COMPUTER SCIENCE
&
ENGINEERING

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Fog Computing

AI DS - B

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Assignment

With this rapid rise in the size of the information being generated and lack of ability of predictable databases to handle different forms of organized and unorganized information, big data analytics has got inordinate consideration at present. The data collected from different devices are being analyzed by various organizations to extract suitable understanding to take crucial decisions.At present, various industries need a powerful cloud-based infrastructure because everything is getting migrated to the cloud as it has different features offering pay-per-use, scalability, and accessibility. The prevailing cloud service offered by CC is Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). All these cloud services are heading in the direction of Everything as a Service (XaaS). Nonetheless, information produced from these millions of sensors, specified as Big Data cannot be processed and moved to cloud completely as this may majorly result in latency Furthermore, few applications of IoT require quick processing than CC present capacity. This issue can be resolved with Fog Computing which ties together the smart devices processing power situated close to the client to assist the usage of networking, processing, and storage near the edge. The functionality of fog with IoT is to cut down the information transfer to CC for storage, analysis, processing, efficiency, and to improve the performance. Thus, the information gathered by the sensor devices is transmitted to network devices such as edge for temporary storage and processing rather than transmitting them to the cloud, thus decreasing the latency and network traffic. The unification of IoT with Fog Computing generates a unique prospect for services, named as Fog as a Service (FaaS), where multiple fog nodes are built by the service provider across various geographic locations and operate as an owner to various inhabitants from different vertical places.

Unlike CC, fog is a distributed computing approach where different devices near the clients use computing capabilities that have less-features but a good computing capacity with several cores. Therefore, several smart devices like network device management, switches, base stations, routers, smartphones, etc. are installed with storage and computing power which can perform as fog computing devices. The deployable environment of Fog Computing and its requirements are the key issues in the Fog Computing principle. This is the reason, the computing schemes that are present in the Fog Computing domain are diverse. Therefore, it is essential to examine the precise requirements of all the other interconnected features such as services, simulations, fault tolerance, hosting issues, and resource administration.

Fog computing is defined as "an extremely virtualized environment that delivers networking, storage, and compute resources between outdated CC information centers, usually, but not entirely situated at the network edge". A fog structure contains various edge nodes with few processing competences, which are frequently called fog nodes. These nodes of fog have less processing facilities and storage. In fog network, sometimes edge and many servers are called cloudlets, which take part in the shared computing surroundings, not outside the network edge. By using these devices of fog, the clients might obtain a real-time response for sensitive latency applications.

Features of Fog Computing: a. Adaptability: There are extensive network sensors that keep

track of the neighboring environment. The fog delivers storage resources and disseminated computing which can operate with such extensive end devices.

b. Real-time communications: Fog computing solicitations provide simultaneous communications amid fog nodes relative to the batch analysis utilized in the cloud.

c. Physical distribution: In divergence to the integrated cloud, fog delivers applications and services that are decentralized and can be hosted in any location.

d. Less latency and position awareness: Fog is near to edge devices, it delivers less waiting time when computing the information of edge devices. Besides, it assists position responsiveness in which fog nodes can be hosted in various places.

e. Compatibility: Fog modules can adapt and interoperate with dissimilar platforms through diverse service providers.

f. Provisions for web-based analytics and integration with cloud: The fog is positioned amid edge devices and cloud to act as a vital role in the raptness and computing of the information near the edge devices.

g. Heterogeneity: Edge devices or fog nodes are devised by various companies and thus originate in diverse arrangements and need to be hosted conferring to their display place. Hence fog can adapt on dissimilar platforms.

h. Provision for flexibility: One of the significant features of fog solicitations is the capacity to link straight to devices such as mobiles and hence enable flexibility techniques, for instance, Locator ID Separation Protocol (LISP) which desires a dispersed indexed system.

