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Edge Computing

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ABSTRACT

With the rapid development of the Internet of Everything (IoE), the number of smart devices connected to the Internet is increasing, resulting in large-scale data, which has caused problems such as bandwidth load, slow response speed, poor security, and poor privacy in traditional cloud computing models. Traditional cloud computing is no longer sufficient to support the diverse needs of today's intelligent society for data processing, so edge computing technologies have emerged. It is a new computing paradigm for performing calculations at the edge of the network. Unlike cloud computing, it emphasizes closer to the user and closer to the source of the data. At the edge of the network, it is lightweight for local, small-scale data storage and processing. In financial services, gaming, health care and retail, low levels of latency are vital for a great digital expertise. To improve reliability and faster response time, combine cloud with edge infrastructure.

Keyword - Edge Computing; Cloud; Internet of Things (IoT); Distributed; Centralized; Smart home and city.

I. INTRODUCTION

In a future various information and things should be connected to network and our expectation will be people can live more convenient and comfortable lives. And with things coordinate together and coordinated with the information is expected that even more values will be created. When there is information and things where connected to network, it is referred to as Internet of Things, IoT. A huge and varied incomplete data generated by IoT need to be processes and responded to in a very short time. Today the cloud has become an indispensable part of that process. However, the cloud that has centrally deployed on a global scale needs to process a numerous amount of data. In addition, as a physical distance between the user and the cloud increases, transmission latency increases with it, also increases responses time and stressing out the users. On top of that the processing speed in this environment is largely depends upon the performance of users devices.

The solution to this problem is the edge computing platform. The edge computing platform works by allowing some application processing to be performed by a small edge server, positioned between the cloud and the user and crucially in a location physically closer to the user. This allow for some of the workloads to be overflowed from the cloud over user device and

a location close to the user for processing. While speeding up the application that require a low latency response.

Definition of edge computing :- Satyanarayanan, a professor at Carnegie Mellon university in the United States, describes edge computing as: "Edge computing is a new computing model that deploys computing and storage resources (such as cloudlets, micro data centers, or fog nodes, etc.) at the edge of the network closer to mobile devices or sensors.

II. WHAT IS THE EDGE COMPUTING

Edge computing is a "mesh network of micro data centers that process or store critical data locally and push all received data to a central data center or cloud storage repository, in a footprint of less than 100 square feet" according to research firm IDC.

Edge computing is a method of optimizing cloud computing systems by performing data processing at the edge of the network, near the source of the data. This reduces the communications bandwidth needed between sensors and the central datacenter by performing analytics and know edge generation at or near the source of the data. This approach requires leveraging resources that may not be continuously connected to a network such as laptops, smartphones, tablets and sensors.

Edge computing covers a wide range of technologies including wireless sensor networks, mobile data acquisition, mobile signature analysis, cooperative distributed peer-to-peer ad hoc networking and processing also classifiable as local cloud/fog computing and grid/mesh computing, dew computing, mobile edge computing, cloudlet, distributed data storage and retrieval, autonomic self-healing networks, remote cloud services, augmented reality, and more. .

III. HOW THE EDGE COMPUTING WORKS

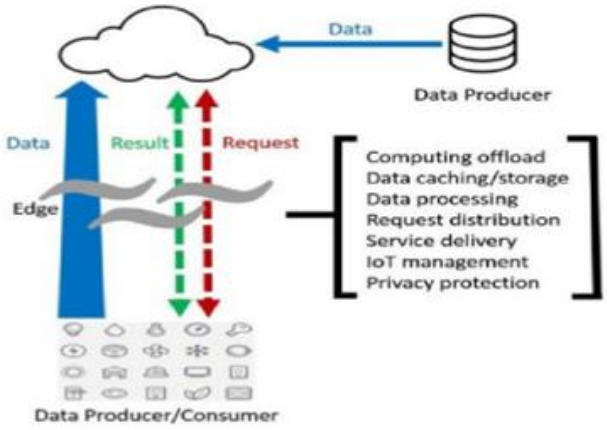
Currently, the entire world is going towards digitalization, and lots of data is produced in various fields. Moreover, in most cases, this data needs to be processed in a short time to facilitate the present technology (real-time applications).A few years back, cloud technologies have been introduced, gradually reducing the need for small and medium-scale companies and research institutes to own a computer to do the computations. Nevertheless, the end-users still need to send and receive the data to and from the location where the machine is located. In contrast, Edge Computing is an alternative option for doing computations where the data is located, and is especially suited for real-time applications.

