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Mobile Edge Computing in 5G Networks

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Abstract: ***As we are moving forward in the fourth industrial revolution, the need & demand for everything at the edge of any network is increasing or we can say that we need "hands on technology". Mobile edge computing (MEC) in the 5G network is stepping towards it. The propinquity with customers and local network stations is a key factor to take off load from cloud stations which have to perform various real-time processes that could exercise the various problems. The 5th generation just popped in right, with it's faster speed we would be able to meet the demand of the MEC. From taking load of the cloud servers, to be in charge of data traffic MEC along with 5G is foreseeing next-Generation needs. The fundamental shift to cellular networks is epic, data transmission has become easier. We aim to achieve low-latency bandwidth, fast speed network, high data transmission in milliseconds, dense area coverage, mobility, cost efficient & quality experience for end users. It might open many opportunities for various companies, vendors & IT services as market value is huge but first we need to overcome many challenges. The requirement of flexible architecture, management, network bearer carriers, infrastructure, security, efficiency and most importantly connecting large numbers of users we have a lot to achieve. Future is virtualization by providing back-haul cloud storage and less computing, globalization could take place in MEC in coming years. In the era of IOT & AI, MEC promises to provide light weight devices, open source innovation by adding high value to business.***

I. INTRODUCTION

Over the past few decades, the technology has been continuously evolving. Cellular networks have also had a significant change in technology from the first generation (1G) to the currently used fourth generation (4G) LTE networks. Though the 4G networks have performed well over the past few years, there is a need to make it more optimized and develop a technology that is efficient enough to fulfil the user requirements according to the current scenario. For this reason, the developers are now striving hard to introduce the fifth generation (5G) technology which serves as a successor to the currently used 4G technology.

The 5G technology is often referred to as the "Wireless technology" and is believed to possess enormous benefits which are designed to satisfy the demands of the continuously evolving technology. The most important aspect of this technology is that it has greater bandwidth which allows more number of devices to be connected by the radio waves thus providing better connectivity. The next important factor which attracts most attention towards the 5G technology is its High speed which makes downloading of various contents much faster than the currently used network. If we see it from the perspective of speed, 5G is said to be 20 times faster than the currently used 4G network. Other characteristics of 5G include low power consumption, Low latency, high reliability and lower cost of developing a framework. Thus it can be said that 5G is a paradigm for the technology that is essential in the modern scenario. The systematic implementation of 5G technology requires an appropriate architecture. Mobile Edge Computing (MEC) is that architecture which provides a framework for the implementation of 5G network. Mobile edge computing is a network architecture in which the cloud computing can be done at the edge of a cellular network, which means it will bring the network closer to the end user. The prime aspect that makes it useful is that it will shift and spread the load, thus reducing congestion on the network and will enable more number of devices to get connected due to its greater bandwidth. MEC includes low latency, making it a must for introducing 5G technology. MEC can be considered as the key driving force for the 5G technology.

In this paper, we will be describing in detail, the importance of Mobile edge computing for developing the 5G technology. The chronology followed will be: Introduction to Mobile Edge Computing , Architecture of MEC, Communication in MEC Implementation of MEC [Advantages of MEC . All these aspects will be discussed with respect to the use of MEC for the upcoming 5G technology.

II. OVERVIEW OF MOBILE EDGE COMPUTING

The continuous advancement has led to the development of technologies which are different from the traditional ones and are being implemented to fulfil the fast growing demand of the users. The users' demand for mobile networks has considerably increased. Thus, it requires deployment of technologies which have greater bandwidth but at the same time have low latency. These are the features which make MEC most suitable technology for the modern scenario. In this section we will be first explaining about what MEC is. Then we will be moving towards its architecture, implementation and communication with respect to 5G.

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A. What is Mobile Edge Computing?

Mobile edge computing has been derived from the recent advancements in Mobile cloud computing(MCC).Mobile edge computing is a technology in which the computing is done by bringing the server at the edge of the cellular network. The basic idea behind MEC is to bring the resources closer to the end users, thus giving them an upper hand than the currently used methods. In MCC, It used to provide a shared pool of resources which included resources such as processor, softwares and storage. It includes computing, caching and communication resources. MEC mainly employs two technologies namely,

1) *Software defined Networking (SDN):* This technology sanctions dynamic and efficient configuration for network management, so as to improve the network performance.
2) *Network Function Virtualisation (NFV):* It is a concept which is used to virtualise the apex of a network into constituents that can connect together so as to enable communication services.

