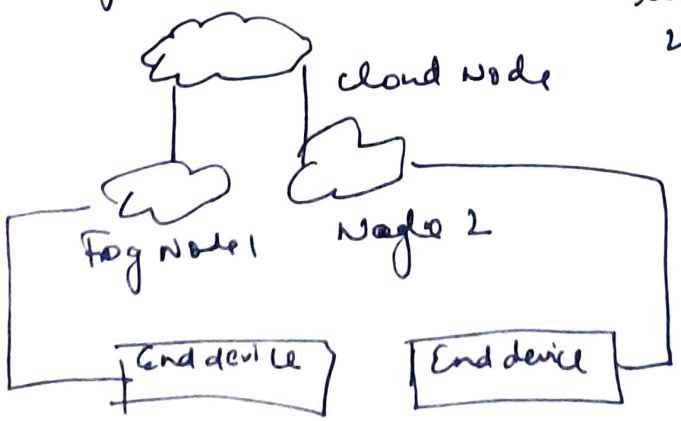
UNIT-1

⇒ FOG COMPUTING

Use of Emerging technologies like IOT, On line applications and popularity of Social Networking are leading to Increase of No of users on Internet. Hence data generated on daily basis is also increasing at an Enormous rate leading to Increase workload on cloud. Also demand for Increased Bandwidth & need for real time applications also Increasing. FOG COMPUTING is a technology Introduced to collaborate with cloud computing for providing solutions. It

Fog Computing is a technology in which resources like compute, data, Storage and applications are located in b/w the End user layer (where data is generated) & the cloud. Devices like gateway can be configured as fog devices

Fog Computing is term Coined by Cisco (2014) that refers to Extending Cloud Computing to an edge of the Enterprise N/W. It facilitates the Operation of computing Storage & N/W Services b/w End users & devices and computing data Centres. After this gained little popularity, IBM 2015 Coined a Similar term Edge Computing



1) The device composing the fog infrastructure known as fog nodes
2) In fog computing, all the storage capabilities, data along with applications are placed b/w cloud & the Physical Host.
3.) 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
4.) It Improves the efficiency of system.

COMPONENTS OF FOG COMPUTING

1.) Physical & Virtual Nodes (end devices) :-
It serve as the points of contact to real world like Mobile phones, sensors.

2.) Fog Nodes :-
It is independent device that pick up the generated Information. Fog Nodes fall under 3 categories:
devices, Servers & gateways.

3.) Monitoring Services :-
It Includes API that keep track of system's performance & resource Availability

4.) Data processors :-
These are programs that run on fog Nodes. They filter, form & even reconstruct faulty data that flows from End devices.

5) Resource Manager :-
It allocates & deallocates resources to various Nodes & Schedules data transfer b/w Nodes & Cloud
It also take care of data backup.

6.) Security tools :-
Since fog components directly Interact with raw data sources, Security must be built

7) Applications :-
It provides actual services to End users.

→ ADVANTAGES OF FOG COMPUTING

1.) Low Latency :-
It provides the benefit of faster response due to geographical location i.e they are located Nearby

2.) Reduced Bandwidth requirements :-
Fog Servers allow low bandwidth consumption b/c data get processed at nearby fog servers. Hence avoiding huge amount of data to be forwarded to distant cloud servers for processing

3.) Reduced Cost :-
Most of the processing is done locally at the fog layer leading to Conservation of N/w resources.

4.) Security & privacy :-
It also allows applications to be Secure & private. b/c data can be processed locally instead of forwarding to remote Centralised cloud.

5) Mobility :-
Fog devices are Mobile. They can easily added or removed ~~from~~ N from N/w

→ APPLICATIONS

1.) Smart Cities :-
Cities that make use of technology to Improve quality of life & Services provided to people. Can be called Smart Cities. With help of this, it is possible to do tasks like creating Smart homes & buildings, maintaing Securities.

2.) Smart Car & Traffic Control System :-
By making use of IoT devices vehicles can Communicate with Internal as well as External Environments with help of Sensors. like Traffic light

3.) Smart Grids :-

Electric grid is a N/W which delivers Energy generated from various Sources to Consumers. The process of efficient distribution of Energy is possible by making use of fog computing. IOT Sensors Can Monitor Energy generated from various Sources like wind Energy farms, thermal plants. This data is then passed to Nearby fog Server to Identify the optimal Source of Energy to be used. & Identify equipment Malfunctions.