1 Edge Computing

The computation capabilities in Edge computing are provided by edge servers or devices of edge. Overall edge computing never impulsively link through any kinds of services of cloud and focuses further on the device side IoT. A particular study states that edge computing as the processing of resource or a network which are in the middle amidst the data centers of cloud and sources of data. Any sensor or devices which are intelligent can have sources of data, however edge computing is diverse. Some IoT sensors and intelligent device can be the source of data, however edge computing is diverse. For instance, a small data processing center or a cloudlet is the edge of cloud computing and applications of mobile, while the gateway of IoT is the edge amid cloud computing and sensors of IoT. Likewise, if an application of cloud computing is running on a mobile phone, then the mobile phone acts as the edge amidst the cloud and the application. From the edge computing perception, devices not only store the information but also generate the information by involving themselves in transitioning. These devices of edge can carry out execution job from the central cloud, additional demanding the delivery of services. Information storage, unloading allocation, and data execution, everything will be completed by the edge node. The devices of edge are also handy in allocating the requirements and delivering the service as a representative of cloud computing to the clients.

2 The Architecture of Fog Computing

these architectures are designed based on different topologies specific to user applications and services. a reference framework of fog computing is designed comprising of the seven levels namely level 1: virtualized and physical, level 2: fog devices, servers, and gateway, level 3: monitoring, level 4: preprocessing and post-processing, level 5: storage and resource management, level 6: security and level 7: application. These levels of the fog framework are categorized based on different applications. The importance of each level is discussed and the usage of the level in various applications is explained. The goal of these levels is to work together to push a task for execution from an IoT to fog nodes and then to the cloud. These levels focus on carrying different tasks such as information management, data analysis, processing of data, categorizing of information to cloud servers and fog servers, and various other tasks based on services of the fog and cloud, and the demand of applications from the users.

2.1 Level 1: Physical and Virtual Sensors

The different forms of information produced by the sensors are the basic information generator of Fog Computing. This information could be produced from different devices such as intelligent homes and devices, surveillance systems of CCTV and traffic, automated driving vehicles, humidity and temperature sensors, and so on. Therefore, the physical level contains virtual and physical sensors, where any information producing device may fall into any of these clusters.

2.2 Level 2: Fog device, server and gateway

An IoT or an independent device may be a fog server, fog device, or a gateway. Nevertheless, it is noticeable that the fog server must have a better configuration than the fog gateway and devices since it controls numerous fog devices. To make fog server run many factors are involved like configuration of hardware, network connectivity, devices it can control, etc. The role of the fog server is defined based on its fragment of IoT. A cluster of virtual sensors and physical sensors are networked to fog devices. Likewise, a cluster of fog devices will be networked to the fog server. This level also controls the processing needs to be demanded by many applications. Processing needs depends on information movement and the entire number of devices linked to IoT associated with the devices of fog and an entire number of devices of fog are linked to the servers of fog. The communication amid various servers of fog is maintained at this level.

2.3 Level 3: Monitoring

The performance of the system and resources are kept track by the monitoring level along with utility and feedback.

During an operating system monitoring facilitates are chosen as the relevant resources. Different operations run in scenarios of systems having smart transportation. A scenario could occur where the availability of the resources will negate for calculations or storage on fog device. Similarly, the same scenario can occur on the server-side of fog. To handle such scenarios the devices and servers on the fog side will access help from different peers. Hence, the components of the system monitoring will decide these efficiently.

2.4 Level 4: Pre and post processing

This level works on data analysis of basic and advanced data, it has multiple components. In this level, it plays the role of obtaining the data by analyzing, filtering, trimming, and reconstructing

