Cloud computing environment is a new, great approach to providing IT-related services. In fact, this approach is a dream of numerous business owners who wish to get all possible IT services at one place. In simple terms, cloud computing environment is all about IT and what IT needs: different kinds of software and hardware, pay-per-use or subscription-based services offered both through the Internet and in real time. This book assists readers to comprehend what the cloud is and what is the method to work with it, though it isn't a portion of their regular accountability. Writers illustrate the ideas of cloud computing in realistic expressions, assisting readers to comprehend the procedure of controlling cloud services and offer worth to their trades via converting information to the cloud.
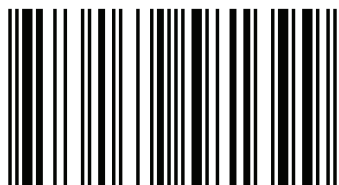
The authors, Dr. Debabrata Sarddar, Assistant Professor, University of Kalyani; Dr. Rajesh Bose, Deputy Manager, Simplex Infrastructures Limited; and Mr. Sandip Roy, research scholar from University of Kalyani, have individually or as co-authors published papers in leading journals on Cloud Computing and IoT technologies.

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Exploring the Fundamentals of Cloud Computing

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SUMMARY

At present, computing is converted into a representation comprising in services which are commercialized and delivered in a means akin to benefits like water, power supply, gas and telecommunications. Consumers get admittance of the services dependent on their necessities irrespective of the place they are hosted, in this representation. Profuse computing prototypes like Grid computing have ascertained to convey this benefit computing perception. Cloud computing is the latest appearing prototype ascertaining to transform the perception of "Computing benefits" into a verity. Cloud computing is a technological development which aims at the path where we constitute computing procedure, modify applications, and influence active services for creating software. This relies on the idea of potent allocation that is customarily used for services and competence for computing, depository, networking and IT infrastructure. Resources are created obtainable and provided on a pay-per-use way from cloud computing sellers. Now-a-days, anybody using a credit card is able to register to cloud services, and install and constitute server for an application not in much time, developing and shrivelling the infrastructure performing its application on the basis of the requirement, and offering price just for then, when resources have been consumed. This chapter supplies a concise synopsis of the cloud computing occurrence by establishing its insight, illustrating its key attributes and trailing the technological growths which have made it feasible. This chapter established a few of its fundamental technologies and discernments too, into the growths of cloud computing atmospheres.

Cloud computing is meaningfully escorting now-a-day's IT venture towards attaining their trade objectives together with supplying maximum user contentment with extremely cheap price concerning infrastructure, platforms, and software outlooks. While these infrastructure-associated annoyance managed by a CSP, cloud service supplier, company requires to aim entirely at the overhaul to their users. Being a customer of cloud services from CSP, companies require not get lofty technical prospective concerning infrastructure and platform. On the contrary, Cloud Service Customers require getting proficiency on the functionality provisioning/service dependent on their user necessities. Together with its advantages, cloud computing also offers different burdens.

Exploring the Fundamentals of Cloud Computing offers a synopsis of the cloud to reader and also the procedure to execute cloud computing in their enterprises. Cloud computing keeps on developing in reputation, and while several folks attend to the expression and apply it in discussion, several are bewildered by it or oblivious of what this truly signifies. This book assists readers to comprehend what the cloud is and what is the method to work with it, though it isn't a portion of their regular accountability. Writers illustrate the ideas of cloud computing in realistic expressions, assisting readers to comprehend the procedure of controlling cloud services and offer worth to their trades via converting information to the cloud. This book provides readers a theoretical knowledge and architecture for going ahead with cloud computing that looks for being comprehensive directions to the cloud.

FOR WHOM THE BOOK IS COMPILED?

All over the world, corporate strategy designers and they who have authority for the work of conveying the borderlines of their specific companies' information technology architecture have initiated to embrace in a prodigious means. Once when it was an emerging technology, service providers and end-consumers continued the range of coveted and acquired presentation stratums. Most was an issue of trial and error.

Due to growing rivalry, most of the cloud based business keeps equilibrium cautiously. This has turned out to be significant. Consequently, managers and Data Center executives can make a cloud elucidation which will be economical for them to operate supply. For the businessmen and students, the context of service rank management, service rank purposes, and ranks of confirmations can be bewildering, immature lump of concepts. This book has been shaped to augment and explain several of these subject matters associated with cloud computing services rank deals.

Enterprises and beginners on a financial plan would discover the segment of on cloud service invoice of engrossment. We expect that for safety executives and data centre executives, the division of executing safety stratums and catastrophe redemption schemes would shape the nucleolus of the book.

We wait to get synopsis made by our readers. Getting charged up by the students, IT experts and those endowed with the assignment of constituting the track to drifting to cloud, the writers created this book. Under no circumstances is this book finished. Nevertheless, it is expected that it will assist them keen in cloud computing to notice enthusiasms irrespective of probable intricacy and murk of the clouds of computing.

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CHAPTER 1

INTRODUCTION TO CLOUD COMUTING

1.1 Why Cloud Computing?

Prior to cloud computing, modern IT world consisting of several small as well as large IT organizations used conventional methods in building IT infrastructure. But the traditional IT structure is subject to very high expenditure by the organisations for maintaining in dubious IT flow. The high cost resulted from required maintenance of a server room which include database server, mail server, firewalls, modem, switches and configurable system. A steady network of high speed internet and specialized engineers to look after the entire system were also come under the primary requirements. With day by day increase in data and need to proper maintenance of data thus imposing a huge cost to the leading IT organisation. In order to reduce heavy pressure of IT infrastructure cost cloud computing is introduced.
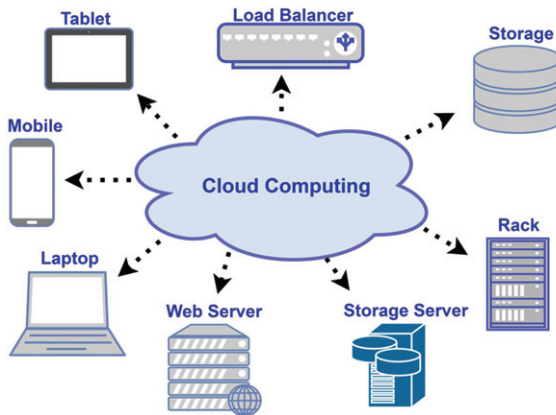
Figure 1.1 Cloud Computing

Cloud technology can be viewed as a metaphor for internet. Here actually a set of various hardware and software are made to work collectively in order to provide multiple services to its end users over internet. Thus a single network (typically the internet) is used to control several IT resources. Cloud computing works via internet on the basis of Pay-as-you-go pricing practice and enables the users with required IT resources.

Following are the ten basic components required for enabling cloud computing, identified by IT organisations.

1. Flexibility: The system should be flexible to meet organisation's requirements. Flexibility is also required for scaling up and down cloud capacity and providing services even to remote servers.

2. Ubiquitous access: It refers to wide accessibility of cloud service by the means of internet.

3. Automatic software updates: Software should be always up to date including security aspect.

4. Security: Important resources of users should be kept secure with cloud computing.

5. Privacy: Important resources should be delivered only to its authorized users and thus securing user's right**.**

6. Reliability: Cloud enabled system should be at par or better than the existing stand-alone system.

7. Open access: The resources should be accessed easily by its users through internet.

8. Disaster recovery: Provisions of disaster recovery is crucial. Since, IT resources are distributed over different location or through multiple clouds, if one appears to be faulty processing task is automatically shifted to other redundant implementation.

9. Capital-expenditure free: The hardware requirement is reduced in cloud computing. It works through internet on the basis of 'pay as you go' service, thus resulted in significant cost saving for organisations.

10. Environment friendly: By increasing power effectiveness it reduces emissions of carbon contributing towards a sustainable environment condition.

1.2 History of Cloud Computing

In this section we briefly discuss about the evolution of cloud computing. There are six different phases which explain transformation of computing technology from earlier mainframe computing to modern PCs and also starting from internet and network computing to latest grid and cloud computing.

The first phase is characterized with powerful mainframes. For easy accessibility several dummy terminals were used during this phase.

Gradually mainframes were started to be replaced with more advanced PCs and these are used to serve users need in an efficient way than earlier. This constitutes the second phase in the evolution process.

In the next stage, focus was given to connect several PCs and servers by the means of local area networking in order to share computing resources.

In the fourth stage initially formed local network connectivity was expanded through interlinking one local network with others. This help to use resources those were previously remain underused and to promote applications.

The global network formed in the fourth phase became stronger when grid computing is introduced with shared memory which expanded storage capacity and additional computing power through distributed computing system.

Finally, cloud computing is emerged as an efficient means of sharing and accessing computing resources via internet.

The concept of cloud computing is thought to be pioneered by scientist John McCarthy in early 1990s. His computing views have a significant contribution in modern world of computing. He imagined computing as a public utility.

With increase in computing resources need to deliver resources to its users begin to develop. It was first started in 1969. For delivering resources these need to be connected with a network which was first introduced by J.C.R.Liclider. He developed ARPANET (Advanced Resource Project Area Network) for this purpose. The initiatives to connect everybody in the earth with each other and also enable to access data and information from any location started from this phase.

In the process of building a virtualised world VMware was introduced in the market in 1970. VMware is software which is able to run different operating system simultaneously.

The dream of commercializing computing so that it can be sold as a utility has come true through initiatives taken by different enterprises. It was begun in1999 when salesforce.com introduced web based application for delivering concerned enterprise application.

Following this, Amazon also maintains server farms to offer applications to its buyers. Amazon Web Service (AWS) app was launched in 2002. Using this app user could enjoy cloud based services like resource storage, computation and human intelligence with the help of Amazon technical wing.

After this, several medium and large scale enterprises also participated in building a global and virtual world where every people and resources can be stayed connected with each other. For example, to monitor different operating system on a single platform Xen introduced Virtual Machine Monitor (VMM), also known as hypervisor in 2003. In 2006, Amazon created Elastic Computing Cloud (EC2) services to enable small organisation and individuals who don't have computers to rent computers for running their own applications. Big giant organisations like Google and Microsoft also launched their own web based services. The web based service of Microsoft is named as Windows Azure. To raise support for a

virtualised and smarter world IBM announced Smarter Cloud framework in 2011. In 2012, oracle offered cloud services like software as a service, Platform as a service, Infrastructure as a service through oracle cloud.

Soft Layer was responsible for providing cloud Infrastructure as a service from large number of data centres in the world which was taken over by IBM in 2013. With this the public cloud marked totalled up to £78 billion which is nearly 18.5% of that in 2012.
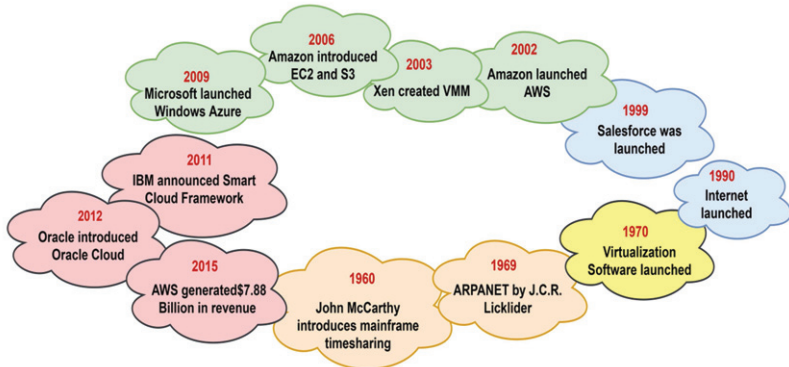
Figure 1.2 History of Cloud Computing

AWS which was launched in 2002 become increasingly popular with the passes of time. In 2014 approximately 1.4 million servers were operated across 28 availability zones with a promise to achieve 100% renewable energy substitution. Estimates also show that global business investment for cloud infrastructure and services increases up to £108 billion, an amount 20% higher than that spent in 2012.

Not only investment but also revenue generated from this web enabled service in 2015 rose to $7.88 billion which is 69% up from the last year. With this, cloud computing opens up a new source of increasing profit for the existing IT organisations. Added to it, Morgan Stanley forecasted cloud product to constitute a significant portion (nearly 30%)in the revenue of Microsoft by 2018. Besides private cloud service, public cloud service will also increase from nearly $70 Billion to more than $141 Billion in 2019 showing an annual compound growth rate of 19.4%. It is predicted that spending on global cloud computing will reach to $241 billion in 2020.

1.3 Characteristics of Cloud Computing

An efficient set up of cloud computing requires some specific characteristics to be enabled by the concerned organisations. These set of characteristics are completely different from that of a traditional web based services. For some organisation it is the cost benefit analysis associated with cloud service that is given most importance while for some other more cautions have been given to privacy and security aspects of resources. Below, we discuss some crucial characteristics of cloud infrastructure.

1. Virtualization: A complete virtual environment is the key feature of cloud enabled services. Here there is no need to check hardware compatibility. The users need not worry at all regarding the physical state of their hardware resources.

2. Resource Pooling: Resources from different web users can be pooled together in a single networking by using cloud. Several physical and virtual resources of users can be assigned or reassigned dynamically as per consumers demand.

3. Elasticity: Availability of IT resource should be elastic in response to users demand. In a phase of rising demand resources are to make flexible enough to fulfil increasing demand while in the phase of deficient demand it should be bring back to the normal level.

4. Self service and On-demand service: It refers to the facility given to cloud users so that they can enjoy computing capabilities even when there is no interaction with cloud service providers.

5. Pricing: Use of cloud service leads to a reduced price for its users since there is in upfront cost in the beginning of contract. The users have to pay a bill amount as per their resource uses. This helps the users to keep a track of their usage and control resource cost.

6. Quality of Service: Users are provided with the best quality of services. Service providers sign a service level agreement where services are outlined with the users. This agreement helps the users to be aware of the services.
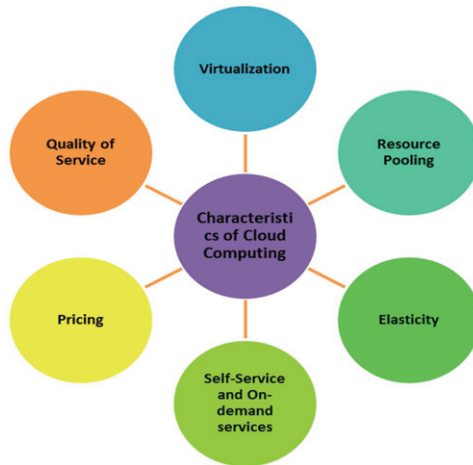
Figure 1.3 Characteristics of Cloud Computing

1.4 Benefits of Cloud Computing

According to the RightScale 2014 State of Cloud Report, 94% of the organizations surveyed are using cloud. This identifies that the uses of cloud computing has several benefits.

1. Cost efficiency: It is a cost effective technology since organisations pay only for what they use. Therefore, there is flexibility at the discretion of organisation to add to or drop cast whenever it expands or shrink.

2. No upfront cost: Upfront cost refers to costs incurred at the beginning of any contract. In case of cloud enabled web services there is no such cost to bear. Here users can get access over the resources in time and in their own expense of building capabilities and suitable infrastructure.

3. Fast deployment: Software based on cloud service required least time and efforts to be installed and configured.

4. Organisation focus: With easy and smooth resource management using cloud organisations can concentrate on their core business.

5. Scalable services: As per organisations requirement cloud capacity can be scaled up or down.

6. Access to remote staff: Users can get access to the remote staff by accessing cloud services. They are also allowed to share their problem on an open platform for all. This helps the organization to reach their goals.
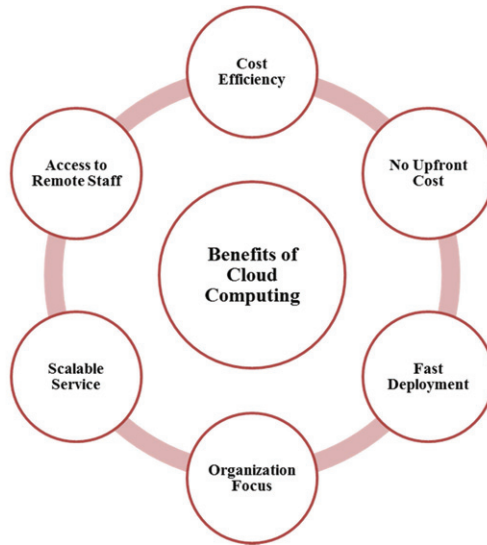
Figure 1.4 Benefits of Cloud Computing

1.5 Risks of Cloud Computing

Despite having several benefits of cloud computing in managing IT resources, the risk associated with it cannot be ignored. The risk concerned is in the security domain of user's resources mainly because large scale data are stored in public cloud. Followings are the risk related to cloud computing.

1. Increased security issues: Sensitive data of different organizations are stored in cloud. So, any movement of these resources require a secure access. In public cloud consumers resources are to be stored within an expanded security boundary. Overlapping security boundaries result in unauthorized access of resources by cloud providers. Both cloud users and providers follow access control norms in order to allow only authorized access to important resources.

2. Portability limitation different cloud providers: There is no fixed standard that can be determined by negotiation among all the cloud providers. As a result it becomes almost impossible for consumers to switch their resources from one provider to other.

3. Region wise legal issues: An important benefit of cloud computing is that users can access resources irrespective of their physical location. So, cloud provider build data centres in different region for sharing consumer's resources. But in some cases it becomes extremely important to have data centres that are under the control of definite industry or local government to satisfy privacy norms and storage policies.

4. Correct billing issues: Cloud computing offers services on pay as you go basis. Thus, consumers need to pay only for the resources they are used.

5. Loss of governance: Both consumers and providers have a shared responsibility of cloud governance. Cloud service agreement should be properly stated to the consumers. Consumers must have sufficient control over their IT resources.

REVIEW QUESTIONS

- ❖ Define cloud computing.
- ❖ What is a cloud?
- ❖ Explain the advantages and disadvantages of cloud computing.
- ❖ Why is cloud necessary?
- ❖ List of characteristics of cloud computing.
- ❖ Explain the benefits of cloud computing.
- ❖ Explain the risks of cloud computing.
- ❖ Why move to the cloud?
- ❖ What are the uses of cloud computing?
- ❖ How does cloud computing provide on-demand function.

CHAPTER 2

WORKING OF CLOUD COMUTING

2.1 Definition of Cloud Computing

In cloud computing hardware and software are combined together to provide a composite service on a single platform through internet.

The National Institute of Standards and Technology's (NIST) definition of cloud computing is considered by many to be the final on cloud. According to the official NIST definition, "Cloud Computing is a model for enabling ubiquitous convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models".

Followings are the five essential components of cloud computing:

On demand Self- Service: A user can set up his own computing capabilities like server timing or network storage as per own requirement with no need of physical interaction with each service authority every time.

Broad Network Access: Computing facilities are provided over a broad uniform network and can be accessed using any standard mechanism. The standard mechanism includes various computing platform such as mobile phones, tablets, laptops and workstations.

Resource Pooling: Cloud providers pooled all the computing resources together to fulfil consumer's resource demand on the cloud platform. A multi-tenant model is used for this where different physical and virtual resources are assigned and reassigned dynamically on the basis of consumer demand. Here resources are available irrespective of location. The users by no means have knowledge regarding the resources demanded or provided to them. The location can be guessed only at a high level of abstraction such as country, state or data centres. Storage, processing, network bandwidth, memory etc. are the examples of resources in cloud platform.

Rapid Elasticity: Computing facilities are largely flexible. It can be automatically scaled inward or outward in proportion to demands. Sometimes consumers are provided with unlimited capabilities while in some situation they are provided in limited quantity at a time.

Measured Service: Cloud computing leads to efficient resource usage by implementing its own metering capability on various types of services. Stored resources can be monitored and

controlled if needed. This provides a transparency of services between the consumer and cloud provider.
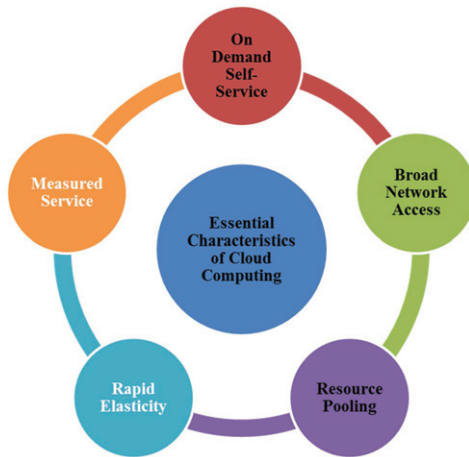
Figure 2.1 Essential Characteristics of Cloud Computing

2.2 Cloud Service Models

Cloud users demand different cloud service models such as infrastructure, software and platform model and so on. The type's model depends on the needs of the organisation and kind of operation to be performed. Depending on the consumer needs there are three basic cloud service models:

(i) Infrastructure as a Service (IaaS)

(ii) Platform as a Service (PaaS)

(iii) Software as a Service (SaaS)
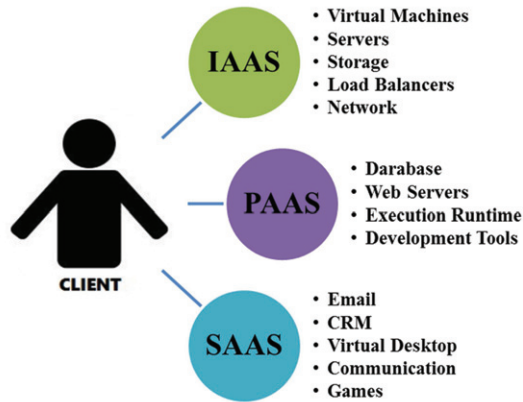
Figure 2.2 Cloud Service Models

i) Infrastructure as a Service (IaaS): It is one of the important layers of Cloud service platform. Here, the computing resources are accessed by its user. The components of computing infrastructure like software, hardware and storage components are hosted by service providers.

IaaS Example: Amazon Web Services (AWS), Microsoft Azure, Google Compute Engine (GCE) etc.

(ii) Platform as a Service (PaaS): Instead of ready-made applications or services, Platform as a Service (PaaS) provides for developing such applications and services. PaaS represents a pre-defined "ready-to-use" environment comprised of already deployed and configured IT resources.   A developer is able to write the application as well as deploy it directly into this PaaS layer. In PaaS layer, back end scalability is handled by the cloud service provider and the end user does not to worry about to manage the infrastructure.

PaaS Example: Apprenda is one provider of a private cloud PaaS for .NET and Java.

(iii) Software as a Service (SaaS): SaaS is also known as "On-Demand Software", provides a complete software solution in which applications are hosted by a cloud service provider and made available to customer over internet. SaaS is accessed by users using a thin client via a web browser without any downloads or installations required, although some time it requires

plugins. A cloud consumer is generally granted very limited administrative control over a SaaS implementation.

SaaS Example: Google Apps, Salesforce, Citrix GoToMeeting, Cisco WebEx etc.

2.3 Cloud Deployment Models

The cloud deployment model represent a specific type of cloud environment based on the location of the cloud, it primarily distinguished by ownership, size, and access.

There are four common cloud deployment models: (i) Public Cloud, (ii) Private Cloud, (iii) Hybrid Cloud, and (iv) Community Cloud.
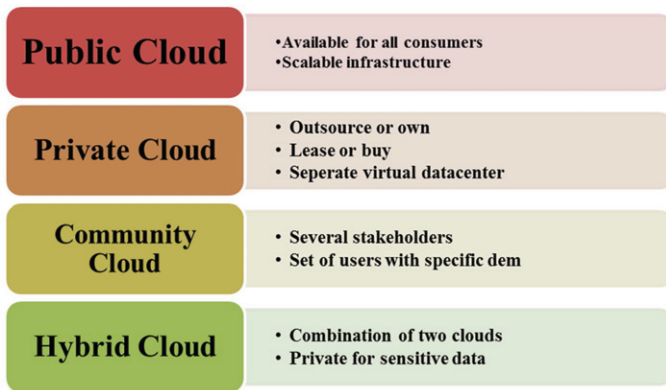
Figure 2.3 Cloud Deployment Models

(i) Public Cloud: Public cloud is a publicly accessible cloud environment owned by a cloud service provider. The responsibility of a cloud provider is to create and on-going maintenance of the public cloud and its IT resources. The cloud consumer can't view the infrastructure.

(ii) Private Cloud: Private cloud is accessible only within a particular organization. Private cloud is own, managed, and internally operated by the organization, a third party, or some combination of them. It may exit on or off premises.

