International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 5 Volume No.6 Aug-Sept – 2022
DOI:10.46647/ijetms.2022.v06i05.091 ISSN: 2581-4621

Edge Computing

Jevin J Thomas[1], Cini Joseph[2], Aryadevi CS[3], James Mathew[4], Vishnu K Saji[5]
[1,3,4,5]PG – Master of Computer Applications, Kristu Jyoti College of Management and Technology, Changanassery, Kerala
[2]Associate Professor, Kristu Jyoti College of Management and Technology, Changanassery, Kerala

ABSTRACT
With a rapid development in the field of internet of everything the number of devices using the internet has also increased this will affect the speed of internet. This will lead to the high bandwidth, slow response, poor security and poor privacy in the cloud computing models. Due to the increase in the internet of things there is a very limitation arising for the cloud computing. So there is a lead towards edge computing. It is a computer paradigm for performing calculations at the edge of the devices. It will be closer to the user and closer to the use of data there need only a small response time than the cloud. This article will go through an introduction of edge computing. The architecture of edge computing. The advantages of edge computing. The applications where it is used. A comparison between edge and cloud and finally towards the conclusion.

1.Introduction
Edge computing is the technology that brings the cloud computing towards the edge of internet of things. In the name itself it is said that it is at the edge of the user. This model is to make decision and make actions itself it is close to the user making an intermediate level between the user and the cloud. Transferring all the data's from the network edge towards the cloud data centers for processing may create a latency problem and the bandwidth capacity of the network will increase. For resolving this issue the edge computing has emerged. Edge computing refers to the range of networks at or near the user. Edge is about processing data closer to where it is being generated so it will increase the speed and reduce the bandwidth. It will lead to quick response without any lag.
Edge computing is a distributed information technology architecture in which client data is processed at the periphery of the network as close to the originating source as possible. Edge computing can be said as an extension of cloud computing.

2. Edge computing brief history
In 1990 Akamai launched its content delivery network which has
nodes closer to the end user .These nodes where used to images and videos. Edge computing followed this concept allowing the nodes to perform basic computational tasks. In 1997 computer scientist Brain Noble introduced how mobile technology could use edge computing for speech recognition. After two years the same technology was used to extend the battery life of mobile phones. In 1999 peer-to-peer computing was arrived after that the cloud computing arrived in 2006 and the companies has adopted it in a huge amount. In 2009 ,"the case of VM based cmdlets in mobile computing" was arrived it gives more focus to end-to-end relationship between latency and cloud computing .In 2012 Cisco introduced fog computing to promote the IoT scalability. This finally brings towards the edge computing and this become a key factor and giving more importance to IoT.

3. Why edge computing
The world now is going towards digitalization so the use of data is increasing and the systems using data is also increasing. IN most cases the data need to be produced in a short time to meet up with the new technologies. Edge computing reduces transmission costs by removing extraneous data at or close to the area where it is gathered, in addition to decreasing businesses cloud processing and storage expenses. The moment at which data is produced is the point at which it is processed and

analyzed. Latency is greatly decreased since data does not have to travel over a network to a cloud or data centre to be processed.

4. Architecture of edge computing

The key components that form an edge are:

- Edge devices: A specialized piece of technology with a constrained computational power.
- Edge node: Any device, server, or gateway that uses edge computing is known as an edge node.
- Edge server: A computer situated in a building near to the edge device is known as an edge server. These machines require higher processing power than edge devices because they manage shared services and application workloads.
- Edge gateway: An edge server that manages firewalls, does protocol translation, and manages wireless connections is an edge gateway. Application workloads may also be hosted via a gateway.
- Cloud: Cloud: A repository for containerized workloads, such as apps and machine learning models, that is either public or private. Additionally, the cloud hosts and operates apps that control edge nodes.

4.2 Edge computing has three primary nodes:

The device edge, local edge, and the cloud**.**

The actual site of an edge device's on-premises operation is known as the device edge (cameras, sensors, industrial machines, etc.). The computing capacity of these gadgets allows for data collection and transmission.

A system called local edge handles both network workloads and applications. Two layers make up the local edge:

Due to its enormous footprint, an application layer that executes apps cannot be used by edge devices (complex video analytics or IoT processing, for example).

The layer of the network that controls real or virtualized network devices like switches and routers.

The processing that other edge nodes are unable to undertake is managed by the cloud's application and network workloads. In spite of its name, this edge layer can operate in a private data centre or the cloud.

Multiple nodes may contain industry solutions and applications since different workloads are better suited for devices or local edges. Other workloads may also switch between nodes dynamically in certain situations (either manually or automatically).

An important component of a large-scale edge computing infrastructure is virtualization. The deployment and operation of various apps on edge servers is made simpler by this technology.

