UNIT – 5

AWS (Amazon Web Services): Amazon applies the IaaS model in providing its services. Figure 4.21 shows the AWS architecture. EC2 provides the virtualized platforms to the host VMs where the cloud application can run. S3 (Simple Storage Service) provides the object-oriented storage service for users. EBS (Elastic Block Service) provides the block storage interface which can be used to support traditional applications. SQS stands for Simple Queue Service, and its job is to ensure a reliable message service between two processes. The message can be kept reliably even when the receiver processes are not running. Users can access their objects through SOAP with either browsers or other client programs which support the SOAP standard.

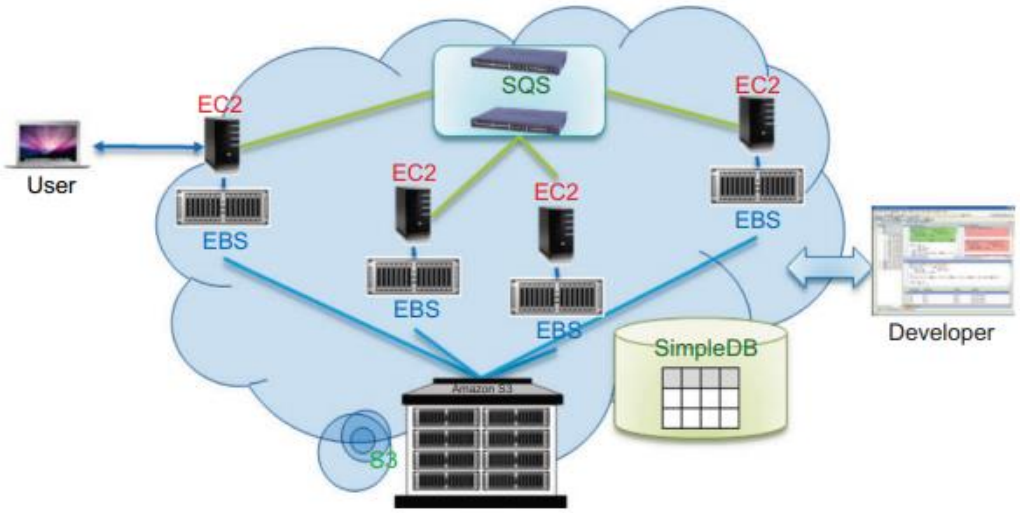

Fig: AWS architecture

Amazon Web Services (AWS) is a cloud service from Amazon, which provides services in the form of building blocks, these building blocks can be used to create and deploy any type of application in the cloud. These services or building blocks are designed to work with each other, and result in applications which are sophisticated and highly scalable. Each type of service in this "What is AWS" blog is categorized under a domain, the few domains which are widely used are:

Features of AWS

The following are the features of AWS:

- Flexibility
- Cost-effective

- Scalable and elastic
- Secure
- Experienced

1) Flexibility

- The difference between AWS and traditional IT models is **flexibility**.
- The traditional models used to deliver IT solutions that require large investments in a new architecture, programming languages, and operating system. Although these investments are valuable, it takes time to adopt new technologies and can also slow down your business.
- The flexibility of AWS allows us to choose which programming models, languages, and operating systems are better suited for their project, so we do not have to learn new skills to adopt new technologies.
- Flexibility means that migrating legacy applications to the cloud is easy, and cost-effective. Instead of re-writing the applications to adopt new technologies, you just need to move the applications to the cloud and tap into advanced computing capabilities.
- Building applications in aws are like building applications using existing hardware resources.
- The larger organizations run in a hybrid mode, i.e., some pieces of the application run in their data center, and other portions of the application run in the cloud.
- The flexibility of aws is a great asset for organizations to deliver the product with updated technology in time, and overall enhancing the productivity.

2) Cost-effective

- Cost is one of the most important factors that need to be considered in delivering IT solutions.
- For example, developing and deploying an application can incur a low cost, but after successful deployment, there is a need for hardware and bandwidth. Owing our own infrastructure can incur considerable costs, such as power, cooling, real estate, and staff.
- The cloud provides on-demand IT infrastructure that lets you consume the resources what you actually need. In aws, you are not limited to a set amount of resources such as storage, bandwidth or computing resources as it is very difficult to predict the requirements of every resource. Therefore, we can say that the cloud provides flexibility by maintaining the right balance of resources.
- AWS provides no upfront investment, long-term commitment, or minimum spend.
- You can scale up or scale down as the demand for resources increases or decreases respectively.
- An aws allows you to access the resources more instantly. It has the ability to respond the changes more quickly, and no matter whether the changes are large or small,

means that we can take new opportunities to meet the business challenges that could increase the revenue, and reduce the cost.

3) Scalable and elastic

- In a traditional IT organization, scalability and elasticity were calculated with investment and infrastructure while in a cloud, scalability and elasticity provide savings and improved ROI (Return On Investment).
- Scalability in aws has the ability to scale the computing resources up or down when demand increases or decreases respectively.
- Elasticity in aws is defined as the distribution of incoming application traffic across multiple targets such as Amazon EC2 instances, containers, IP addresses, and Lambda functions.
- Elasticity load balancing and scalability automatically scale your AWS computing resources to meet unexpected demand and scale down automatically when demand decreases.
- The aws cloud is also useful for implementing short-term jobs, mission-critical jobs, and the jobs repeated at the regular intervals.

4) Secure

- AWS provides a scalable cloud-computing platform that provides customers with end-to-end security and end-to-end privacy.
- AWS incorporates the security into its services, and documents to describe how to use the security features.
- AWS maintains confidentiality, integrity, and availability of your data which is the utmost importance of the aws.