Push from the Cloud Services: In general, Cloud Computing has proven to be very efficient in terms of computation, but in some situations, there has to be an alternative solution to avoid data transfer bottlenecks. Edge Computing is solving this problem. For example, a Boeing 787 produces 5 Gigabytes (GBs) of data every minute , and transferring this data to a satellite or the ground is not efficient for data processing.

Push from the Internet of Things: Presently, electronic devices such as LEDs, surveillance cameras, and air quality sensors are part of the IoT, and they produce and consume a lot of data. In future, there will be even more electronic devices that will be connected to the IoT. It is not feasible to process all the data in the cloud due to the bandwidth and latency. This means some of the data need to be processed at the level of Edge devices. Moreover, privacy is a big concern for cloud solutions. Edge Computing can minimize this concern by restricting the data within the Edge.

Change from a Data Consumer to a Producer: A device at the Edge not only consumes the data from the cloud, but it also produces the data and uploads the data to the cloud. Watching a YouTube video from your mobile phone, using Facebook and Instagram, are examples where Edge users pull the data from the cloud. At the same time, Edge devices produce the data, such as taking pictures or recording videos. When the Edge users try to upload this data to the cloud, it could be a lot of data depending on the resolution. This would occupy even more bandwidth for the uploading. In a

situation like this, the resolution can be adjusted at the Edge device before uploading the data to the cloud.



IV. EDGE COMPUTING TERMS

Here are the key components that form an edge ecosystem: ˆ

Edge devices: A special-purpose piece of equipment with limited computing capacity. These can be any device that produces data. These could be sensors, industrial machines or other devices that produce or collect data. ˆ

Edge node: Any device, server, or gateway that performs edge computing. What the edge is depends on the use case. In a telecommunications field, perhaps the edge is a cell phone or maybe it's a cell tower. In an automotive scenario, the edge of the network could be a car. In manufacturing, it could be a machine on a shop floor; in enterprise IT, the edge could be a laptop.

Edge server: A computer located in a facility close to the edge device. These machines run application workloads and shared services, so they need more computing power than edge devices. Edge servers can be defined as "a computer for running middleware or applications that sits close to the edge of the network, where the digital world meets the real world. Edge servers are put in warehouses, distribution centers and factories, as opposed to corporate headquarters.

Edge gateway: An edge server that performs network functions such as tunneling, firewall management, protocol translation, and wireless connections. A gateway can also host application workloads. A gateway is the buffer between where edge computing processing is done and the broader fog network. The gateway is the window into the larger environment beyond the edge of the network.

Cloud: A public or private cloud that acts as a repository for containerized workloads like applications and machine learning models. The cloud also hosts and runs apps that manage edge nodes.

