Assignment no. 1

Q.1) Recent trends in cloud computing and related technologies.

1. Edge computing

Edge computing is an alternative approach to computing and storing data in the cloud environment. It is an emerging cloud trend that involves building localized data centers for computation and storage at or near where it's being gathered, rather than on a central location that might be thousands of miles away.

This kind of decentralized computing infrastructure helps in decreasing latency issues and increasing application performance. Since the data and resources are closer to the end user's device, it can be processed locally thus allowing organizations to save money as well. Edge is commonly misunderstood as a threat to cloud computing even though the relationship between the two is complementary.

Edge computing is used for time-sensitive data, whereas cloud computing processes data that is not time-driven. The edge computing market is currently one of the most hyped topics and it's only set to expand next year. It offers clear advantages in terms of an increase in the speed of data processing, minimal to now latency, great connectivity, security, and privacy support, and decreased volumes of transmitted data. It will be an amazing enabler for companies interested in operational efficiency.

2. Serverless functions

Serverless computing has been around for a few years now, a long time by cloud standards. It is now being given more importance by all the bigwigs of the cloud computing world. It promises a legitimate pay-as-you-go model that lets organizations pay only for the services that are actually used. This way, the infrastructure can scale invisibly depending on the requirements of an application without any significant capital investment.

Serverless computing also helps eliminate the risk of back-end failures and provides safe sandboxes for organizations to implement their code. Serverless within cloud computing will have a big part to play in creating new user experiences in the coming years.

3. Kubernetes enabling blockchain

Blockchain is an revolutionary technology that provides a tamper-evident, shared digital ledger that records data in a public or private network. It maintains accurate records of transactions without relying on a central authority.

Kubernetes is an open-source container orchestration platform that allows organizations to automatically scale, deploy and manage containerized infrastructure. Current public blockchain infrastructure does not scale in terms of big data storage and management, which makes it difficult to incorporate blockchain systems for big data applications. But the use of Kubernetes for blockchain helps to rapidly scale environments and ensure high availability by always having multiple containers running for key services.

Blockchain on Kubernetes enables service interoperability between organizations that are architected differently. The other advantages of blockchain on Kubernetes are simplified deployments and upgradeability. Deploying blockchain networks and its component parts via Kubernetes clusters might be the standard of adoption in a year or two given that they solve two major issues blockchain faces – its inherent complexity and integration into the existing infrastructure.

4. AI in cloud computing

Cloud computing and Artificial Intelligence have a mutual relationship where the latter powers cloud computing and the former plays a key role in the deliverance of AI services. Cloud services also help in democratizing AI by opening it up to a broader consumer base. It gives smaller businesses access to AI-enhanced business services and helps them access advanced machine learning functions.

Combining AI with cloud services enables organizations to get the most out of both applications in a cost-effective way. AI helps the cloud manage data and gain insights whereas the cloud provides a constant data backup and recovery in a virtual environment. The development and evolution of cloud and AI are interwoven and this will only become increasingly true during 2022.

5. The rise of cloud-gaming

Cloud gaming is an emerging technology that allows users to stream a virtually unlimited option of games for a flat monthly fee. It lets one play on any desktop, laptop, or smartphone without the need for an expensive console.

Leveraging cloud technology in the gaming industry fuels the demand and engagement of multiplayers for different games and removes existing platform barriers. Cloud gaming also eliminates the need for users to have storage space, any specialized hardware, and all the piracy problems, all of which translates to lower overall cost and sustainability.

Some major players in the cloud gaming space at the moment are Microsoft, Google, Amazon, Apple, Samsung, Sony, and Nvidia. Although game streaming technology is not yet as powerful as it could be, its transition to the cloud will ensure that the future of cloud gaming constantly evolves. It will also bring about a future where the cloud is not only the source of the game but also the platform of choice for players.

6. Hybrid cloud and multi-cloud infrastructure

Hybrid services are not about compromise between approaches, instead, they are about combining their strengths. Data that needs quick and frequent access can be kept on public servers and more sensitive data can be kept on private servers with monitored access. A well-integrated and balanced hybrid strategy gives businesses the best of both worlds.

Most organizations have grown past the initial phase of migrating some of their workloads from on-prem to a single cloud vendor, and are looking to indulge in the whole experience. This leads them to deal with multi-cloud environments where multiple services from several different suppliers are used. The multi-cloud model helps companies choose different cloud offerings best suited to their individual application environments, business requirements, and availability needs. Going forward, more organizations will need to develop entirely cloud-native applications with almost no architectural dependence on any specific cloud provider.

Although there has already been significant adoption of hybrid-cloud and multi-cloud strategies as the standard in large organizations, 2022 will witness more business leaders and enterprises realize the advantages of these models and embrace them to enjoy elasticity and agility in the cloud.