Physical security: Amazon has many years of experience in designing, constructing, and operating large-scale data centers. An aws infrastructure is incorporated in AWS controlled data centers throughout the world. The data centers are physically secured to prevent unauthorized access.

Secure services: Each service provided by the AWS cloud is secure.

Data privacy: A personal and business data can be encrypted to maintain data privacy.

5) Experienced

- The AWS cloud provides levels of scale, security, reliability, and privacy.
- AWS has built an infrastructure based on lessons learned from over sixteen years of experience managing the multi-billion dollar Amazon.com business.
- Amazon continues to benefit its customers by enhancing their infrastructure capabilities.

- Nowadays, Amazon has become a global web platform that serves millions of customers, and AWS has been evolved since 2006, serving hundreds of thousands of customers worldwide.

History of AWS:

- **2003:** In 2003, Chris Pinkham and Benjamin Black presented a paper on how Amazon's own internal infrastructure should look like. They suggested to sell it as a service and prepared a business case on it. They prepared a six-page document and had a look over it to proceed with it or not. They decided to proceed with the documentation.
- **2004:** SQS stands for "Simple Queue Service" was officially launched in 2004. A team launched this service in Cape Town, South Africa.
- **2006:** AWS (Amazon Web Services) was officially launched.
- **2007:** In 2007, over 180,000 developers had signed up for the AWS.
- **2010:** In 2010, amazon.com retail web services were moved to the AWS, i.e., amazon.com is now running on AWS.
- **2011:** AWS suffered from some major problems. Some parts of volume of EBS (Elastic Block Store) was stuck and were unable to read and write requests. It took two days for the problem to get resolved.
- **2012:** AWS hosted a first customer event known as re:Invent conference. First re:invent conference occurred in which new products were launched. In AWS, another major problem occurred that affects many popular sites such as Pinterest, Reddit, and Foursquare.
- **2013:** In 2013, certifications were launched. AWS started a certifications program for software engineers who had expertise in cloud computing.
- **2014:** AWS committed to achieve 100% renewable energy usage for its global footprint.
- **2015:** AWS breaks its revenue and reaches to $6 Billion USD per annum. The revenue was growing 90% every year.
- **2016:** By 2016, revenue doubled and reached $13Billion USD per annum.
- **2017:** In 2017, AWS re: invent releases a host of Artificial Intelligence Services due to which revenue of AWS doubled and reached $27 Billion USD per annum.
- **2018:** In 2018, AWS launched a **Machine Learning Speciality Certs**. It heavily focussed on automating Artificial Intelligence and Machine learning.

These services or building blocks are designed to work with each other, and result in applications which are sophisticated and highly scalable. Each type of service in this “What is AWS” blog, is categorized under a domain, the few domains which are widely used are:

- Compute
- Storage
- Database
- Migration
- Network and Content Delivery
- Management Tools
- Security & Identity Compliance
- Messaging

The **Compute** domain includes services related to compute workloads, it includes the following services:

- EC2 (Elastic Compute Cloud)
- Lambda
- Elastic Beanstalk
- Amazon LightSail

The **Storage** domain includes services related data storage, it includes the following services:

- S3 (Simple Storage Service)
- Elastic Block Store
- Amazon Glacier
- AWS Snowball

The **Database** domain is used for database related workloads, it includes the following services:

- Amazon Aurora
- Amazon RDS
- Amazon DynamoDB
- Amazon RedShift

The **Migration** domain is used for transferring data to or from the AWS Infrastructure, it includes the following services:

- AWS database Migration Service
- AWS SnowBall

The **Networking and Content Delivery** domain is used for isolating your network infrastructure, and content delivery is used for faster delivery of content. It includes the following services:

- Amazon Route 53
- AWS CloudFront

The **Management Tools** domain consists of services which are used to manage other services in AWS, it includes the following services:

- AWS CloudWatch
- AWS CloudFomation

- AWS CloudTrail

The **Security & Identity, Compliance** domain consist of services which are used to manage to authenticate and provide security to your AWS resources. It consists of the following services:

- AWS IAM
- AWS KMS
- AWS Shield

The **Messaging** domain consists of services which are used for queuing, notifying or emailing messages. It consists of the following domains:

- Amazon SQS
- Amazon SNS
- Amazon SES
- Amazon Pinpoint

What is IAM?

- IAM stands for Identity Access Management.
- IAM allows you to manage users and their level of access to the AWS console.
- It is used to set users, permissions and roles. It allows you to grant access to the different parts of the aws platform.
- AWS Identity and Access Management is a web service that enables Amazon Web Services (AWS) customers to manage users and user permissions in AWS.
- With IAM, Organizations can centrally manage users, security credentials such as access keys, and permissions that control which AWS resources users can access.
- Without IAM, Organizations with multiple users must either create multiple user accounts, each with its own billing and subscriptions to AWS products or share an account with a single security credential. Without IAM, you also don't have control about the tasks that the users can do.
- IAM enables the organization to create multiple users, each with its own security credentials, controlled and billed to a single aws account. IAM allows the user to do only what they need to do as a part of the user's job.

Features of IAM

- **Centralised control of your AWS account:** You can control creation, rotation, and cancellation of each user's security credentials. You can also control what data in the aws system users can access and how they can access.
- **Shared Access to your AWS account:** Users can share the resources for the collaborative projects.

