Course: Cloud Computing

Week12: **Emerging trends in cloud computing**

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Learning lecturer outcome

- At the end of this lecture, you will be able to;
- Understand the different trends in cloud computing
- Understand the other related and enabling technologies in cloud computing

Emerging trends in cloud computing

- **ML and AI Cloud**
- Machine Learning uses complex supervised and unsupervised algorithms in order to get to results. It uses historical data to analyze patterns and then based on that, it generates the results or performs the intended task according to the algorithms. It is an application of artificial intelligence which provides the system to learn from experience and have the ability to learn automatically (Rastogi, 2018).

Emerging trends in cloud computing

- Machine Learning is the ability of the machines to learn from data. The ML makes computers to discover how to do tasks without being programmed explicitly. It steadily makes its unique way in different kind of areas in enterprise applications such as fraud detection, business intelligence and customer support. Microsoft, Amazon, and Google made significant investments in Machine Learning and Artificial Intelligence (AI).
- As volumes of data increase, services and their usage also increases, which force the cloud providers to provide better accuracy for the predictions. With the use of AutoML, a machine learning pipeline with limited computational budgets can be built. AutoML offers an extent territory to temperamental previously trained models vs. training required models from raw information (Pandian, 2020)

Emerging trends in cloud computing

- **Using machine learning in cloud computing**.
- Different types of predictions are supported by many open-source and proprietary machine learning systems. Public clouds provide inexpensive and low-priced data storage. One can hold verifiable databases or the input of the data as storage systems into the machine learning-enabled applications

Using machine learning in cloud computing

- Machine training systems are increasingly growing due to cloud support; ML and AI systems are accessible through various distribution systems such as GPU-based computing, cognitive computing, ML model management, automated machine learning, and ML model serving, and, unlike other cloud-based facilities. Google Cloud AI, Azure machine learning, and Amazon machine learning are major MLaaS cloud amenities that enable quick model instruction and implementation.

Artificial Intelligence

- **Artificial Intelligence** refers to the ability of a machine to learn and act accordingly for which, machine learning models can be used. These models learn patterns and trends from data
- Using of Artificial intelligence in cloud computing. Cloud computing is transformed by using AI. The next generation cloud computing models are built around AI capabilities. For better digital innovation, AI and cloud computing are the perfect matches. AI's cognitive capabilities and machine learning thrive on massive volumes of data, which become scalable and instantly accessible in a cloud environment

