers, "IDEs" as well as the "third-party components" may be used to run ICEfaces. Ajax Push, invented by ICEfaces, has become a standard in the web development world. With this method, content rendering started by the server or application may be transmitted to browser. Among the most secured Ajax solutions is "ICEfaces". Malicious code injection, Cross-site scripting, and illegal data mining are all prevented by the "Secure Sockets Layer" protocol. User information is not exposed, and SQL injection threats are prevented via ICEfaces, which does not disclose the logic of the application or the user's data. "Asynchronous Request Processing" (ARP) APIs from the third-party application servers such as Apache Tomcat, Jetty, and the others are also supported by "ICEfaces".

Data (XML, JSON)

"Custom markup languages" may be created using the "Extensible Markup Language" (XML). Allowing the user to create markup components is what qualifies it to be the extensible language. Its goal is to make structured data more easily shared. When it comes to serialising objects and describing the structured data, XML is the popular choice.

There are a number of XML-based protocols available for representing data structures and exchanging it. While JSON may be used to express the data structures in plain language prepared for data transmission in the uncompressed form, XML is considered more difficult to use. No techniques exist in XML or JSON to describe the binary data types like photos. It is possible to describe content of the document apart from its presentation with the help of XML and the other standards. That material may be reused in other apps or for different presentation contexts, which is an advantage here.

Furthermore, XML offers a simple syntax which may be utilised to transfer data from one kind of the computer or programme to the other without the requirement for conversion. Well-formedness and validity are the two degrees of XML document correctness. The XML syntax standards must be followed in order for the document to be considered well-formed. The conforming parser would not handle the document which is not properly formatted as XML. The well document that also complies with semantic

criteria, whether they are established by the user or found in the XML schema, is considered valid XML.

In addition to the fundamental limitations of XML, the XML schema describes a specific kind of XML document by imposing additional constraints on document's structure as well as content. Such schemas may be expressed in a variety of the standard as well as the proprietary XML schema languages, a few of which are themselves XML-based. Many rules as well as naming standards apply to XML documents. A meaning of data may be conveyed in markup itself by carefully selecting names of XML components. A syntactic structure required for parsing is preserved but the human readership is improved. Moreover, this might lead to excessive verbosity that complicates the writing process and also increases the size of the files.

JavaScript Object Notation (JSON)

The JSON format is the simple way to exchange data between computers. The text-based format for describing basic data structures as well as associative arrays that is easily understood by humans. "Internet Engineering Task Force RFC 4627" specifies JSON format. Serialization, a technique that involves sending structured data across the network connection, often makes use of "JSON format". Its primary use is as the alternative to XML in "Ajax web application" development. Using the subset of JavaScript, JSON is able to parse JSON data. It is regarded as the data format that may be used with any language. Many

programming languages include libraries for processing and producing JSON data. There is a thorough collection of JSON bindings sorted by language on "json.org" website.

Even while JSON was originally designed to be a data serialisation standard, its nature as the subset of JavaScript raises security risks. It's possible to expose a programme to faulty or even dangerous code if JavaScript is used to dynamically execute JSON. Cross-site request forgery attacks may be used against JSON as well. An attacker may be able to decipher passwords or the other sensitive information from JSON-encoded data in context of the rogue website. An issue arises when server relies on browser's Same "Origin Policy" to deny data transmission in the event of a fraudulent request.

Whenever the server evaluates the request, it would only output data if it finds the request to be legitimate. Cookies cannot be relied upon to determine whether or not the request is legitimate and allowed. Cookies are vulnerable to the cross-site request forgery, and JSON is the better alternative. Even though JSON was designed for basic tasks, there is considerable danger in utilising it, particularly in light of the many alternatives now accessible.

Solution Stacks (LAMP and LAPP)

LAMP

For dynamic websites / servers, LAMP is the popular open-source software solution. Linux, MySQL, Apache, and PHP

are the four components that make up the LAMP stack, which is widely regarded the platform of choice for developing and deploying the high-performance online applications which need a robust and trustworthy base.

The web server architecture or software development environment is essentially defined or created by combining such many technologies. Because of its open nature, cheap cost, and broad availability of its components, the LAMP combo has gained popularity despite the fact that its developers did not plan for all of such open source products to function together. When used together, they provide the solution stack that supports application servers.

Linux, Apache, PostgreSQL, and PHP(or Perl or Python)

In order to operate dynamic websites as well as servers, LAPP stack may be employed. In comparison to the more widely used LAMP stack, many people believe it to be the more powerful solution. With such powerful and also mature components, you can build as well as deploy the high-performance web apps. LAPP provides Apache2 and PostgreSQL with SSL, Python, PHP, and Perl capabilities. PostgreSQL has an administrative front-end, and also the web-based modules for "Apache2" and "PHP" configuration. Encryption of PostgreSQL passwords is turned on by default. When connecting to PostgreSQL through the local UNIX sockets, the users are trusted. "LAPP stack" is considered to be more secure than "LAMP stack" out of a box. Each application has its own unique set

of risks and benefits, and developers must weigh them against each other while making this decision.

5.6.   Standards for Messaging

Message Formats and Protocols There is a good chance you've heard of a communications standard. It's unfortunate that the phrase "message" may imply so many different things to so many individuals. The term "standard" is also a case in point. When you start talking about message standards, people might think you're talking about the networking. The word message, on the other hand, encompasses a wide range of concepts, not only those related to networking. The message is the piece of information which is sent from one location to the another for a purposes of this discussion. The word "standard" may also be ambiguous. According to our knowledge, there are the open international standards as well as de facto (or "de facto"), and private (or "proprietary").

In general, a real standard has specific characteristics, like being overseen by the international standards agency or the industry consortium, and also being developed collaboratively by a group of stakeholders. One of the world's most open standard-setting bodies is probably "Internet Engineering Task Force". Free access to the work of participants is accessible online. Cloud-based communications standards are discussed in a following sections, few of which have become de facto standards because of their widespread usage.

Simple Message Transfer Protocol (SMTP)

In terms of fundamental communications, the "Simple Message Transfer Protocol" (SMTP) is perhaps the most essential protocol now in use. Prior to the creation of SMTP, the email messages were transferred via "File Transfer Protocol". As if it were the file, a sender will create a message as well as send it to a receiver. Despite the fact that this method was successful, it had its drawbacks. This protocol does not allow receivers to identify a sender or a sender to specify the intended recipient since FTP was meant to transport files, not communications. It was administrator's responsibility to open or to print (and occasionally deliver) every message that appeared on "FTP server" before anybody even knew who was meant to receive it.

When using SMTP, sender and receiver information may be included with message. However, a design process took time. An "IETF RFC 561" defined "SMTP" in the year 1973. RFCs 724, 680, and 733 have all made changes to it throughout the years. RFC 821 as well as RFC 822 are the most recent versions of the specifications that govern SMTP. The two-way communication protocol, SMTP uses "Transmission Control Protocol" port 25 for most operations. SMTP may be used to both transmit as well as receive messages, which several people are unaware of. "Post Office Protocol" is more often used than "Simple Mail Transfer Protocol" by workstations to receive email.

