IoT Module 3

CO3	Explain the use of cloud for IoT		
M3.01	Explain the fundamentals of cloud computing.	3	Understanding.
M3.02	Explain challenges of cloud with IoT	3	Understanding.
M3.03	Outline the selection of cloud service provider for IoT applications	2	Understanding.
M3.04	Explain Fog Computing	2	Understanding.
M3.05	Explain the Security and privacy aspects of cloud computing	2	Understanding.

Contents: Fundamentals of cloud computing – Challenges – Selection of cloud services – Introduction to Fog Computing - Security issues.

(Ref: several web sites)

Fundamentals of cloud computing

- Cloud computing is an Internet-based computing solution where shared resources are provided as and when required with pay-as-you-go pricing.
- It delivers IT as a service.
- Computers in the cloud are configured to work together and the various applications use the collective computing power as if they are running on a single system.
- Instead of owning, buying, and maintaining physical data centers and servers, you can access technology services, such as compute power, storage, and databases, as per the need.
- Examples of cloud providers: Amazon Web Services (AWS), Microsoft Azure, or Google Cloud Platform.
- Before cloud computing, websites and server-based applications were executed on a specific system. With the advent of cloud computing, resources are used as an aggregated virtual computer.

Virtualization

Cloud storage and computing environments offer a virtualized environment, which refers to a running environment made to appear as one to all applications and services, but in fact physically two or more running environments and platforms may be present.

Virtualisation of storage means user application or service accesses physical storage using some database interface or file system or logical drive or disk drive. Example- Apple iCloud.

Network Function Virtualisation (NFV) means a user application or service accesses the resources appearing as just one network, though the network access to the resources may be through multiple resources and networks.

Virtualisation of server means the user application accesses not only one server but in fact accesses multiple servers.

Virtualized desktop means the user application can change and deploy multiple desktops, though the access by the user is through their own computer platform (OS).

IoT and Cloud Computing

- Due to the rapid growth of technology, the problem of storing, processing, and accessing large amounts of data has arisen, which can be easily solved by combining the IoT with Cloud computing.
- Benefits And Functions of IoT Cloud:
    - Many connectivity options for a variety of devices to access the cloud.
    - Developers can use IoT cloud computing on-demand.
    - Scalability and flexibility according to the needs.
    - Reliable authentication and encryption protocols.
    - Costs vary depending on use.

Characteristics of Cloud Computing

- On-Demand Self-Service: Cloud services do not require any human administrators or intervention; the users themselves can provision and manage computing resources as needed.
- More Flexible: The cloud offers businesses more flexibility overall versus hosting on a local server. And if you need extra bandwidth, then a cloud-based service can meet your requirements instantly.
- Broad Network Access: Computing services are generally provided over standard networks and heterogeneous devices.
- Resource Pooling: The IT resources (e.g., Compute, Networks, Storage, Applications, and Database services) present are shared across multiple applications. Multiple clients are provided service from the same physical resource in the cloud.
- Rapid Elasticity and Scalability: The computing services should have IT resources that can scale out quickly and on a needed basis. Whenever the user requires services, they will be provided to him, and they will scale out as soon as the user's requirements are met.
- Measured Service: The resource utilization is tracked and monitored for each application and occupant; it will provide both the user and the resource provider with accountability for what has been used. This is done for various reasons, like monitoring billing, security concerns, and effective use of resources.
- Higher Security.
- High Availability.
- Disaster Recovery.
- Fault Tolerance.
- No Location Constraints.

Challenges:

1. Data Security and Privacy: User or organizational data stored in the cloud is critical and private. Even if the cloud service provider assures data integrity, it is your responsibility to carry out user authentication and authorization, identity management, data encryption, and access control.

2. Cost Management: Even as almost all cloud service providers have a "Pay As You Go" model, which reduces the overall cost of the resources being used, there are times when there are huge costs incurred to the enterprise using cloud computing. For example, when there is under optimization of the resources it will add up to the hidden costs.
3. Multi-Cloud Environments: Due to an increase in the options available to the companies, enterprises not only use a single cloud but depend on multiple cloud service providers. This often makes it difficult to manage by the infrastructure team.
4. Performance Challenges: If the performance of the cloud is not satisfactory, it can drive away users and decrease profits. Even a little latency while loading an app or a web page can result in a huge drop in the percentage of users.
5. Interoperability and Flexibility: When an organization uses a specific cloud service provider and wants to switch to another cloud-based solution, it often turns up to be a tedious procedure since applications written for one cloud with the application stack are required to be re-written for the other cloud. Handling data movement, setting up the security from scratch and network also add up to the issues encountered when changing cloud solutions, thereby reducing flexibility.
6. High Dependence on Network: Since cloud computing deals with provisioning resources in real-time, it deals with enormous amounts of data transfer to and from the servers. This is only made possible with the availability of the high-speed network that needs a high cost.
7. Lack of Knowledge and Expertise: Due to the complex nature and the high demand for research working with the cloud often ends up being a highly tedious task. It requires immense knowledge and wide expertise on the subject. Although there are a lot of professionals in the field they need to constantly update themselves.