4) Smart healthCare Systems :-

Health reports of patients Can be recorded using different types of Sensors & forwarded to fog devices Fog devices after performing analysis Can take Necessary actions like diagnose Cardiac disease.

5) Surveillance :-

Security & Surveillance are deployed in many areas. It is difficult to send Massive amount of data collected by these Cameras to Cloud Servers. due to Bandwidth Constraints. Hence. data collected from these Can be forwarded to Nearby fog Servers. Fog Servers in turn Can perform Video processing to find out problems like theft, finding & Missing people.

CHALLENGES IN FOG

1.) Complexity :-

Fog devices Can be diverse in architecture and hence located at different locations adding more Complexity to N/W.

2) Power Consumption :-
It requires high power Consumption for proper functioning. Adding more fog devices increases energy Consumption.

3.) Data Management :-
Data is distributed across Multiple fog devices. Hence it is ~~challenging~~ Challenging

4.) Authentication :-
Establishing trust & authentication may raise issues.

5) Security :-
Since there are many fog devices. each with diffent IP adders. Hackers can hack.

⇒ LIMITATIONS OF CLOUD COMPUTING

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1.) Internet Connectivity :-
Every data is stored on cloud. & we access the data by using Internet Connection. ~~&~~ for this you have good Internet Connection.

2.) Vendor lock-in :-
Organisations may face problems when transferring their services from one vendor to another. As diffent vendors provides diffent platforms, this can cause difficulty moving from one cloud to another.

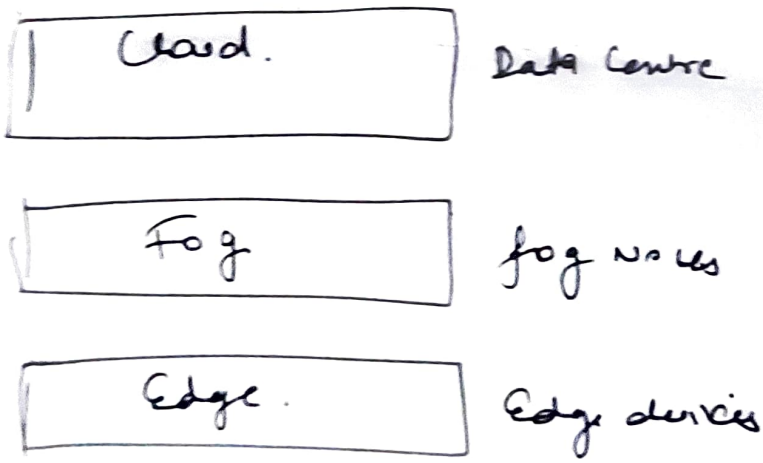
3.) Limited Control :-
Cloud Infrastructure is completely owned, managed & Monitored by Service provider, So Cloud users have lesser control over functions & Execution of Services within Cloud Infrastructure

④ Security :-
You should be aware that you will be sending all your organisation's sensitive info to third party the cloud computing service providers, while sending data, there may be chances that your organisation's info hacked by Hackers

⑤ Technical issues :-
It is always prone to an outage & other technical issues.

⑥ Lack of support :-
Cloud computing companies fails to provide proper support to customers. They depend on FAB's or online help which can be tedious job for non technical persons.

IOT data layers.



⇒ DIFF. B/W FOG & CLOUD COMPUTING

Speciality	Cloud Computing	Fog Computing
1) Delay	Higher latency	Low latency
2) Capacity	Not provide any reduction in data while sending / Recieving data	Reduces the amount of data sent to cloud computing
3.) Responsiveness	Response time is low	High.
4.) Security	lesser Security	High Security
5) Speed	Access Speed is high	even more high Speed
6.) Data Integration.	Multiple data Source can be Integrated	Multiple data Sources & devices Can be Integrated
7.) Mobility	Limited	Mobility is Supported
8.) No of Sever Nodes	Few No' of Server Nodes.	Larger No' of Nodes
9.) Geographical distribution	Centralized.	decentralized & distributed.
10) Location of Service.	Services provided within Internet	Services provided at Edge of local N/W
11.) Working Environment	Specific data Centre building with air Conditioning System	Outdoor (Streets, Cafe, homes)
12.) Communication Mode	IP N/W	Wireless Communication (WLAN, Wifi, 3G, 4G)

⇒ CHARACTERISTICS OF FOG COMPUTING

1.) Heterogeneity :- It is highly virtualized platform that yield compute, storage & N/W Services. They are building blocks of both cloud & fog.