Sending the message from the workstation to the mail server, or communicating between the mail servers, is the most common usage of SMTP.

Post Office Protocol (POP)

However, since an SMTP client should maintain a continuous connection to the server in order to receive "SMTP messages", sending messages through SMTP is inefficient or impossible. These issues were addressed by using "Post Office Protocol". Downloading messages from the server is the only function of the lightweight POP protocol. When the client connects to a server, the server may keep messages till the client demands them. In order to free up space on a server, the POP servers begins to download messages and afterwards remove them from server (the default configuration). SMTP was used to download the message, and the recipients responded. RFC 1939" defines the "POP protocol" and "TCP port 110" is often used.

Internet Messaging Access Protocol (IMAP)

When you use POP to download your email, all of your downloaded messages are immediately erased from a server after download is complete. Because POP customers must store messages locally, this presents backup issues when it is critical to store or preserve messages. Messages are often required to be saved as part of a company's compliance policies. Moving from one computer to another or using mobile networking creates an issue since

communications do not immediately follow the user. The standard known as "Internet Messaging Access Protocol" was developed to address these issues. When using IMAP, messages are saved on a server, but they may be accessed and altered just as they would if they were on the computer. The TCP port 143 is used by IMAP, which is defined by RFC 2060.

Syndication (Atom, Atom Publishing Protocol, and RSS)

By using RSS "Really Simple Syndication" and the other web-based syndication technologies, government material may be made readily available to the public through content syndication. More and more government information is being made available online. New or current material is sometimes hidden when online pages grow increasingly complicated and harder to navigate. The first stage is to dynamically show "what's new" on top of a website.

The small "orange [XML] button", "ATOM", and the other syndication standards let the government to control the short window of material on websites which opt to show government's headlines. Citizen "newsreaders" might gather as well as display the headlines via standalone programmes or as part of their own web page.

"Multiple agency websites" may be aggregated and merged into a single portal. Distributed work may be valued more sustainably this way. RSS feeds for press releases might well be automatically gathered from a variety of sources, as long as they are all labelled with comparable information.

Government information that is time-sensitive and must be made accessible quickly justifies the work it takes to produce and the responsibilities it places on those responsible for making it available.

5.7. Standards for Security

An organisation must adhere to security standards in order to develop a security programme. Additionally, such standards apply to the cloud-related IT operations as well, and contain specific procedures that really should be done to protect the security of private information in the cloud environment while simultaneously maintaining privacy. A collection of fundamental principles underpins security standards, all of which are aimed at safeguarding the kind of the trusted environment described above. All of the same factors must be taken into account when it comes to messaging standards, particularly when it comes to cloud security. Although they aren't specifically related to cloud security, the following measures are worth mentioning. Next, we'll describe what they are and also how cloud computing uses them.

Security (SAML OAuth, OpenID, SSL/TLS)

The notion of defence in depth is a fundamental principle of security. Having many systems in place that are intended to guarantee security even if 1 system fails is necessary. A good illustration of this is the firewall and "intrusion detection system" operating together. Since there is no

single point of the failure as well as no single entry point for an assault, defence in depth ensures security. Network security can't be implemented at either the centre or end of the network, and this is the false dichotomy that has to be avoided. It is significantly preferable to safeguard all systems than to rely on the single security mechanism. We're seeing a lot of this sort of tiered security in the cloud computing. In the past, security measures were applied at endpoints, where user was responsible for granting or denying access. Having IDSs, firewalls, and the anti-virus software installed on the organization's network was a need. Additional cloud security is now possible thanks to cloud provider-managed security services.

Security Assertion Markup Language (SAML)

An "XML-based standard" for exchanging authentication, authorisation, and the attribute data across online partners is known as "SAML". It enables enterprises to securely exchange information about the principal's identity and rights with other organisations. A technical committee of "Organization for the Advancement of Structured Information Standards" (OASIS) is responsible for developing, improving, as well as maintaining SAML. HTTP, SOAP as well as XML are the foundations around which SAML is constructed. SAML mandates the usage of SOAP and also HTTP as its communication protocols (presently, version 1.1). The majority of the SAML transactions are encoded in XML.

XML format is used to specify SAML assertions as well as protocols. Security and integrity are ensured through digital signatures, which are generated using XML Signature standard. However, XML encryption isn't possible in "SAML 1.1", but it is supported in "SAML 2.0". The protocol, assertion, binding, as well as profile are all defined by SAML as being based on XML. Assertions made using SAML as well as the protocol utilized to request and send them from one system entity to the other are collectively referred to as "SAML Core". The "SAML protocol" refers to the content that is communicated, not the method of transmission.

For the purposes of standard communications protocols, the SAML binding specifies how SAML inquiries and answers are to be translated. A SAML SOAP binding is essential binding. Users' entitlements, authentication, as well as the attribute information are all standard in the SAML's XML replies as well as queries.

Using this format, the principal's security information may be requested from the SAML authority. Any platform or application which can transmit security information is referred to as the SAML authority. The partner site which gets security information is relying party (or assertion client, or asking party). Authentication, access authorisation, as well as attribute data are all part of the data that was sent back and forth.

The term "subject" refers to a certain kind of entity in the particular field. The email address may be used to identify a person, as well as the printer. Identity providers often send SAML assertions to service providers. Service providers utilise assertions to make choices about access control. Attribute statements, Authentication statements, as well as authorization decision statements are all supplied by SAML.To the service provider, the authentication statement asserts that principal authenticated with the identity provider at certain time and through a specific mode of authentication, and that a service provider may trust this information. There may be additional information about authenticated individual (referred to as the authentication context) that is included in the authentication statement. Attribute statements claim that a certain topic is linked to a set of characteristics. The attribute consists of a name and a corresponding value. Access control choices are based on qualities. Assuming that evidence E is there, a person is allowed to conduct action A on the resource R. "Authorization decision statements" in SAML can only communicate a limited amount of information.

For example, a SAML protocol specifies how assertions are bundled in SAML requests and responses. It specifies how these items should be processed by SAML entities. It's not uncommon for the SAML protocol to have a straightforward request–response system. A query is the most common sort of SAML request. The identity provider receives a query from a service provider through an

encrypted back channel. As a result, SOAP is the most used format for inquiry messages. SAML queries are divided into three categories based on the three sorts of statements: attribute retrieval, authentication, and authorization decision-making, respectively. Attribute queries are likely the most critical of the three. A SAML answer containing the assertion, in turn, comprises an attribute statement, is the end result of the attribute inquiry.