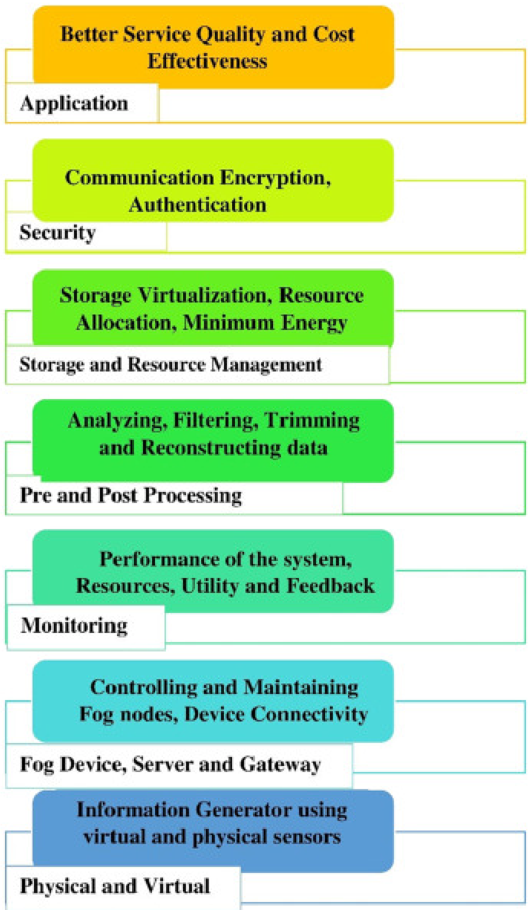

Figure 1: Framework of Fog Computing

the data as and when required. Once the data is processed, the component named data flow selects where the data should be stored whether locally at the fog or in the cloud for storage for a long duration. Another component in this level is the data reconstruction which takes care of data generation that is incomplete by the sensors and faulty tolerance. This component also takes care to reform the information based on the information pattern if one or more sensors fail and prevent application failure and other interruptions.

2.5 Level 5: Storage and Resource Management

The storage module is in charge of storing data using storage virtualization. The component named data backup is responsible to ensure the data availability and data loss. The concept of storage virtualization contains a pool of devices that are responsible for storage in a network that acts as an individual storage device. This individual storage device is easily manageable and maintainable. The main benefit of storage virtualization is that the cost of hardware and storage is low which provides better enterprise functionality. It also minimizes storage complexity. This level contains the energy-saving component used to manage all the resources efficiently. This manages to minimize operational costs. The reliability of the system is managed by the reliability component which focusses on different measures and metrics of reliability.

2.6 Level 6: Security

The security level maintains all the issues related to security like communication encryption and protected information storage. This level also secures the information of the fog users. The fog environment is proposed to be installed as a system of utility like a cloud environment. In the cloud environment, the user demands all the services from the cloud by connecting to it, whereas in the fog environment the clients connect to the fog system for all the services while the middleware in the fog manages and maintains all the communications with the cloud. Therefore, the user who intends to associate with a service should be authorized. So, the component of validation is responsible for giving the authentication requests to all the users in the fog. Most of the fog components are connected through a wireless connection, so it is important to maintain security. The data of the users should not be disclosed in the fog environment, it is important to maintain the privacy of user data.

2.7 Level 7: Application

Initially, the fog was introduced to serve the IoT applications, many applications based on Wireless Sensor Network (WSN) started to support fog computing. Almost all applications that have latency as an issue started to take advantage of the fog environment. In an application, in which the system uses Augmented Reality can adopt fog infrastructure as it will change the current world in the future. The requirements of processing in real-time using augmented reality can be catered by fog environment which can cause prolonged improvement in many services of augmented reality.

3 Fog Computing with the internet of things

The present integrated CC framework is facing different issues for the Internet of Things applications. For example, time-sensitive requests such as augmented reality, audiovisual streaming, and game-playing cannot be supported. In extension, it does not have position responsiveness as it is an integrated prototype. These issues are addressed by Fog Computing. It offers a vastly virtualized prototype of processing, storage, and resource networking between cloud servers and end devices. To upsurge the effectiveness of IoT requests, most of the information produced by these IoT devices must be transformed and examined instantaneously. Fog Computing takes the processing, storage capacity, and cloud network until the network edge to tackle the instantaneous issue of IoT devices and deliver safe and well-organized IoT solicitations. Fog Computing delivers many applications and services with broadly dispersed positioning.

4 Conclusion

The devices of IoT are vigorous and have less processing and storage capacity. Nevertheless, the customary integrated CC has several problems, such as failure of networks and increase latency. To address these problems, fog computing has turned out to be an extension of CC, but nearby to the devices of IoT in which complete information computation will be done at fog nodes, thus decreasing the waiting time, particularly for crucial applications. The combination of IoT with fog computing carries several advantages to several IoT applications.