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360 Deg. Overview of Fog Computing

Saloni Halwai[1], Pritika Pravin[2], Dr. Seema Shah[3]
[1, 2]B. Tech Integrated Computer Engineering, Mukesh Patel School of Technology Management and Engineering, NMIMS University, Mumbai, India.
[3]Department of Computer Engineering, Mukesh Patel School of Technology Management and Engineering, NMIMS University, Mumbai, India.

Abstract: Fog Computing (introduced in 2012) is now considered to be the most prioritized choice for applications of Internet of Things. Fog Computing allows to move a part of the processing in the cloud to the network devices present along the node to the cloud. It makes communications and storage services in proximity to the end user. It is used to well support time dependent, location dependent, massive scale, and latency sensitive applications. Fog computing makes the task laid-back for cloud by filtering the needless data before forwarding the data to the cloud.

This paper is assembled into two parts. The first part covers the basic outline and architecture of fog. The second part talks about the working of Fog Computing and its benefits and limitations.

Keywords: Fog Computing, Cloud Computing, Internet of Things, Fog Servers.

I. INTRODUCTION

Edge computing was introduced to overcome the restraint of cloud computing. A plethora of data is generated by increasing number of connected Internet of Things (IoT) that cloud computing is not enough to deal with. All the servers in cloud computing are remotely situated from the end user which makes the data processing measured due to which it was not suitable enough for real time applications. There were 20.35 billion end user devices in 2017 and the number of devices is expected to be 30.73 billion in 2020 [1]. The basic goal of the Internet of Things (IoT) is to provide connectivity between billions of smart things with the help of the internet. Initially, cloud computing was considered as an ideal choice for large storage and processing power but Cloud is centralized in nature. This means that most of the activities come to pass in the cloud. Due to this, it is incapable of responding efficiently and resourcefully as high mobility, location awareness, and low latency requirements are not successfully fulfilled. Cloud provides three service models i.e. Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). Software as a Service (SaaS) permits the end user to send their own application and software on the cloud lateral. The end user can pay for the application and services to access the cloud from anywhere using Platform as a Service (PaaS). Infrastructure as a Service (IaaS) brings about the system in terms of application, network connectivity and storage [6].

Sending data to cloud through internet leads to privacy issues. This is where Fog Computing benefits. There are several Fog devices which are integrated, together with end devices, edge network devices and cloud servers. Fog Computing eliminates the above-mentioned problems and provides location awareness, low latency and improves the Quality of Service (QoS) for real-time applications. Data and computation are put adjacent to the end user in Fog Computing. It operates as a bridge between IoT devices and cloud computing. For example, before transmitting the data to the cloud, it must be filtered and aggregated in the Fog. Fog Computing deletes unnecessary or wrong information and only forwards the filtered data.

When using the cloud, it takes a lot of time to upload and get the data when required. Fog Computing makes it faster to process and get the data which is why it was necessary to focus on this particular topic and Fog makes it more secure also.

II. FOG COMPUTING.

In layman terms, the Fog means cloud near to ground. So, in Fog Computing, the computation happens away from the cloud i.e., closer to the devices. Fog Computing is not trying to take over cloud, but it provides new services to make the Cloud more efficient [2]. Fog Computing is a highly virtualized platform that provides compute, storage, and network services between end devices and traditional Cloud Computing Data Centres, typically, but not exclusively located at the edge of network [3].

Fog Computing gives more importance to the infrastructure whereas edge computing focuses on the things. Fog nodes can be deployed anywhere such as factories, railway tracks etc. Fog servers process the most time-sensitive data in a real-time manner and then forwards that information to the cloud for historical analysis and long-term storage.

In Fog Computing, data is processed at various stages. Whereas, in Cloud Computing data is processed at a single place. Thus, Fog Computing provides greater security than Cloud Computing. Fog Computing is used in the most basic applications as well as the

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other high-end applications. It makes storage and processing of data more efficient. Fog servers are used to collect, process and filter information locally in big data environment where millions of smart meters are fixed in the consumer home. Due to reduced latency, fog computing turns out to be very useful for emergency medical service, ambulance communications or portable access to patient medical files [5]. Augmented Reality applications are highly bigoted to latency. Client skills can be affected by little delays. Thus, Augmented Reality Systems are supported by Fog Computing which helps to reduce the processing delays and increases performance. Fog computing works fit in a cloud-based control plane to bring control and comprehensive insight across abundance of nodes. These include transportation, surveillance, wind energy, agriculture, smart cities and buildings.