Open Authentication (OAuth)

It was created by "Blaine Cook" and "Chris Messina" as the open standard for API authorisation that may be used by a wide range of different web apps. "Cook" and "Messina" came to the conclusion that API access delegation has no open standards. In April 2007, the small group of the implementers was formed to produce a proposal for the open protocol, and "OAuth discussion group" was established. When "Google's DeWitt Clinton" heard about the OAuth initiative, he showed an interest in helping out. When the team started working on the original specification in the year July 2007, it was issued in October of the same year.

Protected data may be published and accessed via OAuth, a secure way of communication. Developers benefit from OAuth since it allows consumers to access their data whereas securing their account credentials. It is possible to provide service providers and customers access to your information without revealing your full identify via OAuth.

In order to make it clear that this is a starting point, the Core label is employed. OAuth Core 1.0 is intentionally deficient in many key areas (For example , "automated discovery of endpoints", "support for XML-RPC and SOAP","OpenID integration", "language support, "standard definition of resource access", "signing algorithms", etc.). The authors see this deliberate lack of the feature support as a key advantage. It is up to Core to cope with protocol's foundational elements, such as how the user name as well as the password are exchanged for the token with certain permissions and how tools are provided to safeguard the token. You should know that the protocol does not ensure your safety or privacy. Although OAuth itself does not guarantee privacy, it relies on the other protocols like SSL to do so.

However, OAuth implementation may be done in a secure way. Security issues should be taken into mind while dealing with the sensitive data in specification. Tokens and shared secrets are used to get access to the resources through Oauth. The same is true for secrets and passwords.

OpenID

OpenID is the open, decentralised standard for the user authentication and also access management that enables users to log into multiple services with same digital identity. When it comes to access control, this solution employs a "single-sign-on" (SSO). Users are able to log in

once as well as access the resources across the participating systems, rather than having to enter their log-in name as well as password for each system. In May 2005, "Brad Fitzpatrick", the developer of the famous community website LiveJournal, designed the initial OpenID authentication mechanism. Discussions started in late June 2005 between "OpenID developers" and the other "NetMesh software developers". These conversations led to additional cooperation on compatibility between "OpenID" and "NetMesh'sr" elated "Light-Weight Identity" protocol. The "Yadis discovery protocol" was announced on October 24, 2005, as direct outcome of the partnership.

An identification for person and the other entity is provided by the Yadis standard, which may be utilised with a number of services. Using this identifier, the resource description document may be created with a syntax as well as the interpretation of document's components. Given that identification, the "Yadis discovery protocol" is utilised to retrieve the resource description document. Using the single identification, a wide range of services may coexist and interoperate. There is no need for new namespace management infrastructure since the identifier utilises the well-established namespace as well as the defined syntax.

The entity that hosts OpenID URL verifies the OpenID's authenticity by verifying the URL's uniqueness. There is no central authority in "OpenID protocol" to verify the user's identity. Nonstandard types of authentication, like

biometrics, smart cards, or conventional passwords, are permitted by "OpenID protocol" and web sites that require identity.

The following is an example of how OpenID might be put to use: The OpenID log-in form appears on the web page which the user accesses. Log-in forms for OpenID use a single field for OpenID identifier instead of user names and passwords (that is the OpenID URL). This form is linked to the OpenID client library implementations. The OpenID identification has already been registered with the OpenID identity provider by the user. This OpenID identifier is entered into OpenID login form by the user. It then examines the HTML link tag to find out identity service URL from the requested web page at that URL.

When a client requests an XRDS document with content type application or "xrds+xml", it finds the identity source service URL, that might or might not be present at target URL, but is always there for a target XRI. Checkid immediate as well as checkid setup are two modes wherein the reliant party could communicate with an identity provider. If relying party uses checkid immediate, it instructs the service provider to avoid any contact with user. The user is not informed that all the communication is routed through their browser.

Using very same web browser used to view the dependent party site, user talks directly with a provider server when using "checkid" setup. In terms of web traffic, the second

alternative is more popular. Using the associate handle as a point of reference, both relying party as well as identity provider construct the shared secret at the outset of the session. If the identity provider uses checkid setup, relying party can send the user's web browser back to provider for authentication.

OpenID identity providers often ask the user for the password and afterwards whether or not user trusts a relying party web site to receive their credentials and also identity details when authenticating users. Users who refuse to allow their identities to be trusted by relying party web site will be sent back to relying party's website, which will display an authentication rejection message. In turn, the website refuses to verify the user's identity.

User credentials are sent to a predefined return page on a relying party site together with user's acceptance of identity provider's request for trust. The relying party should then verify that credentials are authentic. The reliant party could compare shared secret obtained with credentials to those which already stored if they've already created the shared secret with that party beforehand.

Since it stores shared secret in between the sessions, the reliant party is deemed stateful in this situation (the process sometimes termed to as persistence). The check authentication method should be used by the stateless relying party in order to verify that the data it receives came from an identity provider. Users can log in to the relying

party website using their Open ID credentials once they have been authenticated using their Open ID . In most cases, Open ID identifier is then stored in the user's browser session. Although Open ID doesn't provide one's own authentication mechanisms, it could be used for safe transactions if the identity provider utilizes strong authentication.

SSL/TLS

TLS and its precursor, SSL, are the cryptographically secure protocols meant to ensure the security and also integrity of communications via the TCP/IP protocol stack. At a transport layer, TLS as well as SSL encrypt data transmissions. Web browsers, instant messaging, email, and voice-over-IP all use different versions of protocols.

RFC 5246, the most recent revision of TLS, is the IETF standard protocol. TLS is the protocol aimed at preventing eavesdropping, manipulation, and message forging between client as well as server applications across the network. TLS uses cryptography to offer end-to-end authentication as well as data confidentiality.

To authenticate the server using TLS, the client has only to know server's identity; the server authenticates itself. A client is still unauthenticated in this situation. What this signifies is that a browser has checked whole "Certification Authority" that make up a server certificate's chain of trust.

Validation doesn't really reveal the server's identity to an end user. End users should check server's certificate for authenticity before they can be sure they've been authenticated. Identity could only be determined by checking that the URL, name, or address that a user enters matches what is in a server's certificate. Malicious websites can't make use of another site's valid certificate since they lack the ability to encrypt transmissions in a fashion that a valid certificate could decrypt. An acceptable method of determining whether or not you're visiting a legitimate site is to compare its URL against the one in a certificate because only trustworthy CAs can do so.

The more secure bilateral connection mode is supported by TLS as well, allowing both sides of connection to be certain that they are interacting with the person to whom they believe they're linked. TLS is referred to as the mutual authentication. TLS clients must also keep a certificate for mutual authentication. The TLS process is divided into three distinct stages:

1. Algorithm support through peer-to-peer negotiation.
2. Authentication as well as key exchange
3. Encryption with symmetric cyphers and message verification.

A cypher suite is negotiated between the client as well as server in a first phase, and this sets the parameters for the cyphers to be used, key exchange algorithms to be utilized,

and a message authentication codes to get used. Public key algorithms are often used for key exchange as well as authentication. "Cryptographic hash functions" are used to generate message authentication codes. Data transfer can commence after such decisions have been made.