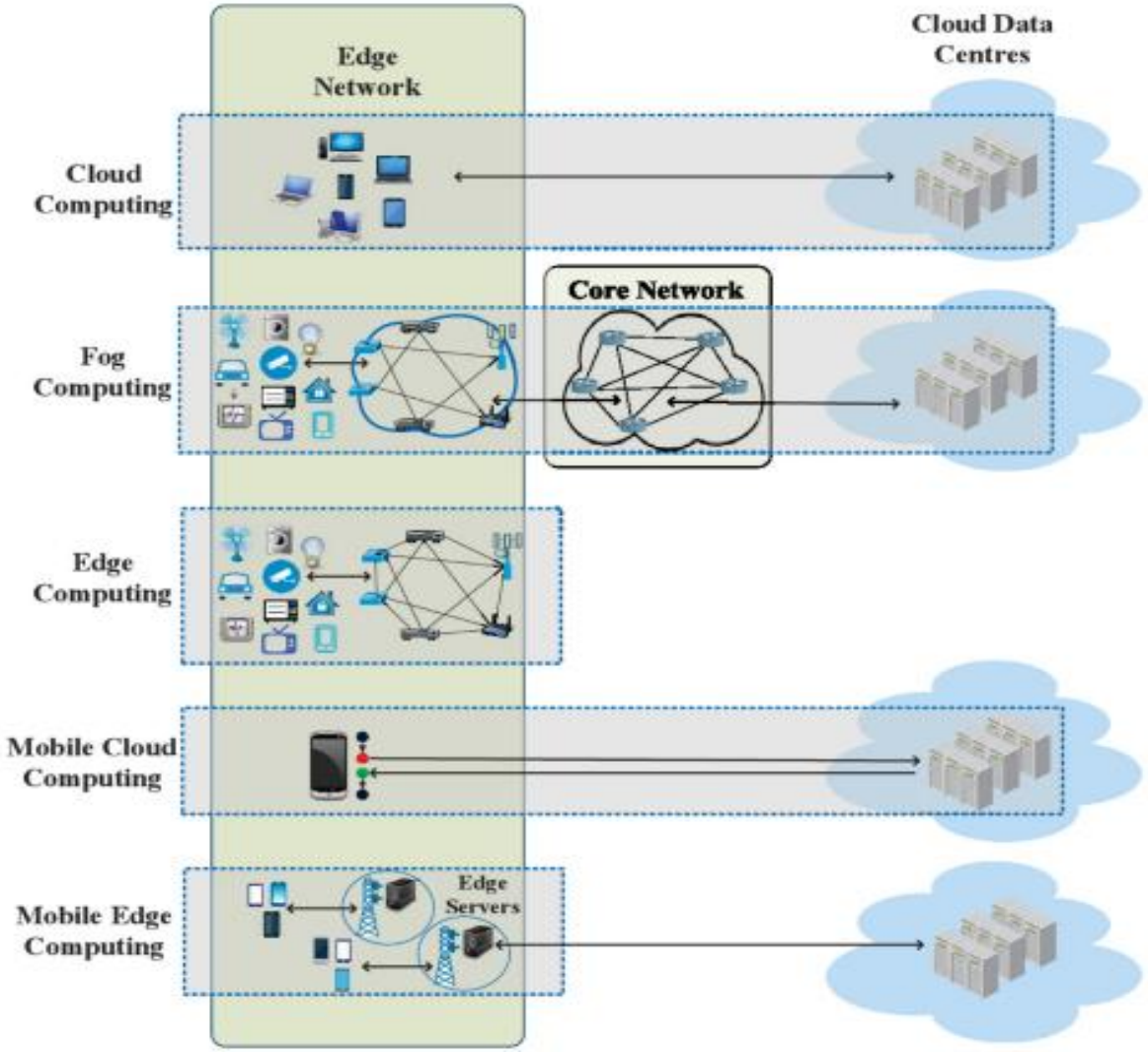
Emerging trends in cloud computing

- **Edge computing**
- Involves moving cloud resources from the data centers to network edge in order to enhance the system's performance, Edge computing has greatly improved and resolved many of the problems associated with cloud computing, since it provides elastic resources to end users at the edge of the network, at a time when cloud computing could only provide resources distributed and hosted on cloud data center in the core network

Emerging trends in cloud computing -Edge computing

- Edge Computing refers to the enabling technologies allowing computation to be performed at the edge of the network, on downstream data on behalf of cloud services and upstream data on behalf of Internet of things services
- Edge Computing refers to applications, services, and processing performed outside of a central data center and closer to end users.

Edge computing with other layers of computing-



(Das, 2023)

Edge computing And IOT

- IOT devices can be used as edge nodes to provide services. As the number of IOT devices continues to grow, IOT and edge computing are likely to become inseparable.

Edge computing And Fog Computing

- Edge computing can also benefit from the fog computing layer, as the resources capabilities on the fog layer are relatively stronger than those on the edge layer. Edge computing and fog computing are sometimes used interchangeably, or considered as one layer. However, edge computing focuses more on the side of the things, while fog computing focuses on the side of infrastructure.

Edge computing And Fog Computing

- Fog computing serves as mediator, linking cloud and end devices, bringing storage and networking resources and processing closer to the end devices respectively.
- The cloud computing layer consists of multiple high-performance servers and storage devices. Among all layers, the cloud computing layer has the highest computation power and storage capacity.

Internet of things (IOT)

- Internet of things (IOT) is a network of physical objects. The internet is not only a network of computers, but it has evolved into a network of device of all type and sizes , vehicles, smart phones, home appliances, toys, cameras, medical instruments and industrial systems, animals, people, buildings, all connected ,all communicating & sharing information based on stipulated protocols .

