CMPE 281 Cloud Technologies
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Homework 1
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1. **Please review services provided by any one of the public cloud providers (e.g., Azure, Google, AWS, etc.) List one example per each cloud delivery model covered in lecture #1. Elaborate on your favorite cloud delivery model and why.**

<u>Review of Various cloud services provided by Amazon web service(AWS).</u>

Compute

<u>Amazon Elastic Cloud Compute(Ec2):</u>
Amazon Ec2 is a cloud computing service where users can rent virtual machines on demand and pay for them for their used time. Amazon Ec2 has a wide range of machines with various selections in terms of memory, storage, and operating systems.

<u>Amazon Elastic Beanstalk:</u>
Amazon Elastic beanstalk service provides users an easier way to host their web applications developed using different languages like java, .net, python, go and host them on popular web servers of industry like apache, Nginx.

Storage

<u>Amazon Simple Storage Service (s3):</u>
S3 is a simple storage service where users can store and retrieve vast amounts of data using different clients. Scalability, availability, security, and performance are critical features of S3. Popular storage and content distribution products heavily relied on S3 to build them. Examples are Netflix and dropbox.

<u>Amazon Elastic File System (EFS):</u>
Amazon Elastic File System is a flexible file system for computers on the cloud and on-premise. EFS practically comes with infinite space for general-purpose workloads. EFS data can parallelly be shared across multiple nodes in Ec2 with low latency.

Security:

<u>Amazon GuardDuty:</u>
Amazon Guard Duty provides security for data, workloads, and accounts. It is a one-click threat detection solution, and setup can be done quickly. It monitors all the resources and provides a report with advanced threat detection capabilities. It does not require the installation of any agent software on the workloads.

<u>Amazon Cognito:</u>
Amazon Cognito offers a straightforward solution to sign-up and sign-in to apps for users using user pools. It also manages and provides AWS credentials to access different AWS services through identity pools for apps, so the applications use those temporary credentials to perform operations on AWS services.

Network

Amazon VPC:
Amazon Virtual Private Cloud provides customers with control of their virtual network. It allows the customer to define and create resources on his logically defined virtual network. This virtual network is closely comparable to the usual data center network and has a highly scalable infrastructure.

Amazon Route53:
Amazon Route53 is a highly available and scalable domain name system(DNS) and DNS registration web service. Route53 is responsible for connecting the oncoming user requests through the internet to the web application/services running on the cloud and on-premise.

Database

Amazon DynamoDB:
Amazon DynamoDB is a NoSQL database service popular for its speed and flexibility. It comes with a performance of single-digit milliseconds at any scale. DynamoDB, by default, comes with robust security, in-memory caching, frequent backups, and various data tools that support simple import and export features.

Amazon Aurora:
Amazon Aurora is a fully managed relational database service with support for exceptional performance and availability features. It has inbuilt features supporting robust security, availability zones, replication and 15 read replicas.

Cloud delivery models and examples:

1. **IaaS(Infrastructure As A Service)** :

- Infrastructure as a Service is a delivery model which was built out to help companies migrate from managing data centers on-premise to the cloud. It helps companies to procure and use compute, network and storage resources over the internet on-demand. Iaas gives flexibility to companies, as they do not need to manage physical hardware for storage, network and compute resources but just use them on a pay-as-you-go model from cloud providers.
- Examples: Amazon Web Service, Google Cloud Platform and Microsoft Azure.

2. PaaS(Platform as a Service):

- Platforms as a Service is a cloud delivery model where a cloud provider provides a company's necessary development platform and tools to its customers through the internet, where customers can just focus on developing their application and not worry about maintaining and updating their hardware and software required for running development platforms and tools.
- Examples: AWS Elastic beanstalk, google app engine and heroku.

3. SaaS(Software as a Service):

- Software as a Service is a cloud delivery model where a company provides software/applications that can be used over the internet for its customers. This is the most restrictive cloud delivery model where customers do not have any control, insight over underlying infrastructure.
- Examples: Slack, Zoom, box, google drive, microsoft office 365 and apple icloud.

My Favorite cloud delivery model is Infrastructure as a service for the following reasons.