V. LITERATURE SURVEY

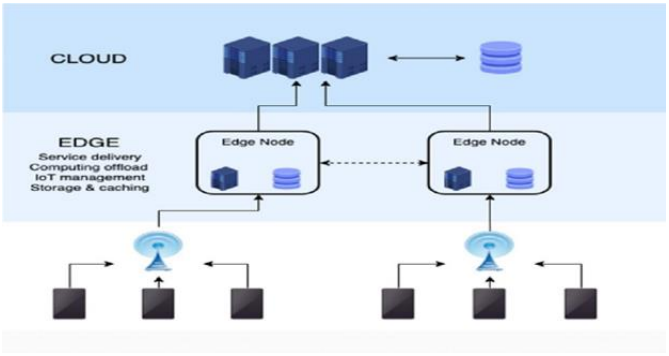
This paper Keyan Cao published on 6 May 2020 describes that With the rapid development of the Internet of Everything (IOE),the number of smart devices connected to the Internet is increasing, resulting in large-scale data, which has caused problems such as bandwidth load, slow response speed, poor security, and poor privacy in traditional cloud computing models. Traditional cloud computing is no longer sufficient to support the diverse needs of today's intelligent society for data processing, so edge computing technologies have emerged. It is a new computing paradigm for performing calculations at the edge of the network. At the edge of the network, it is lightweight for local, small-scale data storage and processing. Reviews the related research and results of edge computing. First, it summarizes the concept of edge computing and compares it with cloud computing. Then summarize the architecture of edge computing, keyword technology, security and privacy protection, and finally summarize the applications of edge computing.[1]

In this paper Ms. Dalbina Dalan Asst. Professor Mar Kuriakose Arts and Science College, Puthuvely, Koothattukulam, Kerala, India sumarises that IoT devices are gaining momentum from wearables to vehicles to robots. As we are moving to a world with lots and lots of data, and data processing the need of a faster connection is becoming crucial[3]. While a centralized data center or cloud for data management, processing and storage has its limitations. Edge

computing can provide an alternative solution for this. But since the technology is still in its immaturity, it is difficult to predict its success in future. Even though, there will be more opportunities for companies to test and set up this technology. In that there are already, some use cases may prove the value of edge computing more clearly, its potential impact on our ecosystem as a whole.[4] Discussed the introduction of edge computing and what is the edge computing which describes the how really the edge computing works. What is the difference between edge computing and cloud computing. They discussed what are the benefits of edge computing and drawbacks of edge computing.
Ezhilmathi Krishnasamy,this report gives an overview of the Edge Computing paradigm and its applications. Indeed, with the advent of the Internet of Things (IoT) era, many electronic devices and sensors produce a vast volume of data which should be processed in a timely manner and this novel computing model is nowadays seen as a pertinent answer to this open challenge. This report thus explains why Edge Computing is needed and how the edge architecture is typically structured. It further presents the technologies that help this cutting-edge model to function properly. Since Edge Computing involves a heterogeneous architecture, it requires to adapt to a few technological recommendations for optimal performance.[1]

VI. ARCHITECTURE OF EDGE COMPUTING

Edge computing architecture is a federated network structure that extends cloud services to the edge of the network by introducing edge devices between terminal devices and cloud computing. The structure of cloud-edge collaboration is generally divided into terminal layer, edge layer and cloud computing layer.
The following is a brief introduction to the composition and functions of each layer in the edge computing architecture.
Edge Device Layer : The Edge Device Layer consists of all types of devices connected to the edge network, including mobile terminals and many Internet of Things devices (such as sensors, smartphones, smart cars, cameras, etc.). In the terminal layer, the device is not only a data consumer, but also a data provider. In order to reduce the terminal service delay, only the perception of the various terminal devices is considered, not the computing power. As a result, hundreds of millions of devices in the terminal layer collect all kinds of raw data and upload it to the upper layer, where it is stored and calculated. ˆ
Local Edge Layer: The edge layer is the core of the three-tier architecture. It is located at the edge of the network and consists of edge nodes widely distributed between terminal devices and clouds. It usually includes base stations, access points, routers, switches, gateways, etc. The edge layer supports the access of terminal devices downward, and stores and computes the data uploaded by terminal devices. Connect with the cloud and upload the processed data to the cloud. Since the edge layer is close to the user, the data transmission to the edge layer is more suitable for real-time data analysis and intelligent processing, which is more efficient and secure than cloud computing.
Cloud Computing Layer: Among the federated services of cloud-edge computing, cloud computing is still the most powerful data processing center. The cloud computing layer consists of a number of high-performance servers and storage devices, with powerful computing and storage capabilities, and can play a good role in areas requiring large amounts of data analysis such as regular maintenance and business decision support. The cloud computing center can permanently store the reported data of the edge computing layer, and it can also complete the analysis tasks that the edge computing layer cannot handle and the processing tasks that integrate the global information. In addition, the cloud module can also dynamically adjust the deployment strategy and algorithm of the edge computing layer according to the control policy.



