An Overview of Edge Computing

Ms. Dalbina Dalan
Asst. Professor
Mar Kuriakose Arts and Science College,
Puthuvely, Koothattukulam, Kerala, India

***Abstract*— Cloud Computing has revolutionized how people store and use their data. However, there are some areas where cloud is limited; latency, bandwidth, security and a lack of offline access can be problematic. To solve this problem, users need robust, secure and intelligent on-premise infrastructure of edge computing. When data is physically located closer to the users who connect to it, information can be shared quickly, securely, and without latency. 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.**

Keywords- 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.

Alex Reznik, Chair of the ETSI MEC ISG standards committee, has a broad definition, "anything that's not a traditional data center could be the 'edge' to somebody."[1] Other definitions are more limited. *The State of the Edge* report[2] concentrates on servers "in close proximity to the last mile network." Philip Laidler believes "edge compute includes workloads running on customer premises."[3] Some call this the customer, enterprise or device edge. Another, more inclusive way to define "edge computing" is to include any type of computer program delivers low latency nearer to the request.

II. WHAT IS EDGE COMPUTING?

By digital transformation and emerging technologies, everything in the world is becoming "smart"-cities, cars, agriculture, health, etc. In future the data will be heavy, with billions of devices connected to the internet, thus faster and more reliable data processing will become crucial.

Centralized nature of cloud computing has proven cost-effective and flexible but rise of IoT and mobile computing has put a strain on networking bandwidth over recent years. For this where edge computing comes in .According to the CB Insights Market Sizing tool, the global edge computing market is established to reach by 2022.[4] edge computing enables data to be processed closer to where it is created, reducing the need to transfer data back and forth between the cloud. Some of the biggest players who are exploring edge computing, and potentially giving rise to the next big computing race are Amazon, Microsoft and Google. IoT is common in our daily life and edge computing has become and an active research field to address the concerns of response time requirement, bandwidth cost saving, data safety and privacy. By edge computing Artificial Intelligence services will effectively mitigate loads on data centers, and also edge computing with the IoT field are created new opportunities by enabling smart homes, smart hospitals, smart cities, smart wearable, e-health, and variety of other smart environments.

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.[5]

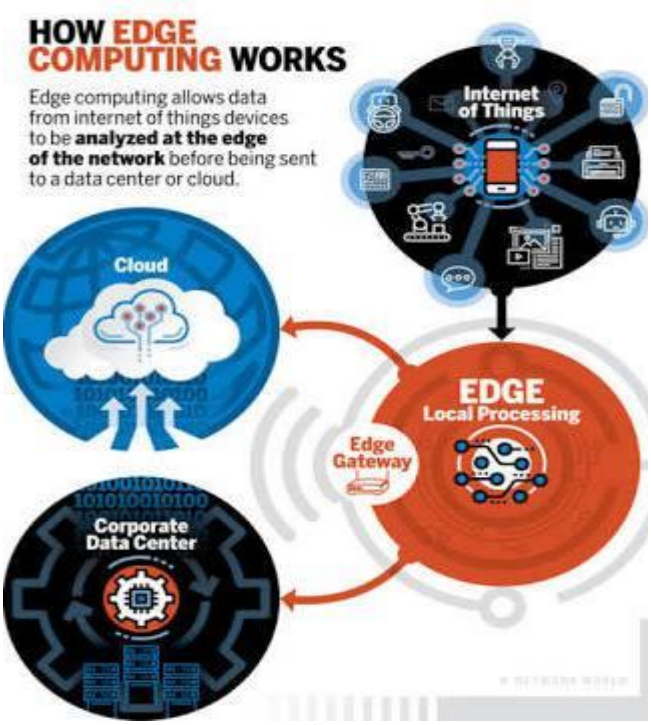

Fig. 1. Working of Edge Computing

The edge is what it depends on the use cases. For telecommunication system, the edge is a cell phone or a cell tower. For an automotive system, the edge could be a car. In manufacturing field, an edge could be a machine on the shop. And for an IT enterprise the edge may be a laptop.[6]

Edge server 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."[6]

Any devices that produce data can be the edge device. It may be sensors, industrial machines or other devices that produce or collect data.