- IaaS reduces upfront costs for startups and entrepreneurs when they are working on a new use case and trying out different things. They do not have to worry about setting up a data center and physical hardware maintenance costs. IaaS eliminates the need for substantial upfront costs, creating a level playing field for entrepreneurs to pursue their ideas. IaaS allows developers to start again and get to a successful product in case the idea fails and needs work.
- Companies can quickly increase or reduce their costs based on their business trends using IaaS, as Iaas provides greater control over the infrastructure. Example success stories are the exponential growth of zoom, Cloudflare, DocuSign, Etc. When the world has stopped everything due to the COVID-19 pandemic but still conducted its business by relying on various cloud tools.
- IaaS provides all the features and controls that a traditional data center provides. Security policies and controls can be set on par with a physical data center. All this is provided on-demand in seconds to anywhere in the world and can be accessed from anywhere. Companies are not bound to a location and quickly migrate their data to any location, as many cloud providers have availability zones worldwide.
- It offers greater flexibility over PaaS, and SaaS for its customers, as developers have flexibility with customization and complete control over their infrastructure architecture and design it to best suit their needs. High Availability and Disaster recovery solutions provided by the cloud vendors helps companies to plan and design for catastrophic events and all this can be done with few lines of code without physical manual effort of setting up and maintaining servers and traveling to various locations.

2. Provide a summary of cloud computing evolution and provide your point of view or understanding of why it has become such a relevant topic in today's IT industry?

History of cloud computing:

The Inception of cloud computing started in the 1960s when John McCarthy stated that "computing can be a utility like telephone system" at his MIT Centennial Speech. Right now, we are almost close to that vision with cloud computing services like amazon web services, google cloud platform and microsoft azure providing pay-per-use computing resources on-demand over the Internet. The vast features of cloud computing currently support entrepreneurs, companies, organizations and governments to build projects that literally don't have limitations on scale and size. Even though the idea of cloud computing was first visioned in the 1960s, to reach the current stage it took around 40 years and cycles through various different iterations of concepts. Cloud computing rose to its popularity after so many inventions, some of the substantial ones are the internet, web services, distributed systems, and Virtualization. The first commercialized cloud service was provided by salesforce in 1999, which provided customer relationship management software as a service to its customers. Later amazon.com started providing its platform as a service and saw the market for it and started amazon web services in 2006 and started providing Ec2 which comes under the delivery model of Infrastructure as a Service. Consequently, all big companies like google, Microsoft, oracle, IBM started their own cloud businesses in 2000s and started providing cloud services and also started collaborating with universities to further research in cloud computing by sharing resources to build systems that can help to share an infinite amount of computing power over the internet.

There are 3 phases in the evolution of cloud computing.

- Idea phase began in the early 1960s with the vision of John McCarthy and introduction of utility and grid computing.
- Pre-cloud phase started in 1999 and lasted until 2006, where application as a service over the internet was popular.
- The cloud phase started in 2007, when IaaS, PaaS, and SaaS were defined officially.

Cloud computing is an improved and collective iteration of various other technologies. Lets see some of the substantial technologies that helped the evolution of cloud computing.

1950s Mainframe Computers: Mainframe computers allowed multiple users access to a central system through access points and terminals. But it's cost-ineffective to buy a terminal for every user. Also, many use cases do not suit the mainframe due to its cost. Large organizations still use this for critical applications because these have zero downtime and high fault tolerance. We first had mainframe computers which used to store data on tapes and even Kilo Bytes of storage used to cost millions of dollars when it was first built and they are cost inefficient and mostly used for research and critical use cases. Due to the cost inefficiency of these mainframe computers, cluster computing emerged.

1960s ARPANET: In the late 1960s, the US Department of Defense developed ARPANET(Internet's Predecessor) which allowed linking of computers in different locations and allowed remote access of resources, which opened up gates for many inventions later. This was developed for research purposes. This is later grown into the internet as we know it today.

1970s Distributed Computing: In a distributed system, a task can be distributed across multiple computers connected in a network. These computers divide the work and collaborate to complete a compute task more efficiently than a single device. Email is one of the earliest examples of a large-scale distributed system.

1970s Cluster computing: Cluster computing is combining multiple computers into a single entity and performing tasks in unison. In this way, we can easily add and delete a node, solving some of the cost problems of the mainframe, but the geographical limitations are still persistent with cluster computing.

