PRINCIPLES OF CLOUD COMPUTING

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Abstract: Cloud computing is the technology that is revolutionising various industries today. In the past decade, it has impacted Gaming, Automotive, Education, Research, Financial, Healthcare, Legal, Media Production and various other industries. It has made small businesses easier to run and flourish. It is impacting our lives every day. As of today, the world is going through the COVID-19 pandemic and various cloud-based technologies have surfaced and shown us the potential uses and power of Cloud. We must learn about cloud and its potential for its further growth, development, and adoption.
Keywords: Cloud computing, Serverless Computing, Virtual Machines, Cloud Providers

I. INTRODUCTION

Cloud [1] is someone else's computer that is available for renting remotely and can be accessed through the internet. Cloud servers are located in data centres all around the world. Cloud allows the user to access the same files and applications from almost any device from anywhere in the world as the storage and computing take place in data centres.

1.1. What is cloud computing?

Cloud computing [2] refers to renting resources, like compute power or storage space, on some other company's computers. You only pay for what you use. The company providing these services is referred to as a cloud provider.
The cloud provider is responsible for the maintenance of physical hardware required to execute your work, and for keeping it up to date. The cloud computing services offered tend to vary by cloud provider.

II. CLOUD COMPUTING SERVICES

For most companies, the setup and maintenance of its servers are not possible. Cloud computing aims to make running a business easier and more efficient, whether it is a small start-up or a large enterprise.
The two most common services that all cloud providers offer are, compute power and storage.
Compute Power [3]
There are generally three compute options: Virtual Machines, Containers and Serverless
computing.

2.1. Virtual Machines

When you are building a product on cloud you can choose how much work do you want to do or how much responsibility for the resources do you want. If you want to have more control and responsibility for maintenance, you could create a virtual machine. A Virtual Machine on the cloud is an emulation of a computer which is remotely accessed through your computer. Each Virtual Machine includes and operating system like Linux or Windows. You can then install whatever software you need to run your task. The major advantage of a virtual machine is that you do not have to buy any of the hardware or install the operating system.

2.2. Containers

Containers are very similar to Virtual Machines except they do not require an operating system.
The application and its dependencies are packed into a package called a "container" and then a standard runtime environment is used to execute the app.
Docker [4] is a standard open-source project that is used to create, deploy, and run applications using containers.

2.3. Serverless Computing

Serverless computing is an approach you go for when you want the least control over the server(s). It lets you run your project without creating, configuring, or maintaining a server. The main idea behind serverless computing is that your application is broken down into separate functions that run when triggered by some action. This type of computing is ideal for the tasks that are automated – for example using chatbots which are triggered by a specific keyword or tasks.

2.4. Storage

Most applications need storage to read or/and write data for various purposes. For example – storing user data, images, videos. Most Cloud Providers offer such services that can take care of all your data storing needs.
The advantage of using cloud storage is you can scale according to your needs. If you need more storage at any given time, you can pay more and expand your available storage.

III. BENEFITS OF CLOUD COMPUTING

One of the best things about cloud computing is that it is not an all or nothing approach.
Companies can choose to use cloud resources as much, or as little, as necessary to fulfil their needs.
Let us learn some of the benefits of cloud computing.

3.1. It is cost-effective

Cloud computing provides a pay-as-you-go model, which means that you only have to pay for the resources that you use. This model brings with it many benefits, including.
* There is no upfront cost
* You do not need to buy hardware and infrastructure
* You do not need to maintain the hardware
* You can stop paying for resources that are no longer needed

* It leads to better cost prediction

3.2. It is scalable
You can increase or decrease the resources and services at any given time according to your needs. You can scale your resources both vertically and horizontally according to your need.
Vertical scaling, also known as "scaling up", refers to adding resources to increase the power of an existing server. For example – adding more GPUs or adding more memory.
Horizontal Scaling, also known as "scaling out", refers to adding more servers that function
together as one unit.

3.3. It is reliable
Cloud providers often provide services like data recovery, disaster recovery and data
replication services, as data is the most crucial information and cloud providers help to secure it. It is achieved through data redundancy. So, if one component fails, a backup component will take its place. This is known
as fault tolerance.

3.4. It is secure
* You have physical security – The data centres are equipped with walls, cameras, security
personnel, gates, and so on to protect their assets.
* You have digital security – The cloud providers make sure that your data is secure from any malicious threats and unauthorised users.

3.5. It is global
Most cloud providers have fully redundant data centres in various regions throughout the globe allowing you to replicate your services into multiple regions for redundancy and locality.

3.6. It is current
The cloud hardware is maintained and upgraded by the cloud providers and you can focus on what matters: building and deploying applications.