(iii) Community Cloud: A community cloud is similar to a public cloud except that its access is limited to a specific community of cloud consumers. It may be owned, managed,

and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.

(iv) Hybrid Cloud: The Hybrid cloud is the composition of public and private cloud or community cloud that is bound together but remains individual entities. A hybrid cloud can cross isolation and overcome boundaries by the cloud service provider by aggregation, assimilation or customization with another cloud package or service.

2.4 Cloud Cube Model

Cloud computing offers a huge possibility for scalability, at almost instantaneous availability and low cost. Business experts require IT operations to assess the risks and benefit this representation of computing model. The Jericho forum, is an independent group of international information security leaders, has designed the Cloud Cube Model to help select cloud formations for secure collaboration. The Jericho forum has identified four dimensions for judgement to differentiate cloud formations from each other and manner of their provisions. These four dimensions are discussed below:
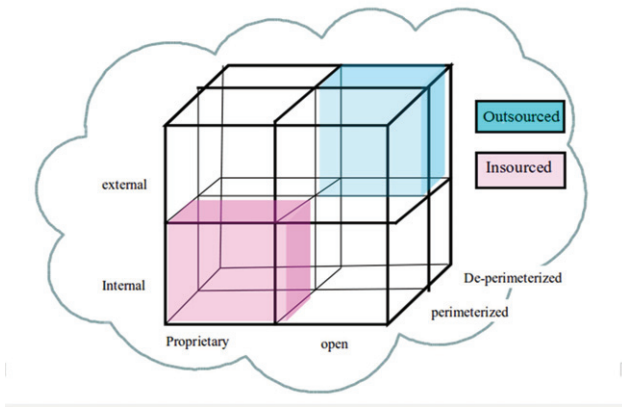
Figure 2.4 Cloud Cube Model

- Internal (I) / External (E)
- Proprietary (P) / Open (O)
- Perimeterised (Per) / De-perimeterised (D-p)
- Insourced / Outsourced

Internal (I) / External (E): This dimension illustrates the substantial position of the data like the place in which the cloud gets shaped we like to employ lie, inside or outside your enterprise's peripheries.

- ✓ It is in-house if it is in one's personal substantial periphery.
- ✓ It is outdoor if it is not in one's own personal periphery.

Proprietary (P) / Open (O): The Proprietary/Open aspect illustrates the condition of possession of the cloud technology, services, and peripheries. It points out the grade of interoperability, as well as empowering "data/application transportability" between one's personal methodologies and other cloud shapes.

- ✓ Proprietary signifies that the agency offering the service is maintaining the procedures of stipulation under their possession.
- ✓ Open refers that there are expected to be more providers, and consumers are not as forced in being competent to allocate their data and team up with certain customers exerting the identical open technology.

Perimeterised (Per) / De-perimeterised (D-p): It is symbolized in the third aspect. De-parameterisation is at all times analogous to the plodding malfunction, fall down, retreat, and exclusion of the customary warehouse-dependent IT boundary.

- ✓ Perimeterised entails progressing to control within the customary IT boundary, over and over again indicated by "network firewalls". While entailing in the boundary domains, consumers may merely widen their individual enterprise's boundary into the outdoor cloud computing region exerting a VPN and entailing the virtual server in their individual IP region, making exertion of their individual index services to manage admittance.
- ✓ De-perimeterised guesses that the organization boundary is designed obeying the ethics delineated in the Jericho Forum's Commandments and Collaboration Oriented Architectures Framework. In a de-perimeterised outline the data would be summed up with meta-data and apparatus which would defend the data from unsuitable convention.

Insourced / Outsourced: This illustrates the fourth aspect getting two conditions in every one of the 8 cloud shapes: Per (IP, IO, EP, EO) and D-p (IP, IO, EP, EO). Who is operating your cloud? If it is subcontracted the service is offered by a third one, and if it is insourced

the service is offered by one's personal employees. It illustrates the release supervision of the cloud services one devours.

- ✓ In subcontracted aspect, the service is offered by a third one
- ✓ In insourced aspect the service is offered by one's personal employees under one's authority

2.5 Cloud Reference Model

The NIST cloud computing description is broadly established and precious in offering a lucid interpretation of cloud computing technologies and cloud services. The NIST cloud computing reference framework is a nonspecific top-rank abstract representation which is an authoritative instrument for analyzing the necessities, constitutions, and functions of cloud computing. It describes a group of performers, actions, and tasks which can be exerted in the course of modifying cloud computing frameworks, and communicates with a friend cloud computing nomenclature. The Reference Framework illustrates five key performers with their tasks and accountabilities exerting the lately modified Cloud Computing Nomenclature. The NIST cloud computing reference framework describes five key performers: (i) cloud user, (ii) cloud supplier, (iii) cloud assessor, (iv) cloud agent, and (v) cloud transporter. Each performer communicates with other based on the task the performer acted upon in the cloud.

(i) Cloud Consumer: A cloud user glances through the service index from a cloud supplier, entreats the suitable service, establishes service agreements with the cloud supplier, and exerts the service. The cloud user may be invoiced for the service provisioned, and requires coordinating imbursements consequently. What type of command the user has from the supplier is based on the kind of cloud services the user entreats. The user can be a:

SaaS consumer: The SaaS users can be enterprise's which offer their associates with admittance to software applications, end consumers who unswervingly apply software applications, or software application administrators who constitute applications for end consumers. SaaS users have admittance and utilize applications based on their requirements, and can be payable on the number of users or the quantity of squandered services. The sole authority the SaaS end consumer has is to right of entry to the SaaS applications. End consumer can be a personal entity, commerce, or a government organization. The cloud supplier may let them lay down assured application configurations. Consumers are not allowed to control or manage application development, deployment, operating systems,

storage, virtual servers, networks, security, backup, and recovery. Application examples for Business support: Human resources, CRM, financial management, forecasting, email and office productivity, document management, workflow management, contract management, and waste management etc.

PaaS consumer: PaaS consumers can be application planner who devise and execute application software, application testers who execute and check applications in different cloud modes, application deplorers who manifest applications into a cloud mode, and application administrators who constitute and scrutinize application presentation on a platform. PaaS users can be paid by the number of users, the sort of resources squandered by the platform, or the tenure of platform convention. PaaS user manages how applications from an organization's in-house data center ought to be transported to the cloud. Users decide what safety equipments the supplier does not have to execute on the platform. The supplier does not manage virtual devices, depository, operating systems, computer resource provisioning, and networks infrastructure to the PaaS consumer.

IaaS consumer: IaaS users can be system planners, system administrators, and information technology (IT) executives, who are keen to form, constitute, control and supervise services for IT infrastructure operations. IaaS users are provisioned with the competence to get right to entry to these computing resources, and are paid for the quantity of resources squandered. The IaaS infrastructure professional has more controls than the PaaS developer. IaaS consumers control and manage the virtual machines that are has to be habitual to execute the PaaS and also can scale up and down virtual devices up to the border allowed by the supplier. They will probably be consented to gain restricted command over host firewalls. The supplier does not command and handle the fundamental cloud infrastructure of physical servers and networks to the IaaS user.
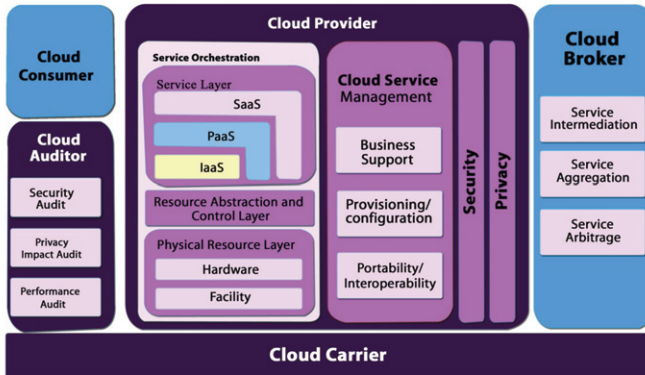
Figure 2.5 Cloud Reference Model

 (ii) Cloud provider: A cloud supplier can be an individual, an enterprise, or a phenomenon accountable for making an service obtainable to cloud users. A cloud supplier constitutes the entreated software/platform/infrastructure services, handles the technical infrastructure necessary for offering the services, stipulation the services at agreed-upon service ranks, and secures the safety and confidentiality of the services. The cloud supplier offers commands on the basis of the sort of cloud services the supplier executes.

SaaS provider: SaaS cloud supplier installs, constructs, upholds, and modifies the operation of the software applications on cloud infrastructure so that the services are provisioned at the usual service ranks to cloud users. The SaaS supplier administers operating systems, computer resource provisioning, service composition, and safety equipment. The supplier modifies the SaaS applications and virtual devices.

PaaS provider: The PaaS supplier is accountable for resource provisioning and operating systems. The supplier offers PaaS planners with application consumption equipment. PaaS cloud supplier handles the cloud infrastructure for the platform, and provisions equipment and implementation resources for the platform users to construct experiment, installation, and control of the applications.

IaaS provider: The IaaS supplier works with the cloud infrastructure of conventional computing, networking, and depository resources fundamental to the virtual machines. The suppliers command platform hosting services management, backup, and revival. IaaS supplier also handles the hosting atmosphere and cloud infrastructure for IaaS users.

(iii) Cloud auditor: A cloud assessor is principally implicated in whether safety commands are executed accurately and whether cloud services are acting upon well. Safety commands are the management, operational, and technical protections or antidotes engaged within an authoritative information system to defend the privacy, reliability, and accessibility of the system and its information. The assessor validates guideline and safety strategy acquiescence and also appraises the services offered by a cloud supplier in terms of safety commands, confidentiality contact, presentation, and loyalty to service rank contract considerations. Centralized organizations ought to take in the convention on the needs of reviewing safety commands offered by the cloud suppliers.

(iv) Cloud broker: The cloud agent stays in between the user and the supplier. The agent assists a cloud user to eliminate the intricacy of opting and handling numerous supplier services. User may entreat cloud services from an agent instead of unswervingly getting in touch with a supplier. Agents offer a sole point of access for handling several cloud services. Cloud Agents offer services in three ways:

Intermediation: The cloud agent offers service by modifying a few explicit potentials and offering value-added services to the cloud users. Intervention signifies to develop admittance management, distinctiveness management, and presentation exposure services from SaaS suppliers.

Aggregation: The Broker provides data and service integration and ensures the secure data movement between the cloud consumer and multiple cloud providers. Aggregation means to combine and integrate multiple services from multiple SaaS providers into one or more services.

Arbitrage: Service arbitrage is akin to service amassment excluding that the services being integrated/centralized are not permanent. Arbitrage signifies to select services from several SaaS or PaaS service suppliers. An agent has the suppleness to select services from various service suppliers.

(v) Cloud carrier: A cloud transporter conveys cloud services between cloud users and cloud suppliers. The cloud supplier is accountable for establishing a Service Level Agreement (SLA) with the transporter on service accessibility assurance. Cloud transporters endow with admittance to users via network, telecommunication, and other admittance tools. A cloud transporter is also to endow with out-and-out and encrypted unions between cloud users and cloud transporters.

REVIEW QUESTIONS

- ❖ What is cloud computing?
- ❖ Explain the essential characteristics of cloud computing.
- ❖ Explain the cloud deployment models.
- ❖ Explain the cloud service models.
- ❖ Discuss the cloud cube model.
- ❖ Define community cloud.
- ❖ What is cloud computing reference model?
- ❖ Draw a neat sketch on cloud computing reference model.
- ❖ What are the different layers of cloud computing?
- ❖ How important is software as a service?

CHAPTER 3

CLOUD COMUTING SERVICES

3.1 Infrastructure as a Service (IaaS)

Infrastructure as a Service (IaaS) offers that cloud users are gaining cloud infrastructure (i.e. servers, depository and networking) in an on-requirement flexible mode and in a pay-as-you-go representation. It is a harmonized, greatly mechanized that are possessed and congregated by a service supplier. API admittance to the transportation may also be on hand as an alternative. The profits of IaaS representation takes in:

1. Scalability: Resources are obtainable based on requirements. There is no impediment in increasing capacity or any surplus of idle potential.

2. Location Independence: The service can be obtained from everywhere via Internet.

3. Physical Security of Data Centre Location: Services are obtainable via a public cloud, or private clouds hosted outwardly with the cloud supplier

4. No Single Point of Failure: The mass of hardware resources signifies, it ought to have one feature of the service, that is, failing the service will be transformed into the other accessible resources.

There is a plenty of blocked and unlock kind IaaS. The instances are recorded as follows:

(i) Amazon Elastic Compute Cloud: Amazon Elastic Compute Cloud (Amazon EC2) offers scalable computing capacity in the Amazon Web Services (AWS) cloud. Amazon Web Services (AWS) is not without charge but it has stupendous conventions in flexible platform. Cloud users can exert Amazon EC2 to start on as many or as few virtual servers on the basis of their requirements, build up safety and networking, and handle depository. Amazon EC2 empowers users to raise or diminish the size to manage amendment in need.

(ii) IBM: IBM Cloud provides an option of accessible cloud infrastructure services for IT operations. Exert SoftLayer self-service IaaS is entirely controlled IaaS to install both virtual and out-and-out naked metal servers, extend applications and execute manufacturing-prepared workloads. IBM has not a without charge instance of IaaS. It empowers to handle all `resources. Furthermore it favours cloud by putting in virtualization concerns.

(iii) Eucalyptus: Eucalyptus (Elastic Utility Computing Architecture for Linking Your Programs to Useful Systems) was set up out of a research project in the Computer Science

Department at the University of California, Santa Barbara, and turned out to be a revenue generating trade named Eucalyptus Systems in 2009. It is an open source software infrastructure that implements IaaS-style cloud computing. The Eucalyptus cloud platform drags together subsisting virtualized infrastructure to generate cloud resources for Infrastructure as a Service (IaaS), Network as a Service (NaaS) and Storage as a Service (STaaS).In 2012, Eucalyptus Systems proclaimed an official contract with Amazon Web Services (AWS) that allows administrators to move instances between a Eucalyptus private cloud and the Amazon Elastic Compute Cloud (EC2) to generate a composite cloud. The corporation also permits Eucalyptus to work with Amazon's creation groups to modify sole AWS-friendly attributes.

(iv) OpenNebula: OpenNebula was published in March 2008.It handles a data center's virtual infrastructure to fabricate private, public and composite executions of Infrastructure as a Service (IaaS). OpenNebula is without charge and accessible-source software, is contingent on the needs of the Apache License version 2. OpenNebula merges subsisting virtualization technologies with progressive attributes for multi-tenancy, mechanical provisioning and suppleness.

Table 1: Comparisons of open and closed in Infrastructure as a Service

	Amazon EC2	**IBM**	**Eucalyptus**	**OpenNebula**
Source Type	Closed	Closed	Open	Open
Web Service	No	Yes	No	No
Operating System	Gentoo, Linux, Windows	Red Hat Enterprise Linux, SUSE	Cent OS	Linux, Open Solaris, Open SUSE
Language Supported	Java, PHP, Ruby, WinDev	All programming languages	Java	Java, Perl, PHP
Control Interface	Application Programming Interface, Command Line	Web Based Application, Control Panel	Web Based Application, Control Panel	Web Based Application, Control Panel

3.2 Platform as a Service (PaaS)

Platform as a Service (PaaS) offered a platform and atmosphere to permit constructors to erect applications and services over the internet. PaaS services are hosted in the cloud and got hold of by cloud users just via their web browser. PaaS offers the platform for modifying

such applications and services. There is a variety of improvement components and such things as Database Management Systems (DBMS), Enterprise Service Buses (ESBs), Application Servers, Business Intelligence (BI) / Business Analytics (BA), and so on which could be exerted to hold up the applications and services improved. The advantages of PaaS representation takes in:

1. Charge Diminution: lesser total charge of possession impending from the statement which there is no need to possess and handle all lesser concept resources such as hardware. The charge reductions most usually impend from harmonized and merged resources (e.g. servers) as well as removal of superfluous exertion across groups.

2. Agility: Agencies empower to more swiftly install atmospheres for improvement, checking and creation. Measuring all resources enthusiastically as required and measuring them at an upper concept stratum (platform atmosphere, improvement environment). PaaS diminishes and in to superior match contribution with necessity, when application workloads vary.

3. Reducing Complexity: Less database components paired with consistency of operating systems, servers, database edition, and constitutions creates for a simpler to handle and more consistent atmosphere. PaaS is functional in which constructors long for mechanizing testing and consumption services. PaaS may be more entirely illustrated as a harmonized, pooled and flexibly scalable application improvement and consumption platform transported as an service.

There are numerous way outs accessible in the PaaS bazaar that is pointed out as follows:

(i) Google App Engine: Google App is an entirely handled platfrom which entirely abstracts away infrastructure so consumers can concentrate only on symbols. App Engine holds up Node.js, Java, Ruby, C#, Go, Python, and PHP. The significant attribute of it precisely plans for real time active application.

(ii) Windows Azure: A Microsoft service-dependent operating atmosphere which will allow constructors to create and host services on Microsoft's infrastructure. Windows Azure is an open platform that supports both Microsoft and non-Microsoft languages and atmospheres. The constructors can make their applications and services, constructors exerting Visual Studio 2008 as well as trendy benchmarks and decorum taking in SOAP, REST, and XML.

(iii) VMware: VMware offers cloud and virtualization software and services and assert to be the first to productively virtualize x86 framework commercially. It was established in 1988 and exerted as composite cloud platform. Moreover it is brought to exert for large vicinity of application architecture and growth. VMware's desktop software gets executed on Microsoft Windows, Linux, and macOS. VMware ESX and VMware ESXi are naked-metal hypervisors that get executed unswervingly on server hardware devoid of needing an supplementary fundamental operating system.

(iv) OpenShift: OpenShift is a computer software creation from Red Hat for repository-dependent software consumption and administration. OpenShift Online is Red Hat's public cloud application development and hosting service. Developers can effortlessly and swiftly develop applications exerting either the web comfort, command-line interface (CLI), or integrated development environment (IDE).

Table 2: Comparisons of open and closed in Platform as a Service

	Google App Engine	**Windows Azure**	**VMware**	**OpenShift**
Owner	Google	Microsoft	VMware Inc.	Red Hat
Source type	Closed	Closed	Open	Open
Service type	Web app	Web app	Simplified infrastructure	Web app
OS Support	Windows or Linux	Windows	Windows or Linux	Linux
Deployment Language	Python, Java	Visual Studio, and .Net, C#, C++	PHP, Java	Java Enterprise Edition
Compatibility	Amazon EC2, Amazon S3	Microsoft App	Eucalyptus, Amazon EC2	Amazon EC2

3.3 Software as a Service (SaaS)

Software-as-a-Service (SaaS) offered to the cloud users that exert the cloud supplier's applications getting executed on a cloud atmosphere. The applications are characteristically got hold of by consumers exerting an emaciated customer via a web browser. SaaS removes the requirement for agencies to establish and execute applications on their personal machines or in their personal data centers. The users do not handle or direct the fundamental cloud

infrastructure taking in hardware or software resources. SaaS has turned out to be a universal liberation representation for several business applications taking in office and messaging software, management software, CAD software, Customer Relationship Management (CRM), Management Information Systems (MIS) and Human Resource Management (HRM) etc. The advantages of SaaS representation takes in:

1. Scalable usage: SaaS provides lofty scalability, which gives users the option to get admittance of more services or attributes on the basis of requirements.

2. Flexible payment: Users donate to a SaaS contribution devoid of buying software to establish, or supplementary hardware to hold up it. Users pay for this service based on monthly recurring. He or she can lapse SaaS contributions too at any time to discontinue giving those recurring charges.

3. Automatic updates: Users can believe in a SaaS supplier to mechanically carry out renewals devoid of buying novel software. This further diminishes the load on domestic IT staff.

4. Accessibility: Users can get admittance SaaS applications from any Internet-empowered tools and setting all over the world.

3.3.1 Difference between SaaS and SOA

Service Oriented Architecture (SOA) offers means for systems improvement and assimilation in which systems cluster functionality around trade progressions and package these as interoperable services. SOA infrastructure permits diverse applications to swap over data with one another as they take part in commerce progressions. A few enterprises present software as an service getting executed on the company's own infrastructure as well. SOA and SaaS are the technologies projected to lessen the IT rates of commercial methods. SOA is dependent on service-point of reference hypothesis that develops computer programs in terms of services. SaaS is a method of consumption of software over the web, not consuming via an on-campus server. The major dissimilarities between SaaS and SOA are recorded in the Table 1 as follows:

SaaS	SOA
SaaS denotes Software as a Service.	SOA stands for Service Oriented Architecture.
SaaS is a representation for sales and distribution of software applications.	SOA is a assembling representation. SOA uses service acclimatized computing ethics to the software elucidations to devise and construct software.
SaaS provides program on the basis of requirement.	SOA provides method for constitutional development and integration of services. These services empower to swap over and make utilization of information.
SaaS is one of the types of cloud computing where the obtainable services are software applications.	SOA is dependent on fundamental scheme where the declaration judgment is on hand in terms of services.
SaaS offers the advantage of ignoring both setting up and upholding of the software.	SOA needs setting up and software upholding.
SaaS scrutinizes and handles its in-house service mechanism.	SOA dependent coordination scrutinizes and handles the transportation, harmonization and cooperation among its service constituents.

3.3.2 Example of SaaS Platform

OpenSaaS demotes to SaaS dependent on open foundation code. Open SaaS is a web-dependent application which is hosted, held up and upheld by a cloud service supplier. The word was worked out in 2011 by Dries Buytaert, maker of the Drupal content management architecture. There are a numerous types of application or software described as open or closed foundation for instance:

(i) AxCMS.net

 AxCMS.net is the closed foundation and Content Management System (CMS) dependent completely on Microsoft.NET platform which abridges intricate procedures concerned in

making and handling lofty scalable and correlative web system. AxCMS.net ascertains brand and content uniformity of several sites and in diverse languages while permitting workers and outdoor resources to generate, handle and bring out web content. It assists enterprises to handle information and procedures for their workers, collaborators and users all the time

(ii) Autonomy Interwoven Teamsite CMS

Autonomy Interwoven Teamsite is a Content Management Solution. Interwoven is proprietor to Interwoven TeamSite, that is a device, applied for Web Content Management. Interweaver's software and services empower agencies to successfully control content to impel trade progress by developing the user job, augmenting partnership, and trade procedures in active atmospheres. Interwoven assists agencies to broaden and defend their sides, optimize their online existence, and offer a reliable and more appealing knowledge across all consumer feeling points. It empowers agencies augmenting output, abridging commerce procedures across different atmospheres.

(iii) AdaptCMS Lite

AdaptCMS is without charge software and a content management system (CMS) written in PHP for front end, exerting a MySQL as backend. With AdaptCMS customers is able to handle any website with a superior alternative, convention grounds, easily amendable patterns, an superior authorization domain and more which helps AdaptCMS be appropriate for any website.

(iv) mojoPortal

mojoPortal is an open foundation content management system (CMS) for ASP.NET that is written in C# programming language. It holds up hook up and has incorporated prop up for photo archives, blogs, event calendars and an e-commerce attribute. The project was rewarded an Open Source Content Management System Award by Packt in 2007 mentioning "ease of exertion, group of significant devices and hook up and the reality too that it is fractious platform, made it stand out on top of the rest".

The comparisons of open and closed source in SaaS are listed in Table 4.