5.8. End user access to cloud computing

YouTube

YouTube is indeed the world's most popular place for watching and sharing original videos on Internet via websites, blogs, mobile devices, and email, as well as on television. Users can upload and also distribute videos on YouTube website with ease. For example, see Figure 8.1 showing homepage of youtube.

All of this could be found on YouTube, where members may watch first-hand descriptions of the current events as well as videos relating to their own interests, hobbies, and pastimes. YouTube was established in Feb 2005 and it received funding from "Sequoia" Capital in Dec 2005. , who joined the company as co-founders and co-founders, respectively. An acquisition of YouTube by Google was among the most discussed topic purchases of all time, taking place in Nov 2006. From CBS to BBC to "Universal Music Group" to "Sony Music Group" to "Warner Music Group" to "NBA" and several content companies have partnered with YouTube since then.
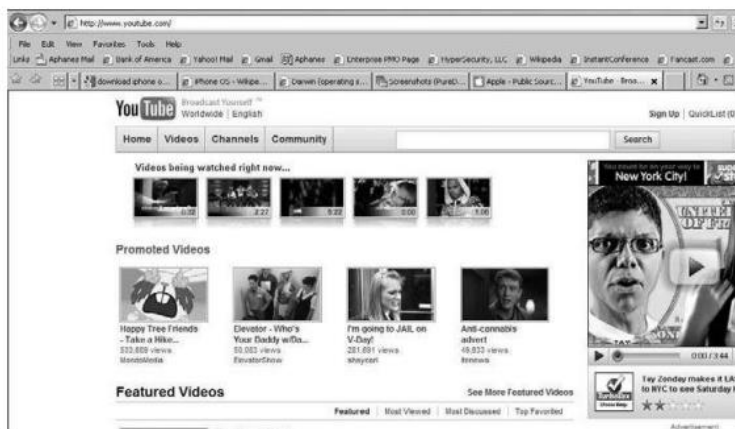
Figure 5.4 YouTube's home page[*]

For developers who want to incorporate YouTube features into their websites, YouTube has developed the set of the "application programming interfaces". The APIs as well as tools provided by YouTube enable third-party developers to integrate YouTube functionality into their own websites, applications, and gadgets. The site's immense popularity has grown even more as a result of this approach's willingness to consider all viewpoints.

[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(2009)/Chapter%208%20-%20End-User%20Access%20to%20Cloud%20Computing.pdf
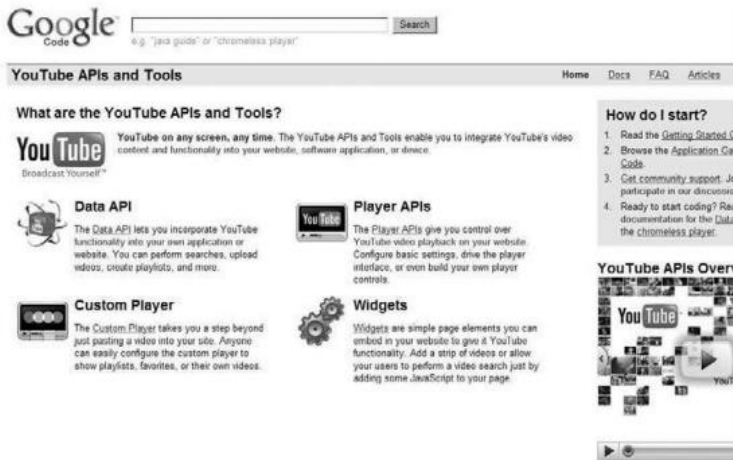
Figure 5.5 The starting point for YouTube APIs[*]

Starting point for accessing YouTube APIs is depicted in Figure 5.5.

Video content as well as functionality from YouTube platform can be integrated into any website, software applications, or devices using the APIs as well as tools available from YouTube developer community.

Developers must first choose that APIs as well as tools are most appropriate for their purposes. Consider Widgets as well as custom player for individuals who are knowledgeable with "HTML" but not with "JavaScript".

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[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(2009)/Chapter%208%20-%20End-User%20Access%20to%20Cloud%20Computing.pdf

Check out Player APIs if your development team is familiar with "JavaScript" and "Flash Player". The Data API is for individuals who are designing the device or the server-side logic for the web site.

Zimbra

Yahoo! stated on September 17th, 2007 which it had agreed to pay $350 million for Inc., Zimbra, the web-based email as well as collaboration software company. In addition to Mac OS X, Linux, and Zimbra's email, virtualization platforms, and calendar server is available. In addition to supporting mobile devices (such as the iPhone as well as BlackBerry), Zimbra also offers support for desktop clients (like "Outlook"& "Thunderbird").