2.) Edge location :- It support End points with such Services at edge of N/W like gaming

3.) Geographical distribution :-
Fog play active role in delivering high quality streaming to moving vehicles, along with highway & tracks.

4.) Large Scale Sensor N/W :- To Monitor the Environment & Smart grid and other Ex:- of Inherently distributed Systems.

5) Large No of Nodes.

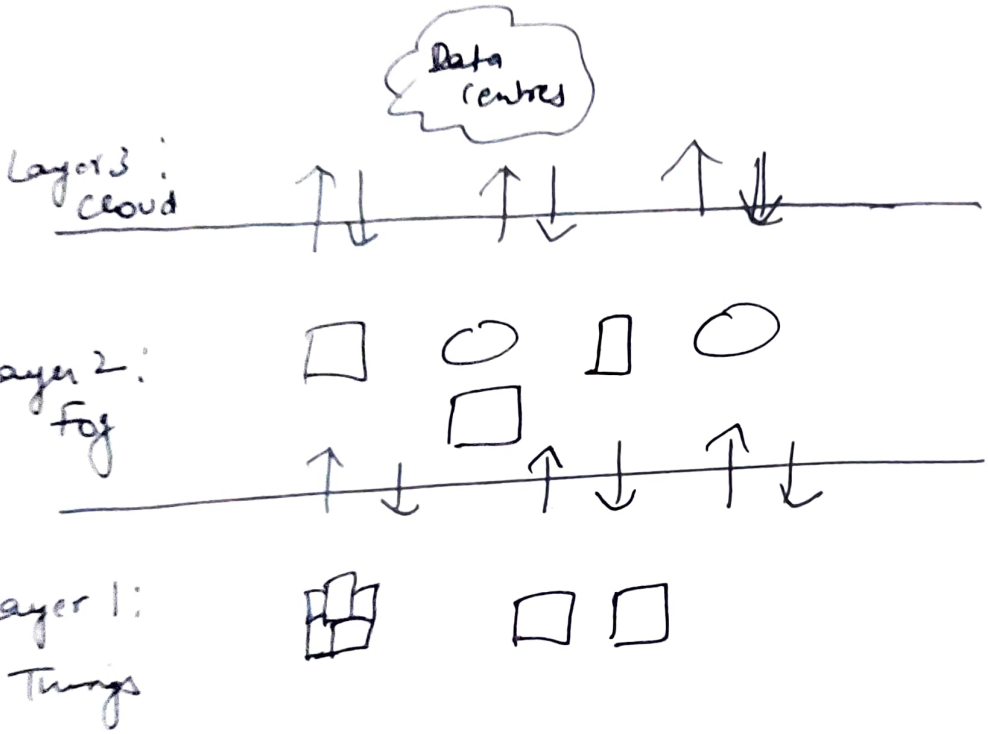
6.) Support for Mobility :-

7) Real time Interactions :-

8) Control of privacy.

⇒ ARCHITECTURE OF FOG COMPUTING

Fog architecture involved using Services of End devices (Switches, routers etc) for Computational Storage and Processing purposes. It consist of physical as well as logical elements of N/W, S/W & H/W to form Complete large no of Interconnecting devices.



(I) It consist of 3 layers:-

1.) Terminal layer

It is basic layer & Includes devices like Mobile Phones, Sensors, Smart Vehicles etc. Devices which Can Sense & Capture data are present in this layer

The layer mostly deals with data Sensing & Capturing. Devices from different Platforms & different architectures are mainly found in this layers.

Device have property of working in heterogenous Environment

2.) Fog layer

It Includes devices like router, gateway, access points Fog Servers called ~~as~~ fog Nodes.

Fog Nodes located at Edge of N/W. ~~Not~~ Nodes are Situated in b/w End devices & cloud data Centres.

Fog Nodes Can be static or moving

fog Nodes Ensures Services to end devices. Nodes Can Compute, transfer & Store data temporarily

3.) Cloud layer

It Consist of devices that Can provide large Storage & Servers with high performance.

This layer perfoms Computation analysis & Stores data permanently.

It has high Storage & powerful Computing Capabilities. The data Centre provide all basic Characteristics of Cloud computing to users.

The Cloud layer lies at the Extreme End of architecture. It act as as backup as well as provides permanent Storage for data.

Layered architecture

1.) Physical & Virtualization layer:-

This layer Comprises Nodes (Physical & Virtual) The Nodes perform the primary task of Capturing data & located at diffent locations. Nodes usually Involve Sensing technology to Capture their Surroundings.