Table 4: Comparisons of open and closed source in SaaS

	AxCMS.net	Autonomy Interwoven Teamsite CMS	AdaptCMS Lite	mojoPortal
Software type	Closed	Closed	Open	Open
Web management	Yes	Yes	Yes	Yes
Platform	ASP.NET	Perl, Java	PHP	ASP.NET
Supported	SQL Server	Oracle, SQL Server, DB2	MySQL	SQL Server, MySQL, SQL Lite, SQLCE
Software provider	Axinom	Interwoven TeamSite	Charlie Page's	Packt

3.4 Identity as a Service (IDaaS)

Workers in an agency need to sign in to system to spot them and carry out diverse jobs. It is very burdensome job for the workers are to keep in mind diverse username and password arrangements for getting admittance to several servers. Furthermore, if a worker relinquishes the organization, it is necessary to ascertain that each account of that user is immobilized. This augments workload on IT employees. To make solutions of above disputes, a novel procedure comes out that is acknowledged as Identity as a Service (IDaaS) that signifies uniqueness and admittance management services which are provided via the cloud or SaaS (Software as a Service) based on donations. An object is anything which can be exclusively acknowledged. Attribute information being possessed by an object are called features and if the features empower adequately recognize an object within a definite context they provide an Identity. Employees in an organization are identified using Identity which refers to set features connected with something to make it identifiable. There are numerous distinctiveness services which are set up to authenticate services like validating web sites, deals etc. Identity-as-an-Service may take in the features as follows:

These IDaaS elucidations offer a variety of distinctiveness and admittance management services like:

- Federated Identity Management
- Single Sign-On (SSO)

(i) Federated Identity Management

An object is nothing but in subsistence which can be exclusively acknowledged. Attribute information components getting possessed by an object are called features and if the features empower to adequately recognize an object within a definite background, they offer recognition. The Identity Management (IdM) is the means of handling individualities and their features. An alliance is a union of any number of consumers, service suppliers and recognition service suppliers and a united recognition is a recognition which can be exerted to get admittance of the services of an alliance. The Federated Identity Management (FIdM) is the means of handling united recognitions. With FIdM, consumers need only one recognition in order to get admittance of all the services within the alliance.
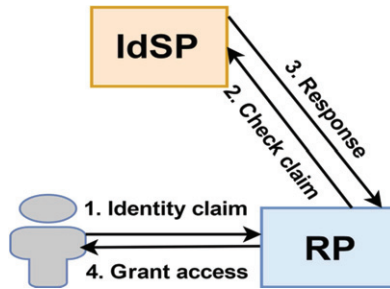
Figure 3.2 Basic model for identity information exchange

The model means for FIdM engrosses identity service providers (IdSPs) and relying parties (RPs). An IdSP handles and checks the recognitions of other objects and an RP depends on recognition representations authorized by IdSPs. The recognition information is over and over again substituted as declarations (or assertions). Declarations and assertion are exerted reciprocally and they both entail a proclamation, about anything, created devoid of any proof of its authenticity; the RP believes that the declarations from the IdSP are apt.

In Figure 3.2, a fundamental representation for substituting recognition information is described. The RP gets a declaration from a consumer regarding the consumer's recognition, asks the IdSP to authenticate the declaration and, if the declaration authenticates, allows admittance. This representation is at present exerted by a few open IdM procedures. One dilemma connected with this representation engrosses confidentiality, since the consumer has no command over the information substituted between the RP and the IdSP.
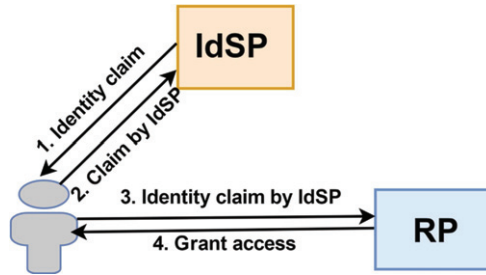
Figure 3.3 User-centric identity information exchange model

An elucidation to the confidentiality alarm engrosses the application of customer-centric representations which provide the consumers complete command over the application of their recognition by unswerving all recognition information substitute via the consumers. In a consumer-centric representation, as defined in Figure 3.3, the consumer gets back a declaration about his/her distinctiveness from an IdSP which the RP believes. That declaration will then permit the consumer to get admittance of the RP. One impediment connected with both these representations engrosses scalability while totalling IdSPs and RPs; consumers must either be supplementary to numerous IdSPs or the RPs must be extensive to believe more IdSPs. Figure 3.4 defines a representation where a consumer empowers to exert soles IdSP to get admittance dissimilar RPs, apart from whether or not they believe the consumer's IdSP. In this representation, RP only believes IdSP2, and the consumer only empowers to validate with IdSP1, however, since IdSP2 believes IdSP1 to validate consumers, the consumer can be approved admittance. Neither the consumer nor the RP are needed to be concerned of everything other than the IdSP which they believe in. Consumers and RPs can be supplementary to the IdSP which they are possessed to and novel IdSPs only need to be constituted at the active IdSPs. This representation is functional for alliance in a trade association since each party can have an IdSP, that is handling its consumers and RPs and the IdSPs can construct faith associations with each other, permitting the consumers to get admittance all the apt RPs in the alliance.
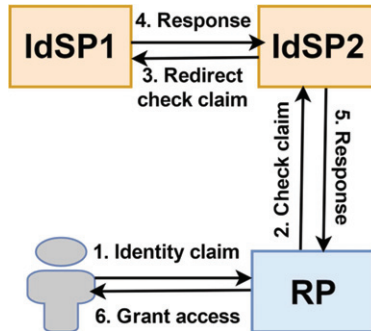
Figure 3.4 Model with one IdSP trusting another IdSP to authenticate users

The final representation can also be transformed into a consumer-centric representation and all the stated representations can be comprehensive to take in, for instance, uniqueness characteristic suppliers to provide features in place of the IdSP.

(ii) Single Sign-On (SSO)

Single Sign-On has sole verification server is that which is exerted to resolve the dispute of using dissimilar usernames and passwords amalgamations for diverse servers. Enterprises exert Single Sign-On software that permits the consumer to sign in only one time and deal with the numerous admittances to other systems.

To get admittance any tenable sheet in a web application, the consumer requires approving and if the consumer wishes to get admittance to several web applications then the consumers have to sign in for each of that application independently. Signing in several times can be removed with Single Sign-On i.e. consumer has to sign in only once and can get admittance to several web applications.

The functioning opinion of Single Sign-On software is illustrated as follows:

1. Consumer signs into the verification server by means of a username and password.

2. The verification server precedes the user's tag.

3. User transmits the tag to intranet server.

4. Intranet server transmits the tag to the verification server.

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5. Verification server transmits the user's safety testimonial for that server back to the intranet server.
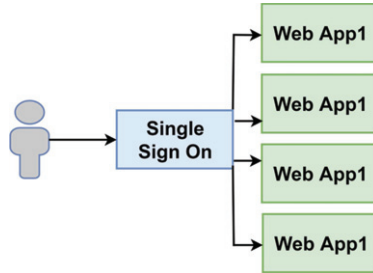
Figure 3.5 Basic model of Single Sign-On
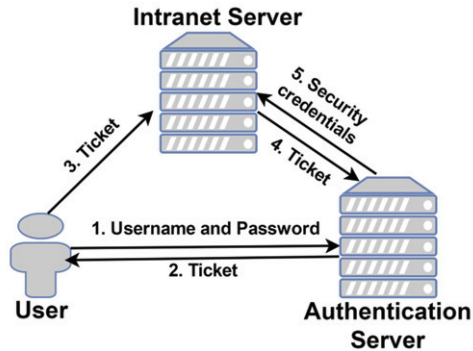
Figure 3.6 Steps of Single Sign-On Software

3.5 Compliance as a Service (CaaS)

A rising number of trades like banks, insurance, and payment card enterprises have to pay a huge fine and punishments due to rebelliousness with benchmark business guideline. This growing occurrence of rebelliousness is flattering an expensive and time consuming confront for these trades. It is an enterprise's duty to obey with pertinent laws and policies set by the government. Policies of one country won't be alike for another country. Developed economies like North America and Europe have set benchmark parameter in every industrialized and service division. These policies are made in order to defend user privileges and endorse reasonable rivalry among business. Nevertheless, growing number of convention and need of consideration by concern is important to rebelliousness of policies.

Consequently, agencies require looking into profoundly in conformity management to determine this trouble. Compliance as a Service (CaaS) suppliers devise conformity elucidations by evaluating universal regulation documentation with conformity necessity specified by the concern. The concern then executes this elucidation in order to convert its association targets as per the parameter. CaaS supplier provides watchful and determines any caution produced due to nonconformity of policies. This is how concerns can reduce the attempt and charge required to devise conformity elucidation.

Cloud computing is a key region were CaaS acceptance is departing to augment in approaching years. Several concerns are exerting cloud computing to endorse their trade in successful mode. Cloud computing has latent repel from confidentiality issues, data safety issues and authorized stakeholders within the commerce. Cloud computing ought to be able to deal with authorized, confidentiality and safety issues as early as possible. The enterprise's function on height of conformity relies on the stratum of influence it has in cloud computing services. If an enterprise is exerting software as a service (SaaS) elucidation, the stratum of influence will be less compared to SaaS supplier. While a concern applying infrastructure as a service (IaaS) will have more influence in comparison with IaaS supplier. This is how, a CaaS supplier can supply conformity elucidation to the concern on the basis of the kind of cloud computing service. CaaS is being exerted in Payment Card Industry for Data Security operation. This is how, due to growing exploitation of payment card in business industry, the bazaar for CaaS is going to augment in approaching years. The health insurance portability and accountability act (HIPAA) has focussed healthcare segment in the U.S. to execute firm conformity benchmark. This will facilitate to build up goods bazaar in approaching years for CaaS in the U.S.

One of the major confronts for the adoption of CaaS is company's uncertainty in outsourcing conformity management due to safety motives. Nevertheless, growing number of conformity infringements and growing authoritarian atmosphere will assist to accept CaaS across a variety of industrial segments in approaching years. CaaS discovers its application in domains of banking, financial services and Insurance (BFSI), government, healthcare, energy and usefulness, retail and consumer goods, education and cloud computing.

The attributes holding up CaaS are illustrated as follows:

(i) Worry-free Infrastructure and Application Management: Remove the saddle of having to acquire and uphold infrastructure, software renewals and scraping, data backup, etc.

(ii) Inventory Management: Methodically uphold list of procedures and possessions and valid policies, benchmarks, and commands across the union and lower units. Make and

follow solution documents, relics, statuses and dates, to hold up on-going jeopardy and conformity management.

(iii) Full-product Functionalities: Identical potentials as comprehensive below with the additional profits of admittance to finest prop up, accessibility to application and content renewals, and based on requirement on the basis of computer training archives.

(iv) Findings Identification and Remediation Management: Prioritize and enumerate results, connect results to information and to affected possessions, and handle results as remedial actions and milestones for succeeding jeopardy remediation.

(v) Control Implementation and Assessment: Offer a reliable architecture to assess possessions and processes based on jeopardy, task of appropriate commands, handle execution, and appraisal of command efficiency.

(vi) Dashboard and Reporting: Optical control panel offers lofty stratum and detailed outlooks to jeopardy metrics, appraisal conformity, results, and remedial performance in both real-time and as trends over time. Produce permits and information on the basis of pre-illustrated patterns.

(v) Risk and Compliance Alerting: Acquire real-time and programmed announcements on input changes of one's data, 24 x 7 x 365.

REVIEW QUESTIONS

- ❖ What does software as a service provide?
- ❖ How important is platform as a service?
- ❖ What resources are provided by infrastructure as a service?
- ❖ Mention open and closed type cloud services.
- ❖ What is Single Sign On?
- ❖ Discuss about Federated Identity Management.
- ❖ What is the use of eucalyptus in cloud computing environment?
- ❖ Discuss about Compliance as a Service (CaaS). What are the main features of CaaS?
- ❖ What are the main features of cloud services?
- ❖ How many types of deployment models are used in cloud?

CHAPTER 4

CLOUD COMUTING FRAMEWORK

4.1 Cloud Computing Framework

Cloud computing allocates the file arrangement which proliferates over numerous hard disks and devices. Data is by no means piled up just in a single position and if one element flops, another one will adopt by design. Cloud computing is a sturdy disseminated atmosphere and it sturdily relies on resource distribution algorithm. Figure 3.1 portrays the model of cloud-dependent framework.

Cloud computing takes in two constituents: front end and back end. Front end takes in consumer component of cloud computing arrangement. This takes in boundaries and uses which are needed to way in the cloud computing platform.

Back end signifies the cloud itself that takes in the resources which are needed for cloud computing services. This takes in virtual devices, servers, data depository, safety apparatus etc. It is under management of cloud service suppliers.
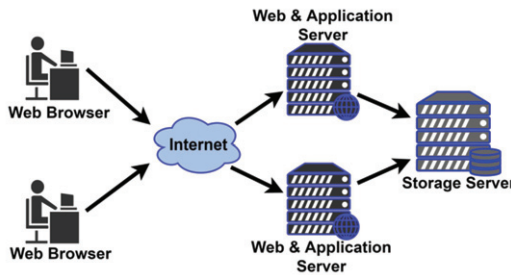
Figure 4.1 Cloud Computing Framework

4.2 Software Appliance

A software appliance is a software application pooled with presently adequate operating system to execute optimally on enterprise-benchmark hardware (usually a server) or in a virtual device. It is a software distribution or firmware which applies a computer appliance.

Virtual appliances are a compartment of software appliances. The key difference is the packaging set-up and the particularization of the objective platform. A virtual machine is a virtual device representation premeditated to get executed on an explicit virtualization platform, while a software application is habitually enclosed in more commonly pertinent

illustration design such as Live CD which holds up mechanism to substantial devices and numerous sorts of virtual devices.

Putting in a software appliance to a virtual device and enclosing that into a representation, generates a virtual appliance.

4.2.1 Benefits

Software appliances have numerous advantages over customary software uses which are set up on the peak of an operating system:

- ✓ **Basic Consumption:** A software appliance sums up a user's enslavements in a pre-combined, self-enclosed element. It can noticeably abridge software exploitation by freeing users from getting concerned about resolving expected combined operating system agreement lookouts, records dependence or disadvantageous contact with other utilizations. This is accepted as a "toaster."

- ✓ **Better isolation:** Software appliances are characteristically employed to execute applications in seclusion from one another. If the safety of a machine is cooperated, or if the machine breakdowns, other secluded machines will not be harmed.

- ✓ **Better arrangement:** A software appliance does not set in any novel operating system services, uses or any outline of bloatware therefore it does not intend to allocate the hardware resources (CPU, memory, storage space etc.) generally inspired by these on a basic OS unit. This in nature guides to quicker boot time and exertion implementation speed. In this issue in which numerous software appliances allocate and execute concurrently on the identical hardware (on a virtualization platform for an instance) this will not grip factual as execution examples of a software device (OS and software application) will get through more hardware resources than executing examples of a software application on one example of an operating system on account of the overhead of executing $(n-1)$ more examples of operating system.

4.2.2 Sorts of Software Appliances

i) Virtual Appliances

A software appliance can be wrapped in a virtual machine layout as a virtual appliance permitting it to be executed in a virtual machine storage place. A virtual appliance could be established applying either a model virtual machine layout like Open Virtualization Format

(OVF), or a layout explicit to a meticulous virtual machine storage place for instance VMware, VirtualBox, or Amazon EC2.

ii) Live CD Appliance

A software appliance can be wrapped as a Live CD representation, permitting it to get executed on authentic hardware together with most types of virtual machines. It permits constructors to keep away from the intricacies involved in holding up numerous unsuited virtual machine representation layouts and aim at the least common denominator as an alternative such as ISO representations are held up by most Virtual Machine platforms.

4.3 Virtual Appliance

A virtual appliance is a pre-constituted virtual machine representation, all set to get executed on a hypervisor; virtual appliances are a rift of the more expansive rank of software devices. Setting up of a software device on a virtual appliance and wrapping it into a representation makes a virtual appliance. As same as software appliance, virtual appliances are keen to do away with the setup, constitution and upholding prices connected with executed intricate piles of software.

A virtual appliance is not an inclusive virtual machine platform, but rather a software representation taking in a software pile blueprinted to get executed on a virtual machine platform that may be a Type 1 or Type 2 hypervisor. As same as a substantial computer, a hypervisor is simply a platform for getting executed an operating system atmosphere and does not offer application software itself.

Profuse virtual appliances offer a Web page consumer boundary to allow their constitution. A virtual appliance is as a rule established to congregate a sole application. So, it characterizes a novel means to install applications on a network.

Virtual devices are supplied to the client or consumer in the shape of files, through either electronic downloads or substantial allotment. The file arrangement most regularly applied is the Open Virtualization Format (OVF). The Distributed Management Task Force (DMTF) manifests the OVF requirement records. Most virtualization traders, taking in VMware, Microsoft, Oracle, and Citrix, hold up OVF for virtual devices.

Virtual appliances are vital resources in infrastructure-as-an-service cloud computing. The file arrangement of the virtual device is the lookout of the cloud supplier and habitually not

pertinent to the cloud consumer despite the cloud consumer may be the proprietor of the virtual device. Nevertheless, disputes may come up with the transmission of virtual device possession or transmission of virtual devices between cloud data centers. Here, virtual device replica or export/import attributes can be exerted to conquer this dilemma.

Along with the augment of virtualization as a platform for hosted services stipulation, virtual devices have approached to offer a straight way for customary on-campus applications to be hastily reinstalled in software as a service (SaaS) mode – devoid of being necessary to key application re-configure for multi-tenancy. By decoupling the hardware and operating system infrastructure supplier from the application pile supplier, virtual devices permit financial systems of range on the one side to be controlled by the financial system of ease on the other. Customary looms to SaaS, like that hyped by Salesforce.com, control allocated infrastructure by compelling huge amendment and amplified intricacy on the software pile.

A tangible instance of the virtual devices come up to to conveying SaaS is the Amazon Elastic Compute Cloud (EC2) – a network of Xen hypervisor nodes combined with the accessibility of pre-wrapped virtual devices in the Amazon Machine Image format. Amazon EC2 diminishes the price-hurdle to that extent in which it turns out to be viable to get each user of a hosted SaaS elucidation supplied with their personal virtual device example(s) rather than compelling them to allocate familiar examples. Prior to EC2, sole-tenant hosted representations were very much costly, guiding to the collapses of lots of premature ASP proposals.

In addition, in distinction to the multi-tenancy looms to SaaS, a virtual device can also be installed on-campus for users which require local network admittance to the executed application, or get safety needs which a third-party hosting representation does not come across. The fundamental virtualization technology too permits for hasty progress of virtual devices examples between substantial running atmospheres. Customary looms to SaaS join the application in position on the hosted infrastructure.

A virtual appliance expands the idea of a hardware device by providing the same advantages in a future more vibrant, measurable, and supple approach. Virtual appliances do away with the requirement for convention or intermediary substantial hardware and empower elucidations to be executed on a virtualization platform.

Virtual appliances convert software release by creating it easier and inexpensive to build up, allocate, install and deal with pre-constituted which can be executed in virtual atmosphere:

- ✓ Diminish growth, allocation and consumption price for software installations

- ✓ Speed up software sales sequence and inflate user access

Conveying software as a virtual appliance has several trades and technical profits, the end consequence of that is superior transformation rates, less vending rotations, and augmented regenerations. Virtual machines allow software developers to locate novel user sections, inflate allocation networks, and offer effortlessly used assessment and evidence-of-perception versions.

Since virtual appliances are enclosed as trouble-free dossier, users can download the dossier and then hit off 'power on' to have a revelation, assessment, or completely authorized exertion up and execute at once devoid of the requirement for an onsite Sales Engineer.
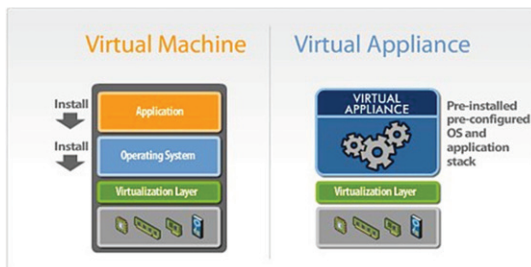
Figure 4.1 Virtual Appliance

4.4 Service Level Agreement

A **service-level agreement** (**SLA**) is characterized as an authorized assurance which exists in the midst of a service supplier and a customer. Meticulous facets of the service – class, accessibility, accountabilities – are consented between the service supplier and the service customer. The universal constituent of SLA is, the services ought to be supplied to the user as consented on in the agreement. For an instance, Internet service suppliers and telcos will usually take in service rank contracts concerning their agreements with users to illustrate the ranks of service being disposed in simple language expressions. At this the SLA will characteristically have a technical characterization in the period between

breakdowns (MTBF), mean time to mend or mean time to revival (MTTR); recognizing which customer is accountable for accounting errors or offering price; accountability for diverse data progressions; throughput; boogie; or analogous assessable factors.

Service level agreements are also defined at different levels:

- **User-dependent SLA**: A contract with a solo user set, enclosing every service they consume. For instance, an SLA between a provider (IT service supplier) and the funding section of a giant association for the services like funding scheme, payroll scheme, invoicing scheme, accumulation/sale scheme, etc.

- **Service-dependent SLA**: A contract for each user consuming the services being conveyed by the service supplier**. For instance:
  - ✓ A cell phone service supplier provides a routine service to all the users and provides explicit upholding as a component of a provision with the worldwide fees.
  - ✓ An email scheme for the whole association. There are scopes of intricacies appearing in this kind of SLA as rank of the services being provided may differ for various users (for instance, central office persons may consume high-speed LAN links whereas local offices may have to consume a lower speed hired channel).

- **Multilevel SLA**: The SLA is broken into the diverse ranks, each locating dissimilar group of users for the identical services, as same as SLA.

- **Corporate-level SLA**: Enclosing all the basic service rank management (frequently abbreviated as SLM) aspects suitable to every user all over the association. These aspects are expected to be not as much of unstable and so renewals (SLA reassessments) are not as much of often necessary.

- **Customer-level SLA**: Enclosing all SLM aspects pertinent to the meticulous user collections, apart from the services being consumed.

- **Service-level SLA**: Enclosing each SLM aspect pertinent to the explicit services, concerning to this explicit user collections.

4.4.1 Service Rank Contract constituents
A consummate SLA has the constituents as follows:
- ✓ **Objective** – It points out the reason behind SLA's formation.

✓ **Groups** – It points out the groups taken in the SLA and their roles.

✓ **Legitimacy Phase**- It says the duration enclosed by the SLA. It is illustrated by both the commencement time and the finishing time of the duration.

✓ **Possibility** – It illustrates the services mentioned in the SLA; SLA configuration ought to define the service so that the user will be able to identify the services method easily.

✓ **Limitations** – It points out the necessary grades to be carried out for providing the necessary service ranks.

✓ **Service-rank goals** – The goals are accepted by the user and the suppliers. It takes in a set of service rank pointers like accessibility, presentation, and steadfastness. Each portion of the service rank such as accessibility will have a goal rank to be inclusive. Service Rank goals have day-time limitations connected with them to portray their legitimacy.

✓ **Service-rank pointers** – These pointers are applied to assess these ranks of services.

✓ **Retributions** – It characterized the procedure to be performed when the supplier is not able to acquire the targets in the SLA. If the SLA is captured with an outdoor supplier, there ought to be an option of terminating the agreement.

✓ **Additional services** – These services which are not customarily required by the user, but might be required as omission.

  ✓ **Omissions** – It points out what is excluded in the SLA.

  ✓ **Management** – It illustrates the methods created in the SLA to attain and assess its targets

4.5 Cloud SLA Life Cycle

SLA has six key layers to be inclusive. These layers are stated below; progress of both service and SLA patterns, finding and compromise of an SLA, service provisioning and consumption, implementation of the service, evaluation and remedial achievements in the time of implementation, and both extinction and decommission of the service. The SLA lifespan was illustrated by the Tele Management Forum as displayed in Figure 4.2.
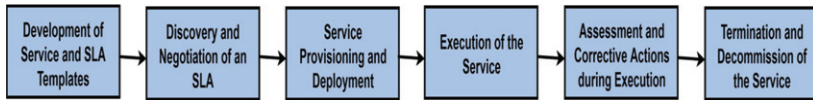
Figure 4.2 Cloud SLA Life Cycle

4.5.1 Improvement of Service and SLA Patterns: This phase takes in the recognition of user needs and needs, the network competence, the recognition of the fitting service attributes and limitations, service layers, service implementation-able atmosphere, and the execution of the level of SLA patterns.