The major drawback of the traditionally used mobile cloud services is it's long latency which makes it unfit for real time application. This problem has been resolved after mobile edge computing came into picture. Mobile edge computing possess tremendous capabilities which include:

a) *Greater Bandwidth:* It has more range thus connecting more devices globally.
b) *Low Latency:* It can exercise large volumes of data within a minimum time period. Thus, making it suitable for real time applications.
c) *Maximum Throughput:* Since, MEC utilizes caching , therefore the throughput which is obtained by the user is more as compared to the one generated by the data center
d) *Provides Local Storage and Better Security:* In MEC the data is not uploaded on a remote public cloud instead it is stored on a local storage, thus making it more safe and secure.

The key objective of mobile edge computing is to elevate Quality of Experience(QoE) . the resources used in MEC such as caching, computing and storage makes it possible to achieve this goal. MEC generally tries to restrict the use of core data centres instead through caching it enables the processing of data closer to the end user, thus making data processing faster. Now, 5G opens up the opportunity to communicate into the premises where the work is performed.

B. Implementation of MEC in 5G

From the earlier discussion it is clear that MEC has been introduced with an objective to combine the telecom services and the cloud services. The content in 5G technology is transmitted using radio waves. For the purpose of increasing the responsiveness in MEC, the data is stored closer to the end user. The MEC application server is consolidated at the RAN element. RAN stands for Radio Access Network, and is based on radio access technology. It connects the remote devices through radio technology, thereby enabling the transmission of data. The RAN element in MEC, enables distributed computing. The data in distributed computing is decentralised.

The application server provides all the resources for which MEC is used such as storage, computing and connectivity. MEC allows applications and services to function above the network layer. So, these applications avail a benefit as they are closer to the end user as well as from receiving RAN information. There are three ways to implement MEC in 5G or in general to implement MEC.

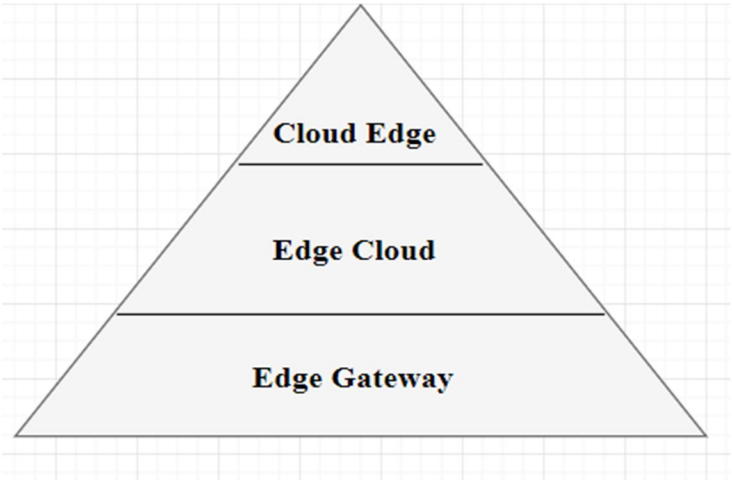

Fig 1: Ways to implement MEC in 5G

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Broadly, three 5G frameworks are related to Edge computing: Ultra-reliable low latency communication (URLCC), Enhanced mobile broadband (eMBB) and massive machine type communication (mMTC). The 5G control plane is implemented in a centralised way. 5G MEC involves the deployment of 5GC UPF (User Plane Function) near to the end users as well as the computing applications. The basic requirement of the 5GC UPF is to communicate with the plane as well as the application systems in the cloud which is situated at the center. One control plane(Session management Function) is capable of managing multiple UPFs simultaneously without the performance of the 5GC network getting affected. The user plane of 5G is installed in a distributed manner. UPFs are installed at the edge of the cellular network (network edge) to support edge computing.
The service traffic from User Equipment(UE) can be guided to the local UPFs or to the main UPF. 5G sets up a strong base for the implementation and development of MEC

C. Architecture

Moving into the 5G era, MEC focuses on close relation with end users.There are two types of architectures 1) Centralised 2) Distributed. In centralised system we can access data from the main server (Amazon,Microsoft cloud). While in the distributed system we have local host, base station, mobile edge host that will provide ultra-low latency required for functioning. The framework of MEC is divided into 3 levels within the operator network. With the help of radio access network (RAN) mobile network operators can allow multiple 3rd party users access at real time with the help of setting various base stations at local areas that cover large areas which was difficult in centralised architecture. Before going into the deep let's understand some terms:-

1) *Radio Access Network:* Mobiles use radio waves to communicate and connect through other end users by converting into signal,radio transceivers help to connect to cloud, In 5G multiple IN-OUT ,low latency,wide bandwidth ,advance carrier will RAN to expand.
2) *Base Station:* An antenna that receives signals from cellular devices and connects it to the central hub. In 5G it's all about receiving multiple radio waves and connecting it to a hub.
3) *3GPP Network:* 3rd Generation Participation project collaborates over cellular networks.