5. IoT and edge computing

The process of attaching actual physical objects to the internet is known as the Internet of Things (IoT). Any system of physical hardware or devices that receive and transmit data via networks without human involvement is referred to as an Internet of Things system. An IoT system typically operates by transmitting, receiving, and evaluating data in a feedback loop continually. Humans or artificial intelligence and machine learning (AI/ML) can perform analysis, either in near real-time or over a longer period of time.

When anything is described as smart, IoT is usually implied. As examples, consider autonomous vehicles, smart houses, smart watches, virtual and augmented reality, and industrial IoT.

Edge computing occurs at or close to the physical location of the user or the data source. Users gain from faster, more dependable services with better user experiences when computing services are located closer to these areas, and businesses profit by being better able to support latency-sensitive applications, spot trends, and provide better goods and services.

Edge computing is a method by which a business can scale centralized infrastructure to meet the demands of growing numbers of devices and data by using and distributing a shared pool of resources across a large number of locations.

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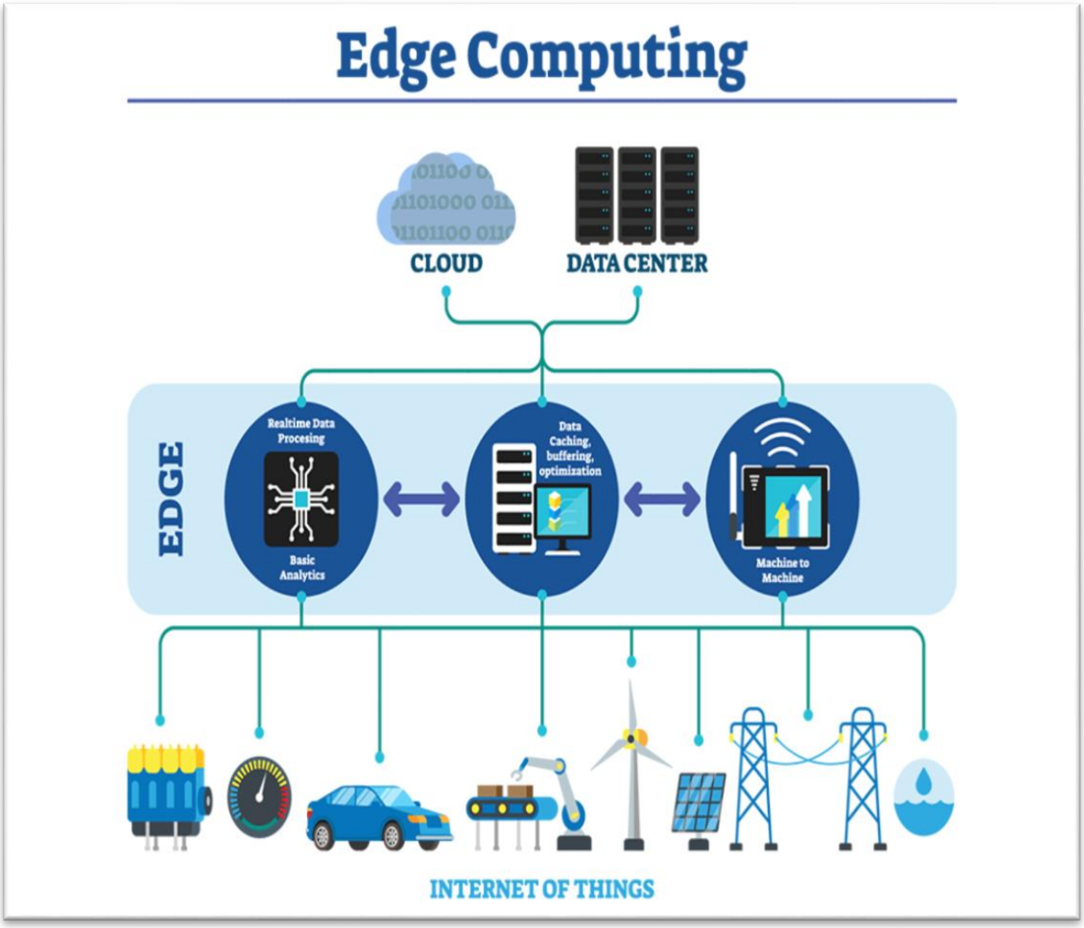

Figure 2. Architecture of edge computing

6. 5G and edge computing

Edge computing has become even more appealing with the introduction of 5G, which has greatly expanded network capacity, decreased latency, boosted speeds, and enhanced efficiency. Data transfer rates of more than 20 Gbps and a million connected devices per square kilometer are two benefits of 5G.

