Cloud-integrated Fog Big Data Analytics for the Internet of Things Design

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ABSTRACT
An enormous amount of data is produced by the diverse devices connected to the Internet of Things (IOT) and must be transferred to a central server for review. The cloud is used to store and handle vast amounts of data, but its services have a far delay in responding, making them unsuitable for real-time applications occasionally. To deal with this, a novel concept known as fog computing is presented, which will speed up the process of obtaining information. This research has investigated how big data analytics can be improved by integrating fog computing with cloud computing. It also discusses issues associated with fog computing.

Keywords: Bigdata, Data Analytics, Cloud Computing, Internet of things, Fog computing.

INTRODUCTION
In an Internet of Things (IOT) context, big data refers to the enormous volume of data gathered from homogeneous devices or various device kinds across the internet. Bigdata analytics is the use of sophisticated analytical techniques on large datasets to extract meaningful information and practical knowledge [11]. Data in an IOT environment can originate from a variety of sources, including sensors found in smart TVs, devices such as smart speakers, smart metres, and professional safety devices, among others. Since the memory on these Internet of Things devices is so small, it is nearly impossible to keep, process, and retrieve information obtained from them [12]. This problem is resolved by cloud computing, which saves data on cloud servers and connects to IOT devices virtually.
Cloud data centres that are centrally located make up cloud computing. Massive amounts of data are processed by these information centres originating with IoT gadgets. As a result, cloud computing offers services related to data storage and accessibility via the web from anywhere in the world. But using cloud services comes with a price: greater delay, slower reaction times, greater bandwidth needs, less support for mobility, lower throughput, and less privacy [13].
These issues make cloud computing inappropriate for applications that require latency, time sensitivity, and mobility support systems.
By combining fog computing and cloud computing, the difficulties in cloud computing can be solved. Between the client and the cloud, fog computing is a virtual layer that facilitates access to information, processing, and data storing and retrieval on final devices. Fog computing finds use in automated parking, intelligent transport, smart building, intelligent traffic signalling, smart driverless car, smart railway, smart recognition of faces, and more.
The remainder of this essay is divided into four sections: II presents an overview of fog computing; III details the framework of the fog integrated cloud; IV discusses the problem in fog computing; and Section

V offers a conclusive section.

RELATED WORK

Too far, many experts have focused on improving data analytics methods in the context of the Internet of Things with cloud and fog computing. In Table 1, their work is examined.

Table 1: Data analytics techniques in the environment of internet of things

Author/Year	Title	Concept
Sultan Ahmad (2020)	Big Data Analytics with Fog Computing in integrated Cloud Fog and IoT Architecture for Smart Devices	Suggested a fog computing architecture that transfers the computational load directly to the edge devices, so addressing the problems with overall performance.
Segall, R et al.(2018)	Big Data and Its Visualization With Fog Computing	The challenging circumstances and potential applications of Big Data and fog computing have also been explained in relation to their work [1].
Segall, R et al.(2019),	Overview of Big Data-Intensive Storage and its Technologies for Cloud and Fog Computing	Examined issues with High Performance Computing (HPC) infrastructure, environments for data-intensive applications' storage systems, and storage configurations and architectures for Big Data using fog-to-cloud infrastructure. [2]
Mehdipour, F et al. (2019)	Fog Computing Realization for Big Data Analytics. Fog and Edge Computing: Principles and Paradigms,	The Fog Engine deployment process for large-scale data analytics [3].
A.A. Mutlag et al. (2018)	Enabling technologies for fog computing in healthcare IoT systems, Future Generation Computer.	They used simulation to describe the latency advantage of fog computing over cloud computing, which is important for real-time applications like healthcare [4].

Chang et al (2017)	Efficient Fog Computing Infrastructure for the Internet of Things, in Computer.	It functions to process data that has been gathered from various sensors and devices. A growing number of static sensor devices may be added to the Indie Fog framework, which also provides the basis for exceptional services and active statistics collecting and processing [6].

OVERVIEW OF FOG COMPUTING

Introduced by Cisco in 2012, fog computing is a shared computing concept that is coupled with cloud computing to improve the quality of service and create various Internet of Things applications [8]. Fog computing is making use of a cloud situated near the consumer's residence or place of business to carry out local data pre-processing and filtration in fog devices, as opposed to transferring data to a cloud. Fog computing reduces the volume of data sent throughout the system, increasing its overall effectiveness. The fog cloud has a modest amount of storage and little processing power.

Numerous fog nodes are arranged in a network close to the end user in the fog network. Fog gateways, fog servers, and fog devices are examples of the fog nodes. The required data can be stored by the fog devices, and the data can also be computed by the fog servers. Typically, fog servers are connected to fog devices. Redirecting information between the various fog devices and servers is the responsibility of fog gateways.