III. EDGE COMPUTING AND CLOUD COMPUTING

Cloud computing enables user to store and process data outside their physical hardware and across a network of remote servers, i.e. cloud. But centralized cloud computing is not ideal for all applications and use cases. Edge computing gives a solution to this[7].

Edge computing is a form of distributed computing, which covers a broad range of technologies. Edge computing is a growing trend in big data, why because it by moving the computer workload closer to the consumer reduces latency, bandwidth and overhead for centralized data center.

Edge technologies are the gateway through which virtually any industrial machine can connect to and creates a complete computing paradigm from devices at the edge of the system, enables "cloud like" analytics and computing to run on the machine itself. It can understand different computer languages and having the most advanced cyber security features built into the system, enables new control capabilities, and allow machine to act one new data insights by themselves thereby optimizing their performance.

When machine connect to the internet and the cloud, they are able to learn from the overall network that is from other machines, other data sources, etc. and adjust accordingly.

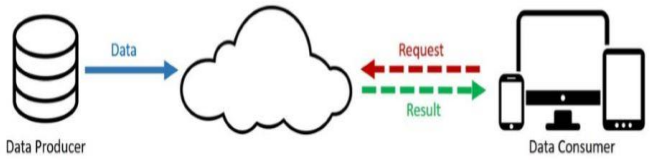

Fig. 2. Cloud computing paradigm

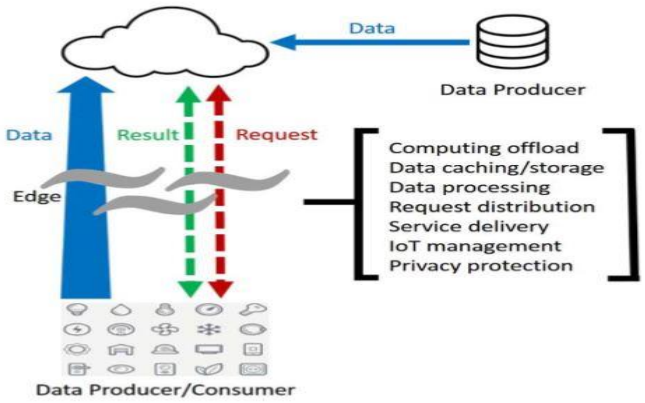

Fig. 3. Edge computing paradigm

IV. APPLICATION DOMAINS

Edge computing across industries

"When we take the power of the cloud down to the device – the edge – we provide the ability to respond, reason and act in real time and in areas with limited or no connectivity … it's still early days, but we're starting to see how these new capabilities can be applied towards solving critical world challenges." – Kevin Scott Microsoft CTO.[8]

A. 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.

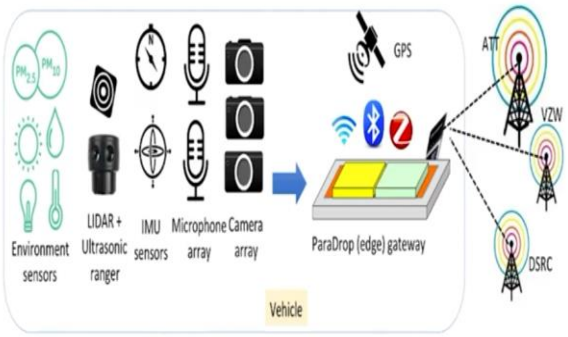

Fig. 4. A platform to support vehicular application

The IMU sensors can provide accurate analytics on what motion happened in driving a car-i.e., hard brakes, sudden lane 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[9].