III. FOG COMPUTING ARCHITECTURE.

The structure of Cloud Computing consists of the end users/devices and the Cloud, but the Fog Computing structure is different. The Fog Computing structure has three layers: end users/devices (Device layer is the bottom layer), Fog nodes (Fog Layer is the middle layer), and the Cloud (Cloud Layer is the topmost layer).

A. Device Layer

This layer lies at the bottom of the Fog Computing Structure. This layer includes all the end-user devices like mobile phones, smart cards, smart vehicles etc. which are distributed geographically. The information from this layer is Collected and sent to the upper layers for further pXocessing [4].

B. Fog Layer

This is the middle layer. This layer lies between the Cloud and the end devices. Fog Layer contains various devices such as router, access points, gateways, switches, and video surveillance cameras that act as the Fog nodes (also called as Fog Servers). These Fog nodes are distributed geographically among the end devices. They collect information from the Device Layer. This layer plays an important role in the transmission between the Cloud Computing Layer and the Device Layer [4].

C. Cloud Layer

It is the topmost layer in the Fog Computing environment. This layer is responsible for making all decisions and analysing the data. It is also responsible for permanent storage [4]. Cloud Layer can store and process massive amounts of data. The Fog Computing Layer can be assigned some task by this layer as the Fog servers are more meaningful for local analysis and quick decision making.

IV. HOW FOG COMPUTING WORKS?

Fog nodes are deployed throughout your network in Fog Computing Architecture. They are deployed in target areas (such as, your office or vehicle).

The data generated by the IoT devices (end-user devices) can be analysed by means of these Fog Nodes without the need of being sent all the way to the cloud.

Transporting data through Fog Computing has the resulting steps:

A. Signals from the end-user devices are wired to an automation controller which then implements a control system program to automate the devices.
B. The control system program sends the data through to a protocol gateway.
C. The data is then transformed into a protocol that can be more effortlessly understood by the internet-based services.
D. This data is the finally sent to the Fog Nodes for analysis where it is filtered and saved to send to the cloud later.

V. BENEFITS AND LIMITATIONS OF FOG COMPUTING.

There are various reasons as to why Fog Computing has been deployed even though Cloud is already there. The focus is mainly on better efficiency but there are various other benefits:

A. Low Latency

Fog Nodes are closer to the end-user devices, providing computing services and taking decisions based on the local data without using the cloud. Thus, the latency in response is much less than the latency in Cloud computing architecture which has very high latency.

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B. Reduced Performance Requirements

The amount of bandwidth is reduced as the need to communicate to sensors and the cloud is undesired. This is because the data is not sent to the Cloud.

C. Geographical Distribution

As Fog Computing is a decentralized form of networking, it offers a very extensive range of geographical distribution than the traditional networking or cloud computing Architecture [3].

D. Location Awareness

It is the ability to find out the geographical location of a device [4]. The end-user device is connected to the nearest Fog Node and this Fog Node knows where the client is located. This is very helpful during emergency situations.

E. Save Storage Space

Fog Computing structure is one of the best options to avoid improper or unrelated data to move to the whole network. Thus, it saves the storage space [4].

Even though Fog Computing has various benefits over Cloud Computing, it has its own limitations too:

1) *Physical Location:* Fog Computing is much more geographically restrictive and limiting than a cloud service. It cannot be accessed from anywhere as it is used to cooperate with the devices on a local level.
2) *Security:* Fog Computing relies strongly on trusting those near to the edge of the network and the Fog Servers to maintain and guard them against malicious objects. The lack of perceptibility of these systems due to their physical location can leave enterprises exposed to external threats.
3) *Complexity:* The Fog Computing architecture needs to be maintained and adding a patchwork of complex technologies (traditional infrastructure, cloud services and fog computing) together makes this a very problematic task.

VI. FUTURE SCOPE

Fog Computing is still in its preliminary stages and it is constantly being updated and worked on. A major extension for Fog Computing would involve using machine learning techniques to decide which packet should be processed in the Fog and which packet should be processed in the Cloud.

Another change that needs to be worked on are the security challenges faced by Fog Computing. Increased authentication, validation, privacy, and data security has to be achieved.