- **Granular permissions:** It is used to set permission that user can use a particular service but not other services.
- **Identity Federation:** An Identity Federation means that we can use Facebook, Active Directory, LinkedIn, etc with IAM. Users can log in to the AWS Console with same username and password as we log in with the Active Directory, Facebook, etc.
- **Multifactor Authentication:** An AWS provides multifactor authentication as we need to enter the username, password, and security check code to log in to the AWS Management Console.
- **Permissions based on Organizational groups:** Users can be restricted to the AWS access based on their job duties, for example, admin, developer, etc.
- **Networking controls:** IAM also ensures that the users can access the AWS resources within the organization's corporate network.
- **Provide temporary access for users/devices and services where necessary:** If you are using a mobile app and storing the data in AWS account, you can do this only when you are using temporary access.
- **Integrates with many different aws services:** IAM is integrated with many different aws services.
- **Supports PCI DSS Compliance:** PCI DSS (Payment Card Industry Data Security Standard) is a compliance framework. If you are taking credit card information, then you need to pay for compliance with the framework.
- **Eventually Consistent:** IAM service is eventually consistent as it achieves high availability by replicating the data across multiple servers within the Amazon's data center around the world.
- **Free to use:** AWS IAM is a feature of AWS account which is offered at no additional charge. You will be charged only when you access other AWS services by using IAM user.

S3-101

- S3 is one of the first services that has been produced by aws.
- S3 stands for Simple Storage Service.
- S3 provides developers and IT teams with secure, durable, highly scalable object storage.
- It is easy to use with a simple web services interface to store and retrieve any amount of data from anywhere on the web.

What is S3?

- S3 is a safe place to store the files.
- It is Object-based storage, i.e., you can store the images, word files, pdf files, etc.
- The files which are stored in S3 can be from 0 Bytes to 5 TB.
- It has unlimited storage means that you can store the data as much you want.

- Files are stored in Bucket. A bucket is like a folder available in S3 that stores the files.
- S3 is a universal namespace, i.e., the names must be unique globally. Bucket contains a DNS address. Therefore, the bucket must contain a unique name to generate a unique DNS address.

If you create a bucket, URL look like:

- If you upload a file to S3 bucket, then you will receive an HTTP 200 code means that the uploading of a file is successful.

Advantages of Amazon S3

- **Create Buckets:** Firstly, we create a bucket and provide a name to the bucket. Buckets are the containers in S3 that stores the data. Buckets must have a unique name to generate a unique DNS address.
- **Storing data in buckets:** Bucket can be used to store an infinite amount of data. You can upload the files as much you want into an Amazon S3 bucket, i.e., there is no maximum limit to store the files. Each object can contain upto 5 TB of data. Each object can be stored and retrieved by using a unique developer assigned-key.
- **Download data:** You can also download your data from a bucket and can also give permission to others to download the same data. You can download the data at any time whenever you want.
- **Permissions:** You can also grant or deny access to others who want to download or upload the data from your Amazon S3 bucket. Authentication mechanism keeps the data secure from unauthorized access.
- **Standard interfaces:** S3 is used with the standard interfaces REST and SOAP interfaces which are designed in such a way that they can work with any development toolkit.
- **Security:** Amazon S3 offers security features by protecting unauthorized users from accessing your data.

S3 is a simple key-value store

S3 is object-based. Objects consist of the following:

- **Key:** It is simply the name of the object. For example, hello.txt, spreadsheet.xlsx, etc. You can use the key to retrieve the object.
- **Value:** It is simply the data which is made up of a sequence of bytes. It is actually a data inside the file.
- **Version ID:** Version ID uniquely identifies the object. It is a string generated by S3 when you add an object to the S3 bucket.

- **Metadata:** It is the data about data that you are storing. A set of a name-value pair with which you can store the information regarding an object. Metadata can be assigned to the objects in Amazon S3 bucket.
- **Subresources:** Subresource mechanism is used to store object-specific information.
- **Access control information:** You can put the permissions individually on your files.

Amazon EC2:

Amazon EC2 (Elastic Compute Cloud) is a web service interface that provides resizable compute capacity in the AWS cloud. It is designed for developers to have complete control over web-scaling and computing resources.

EC2 instances can be resized and the number of instances scaled up or down as per our requirement. These instances can be launched in one or more geographical locations or regions, and **Availability Zones (AZs)**. Each region comprises of several AZs at distinct locations, connected by low latency networks in the same region.

EC2 Components

In AWS EC2, the users must be aware about the EC2 components, their operating systems support, security measures, pricing structures, etc.

Operating System Support

Amazon EC2 supports multiple OS in which we need to pay additional licensing fees like: Red Hat Enterprise, SUSE Enterprise and Oracle Enterprise Linux, UNIX, Windows Server, etc. These OS needs to be implemented in conjunction with Amazon Virtual Private Cloud (VPC).

Security

Users have complete control over the visibility of their AWS account. In AWS EC2, the security systems allow create groups and place running instances into it as per the requirement. You can specify the groups with which other groups may communicate, as well as the groups with which IP subnets on the Internet may talk.

Pricing

AWS offers a variety of pricing options, depending on the type of resources, types of applications and database. It allows the users to configure their resources and compute the charges accordingly.

Fault tolerance

Amazon EC2 allows the users to access its resources to design fault-tolerant applications. EC2 also comprises geographic regions and isolated locations known as availability zones for fault tolerance and stability. It doesn't share the exact locations of regional data centers for security reasons.

When the users launch an instance, they must select an AMI that's in the same region where the instance will run. Instances are distributed across multiple availability zones to provide continuous services in failures, and Elastic IP (EIPs) addresses are used to quickly map failed instance addresses to concurrent running instances in other zones to avoid delay in services.

Migration

This service allows the users to move existing applications into EC2. It costs $80.00 per storage device and $2.49 per hour for data loading. This service suits those users having large amount of data to move.

