Terna Engineering College
Computer Engineering Department
Program: Sem VIII

Course: Cloud Computing Lab (CSL803)

Faculty: Reshma Koli

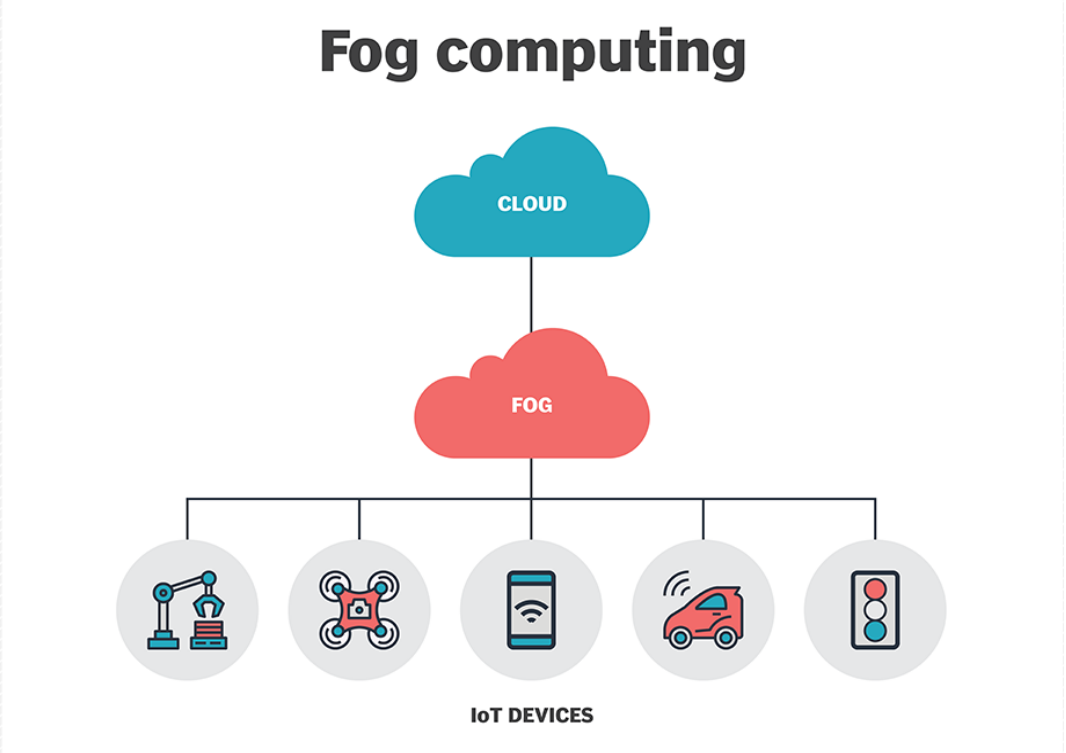
Experiment No. 8

A.1 Aim: To have a basic understanding of implementation/applications of fog computing. (Case study)

PART B
(PART B: TO BE COMPLETED BY STUDENTS)

Roll No. 50	**Name:** AMEY MAHENDRA THAKUR
Class: BE COMPS B 50	**Batch:** B3
Date of Experiment: 10-03-2022	**Date of Submission:** 10-03-2022
Grade:	

B.1 Question of Curiosity:
Q.1 What do you mean by fog computing? Explain in detail and draw its architecture.
ANS:



Fog Computing:

- Fog computing is a decentralized computing infrastructure in which data, compute, storage and applications are located somewhere between the data source and the cloud. Like edge computing, fog computing brings the advantages and power of the cloud closer to where data is created and acted upon. Many people use the terms fog computing and edge computing interchangeably because both involve bringing intelligence and processing closer to where the data is created. This is often done to improve efficiency, though it might also be done for security and compliance reasons.
- The fog metaphor comes from the meteorological term for a cloud close to the ground, just as fog concentrates on the edge of the network. The term is often associated with Cisco; the company's product line manager, Ginny Nichols, is believed to have coined the term. Cisco Fog Computing is a registered name; fog computing is open to the community at large.

How does fog computing work?

- Fog networking complements -- doesn't replace -- cloud computing; fogging enables short-term analytics at the edge, while the cloud performs resource-intensive, longer-term analytics. Although edge devices and sensors are where data is generated and collected, they sometimes don't have the compute and storage resources to perform advanced analytics and machine learning tasks. Though cloud servers have the power to do this, they are often too far away to process the data and respond in a timely manner.
- In addition, having all endpoints connecting to and sending raw data to the cloud over the internet can have privacy, security and legal implications, especially when dealing with sensitive data subject to regulations in different countries. Popular fog computing applications include smart grids, smart cities, smart buildings, vehicle networks and software-defined networks.