VII. ADVANTAGES AND DISADVANTAGES OF EDGE COMPUTING

1) Advantages of edge computing: -

1. Faster response time: Power of data storage and computation is distributed and local. No roundtrip to the cloud reduces latency and empowers faster responses. This will help stop critical machine operations from breaking down or hazardous incidents from taking place.
2. Reliable operations when intermittent connectivity: For most remote assets, monitoring or unreliable internet connectivity regions such as oil wells, farm pumps, solar farms or windmills can be difficult. Edge devices' ability to locally store and process data ensures no data loss or operational failure in the event of limited internet connectivity.
3. Security and compliance: Due to edge computing's technology, A lot of data transfer between devices and cloud is avoidable. It's possible to filter sensitive information locally and only transmit important data model building information to the cloud. This allows users to build an adequate security and compliance framework that is essential for enterprise security and audits.

2) Disadvantages of edge computing

1. Security: Ensuring adequate security can be often challenging in a edge distributed environment. Due to the fact that data processing takes place at the outside edge of the network there are often risks of identity theft and cyber security breaches. Additionally, whenever a new IoT device is added here, it will increase the opportunity for the attackers to infiltrate the device.
2. More Storage Space: Edge computing does take a considerably higher storage space on your device. Since the storage devices are becoming more compact this will not actually be a problem. However, it is a point to remember in when developing an IoT device.
3. Investment Cost: Implementing an edge infrastructure can be costly and complex. This is due to their complexity which needs additional equipment and resources. In addition to that the IoT device with the edge computing comes with the need of more local hardware for them to function. This can overall lead to more efficiency but a significant investment is required.

VIII. CONCLUSION

This report gives an overview of the Edge Computing paradigm and its applications, provides the comparison between edge and cloud computing and what are the advantages of edge computing. Edge computing provides data storage and computing at the edge of the network, and provides Internet intelligent services nearby, providing support for the digital transformation of various industries, and meeting the requirements of different industries for data diversification.

IX. FUTURE WORK

Shifting data processing to edge of the network can help companies take advantage of the growing number of the iot edge devices, improve network speeds, and enhance customer experiences. Edge computing offers several advantages over traditional forms of network architecture and will surely continue to play an important role for companies going forward

X. APPLICATIONS OF EDGE COMPUTING

1. Transportation: Autonomous vehicles are one of the potential applications of edge computing. Self driving vehicles for its smooth operation, they are heavily equipped with all type of sensors.The IMU sensors can provide accurate analytics on what motion happened in driving a car-i.e., hard brakes, suddenlane changes, etc. Data from IMU sensors does not answer why the driver acted in that manner. For that, we have lots of camera, the video stream from these cameras will only go locally to the edge server and process them locally and give directions, instead of sending it to cloud, which result in latency.

2. Healthcare: People have become increasingly comfortable wearing fitness trackers. Critical brain disease for example are diseases which require real time management. The real time data sending to the network is very big leading to hundreds of mega byte for one patient. And with so many of such cases sending data concurrently will result in network congestion. The doctor response to emergencies is late because of the increased response latency. Edge computing is a solution to this. Collect the data from the patient such as ECG, Heart rate, EEG, etc. and send it to any smart edge device, where data get processed intelligently and understand patient condition. Thus reducing the amount of data to be send to the server. Doctors would be able to offer faster better care to patients while also adding an additional layer of security to the patient generated health data.

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