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A study of computing paradigms: Cloud, Edge, Multi-Access Edge Computing

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ABSTRACT

Internet of Things, Edge computing, Cloud computing, and Multi-edge computing are booming in the education and business. MEC, or mobile edge computing, is a critical technology that can maximize mobile resources by hosting compute-intensive applications, processing massive data before transferring it to the cloud, and providing user with cloud computing capabilities. A straightforward and concise overview of these computing paradigms and their relationships and each paradigm like cloud computing evolution from edge computing is addressed with its key points and relationships. This survey provides a holistic description of MEC technology and its possible applications along with different computing paradigms.

Keywords– *Distributed Computing, Cloud Computing, Edge Computing, Mobile Edge Computing*

1. INTRODUCTION

For a decade Cloud computing is known as mainstream information platform and a new model. Cloud computing is a service that allows users to access computing services based on storage through the Internet. Cloud computing is concerned with computation, applications, data access, and storage facilities that do not necessitate end-user awareness of the system's physical location and configuration. Cloud computing is used to effectively control and optimize resources stored on a centralized cloud platform without regard to time or space constraints. However, as future innovation technology has progressed, the limitations of cloud computing have become apparent, as have new standards for high technology. Regardless of how massive the Cloud server is, it cannot handle large amounts of data. Edge computing, a modern computing technology, is becoming potential solution to most of these complications. Edge computing is a distributed computing paradigm that reduces reaction times and bandwidth consumption by bringing processing and data storage closer to the point of usage. Edge computing concepts include fog computing, cloudlets, and mobile edge computing, to name a few. Edge computing is a system that analyses and processes data at the network's edge where it is processed in real time. It's not a data center that processes and computes data from a far. MEC brings traffic and service delivery closer to the user by moving traffic from the center of the cloud towards the network's edge. Rather than sending all data to the cloud, data is analyzed, processed, and stored locally at the network edge. Collecting and Data processing nearer to the consumer reduces latency and provides real-time reliability to high-bandwidth applications.

2. LITERATURE SURVEY

This paper discusses about 5g edge Computing and proposes hybrid architecture built on their requirement to evaluate the architecture agent-based simulations on proposed architecture. Fog computing and 5G MEC and the latency decreased to 11% compared to 5G MEC [1].

It explains [2] concept behind cloud computing the need for mobile –edge challenges and the role of mobile –edge computing in the app design and security issues. Major cloud vendors and some of the cutting-edge practices in the field.

Paper [3] describes about the future MEC application allocation, user plain selection, traffic local routing and steering working mechanics and use case scenarios, support of delay critical mobile application require network enhancement.

In this paper [4] author discussed about the privacy and security of the MEC system and the Vulnerabilities leading to the identified threat vectors security solutions. The privacy issue has been discussed in detail and the objectives for retaining the privacy. And further discussed the enhancement security and privacy in MEC.

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It talks about [5] the storage and computational resource at the edge, reducing latency for the mobile end users. In detail about the MEC orchestration both as single service and network MEC supporting service and orchestration and content providers and third parties. Lastly it discusses about the open research challenges.

3. EVOLUTION OF COMPUTING PARADIGMS

Accepting cloud computing technologies is increasingly vital for firms hoping to thrive in the next years. At both the consumer and commercial sectors, cloud computing adoption has surged in the previous decade. Interactive efforts have been made to motive users to migrate to the cloud counter-parts. This includes pay-as-you-go feature. At the same time, a slew of cloud-native providers has sprung up. Now, software as a service (SAAS) are exclusively available in the cloud. Not only is software as a service, but also backup as a service (BaaS) and disaster recovery as a service (DRaaS) is also available. Almost everything is now available in the form of service. Cloud computing will see an increase in the number of cloud-based services and solutions. Hybrid and multi-Cloud methods will become exponentially important. The areas of security and compliance will be scrutinized. Cloud can be deployed in different ways here cloud figure shows the overview of the deployment of these three clouds. The biggest concerns about cloud computing are security and privacy.

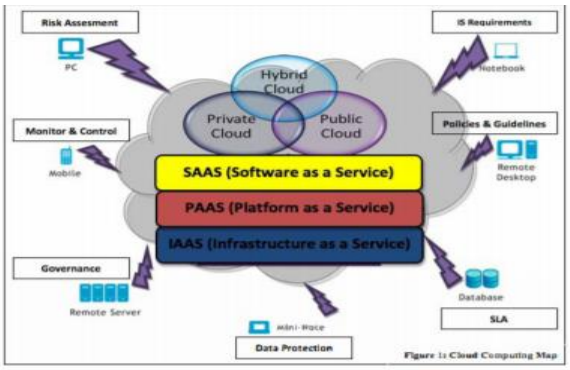

Fig 1: Cloud deployment

4. MULTI-ACCESS EDGE COMPUTING

MEC, or mobile-edge computing, is an ETSI-defined architecture in network that supports cloud computing and service in IT environments at the cellular network's edge. Due to network congestion, MEC will run the application and perform relevant processing activities closer to the cellular consumer, bringing app content providers and developers with cloud computing abilities closer to the cellular. The MEC environment has extremely low latency, maximum bandwidth, and real-time access to the radio network information that the application requires. RAN edge legally allows third-parties to deploy software and services, and services to mobile consumers.