Features of EC2

Here is a list of some of the prominent features of EC2 −

- **Reliable** − Amazon EC2 offers a highly reliable environment where replacement of instances is rapidly possible. Service Level Agreement commitment is 99.9% availability for each Amazon EC2 region.
- **Designed for Amazon Web Services** − Amazon EC2 works fine with Amazon services like Amazon S3, Amazon RDS, Amazon DynamoDB, and Amazon SQS. It provides a complete solution for computing, query processing, and storage across a wide range of applications.
- **Secure** − Amazon EC2 works in Amazon Virtual Private Cloud to provide a secure and robust network to resources.
- **Flexible Tools** − Amazon EC2 provides the tools for developers and system administrators to build failure applications and isolate themselves from common failure situations.
- **Inexpensive** − Amazon EC2 wants us to pay only for the resources that we use. It includes multiple purchase plans such as On-Demand Instances, Reserved Instances, Spot Instances, etc. which we can choose as per our requirement.

How to Use AWS EC2

Step 1 − Sign-in to AWS account and open IAM console by using the following link https://console.aws.amazon.com/iam/.

Step 2 − In the navigation Panel, create/view groups and follow the instructions.

Step 3 − Create IAM user. Choose users in the navigation pane. Then create new users and add users to the groups.

Step 4 − Create a Virtual Private Cloud using the following instructions.

- Open the Amazon VPC console by using the following link − https://console.aws.amazon.com/vpc/
- Select VPC from the navigation panel. Then select the same region in which we have created key-pair.
- Select start VPC wizard on VPC dashboard.
- Select VPC configuration page and make sure that VPC with single subnet is selected. The choose Select.
- VPC with a single public subnet page will open. Enter the VPC name in the name field and leave other configurations as default.
- Select create VPC, then select Ok.

Step 5 − Create WebServerSG security groups and add rules using the following instructions.

- On the VPC console, select Security groups in the navigation panel.
- Select create security group and fill the required details like group name, name tag, etc.
- Select your VPC ID from the menu. Then select yes, create button.
- Now a group is created. Select the edit option in the inbound rules tab to create rules.

Step 6 − Launch EC2 instance into VPC using the following instructions.

- Open EC2 console by using the following link − https://console.aws.amazon.com/ec2/
- Select launch instance option in the dashboard.
- A new page will open. Choose Instance Type and provide the configuration. Then select Next: Configure Instance Details.
- A new page will open. Select VPC from the network list. Select subnet from the subnet list and leave the other settings as default.
- Click Next until the Tag Instances page appears.

Step 7 − On the Tag Instances page, provide a tag with a name to the instances. Select Next: Configure Security Group.

Step 8 − On the Configure Security Group page, choose the Select an existing security group option. Select the WebServerSG group that we created previously, and then choose Review and Launch.

Step 9 − Check Instance details on Review Instance Launch page then click the Launch button.

Step 10 − A pop up dialog box will open. Select an existing key pair or create a new key pair. Then select the acknowledgement check box and click the Launch Instances button.

Microsoft Azure:

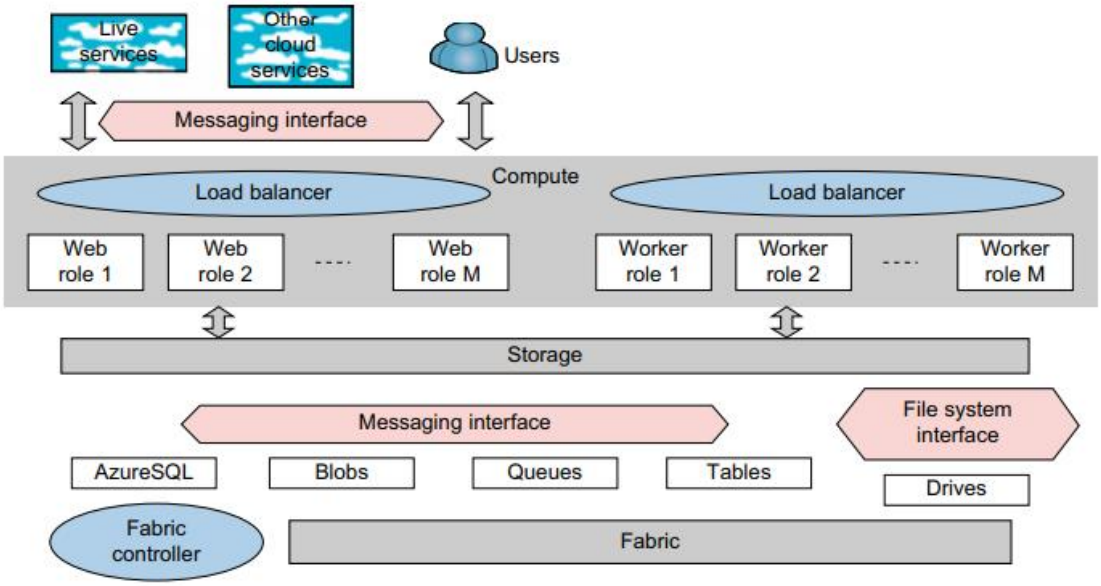

Fig: Features of the Azure cloud platform

Azure as PaaS (Platform as a Service)

As the name suggests, a platform is provided to clients to develop and deploy software. The clients can focus on the application development rather than having to worry about hardware and infrastructure. It also takes care of most of the operating systems, servers and networking issues.

Pros

- The overall cost is low as the resources are allocated on demand and servers are automatically updated.
- It is less vulnerable as servers are automatically updated and being checked for all known security issues. The whole process is not visible to developer and thus does not pose a risk of data breach.

- Since new versions of development tools are tested by the Azure team, it becomes easy for developers to move on to new tools. This also helps the developers to meet the customer's demand by quickly adapting to new versions.

Cons

- There are portability issues with using PaaS. There can be a different environment at Azure, thus the application might have to be adapted accordingly.

Azure as IaaS (Infrastructure as a Service)

It is a managed compute service that gives complete control of the operating systems and the application platform stack to the application developers. It lets the user to access, manage and monitor the data centers by themselves.