Q.2) Comparative study of different computing technologies [Parallel, Distributed, Cluster, Grid, Quantum]

1. High-Performance Computing

In high-performance computing systems, a pool of processors (processor machines or central processing units [CPUs]) connected (networked) with other resources like memory, storage, and input and output devices, and the deployed software is enabled to run in the entire system of connected components.

The processor machines can be of homogeneous or heterogeneous type. The legacy meaning of high-performance computing (HPC) is the supercomputers; however, it is not true in present-day computing scenarios. Therefore, HPC can also be attributed to mean the other computing paradigms that are discussed in the forthcoming sections, as it is a common name for all these computing systems.

Thus, examples of HPC include a small cluster of desktop computers or personal computers (PCs) to the fastest supercomputers. HPC systems are normally found in those applications where it is required to use or solve scientific problems. Most of the time, the challenge in working with these kinds of problems is to perform suitable simulation study, and this can be accomplished by HPC without any difficulty.

Scientific examples such as protein folding in molecular biology and studies on developing models and applications based on nuclear fusion are worth noting as potential applications for HPC.

2. Parallel Computing

Parallel computing is also one of the facets of HPC. Here, a set of processors work cooperatively to solve a computational problem. These processor machines or CPUs are mostly of homogeneous type. Therefore, this definition is the same as that of HPC and is broad enough to include supercomputers that have hundreds or thousands of processors interconnected with other resources.

One can distinguish between conventional (also known as serial or sequential or Von Neumann) computers and parallel computers in the way the applications are executed.

In serial or sequential computers, the following apply:

• It runs on a single computer/processor machine having a single CPU. • A problem is broken down into a discrete series of instructions. .

• Instructions are executed one after another.

In parallel computing, since there is simultaneous use of multiple processor machines, the following apply:

• It is run using multiple processors (multiple CPUs).

• A problem is broken down into discrete parts that can be solved concurrently.

• Each part is further broken down into a series of instructions.

• Instructions from each part are executed simultaneously on different processors.

• An overall control/coordination mechanism is employed

3. Distributed Computing

Distributed computing is also a computing system that consists of multiple computers or processor machines connected through a network, which can be homogeneous or heterogeneous, but run as a single system. The connectivity can be such that the CPUs in a distributed system can be physically close together and connected by a local network, or they can be geographically distant and connected by a wide area network.

The heterogeneity in a distributed system supports any number of possible configurations in the processor machines, such as mainframes, PCs, workstations, and minicomputers. The goal of distributed computing is to make such a network work as a single computer. Distributed computing systems are advantageous over centralized systems, because there is a support for the following characteristic features:

1. Scalability: It is the ability of the system to be easily expanded by adding more machines as needed, and vice versa, without affecting the existing setup.

2. Redundancy or replication: Here, several machines can provide the same services, so that even if one is unavailable (or failed), work does not stop because other similar computing supports will be available.

4. Cluster Computing

A cluster computing system consists of a set of the same or similar type of processor machines connected using a dedicated network infrastructure. All processor machines share resources such as a common home directory and have a software such as a message passing interface (MPI) implementation installed to allow programs to be run across all nodes simultaneously. This is also a kind of HPC category. The individual computers in a cluster can be referred to as nodes.

The reason to realize a cluster as HPC is due to the fact that the individual nodes can work together to solve a problem larger than any computer can easily solve. And, the nodes need to communicate with one another in order to work cooperatively and meaningfully together to solve the problem in hand.

If we have processor machines of heterogeneous types in a cluster, this kind of clusters become a subtype and still mostly are in the experimental or research stage.

5. Grid Computing

The computing resources in most of the organizations are underutilized but are necessary for certain operations. The idea of grid computing is to make use of such non utilized computing power by the needy organizations, and there by the return on investment (ROI) on computing investments can be increased.

Thus, grid computing is a network of computing or processor machines managed with a kind of software such as middleware, in order to access and use the resources remotely. The managing activity of grid resources through the middleware is called grid services. Grid services provide access control, security, access to data including digital libraries and databases, and access to large-scale interactive and long-term storage facilities.

Grid computing is more popular due to the following reasons:

• Its ability to make use of unused computing power, and thus, it is a cost effective solution (reducing investments, only recurring costs)

• As a way to solve problems in line with any HPC-based application

• Enables heterogeneous resources of computers to work cooperatively and collaboratively to solve a scientific problem.

6 Cloud Computing

The computing trend moved toward cloud from the concept of grid computing, particularly when large computing resources are required to solve a single problem, using the ideas of computing power as a utility and other allied concepts.

However, the potential difference between grid and cloud is that grid computing supports leveraging several computers in parallel to solve a particular application, while cloud computing supports leveraging multiple resources, including computing resources, to deliver a unified service to the end user. In cloud computing, the IT and business resources, such as servers, storage, network, applications, and processes, can be dynamically provisioned to the user needs and workload.