Selection of Cloud Services

Choosing the right cloud service provider is essential for any organization because it can significantly impact your cloud computing environment's performance, security, and cost.

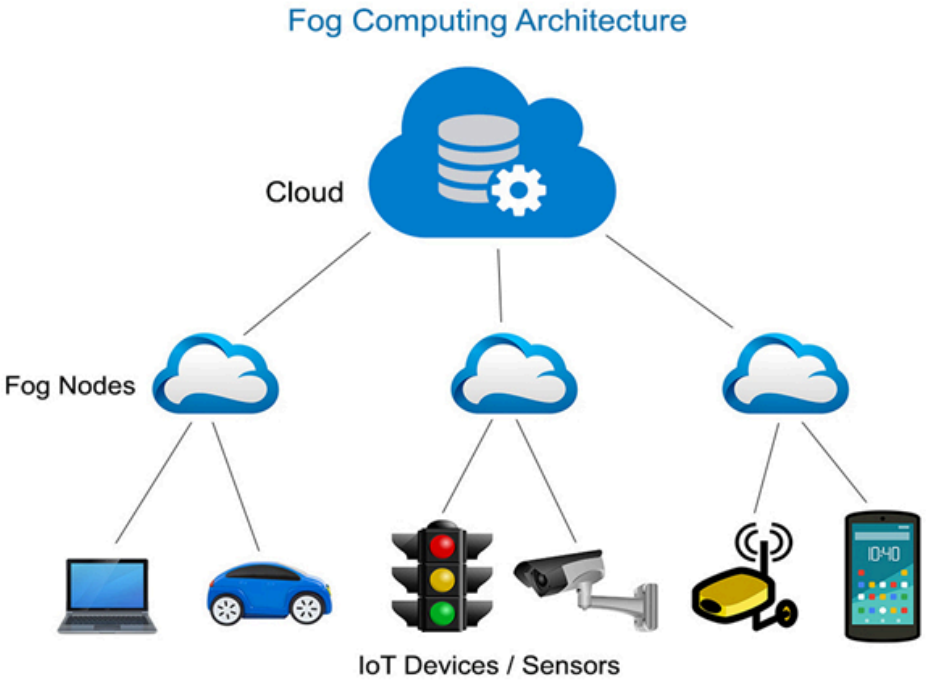
- Features of Devices Management:
    - Consider how well the platform can monitor, manage, and segregate edge devices.
    - You'll need a device management solution to get the correct data and information from your devices.
- Service offerings:
    - Different cloud service providers offer a variety of services, such as infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS).
- Scalability:
    - An IoT cloud platform's job is to simultaneously support millions of device connections.
    - Users should be able to set up a varying number of devices for machine-to-machine communication.
    - A good cloud service provider should be able to scale up or down quickly and efficiently to meet your needs.
- Security:
    - Integrating data streams and IoT sensors processes terabytes of data, which could lead to security and privacy vulnerabilities.

- Choosing a cloud service provider with robust security measures is essential to protect your data and applications.

- Data Management:
  - The cloud should be capable of storing, processing, and analyzing data efficiently.
  - A good IoT cloud platform can aggregate data from various devices to provide comprehensive corporate insight and analytics.

Introduction to Fog Computing

- Fog computing is a form of distributed computing that brings computation and data storage closer to the network edge, where many IoT devices are located.
- By doing this, fog computing reduces the dependance on the cloud for these resource-intensive tasks, improving performance and reducing latency.
- In fog computing, all the storage capabilities, computation capabilities, data along with the applications are placed between the cloud and the physical host. All these functionalities are placed more towards the host. This makes processing faster as it is done almost at the place where data is created.
- The devices in the fog are called fog nodes.
- Fog computing improves the efficiency of the system.



- Fog computing is often used in cases where real-time response is needed, such as with industrial control systems, video surveillance, or autonomous vehicles.
- It can also be used to offload computationally intensive tasks from centralized servers or to provide backup and redundancy in case of network failure.

Security issues and Challenges in Fog Computing

1. Data privacy

As fog computing involves deployment of fog nodes at the edge of the Internet, more end users are more accessible to the fog nodes. This increases the number of sensitive data being collected by the fog nodes compared to the remote cloud making it become the target of cyber attackers.

2. Security

The most critical security is the risk of having a malicious user in using a fake IP address to access the data stored in the certain fog node as fog computing involves authentication of devices at different gateways. This leads to the need for the use of intrusion detection systems at every layer of the platform.

3. Network management

The management of fog nodes, network, and also the connection between the nodes are a heavy task since they are connected to heterogeneous devices.

4. Positioning the fog servers

The positioning of the group of fog servers requires analysis on work done in each node in the servers in order to optimize the service delivered by fog computing as well as lowers the maintenance cost.

5. Energy Consumption

Fog computing involves high consumption of energy fog environments apply to a massive number of fog nodes.