2) Monitoring layer:

In this we perform Node, Monitoring related to various tasks. Nodes can be Monitored for the amount of time they work, the temp. & other physical properties, max. battery life of device

→ Performance is also Monitored.

→ Fog Nodes are checked for their energy Consumption.

3.) Preprocessing layer

→ It performs various data operation related to Analysis

→ Data is cleaned & checked for unwanted data present. Data Impurity is removed & only useful data is Collected.

4) Temporary Storage

→ It is associated with Non permanent distribution & replication of data.

→ Storage Virtualisation used in this layer.

→ Data is removed from Temporary layer once data is moved to cloud from this layer.

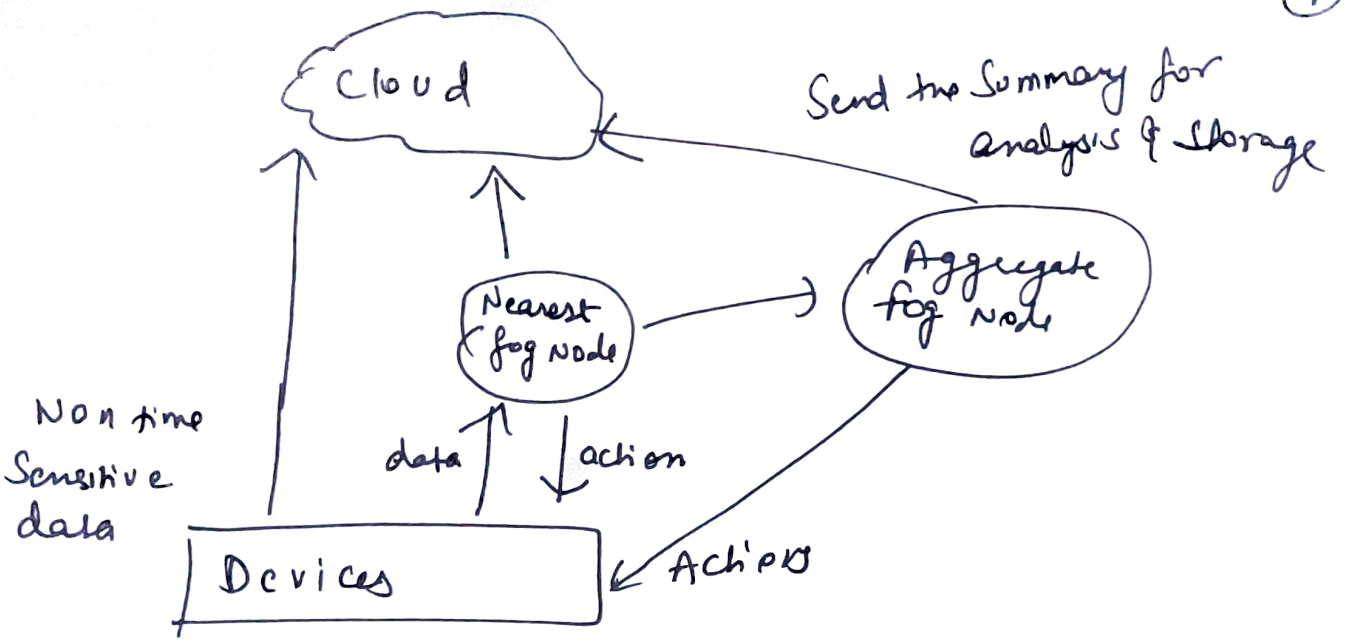
5) Security layer

Its function is to upload partly-processed & fine grained Secured data to cloud layer for permanent Storage.

The data is then passed through Smart gateways before uploading on cloud.

Transport layer	Uploading pre-processed & Secured ~~stored~~ data to cloud
Security layer	Encryption / decryption
Temp. Storage layer	Data distribution replication & de-duplication Storage space & devices
Pre processing layer	Data Analysis, filtering & ~~from~~ trimming
Monitoring layer	Activies Monitoring, POWER Monitoring, RESOURCE Monitoring
Physical & Virtualization layer	Virtual Sensor & Virtual Sensor N/W Things & physical Sensors ~~and~~ Wireless Sensor N/W

⇒ WORKING OF FOG COMPUTING



1.) Data is collected from various devices & Sensors Connected to Internet

2.) Then data is Sent to fog Node which can be Anything from Smartphone

3.) Fog Node process data & Sent it back to devices or Sensors

4.) The fog Node sends data to Central cloud Server

5) The data is then processed by Cloud Server & Stored in database.