VII. CONCLUSION

I have outlined the vision of Fog Computing. This paper discusses the basic concept of Fog Computing and the structure of Fog Computing. It talks about the working of Fog Computing and how it is used along with its benefits and certain limitations.

I further proceeded to compare the similar paradigms of Fog Computing and how they are different from each other. Then I have given the basic overview of the applications of Fog Computing in various fields like smart grid, health care system, augmented reality etc.

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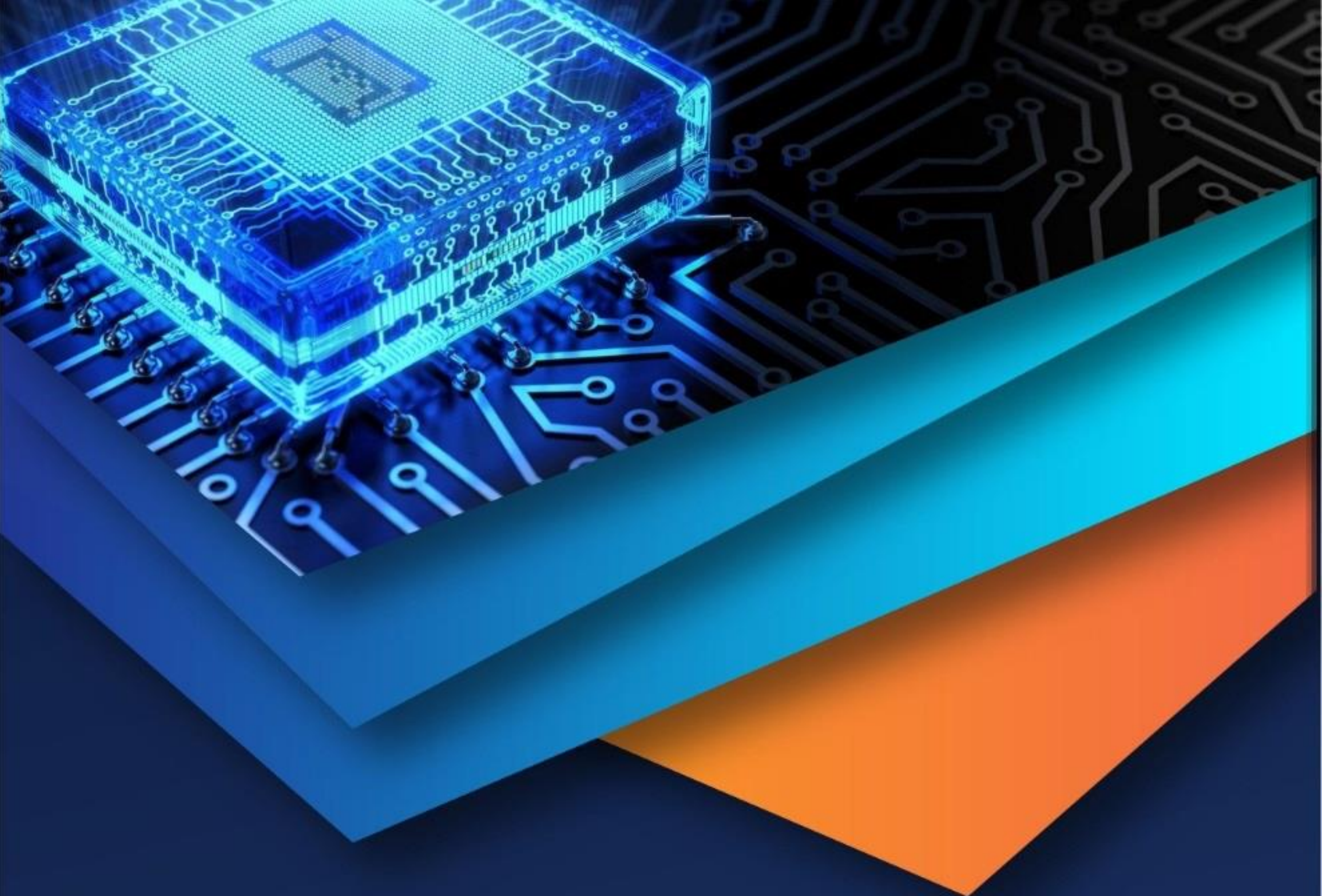

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