Benefits of fog computing:

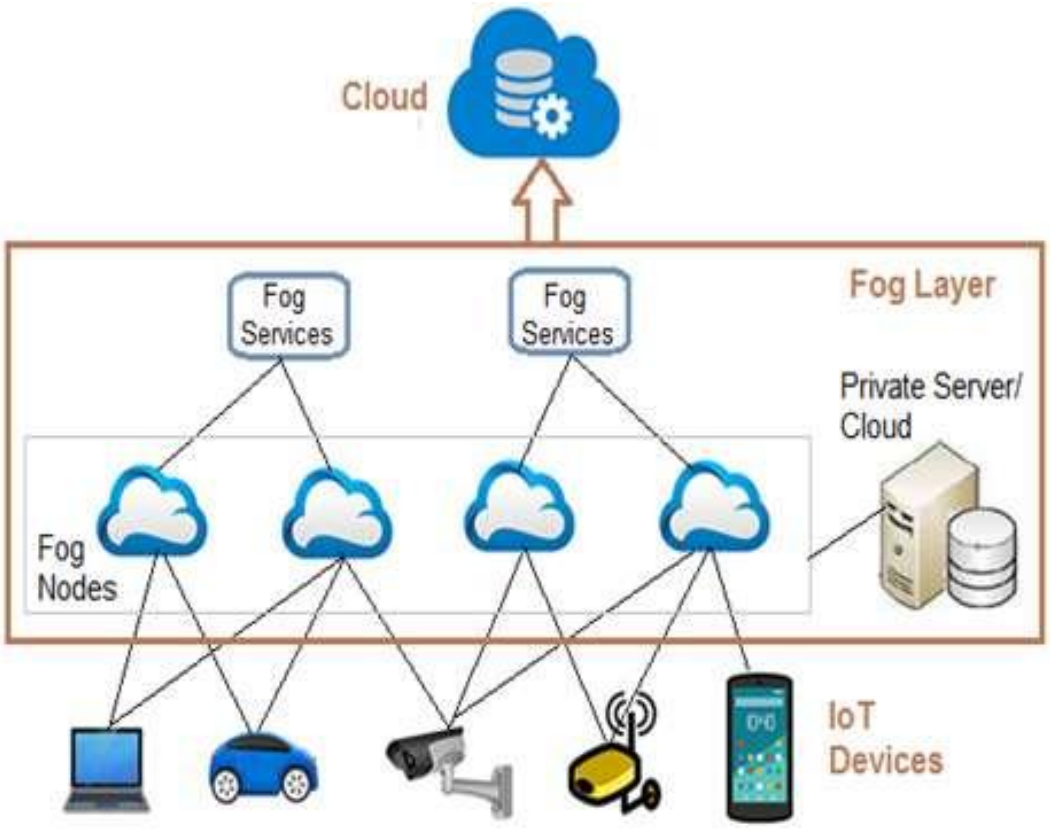
- Bandwidth conservation. Fog computing reduces the volume of data that is sent to the cloud, thereby reducing bandwidth consumption and related costs.
- Improved response time. Because the initial data processing occurs near the data, latency is reduced, and overall responsiveness is improved. The goal is to provide millisecond-level responsiveness, enabling data to be processed in near-real-time.
- Network-agnostic. Although fog computing generally places compute resources at the LAN level -- as opposed to the device level, which is the case with edge computing -- the network could be considered part of the fog computing architecture. At the same time, though, fog computing is network-agnostic in the sense that the network can be wired, Wi-Fi or even 5G.

Disadvantages of fog computing:

- Physical location. Because fog computing is tied to a physical location, it undermines some of the "anytime/anywhere" benefits associated with cloud computing.
- Potential security issues. Under the right circumstances, fog computing can be subject to security issues, such as Internet Protocol (IP) address spoofing or man in the middle (MitM) attacks.
- Startup costs. Fog computing is a solution that utilizes both edge and cloud resources, which means that there are associated hardware costs.
- Ambiguous concept. Even though fog computing has been around for several years, there is still some ambiguity around the definition of fog computing with various vendors defining fog computing differently.

Fog Computing Architecture

- The Fog computing architecture consists of physical and logical elements in the form of hardware and software to implement the IoT (Internet of Things) network.
- As shown in the figure, it is composed of IoT devices, fog nodes, fog aggregation nodes with the help of fog data services, remote cloud storage and local data storage server/cloud. Let us understand fog computing architecture components.