4.5.2 Exploration and Compromise of an SLA: Exploration phase comprises in; the compromise of an SLA with the user to choose the significance of SLA limitations associated with precise services, the price profited from the service user after logging on the SLA, the price acquired by the service supplier when the SLA is desecrated, the characterization and at last cycle of the accounts connected with service to be conveyed to the service user. There was a research offered in theoretical SLA architecture for cloud computing that stated that there are several procedures of commencing the negotiation method in an online means. The feasible negotiation circumstances associated with cloud computing were illustrated. The primary condition is straightway negotiation between the cloud consumer and the cloud provider. The service provider can create a sole outline and mention all SLA segments such as length of conference, imbursement, time of response. When the SLA structure is positioned, cloud consumers can cast the glance at the SLA situations and counter by logging on the SLA, negotiating again or closing the negotiation. Straightway negotiation is a well-known method applied by several of cloud providers. The second condition is negotiated by an ascertained mediator, who is, a mediator with competence in opting the cloud providers and mentioning the solemn limitations for the SLA. This can be a key aspect when a trade requires focusing on the chore trade activities. A set of activities ought to be particularized to the external mediators who perform the negotiation in flexible and reliable ways. They could set in with the assessment of trade both methods and goals and carry out the negotiation by handling all or some of the SLA limitations. Also, the positive mediator can make exertion of other mediators to accomplish some activities like service identification and handling of the presentation. In the third condition several mediators are engaged to carry out the similar type of negotiation. Since there are four different types of cloud services, a cloud consumer could

log on a conference with four different agents (IaaS agent, PaaS agent, and SaaS) that acquire the job of mentioning SLA limitations and accomplish the negotiation method. This type of negotiation can be fine if the cloud consumer require more than one type of cloud service.

4.5.3 Service Provisioning and Consumption

These phases take in the service resource provisioning, in which the service is empowered and processed for the service customer deployment, arrangement of the network that might be to acquire explicit necessities in the service, or to hold up the service network in the whole, and service foundation. Service provisioning and consumption phase may require the rearrangement of the service resources to hold up the implementation able phase that will guide to a thriving attainment of the SLA limitations.

4.5.4 Implementation of the Service: This phase is the real examination of the service. It comprises in three key stages, the first is service implementation and supervision, Then the genuine time of reporting and at last the validation of QOS which refers to the quality of service. The final phase of this stage is SLA violation processing.

4.5.5 Evaluation and Remedial Actions during Implementation: SLA evaluation phase compromises in two segments, the evaluation with the single user, and the service evaluation on the whole. The SLA evaluation of the user takes in evaluating the Quality of Customer Service (QoS), user satisfaction, acquiring the probable improvements, and amending needs are scrutinized for each SLA. Service evaluations on the whole for key actions are reconsidering of service targets, service functions improving, illustrating the sustainment dilemmas of the services, and in conclusion setting up diverse service stratums.

4.5.6 Extinction and Decommission of the Service: Extinction and Decommission of the service layer in charge with the extinction of the service. This extinction will probably be a consequence of diverse grounds; it might be an aspect in the agreement, conclusion, or infringement. The decommissioning of withdrawn services can bring about extinction to the SLA.

REVIEW QUESTIONS

- ❖ Define Service Level Agreement (SLA).

- ❖ What is the purpose of a Service Level Agreement (SLA)?

- ❖ What information is contained in a Service Level Agreement?

- ❖ Explain the life cycle of Service Level Agreement.

- ❖ Explain the benefits of Software Appliance.

- ❖ What reports will the Provider produce?

- ❖ What are the purposes of Service Rank Contract?

- ❖ Do you publish SLAs, and how are these documents accessed?

- ❖ List the stages of service lifecycle in SOA and cloud.

- ❖ Who is cloud broker?

CHAPTER 5

VIRTUALIZATION

5.1 What is Virtualization?

Virtualization is a kind of technology which allows to share single physical instance of an application or resource among multiple organizations or customers. It does so by assigning a logical name to a physical resource and providing a pointer to that physical resource on demand. It reduces hardware utilization, saves energy and costs and makes it possible to run multiple applications and various operating systems on the same server at the same time. It increases the utilization, efficiency and flexibility of existing computer hardware.

5.2 Need of Virtualization

Virtualization provides various benefits including saving time and energy, decreasing costs and minimizing overall risk.

- ✓ Provides ability to manage resources effectively
- ✓ Increases productivity as it provides secure remote access.
- ✓ Provides for data loss prevention
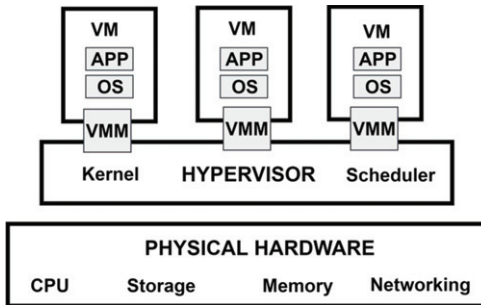
Figure 5.1 Virtualized Environment Representations

5.3 Types of Virtualization

There are different types of Virtualization.

1. Server Virtualization

2. Hardware Virtualization

3. Operating system Virtualization

4. Storage Virtualization

1. Server Virtualization

When the virtual machine software or virtual machine manager (VMM) is directly installed on the Server system is known as server virtualization.

2. Hardware Virtualization

When the virtual machine software or virtual machine manager (VMM) is directly installed on the hardware system is known as hardware virtualization. The main job of hypervisor is to control and monitoring the processor, memory and other hardware resources. After virtualization of hardware system we can install different operating system on it and run different applications on those operating systems.

3. Operating System Virtualization

When the virtual machine software or virtual machine manager (VMM) is installed on the Host operating system instead of directly on the hardware system is known as operating system virtualization.

4. Storage Virtualization

Storage virtualization is the process of grouping the physical storage from multiple network storage devices so that it looks like a single storage device. Storage virtualization is also implemented by using software applications.

5.4 Pros and Cons of Virtualization

The advantages of switching to a virtual environment are plentiful, saving user money and time while providing much greater business continuity and ability to recover from disaster.

i) Easier backup and disaster recovery: Disasters are swift and unexpected. In seconds, leaks, floods, power outages, cyber-attacks, theft and even snow storms can wipe out data essential to your business. Virtualization makes recovery much swifter and accurate, with less manpower and a fraction of the equipment.

ii) Reduced spending: For companies with fewer than 1,000 employees, up to 40% of an IT budget is spent on hardware. Purchasing multiple servers is often a good chunk of this cost.

Virtualizing requires fewer servers and extends the lifespan of existing hardware. This also means reduced energy costs.

iii) More efficient IT operations: Going to a virtual environment can make everyone's job easier – especially the IT staff. Virtualization provides an easier route for technicians to install and maintain software, distribute updates and maintain a more secure network. They can do this with less downtime, fewer outages, quicker recovery and instant backup as compared to a non-virtual environment.

iv) Dynamic load balancing: As server workloads vary, virtualization provides the ability for virtual machines that are over utilizing the resources of a server to be moved to underutilized servers. This dynamic load balancing creates efficient utilization of server resources.

The disadvantages of virtualization are mostly those that would come with any technology transition. With careful planning and expert implementation, all of these drawbacks can be overcome.

i) Software licensing considerations: This is becoming less of a problem as more software vendors adapt to the increased adoption of virtualization, but it is important to check with your vendors to clearly understand how they view software use in a virtualized environment.

ii) Upfront costs: The investment in the virtualization software, and possibly additional hardware might be required to make the virtualization possible. This depends on your existing network. Many businesses have sufficient capacity to accommodate the virtualization without requiring a lot of cash. This obstacle can also be more readily navigated by working with a Managed IT Services provider, who can offset this cost with monthly leasing or purchase plans.

iii) Data security: Data is crucial to your business; it is of utmost importance that you only choose virtualization solutions that offer adequate data protection. Remember that not having your own server can put your data at risk, making it vulnerable.

iv) Availability and scalability: Most of the time, the terms availability and scalability are intertwined when it comes to networking, as both are relevant to server virtualization after all. Availability would become a problem if virtualized servers go offline and every website they host would also fail. Scalability is even trickier, considering that virtualization offers a means

for several small businesses to share the costs associated with hosting. As you can see, while a business may start out small, there is always the possibility that it could grow big and easily dominate a virtualized server, robbing resources from other websites.

5.5 Hypervisor

In virtualization technology, hypervisor is a software program that manages multiple operating systems (or multiple instances of the same operating system) on a single computer system. The hypervisor manages the system's processor, memory, and other resources to allocate what each operating system requires. Hypervisors are designed for particular processor architecture and may also be called virtualization managers.

The term hypervisor was first coined in 1956 by IBM to refer to software programs distributed with IBM RPQ for the IBM 360/65. The hypervisor program installed on the computer allowed the sharing of its memory.

5.5.1 Types of Hypervisor

There are two types of hypervisors:

1. Type 1 hypervisor

2. Type 2 hypervisor

1. Type 1 hypervisor

Hypervisors run directly on the system hardware – A "bare metal" embedded hypervisor.

2. Type 2 hypervisor

Hypervisors run on a host operating system that provides virtualization services, such as I/O device support and memory management.
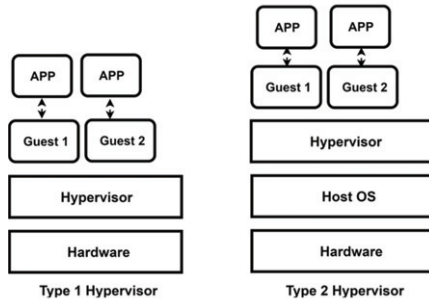
Figure 5.2 Types of Hypervisor

5.5.2 Example of different Hypervisor

Type 1 Hypervisor

1. Microsoft Hyper-V

The Microsoft hypervisor, Hyper-V doesn't offer many of the advanced features that VMware's products provide. However, with XenServer and vSphere, Hyper-V is one of the top 3 Type-1 hypervisors. It was first released with Windows Server, but now Hyper-V has been greatly enhanced with Windows Server 2012 Hyper-V. Hyper-V is available in both a free edition (with no GUI and no virtualization rights) and 4 commercial editions – Foundations (OEM only), Essentials, Standard, and Datacenter.

2. VMware ESX and ESXi

VMware ESXi is the industry-leading, purpose-built bare-metal hypervisor. ESXi installs directly onto your physical server enabling it to be partitioned into multiple logical servers referred to as virtual machines. These hypervisors offer advanced features and scalability, but require licensing, so the costs are higher. There are some lower-cost bundles that VMware offers and they can make hypervisor technology more affordable for small infrastructures. VMware is the leader in the Type-1 hypervisors. Their vSphere/ESXi product is available in a free edition and 5 commercial editions.

Type 2 Hypervisor

1. VMware Workstation/Fusion/Player

VMware Workstation Pro and VMware Workstation Player are the industry standard for running multiple operating systems as virtual machines on a single PC. Thousands of IT professionals, developers and businesses use Workstation Pro and Workstation Player to be more agile, more productive and more secure every day. VMware Player is a free virtualization hypervisor. VMware Workstation is a more robust hypervisor with some advanced features, such as record-and-replay and VM snapshot support.

2. Oracle VM VirtualBox

VirtualBox hypervisor technology provides reasonable performance and features if you want to virtualize on a budget. Despite being a free, hosted product with a very small footprint, VirtualBox shares many features with VMware vSphere and Microsoft Hyper-V.

5.6 Load Balancing in Cloud

The increase in web traffic and different application in the web world is increasing day by day where millions of data are created every second. Load balancing has become a very prevalent research field due to need of balancing the load on this heavy traffic. Cloud computing is a concept that use virtual machine instead of physical device to host, store and link the different nodes for their specific purpose. The load balancing is needed on CPU load, memory capacity and network. Load Balancing is done in such a way that the entire load is distributed among various nodes in a distributive system. If there is a failure of any node or host system in the network, it will lead to isolation of web resource in the web world. Load balancing in such situation should be able to provide availability and scalability. Many authors agree with the definition of Cloud Computing as it consists of clusters of distributed computers (Clouds) providing on-demand resources or services over a network with the scale and reliability of a data centre. Load balancing is a process of reassigning the total load to the individual nodes of the computing environment, this facilitates the network and resources and further improving the system performance. The important parts of this process are estimation and comparison of the stability, load and performance of the system, internodes traffic optimization. To construct load balancing mechanism many techniques and strategies are used. The load need to be distributed over the resources in cloud-based architecture, consequently each resource does almost the equal amount of task at any point of time. The

basic goal is to design some techniques to balance requests to provide the solutions. Cloud vendors are based on automatic load balancing services, which allow users to raise the number of CPUs or memories for their resources to scale with increased demands. This service provided is elective and depends on the clients business needs. Hence load balancing serves two important needs, mainly to promote availability of Cloud resources and secondarily to promote performance.

In order to balance the demands of the resources it is important to recognize a few major goals of load balancing algorithms:

i) Cost effectiveness: The major aim is to achieve an overall improvement in system performance at a reasonable cost.

ii) Scalability and flexibility: The distributed system in which the algorithm is implemented may change in topology or size. Thus the algorithm must be scalable and flexible enough to allow such changes to be handled easily.

iii) Priority: It require prioritization of the resources or jobs need to be done on beforehand through the algorithm itself for better service to the important or high prioritized jobs in spite of equal service provision for all the jobs regardless of their origin.
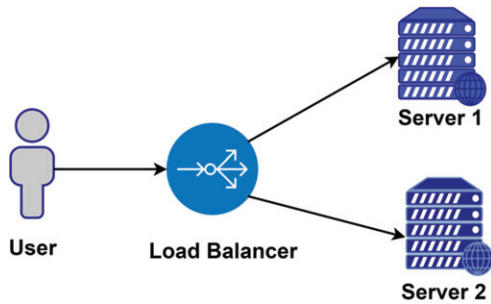
Figure 5.3 Load Balancing in Cloud

5.7 Virtual Machine Instances

An instance is a running virtual machine, in addition to some data the cloud maintains to help track ownership and status. The cloud manages a large pool of hardware that can be used to create running instances from images. The virtual machine includes a copy of the image that

it instantiates and the changes that it saves while it runs. The instance also includes virtualizations of the different hardware that it needs to run, including CPUs, memory, disk, and network interfaces. The cloud manages a pool of hypervisors that can manage the virtual machine instances. However, a user of the cloud does not need to worry about the hypervisors. In fact, the hypervisor users are using—KVM, Xen, VMware, or any other—makes no difference. When users delete an instance, that hardware can be reused. The cloud scrubs their hard disk before doing so, to make sure that the next user of the hardware finds no traces of previous data.

5.7.1 Virtual Machine Image:

A virtual machine image is a template for creating new instances. Users can choose images from a catalog to create images or save their own images from running instances. Specialists in those platforms often create catalog images, making sure that they are created with the proper patches and that any software is installed and configured with good default settings. The images can be plain operating systems or can have software installed on them, such as databases, application servers, or other applications. Images usually remove some data related to runtime operations, such as swap data and configuration files with embedded IP addresses or host names.

Image development is becoming a larger and more specialized area. One of the outstanding features of the IBM SmartCloud Enterprise is the image asset catalog. The asset catalog stores a set of additional data about images, including a "Getting Started" page, a parameters file that specifies additional parameters needed when creating an instance and additional files to inject into the instance at startup. It also hosts forums related to assets, to enable feedback and questions from users of images to the people who created those images. Saving their own images from running instances is easy, but making images that other people use requires more effort; the IBM SmartCloud Enterprise asset catalog provides users with tools to do this.

Because many users share clouds, the cloud helps you track information about images, such as ownership, history, and so on. The IBM SmartCloud Enterprise knows what organization users belong to when user log in. Users can choose whether to keep images private, exclusively for their own use, or to share with other users in their organization. If users are an independent software vendor, they can also add their images to the public catalog.

Some differences between Linux and Windows exist. The file like description of the Linux operating system makes it easy to prepare for virtualization. An image can be manipulated as a file system even when the instance is not running. Different files, such as a user's public SSH key and runtime parameters can be injected into the image before booting it. Cloud operators take advantage of this for ease of development and to make optimizations. The same method of manipulating files systems without booting the OS cannot be done in Windows.

5.8 Open Virtualization Format

The DMTF's Open Virtualization Format (OVF) standard provides the industry with a standard packaging format for software solutions based on virtual systems, solving critical business needs for software vendors and cloud computing service providers. OVF has been adopted and published by the International Organization for Standardization (ISO) as ISO 17203. OVF provides a platform independent, efficient, open and extensible packaging and distribution format that facilitates the mobility of virtual machines and gives customers' platform independence.

An OVF package can be used:

- ✓ By an independent software vendor (ISV) to publish a software solution
- ✓ By a data center operator to transport a software solution from one data center to another
- ✓ By a customer to archive a software solution

In any other use case that can be met by having a standardized package for a software solution from the user's point of view, OVF is a packaging format for virtual appliances. Once installed, an OVF package adds to the user's infrastructure a self-contained, self-consistent, software application that provides a particular service or services. The OVF package enables the authoring of portable virtual systems and the transport of virtual systems between virtualization platforms.
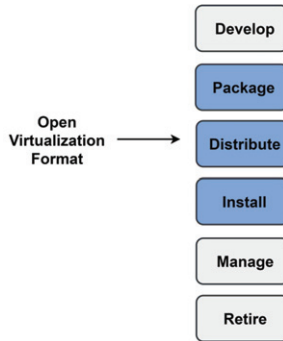
Figure 5.4 Open Virtualization Format

A) Open Virtualization Format: Version 1.1

Developed by about 10 different cloud providers, OVF 1.1/DSP0243 was published in early 2011 (under the reference ISO/IEC 17203), as an international standard for cloud infrastructure portability.

The open standard helps:

- ✓ optimize the distribution of virtual applications
- ✓ improve lifecycle management for virtual machines
- ✓ offer distribution across several virtual machines
- ✓ package a portable and independent virtual machine not tied to any particular virtualization platform or hypervisor

This standard, including various open source elements, is already applied by several cloud providers in the virtualization systems they offer.

B) Open Virtualization Format: Version 2.0

The System Virtualization, Partitioning, and Clustering (SVPC) work group that specified OVF is currently developing a new version: OVF 2.0, with new features for placement, scale-out, encryption and shared disks.

The new version will also include several upgrades:

- ✓ upgraded network services to monitor and improve network QoS

✓ new services like load balancing, firewall, and a feature to describe complex network topology

The key properties of the format are as follows:

i) Optimized for distribution: OVF supports content verification and integrity checking based on industry-standard public key infrastructure, and it provides a basic scheme for management of software licensing.

ii) Optimized for a simple, automated user experience: OVF supports validation of the entire package and each virtual system or metadata component of the OVF during the installation phases of the virtual system (VS) lifecycle management process. It also packages with the package relevant user-readable descriptive information that a virtualization platform can use to streamline the installation experience.

iii) Supports both single VS and multiple-VS configurations: OVF supports both standard single VS packages and packages containing complex, multi-tier services consisting of multiple interdependent VSs.

iv) Portable VS packaging: OVF is virtualization platform neutral, while also enabling platform-specific enhancements to be captured. It supports the full range of virtual hard disk formats used for hypervisors today, and it is extensible, which allow it to accommodate formats that may arise in the future. Virtual system properties are captured concisely and accurately.

v) Vendor and platform independent: OVF does not rely on the use of a specific host platform, virtualization platform, or guest software.

vi) Extensible: OVF is immediately useful — and extensible. It is designed to be extended as the industry moves forward with virtual appliance technology. It also supports and permits the encoding of vendor-specific metadata to support specific vertical markets.

vii) Localizable: OVF supports user-visible descriptions in multiple locales, and it supports localization of the interactive processes during installation of an appliance. This capability allows a single packaged appliance to serve multiple market opportunities.

viii) Open standard: OVF has arisen from the collaboration of key vendors in the industry, and it is developed in an accepted industry forum as a future standard for portable virtual systems.

REVIEW QUESTIONS

- ❖ What is virtualization?
- ❖ What are the types of virtualization?
- ❖ What are uses of server virtualizations?
- ❖ Define Virtual Machine Instances.
- ❖ What is hypervisor? What are the types of hypervisor?
- ❖ Explain the usage of Open Virtualization Format (OVF).
- ❖ What is network virtualization?
- ❖ What is storage virtualization?
- ❖ Explain load balancing in cloud computing.
- ❖ What are the benefits of virtualization?

CHAPTER 6

Google Web Services

6.1 Google Search Engine

Google Search Engine, widely known as google.com, is the most frequently used and popular search engine of this modern era. It has been developed by Google Inc. (an American based MNC founded by Larry Page and Sergey Brin). Other than this it also provides a wide range of products starting from web browsers (Google Chrome), to Android platform for smart phones, automatic driving vehicle, Chromium Operating System for personal computers and many more.

Google works basically on various types of services related to internet.
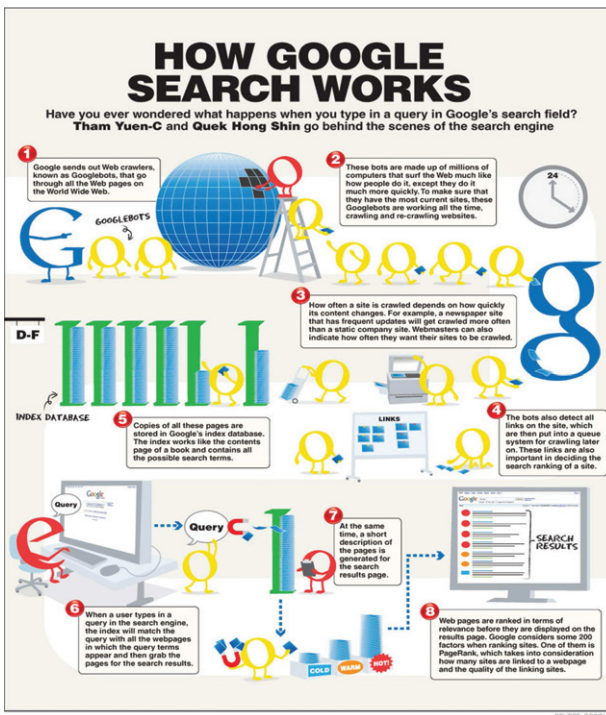
Figure 6.1 Steps for Google Searching

It has its business based on searching technology. It is the prototypical cloud computing Services Company that supports some of the largest Web sites services around the globe.

Let's learn the services provided by Google briefly: Google uses an automated system to index the web with the help of a special type of software called "Spider" (most popularly known as "Googlebot"). These spiders crawls the web and adds or updates newly updated or published pages in its index. The spider at first starts searching by fetching few webpages and then they search in the links that are present in that webpages and link to those webpages. After that the spider links to webpages present in those fetched webpages and in this way within a few seconds it fetches and links with millions of sites. Simultaneously it also checks for spam websites, dead links. This web crawler takes the help of the sitemap. These site maps are stored in robots.txt file of a website. A site owner decides whether to make that file accessible to the Googlebot or not. In this file the site owner may even specify that how a website is needed to be crawled to the web crawler.

A site map (or sitemap) is a list of pages of a web site accessible to crawlers or users. It can be either a document in any form used as a planning tool for Web design, or a Web page that lists the pages on a website that are organized in hierarchical fashion.

The most important thing is that how Google search will choose the most promising results. This is mainly based on few things like keyword density, page rank of a page (Alexa ranking). At first the Googlebot searches that how many times the given search terms are present in the websites. It checks the header, title, body, URL, checks if the page includes synonyms for those words, even checks the link is from quality or low quality website or even spam. The page having maximum keyword density will be shown higher in the list. It also checks the number of visits of the webpage, number of times the webpage is getting updated. The higher the page rank the higher rank, the page will get in the Google search result. Google is always tweaking its searching algorithm to prevent Search Engine Optimization (SEO) from gamming the system. Google Corporation doesn't take payment to add pages to the web index, or to improve the ranking. It only searches in the pages that have been registered with the Search Engine. Based on this algorithm, Google returns what is called a Search Engine result Page (SERP) for a query that is parsed for its keywords. The search result includes Webpage Titles, URLs, Snippets of text for help, which makes us understand that whether we have found the desired result or not, and if possible it also provides co-related ads at the sides of the pages. At the bottom of the page more links of similar types are present.

6.2 Dark Web

The dark web is nothing but the part of the World Wide Web (WWW) that has not been indexed by search engines like Yahoo, Google. It requires some special software s and authentication to be used. Special software s like TOR browser is used to access the dark net. One of the most popular search engines of dark web is the duckduckgo.com. The dark web forms a small part of the deep web; the part of the Web not indexed search engines, although sometimes the term "deep web" is confusingly used to refer specifically to the dark web.

Figure 6.2 Deep Web and Dark Web

Interesting facts about Dark Web:

1. The darknets which constitute the dark web include P2P networks, as well as large, popular networks like Freenet, Tor that are operated by public organizations and individuals.

2. None can use the standard access methods to gain entry into the Dark Web. The most common method to access it is through the Tor network, an anonymous network that has been created from nodes which disguise online activity. Tor browser is used to access the

dark net parts. And in some cases it may also need to be issue an invitation to access certain Onion domains hidden within the Dark Web.