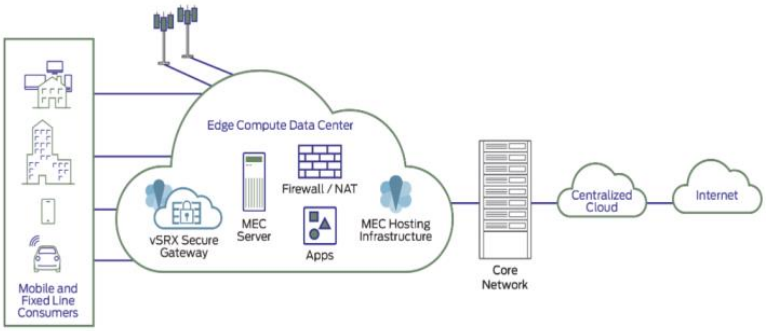

Fig 2: Distributed Computing

5. ANALYSIS OF CLOUD COMPUTING PARADIGMS

In this section analysis of moving the cloud to edge and now multi edge computing based why cloud computing paradigms alone is not enough?

Cloud computing can't keep up with the volume of data being processed every second. Having discussed latency in the context of cloud computing, there is much that cloud computing does not offer cloud-based applications. Due to the large volume of data saved in the cloud, there are two issues that arise during the processing stage: processing latency and a large number of wasted resources. Decentralized data centres, mobile edge nodes, and cloudlets are all affected by these challenges. Everything is piled on and uploaded to the cloud for additional processing when smart devices generate data. The cloud's data centers and networks get overburdened as a result. Cloud-based data may face insurmountable challenges due to increased latency and inefficiency. Data can be evaluated closer to the source of the data with edge computing. This strategy not only helps to reduce data dependency on the app or service, but it also helps to speed up the processing of such data.

MEC is the widely accepted standard that must be met for a technology to be considered edge computing. While not an industry mandate that products meet MEC standards to be billed as edge solutions, many vendors are building around the standard. Edge computing is the practice of offloading computing processes (and, in some cases, the management of storage and networking

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resources) from a user's computer or device to a local network node or another computer. Mobile Edge Computing (MEC) is a variant of the Edge computing paradigm that provides Cloud computing features (such as processing and storage) to the mobile network's edge, within the Radio Access Network (RAN).The Controller of Radio Network or a big base radio station are usually where MEC nodes are found. Location/context awareness, minimum latency, and maximum bandwidth are just a few of the advantages of deploying Cloud services Inside the RAN. Low latency, context and location awareness, elevated scalability and availability, and mobility support are all advantages provided by all Edge implementations. Depending on the type of gadget and its closeness to end users, they can be used in a variety of ways. MEC node deployment. For instance, MEC nodes situated on the mobile infrastructure edge will have the abilities to offer MEC services, whereas other entity can install MCC infrastructure.

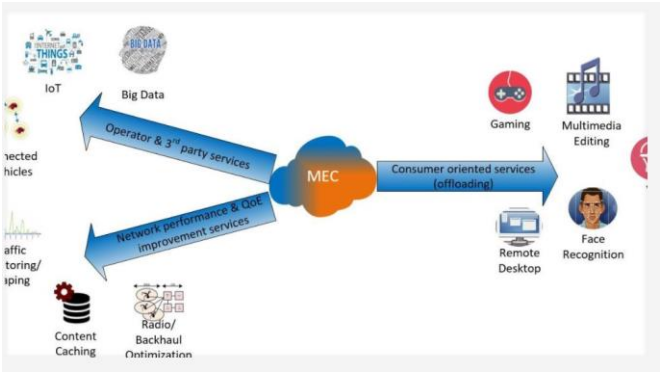

Fig 3: Multi-Access Edge Computing Deployment

6. CHALLENGES

There are numerous issues in wireless networks and at the network edge that must be addressed in order to optimize edge caching, compute, big data analytics, security, and data privacy. While ML can provide solutions to problems that have already been solved.

Table 1: Challenges of the MEC application

Application	Existing Works	Challenges
Edge Computing	DRL-based caching strategies	-Combination of transfer learning and DRL to exploit knowledge from other domains -Competition and collaboration between caching nodes (e.g.ENb or device caching)
Computing Offloading	DRL-based Computation offloading	-Dependence on statistical information of channel quality and task arrival rates. -Time varying and spatio-temporal user behaviour.
Joint Resource Optimization	ML for caching, computing communication and control	-Real time learning training model for time varying and dynamic MEC system. -High overhead of signaling transmission and information exchange for generation of the network state and action spaces, especially in ultra-dense network.
Privacy and Security	DRL-based Privacy and security	-Lack for massive and high-quality training, validation and test dataset, which is caused by heterogeneity of wireless network, mobile devices and edge nodes.
Big data analystics	MI-based big data processing	-Storage and Computation burdens due to the curses of big –data dimensionally -Tradeoff between the resources –limited MEC serves and the large-scale DL models
Mobile Crowd sensing	DL based MCS	-Lack of privacy and security protection schema for crowd sensing data.

7. CONCLUSION

MEC capacity to deal with latency and bandwidth difficulties while also lowering the cost of transporting data to the cloud. The MEC paradigm is gaining traction in the telecommunications and IT sectors. MEC provides a large subject that can be used in a variety of domains and deployed in a variety of technologies, and it can be used in any way that the user desires in the development. The advantages of the edge versus the cloud are numerous. MEC is an excellent choice for today's requirements because it can be deployed used in variety of technologies.

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