Communications service providers (CSPs) can route user traffic to the edge nodes with the lowest latency using edge computing and 5G in a much more secure and effective way. CSPs can now support real-time communications for cutting-edge technologies like driverless vehicles, drones, and remote hospital monitoring thanks to 5G. By combining 5G and edge computing, data-intensive apps that upload massive volumes of data to the cloud can operate more efficiently.

Developers will need to keep working on enhancing the efficiency of native cloud applications as 5G and edge computing become more prevalent. In order for businesses to fully utilise the potential of 5G and edge computing, existing apps will need to be modified to accommodate the constant arrival of newer, smaller edge devices. Applications may occasionally need to be containerized in order to run on very small devices. In some situations, it may be necessary to reconfigure the virtualized network components in order to fully utilize the 5G network. There are numerous additional situations that need to be assessed as part of the future state architecture and application development roadmap.

7. Types of edge computing

7.1. Internet of things edge

Expectations for latency at this Edge are typically lower than one millisecond. Almost every device with connectivity to a public or private network, like the internet, is covered by this. The gadget could be a basic sensor that transmits information about its surroundings or a sophisticated device with data processing capabilities, like a smart phone. Camera's, factory sensors, connected autos, drones, connected streetlamps, smart parking meters, remote surgery equipment, etc. are a few examples, but there are many more.

7.2. On premise edge

Expectations for latency at this Edge are typically lower than 5 milliseconds. In order to store, process, analyze, and reply to pertinent requests utilizing the data, one requires a mechanism to aggregate data from several devices at the IoT Edge. By providing computational resources on-site, On Premise Edge aids in localizing data processing and cuts down on processing time. For additional requests, the devices at this Edge often connect to a network edge or data centre.

Huge businesses, industrial production facilities, large retail operations, etc. benefit from these types of installations since they may process data close to its source while maintaining their unique rights to the required gear. For instance, Universal Customer Premise Equipment (u-CPE) combines a firewall, WAN optimizer, and router into a single piece of on-premises equipment.

The Software Defined Wide Area Network (SD-WAN) is typically used to meet networking requirements since it enables businesses to combine MPLS, LTE, and broadband internet services. Small Cells can now be installed on-premise and function in both licensed and unlicensed spectrum thanks to 5G.

7.3. Access edge

At this Edge, a typical latency expectation is between 10 and 40 milliseconds. The classic Radio Access Network (RAN), which was previously only available as a fixed function device, has now been decomposed and is now operated as a collection of virtual functions in software on commercially available servers. The key link connecting wireless devices to the main telecom operator network is the radio access network, or RAN.

These virtualized deployments may now be managed using interfaces comparable to managing any other edge device thanks to ideas like virtual RAN (vRAN) and industry projects like Open-RAN and O-RAN. By utilizing Continuous Integration (CI)/Continuous Deployment (CD) frameworks that leverage DevOps paradigms, the move towards cloud native instantiation of RAN function is simplifying the life cycle management of a large number of RAN deployments. Access Edge is a general term for the collection of infrastructures required to deploy and manage software RAN functionalities.

7.4. Network edge

The expected latency at this Edge is typically less than 10 to 40 milliseconds. Before connecting to the centralized data centre, which can cover a wide range of regions, data from various IoT edges, On-premises edge, and Access edge, catering to the individual region, needs to be aggregated. Depending on how close the deployments are to the service provider's primary data centre, they may be referred to as "Network Edge" or "near Edge" deployments.

The Next Generation Central Office (NGCO) design seeks to meet Network Edge needs. Wire line Fixed Access Edge, which offers broadband services like IPTV, VoIP, internet services, etc., is another illustration of this type of edge. The line dividing different device types at this Edge is blurring with the introduction of Fixed Mobile Convergence due to architectural convergence.

8. Edge computing and cloud computing

Compute resources and services are frequently consolidated at sizable datacenters in a cloud computing approach. A piece of the network infrastructure needed to link IoT devices to the internet is frequently provided by clouds.

To enable remote management, to receive automation commands, to forward network telemetry traffic required for analytics, and to send data information which will be recently stored in databases, and analyzed to achieve business objectives, edge devices need network connectivity to central locations.

An edge device could send a log of the decisions it made back to the datacenter for data storage, data management, data processing, or big data analysis as part of the communication offered by a cloud service. Alternatively, the communication could simply be the transfer of data from an edge device across a cloud and into a datacenter.
All data operations in cloud computing take place in a single location.
The majority of data-related processes happen locally in edge computing (on the edge of the environment).
Edge computing is perfect for use cases where processing time-sensitive data is necessary for making decisions. Operations in remote areas with little to no Internet connectivity are another scenario where edge computing is superior to a cloud solution.
Edge computing, however, cannot take the place of the cloud. Edge computing complements the cloud, and the two technologies together ensure better performance for particular use cases. These technologies are not interchangeable.