The free, open-source email as well as calendar client, Yahoo! Zimbra Desktop11 operates on any Windows, Macintosh, or the Linux desktop. Any POP or IMAP email account, like Zimbra Mail, Yahoo! Mail,AOL, Hotmail, Gmail or any other work or the personal account which supports POP or IMAP, can be used with this programme, both online as well as off. Zimbra's email as well as collaboration tools include email, contacts, group calendars, file storage, instant messaging, and web-based document management systems.
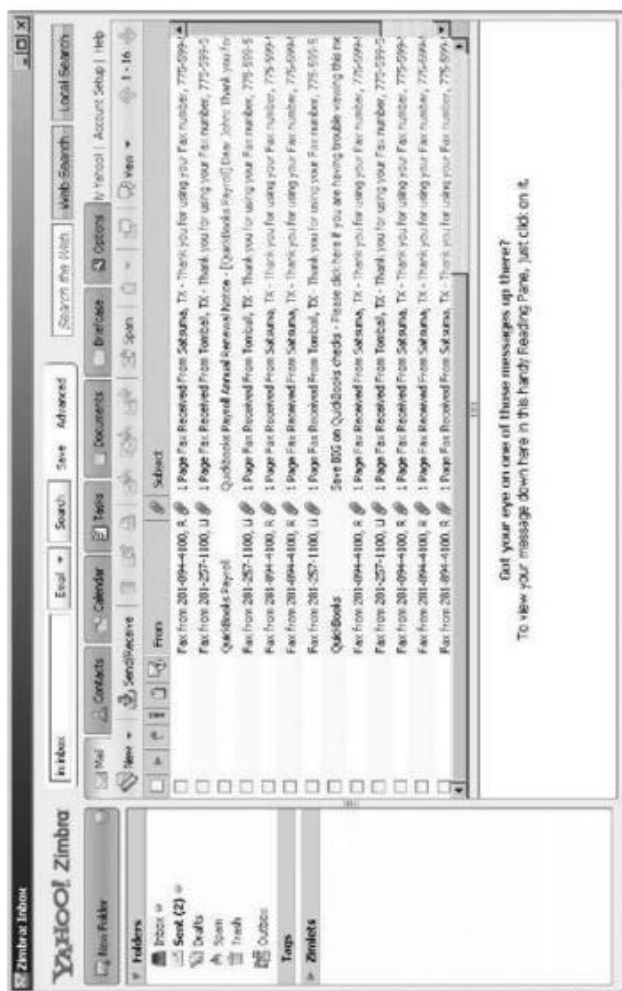
*Figure 5.6 The Yahoo! Zimbra desktop**
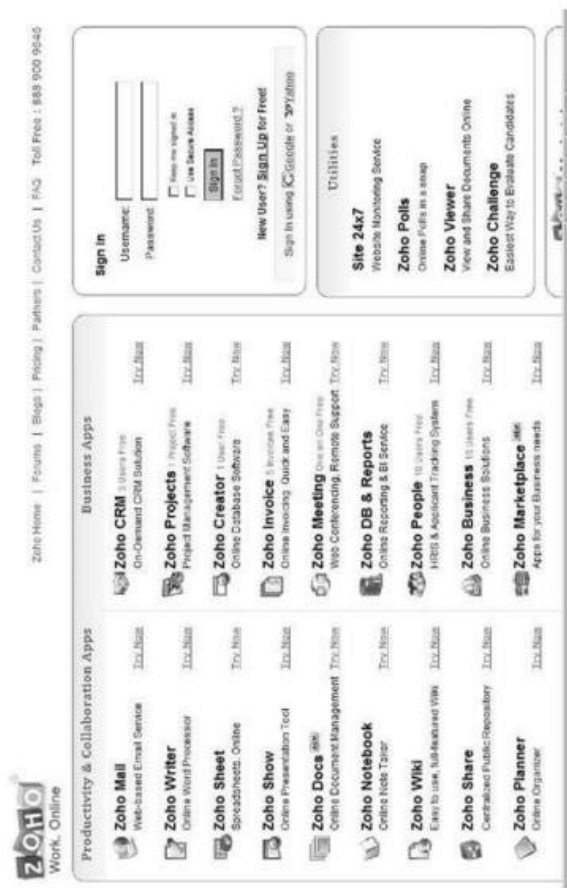
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neering/Cloud%20Computing%20-
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09)/Chapter%208%20-%20End-
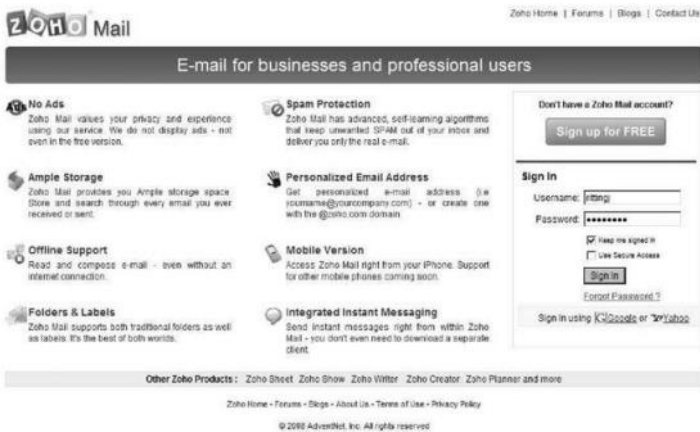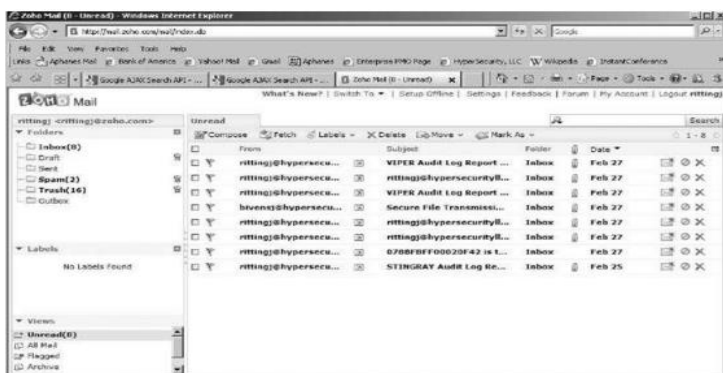User%20Access%20to%20Cloud%20Computing.pdf

For on-premises or the hosted email solutions, Zimbra does not place any limit on amount of the email storage. Conversation Views as well as Message Tags, two features of cutting-edge web technology, make it easy to see the most significant emails across all of the email accounts. With the help of visual search builder, you can easily locate crucial images, records, or messages from the people you cares about.

You may also keep track of your Contacts, Calendar, Documents, Tasks, as well as Attachments with Yahoo! Zimbra Desktop. When it comes to handling many email accounts with large amounts of storage, Zimbra Desktop makes use of Web 2.0 AJAX technologies. Zimbra's archiving as well as discovery features are also designed to meet the regulatory requirements. Figure 5.6 depicts the "Yahoo Zimbra desktop".

Facebook

The headquarters of Facebook, Inc., is located in a heart of "Silicon Valley" and is the major technical business. Once known as TheFacebook, the free-to-use social networking website maintained by Facebook Inc. was renamed in 2012 to just "Facebook." "Mark Zuckerberg" launched Facebook with the Harvard roommates "Dustin Moskovitz" and "Chris Hughes", both of whom were majoring in the computer science at the time. Until recently, only Harvard students could join the site. Other universities in the wider Boston area, as well as "Ivy League", and

"Stanford University" were later added to the club's membership. Any university student, next a high-school student, and ultimately a person beyond the age of 13 were included.

It's simple to join Facebook. As illustrated in Figure 8.4, you must first create the sign-on identity and also provide the email address. The three-step approach is all that is required to open a bank account. Your home page is ready for you to personalize after you've completed account-creation process. Figure 5.7 depicts a pre-customization home page.

And over 175 million people throughout world currently use Facebook. To connect and communicate with others, users could join networks based on their workplace, city, school, or regional area of residence. It's possible to add and communicate new friends, as well as make changes to one's own profile and alert existing friends. The site's name alludes to paper facebooks the new students, instructors, and also the staff at several American colleges as well as prep schools receive as a means of getting to know one another.

Only 200 engineers are needed to produce and over 50 billion page views every month on Fb. As the second most popular PHP hypertext preprocessor site in a world, and as among the largest MySQL installs in the world, it is a major player in PHP community. Facebook has more overall photo page views than any of the other photo-sharing

websites put together. In United States, it's the most popular photo-sharing service, with more than a billion photographs available.

Figure 5.7 Finding friends on Facebook[*]

[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(2009)/Chapter%208%20-%20End-User%20Access%20to%20Cloud%20Computing.pdf

Figure 5.8The Facebook default home page[*]

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[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(2009)/Chapter%208%20-%20End-User%20Access%20to%20Cloud%20Computing.pdf

There are above 14 million[*] new images uploaded to Facebook every day, making it a fourth most popular website in US. Open source caching system memcached, created by LiveJournal, is by far the most heavily utilised. Facebook's engineering staff is clearly pushing the boundaries of IT engineering based on these numbers. They've constructed the search engine from scratch that can handle millions of searches every day, all in memory, also with the real-time updates.