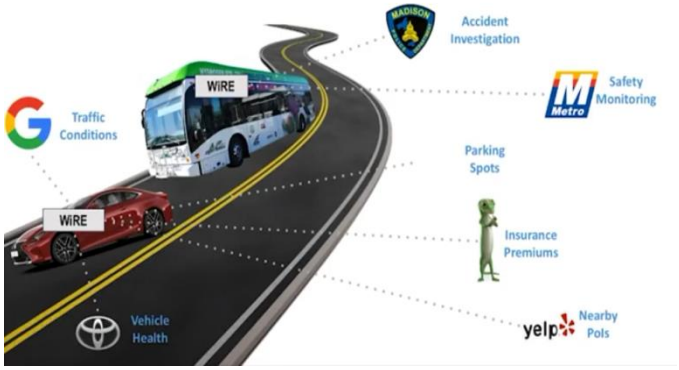

Fig. 5. Transportation application

B. Health care

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[10].

C. Smart Home

Some products such as smart TV, smart light, robot vaccum are available in market today. These all are because of the influence of new technology Internet of Things in peoples life. In smart home environment, the devices are connected and can be controlled by a smart phone, or by a smart device. Besides that a large amount of data being produced and it should be transmitted over network. The cloud has to process these whole data and thus response time will be high, as well as bandwidth and latency. Edge computing is considered to be perfect for building smart home. The data is being analysed and processed where it is created. With the edge gateway running in an edge operating system (edgeOS), the things can be easily connected and being easily managed. The data are being processed locally and there by releases the burdens for internet bandwidth and high privacy and security is given to the data[11].

D. Agricuture

Smart farms use edge computing to monitor temperature, equipment performance and in case of overheating equipments edge computing will help to automatically slow or shut down the processes.

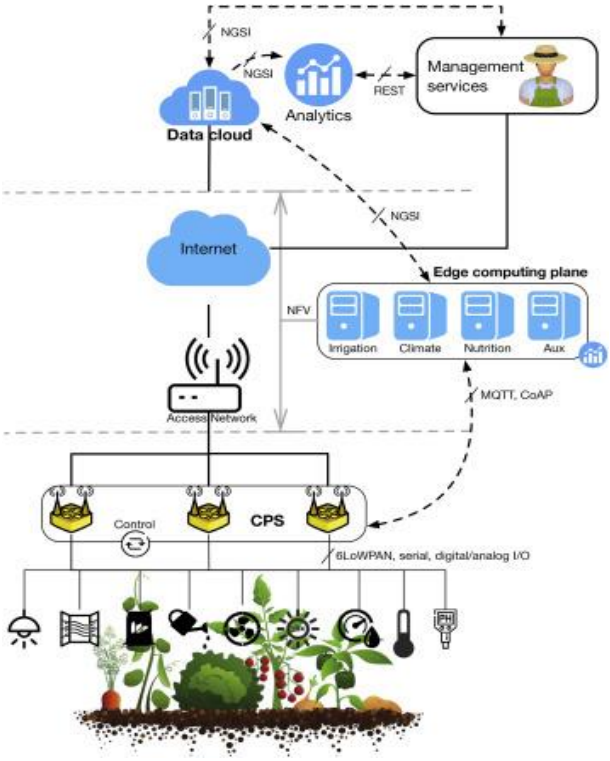

Fig.6. Agricultural application

V. BENEFITS OF EDGE COMPUTING

A. By edge computing you can solve the latency problem. Edge computing on devices ensures that only non-critical data can be acted upon immediately.

B. Edge computing decreases the bandwidth by its decentralized approach. When data are collected, at the every second data processing starts and only those data that need to store are sent to the cloud. This makes edge computing more scalable,efficient and also reduces load on network.

C. By edge computing we can say that there us an additional layer of security too, because most of the data from IoT devices doesnot traverse through the network. Instead at the point of creation itself it is processed.

VI. DRAWBACKS

One drawback of edge computing is that the addition of more ‘smart’ devices into the edge servers and IoT devices that have robust built-in computers, there are new opportunities for malicious actors to compromise these devices.

Another drawback is that it requires more local hardware components. It would require a much more sophisticated computer with more processing power and thereby increasing the cost

VII. CONCLUSION

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. 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.

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