3. Onion address is the result of Onion networking that is a low-latency communication that has been designed to resist traffic analysis and surveillance. The use of Onion networking is not a perfect solution to maintain anonymity, but it indeed helps disguise who is communicating with whom.

4. There are many vendors who peddle their illegal wares (mainly) within the Dark Web. While drugs are the most commonly-thought of when it comes to the secretive area, anyone can purchase a plethora of other illegal goods. Weapons, porn, counterfeit money and fake identities, hacked accounts can be found if you have the cash.

5. Anyone can buy lifetime membership passes to popular services such as Netflix, old consoles, clothing, emulators and DVDs, a car or two and bulk weight loss pills. Both counterfeit and apparently legitimate devices are available.

6. The Dark Web is even used for buying and selling "ethical" hacking and political forums, archives of forbidden books, tips on how to care for your cat, there are potentially thousands of private .onion addresses hosted which go beyond marketplaces.

7. Trading is not safe or risk-free. Vendors and sellers might be trying to avoid the eyes of legal enforcement in the darker side of the Internet, but this doesn't stop scams from taking place. Scam vendors and quick grab-and-run schemes run rampant -- especially as there is no way to follow up with failed sales down the legal route.

8. Buying and selling through the Dark Web is done without linking to bank account. Virtual currency is the most common method, which includes "tumbling," a laundering process which destroys the connection between a Bitcoin address which sends virtual currency and the recipient in the hopes of covering a user's tracks. Some vendors offer escrow services which hold Bitcoin in trust until goods have been delivered and both parties are happy -- although value fluctuations linked to Bitcoin use makes this move risky.

9. Avoiding spying eyes:-Aside from using the Tor browser and VPNs, a number of buyers and sellers use "Tails," free software which can be booted from flash storage to provide end-to-end encryption for your browsing sessions. To further cover their tracks, vendors and sellers will often also use public Wi-Fi hotspots to conduct their business.

10. Reddit is a communication platform that is used for Dark Web transactions:-Although far from exhaustive, the best Clear Web resource to bounce around and learn a little about the darker, nastier aspects of the Internet is on Reddit. There are sub-forums in which Dark Web vendors and buyers exchange news, thoughts and seller reviews. Advice is also issued on how best to "clean house," create safe "drop" zones to pick up packages ordered from the Dark Web and also what can be done if anyone finds law enforcement is keeping an eye on you.

Important terms related to Dark Web and Deep Web:

A) Bitcoin services:

Bitcoin services such as tumblers are often available on Tor network, and some – such as Grams – offer darknet market integration. A research carried out by the United Nations Office on Drugs and Crime, highlighted new trends in the use of Bitcoin tumblers for money laundering purposes. A common approach was to use a digital currency exchanger service which converted Bitcoin into an online game currency (such as gold coins in World of Warcraft or any online games like that) that will later be converted back into money.

B) Darknet Market:

Commercial darknets, which mediate transactions for illegal drugs and other goods, attracted significant media coverage starting with the popularity of Silk Road and its subsequent seizure by legal authorities. Other markets sell software exploits and weapons.

C) Puzzles:

Puzzles such as Cicada 3301 and successors will sometimes use hidden services in order to more anonymously provide clues, often increasing speculation as to the identity of their creators.

6.3 Productivity Applications and Services

Google stores information about the user to help serve the users better. Google serves its customers across multiple purposes using wide range and variety of products

1) Alerts: It sends periodic remainder based on your search terms (e.g. news, blogs, and videos)

2) Blog Search: - Displays an aggregation page from blog

3) Blogger: For creating personal blogs. (Currently free of cost. People need to have a Gmail account to use this service)

4) Books: Contains collection of books

5) Calendar: It is used for scheduling events systematically and give remainders to the concerned people or group

6) Chrome: Google's self-developed browser and OS based on Chromium language and Linux kernel respectively

7) Code: Developers tool and resources

8) Custom search: Provides in-site search engine

9) Earth: An online atlas and mapping service with mashups

10) Orkut: Social media service with instant messaging

11) Translate: Language translation utility

12) Picasa: Photo-editing and managing software

Figure 6.3 Productivity Applications and Services

6.3.1 Enterprise Offerings

1) Google commerce Search: This is a search service for online retailers who market products in their site searches with number of navigations, filtering, promotion and analytical functions.

2) Google site search: Google sells its search engine customized for a specific enterprise. On searching Google returns result from that corresponding site.

3) Google Search Appliance (GSA): This server can be employed within an organization to fasten up the browsing speed for both intra and internet. They provide indexing, along with document management features, perform custom searches, cache content, and give local support to Google Analytics and Google sitemaps.

4) Google mini: Smaller version of GSA.

Google has separate package for school, government, ISPs, NGOs and etc. To provide support for Google's Premier and Education Editions Gmail, Google purchased the Postini archiving and discovery service. Google Postini Services provides security services like threat assessment, proactive link blocking. These are prepaid services that add from $12 to $45 per user/per year based on option chosen.

6.4 Google AdWords

Online advertising allows organization to show their ads to the people who are likely to be interested in their products and services. Organization can also track whether those people clicked their ads. Online advertising also gives organization the opportunity to reach potential customers as they use multiple devices — desktops, laptops, tablets, and smartphones.

AdWords allows you to take advantage of the benefits of online advertising: show ads to the right people, in the right place, and at the right time. AdWords offers several benefits.

1. Target organization ads customer to show their ads to reach people with specific interests — namely, people who are interested in their products and services — and show them relevant ads. AdWords offers different ways of targeting to their customers which are discussed below:

Keywords: Words or phrases relevant to your products and service, which are used to show organization ads when customers search for those terms or visit relevant websites.

Ad location: Show organization ads on search engines, commercial sites, or personal sites.

Age, location, and language: Choose the age, geographic location, and language of their customers.

Days, times, and frequency: Show organization ads during certain hours or days of the week, and determine how often their ads appear.

Devices: Organization's ads can appear on all types of devices, and they can fine-tune which devices their ads appear on and when.

2. Control costs AdWords give them to control over how they spend their money. There's no minimum. And they can choose how much they spend per month, per day, and per ad. They'll only pay when someone clicks their ad.

3. Measure their success With AdWords, if someone clicked their ad, they'll know. If they clicked their ad and then did something valuable to their business – purchased their product, downloaded their app, or phoned in an order -- they can track that, too. By seeing which ads get clicks and which ones don't, they'll also quickly see where to invest in their campaign. That, in turn, can boost the return on their investment. They can get other valuable data, including how much it costs, on average, for advertising that leads to their customers' online purchases or phone calls. They can also use analytical tools to learn about their customer's shopping habits -- how long, for instance, they tend to research your product before they buy.

4. Manage their campaigns AdWords also offers tools to easily manage and monitor accounts. If they manage multiple AdWords accounts, a My Client Center (MCC) manager account is a powerful tool that could save their time. It lets easily view and manages all of their AdWords accounts from a single location.
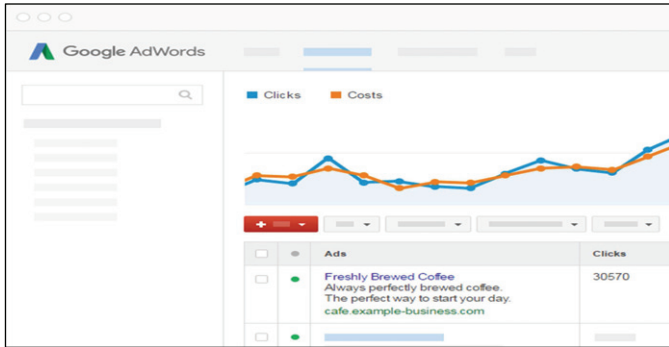
Figure 6.4 Google AdWords

6.4.1 Google's Advertising Network

With AdWords, organization ads can show on one or both of Google's advertising networks: the Google Search Network and the Google Display Network.

A) Google Search Network

The Search Network includes Google Search, other Google sites such as Maps and Shopping, and hundreds of non-Google search partner websites (like AOL) that show AdWords ads matched to search results.

The Search Network can help advertisers do the following:

- ✓ Show their text ads next to Google search results
- ✓ Reach customers actively searching for their specific product or service

B) Google Display Network

The Display Network includes a collection of Google websites (like Google Finance, Gmail, Blogger, and YouTube), partner sites, and mobile sites and apps that show AdWords ads matched to the content on a given page. The Display Network can help advertisers do the following:

- ✓ Use appealing ad formats to reach a wide range of customers with broad interests
- ✓ Build brand awareness and customer loyalty
- ✓ Increase engagement with customers
- ✓ Choose more specifically where their ads can appear, and to what type of audience

6.5 Google Analytics

Google Analytics is a freemium analytic tool that provides a detailed statistics of the web traffic. It is used by more than 60% of website owners. Google analytics helps you to track and measure visitors, traffic sources, goals, conversion, and other metrics. It basically generates reports on:

A) Audience Analysis

B) Acquisition Analysis

C) Behavior Analysis

D) Conversion Analysis
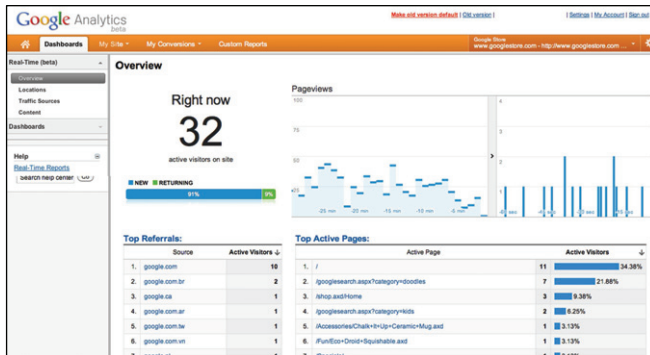
Figure 6.5 Google Analytics

A) Audience Analysis:

As the name suggests, audience analysis gives you an overview of the audience who visit organization site along with their session history, page-views, bounce rate, etc. They can trace the new as well as the returning users along with their geographical locations.

They can track:

i) The age and gender of your audience under **Demographics**

ii) The affinity reaches and market segmentation under **Interests**

iii) Language and location under **Geo**

iv) New and returning visitors, their frequency, and engagement under **Behavior**

v) Browsers, Operating systems, and network of your audience in **Technology**

vi) Mobile device info under **Mobile**

vii) Custom variable report under **Custom.** This report shows the activity by custom modules that you created to capture the selections.

viii) Benchmarking channels, locations, and devices under **Benchmarking**. Benchmarking allows organization to compare their metrics with other related industries. So, they can plot what they need to incur in order to overtake the market

ix) Flow of user activity under **Users flow** to see the path they took on their website

B) Acquisition Analysis

Acquisition means 'to acquire.' Acquisition analysis is carried out to find out the sources from where organization web traffic originates. Using acquisition analysis, they can:

i) Capture traffic from all channels, particular source/medium, and from referrals

ii) Trace traffic from **AdWords** (paid search)

iii) See traffic from **search engines**. They can see Queries, triggered landing pages, and geographical summary

iv) Track **social media traffic**. It helps them to identify networks where their users are engaged. They can see referrals from where their traffic originates. They can also have a view of their hub activity, bookmarking sites follow-up, etc. In the same tab, they can have a look at their endorsements in details. It helps them measure the impact of social media on their website.

v) See which plug-ins gave them traffic

vi) Have a look at all the campaigns them built throughout their website with detailed statistics of paid/organic keywords and the cost incurred on it

C) Behaviour Analysis

Behavior analysis monitors users' activities on a website. Organization can find behavioral data under the following four segments:

i) **Site Content:** It shows how many pages were viewed. Organization can see the detailed interaction of data across all pages or in segments like content drill-down, landing pages, and exit pages. Content drill-down is breaking up of data into sub-folders. Landing page is the page where the user lands, and exit page is where the user exits their site. They can measure the behavioral flow in terms of content.

ii) **Site Speed:** Organization can capture page load time, execution speed, and performance data. They can see how quickly the browser can parse through the page. Further, they can also measure page timings, user timings, and get speed suggestion. It helps to know where they are lagging.

iii) **Site Search:** It gives them a full picture of how the users search across their site, what they normally look for, and how they arrive at a particular landing page. They can analyse what they search for before landing on their website.

iv) **Events:** Events are visitors' actions with content, which can be traced independently.

Example: downloads, sign up, log-in, etc.

D) Conversion Analysis

Conversion is a goal completion or a transaction by a user on organization website.

For example download, checkout, buy, etc. To track conversions in analytics, you need to define a goal and set a URL that is traceable.

i) **Goals:** Metrics that measure a profitable activity that they want the user to complete. They can set them to track the actions. Each time a goal is achieved, a conversion is added to their data. They can observe goal completion, value, reverse path, and goal flow.

ii) **Ecommerce:** They can set ecommerce tracking to know what the users buy from their website. It helps them to find product performance, sale performance, transactions, and purchase time. Based on these data, they can analyse what can be beneficial and what can incur them loss. iii) **Multi-channel funnels:** Multi-channel funnels or MCF reports the

source of conversion; what roles the website plays, referrals' role in that conversion; and what all slabs did when users pass through landing page to conversion. For example, a user searched for a query on Google search page, he visited the website, but did not convert. Later on, he directly typed your website name and made a purchase. All these activities can be traced on MCF.

iv) **Attribution:** Attribution modelling credits sales and conversions to touch points in conversion tracking. It lets them to decide what platforms or strategy or module is the best for their business. Suppose a person visited organization website through AdWords ad and made no purchase. A month later, he visits via a social platform and again does not buy. Third time, he visited directly and converted. Here, the last interaction model will credit direct for the conversion, whereas first interaction model will assign credit to paid medium. This way, they can analyse what module should be credited for a conversion.

6.6 Google Translate

Google Translate is a free multilingual machine translation service developed by Google, to translate text, speech, images, sites, or real-time video from one language into another. It offers a web interface, mobile apps for Android and iOS, and an API that helps developers build browser extensions and software applications. It is used for translating a text written in one language to other language. The current version supports more than 100 languages as shown in the figure below and as per report of 2016 Google translate supports 103 languages at various levels and serves over 200 million people daily.

For some languages, Google Translate can pronounce translated text, highlight corresponding words and phrases in the source and target text, and act as a simple dictionary for single-word input. If "Detect language" is selected, text in an unknown language can be automatically identified. If a user enters a URL in the source text, Google Translate will produce a hyperlink to a machine translation of the website. For some languages, text can be entered via an on-screen keyboard, handwriting recognition, or speech recognition.
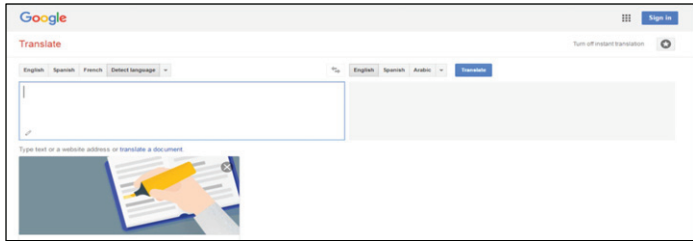
Figure 6.6 Google Translate

6.7 Google API

Google APIs is a set of application programming interfaces (APIs) developed by Google which allow communication with Google Services and their integration to other services. Examples of these include Search, Gmail, Translate or Google Maps. Third-party apps can use these APIs to take advantage of or extend the functionality of the existing services. Google API is a great set of developer's tools. These tools make programmers able to perform operations using Google API and living within their development framework. Google API provides a way to use its features easily. Some APIs are discussed below:

Figure 6.7 Google API

i) Places API: Google Places is a large directory of local businesses and attractions all around the world. The Places API lets you access that information and display it on your website, as well as display check-ins by users.

ii) Feed API: The Google Feed API lets you to download any public feed (including RSS, Media RSS, and Atom) and then combine them into mashups. It simplifies the mashup process by using JavaScript rather than more complex server-side coding.

iii) Geocoding API: The Geocoding API lets you convert any address into geographic coordinates, which can then be used to place markers on a map.

iv) Analytics Management API: The Analytics Management API gives improved access to your Analytics data, and lets you fine-tune your requests to just pull the information and reports you need for your application.

v) Tasks API: The Tasks API offers endpoints for reading, searching, and updating Google Tasks content and metadata.

vi) Blogger Data API: The Blogger Data API lets your application create and post new blog posts, edit or delete existing posts, and search for posts based on specific criteria.

vii) Calendar API: The Calendar API gives access to many of the standard web interface tools and operations to your web app. Public calendar events can be searched and viewed without authentication, while authenticated sessions can access private calendars, as well as edit, create, or delete those calendars.

viii) Books API: The Google Books API lets you integrate book searches into your application, and embed book previews on your site.

ix) Moderator API: Google Moderator is a tool for collecting ideas, questions, and recommendations from any size audience. The API allows your website or application to do the same.

x) Prediction API: The Prediction API helps you make smarter apps that can analyse historic data and predict future outcomes. It can be used for things like recommendation systems, spam detection, upsell opportunity analysis, and more.

xi) Picasa Web Albums Data API: The PWA Data API can be used to create albums and upload, retrieve, or comment on photos, among other features. It's been used for everything from powering digital photo frames to full-featured mobile clients and more.

xii) Static Maps API: You don't always want an interactive map on your site. Sometimes a static map is just what you need. The Static Map API lets you embed static Google Maps onto your site, including custom styled maps.

xiii) Directions API: The Directions API lets your users get directions from one point to another using a variety of travel modes from within your site or app, and doesn't require a Google Maps API Key.

xiv) YouTube APIs: YouTube has two APIs available: Player APIs and Data API. The Player APIs allow you to have an embedded player, or a chrome less player that you can then customize within HTML or Flash. The Data API lets your app perform a lot of the operations available on YouTube, including uploading videos and modifying user playlists.

xv) Webmaster Tools API: The Webmaster Tools API lets your client application use a variety of Webmaster Tools functions, including viewing sites, adding and removing sites, verifying site ownership, and submitting and deleting Sitemaps.

xvi) Open Social: OpenSocial can be used for building social applications, creating social app platforms, and sharing and accessing social data.

xvii) Google Web Fonts API: The Web Fonts API makes it easy to add free web fonts to your website or application. Their collection of fonts grows on a continuous basis and already includes a huge variety.

6.8 Google App Engine

Google App Engine (often referred to as GAE or simply App Engine) is a cloud computing platform for developing and hosting web applications in Google-managed data centers. Applications are sandboxed and run across multiple servers. App Engine offers automatic scaling for web applications—as the number of requests increases for an application, App Engine automatically allocates more resources for the web application to handle the additional demand.

Google App Engine is free up to a certain level of consumed resources. Fees are charged for additional storage, bandwidth, or instance hours required by the application. It was first released as a preview version in April 2008 and came out of preview in September 2011.

6.8.1 Google App Engine Features

A powerful platform to build apps and scale automatically

i) Popular Languages: Build your application in Node.js, Java, Ruby, C#, Go, Python, or PHP—or bring your own language runtime

ii) Open & Flexible: Custom runtimes allow you to bring any library and framework to App Engine by supplying a Docker container

iii) Fully Managed: A fully managed environment lets you focus on code while App Engine manages infrastructure concerns

iv) Monitoring, Logging & Diagnostics: Google Stackdriver gives you powerful application diagnostics to debug and monitor the health and performance of your app

v) Application Versioning: Easily host different versions of organization's app; easily create development, test, staging, and production environments

vi) Traffic Splitting: Route incoming requests to different app versions, A/B test and do incremental feature rollouts

vii) Services Ecosystem: Tap a growing ecosystem of GCP services from organization's app including an excellent suite of cloud developer tools

REVIEW QUESTIONS

- ❖ List the advantages of Google Apps for Enterprise and Academic Institutions.
- ❖ What is dark web?
- ❖ State the uses of Google App Engine.
- ❖ Define Google API.
- ❖ Explain the uses of Google Analytics.
- ❖ What are the purposes of Google Translate? Define Google AdWords.
- ❖ Explain how Google Apps can be used in government operations.
- ❖ Explain the significance of deep web and dark web.

CHAPTER 7

Amazon Web Services

7.1 Amazon Web Services: Basic Concept

Amazon Web Services (AWS) is a bundled remote computing service that provides cloud computing infrastructure over the Internet with storage, bandwidth and customized support for application programming interfaces (API). These services operate from many global geographical regions including 6 in North America.

Launched in March 2006, AWS is provided by cloud solution concept pioneer Amazon Inc. Amazon's internal IT resource management built AWS, which expanded and grew into an innovative and cost-effective cloud solution provider. AWS has more than 70 services, spanning a wide range, including compute, storage, networking, database, analytics, application services, deployment, management, mobile, developer tools and tools for the Internet of Things.

AWS is readily distinguished from other vendors in the traditional IT computing landscape because it is:

i) Flexible: AWS enables organizations to use the programming models, operating systems, databases, and architectures with which they are already familiar. In addition, this flexibility helps organizations mix and match architectures in order to serve their diverse business needs.

ii) Cost-effective: With AWS, organizations pay only for what they use, without up-front or long-term commitments.

iii) Scalable and elastic: Organizations can quickly add and subtract AWS resources to their applications in order to meet customer demand and manage costs.

iv) Secure: In order to provide end-to-end security and end-to-end privacy, AWS builds services in accordance with security best practices, provides the appropriate security features in those services, and documents how to use those features.

v) Experienced: When using AWS, organizations can leverage Amazon's more than fifteen years of experience delivering large-scale, global infrastructure in a reliable, secure fashion.

7.2 Amazon Web Services in Cloud Platform

Amazon Web Services (AWS) offers a broad set of global cloud-based products including compute, storage, databases, analytics, networking, management tools, mobile, Internet of Things (IoT), developer tools, security and enterprise applications.

These services help organizations move faster, lower IT costs, and scale. AWS is trusted by the largest enterprises and the hottest start-ups to power a wide variety of workloads including: web and mobile applications, game development, data processing and warehousing, storage, archive, and many others. AWS consists of many cloud services that user can use in combinations tailored to their business or organizational needs. This section introduces the AWS services in the following categories:

 A) Compute: Amazon Elastic Compute Cloud, also known as "EC2" is an IaaS service providing virtual servers controllable by an API, based on the Xen hypervisor. Equivalent services include Microsoft Azure, Google Compute Engine and Rackspace or on-premises equivalents such as **OpenStack** or Eucalyptus.

B) Networking: Amazon Route 53 provides highly available and scalable Domain Name System (DNS), domain name registration, and health-checking web services. It is designed to give developers and businesses an extremely reliable and cost effective way to route end users to Internet applications by translating names like example.com into the numeric IP addresses, such as 192.0.2.1, that computers use to connect to each other. User can combine their DNS with health-checking services to route traffic to healthy endpoints or to independently monitor and/or alarm on endpoints. User can also purchase and manage domain names such as example.com and automatically configure DNS settings for their domains. Route 53 effectively connects user requests to infrastructure running in AWS – such as Amazon EC2 instances, Elastic Load Balancing load balancers, or Amazon S3 buckets – and can also be used to route users to infrastructure outside of AWS.

C) Storage and Content delivery: Amazon Simple Storage Service provides a fully redundant data storage infrastructure for storing and retrieving any amount of data, at any time, from anywhere on the Web.

A Content Delivery Network (CDN) is a critical component of nearly any modern web application. It used to be that CDN merely improved the delivery of content by replicating commonly requested files (static content) across a globally distributed set of caching servers. However, CDNs have become much more useful over time. For caching, a CDN will reduce

the load on an application origin and improve the experience of the requestor by delivering a local copy of the content from a nearby cache edge, or Point of Presence (PoP). The application origin is off the hook for opening the connection and delivering the content directly as the CDN takes care of the heavy lifting. The end result is that the application origins don't need to scale to meet demands for static content. Amazon CloudFront is a large scale, global, and feature rich CDN that provides secure, scalable and intelligently integrated application delivery.

D) Databases: AWS offers a wide range of database services to fit your application requirements. These database services are fully managed and can be launched in minutes with just a few clicks. AWS database services include Amazon Relational Database Service (Amazon RDS), with support for six commonly used database engines, Amazon Aurora, a MySQL and PostgreSQL-compatible relational database with five times the performance, Amazon DynamoDB, a fast and flexible NoSQL database service, Amazon Redshift, a petabyte-scale data warehouse service, and Amazon Elasticache, an in-memory cache service with support for Memcached and Redis. AWS also provides the AWS Database Migration Service, a service which makes it easy and inexpensive to migrate your databases to AWS cloud.