Zoho

The office productivity suite called Zoho was established by "AdventNet", Inc. in the year1996. Over 120 developers[†] contribute to the Zoho platform. Zoho has already released 15 applications, and even more are in a pipeline. You see a page depicted in Figure 5.9 when you visit Zoho website for the first time.

It is possible to sign up or log in directly from a home page. You'll have a slew of options when logging into Zoho. With

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[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(2009)/Chapter%208%20-%20End-User%20Access%20to%20Cloud%20Computing.pdf
[†]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(2009)/Chapter%208%20-%20End-User%20Access%20to%20Cloud%20Computing.pdf

"Zoho Mail", depicted in Figure 5.10, you have access to a wide range of options.

Figure 5.9 The Zoho home page

Figure 5.10 Zoho Mail home page[*]

Figure 5.11The inbox for Zoho mail[†]

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[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engi
neering/Cloud%20Computing%20-
%20Implementation%20Management%20and%20Security%20(20
09)/Chapter%208%20-%20End-
User%20Access%20to%20Cloud%20Computing.pdf
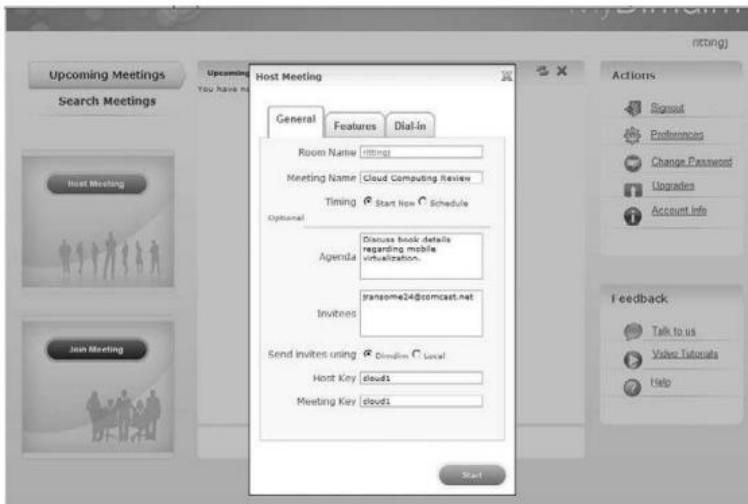[†]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engi
neering/Cloud%20Computing%20-
%20Implementation%20Management%20and%20Security%20(20
09)/Chapter%208%20-%20End-
User%20Access%20to%20Cloud%20Computing.pdf

Zoho Mail has a lot of storage room. Every email you've ever sent or received could be stored and searched, and it has offline capability so that you could carry your mail with you wherever you go. Even if you don't have the Internet connection, you could read as well as write emails and also send them once you do. Labels and regular folders are both supported by Zoho Mail. Labels are folders that allow you to give them a name and change the colour of the folder.

To ensure that you receive only valid emails, Zoho Mail uses self-learning algorithms to filter out spam. With Zoho, you may get a custom email address or build one using "zoho.com" domain. Additionally, mobile devices are accommodated. An iPhone could access Zoho Mail, and more mobile devices should be supported by the end of the year. Because Zoho Mail has integrated IM, you could send messages right from your inbox without having to install the separate client.

DimDim Collaboration

Dimdim12 spent and over 15 person-years developing a software to handle web meetings that were sophisticated. Anyone can use this free service to converse in the real time with the rich media. Users don't have to download or install anything to participate in the web meeting using Dimdim, in contrast to other similar services. With just a few mouse clicks, users may start or join the meetings.

Open source software "Dimdim" could be readily extended because it already connects with the "CRM" and

"LMS" systems. As the hosted or on-site solution, it's completely adaptable to your needs. An open source version of Dimdim for the developers as well as the highly technical fans, codenamed "Liberty," has been released. It is centered on the open source streaming and video components and also has nearly all of features advertised by "commercial Dimdim" version.

*Figure 5.12 The Dimdim sign-in page**

On top of the SynchroLive platform, the Dimdim Enterprise uses the "commercial streaming" as well as "media

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*https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engi neering/Cloud%20Computing%20- %20Implementation%20Management%20and%20Security%20(20 09)/Chapter%208%20-%20End- User%20Access%20to%20Cloud%20Computing.pdf

components". An Open Source Community Edition enjoys widespread support within the open source world. Dimdim's user interface is straightforward, making it convenient for presenters as well as spectators alike. Since all that's needed to broadcast the audio and also the video is simple plug-in, the meeting hosts and guests need not bother installing anything.
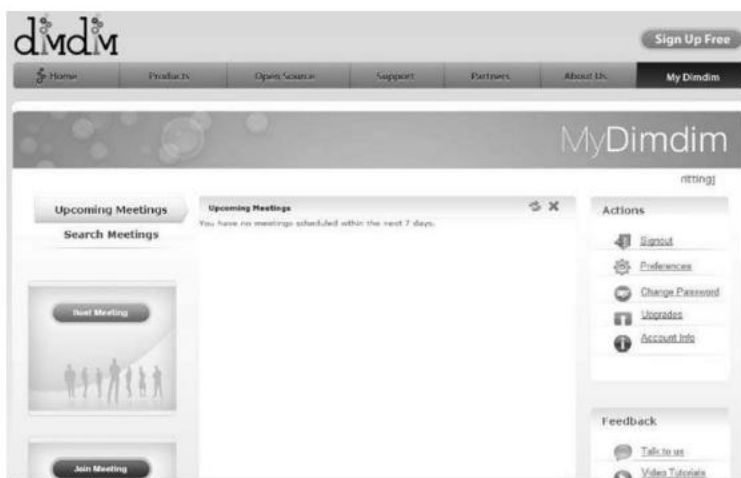
*Figure 5.13 The Dimdim home screen**

With Dimdim Free's robust feature set, anyone can host meetings for up to 20 people concurrently on a variety of platforms, including Windows, Mac, and Linux. Figure 5.12

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*https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(2009)/Chapter%208%20-%20End-User%20Access%20to%20Cloud%20Computing.pdf

illustrates how simple it is to become a Dimdim user. All you have to do is go to the website as well as fill out the form. The information you already have on file will be accepted if you actually have the user account. In the alternative, you can make one with a few mouse clicks as well as sign in.

Figure 5.13 depicts the Dim dim home screen after logging in for the first time. Just click Host Meeting icon as seen in Figure 5.14 to begin the meeting using Dimdim. Enter name of meeting as well as agenda, and afterwards e-mail addresses of those who will be participating.

Figure 5.14 Dimdim Host Meeting screen[*]

[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(20

Next, select a key for Host as well as one for each attendee and press the "Start" button.