9. Advantages of edge computing

- Improved speed or reduced latency:

Edge computing eliminates the need to transfer data back and forth between endpoints and the cloud by definition and design. The time savings from eliminating that travel can be measured in seconds, and occasionally even milliseconds. That might not seem like much, but latency, or travel time, is a crucial factor in a connected world where endpoint devices must be able to make decisions in real-time to function properly.
For instance, in order for machines to function safely, autonomous vehicles, industrial and manufacturing IoT deployments, and medical use cases all need them to analyze data and return instructions almost instantly.

- Security and privacy protections:

Because edge computing keeps data close to the edge and away from centralized servers, it can offer improved security and more privacy protections. Edge devices are still susceptible to hacking, especially if they are not sufficiently secured. However, edge devices only store a tiny fraction of the data that could be used by hackers, and frequently incomplete data sets.
On the other hand, endpoint data that is stored in centralized servers has a tendency to be combined with additional data points, which results in a more comprehensive collection of information that hackers may use for malicious purposes. Think about edge computing in a medical setting, for instance. Vital signs are gathered by sensors and analyzed by an edge computing device. Only those readings are stored in that device.
However, if the endpoint sensors send the data back to centralized servers where it's stored with other information, including personally identifiable information about the patient, and that information is hacked, then that patient's privacy is compromised.

- Reduced operational cost:

Although the cost of data storage has significantly decreased over the past decade or so, the cost of moving data is rising as its volume rises. According to experts connectivity fees will increase further as data volumes soar. In order to handle the load, users will presumably need to implement more bandwidth, which will raise the cost.
By minimizing the amount of data transferred back and forth to the cloud, edge computing can help keep costs under control, or at least from rising as high as they could.

- Reliability and resiliency:

If the communication channels are slow even though the edge computing can operate. For example, an energy company could choose to move only the necessary processed data from the edge back to its data centre when the connection is available rather than continuously relying on a satellite connection to relay data to a data centre for processing. A failure at one edge device won't affect the performance of other edge devices in the ecosystem, improving the reliability of the entire connected environment. Edge computing further improves resilience by reducing a central point of failure, as is the case with centralized servers.

- Scalability:

Similar to cloud computing, businesses can add edge devices as their uses grow, ensuring that they are only deploying and managing what is necessary. Organizations can scale at the edge more effectively because endpoint hardware and edge devices frequently cost less than adding more computing resources inside a centralized data centre.

10. Disadvantages of edge computing

Edge computing expands a network's potential attack surface. In order to inject malicious software and infect the network, an attacker may use edge devices as a point of entry for cyber attacks. Unfortunately, in a distributed environment, setting up adequate security is challenging. The majority of data processing happens away from the main server and the security team. When a company adds a new piece of equipment, the attack surface also expands. The cost of edge computing is another frequent issue. Setting up the infrastructure is expensive and difficult unless a business collaborates with a nearby edge partner. Due to the team's need to maintain numerous devices at various locations, maintenance costs are frequently high.

11. Edge computing use cases

Autonomous vehicles: Autonomous vehicles have the ability to connect to the edge to increase efficiency, decrease accidents, and relieve traffic congestion. These vehicles contain a variety of sensors, and it is necessary to process the enormous amount of data that these sensors generate quickly.

Healthcare: By analyzing information from medical devices like blood pressure cuffs and glucose monitors, Edge could support sophisticated remote patient monitoring by warning clinicians when readings are concerning. It might make it possible to manage medical equipment in real-time as different pieces travel between hospitals.

Industries: The edge brings computing as near as possible to the data source. Connecting all the resources used in manufacturing oil and gas, energy, or transportation is known as industrial edge computing, and processing that data locally is what it entails. The way data is handled, processed, and delivered is transformed for immediate business benefits by running fewer processes in cloud and enterprise systems and bringing them closer to the devices generating data.

Agriculture: By using edge computing, the farm or greenhouse will be able to operate independently of its connection to the main server and base its decisions on information from nearby sensors. As a result, agriculture may become more dependable in terms of the process and waste may be reduced.

These are some of the use cases from a large number of use cases.

Conclusion

In this changing world the technology also need to be improved. The internet of things are increasing so fetching data from cloud will lead to a greater latency by that the time will be wasted the response can't be done quickly. So to resolve this problem edge computing is introduced. We had gone through an introduction to edge computing and the architecture and some of its use cases and o the coming scenarios the edge computing will be a great use full one for the digital world.

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DOI:10.46647/ijetms.2022.v06i05.091 ISSN: 2581-4621

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