Fog Computing Architecture

IoT devices:

- These are devices connected to IoT networks using various wired and wireless technologies. These devices produce data regularly in huge amounts. There are numerous wireless technologies used in IoT which include Zigbee, Zwave, RFID, 6LoWPAN, HART, NFC, Bluetooth, BLE, NFC, ISA-100.11A etc. IoT protocols used include IPv4, IPv6, MQTT, CoAP, XMPP, AMQP etc.

Fog Nodes:

- Any device with computing, storage and network connectivity is known as a fog node. Multiple fog nodes are spread across the larger regions to provide support to end devices. Fog nodes are connected using different topologies. The fog nodes are installed at various locations as per different applications such as on the floor of a factory, on top of a power pole, alongside the railway track, in vehicles, on oil rigs and so on. Examples of fog nodes are switches, embedded servers, controllers, routers, cameras etc. High sensitive data are processed at these fog nodes.

Fog aggregate nodes:

- Each fog nodes have their aggregate fog node. It analyzes data in seconds to minutes. IoT data storage at these nodes can be of duration in hours or days. Its geographical coverage is wider. Fog data services are implemented to implement such aggregate node points. They are used to address average sensitive data.

Remote Cloud:

- All the aggregate fog nodes are connected with the cloud. Time insensitive data or less sensitive data are processed, analyzed and stored in the cloud.

Local server and cloud:

- Often fog computing architecture uses a private server/cloud to store the confidential data of the firm. This local storage is also useful to provide data security and data privacy.

Q2: What are the disadvantages of cloud computing?
ANS:
Disadvantages of Cloud Computing:

1. Performance Can Vary

- When you are working in a cloud environment, your application is running on the server which simultaneously provides resources to other businesses. Any greedy behaviour or DDOS attack on your tenant could affect the performance of your shared resource.

2. Technical Issues
- Cloud technology is always prone to an outage and other technical issues. Even, the best cloud service provider companies may face this type of trouble despite maintaining high standards of maintenance.

3. Security Threat in the Cloud
- Another drawback while working with cloud computing services is security risk. Before adopting cloud technology, you should be well aware of the fact that you will be sharing all your company's sensitive information to a third-party cloud computing service provider. Hackers might access this information.

4. Downtime
- Downtime should also be considered while working with cloud computing. That's because your cloud provider may face power loss, low internet connectivity, service maintenance, etc.

5. Internet Connectivity
- Good Internet connectivity is a must in cloud computing. You can't access the cloud without an internet connection. Moreover, you don't have any other way to gather data from the cloud.

6. Lower Bandwidth
- Many cloud storage service providers limit the bandwidth usage of their users. So, in case your organization surpasses the given allowance, the additional charges could be significantly costly

7. Lacks of Support
- Cloud Computing companies fail to provide proper support to the customers. Moreover, they want their user to depend on FAQs or online help, which can be a tedious job for non-technical persons.

Q3: Compare cloud computing and fog computing.
ANS:

Feature	**Cloud Computing**	**Fog Computing**
Latency	Cloud computing has high latency compared to fog computing	Fog computing has low latency

Capacity	Cloud Computing does not provide any reduction in data while sending or transforming data	Fog Computing reduces the amount of data sent to cloud computing.
Responsiveness	Response time of the system is low.	Response time of the system is high.
Security	Cloud computing has less security compared to Fog Computing	Fog computing has high Security.
Speed	Access speed is high depending on the VM connectivity.	High even more compared to Cloud Computing.
Data Integration	Multiple data sources can be integrated.	Multiple Data sources and devices can be integrated.
Mobility	In cloud computing mobility is Limited.	Mobility is supported in fog computing.
Location Awareness	Partially Supported in Cloud computing.	Supported in fog computing.
A number of Server Nodes	Cloud computing has Few numbers of server nodes.	Fog computing has a Large number of server nodes.
Geographical Distribution	It is centralized.	It is decentralized and distributed.
Location of service	Services provided within the internet.	Services are provided at the edge of the local network.
Working environment	Specific data centre building with air conditioning systems	Outdoor (streets, base stations, etc.) or indoor (houses, cafes, etc.)

Communication mode	IP network	Wireless communication: WLAN, WiFi, 3G, 4G, ZigBee, etc. or wired communication (part of the IP networks)
Dependence on the quality of core network	Requires strong network core.	Can also work in Weak network core.

B.2 Conclusion:

We successfully developed an understanding of the implementation/applications of fog computing.