E) Analytics: Extracting insights and actionable information from data requires a broad array of technology that can work with data efficiently, scalably, and cost-effectively. AWS offers a comprehensive set of services to handle every step of the analytics process chain including data warehousing, business intelligence, batch processing, stream processing, machine learning, and data workflow orchestration. These services are powerful, flexible, and yet simple to use, enabling organizations to put their raw data to work quickly and easily.

AWS Data Analytics Products:

Service	Product Type	Description
Amazon Athena	Serverless Query Service	Easily analyze data in Amazon S3, using standard SQL. Pay only for the queries you run.
Amazon EMR	Hadoop	Provides a managed Hadoop framework to process vast amounts of data quickly and cost-effectively. Run open source frameworks such as Apache Spark, HBase, Presto, and Flink.

Amazon Elasticsearch Service	Elasticsearch	Makes it easy to deploy, operate, and scale Elasticsearch on AWS.
Amazon Kinesis	Streaming Data	Easiest way to work with streaming data on AWS.
Amazon QuickSight	Business Analytics	Very fast, easy-to-use, cloud-powered business analytics for 1/10th the cost of traditional BI solutions.
Amazon Redshift	Data Warehouse	Fast, fully managed, petabyte-scale data warehouse that makes it simple and cost-effective to analyze all of your data using your existing business intelligence tools.
AWS Glue	ETL	Prepare and load data to data stores.
AWS Data Pipeline	Data Workflow Orchestration	Helps you reliably process and move data between different AWS compute and storage services, as well as on-premise data sources, at specified intervals.

F) Application Services: There are different types of application services offered by AWS. Amazon API Gateway is a service for publishing, maintaining and securing web service APIs. Amazon CloudSearch provides basic full-text search and indexing of textual content. Amazon DevPay, currently in limited beta version, is a billing and account management system for applications that developers have built atop Amazon Web Services. Amazon Elastic Transcoder (ETS) provides video transcoding of S3 hosted videos, marketed primarily as a way to convert source files into mobile-ready versions. Amazon Simple Email Service (SES) provides bulk and transactional email sending. Amazon Simple Queue Service (SQS) provides a hosted message queue for web applications. Amazon Simple Notification Service (SNS) provides a hosted multi-protocol "push" messaging for applications. Amazon Simple Workflow (SWF) is a workflow service for building scalable, resilient applications. Amazon Cognito is a user identity and data synchronization service that securely manages and synchronizes app data for users across their mobile devices. Amazon AppStream 2.0 is a low-latency service that streams and resources intensive applications and games from the cloud using NICE DVC technology.

G) Deployment and Management: AWS tools are designed to help individual developers, teams of developers, and system administrators store, integrate, and deploy their code on the cloud. These are described as follows:

i) AWS CodeDeploy: This service efficiently deploys user released code to a "fleet" of EC2 instances while taking care to leave as much of the fleet online as possible. It can accommodate fleets that range in size from one instance all the way up to tens of thousands of instances.

ii) AWS CodeCommit: This is a managed revision control service that hosts Git repositories and works with all Git-based tools. Users no longer need to worry about hosting, scaling, or maintaining your own source code control infrastructure.

iii) AWS CodePipeline: This service will help you to model and automate users' software release process. Users can design a development workflow that fits their organization's needs and their working style and use it to shepherd their code through the staging, testing, and release process. CodePipeline works with third-party tools but is also a complete, self-contained end-to-end solution.

H) Mobile and Applications: AWS provides a range of services to help you develop mobile apps that can scale to hundreds of millions of users, and reach global audiences. With AWS user can get started quickly, ensure high quality by testing on real devices in the cloud, and measure and improve user engagement.

i) AWS Mobile Hub: AWS Mobile Hub provides an integrated console that helps user build, test, and monitor their mobile apps. Use the console to choose the features and include in their app. Mobile Hub then provisions and configure the necessary AWS services on their behalf and create a working sample app for user.

ii) AWS Mobile SDK: The AWS Mobile SDK helps user to build high quality mobile apps quickly and easily. It provides easy access to a range of AWS services, including AWS Lambda, Amazon S3, Amazon DynamoDB, Amazon Mobile Analytics, Amazon Machine Learning, Elastic Load balancing, Auto Scaling and more. The AWS Mobile SDK includes libraries, code samples, and documentation for iOS, Android, Fire OS, and Unity so user can build apps that deliver great experiences across devices and platforms.

amazon
web services

Cross-Service
Support
Phone & email fast-response 24X7 Support
Marketplace
Buy and sell Software and Apps
Management Console
UI to manage AWS services
SDKs, IDE kits and CLIs
Develop , integrate and manage services

Deployment & Management
CloudFormation
Templated AWS Resource Creation
CloudWatch
Resource and Application Monitoring
Elastic Beanstalk
AWS Application Container
IAM
Secure AWS Access Control
CloudTrail
User Activity Logging
OpsWorks
DevOps Application Management Service
CloudHSM
Hardware-based key storage for compliance

Database
DynamoDB
Predictable and Scalable NoSQL Data Store
ElastiCache
In-Memory Cache
RDS
Managed Relational Database
Redshift
Managed Petabyte-Scale Data Warehouse

Analytics
Elastic MapReduce
Managed Hadoop Framework
Kinesis
Real-Time Data Stream Processing
Data Pipeline
Orchestration for Data-Driven Workflows

App Services
CloudSearch
Managed Search Service
Elastic Transcoder
Easy-to-use Scalable Media Transcoding
SES
Email Sending Service
SNS
Push Notification Service
SQS
Message Queue Service
SWF
Workflow Service for Coordinating App Components
AppStream
Low-latency Application Streaming

Storage & CDN
S3
Scalable Storage in the Cloud
EBS
Networked Attached Block Device
CloudFront
Global Content Delivery Network
Glacier
Archive Storage in the Cloud
Storage Gateway
Integrates On-Premises IT with Cloud Storage
Import Export
Ship Large Datasets

Compute & Networking
EC2
Virtual Servers in the Cloud
VPC
Virtual Secure Network
ELB
Load balancing Service
WorkSpaces
Virtual Desktops in the cloud
Auto Scaling
Automatically scale up and down
DirectConnect
Dedicated Network Connection to AWS
Route 53
Scalable Domain Name System

AWS Global Physical Infrastructure
(Geographical Regions, Availability Zones, Edge Locations)

Figure 7.1 List of products of AWS

7.3 Amazon Elastic Compute Cloud

Amazon Elastic Compute Cloud (Amazon EC2) is a web service that provides resizable compute capacity in the cloud. It is designed to make web-scale computing easier for developers and system administrators.

Amazon EC2's simple web service interface allows you to obtain and configure capacity with minimal friction. It provides you with complete control of your computing resources and lets you run on Amazon's proven computing environment. Amazon EC2 reduces the time required to obtain and boot new server instances (called Amazon EC2 instances) to minutes, allowing you to quickly scale capacity, both up and down, as your computing requirements change. Amazon EC2 changes the economics of computing by allowing you to pay only for capacity that you actually use. Amazon EC2 provides developers and system administrators the tools to build failure resilient applications and isolate themselves from common failure scenarios.

7.3.1 Application Architecture

When users are considering how to model task definitions and services, it helps to think about what processes need to run together on the same instance and how user will scale each component. As an example, imagine an application that consists of the following components:

- ✓ A front-end service that displays information on a web page

- ✓ A backend service that provides APIs for the front-end service

- ✓ A data store

Users probably run all three containers together on their Docker host. User might be tempted to use the same approach for their production environment, but this approach has several drawbacks:

- ✓ Changes to one component can impact all three components, which may be a larger scope for the change than user want

- ✓ Each component is more difficult to scale because user have to scale every container proportionally

- ✓ Task definitions can only have 10 container definitions and user application stack might require more, either now or in the future

- ✓ Every container in a task definition must land on the same container instance, which may limit user instance choices to the largest sizes

Instead, user should create task definitions that group the containers that are used for a common purpose, and separate the different components into multiple task definitions. In this example, three task definitions each specify one container. The example cluster below has three container instances registered with three front-end service containers, two backend service containers, and one data store service container. User can group related containers in a task definition, such as linked containers that must be run together. For example, user could add a log streaming container to their front-end service and include that in the same task definition. After users have their task definitions, user can create services from them to maintain the availability of their desired tasks.
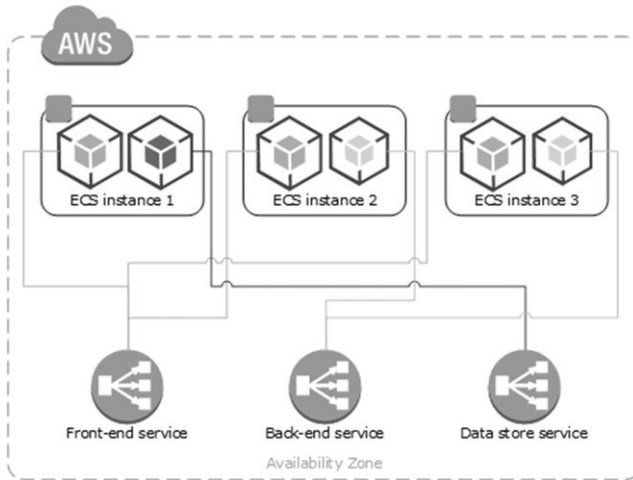
Figure 7.2 Availability Zone

7.3.2 Benefits of EC2

There are several benefits of EC2 which are discussed below:

i) Elastic Web-Scale Computing

Amazon EC2 enables user to increase or decrease capacity within minutes, not hours or days. User can commission one, hundreds or even thousands of server instances simultaneously. User application can automatically scale itself up and down depending on its needs.

ii) Completely Controlled

Users have complete control of their Amazon EC2 instances. Users have root access to each one, and user can interact with them. User can stop their Amazon EC2 instance while retaining the data on their boot partition, and then subsequently restart the same instance using web service APIs. Instances can be rebooted remotely using web service APIs. In addition, user can use the AWS Management Console, a simple, web-based user interface, to access and manage user Amazon EC2 instances.

iii) Flexible Cloud Hosting Services

User can choose among multiple Amazon EC2 instance types, operating systems, and software packages. Amazon EC2 allows user to select a configuration of memory, CPU, instance storage, and the boot partition size that is optimal for their choice of operating system and application. For example, user choice of operating systems includes numerous Linux distributions and Microsoft Windows Server.

iv) Designed for use with other Amazon Web Services

Amazon EC2 works in conjunction with Amazon Simple Storage Service (Amazon S3), Amazon Relational Database Service (Amazon RDS), Amazon DynamoDB, and Amazon Simple Queue Service (Amazon SQS) to provide a complete solution for computing, query processing, and storage across a wide range of applications.

v) Reliable

Amazon EC2 offers a highly reliable environment where replacement instances can be rapidly and predictably commissioned. The service runs within Amazon's proven network infrastructure and data centers. The Amazon EC2 Service Level Agreement commitment is 99.95% availability for each Amazon EC2 region.

vi) Secure

Amazon EC2 works in conjunction with Amazon Virtual Private Cloud (Amazon VPC) to provide security and robust networking functionality for users' compute resources. Users' compute instances are located in an Amazon Virtual Private Cloud with an IP address range that the user specifies. Users decide which instances are exposed to the Internet and which remain private. Security groups and networks ACLs allow you to control inbound and outbound network access to and from users' instances. User can connect their existing IT infrastructure to resources in their Amazon VPC using industry-standard encrypted IPsec VPN connections. User can provision your Amazon EC2 resources as Dedicated Instances. Dedicated Instances are Amazon EC2 instances that run on hardware dedicated to a single customer for additional isolation.

vii) Inexpensive

Amazon EC2 passes on to user the financial benefits of Amazon's scale. User can pay a very low rate for the compute capacity their actually consume.

viii) On-Demand Instances

On-Demand instances let user pay for compute capacity by the hour with no long-term commitments. This frees user from the costs and complexities of planning, purchasing, and maintaining hardware and transforms what are commonly large fixed costs into much smaller variable costs. On-Demand Instances also remove the need to buy "safety net" capacity to handle periodic traffic spikes.

ix) Reserved Instances

Reserved Instances give user the option to make a low, one - time payment for each instance that the user want to reserve and in turn receive a significant discount on the hourly charge for that instance. There are three Reserved Instance types (Light, Medium, and Heavy Utilization Reserved Instances) that enable user to balance the amount their pay upfront with their effective hourly price. The Reserved Instance Marketplace is also available, which provides user with the opportunity to sell Reserved Instances if user needs change. For example, user might want to move instances to a new AWS region, change to a new instance type, or sell capacity for projects that end before user Reserved Instance term expires.

x) Spot Instances

Spot Instances allow user to bid on unused Amazon EC2 capacity and run those instances for as long as your bid exceeds the current Spot Price. The Spot Price changes periodically based on supply and demand, and customers whose bids meet or exceed it gain access to the available Spot Instances. If user can be flexible about when their applications need to run, Spot Instances can significantly lower their Amazon EC2 costs.

7.4 Amazon Simple Storage System

Amazon's Simple Storage Service (Amazon S3) is a personal cloud storage service from Amazon's Web Services (Amazon AWS). Amazon S3 debuted in 2006 as a cost-effective Web services solution for developers to store and retrieve data at any point in time from anywhere Web access is available.

Amazon S3 customers receive up to 5 GB of online data storage for free, with commercial tiered plans available for those with additional storage or more intensive data transfer needs. In addition to its use for personal cloud storage, Amazon S3 has also become increasingly utilized by commercial services for cloud services, with companies like Dropbox, Ubuntu One and SmugMug relying on Amazon S3 for cloud storage and transfer. Amazon S3 is designed for large-capacity, low-cost storage provision across multiple geographical regions. Amazon S3 provides developers and IT teams with Secure, Durable and Highly Scalable object storage.

i) Amazon S3 is Secure:

AWS provides encryption to the stored data; it can happen in two ways:

- ✓ Client Side Encryption
- ✓ Server Side Encryption

Multiple copies are maintained to enable regeneration of data in case of data corruption versioning, wherein each edit is archived for a potential retrieval.

ii) Amazon S3 is Durable:

It regularly verifies the integrity of data stored using checksums e.g. if S3 detects there is any corruption in data, it is immediately repaired with the help of replicated data. Even while storing or retrieving data, it checks incoming network traffic for any corrupted data packets.

iii) Amazon S3 is Highly Scalable:

Since it automatically scales user storage according to their requirement and user only pay for the storage they use.

7.4.1 Working with Amazon S3 Buckets

Amazon S3 is cloud storage for the Internet. To upload your data (photos, videos, documents etc.), you first create a bucket in one of the AWS Regions. You can then upload any number of objects to the bucket.

In terms of implementation, buckets and objects are resources, and Amazon S3 provides APIs for you to manage them. For example, you can create a bucket and upload objects using the Amazon S3 API. You can also use the Amazon S3 console to perform these operations. The

console internally uses the Amazon S3 APIs to send requests to Amazon S3. Amazon S3 bucket names are globally unique, regardless of the AWS Region in which user create the bucket. Users specify the name at the time when they create the bucket. Amazon S3 creates buckets in a region user specify. User can choose any AWS Region that is geographically close to user to optimize latency, minimize costs, or address regulatory requirements. For example, if user resides in Europe, they might find it advantageous to create buckets in the EU (Ireland) or EU (Frankfurt) regions.

i) Creating a Bucket: Amazon S3 provides APIs for user to create and manage buckets. By default, user can create up to 100 buckets in each of your AWS accounts. If user needs additional buckets, user can increase your bucket limit by submitting a service limit increase. When you create a bucket, you provide a name and AWS Region where you want the bucket created. Within each bucket, you can store any number of objects. You can create a bucket using any of the following methods:

     i) Create the bucket using the console

     ii) Create the bucket programmatically using the AWS SDKs

ii) Accessing a Bucket: User can access their bucket using the Amazon S3 console. Using the console UI, user can perform almost all bucket operations without having to write any code.

If user access a bucket programmatically, note that Amazon S3 supports RESTful architecture in which their buckets and objects are resources, each with a resource URI that uniquely identify the resource.

iii) Bucket Configuration Options: Amazon S3 supports various options for user to configure the bucket. For example, user can configure their bucket for website hosting, add configuration to manage lifecycle of objects in the bucket, and configure the bucket to log all access to the bucket. Amazon S3 supports subresources for user to store, and manages the bucket configuration information. That is, using the Amazon S3 API, user can create and manage these subresources. User can also use the console or the AWS SDKs.

iv) Bucket Restrictions and Limitations: A bucket is owned by the AWS account that created it. By default, user can create up to 100 buckets in each of their AWS accounts. If

users need additional buckets, user can increase their bucket limit by submitting a service limit increase.

7.5 Amazon Elastic Block Store

Amazon Elastic Block Store (Amazon EBS) provides persistent block storage volumes for use with Amazon EC2 instances in the AWS Cloud. Each Amazon EBS volume is automatically replicated within its Availability Zone to protect user from component failure, offering high availability and durability. Amazon EBS volumes offer the consistent and low-latency performance needed to run user workloads. With Amazon EBS, user can scale their usage up or down within minutes – all while paying a low price for only what they provision.

Amazon EBS is designed for application workloads that benefit from fine tuning for performance, cost and capacity. Typical use cases include Big Data analytics engines (like the Hadoop/HDFS ecosystem and Amazon EMR clusters), relational and NoSQL databases (like Microsoft SQL Server and MySQL or Cassandra and MongoDB), stream and log processing applications (like Kafka and Splunk), and data warehousing applications (like Vertica and Teradata).

Amazon EBS is recommended when data must be quickly accessible and requires long-term persistence. EBS volumes are particularly well-suited for use as the primary storage for file systems, databases, or for any applications that require fine granular updates and access to raw, unformatted, block-level storage. Amazon EBS is well suited to both database-style applications that rely on random reads and writes, and to throughput-intensive applications that perform long, continuous reads and writes.

For simplified data encryption, user can launch their EBS volumes as encrypted volumes. Amazon EBS encryption offers user a simple encryption solution for their EBS volumes without the need for user to build, manage, and secure their own key management infrastructure. When user create an encrypted EBS volume and attach it to a supported instance type, data stored at rest on the volume, disk I/O, and snapshots created from the volume are all encrypted. The encryption occurs on the servers that host EC2 instances, providing encryption of data-in-transit from EC2 instances to EBS storage.

Amazon EBS encryption uses AWS Key Management Service (AWS KMS) master keys when creating encrypted volumes and any snapshots created from users' encrypted volumes. The first time you create an encrypted EBS volume in a region, a default master key is

created for the users automatically. This key is used for Amazon EBS encryption unless they select a Customer Master Key (CMK) that they created separately using the AWS Key Management Service. Creating users' own CMK gives user more flexibility, including the ability to create, rotate, disable, define access controls, and audit the encryption keys used to protect user data.

User can attach multiple volumes to the same instance within the limits specified by users' AWS account. User account has a limit on the number of EBS volumes that they can use, and the total storage available to the user.

7.6 Amazon SimpleDB

Amazon SimpleDB is a highly available NoSQL data store that offloads the work of database administration. Developers simply store and query data items via web services requests and Amazon SimpleDB does the rest.

Unbound by the strict requirements of a relational database, Amazon SimpleDB is optimized to provide high availability and flexibility, with little or no administrative burden. Behind the scenes, Amazon SimpleDB creates and manages multiple geographically distributed replicas of users' data automatically to enable high availability and data durability. The service charges user only for the resources actually consumed in storing user data and serving their requests. User can change their data model on the fly, and data is automatically indexed for them. With Amazon SimpleDB, user can focus on application development without worrying about infrastructure provisioning, high availability, software maintenance, schema and index management, or performance tuning.

7.6.1 Benefits

i) **Low touch:** The service allows user to focus fully on value-added application development, rather than arduous and time-consuming database administration. Amazon SimpleDB automatically manages infrastructure provisioning, hardware and software maintenance, replication and indexing of data items, and performance tuning.

ii) **Highly available:** Amazon SimpleDB automatically creates multiple geographically distributed copies of each data item you store. This provides high availability and durability – in the unlikely event that one replica fails, Amazon SimpleDB can failover to another replica in the system.

iii) Flexible: As user business changes or application evolves, user can easily reflect these changes in Amazon SimpleDB without worrying about breaking a rigid schema or needing to refactor code – simply add another attribute to users' Amazon SimpleDB data set when needed. User can also choose between consistent or eventually consistent read requests, gaining the flexibility to match read performance (latency and throughput) and consistency requirements to the demands of their application, or even disparate parts within their application.

iv) Simple to use: Amazon SimpleDB provides streamlined access to the store and query functions that traditionally are achieved using a relational database cluster – while leaving out other complex, often - unused database operations. The service allows user to quickly add data and easily retrieve or edit that data through a simple set of API calls.

Amazon SimpleDB is designed to integrate easily with other AWS services such as Amazon S3 and EC2, providing the infrastructure for creating web-scale applications. For example, developers can run their applications in Amazon EC2 and store their data objects in Amazon S3. Amazon SimpleDB can then be used to query the object metadata from within the application in Amazon EC2 and return pointers to the objects stored in Amazon S3. Developers can also use Amazon SimpleDB with Amazon RDS for applications that have relational and non-relational database needs. Data transferred between Amazon SimpleDB and other Amazon Web Services within the same Region is free of charge.

v) Secure: Amazon SimpleDB provides an https end point to ensure secure, encrypted communication between your application or client and your domain. In addition, through integration with AWS Identity and Access Management, you can establish user or group-level control over access to specific SimpleDB domains and operations.

vi) Inexpensive: Amazon SimpleDB passes on to user the financial benefits of Amazon's scale. User pay only for resources their actually consume. For Amazon SimpleDB, this means data store reads and writes are charged by compute resources consumed by each operation, and users aren't billed for compute resources when they aren't actively using them (i.e. making requests).

vii) Logging: Amazon SimpleDB allows user to completely offload the work required to run a production database, many developers find it an ideal, low-touch data store for logging information about conditions or events, status updates, recurring activities, workflow processes, or device and application states. Amazon SimpleDB lets you cost-effectively "set

and forget" these data logs and use them for diverse purposes, such as: Monitoring or tracking, Metering, Trend of business analysis, Auditing, Archival or regulation compliance

Application examples include:

- ✓ Storing server logs centrally to reduce the space they consume on each running server
- ✓ Logging operational metrics or the results of ongoing performance tests for later analysis
- ✓ Auditing access entries or configuration changes for applications or networked devices
- ✓ Capturing and monitoring environment conditions (temperature, pressure levels, humidity, etc.) at various locations and programming alerts for particular conditions
- ✓ Logging and tracking geolocation information about objects or process status for activities in a workflow

Multiple attributes of Amazon SimpleDB make it an attractive data store for data logs:

i) Central, with High Availability: If user data logs were previously being trapped locally in multiple devices/objects, applications, or process silos, user will enjoy the benefit of being able to access their data centrally in one place in the cloud. What's more, Amazon SimpleDB automatically and geo-redundantly replicates user data to ensure high availability. This means that unlike a centralized on-premise solution, they're not creating a single point of failure with Amazon SimpleDB, and user data will be there when they need it. All of the data can be stored via web services requests with one solution and then accessed by any device.

ii) Zero Administration: Users store their data items with simple web services requests and Amazon Web Services takes care of the rest. The set it and forget it nature of the service means they aren't spending time on database management in order to store and maintain data logs.

iii) Cost-efficient: Amazon SimpleDB charges inexpensive prices to store and query user data logs. Since users are paying as they go for only the resources they consume, users don't need to do their own capacity planning or worry about database load. The service simply responds to request volume as it comes and goes, charging only for the actual resources consumed.

7.7 Amazon Relational Database Service

Amazon Relational Database Service (Amazon RDS) is a web service that makes it easier to set up, operate, and scale a relational database in the cloud. It provides cost - efficient, resizable capacity for an industry-standard relational database and manages common database administration tasks.

When users buy a server, they get CPU, memory, storage, and IOPS, all bundled together. With Amazon RDS, these are split apart so that they can scale them independently. So, for example, if they need more CPU, less IOPS, or more storage, user can easily allocate them.