Internet of things (IOT)

- Cloud computing and IOT are work towards increasing the efficiency of everyday tasks and both have a complementary relationship. IOT generates lots of data while on the other hand, cloud computing provides a way for this data to travel.
- This IOT and Cloud computing combined feature is a vital parameter for user security and privacy. Using Cloud platform, IoT developers can store the data remotely and access easily

Internet of things (IOT)

- (Patel, 2016)

Big data

- Big data has resulted from the flow of huge data into the cloud; it refers to large and complex datasets that are difficult to manage and process
- **Characteristics that describe big data**
- **Volume**: Enormous or massive data, ranging from terabytes to petabytes and beyond coming from various sources like social media applications, databases, management information systems, sensors, machines, transactions, and interactions, resulting into large quantities of data.

Big data

- **Velocity**: Big data is generated at high speed, all the time, so to say in real-time. Examples of high-velocity data sources include social media streams, sensor data from IoT devices, and financial market data like forex trade.
- **Variety**: Big data comes in diverse formats and types, including structured, semi-structured, and unstructured data in form of text, images, videos, sensor data, and log files.

Block chain

- Block chain; is a distributed transactional database that is managed by network agreements and secured by advanced cryptography. Block chain provides a decentralized, open, fault-tolerant transaction mechanism
- To users, Block chain is some kind of data structure that consists of an ever increasing number of blocks linked together through cryptography. Each block includes a cryptographic hash of the previous block, a timestamp and data that users wish to exchange throughout the network.

Block chain

- Data blocks are shared among users and not saved on a centralized server. The chain of blocks continuously grows when new blocks are appended into it and this change will be reflected to all users within the chain.
- Block-chain as a Service (BaaS)
- The Block-chain-as-a-service (BaaS) term refers to a combination of the Block-chain and cloud computing that allows clients to use cloud computing solutions to create, host, and manage Block-chain applications such as smart contracts and other Block-chain network functions

Block chain

- BaaS service is based on the Software-as-a-Service (SaaS) model and works in the same way. Many BaaS service providers offer the essential Block-chain networks and the required infrastructure for a fee. After the client creates his system, the service provider manages the complicated back-end procedures for the client. The BaaS operator provides several services like managing resource allocation, application hosting, data security characteristics, and bandwidth management.