The following benefits are provided by fog computing:

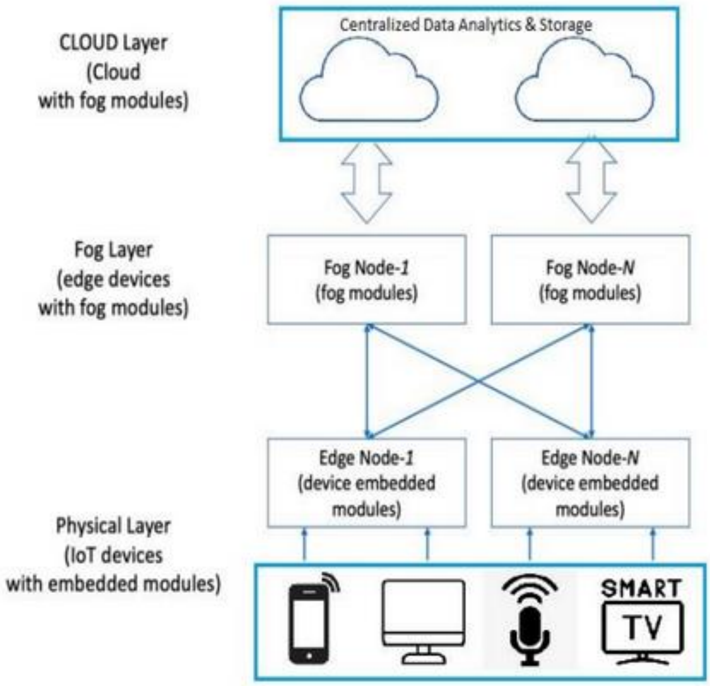
- It allows for certain information preparation and retention, which lowers the amount of data and, thus, the load on the cloud [19].
- It offers the best use of edge network resources compared to cloud networking.
- Fog computing enhances data safety and reliability while minimising delay issues and operating efficiently on low connectivity.
- More mobility and availability of services are offered by the fog nodes, even in the event of an Internet connection outage.
- A better user experiences with quick responses.

CLOUD ARCHITECTURE WITH FOG INCORPORATED.

IoT environments use a complex structure for data analytics that combines cloud computing, edge fog computing, and interconnected sensors. Big Data collection, processing, and distribution are some of the elements of fog computing, which is a distributed system [15]. In Figure 1, the schematic architecture is displayed. IoT devices with sensors gather data and send it to edge and fog servers. A computer or another gadget linked to the device system, such as routers, servers, or controllers, is an edge node. Irrespective of the data's significance, the edge nodes send all of the data they have generated or acquired to the fog nodes.

A layer that lies between the cloud and the edge is called fog. After receiving the input, the fog nodes examine what's significant. Significant information prior processing, extraction, and filtering are further functions that fog nodes can do. They can either remove the unnecessary data or save it for later examination. The information that has been processed is then sent to the cloud by the fog nodes for storage. Fog computing delivers critical data fast and conserves a lot of cloud capacity in this way. By combining cloud computing and fog, an IoT platform's data analysis costs can be reduced while its effectiveness is raised.

Figure 1: FOG incorporated with Cloud architecture.



DIFFICULTIES WITH FOG COMPUTING

Fog computing operates in a distributed environment that considers numerous obstacles among the principal obstacles are:

Decentralised architecture: Fog computing's decentralised architecture produces a duplicate structure. Devices situated at the periphery of the network may exhibit instances of code duplication. The fog environment should therefore concentrate on lowering the redundancy.

Networking resources: At the edge of the fog architecture, the network resources are dispersed at random. To handle the intricacy of connectivity, a suitable network is needed.

Gadget variability: The fog architecture's endpoints are diverse. Furthermore, this element of heterogeneity at the device and network should be considered by the fog services.

Computational difficulties: While certain calculations are carried out at low costs of computation at fog clouds, others are offloaded to clouds where response time and computational capacity are not restricted. Determining which calculations must be carried out at the cloud and which ones must be performed at the fog is a hurdle.

The Fog Architecture poses security problems due to its diverse composition of devices. They could be open to several kinds of attacks. Since the fog's gadgets are situated in an area with low levels of security, any weak point or physical assault can be quickly exploited.

CONCLUSION

The benefits of fog computing and how it integrates with cloud computing are the main topics of this study. Additionally, it outlines an architecture that shows how the Cloud, Fog, and IoT layers combine to enable efficient big data analytics. It is evident that fog computing is necessary for the burgeoning networks like IoT and big data, which demand quicker processing with lower latency. Nonetheless, there are still certain difficulties with fog technique utilisation, which are covered in this study.

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