- ✓ Amazon RDS manages backups, software patching, automatic failure detection, and recovery

- ✓ In order to deliver a managed service experience, Amazon RDS does not provide shell access to DB instances, and it restricts access to certain system procedures and tables that require advanced privileges

- ✓ User can have automated backups performed when they need them, or create user own backup snapshot. These backups can be used to restore a database, and the Amazon RDS restore process works reliably and efficiently

- ✓ User can get high availability with a primary instance and a synchronous secondary instance that user can failover to when problems occur. User can also use MySQL, MariaDB, or PostgreSQL Read Replicas to increase read scaling

- ✓ User can use the database products user are already familiar with: MySQL, MariaDB, PostgreSQL, Oracle, Microsoft SQL Server, and the new, MySQL-compatible Amazon Aurora DB engine

In addition to the security in users' database package, user can help control who can access their RDS databases by using AWS IAM to define users and permissions. Users can also help protect their databases by putting them in a virtual private cloud.

7.7.1 Amazon RDS Components

i) DB Instances: The basic building block of Amazon RDS is the *DB instance*. A DB instance is an isolated database environment in the cloud. A DB instance can contain multiple user-created databases, and user can access it by using the same tools and

applications that user use with a stand-alone database instance. User can create and modify a DB instance by using the AWS Command Line Interface, the Amazon RDS API, or the AWS Management Console.

Each DB instance runs a DB engine. Amazon RDS currently supports the MySQL, MariaDB, PostgreSQL, Oracle, and Microsoft SQL Server DB engines. Each DB engine has its own supported features, and each version of a DB engine may include specific features. Additionally, each DB engine has a set of parameters in a DB parameter group that control the behavior of the databases that it manages.

The computation and memory capacity of a DB instance is determined by its *DB instance class*. Users can select the DB instance that best meets their needs. If their needs change over time, they can change DB instances.

DB instance storage comes in three types: Magnetic, General Purpose (SSD), and Provisioned IOPS (PIOPS). They differ in performance characteristics and price, allowing user to tailor their storage performance and cost to the needs of their database. Each DB instance has minimum and maximum storage requirements depending on the storage type, and the database engine it will support. It's important to have sufficient storage so that user databases have room to grow and that features for the DB engine have room to write content or log entries.

User can run a DB instance on a virtual private cloud using the Amazon Virtual Private Cloud (VPC) service. When users use a virtual private cloud, they have control over their virtual networking environment: user can select their own IP address range, create subnets, and configure routing and access control lists. The basic functionality of Amazon RDS is the same whether it is running in a VPC or not; Amazon RDS manages backups, software patching, automatic failure detection, and recovery. There is no additional cost to run the DB instance in a VPC.

ii) Regions and Availability Zones: Amazon cloud computing resources are housed in highly available data center facilities in different areas of the world (for example, North America, Europe, or Asia). Each data center location is called a region. Each region contains multiple distinct locations called Availability Zones, or AZs. Each Availability Zone is engineered to be isolated from failures in other Availability Zones, and to provide inexpensive, low-latency network connectivity to other Availability Zones in the same

region. By launching instances in separate Availability Zones, user can protect their applications from the failure of a single location. User can run their DB instance in several Availability Zones, an option called a Multi-AZ deployment. When user selects this option, Amazon automatically provisions and maintains a synchronous standby replica of their DB instance in a different Availability Zone. The primary DB instance is synchronously replicated across Availability Zones to the standby replica to provide data redundancy, failover support, eliminate I/O freezes, and minimize latency spikes during system backups.

iii) Security Groups: A security group controls the access to a DB instance. It does so by allowing access to IP address ranges or Amazon EC2 instances that you specify. Amazon RDS uses DB security groups, VPC security groups, and EC2 security groups. In simple terms, a DB security group controls access to a DB instance that is not in a VPC, a VPC security group controls access to a DB instance inside a VPC, and an Amazon EC2 security group controls access to an EC2 instance and can be used with a DB instance.

7.7.2 Available RDS Interfaces

There are several ways that user can interact with Amazon RDS.

i) Amazon RDS Console: The Amazon RDS console is a simple web-based user interface. From the console, user can perform almost all tasks for their need to do from the RDS console with no programming required.

ii) Command Line Interface: Amazon AWS provides a command line interface that gives user access to much of the functionality that is available in the Amazon RDS API.

iii) Programmatic Interfaces: The following table lists the resources that you can use to access Amazon RDS programmatically.

Resource	Description
AWS SDKs	The AWS SDKs include sample code, libraries, tools, documentation, and templates.
Libraries	AWS provides libraries, sample code, tutorials, and other resources for software developers who prefer to build applications using language-specific APIs instead of Amazon Relational Database Service's SOAP and Query APIs. These libraries provide basic functions (not included

	in Amazon Relational Database Service's SOAP and Query APIs), such as request authentication, request retries, and error handling so user can get started more easily. Libraries and resources are available for the following languages: ✓ Java ✓ PHP ✓ Python ✓ Ruby ✓ Windows and .NET
Amazon RDS API	If user prefer, user can code directly to the Amazon RDS API.

7.8 Amazon CloudFront

Amazon CloudFront is a content delivery network (CDN) offered by Amazon Web Services. Content delivery networks provide a globally-distributed network of proxy servers which cache content, such as web videos or other bulky media, more locally to consumers, thus improving access speed for downloading the content.

CloudFront has servers located in Europe (United Kingdom, Ireland, The Netherlands, Germany, Spain), Asia (Hong Kong, Singapore, Japan, Taiwan and India), Australia, South America, as well as in several major cities in the United States. The service operates from (as of 9 February 2017) 69 edge locations on five continents. CloudFront operates on a pay-as-you-go basis.

CloudFront competes with larger content delivery networks such as Akamai and Limelight Networks. Upon launch, Larry Dignan of ZDNet News stated that CloudFront could cause price and margin reductions from competing CDNs.

Amazon CloudFront is a web service that speeds up distribution of user static and dynamic web content, for example, .html, .css, .php, image, and media files, to end users. CloudFront delivers user content through a worldwide network of edge locations. When an end user requests content that you're serving with CloudFront, the user is routed to the edge location that provides the lowest latency, so content is delivered with the best possible performance. If the content is already in that edge location, CloudFront delivers it immediately. If the content is not currently in that edge location, CloudFront retrieves it from an Amazon S3 bucket or an HTTP server (for example, a web server) that users have identified as the source for the definitive version of their content.

7.8.1 The Amazon CloudFront Global Edge Network

To deliver content to end users with lower latency, Amazon CloudFront uses a global network of 95 Edge locations (84 Points of Presence and 11 Regional Edge Caches) in 50 cities across 23 countries. Amazon CloudFront edge locations are located in:

i) North America

Edge Locations: Ashburn, VA (3); Atlanta, GA (3); Boston, MA; Chicago, IL (2); Dallas/Fort Worth, TX (3); Hayward, CA; Jacksonville, FL; Los Angeles, CA (2); Miami, FL; Minneapolis, MN; Montreal, QC; New York, NY (3); Newark, NJ; Palo Alto, CA; Philadelphia, PA; San Jose, CA; Seattle, WA (3); South Bend, IN; St. Louis, MO; Toronto, ON

Regional Edge Caches: Virginia; Ohio; Oregon

ii) Europe

Edge Locations: Amsterdam, The Netherlands (2); Berlin, Germany; Dublin, Ireland; Frankfurt, Germany (6); London, England (4); Madrid, Spain; Marseille, France; Milan, Italy; Munich, Germany; Paris, France (3); Prague, Czech Republic; Stockholm, Sweden (2); Vienna, Austria; Warsaw, Poland; Zurich, Switzerland

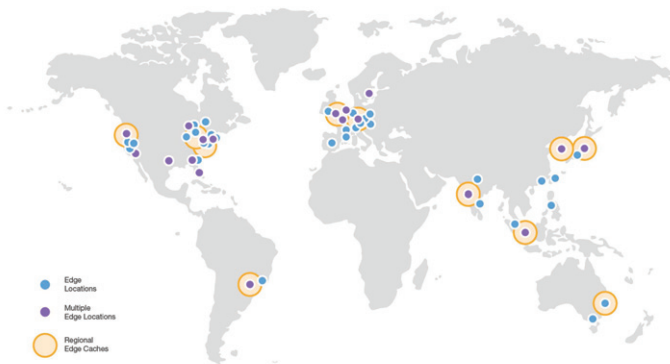**Regional Edge Caches:** Frankfurt, Germany; London, England

Figure 7.3 Amazon CloudFront Global Edge Network

iii) Asia

Edge Locations: Chennai, India; Hong Kong, China (3); Kuala Lumpur, Malaysia; Mumbai, India (2); Manila, Philippines; New Delhi, India; Osaka, Japan; Seoul, Korea (3); Singapore (2); Taipei, Taiwan; Tokyo, Japan (4)

Regional Edge Caches: Mumbai, India; Singapore; Seoul, South Korea; Tokyo, Japan

iv) Australia

Edge Locations: Melbourne, Australia; Sydney, Australia

Regional Edge Caches: Sydney, Australia

v) South America

Edge Locations: São Paulo, Brazil (2); Rio de Janeiro, Brazil

Regional Edge Caches: São Paulo, Brazil

REVIEW QUESTIONS

- ❖ What are Amazon Web Services?
- ❖ Explain Amazon Elastic Compute Cloud (Amazon EC2).
- ❖ Explain the usage of DynamoDB.
- ❖ What is CloudFront? Explain Amazon CloudFront Global Edge Network.
- ❖ List Amazon Web Service components.
- ❖ What are uses of Amazon S3?
- ❖ Explain Amazon SimpleDB. What are the benefits of it?
- ❖ Distinguish between scalability and flexibility.
- ❖ Define auto-scaling.
- ❖ What is the relation between an instance and AMI?
- ❖ Mention what is the difference between Amazon S3 and EC2?
- ❖ Explain how the buffer is used in Amazon web services?

CHAPTER 8

Microsoft Cloud Services

8.1 Windows Azure Platform

Microsoft Azure (formerly Windows Azure) is a cloud computing service created by Microsoft for building, testing, deploying, and managing applications and services through a global network of Microsoft-managed data centers. It provides software as a service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS) and supports many different programming languages, tools and frameworks, including both Microsoft-specific and third-party software and systems.

Azure was announced in October 2008 and released on February 1, 2010 as "Windows Azure" before being renamed "Microsoft Azure" on March 25, 2014.

8.1.1 Microsoft Azure Open Source Support

Microsoft Azure helps user to build and manage enterprise level web, mobile, Internet of Things (IoT) apps faster using their existing skills and technologies they know. Even it supports the entire most popular open source available around the world.
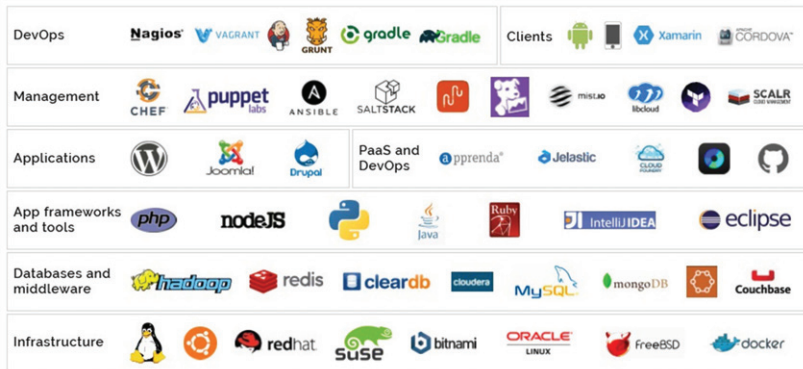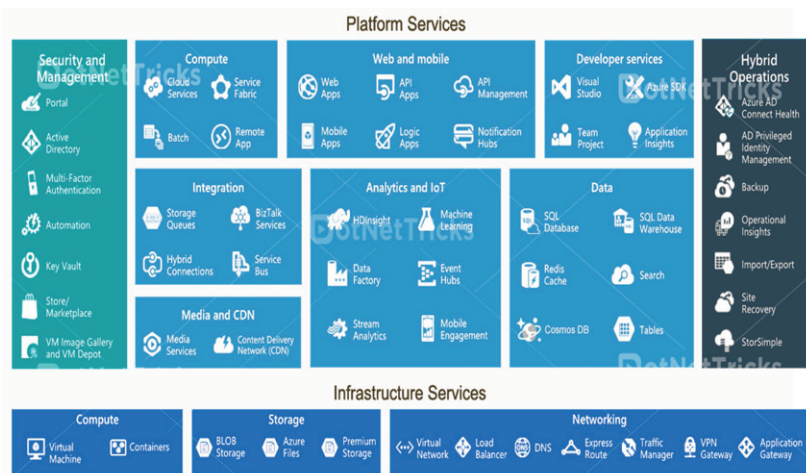

Figure 8.1 Microsoft Azure Open Source Support

8.1.2 Microsoft Azure Services

Microsoft Azure offers so many services through its cloud computing platform. Some of them are listed in the Figure 8.2.

Figure 8.2 Microsoft Azure Cloud Services

A. Compute Services

Compute services are used for cloud computing operations like app building, hosting and deployment in Azure Platform.

i) Virtual Machine

Virtual Machine allows user to deploy any app, language and any operating system (Windows, Linux and Ubuntu) virtually on a machine.

ii) Virtual Machine Scale Sets

Virtual Machine Scale Sets allows user to create thousands of identical, auto-scaling Windows or Linux virtual machines in minutes.

iii) Azure Container Service

Azure Container Service allows user to create a container hosting solution optimized for Azure. It can be used to scale and orchestrate applications using DC/OS, Docker Swarm or Kube Azure Compute Services.

iv) Azure Container Registry

Store and manage container images across all types of Azure deployments.

v) Batch

Batch allows user to run large-scale parallel and high-performance computing applications efficiently in the cloud. It can be Scale to tens, hundreds or thousands of virtual machines.

vi) Functions

Azure Functions is a serverless compute service which allows user to run code on-demand regardless of infrastructure and provisioning of servers. Use Azure Functions to run a script or piece of code in response to a variety of events.

vii) Service Fabric

Service Fabric simplifies micro service-based application development and lifecycle management. It delivers low-latency performance and efficiency at massive scale.

viii) Cloud Services

Cloud Services allows user to deploy highly-available, massively-scalable applications and APIs. Cloud Services support deployment of Java, Node.js, PHP, Python, .NET and Ruby.

B. Azure Networking

Azure Networking allows user to connect privately and securely to Cloud with Azure ExpressRoute and distribute user traffic to specific endpoints with Azure Traffic Manager.

i) Virtual Network

Perform Network isolation and segmentation. Filter and Route network traffic.

ii) Load Balancer

Deliver high availability and network performance to your applications. Load balance incoming Internet traffic to Virtual Machines and forward external traffic to a specific virtual machine.

iii) Application Gateway

It is a dedicated virtual appliance providing Application Delivery Controller (ADC) as a service. It comprises of multiple worker instances for scalability and high availability Azure Networking Services.

iv) VPN Gateway

Virtual network gateway which sends encrypted traffic across a public connection. Use VPN gateways to send traffic between Azure virtual networks over the Microsoft network.

v) Content Delivery Network (CDN)

CDN caches static web content at strategically placed locations to provide maximum throughput for delivering content to users.

vi) Azure DNS

DNS is responsible for translating a website or service name to its IP address. Azure DNS is a hosting service for DNS domains, providing name resolution using Microsoft Azure infrastructure Azure Networking Services.

vii) Traffic Manager

Allows you to control the distribution of user traffic for service endpoints such as, Azure VMs, Web Apps, and cloud services in different Data centers.

viii) Express Route

Extended on-premises networks into the Microsoft cloud over a dedicated private connection facilitated by a connectivity provider. Establish connections to Microsoft cloud services, such as Microsoft Azure, Office 365, and CRM Online Azure Networking Services.

C. Azure Storage Services

Azure Storage Services provide cloud storage solution for modern applications that rely on durability, availability, and scalability to meet the needs of their customers.

i) Blob Storage

Azure Blob storage is a service that stores unstructured data in the cloud as objects/blobs. It can store any type of text or binary data, such as a document, media file, or application installer.

ii) Queue Storage

Azure Queue storage provides cloud messaging between application components. Queue storage delivers asynchronous messaging for communication between application components.

iii) Table Storage

Azure Table storage is a service that stores semi-structured NoSQL data in the cloud, providing a key/attribute store with a schema less design.

iv) File Storage

Offers file shares in the cloud using the standard Server Message Block (SMB) Protocol. With Azure File storage, you can migrate legacy applications that rely on file shares to Azure quickly and without costly rewrites Azure Storage Services.

Web and Mobile Services
i) Web Apps

Azure Web Apps enables user to build and host websites in the programming language of their choice without managing infrastructure.

ii) Mobile Apps

Mobile Apps in Azure App Service offer a highly scalable, globally available mobile application development platform for Enterprise Developers and System Integrators.

iii) API Apps

API apps in Azure App Service offer features that make it easier to develop, host and consume APIs in the cloud and on-premises Web + Mobile Services.

iv) Notification Hubs

Azure Notification Hubs provide an easy-to-use, multi-platform, scaled-out push engine.

v) Logic Apps

Logic Apps provide a way to simplify and implement scalable integrations and workflows in the cloud. It provides a visual designer to model and automate the user process as a series of steps known as a workflow.

vi) Azure Search

Azure Search is a cloud search-as-a-service solution that delegates server and infrastructure management to Microsoft. It leaves user with a ready-to-use service that user can populate with their data and then use to add search to your web or mobile application.

vii) Event Hubs

Azure Event Hubs is a highly scalable data streaming platform capable of ingesting millions of events per second. Data sent to an event hub can be transformed and stored using any real-time analytics provider or batching/storage adapters Web and Mobile Services.

Azure Database Services

i) SQL Database

SQL Database is a relational database service in the Microsoft cloud based on the market-leading Microsoft SQL Server engine.

ii) DocumentDB

DocumentDB is a fully managed NoSQL database service built for fast and predictable performance, high availability, elastic scaling, global distribution, and ease of development.

iii) Redis Cache

It is a secure and dedicated Redis cache, which is an advanced key-value store, where keys can contain data structures such as strings, hashes, lists, sets, and sorted sets.

Enterprise Integration Services

i) Service Bus

Microsoft Azure Service Bus is a reliable information delivery service which is a brokered, or third-party communication mechanism. The Service Relay service supports traditional one-way messaging, request/response messaging, and peer-to-peer messaging.

ii) SQL Server Stretch Database

Stretch database migrates user cold data transparently and securely to the Microsoft Azure cloud. Stretch Database targets transactional databases with large amounts of cold data, typically stored in a small number of tables.

Security and Identity Services

i) Key Vault

Azure Key Vault helps safeguard cryptographic keys and secrets used by cloud applications and services and streamlines the key management process.

ii) Azure Active Directory

Azure Active Directory (Azure AD) is Microsoft's multi-tenant cloud based directory and identity management service including multi-factor authentication, device registration etc.

iii) Azure Active Directory B2C

Azure Active Directory B2C is a comprehensive cloud identity management solution for user consumer-facing web and mobile applications. It is a highly available global service that scales to hundreds of millions of consumer identities.

iv) Azure AD Domain Services

Azure AD Domain Services provides managed domain services such as, domain join, group policy, LDAP, Kerberos/NTLM authentication that are fully compatible with Windows Server Active Directory.

v) Multi-Factor Authentication

Azure Multi-Factor Authentication (MFA) is Microsoft's two-step verification solution which helps safeguard access to data and applications while meeting user demand for a simple sign-in process.

Monitoring and Management Services

i) Microsoft Azure Portal

Build, manage, and monitor everything from simple web apps to complex cloud applications in a single, unified console.

ii) Azure Resource Manager

Azure Resource Manager enables user to repeatedly deploy your app and have confidence their resources are deployed in a consistent state. Azure Resource Manager makes it easy for user to manage and visualize resources in their app. With Azure Resource Manager, user can control who in their organization can perform actions on the resources.

iii) Automation

Microsoft Azure Automation provides a way to automate the manual, long-running, error-prone, and frequently repeated tasks that are commonly performed in a cloud and enterprise environment. User can automate processes using runbooks or automate configuration management using Desired State Configuration.

8.2 Microsoft Azure Reference Architecture

Microsoft Azure Reference Architecture includes recommended practices, along with considerations for scalability, availability, manageability, and security. Most also include a deployable solution.

The architecture has the following components:

i) Resource group: A resource group is a logical container for Azure resources.

ii) App Service app: Azure App Service is a fully managed platform for creating and deploying cloud applications.

iii) App Service plan: An App Service plan provides the managed virtual machines (VMs) that host user app. All apps associated with a plan run on the same VM instances.

iv) Deployment slots: A deployment slot lets you stage a deployment and then swap it with the production deployment. That way, users avoid deploying directly into production.

v) IP address: The App Service app has a public IP address and a domain name. The domain name is a subdomain of azurewebsites.net, such as contoso.azurewebsites.net. To use a custom domain name, such as contoso.com, create domain name service (DNS) records that map the custom domain name to the IP address. For more information, see Configure a custom domain name in Azure App Service.

vi) Azure SQL Database: SQL Database is a relational database-as-a-service in the cloud.

vii) Logical server: In Azure SQL Database, a logical server hosts user databases. User can create multiple databases per logical server.

viii) Azure Storage: Create an Azure storage account with a blob container to store diagnostic logs.

ix) Azure Active Directory (Azure AD): Use Azure AD or another identity provider for authentication.
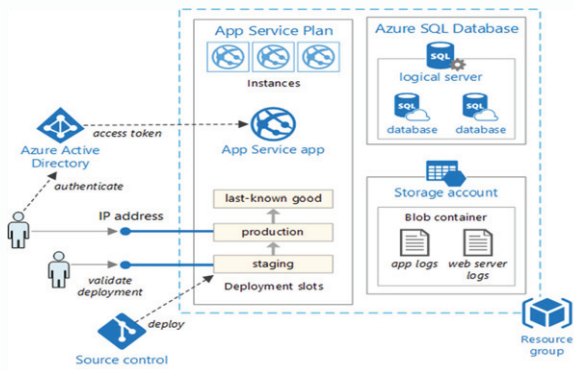
Figure 8.3 Microsoft Azure Reference Architecture

8.3 Microsoft Azure AppFabric

AppFabric is a set of middleware technologies for Windows Server, released by Microsoft. In June 2010, Microsoft released Windows Server AppFabric 1.0. The next release, 1.1, was rebranded to Microsoft AppFabric 1.1 for Windows Server.

In April 2015, Microsoft announced that it would end support for AppFabric for Windows Server on 2 April 2016. In June 2015, Microsoft announced that it would end support for AppFabric 1.1 for Windows Server on 11 April 2017, with Extended Support being available until 12 April 2022. It consists of two main feature areas: AppFabric Hosting and AppFabric Caching. Microsoft support for these will end in November 2017. A newer version of the product from Microsoft is Azure Service Fabric.

8.3.1 AppFabric hosting

AppFabric Hosting features provide a way for users to deploy and manage Windows Workflow Foundation (WF) workflows that are hosted in Windows Communication Foundation (WCF) services. AppFabric includes an extension of the Internet Information Services management tool that enables an IIS administrator to monitor the performance of services and workflows. There is also a set of Windows PowerShell commands to manage persistence, hosting, and monitoring tasks. AppFabric Hosting features provides persistence, hosting, and monitoring.

Persistence allows Windows Workflow Foundation services to save the state of long running workflows to a database. This makes Workflow more durable in the event of deliberate suspensions or unexpected hardware failures. Hosting facilitates the management of WCF and WF services within IIS and the Windows Process Activation service (WAS). Monitoring stores and correlates service events in a backend database.

User will begin with an initial and typical configuration commonly found in small single-server Windows Server AppFabric hosting and management installations. An initial "base server" will function as the AppFabric hosting and management configuration model for all other servers in the Web farm. From the base server comes the IIS and AppFabric hosting and management base configuration that is duplicated on all other servers in the Web farm. In this configuration all the .NET Framework 4 WCF/WF services are managed on one AppFabric hosting and management server. The persistence and monitoring databases exist on a separate server running SQL Server. Multiple clients access the .NET Framework 4 WCF/WF services through the single AppFabric hosting and management Web server.
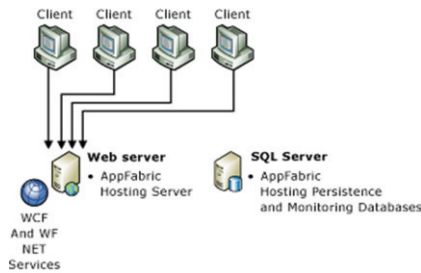
Figure 8.4 AppFabric Hosting

The Challenge

Setting up a hosting environment for an application that includes WCF- and WF-based services can be complex and time-consuming. While IIS/WAS provides a robust hosting environment for such applications, taking advantage of its features can require a considerable development effort, custom deployment solutions, and manual configuration procedures. Once a solution is deployed and configured, managing services can be a challenge.