1990s Grid computing: grid computing coined from the electric grid in the early 1990s, where computing power can be used from a grid like the electricity. grid computing was made possible with the use of the internet. In grid computing, there are multiple systems performing multiple tasks and dealing with multiple files.

2000s Utility computing: Utility computing was the invention that was made from the need of pay per use, where users had flexibility to solicit computing, storage, network resources on-demand and pay-per-usage mode. This allowed users to rent resources when they need them and cancel when they don't, contributing to the rise of cloud computing.

The 1960s to 2020s Virtualization: Virtualization is a critical technology for the rise of cloud computing as this has allowed the separation of computing resources from the physical Infrastructure. Virtualization allows multiple operating systems, software, and application under the same Infrastructure by providing efficient isolation from the underlying resources. Virtualization is also an evolving technology like cloud computing, as it has been through its iterations since the 1960s. Currently relying on foundations of web service, we are seeing the growing popularity of containerization and orchestration using technologies docker and Kubernetes.

Why has cloud computing become such a relevant topic in today's IT industry?

Cloud computing has become a relevant topic in the IT Industry due to its various characteristics and broad adoption across the industry, with almost 90% of companies using one or other forms of cloud product/service. Some of the key characteristics of cloud computing are as follows.

Costs: Cloud computing will eliminate the capital expense of buying hardware and software upfront. Maintaining data centers and keeping them up and running costs a lot of money in terms of human, Infrastructure, and electricity costs.
It is often inefficient to manage huge rooms of servers without proper utilization, and patching servers for software updates also costs money. Companies can save on upfront and maintenance costs by adopting cloud computing and moving to pay-per-use models.

Scalability and elasticity: Cloud computing resources are self-provisioned on-demand and can provision numerous computing resources in seconds. Running your company infrastructure on the cloud gives power to summon huge data centers in a matter of seconds. A company can hugely increase its costs as well as decrease them in a blip based on its business trends.

Security: With its broad set of policies, checks, and controls provided by cloud computing, it has an overall security posture that is well strengthened and helps companies to protect their data, applications and Infrastructure against any cyber threats.

Innovation and Talent: Businesses can mainly focus on their product and services and not worry about maintaining Infrastructure. It enables businesses to innovate faster and grow to a greater scale by keeping their talent focused on the problem at hand and its business use case.

Agility: An organization can quickly scale and de-scale based on its demand. It can make those changes in minutes to save up costs in case of a business downturn and expand the business in seconds using powerful tools provided by cloud computing.

Location Independence: Using the cloud, we can provision Infrastructure literally from anywhere in the world as cloud providers maintain data centers worldwide and connect to them from anywhere using any device. It gives greater location independence for companies and does not make them bound by a location as they can connect to it anywhere.

Reliability and Availability: Reliability means having the service without any errors. Availability means having a service up and running without any outages. Reliability and availability are important for customers as it is required for them to offer their service without any issue and any performance problems round the clock. By running their services on cloud Companies can avoid costs of frequent upgrading and patching their infrastructure and buying new hardware, as the cloud vendor takes care of it. Even any security patches can be reliably taken care of by a cloud vendor as they have dedicated engineers working on it who have specialized knowledge on it.

Multitenancy: Allows systems and resources to be shared across users, enabling efficient usage of resources and thus lowering customer costs.

Disaster Recovery: Companies can define and set up disaster recovery for their services using the cloud and offered by the cloud providers to their customers to have the perks of business continuity and disaster recovery in case of unforeseen events.

Today's IT industry's common theme is migrating to the cloud. Most companies rely on the cloud to provide services and conduct business. During the COVID-19 pandemic, most of the world's workforce telecommuted to work and could fulfill their duties using various cloud services. The broad adoption of cloud computing is helping people across the world build products for people worldwide. There are so many success stories of cloud computing. Some popular ones are Netflix, Salesforce, Dropbox, Workday, etc. Cloud computing market size is 454 billion dollars in 2021 and expected to grow to 950 billion dollars by 2026. There are many things that are made possible by cloud computing and made life easier for us and helped us get through the COVID-19 pandemic by its powerful tools. According to me, cloud computing will stay relevant in years to come and make more things a reality.

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