Figure 5.14 illustrates a meeting which will start soon. Using the Timing option, you can arrange the meeting for future. Figure 5.15 shows the result of this action. Enter start and finish dates, as well as the time, on the Meeting Scheduling screen. You should pick a time zone that corresponds to the time zone in which meeting would take place. The dialogue box seen in Figure 5.16 can be accessed by clicking "Schedule button".

*Figure 5.15 Dimdim Schedule Meeting screen**

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*https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engi
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%20Implementation%20Management%20and%20Security%20(20

A message similar to shown in Figure 5.17 would be sent to everyone who signed up for the event. Clicking on the button in Figure 5.18 will begin your meetings. Even your complete desktop is shared with just one click. The meeting can be taken over by any attendee with a simple click of a mouse. It's easy to share the microphone or webcam with only one click.

Figure 5.16 Meeting Scheduled dialog box[*]

While listening to numerous voices through IP, attendees could see and also hear presenter's desktop as well as live video . You could use free teleconference option for larger gatherings. Attendees who have been granted permission by a host could simultaneously annotate the presentation and make notes on the whiteboard, as well as send

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[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(2009)/Chapter%208%20-%20End-User%20Access%20to%20Cloud%20Computing.pdf

the instant messages and stream audio as well as video. The Whiteboard is shown in Figure 5.16.

Figure 5.17 An email confirming the meeting invitation extended via DimDim*

Using Dimdim's built-in web browser, you may take your audience to the variety of websites and demonstrate specific

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capabilities live on an internet. Figure 8.17 illustrates how you might display your viewers throughout your site.
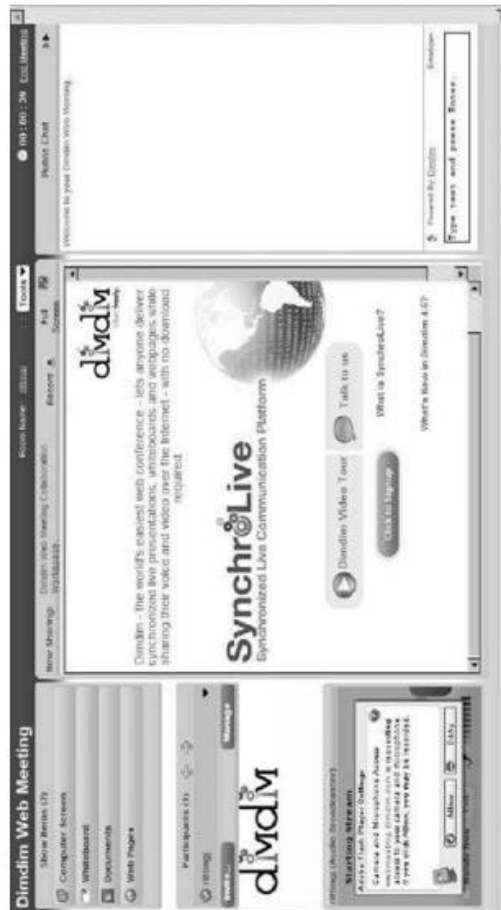
Figure 5.18 Dimdim Web Meeting opening screen[*]

[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engi neering/Cloud%20Computing%20-
%20Implementation%20Management%20and%20Security%20(20 09)/Chapter%208%20-%20End-
User%20Access%20to%20Cloud%20Computing.pdf
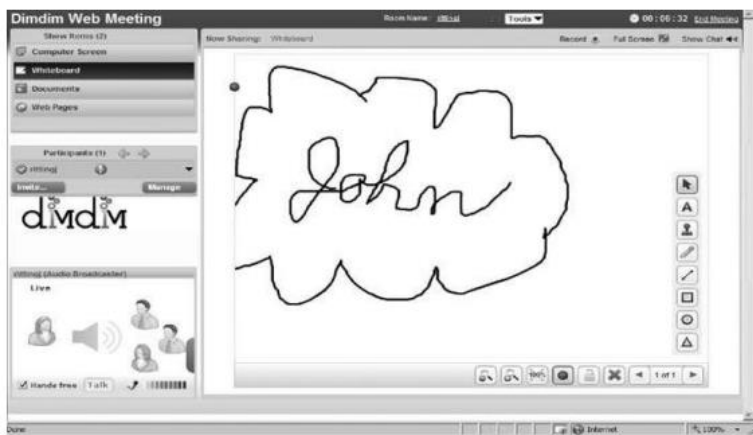
Figure 5.19 Using the Whiteboard in a Dimdim meeting[*]

When it comes to online teamwork, Dimdim is an excellent choice. Open source software like "SugarCRM13" can be integrated with the Dimdim's web conferencing software to allow the users and also the developers to collaborate with the groups of any size across several regions while concurrently logging the action in "SugarCRM" application.

Dimdim's online support14 features a comprehensive set of the tools aimed at enhancing the Dimdim user experience. For starters, you could take use of Dimdim's Forums, wherein you could interact with members of Dimdim community and also learn about important topics.

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[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engi neering/Cloud%20Computing%20-
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Figure 5.20 Showing your audience a web site.[*]

They also use forums to learn more about their customers' problems. The support database is linked to the online knowledgebase. It's always up to date as well as an excellent resource for finding self-help information. It's easy to monitor status of the issue or see issues for all the users by using Dimdim's issue tracker. Before conducting the meeting, you can use tools to check the system, bandwidth, and also even test the webcam. Downloading any necessary plug-ins is also possible. Additionally, the support site provides access to a wide range of other

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[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%2 0Engineering/Cloud%20Computing%20- %20Implementation%20Management%20and%20Security %20(2009)/Chapter%208%20-%20End- User%20Access%20to%20Cloud%20Computing.pdf

resources, including product as well as API documentation, Dimdim support policies, videos, supported platforms, as well as the open source support links.

5.9.   Mobile Internet devices and the cloud.

Mobile Operating Systems for Smartphones

Smartphones are often referred to as "minicomputers on the go." The operating system on vast majority of smartphones is easily recognizable and also open source, often allowing third-party applications to be installed. One of the primary ways smartphones vary from more traditional mobile phones is their ability to run third-party applications.

iPhone

The Apple iPhone runs on "Darwin OS", which is centered on 3G technology. Apple's Mac OS X as well as iPhone operating systems are built on Darwin's foundation. SUSv3-compliant and POSIX-compliant UNIX applications as well as utilities can be run on Darwin. Apple's latest iPhone boasts features like GPS navigation, the App Store, and support for the enterprise programmes like "Microsoft Exchange". The iPhone, such as the iPod, is the wide-screen mobile device. It has a plethora of features, including HTML email as well as a top-notch web browser.

Figure 5.21The iPhone home screen[*]

Google (Android)

The mobile operating system centered on "Linux kernel", Android is known as a Linux-based platform. At first, Google worked on it, and then "Open Handset Alliance" took over.