Pros

- This is ideal for the application where complete control is required. The virtual machine can be completely adapted to the requirements of the organization or business.
- IaaS facilitates very efficient design time portability. This means application can be migrated to Windows Azure without rework. All the application dependencies such as database can also be migrated to Azure.
- IaaS allows quick transition of services to clouds, which helps the vendors to offer services to their clients easily. This also helps the vendors to expand their business by selling the existing software or services in new markets.

Cons

- Since users are given complete control they are tempted to stick to a particular version for the dependencies of applications. It might become difficult for them to migrate the application to future versions.
- There are many factors which increases the cost of its operation. For example, higher server maintenance for patching and upgrading software.
- There are lots of security risks from unpatched servers. Some companies have welldefined processes for testing and updating on-premise servers for security vulnerabilities. These processes need to be extended to the cloud-hosted IaaS VMs to mitigate hacking risks.
- The unpatched servers pose a great security risk. Unlike PaaS, there is no provision of automatic server patching in IaaS. An unpatched server with sensitive information can be very vulnerable affecting the entire business of an organization.
- It is difficult to maintain legacy apps in Iaas. It can be stuck with the older version of the operating systems and application stacks. Thus, resulting in applications that are difficult to maintain and add new functionality over the period of time.

It becomes necessary to understand the pros and cons of both services in order to choose the right one according your requirements. In conclusion it can be said that, PaaS has definite economic advantages for operations over IaaS for commodity applications. In PaaS, the cost of operations breaks the business model. Whereas, IaaS gives complete control of the OS and application platform stack.

Azure Management Portal

Azure Management Portal is an interface to manage the services and infrastructure launched in 2012. All the services and applications are displayed in it and it lets the user manage them.

Getting started

A free trial account can be created on Azure management portal by visiting the following link - manage.windowsazure.com

The screen that pops up is as shown in the following image. The account can be created using our existing Gmail, Hotmail or Yahoo account.

Aneka Framework: Aneka is a cloud application platform developed by Manjrasoft, based in Melbourne, Australia. It is designed to support rapid development and deployment of parallel and distributed applications on private or public clouds. It provides a rich set of APIs for transparently exploiting distributed resources and expressing the business logic of applications by using preferred programming abstractions. System administrators can leverage a collection of tools to monitor and control the deployed infrastructure. It can be deployed on a public cloud such as Amazon EC2 accessible through the Internet to its subscribers, or a private cloud constituted by a set of nodes with restricted access. Aneka acts as a workload distribution and management platform for accelerating applications in both Linux and Microsoft .NET framework environments. Some of the key advantages of Aneka over other workload distribution solutions include:

Support of multiple programming and application environments

- Simultaneous support of multiple runtime environments
- Rapid deployment tools and framework
- Ability to harness multiple virtual and/or physical machines for accelerating application provisioning based on users' Quality of Service/service-level agreement (QoS/SLA) requirements
- Built on top of the Microsoft .NET framework, with support for Linux environments through Mono

Aneka offers three types of capabilities which are essential for building, accelerating, and managing clouds and their applications:

- **Build:** Aneka includes a new SDK which combines APIs and tools to enable users to rapidly develop applications. Aneka also allows users to build different runtime environments such as enterprise/private cloud by harnessing compute resources in network or enterprise data centers, Amazon EC2, and hybrid clouds by combining

enterprise private clouds managed by Aneka with resources from Amazon EC2 or other enterprise clouds built and managed using XenServer.

- **Accelerate**: Aneka supports rapid development and deployment of applications in multiple runtime environments running different operating systems such as Windows or Linux/UNIX. Aneka uses physical machines as much as possible to achieve maximum utilization in local environments. Whenever users set QoS parameters such as deadlines, and if the enterprise resources are insufficient to meet the deadline, Aneka supports dynamic leasing of extra capabilities from public clouds such as EC2 to complete the task within the deadline
- **Manage:** Management tools and capabilities supported by Aneka include a GUI and APIs to set up, monitor, manage, and maintain remote and global Aneka compute clouds. Aneka also has an accounting mechanism and manages priorities and scalability based on SLA/QoS which enables dynamic provisioning.

  Here are three important programming models supported by Aneka for both cloud and traditional parallel applications:

  1. Thread programming model, best solution to adopt for leveraging the computing capabilities of multicore nodes in a cloud of computers.
  2. Task programming model, which allows for quickly prototyping and implementing an independent bag of task applications.
  3. MapReduce programming model.