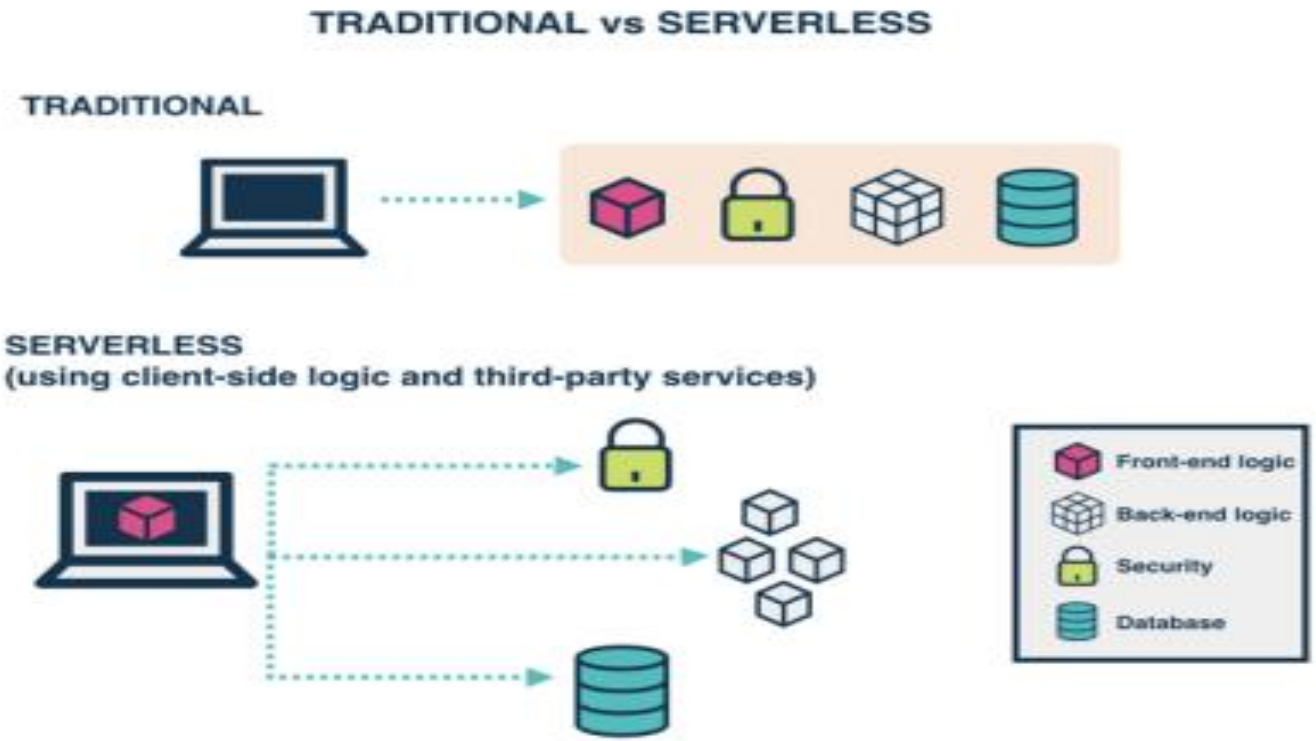
Server less computing

- Server-less computing, also known simply as "server-less," represents a significant transformation in how applications are designed, deployed, and executed. Contrary to traditional methods where developers manage servers, server-less allows them to focus only on coding, trusting cloud providers with infrastructure responsibilities.

Server less computing

- Despite its name, server-less computing does not imply the absence of servers. Instead, it emphasizes the developer's detachment from server management, allowing them to focus exclusively on the application's functionality. This approach relies on cloud service providers to dynamically allocate and execute backend code, billing users based on actual compute processes rather than predetermined server capacity Traditional computing models necessitated intricate involvement in infrastructure setup, scaling, maintenance, and updates.

Server less computing



- (Thatikonda, 2023)

Server less computing

- Two principal components of server-less architectures are Function as a Service (FaaS) and Backend as a Service (BaaS). FaaS involves executing code snippets in response to events, eliminating the need for long-running server processes. Examples include AWS Lambda and Azure Functions

Advantages of Server-less

- Computing Cost Efficiency; server-less computing is cost efficiency. The pay-as-you go model ensures businesses are billed based on actual resource consumption rather than allocated server capacity
- Scalability Server-less computing offers inherent scalability. Cloud providers automatically handle scaling based on the application's demand, ensuring seamless operation without manual intervention

Advantages of Server-less

- Improved Development Speed
- Server-less architectures speed up software development. Without the need to manage infrastructure, developers can focus solely on writing and refining code, drastically reducing development cycles

Limitations and Concerns of Server-less Computing

- Cold Start: A cold start occurs when a new instance of a function is initiated, and there's a latency involved before the Function begins executing, primarily because the environment needs to be set up from scratch
- Vendor Lock-in: adopting server-less architectures often means aligning with a specific provider's toolset, infrastructure, and services. This dependence can lead to vendor lock-in, where migrating to a different platform becomes time-consuming and costly due to incompatible interfaces and configurations

Limitations and Concerns of Server-less Computing

- Limited Customization and Control
- As server-less platforms manage the underlying infrastructure, they often impose certain restrictions on runtime environments, memory limits, and execution durations. This can limit the scope for customization, which might be essential for some niche applications
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Other related/enabling technologies

- **Internet**
- The internet is a large connection of multiple TCP/IP networks, connecting millions of computers around the world. Every networked computer is a part of it (Internet).
- The internet enables the transfer of information in a very short time (seconds)
- Data is able to travel across the internet by the support of the internet infrastructure, tools, protocols and technologies that interconnect various Internet devices

Other related/enabling technologies

- The Internet provides several different basic tools for data sharing.
- **Internet Infrastructure** – The Internet has an infrastructure at the backend which include; Network Access Points, backbones and thousands of ISPs (Internet Service Providers.
- The backbones (Backbones are fiber optic trunk lines with multiple fiber optic cables) connect together through network access points (NAPs).