D. Currently Working on 5G.

1) *Virtualisation Infrastructure:* In real-time it lets you share multiple resources at the server with various virtual machines in your infrastructure.

Three layer architecture of MEC have NETWORK, MOBILE EDGE SYSTEM LEVEL and MOBILE EDGE HOST LEVEL.
Network layer consist of external networks, local network, 3GPP and other external entities.This layer is basically responsible for its connectivity to various networks such as the internet . Mobile edge system level basically consists of management of system & ME host which is responsible for overall lookup of edge system.
Mobile edge system level management is the overall view of a mobile edge system . It consists of edge orchestrator ,an operation support system and user application lifecycle management proxy . The edge orchestrator is keeping up an by and large see of the MEC framework based on conveyed edge host, on-boarding of several packages, counting, checking, validating of the packages, application rules and necessities. Selecting a versatile edge host , asset and supports various application triggers.The OSS acts as an operator which grants requests for different kinds of application operation and forwards it to the orchestrator. User application lifecycle management proxy response and authorize the request of UE application. It only works in mobile network range. It interacts with the orchestrator and oss for the request response process.
Mobile edge host level is the middle layer of the architecture. It comprises mobile edge host management , mobile edge host , mobile edge platform and mobile edge application. Mobile edge application is located on top of virtualisation infrastructure . It can act as VMware and can interact with edge platforms to service support and services procedures but only when all requirements are fulfilled . Mobile edge platform provides a platform for edge application , host manager etc to run and perform edge services like manganing data traffic , receiving DNS records and proxy , providing access for storage.It also converts UEs into IP addresses. Mobile edge hosts is an entity that consists of a platform , the mobile edge management and virtualization infrastructure which are necessary to run mobile edge applications within an operator network and to provide storage , computation etc.The last element of MEC architecture is mobile edge host manager which basically manages the edge platform and virtualization infrastructure. Mobile edge platform manager is responsible for handling the lifecycle of an application,providing element function to platform level,regulating policies and completing requirements of application , DNS , proxy , services authorization etc. It gives performances reports to the virtual infrastructure manager which handles all the resource functionality.

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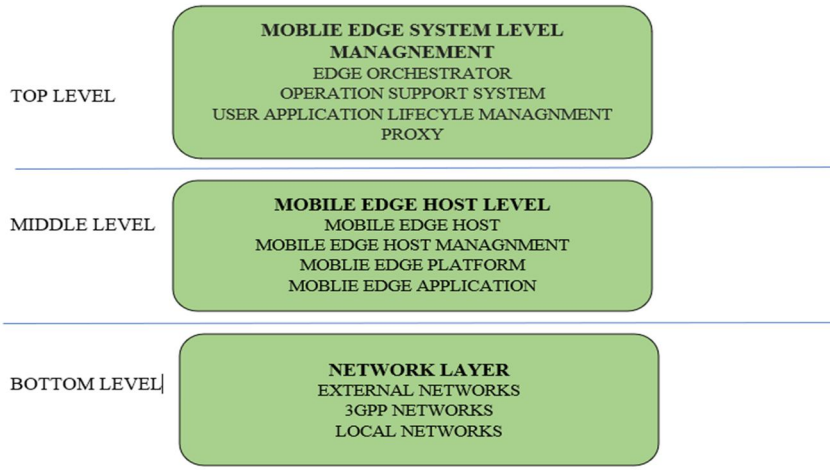