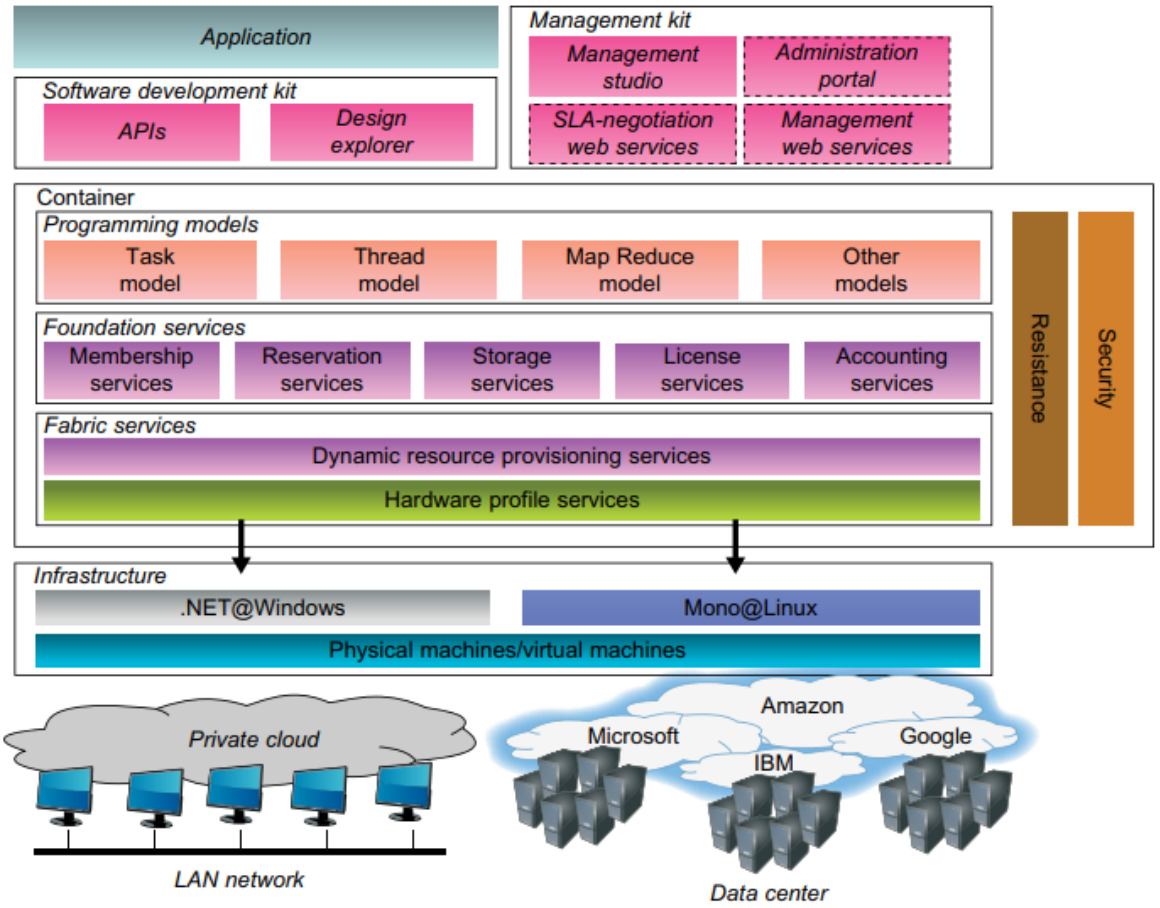

Fig: Architecture and components of Aneka

Integration of Private and Public Clouds:

Private Cloud: Private Cloud is a type of computing model in which resources are made available within the organisational premises. Facilitates a secure cloud network which can only be accessed by specific users or clients.

- Flexible and improved allocation of resources to different departments within an organisation
- High level of security
- Efficient upgradation of resources
- Virtualized operating environments making the network is more resilient to individual failures within the infrastructure.
- Allows sensitive processes to switch to public cloud easily.

Public Cloud: Public Cloud is a type of computing in which resources are made available to the public by the service provider via the internet. Resources Cloud Storage, Virtual machines etc. Advantages:

- Easily scalable resources according to current requirements.
- Ease of accessibility i.e via the internet, anywhere.
- Strict security policies to secure user's data
- Services according to organisational requirements i.e IaaS, PaaS, SaaS.
- Hassle-free maintenance.
- Efficient Disaster Recovery mechanism.

Hybrid Cloud: Hybrid Cloud is an integration of both Private and Public Cloud for high efficiency in performing distinct functions in an organisation. For example, an environment created mixing On-premise, private cloud and public cloud (i.e GCP, AWS, Azure). This framework efficiently utilises the advantages of public resources to upscale their internal resources without risking an overload in case of unexpected spikes in usage.

- Ease of scalability.
- Cost efficiency much greater than private cloud
- Enables more private functions to run on Private framework and sensitive functions to run on Public.
- Highly secure and flexible according to organisational needs.

Design and Implementation Guidelines: The particular nature of hybrid clouds demands additional and specific functionalities that software engineers have to consider while designing software systems supporting the execution of applications in hybrid and dynamic environments. These features, together with some guidelines on how to implement them, are presented in the following:

- **Support for Heterogeneity:** Hybrid clouds are produced by heterogeneous resources such as clusters, public or private virtual infrastructures, and workstations. In particular, for what concerns a virtual machine manager, it must be possible to integrate additional cloud service providers (mostly IaaS providers) without major changes to the entire system design and codebase. Hence, the specific code related to a particular cloud resource provider should be kept isolated behind interfaces and within pluggable components
- **Support for Dynamic and Open Systems:** Hybrid clouds change their composition and topology over time. They form as a result of dynamic conditions such as peak demands or specific Service Level Agreements attached to the applications currently in execution. An open and extensible architecture that allows easily plugging new components and rapidly integrating new features is of a great value in this case. Specific enterprise architectural patterns can be considered while designing such software systems. In particular, inversion of control and, more precisely, dependency injection5 in component-based systems is really helpful.

- **Support for Basic VM Operation Management:** Hybrid clouds integrate virtual infrastructures with existing physical systems. Virtual infrastructures are produced by virtual instances. Hence, software frameworks that support hypervisor-based execution should implement a minimum set of operations. They include requesting a virtual instance, controlling its status, terminating its execution, and keeping track of all the instances that have been requested.
- **Support for Flexible Scheduling Policies:** The heterogeneity of resources that constitute a hybrid infrastructure naturally demands for flexible scheduling policies. Public and private resources can be differently utilized, and the workload should be dynamically partitioned into different streams according to their security and quality of service (QoS) requirements. There is then the need of being able to transparently change scheduling policies over time with a minimum impact on the existing infrastructure and almost now downtimes. Configurable scheduling policies are then an important feature.
- **Support for Workload Monitoring:** Workload monitoring becomes even more important in the case of hybrid clouds where a subset of resources is leased and resources can be dismissed if they are no longer necessary. Workload monitoring is an important feature for any distributed middleware, in the case of hybrid clouds, it is necessary to integrate this feature with scheduling policies that either directly or indirectly governs the management of virtual instances and their leases.