Other related/enabling technologies

- **Internet Topology** –Built in a Tiered model. From bottom to-top it consists of end systems (PCs, workstations, etc.) connected to local Point of Presence (POP) of the Internet Service Providers (ISPs). The local ISPs are in turn connected to regional ISPs, which in turn connect to the backbone through NAPs.
- **Architecture** Internet uses client/server model for running its basic tools such as Telnet, FTP, Gopher, E-mail and World Wide Web and others. In the client/server model, all computers on the Internet are either clients or servers.

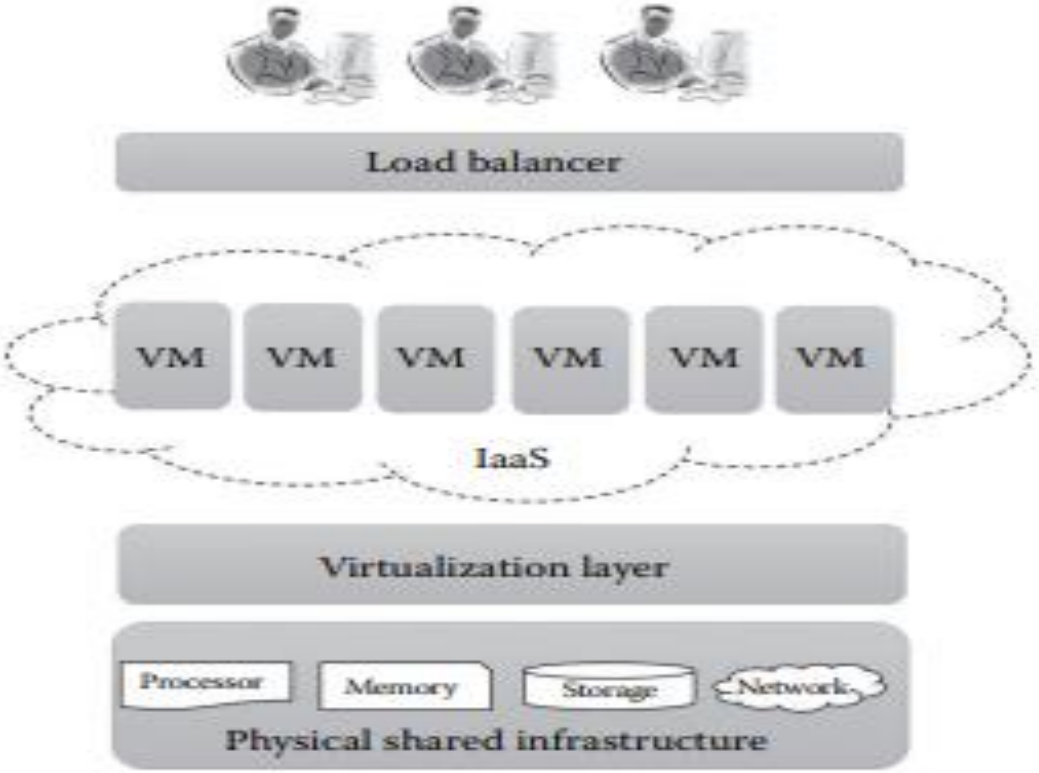
Internet

- **ISP (Internet service provider)** is an organization that provides connectivity/access to the Internet.
- The role of an ISP is to take a local customer from the Point of Presence of the ISP to a network access point (NAP).