3.7. It is elastic
Your cloud computing system can compensate for workload changes due to spike or drop-in
demand by automatically adding or removing resources.
For example – Imagine your website experiences a sudden spike in traffic due to some reason. The cloud will automatically allocate more computing resources to handle increased traffic. When the traffic is normalized the cloud will automatically deallocate additional resources to minimize cost.

IV. MAIN SERVICE MODELS OF CLOUD COMPUTING [5]

4.1. Software-as-a-Service (SaaS)
SaaS applications are the applications that are hosted on cloud servers and users access then over the internet. SaaS is just like renting a fully furnished house: you get to use it as your own, but it is still owned by your landlord.
Example: Google Apps, Dropbox, Salesforce

4.2. Platform-as-a-service (PaaS)
PaaS is a kind of service in which the vendor offers you everything you need to build your application like development tools, infrastructure, operating system. You get a complete environment to build, test and deploy your application.
Example: Microsoft Azure, Heroku, Google App Engine

4.3. Infrastructure-as-a-Service (IaaS)
It is the most flexible kind of cloud service. In this kind of service, a company rents the infrastructure and storage they need from the cloud vendor and then use that cloud infrastructure to build their application.
IaaS is like leasing land on which you can build whatever you want.
Example: Digital Ocean

4.4. Function-as-a-Service (FaaS)
Function as service is also known as serverless computing. The main idea behind serverless computing is that your application is broken down into separate functions that run when triggered by some action.

V. CLOUD DEPLOYMENT MODELS

5.1. Private Cloud [6]
In a Private Cloud, you create a cloud environment in a data centre that is completely dedicated to your organization. This allows simulation of public cloud to your organization, but you are completely responsible for the maintenance of hardware and the software services you provide.

5.2. Public Cloud [7]
Public cloud service is run by an external vendor. Using virtual machines, individual servers are shared by multiple organizations.

5.3. Hybrid Cloud
Hybrid cloud is an assortment of Public Cloud and Private Cloud. An organization might use public cloud for one service and private cloud for some other service.

VI. CLOUD IN VARIOUS INDUSTRIES

6.1. Gaming Industry
Cloud gaming/Game streaming is a type of online gaming in which the games are run on the clouds in the data centre and the video is streamed on the user's device. It eliminated the need for purchasing powerful hardware to play graphics-intensive games. This technology when first appeared had a huge obstacle of latency.

Latency: It is the delay between user input and system response
But with the emerging improvement in the processing power and internet bandwidth, this latency is diminished to the point that most of the people might not even notice it.
The major game streaming providers right now in the

industry are Google Stadia [8], NVIDIA GeForce Now [9], Microsoft Project xCloud [10] and PlayStation Now [11].

6.2. Education Industry

This is the industry that is recently been severely affected by the global pandemic. A student unable to attend Schools/Colleges is being taught through online classes that are taking place on cloud-based streaming applications.
Applications like Google Meet [12], Zoom [13] and Microsoft Teams [14] are allowing students and various businesses to do online video conferencing.

6.3. Research

Cloud is also helping in Research and Development as they provide compute power for running simulation which are crucial in any kind of research.
Cloud providers like Microsoft have provided Microsoft Azure's compute resources for projects like Folding@home. Folding@home[15] is a kind of distributed computing project. It is used in simulating protein dynamics, including the process of protein folding and the movements of proteins implicated in a variety of diseases. This is also helping scientists to research COVID-19. [16]

6.4. Healthcare Industry

Healthcare industry is known to be slow in the transition to new technologies due to fear of inadequate security and the time it would take to switch. Cloud makes it easy to set up the networking infrastructure of any organization as you can choose to have as much or as little control of the infrastructure and you do not have to worry about upgrading or maintaining the hardware.

6.5. Legal Industry

The legal industry relies heavily on the ability to store large quantities of files for a long period. This data needs to be remain accessible and secure. Cloud allows advanced backup, failover, recovery, and computing to be accessible to anybody. The legal firms should and are taking advantage of this technology.

6.6. Media Production Industry

Media Production companies need to store huge amounts of data at any given time. With improving qualities of cameras, the media production companies require more and more storage to store their media files. Cloud is very useful as most Cloud Providers offer such services that can take care of all the data storing needs.
The advantage of using cloud storage is it can scale according to the needs. If you need more storage at any given time, you can pay more and expand your available storage.
Moreover, cloud computing also allows Media production houses to rent computing resources for video editing.

VII. CONCLUSION

Cloud computing allows the growth and development of all kinds of businesses as you can spend more time on what matters and less time managing the underlying details. It is cost-efficient, scalable, reliable, secure, global, current and elastic. It is impacting Gaming, Automotive, Education, Research, Financial, Healthcare, Legal, Media Production and various other industries. It has endless uses unique to the type of user. We must learn about cloud and its potential for its further growth, development, and adoption.

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