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[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(2009)/Chapter%209%20-%20Mobile%20Internet%20Devices%20and%20the%20Cloud.pdf

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Figure 5.22 The T-Mobile G1[*]

A full, open, as well as free mobile platform has never existed before. To get their projects off the ground, programmers can use the Android SDK. In order to control the mobile device, the Android developers can create manageable Java code. Android mobile phone users could

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[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engi neering/Cloud%20Computing%20-
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%20Mobile%20Internet%20Devices%20and%20the%20Cloud.pdf

download and also use the applications developed by the Android developers. Developers can publish as well as distribute their applications directly to the Android-compatible phone owners through Android Market. One of the more well-known commercial Android devices is T-Mobile G1, which may be seen in Figure 5.22.

Windows Mobile

Figure 5.23 Windows Mobile[*]

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[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(2009)/Chapter%209%20-%20Mobile%20Internet%20Devices%20and%20the%20Cloud.pdf

There are a few essential apps available for Windows Mobile, which makes it a good fit for most mobile handsets. It is centered on Win32 API provided by Microsoft. Pocket PCs, portable media centres, smartphones, and some automotive on-board computers all run Windows Mobile. The look and feel of Windows Mobile is intended to be comparable to that of the Microsoft's desktop operating system. Third-party software development is supported by the platform. In the beginning, Windows Mobile was called as "Windows Compact" . Windows Mobile has indeed been upgraded numerous times since then. Windows Mobile 7.0, the next anticipated release, is expected in a latter part of 2009. In this case, the intended appearance is depicted in Figure 5.23.

Blackberry

In order to access email as well as the other communication services, BlackBerry solution includes handsets which are pre-installed with the email client software. The BlackBerry is the two-way pager developed by "Canadian company" - "Research In Motion"(RIM) and first launched in 1999. Known as BlackBerry, RIM's smartphone was debuted in 2002 and quickly became a popular choice for consumers. Other wireless information services, such as push email as well as mobile phone calling, were also enabled, as were internet faxing, text messaging, as well as web browsing. Initially, BlackBerry's success in a commercial market was largely due to its focus on business email.

The "QWERTY keyboard" on "BlackBerry" is specially designed for "thumbing". Using the scroll wheel in middle of a device is a primary method of the system navigation . It is currently possible to access applications phone, email, data, and also the games from the smartphone that is state-of-the-art as depicted in figure 5.24.

*Figure 5.24 The Blackberry**

*https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(2009)/Chapter%209%20-%20Mobile%20Internet%20Devices%20and%20the%20Cloud.pdf

5.9.1. Mobile Platform Virtualization

There is a significant amount of innovation as well as change taking place in the mobile phone sector because of the growing popularity of the smartphones with sophisticated and also open operating systems. A competitive push to get the feature-rich phones to the market faster and shift from the proprietary operating systems to the open operating systems without sacrificing a security of the trusted services has intensified due to a pressure to decrease development costs and also get phones to the market faster.

Figure 5.25 Ubuntu MID instant messenger[*]

As the mobile phones became more powerful, they now include music, cameras, video, and also the built-in GPS capabilities, in addition to their fundamental phone functions. Daily, rich apps are being produced the open operating systems by lively developer community. In order

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[*]https://nscpolteksby.ac.id/ebook/files/Ebook/Computer%20Engineering/Cloud%20Computing%20-%20Implementation%20Management%20and%20Security%20(2009)/Chapter%209%20-%20Mobile%20Internet%20Devices%20and%20the%20Cloud.pdf

to provide the richer and even more valuable experience into the persona that could be transported and also transferred seamlessly when upgrading to the new phone, such capabilities have indeed been combined to provide mobile phone user with the ability to include applications, emails, videos, pictures, music, bank and also credit card information and also "Product information management" .

*Figure 5.26 Internet browsing on Ubuntu MID**

The capacity to safeguard and move personas would become a significant consideration when selecting a product or service. For the confidential information, not

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protecting and controlling employee-owned devices poses a substantial risk, as well as managing a wide range of the devices is both expensive and difficult. These problems can be addressed in large part through the use of virtualization. Following are two instances of the virtualization software that is now being utilised on the smartphones.

KVM

It is the open source software which provides a complete virtualization solution for "Linux" on "x86 hardware", including virtualization extensions, such as the "KVM kernel extension" ("Intel VT" or "AMD-V"). Kernel modules "kvm.ko"as well as "kvm-intel.ko" or "kvm-amd.ko", based on CPU vendor, provide the basic virtualization framework (Intel or AMD). A customised version of QEMU is also needed for KVM, 7 although efforts are being made to get the necessary changes upstreamed. KVM could be used to operate the multiple virtual machines using the unmodified images of Linux or Windows.

VMWare

For mobile devices, VMWare's "Mobile Virtualization Platform" (MVP) acts as the layer of software between the applications as well as data and also the phone's hardware. Low-memory, Low-power mobile can run it effectively. With MVP, phone makers will be able to get their products to market faster and also with less hassle. 8 When Trango purchased "Trango Virtual Processors" in October 2008,

VMware received MVP software as part of the deal. With this technology, you can easily move applications from one device to another, just like VMware's flagship server product does with its software layer.

Such trusted services can be isolated from an open operating system by using VMware MVP, allowing vendors to operate them in secure virtual machines which can't be altered even if open environment is interrupted.

5.9.2. Collaboration Applications for Mobile Platforms

There has been a shift in the way we collaborate as a result of the rise of the mobile devices like BlackBerry Storm, iPhone, and also Google phone, as well as "Web 2.0" as the new platform for building interactive applications that could indeed be used on multiple devices at same time.

As such three phones and the others on the horizon have demonstrated, mobile collaboration is more than just a matter of aesthetics; it is also dependent on factors including such network coverage as well as pricing structures. In the last few years, the mobile phones have transformed from specialised "voice communication devices" to general-purpose computing devices which can run a wide variety of the data applications. In addition to Bluetooth, cellular, Wi-Fi, as well as WiMAX, the most recent mobile phones also offer a wide range of the networking options to meet the variety of the coverage as well as bandwidth needs. In today's world, mobile phones are the preferred method of communication for

people to stay in touch with friends, loved ones, and colleagues. In addition to making phone calls, existing mobile phones enables users to view email as well as short messages, share information, play games, conduct video conferences, as well as the coordinate business actions..

5.9.3. Future Trends

With cloud computing, data as well as software can be accessed from anywhere, anytime, and in any format, including on the mobile devices. Customers of the cloud computing services don't have to worry about underlying technologies often used accomplish the server capabilities because they can buy computing power on demand. The 3rd provider typically owns and operates the computing resources that are accessed in the data centre locations. It is possible to use the virtualization in conjunction with the stateless model to maximise the efficiency of data centres as well as computing resources.Networked storage is the essential component of the stateless computing environment, making cloud an ideal environment for the mobile smartphone users to have accessibility of its powerful computing power.