Virtualization

- Refers to the act of creating a virtual (rather than actual) version of something, including but not limit to virtual computer hardware platform, operating system, storage device or computer network resources.
- In virtualization a single physical machine (hardware) is configured to use multiple Virtual machines within it (Buyya, 2013)

Infrastructure as a service

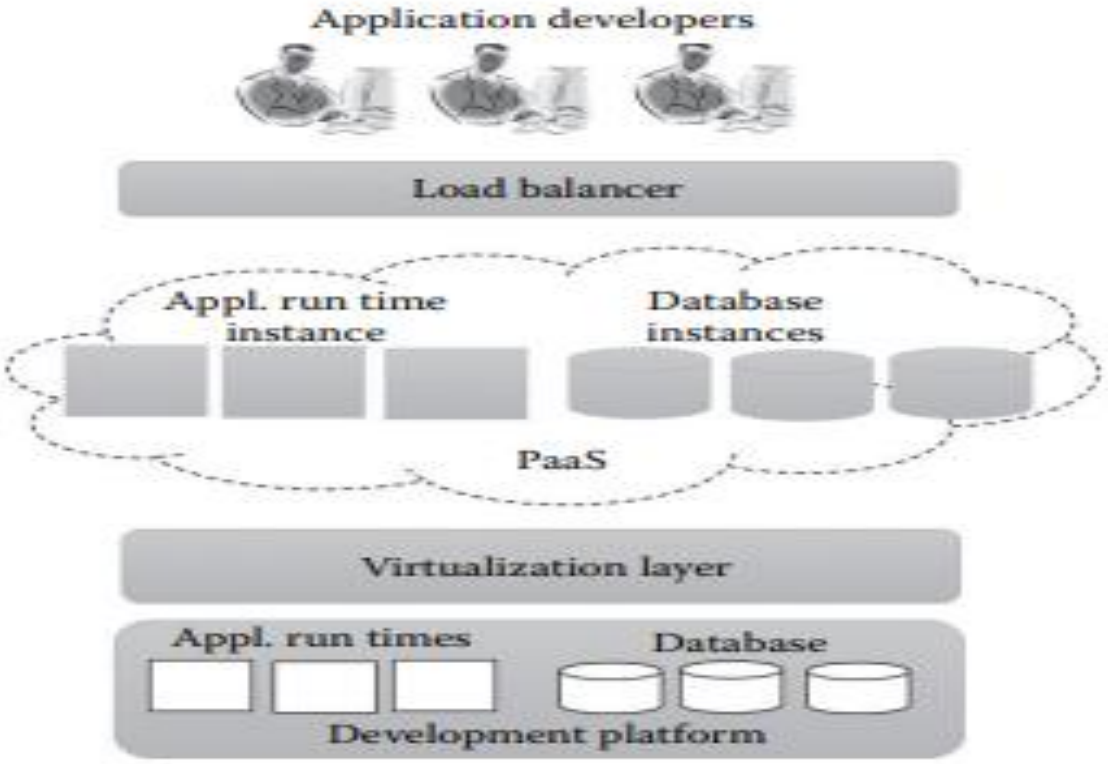


- (CHANDRASEKARAN, 2015)

Infrastructure as a service

- The IaaS service offers virtual memory, virtual processors, virtual storage, and virtual networks to run the VMs. The IaaS service utilizes the memory, processor, storage, and network virtualization of the underlying infrastructure.
- The IaaS layer uses the hypervisors to abstract the underlying resources for the VMs. The virtual data center will not be simply referred to as a cloud data center.