Protein structure prediction in Cloud Computing:

Cloud computing is an emerging technology that provides various computing services on demand. It provides convenient access to a shared pool of higher-level services and other system resources.

Nowadays, cloud computing has a great significance in the fields of geology, biology, and other scientific research areas.

Protein structure prediction is the best example in research area that makes use of cloud applications for its computation and storage. A protein is composed of long chains of amino acids joined together by peptide bonds. The various structures of protein help in the designing of new drugs and the various sequences of proteins from its three-dimensional structure in predictive form are known as a Protein structure prediction.

Firstly primary structures of proteins are formed and then prediction of the secondary, tertiary and quaternary structures is done from the primary one. In this way predictions of protein structures are done. Protein structure prediction also makes use of various other technologies like artificial neural networks, artificial intelligence, machine learning and probabilistic techniques, also holds great importance in fields like theoretical chemistry and bioinformatics. There are various algorithms and tools that exist for protein structure prediction. CASP (Critical Assessment of Protein Structure Prediction) is a well-known tool

that provides methods for automated web servers and the results of research work are placed on clouds like CAMEO (Continuous Automated Model Evaluation) server. These servers can be accessed by anyone as per their requirements from any place. Some of the tools or servers used in protein structure prediction are Phobius, FoldX, LOMETS, Prime, Predict protein, SignalP, BBSP, EVfold, Biskit, HHpred, Phre, ESyired3D. Using these tools new structures are predicted and the results are placed on the cloud-based servers.

Data Analysis in Cloud Computing: Cloud analytics is a service model where one or more components of analytics are implemented in the cloud. These services could be part of a hybrid model, where some components are on-premise, or fully in the cloud. The cloud model allows organizations to scale analytics capabilities as their company grows. It also removes the burden of on-premise management and implementation. This service model is a growing aspect of modern business intelligence systems today.

Components of Cloud Analytics

Gartner defined six elements of analytics as:

- **Data sources:** These are the original sources of data which could include ERPs, CRMs, social media data, or website usage data. An example of a cloud-based data source would be Twitter sentiment data.
- **Data models**: Cloud-based data models make sense of and standardize how data points are related to each other. These are typically created with structured data types.
- **Processing applications**: These applications process large volumes of big data, as it's ingested into a data warehouse. Hadoop is a popular application for data processing.
- **Computing power**: Companies need raw computing power at scale to ingest, structure, clean, analyze, and serve business data.
- **Analytic models**: These mathematical models are closed functions used to predict outcomes and require strong computing power to create.
- **Sharing and/or storage of**: Data warehouses as a service enable organizations to quickly implement a modern analytics architecture and easily scale.

Fig: Components of Cloud Computing

Types of Cloud Analytics:

- **Public Cloud**: Public clouds offer organizations applications-as-a-service, such as virtual machines, storage, and data processing. They are available to the public and sit on a multi-tenant architecture where IT systems are shared, but data is not. This allows for companies to reduce cost and streamline IT management.
- **Private Cloud**: Private clouds are proprietary clouds dedicated to a single organization. They serve as extensions of an organization's existing IT infrastructure and are accessible only to the company. These are implemented when data privacy and security are a top priority. The downside to this implementation is its high cost.
- **Hybrid Cloud**: Hybrid clouds are a combination of public and private clouds. These implementations enable organizations to reap the benefits of on-demand IT infrastructure for non-sensitive data, but also maintain sensitive data in a private cloud.

Benefits of Cloud Analytics:

- **Enterprise data consolidation**: Large enterprises have many disparate data sources, and it's difficult to see how all the moving parts of an organization are working together if they're in different places. A cloud implementation can provide a data warehouse that's accessible to those who need the data. Companies can easily ensure data governance so only those who need the data get it. Another advantage of

consolidation is the ability to use online services to perform data mining and advanced analytics to create prediction models updated in real time.

- **Ease of access**: Data in the cloud can be accessed by both employees and external stakeholders, and governance controls can be put in place to control access to the right people. Managing access from disparate data sources requires more resources to manage internally and slows down innovation and insights.

- **Sharing and collaboration**: Increased ease of access and data consolidation lead to more sharing and collaboration between employees, which is why cloud analytics is a good fit for global companies. Employees can easily transfer files and collaborate in real time when they view analytics in the cloud from anywhere in the world. This is also conducive to the growing trend of a telecommuting work culture. Data discovery becomes an everyday part of the culture when cloud analytics is implemented within a BI system.

- **Reduced operating costs**: Setting up an in-house analytics solution can be extremely costly, especially for smaller organizations who may not have the internal skillsets to do so. With cloud analytics, organizations don't need to purchase hardware and provide continuous support, which can be very demanding and creates vulnerability if not properly executed. There are also on going upgrades which need to occur and can create unnecessary downtime. A cloud solution will take this burden off an organization's hands so they can focus on their core competency.

- **Scalability**: It's also easier to scale up capacity as the business grows, as the organization can simply increase its number of subscriptions as opposed to purchasing new hardware. It also ensures systems scale up accordingly if there is a sudden increase in demand for the analytics systems.

Challenges of Cloud Analytics:

- **Performance**
  While many cloud analytics solution providers are very reliable, an organization is still at their mercy when it comes to potential downtimes. Most vendors will promote their uptime rates, which should be considered when a vendor is chosen. For enterprises where 100% uptime is needed, a hybrid approach to cloud analytics may be the best approach.