The Solution

AppFabric Hosting Services enable user to get their WCF- and WF-based services up and running easily. User can take advantage of AppFabric's hosting capabilities without developing additional hosting features. The Hosting Services extend the hosting capabilities

of WAS by providing a default configuration of the WAS hosting environment. Hosting Services includes features provided by the Workflow Management Service, including lock/retry, auto-start, durable timers, and a command queue.

AppFabric Hosting Administration provides tools to manage users' running workflow instances much more easily, with control, monitoring, and query capabilities. User can also configure WAS and the applications hosted within WAS in a standard way. The Hosting Administration tools enable user to configure the address of service endpoints, manage auto-start activation, and configure security and performance settings.

8.3.2 AppFabric caching

AppFabric Caching features use a cluster of servers that communicate with each other to form a single, unified application cache system. As a distributed cache system, all cache operations are abstracted to a single point of reference, referred to as the cache cluster. In other words, client applications can work with a single logical unit of cache in the cluster regardless of how many computers make up the cache cluster.

The primary components of the physical architecture consist of the cache server, the cache host Windows service, the cache cluster, the Windows PowerShell-based cache administration tool, the cluster configuration storage location, and the cache client. The following diagram shows how all of these elements relate. AppFabric Caching is an in-memory, distributed cache that runs on one or more on-premises servers to provide a performance and scalability boost for .NET Framework applications. AppFabric caches store data in key-value pairs using the physical memory across multiple servers. The service presents that memory as a single resource. Caches are configured and managed through a set of Windows PowerShell commands.

The Challenge

The use of an in-memory cache to store frequently used application data is a long-standing method for improving application performance. Reading from and writing to memory is orders of magnitude faster than reading from and writing to disk. However, in-memory cache size is generally limited by the amount of memory available on the computer that the application is running on and data stored in an in-memory cache is subject to total loss due to the inherent volatility of computer memory. Development of applications that can make full use of an in-memory cache is further limited by the lack of an application programming interface (API) for storage and retrieval of objects in a memory cache. Development of

applications that make use of caching may also be hindered by the lack of cache management functionality.

The Solution

AppFabric caching features can help scale your .NET applications easily and inexpensively by allowing user to combine the memory capacity of multiple computers into a single unified cache cluster. These features include Caching Services, the Cache Client, and Cache Administration tools. The AppFabric Caching Services are highly scalable, allowing many computers to be configured as nodes of a cache cluster that is available as a single unified memory cache. The Caching Services provide a high-availability feature that supports continuous availability of user cached data by storing copies of that data on separate cache hosts. When high availability is enabled on a multi-server cluster, user application can still retrieve its cached data if a cache server fails.

The Caching Services provide a comprehensive set of fully documented API's for integrating the use of an in-memory cache with your .NET based application. In addition, there is seamless integration with ASP.NET for storing session state in the cache. This can provide ASP.NET sites with a cost-effective path for quickly improving site performance and scale. The AppFabric Cache Administration provides a full set of administration tools for the creation, configuration, and management of in-memory caches. The caching and hosting features of AppFabric are both included in an integrated installation package.
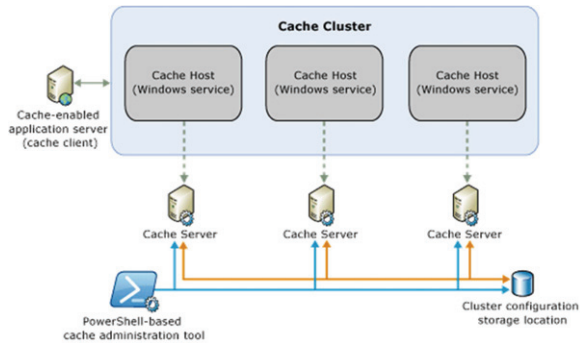

Figure 8.5 AppFabric Caching

8.4 Microsoft Azure Content Delivery Network

The Microsoft Azure Content Delivery Network (CDN) offers developers a global solution for delivering high-bandwidth content that is hosted in Azure or any other location. Using the CDN, user can cache publicly available objects loaded from Azure blob storage, a web application, virtual machine, application folder, or other HTTP/HTTPS location. The CDN cache can be held at strategic locations to provide maximum bandwidth for delivering content to users. The CDN is typically used for delivering static content such as images, style sheets, documents, files, client-side scripts, and HTML pages. User can also use the CDN as a cache for serving dynamic content, such as a PDF report or graph based on specified inputs; if the same input values are provided by different users the result should be the same. The major advantages of using the CDN are lower latency and faster delivery of content to users irrespective of their geographical location in relation to the datacenter where the application is hosted. The Microsoft Azure Content Delivery Network (CDN) also caches static web content at strategically placed locations to provide maximum throughput for delivering content to users. The CDN offers developers a global solution for delivering high-bandwidth content by caching the content at physical nodes across the world.
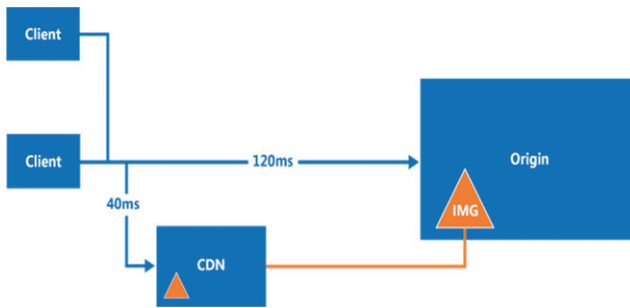
Figure 8.6 Azure Content Delivery Network Overview

Using the CDN should also help to reduce the load on application because it is relieved of the processing required to access and deliver the content. This reduction in load can help to increase the performance and scalability of the application, as well as minimizing hosting costs by reducing the processing resources required to achieve a specific level of performance and availability.

The benefits of using the CDN to cache web site assets include:

- Better performance and user experience for end users, especially when using applications where multiple round-trips are required to load content
- Large scaling to better handle instantaneous high load, like at the start of a product launch event
- By distributing user requests and serving content from edge servers, less traffic is sent to the origin
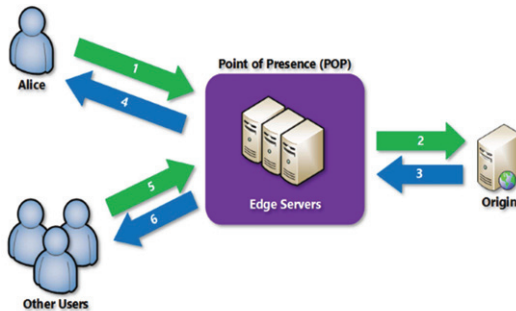
Figure 8.7 Azure Content Delivery Network Working Principle

8.4.1 How it Works

1. A user (Alice) requests a file (also called an asset) using a URL with a special domain name, such as <endpointname>.azureedge.net. DNS routes the request to the best performing Point-of-Presence (POP) location. Usually this is the POP that is geographically closest to the user.

2. If the edge servers in the POP do not have the file in their cache, the edge server requests the file from the origin. The origin can be an Azure Web App, Azure Cloud Service, Azure Storage account, or any publicly accessible web server.

3. The origin returns the file to the edge server, including optional HTTP headers describing the file's Time-to-Live (TTL).

4. The edge server caches the file and returns the file to the original requestor (Alice). The file remains cached on the edge server until the TTL expires. If the origin didn't specify a TTL, the default TTL is seven days.

5. Additional users may then request the same file using that same URL, and may also be directed to that same POP.

6. If the TTL for the file hasn't expired, the edge server returns the file from the cache. This results in a faster, more responsive user experience.

8.4.2 Challenges

There are several challenges to take into account when planning to use the Content Delivery Network (CDN):

Deployment: Decide the origin from which the CDN fetches the content, and whether user need to deploy the content in more than one storage system (such as in the CDN and an alternative location).

- ✓ **Versioning and cache-control**: Consider how user will update static content and deploy new versions. The CDN content may be purged using the Azure portal when new versions of their assets are available. This is a similar challenge to managing client-side caching, such as that which occurs in a web browser.
- ✓ **Testing**: It can be difficult to perform local testing of user CDN settings when developing and testing an application locally or in a staging environment.
- ✓ **Search engine optimization (SEO)**: Content such as images and documents are served from a different domain when user uses the CDN. This can have an effect on SEO for this content.
- ✓ **Content security**: Many CDN services such as Azure CDN do not currently offer any type of access control for the content.
- ✓ **Client security:** Clients might connect from an environment that does not allow access to resources on the CDN. This could be a security-constrained environment that limits access to only a set of known sources, or one that prevents loading of resources from anything other than the page origin. A fallback implementation is required to handle these cases.
- ✓ **Resilience**: The CDN is a potential single point of failure for an application. It has a lower availability SLA than blob storage (which can be used to deliver content directly) so user may need to consider implementing a fallback mechanism for critical content. User can monitor their CDN content availability, bandwidth, data transferred, hits, cache hit ratio, and cache metrics from the Azure portal in real-time and aggregate reports.

8.5 Microsoft Azure SQL Database

Microsoft Azure SQL Database (formerly SQL Azure, SQL Server Data Services, SQL Services, and Windows Azure SQL Database) is a managed cloud database (SaaS) provided as part of Microsoft Azure.

A cloud database is a database that runs on a cloud computing platform, and access to it is provided as a service. Managed database services take care of scalability, backup, and high availability of the database. Azure SQL Database is a managed database service which is different from AWS RDS which is a container service.

Microsoft Azure SQL Database includes built-in intelligence that learns app patterns and adapts to maximize performance, reliability, and data protection. It was originally announced in 2009 and released in 2010.

8.5.1 Key Capabilities:

- ✓ Continuous learning of your unique app patterns, adaptive performance tuning, and automatic improvements to reliability and data protection
- ✓ Scaling as needed, with virtually no app downtime
- ✓ Management and monitoring of multitenant apps with isolation benefits of one-customer-per-database
- ✓ Leverage open source tools like cheetah, SQL/CLI, VS Code and Microsoft tools like Visual Studio and SQL Server Management Studio, Azure Management Portal, PowerShell, and REST APIs
- ✓ Data protection with encryption, authentication, limiting user access to the appropriate subset of the data, continuous monitoring and auditing to help detect potential threats and provide a record of critical events in case of a breach

8.5.2 Scalable Performance and Pools:

With SQL Database, each database is isolated from each other and portable, each with its own service tier with a guaranteed performance level. SQL Database provides different performance levels for different needs, and enables databases to be pooled to maximize the use of resources and save money. Azure SQL Database offers Basic, Standard, Premium, and Premium RS service tiers for both single databases and elastic pools. Service tiers are primarily differentiated by a range of performance level and storage size choices, and price. All service tiers provide flexibility in changing performance level and storage size. Single

databases and elastic pools are billed hourly based on service tier, performance level, and storage size. Table 8.1 is described the service tier in below:

	Basic	**Standard**	**Premium**	**Premium RS**
Target workload	Development and production	Development and production	Development and production	Workload that can tolerate data loss up to 5-minutes due to service failures
Uptime SLA	99.99%	99.99%	99.99%	N/A while in preview
Backup retention	7 days	35 days	35 days	35 days
CPU	Low	Low, Medium, High	Medium, High	Medium
IO throughput	Low	Medium	Order of magnitude higher than Standard	Same as Premium
IO latency	Higher than Premium	Higher than Premium	Lower than Basic and Standard	Same as Premium
Columns tore indexing and in-memory OLTP	N/A	N/A	Supported	Supported

8.5.3 Adjust Performance and Scale without Downtime

SQL Database offers four service tiers to support lightweight to heavyweight database workloads: Basic, Standard, Premium, and Premium RS. You can build your first app on a small, single database at a low cost per month and then change its service tier manually or programmatically at any time to meet the needs of user solution. User can adjust performance without downtime to their app or to their customers. Dynamic scalability enables their database to transparently respond to rapidly changing resource requirements and enables user to only pay for the resources that user need when the user need them.
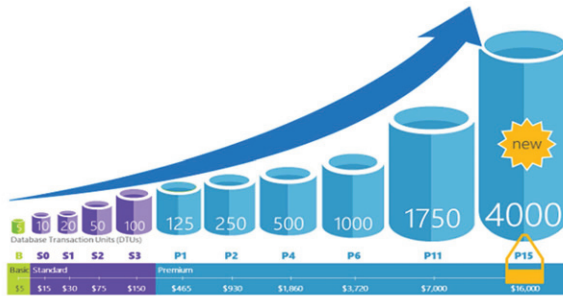

Figure 8.8 Service Tier of SQL Database

8.5.4 Elastic pools to maximize resource utilization

For many businesses and applications, being able to create single databases and dial performance up or down on demand is enough, especially if usage patterns are relatively predictable. But if users have unpredictable usage patterns, it can make it hard to manage costs and their business model. Elastic pools are designed to solve this problem. The concept is simple. Users allocate performance resources to a pool rather than an individual database, and pay for the collective performance resources of the pool rather than for single database performance.

With elastic pools, users don't need to focus on dialing database performance up and down as demand for resources fluctuates. The pooled databases consume the performance resources of the elastic pool as needed. Pooled databases consume but don't exceed the limits of the pool, so cost remains predictable even if individual database usage doesn't. User can add and remove databases to the pool, scaling their app from a handful of databases to thousands, all within a budget that their control. User can also control the minimum and maximum resources available to databases in the pool to ensure that no database in the pool uses all the

pool resources and that every pooled database has a guaranteed minimum amount of resources.
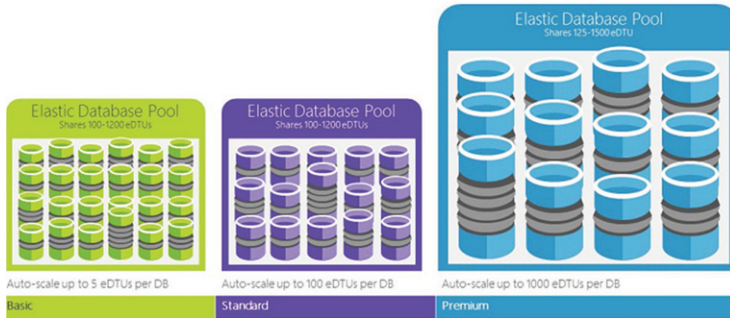

Figure 8.9 Azure SQL Elastic Database Pool

8.5.5 Extensive Monitoring and Altering Capabilities

SQL Database can emit metrics and diagnostic logs for easier monitoring. User can configure SQL Database to store resource usage, workers and sessions, and connectivity into one of these Azure resources:

a) Azure Storage: For archiving vast amounts of telemetry for a small price

b) Azure Event Hub: For integrating SQL Database telemetry with users' custom monitoring solution or hot pipelines

c) Azure Log Analytics: For built-in monitoring solution with reporting, alerting, and mitigating capabilities
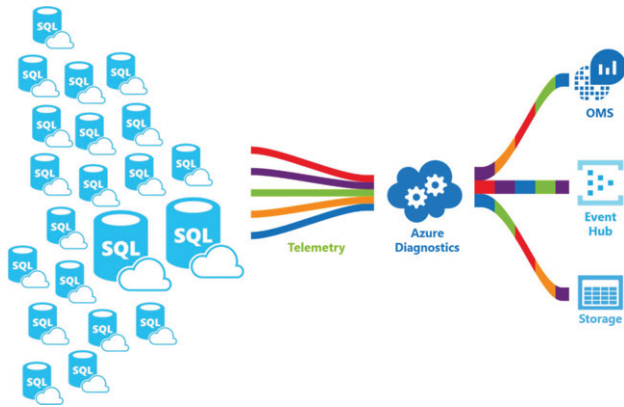
Figure 8.10 Azure Monitoring and Altering Capabilities

8.5.6 Availability capabilities

Azure's industry leading 99.99% availability service level agreement (SLA), powered by a global network of Microsoft-managed datacenters, helps keep your app running 24/7. In addition, SQL Database provides built-in business continuity and global scalability features, including:

a) Automatic backups: SQL Database automatically performs full, differential, and transaction log backups.

b) Point-in-time restores: SQL Database supports recovery to any point in time within the automatic backup retention period.

c) Active geo-replication: SQL Database allows user to configure up to four readable secondary databases in either the same or globally distributed Azure data centers. For example, if users have a SaaS application with a catalog database that has a high volume of concurrent read-only transactions, use active geo-replication to enable global read scale and remove bottlenecks on the primary that are due to read workloads.

d) Failover groups: SQL Database allows user to enable high availability and load balancing at global scale, including transparent geo-replication and failover of large sets of databases and elastic pools. Failover groups and active geo-replication enables creation of globally

distributed SaaS applications with minimal administration overhead leaving all the complex monitoring, routing, and failover orchestration to SQL Database.

8.6 Windows Live Services

Windows Live is a discontinued brand-name for a set of web services and software products from Microsoft as part of their software plus services platform. It has been superseded by a product branded Office 365. Chief components under the brand name include web services (all of which are exposed through corresponding web apps), several computer programs that interact with the services, and specialized web services for mobile devices.

According to Microsoft, Windows Live "is a way to extend the Windows user experience". As such, Windows Vista's welcome screen provides a link to download Windows Live Messenger or to subscribe to Windows Live OneCare. Also, Windows Mail, Windows Photo Gallery and Windows Movie Maker were not offered with Windows 7 and became an exclusive part of Windows Live. Microsoft announced that Windows 8 would see Windows Live apps included right out-of-the-box, and would include built-in synchronization technologies powered by OneDrive (then SkyDrive). The Windows Live brand was phased out during August 2012, when Microsoft released Windows 8 to manufacturing. Active Windows Live services remained active but were gradually renamed.

In addition to Windows Live, which is mainly aimed at individuals, Microsoft brands other properties as "Live", including:

- ✓ Xbox LIVE (a multiplayer gaming and content-delivery system for Xbox)
- ✓ Games for Windows - LIVE (multiplayer gaming service for Microsoft Windows)
- ✓ Office Live. Office Live merged into Windows Live during the Wave 4 update Microsoft merged Office Live into the Windows Live team in January 2009

8.6.1 Services
i) Search Services
Bing, a replacement of the search engine Live Search, was originally named Windows Live Search (and MSN Search prior to that) and was once part of the Windows Live family of services. Windows Live Search once occupied the homepage of Live.com, the domain for all Windows Live services. However, on March 21, 2007, Microsoft decided to separate its

search developments from its Windows Live services family, forming part of the Live Search and Ad Platform. As part of this reorganization, the new search brand, Live Search, was consolidated with Microsoft adCenter, a part of Microsoft's Platform and Systems division. However, Microsoft recognized that there was a brand issue as the word "Live" continued to remain in the brand. As an effort to create a new identity for Microsoft's search services, on June 3, 2009, Live Search was officially rebranded as Bing.

ii) Developer Services

Live Connect is a collection of APIs and common controls that allow developers to have a deeper control and offers access to the core Windows Live services and data through open and easily accessible application programming interfaces (APIs). Live Connect is built on standard web technologies such as OAuth 2.0, Representational State Transfer (REST), and JavaScript Object Notation (JSON), and is designed to work with any technology or device. Live Connect unites the previously separate APIs of Windows Live into a single API that is based on industry standards and specifications.

Software

Microsoft has released several computer programs with "Windows Live" brand, a summary of which is included below. All except Windows Live OneCare are freeware and published in a software suite called Windows Essentials (formerly Windows Live Essentials). Essentials programs are designed to integrate well with each other, within Windows, and with other Windows Live services such as OneDrive and Outlook.com. Windows Live OneCare on the other hand, was a commercial consumer's utility marketed with software as a service licensing model.

Service	Description	Fate
Family Safety	Parental controls similar to Windows Vista's Family Safety feature	Integrated into Windows 8 and late
Mail	Desktop mail and calendar client designed to succeed Outlook Express on Windows XP and Windows Mail on Windows Vista, with full RSS support	Integrated into Windows 8 and late
Movie Maker	A video editing program for consumers	Discontinued
Messenger	Instant messaging app	Replaced by Skype
Messenger Companion	An add-in for Internet Explorer that allows users to share a webpage with their friends on	Discontinued

	Windows Live, see links to webpages the user's friends have shared and comment on these shared pages.	
OneCare	A suite of computer security programs with antivirus program, backup utility, and a personal firewall.	Discontinued; functionality is partially offered by Microsoft Security Essentials, Windows Defender, System Center Endpoint Protection, Windows Backup and Windows Firewall.
Toolbar	A toolbar plug-in for Windows Internet Explorer, which allows quick access to a user's Windows Live Spaces, Hotmail, Favorites and Live Search from a button on the toolbar.	Replaced by Bing Desktop and Bing Bar
Photo Gallery	Image organizer that makes posting photos to SkyDrive and Facebook easier	Discontinued; functionality is partially offered by Photos app in Windows 10, and OneDrive app.
Writer	Desktop blog publishing tool that can publish to popular blogging services and make use of SkyDrive for photo storage.	Discontinued; open sourced as Open Live Writer in late 2015.

iii) Online Services: The following services were once part of Windows Live but are still online even though the brand name is dropped.

Name	Later renamed to	Website	Description
Calendar	Outlook Calendar (Outlook.com)	calendar.live.com	Calendaring web app that allow users to organize appointments, schedule meetings, set reminders, and share their calendar events.
Hotmail	Outlook.com	outlook.com	Free webmail service using AJAX technology
ID	Microsoft account	account.live.com	Provides single sign-on service, allowing users to log into various Microsoft products and services with the same credentials. Users can manage their accounts and link multiple IDs together using this service.
Live@edu	Office 365	outlook.office365.	Hosted email service for academic

	for Education	com	institutions.
Search	Bing	bing.com	Microsoft search engine and advertisement platform.
People	People (Outlook.com)	people.live.com	An address book service, which allows users to keep track and synchronize their contact's information. Allow users to add contacts from other social networks including Facebook, Twitter, LinkedIn, Google, Flickr and soon Sina Weibo and Skype to their Microsoft account.
Profile	N/A	profile.live.com	Allow users to manage their profile information and displays information about the particular user, their recent activities, and their relationship with other Windows Live users.
Office	Office Web Apps, Office Online	office.com	Free-to-use web app versions of Microsoft Word, Excel, PowerPoint and OneNote.
SkyDrive	OneDrive	onedrive.com foldershare.com	Password-protected file hosting service. Enables file sharing and content synchronization. Can preview images, Microsoft Office documents and ZIP files. Integrates tightly with Office Web Apps and Outlook.com to serve as an online storage for their needs.
Service status	Office 365service status	portal.office.com/ servicestatus	A diagnostics web page that Microsoft uses to announce the status of its online services. It gathers a status history.

iv) Renamed Services

The Windows Live services are renamed as listed:

Service type	Service name	Previous name	Website	Desktop app	Metro-style app	Windows Phone app
Search	Bing	Search	bing.com	Bing Toolbar, Bing Desktop	Bing	Bing Mobile

Account	Microsoft account	ID, Passport	account.live.com	N/A	Integrated into Windows 8	Microsoft account
Storage	OneDrive	FolderShare, Mesh, SkyDrive	onedrive.com	OneDrive (Integrated into Windows 8.1)	OneDrive	OneDrive, Office Mobile
Email	Outlook.com	Hotmail	outlook.com	Outlook Express, Windows Mail, Live Mail, Outlook	Mail	Mail
Contacts	People	Contacts	people.live.com	Live Mail, Outlook 2013and later	People	People Mobile
Web-based chat	Integrated into all services	Web Messenger	N/A	N/A	N/A	N/A
Photos and videos	Integrated into OneDrive	Photos	N/A	Photo Gallery, Movie Maker	Photos	Photos, Camera Roll

REVIEW QUESTIONS

- ❖ What is Microsoft Azure and why is it used?

- ❖ Explain three components provided by Windows Azure.

- ❖ State the benefits offered by Microsoft with cloud computing.

- ❖ What are the three main components of Windows Azure Platform?

- ❖ What Is Windows Azure Diagnostics?

- ❖ What is difference between Windows Azure Platform and Windows Azure?

- ❖ What are the options to manage session state in Windows Azure?

- ❖ What is the difference between Windows Azure Queues and Windows Azure Service Bus Queues?

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