Platform as service

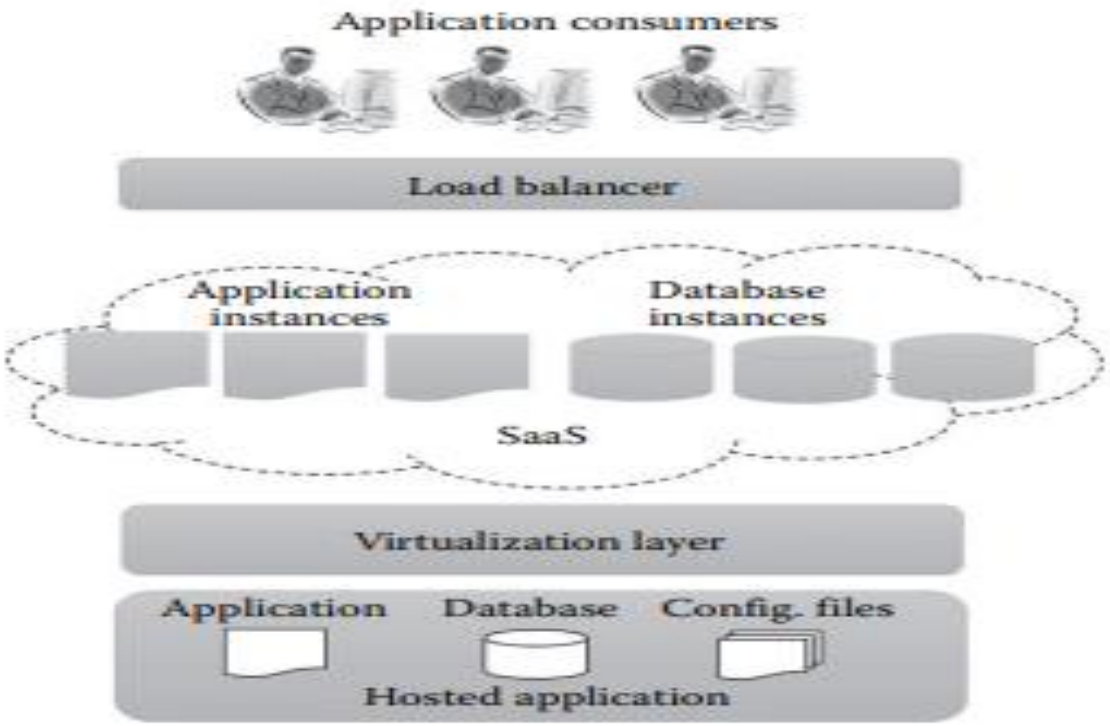


- (CHANDRASEKARAN, 2015)

Platform as service

- The PaaS services utilize the OS-level, database-level, programming language–level virtualization to provide the virtual development platform to the end users. Generally, the PaaS providers will provide a variety of client tools such as Web CLI, REST APIs, and Web UI to the developers for accessing the virtual platform

Software as a service



- (CHANDRASEKARAN, 2015)

Software as a service

- SaaS utilizes application-level virtualization to deploy the application. The SaaS application allows multiple customers to share the same instance of an application. This technology is popularly known as multitenancy

Load balancing in cloud computing

- Load balancing is the technique of distributing the load between various resources in any system. Work-load then requires to be distributed over the resources in cloud-based architecture, so that each resource does almost the equal amount of work at any point of time.

Load balancing in cloud computing

- Cloud Load Balancers manage online traffic by distributing workloads between multiple servers and resources automatically. They maximize output, reduce response time, and avoid overload.
- In a distributed system environment, it is the process of distributing load among various other nodes of distributed system to improve both resource utilization and job response time.

Load balancing in cloud computing

- A good load balancing algorithm should avoid overloading or under loading of any specific node. But, in case of a cloud computing environment the selection of load balancing algorithm is not easy because it includes additional restraints like security, reliability, throughput etc. So, the main goal of a load balancing algorithm in a cloud computing environment is to improve the response time of the job by distributing the total load of system.

Parallel computing

- **Parallel processing involves** Processing of multiple tasks simultaneously on multiple processors. The parallel program consists of multiple active processes (tasks) simultaneously solving a given problem. A given task is divided into multiple subtasks using a divide-and-conquer technique, and each subtask is processed on a different central processing unit (CPU).