- **Data security**
  According to RightScale, data security is the number one challenge cited by corporate cloud users. They fear data loss and leakage, and cloud implementation can create some vulnerabilities. However, as cloud adoption increases, data security becomes less of a concern as organizations become more familiar with managing risk. Training and certification can help improve security efforts to minimize this risk.

- **Finding the right skillsets for the job**

Companies have a hard time ensuring they have the right skillsets to build and manage a cloud analytics operation. The challenge is training and hiring to keep up with changing technology. There is a known shortage of cloud architects and developers according to a RightScale survey. However, many tasks are becoming more automated, so the value proposition for cloud analytics has improved. For example, tools exist to monitor usage patterns, resources, and automate backups.

- **Managing cost**
  The on-demand nature of cloud analytics allows organizations to scale as needed, but companies often underestimate how much they will use their cloud analytics capabilities. They also need to ensure safeguards are in place to shut down instances that are forgotten about. This can lead to unexpected costs. Additionally, hiring cloud experts can be costly because of the shortage of professionals with this skillset.

- **Migration**
  Migrating legacy systems such as data warehouses to the cloud can be time-consuming and expensive. There's also a risk of data loss if the migration is not done properly. It's important that companies consider all aspects of a platform migration and back up all data in a secure fashion.

Satellite Image Processing:

Satellite Image Processing is an important field in research and development and consists of the images of earth and satellites taken by the means of artificial satellites. Firstly, the photographs are taken in digital form and later are processed by the computers to extract the information. Statistical methods are applied to the digital images and after processing the various discrete surfaces are identified by analyzing the pixel values.

The satellite imagery is widely used to plan the infrastructures or to monitor the environmental conditions or to detect the responses of upcoming disasters. In broader terms we can say that the Satellite Image Processing is a kind of remote sensing which works on pixel resolutions to collect coherent information about the earth surface.

Majorly there are four kinds of resolutions associated with satellite imagery. These are:

- **Spatial resolution:** It is determined by the sensors Instantaneous Field of View(IFoV) and is defined as the pixel size of an image that is visible to the human eye being measured on the ground. Since it has high resolving power or the ability to separate and hence is termed as Spatial Resolution.
- **Spectral resolution:** This resolution measures the wavelength internal size and determines the number of wavelength intervals that the sensor measures.
- **Temporal resolution:** The word temporal is associated with time or days and is defined as the time that passes between various imagery cloud periods.
- **Radiometric resolution:** This resolution provides the actual characteristics of the image and is generally expressed in bits size. It gives the effective bit depth and records the various levels of brightness of imaging system.

Thus, Satellite Image Processing has huge amount of applications in research and development fields, in remote sensing, in astronomy and now even in cloud computing on a large scale.

CRM:

CRM stands for Customer Relationship Management and is software that is hosted in cloud so that the users can access the information using internet. CRM software provides high level of security and scalability to its users and can be easily used on mobile phones to access the data. Now a days, many business vendors and service providers are using this CRM software to manage the resources so that the user can access them via internet. Moving the business computation from desktop to the cloud is proving a beneficial step in both the IT and Non-IT fields. Some of the major CRM vendors include Oracle Siebel, Mothernode CRM, Microsoft Dynamics CRM, Infor CRM, SAGE CRM, NetSuite CRM.

Cloud CRM typically offers access to the application via Web-based tools (or Web browser) logins where the CRM system administrator has previously defined access levels across the organization. Employees can log in to the CRM system, simultaneously, from any Internet-enabled computer or device. Often, cloud CRM provide users with mobile apps to make it easier to use the CRM on smartphones and tablets.

Advantages:

Few advantages of using CRM are as follows:

- **Hassle-free installation**: A deep-rooted fear that CRM comes with complex installation process is no longer valid. A modern Cloud-based CRM is, in fact, "IT worry-free", and you can be up and running in no time (no business case required, but if you do need one, you can find it here). All you need is the internet connection. Then, you sign in online and use it. As simple as that. You don't have to pay for hardware, server and software maintenance. Nor do you need to have a permanent IT person on site, worry about complex installations, data migration, or even upgrades – all this is done remotely for you.
- **Seamless access**: Round-the-clock accessibility is by far the greatest benefit of a CRM in the cloud. Imagine that you need to make some urgent, yet game-changing sales calls while on-the-go, or send an amended sales proposal, or quickly find a contact's phone number or an e-mail when you are out of the office? Cloud CRM gives you access to the system from anywhere – in the office or if working remotely – on a train, in a café, at home; and on any device – be it a desktop, a laptop, a smartphone, or a tablet. Again, all you need is the internet. Your colleagues and you can access the centralized database at any time, even outside working hours if need be, which is particularly handy for any modern business. By always staying connected to the central database, Cloud CRM gives you the flexibility and freedom to do what you need to do when you need to do it.

- **Ease of use**: It can't get easier than Cloud CRM usage. First, you buy a software package at a fixed monthly price. All you need to do is log in with the access codes provided, and make sure you have a reasonably fast Internet connection at all times and a device you prefer to work on. As to the system maintenance, it is provided by the vendor and accompanied by a wide range of self-service online services.
- **Affordable product**: Another benefit is that this business-enhancing product certainly won't break your bank. No business likes to allocate big sums of money for a one-off purchase, and smaller, regular installments are usually preferred. Typically Cloud CRM operates on the pay-as-you-go subscription model, which requires minimal upfront investment and, as a result, reduces risk. Also, there are no hidden costs like buying additional hardware or licenses fees. What you pay is a set monthly fee for a Cloud CRM package, which can be as low as €37.
- **High security levels**: A very serious concern for any business using web-based information storage systems is, of course, security. As shown in the chart by Forrester Research below, the most common reason why businesses are wary of adopting a cloud solution, also known as software-as-a-service or (SAAS), is security concerns.