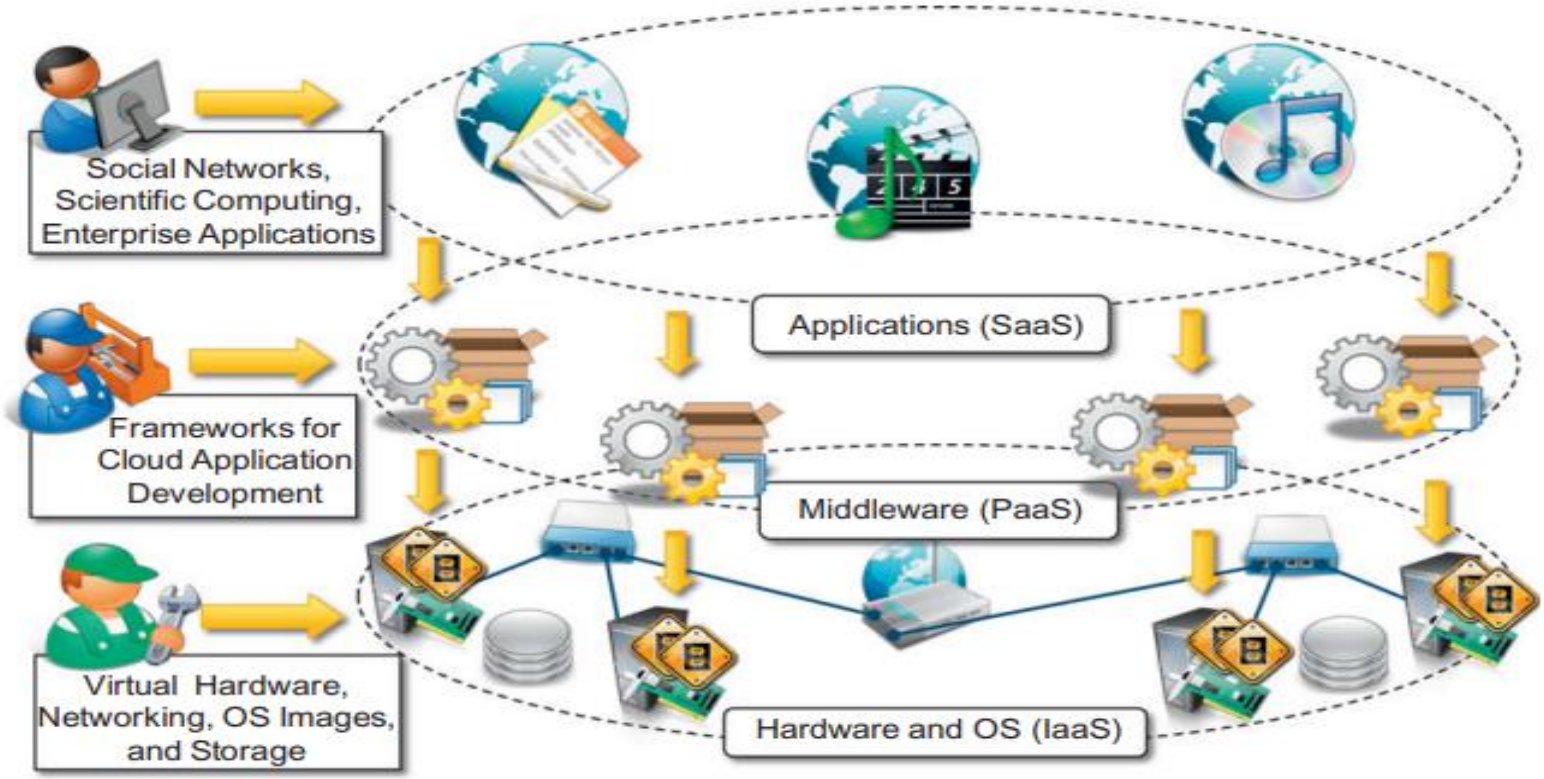
Parallel processing involves

- Programming on a multiprocessor system using the divide-and-conquer technique is called parallel programming. Parallel processing provides a cost-effective solution to this problem by increasing the number of CPUs in a computer and by adding an efficient communication system between them. The workload can then be shared between different processors.

Distributed computing

- A distributed system is a collection of independent computers that appears to its users as a single coherent system. Communication is a fundamental aspect of distributed computing. Since distributed systems are composed of more than one computer that collaborate together, it is necessary to provide some sort of data and information exchange between them, which generally occurs through the network. A distributed system is one in which components located at networked computers communicate and coordinate their actions only by passing messages.

Cloud computing distributed system



- (Buyya, 2013)

Summary of previous weeks

- In the previous weeks we were able to look at a number of concepts;
- Cloud Services and Cloud deployment models
- Data storage and networking in the Cloud
- Virtualization and Cloud architecture
- Scalability and performance in the Cloud
- Cloud security and Migration into the Cloud
- The concept of mobile cloud computing

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