3-Level Architecture

III. COMMUNCIATION

For communication in MEC we need ultra-low latencies, fast speed, accuracy, reliable sources etc. The 3gpp latest project '5th Generation' will be able of achieve it. The 5 G network will basically include a variety of technologies, including the heterogeneous network (HetNet) (i.e. the use of numerous radio connectivity technologies, several backhaul strategies and a cell hierarchy — macro, pico, femto), massive MIMO (i.e. large BS antenna arrays to support several users simultaneously), cognitive radio network (CRN) (where secondary users opportunistically use primary us),Spectrum of millimetre wave (mmWave) (works over 30-300 GHz frequency) and D2D contact. The mmWave spectrum in 5 G can be used to form short-range D2D connexions between UEs. Because mmWave suffers from low multi-user interference, many mmWave D2D connexions can operate simultaneously, thus increasing network performance. D2D connectivity complements HetNets and massive-MIMO(multiple-input, multiple-output) - enabled BSs to increase spectral efficiency and data rates. Additionally, by leveraging diversity and multiplexing benefits, MIMO antennas embedded in UEs can improve noise resilience and device power. D2D-based relays with MIMO-enabled devices can also significantly enhance machine capacity.

A. Device to Device Communication

D2D or Device to Device communication is going to play a prominent role in 5G networks as it promises to provide ultra-low latency for user communication. It uses direct link to travel all the way to base stations. In D2D connection we can use various wireless technologies like WIFI, Bluetooth, LTE etc. They differ mostly in the data rates, distance between 1-hop devices, device discovery mechanisms and typical applications. For example, Bluetooth supports 50 Mbps and a range close to 240 m, WIFI allows up to 250 Mbps rate and 200 m range while LTE provides rates up to 13.5 Mbps and a range of 500m.D2D communication technique is what we are looking forward to.

B. So what Happens When you Request for Service?

Let us when external devices send a request to the MEC server. How do the High end capacity processor and server respond to it? When a smart phone sends a request to the nearest end to end communication provider (relay gateway) for specific service. This request is forwarded to the relay gateway handler (oss) of mobile edge system level management whose job was to grant the request and forward it to the orchestrator which acts accordingly to the request information that is it check if its resource is present or not .If present it processes the requested service and the handler gets a result for performing the task further encodes it into user readable format ,sends it to smartphone. If it is not available then a certain selection of relay gateways take place and then its processing starts.

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IV. ADVANTAGES OF MEC

As stated earlier, Mobile Edge computing has numerous benefits which gives this technology a upper-hand in implementing the 5G technology. These include:

A. Enormous number of Connections

MEC is capable of connecting various devices across the globe. This feature is achieved due to its greater bandwidth as it increases the flexibility of the network. It also reduces the network congestion.

B. Vicinity

As we know that, the Mobile edge computing utilises RAN to access the edge network. The mobile devices which are close to each other can connect through D2D i.e. Device to Device communication and at the same time these devices can approach edge server. In MEC, the edge server is placed closer to the end user therefore analysing the pattern becomes easy which inturn helps in improving services.

C. Low Latency of the Network

One of the most important advantages of MEC is the low latency. Low latency implies the processing of high volumes of data. Since, in MEC, the network is placed at the edge of the end user , due to high bandwidth, the capacity of the network increases thus reducing its average latency.

D. Flexible Deployment

This means that the MEC network can be positioned at different locations of the 5G network. The deployment depends on factors such as framework of the network, application, services, architecture, etc. Also , without bringing out any change in the ongoing 5G architecture it can offer recently developed services to the users.

E. Security

MEC also provides better security of data. In MEC, the data is stored in local storage and is not uploaded to the public clouds, which inturn preserves the data from getting exposed to the people other than the owner himself.

F. Cost Efficient

MEC is not only flexible but also economically viable. The key reason for this feature is that it does not require core data centres because it is situated at the edge. So, it avoids the requirements of expensive data centres.

G. Real Time Data Access

MEC has a distributed architecture. It provides its users with real time access to data as the data is stored in local storage under the IoT domain. Thus, the information can be immediately. accessed anywhere and at any instant of time by the user .

V. CONCLUSION

This paper gives us a basic idea of mobile edge computing in the 5G network. The coming generation would be able to access data efficiently regardless of increase in data traffic and MEC has promised to deliver it. We have discussed briefly about how the implementation of MEC in 5G takes place with numerous technologies playing their role in providing resources at ease in radio access network (RAN) base stations.

Three layer architecture , mobility management & services handles the standard protocol when a user requests services. Lastly D2D , real time gateway , MIMO etc. has helped a lot in achieving user friendly ,reliable and multiple resource sharing communication in MEC.

As moving forward in this era , some countries have already achieved 5G networks but still there is a lot of work to be done . By 2025 trillions of dollars money would be invested in 5G networks and smartphones. Everyone will be using a 5G Smartphone and therefore the challenges and deployment constraints are in our way, but once this is achieved we can get our hands on technology.

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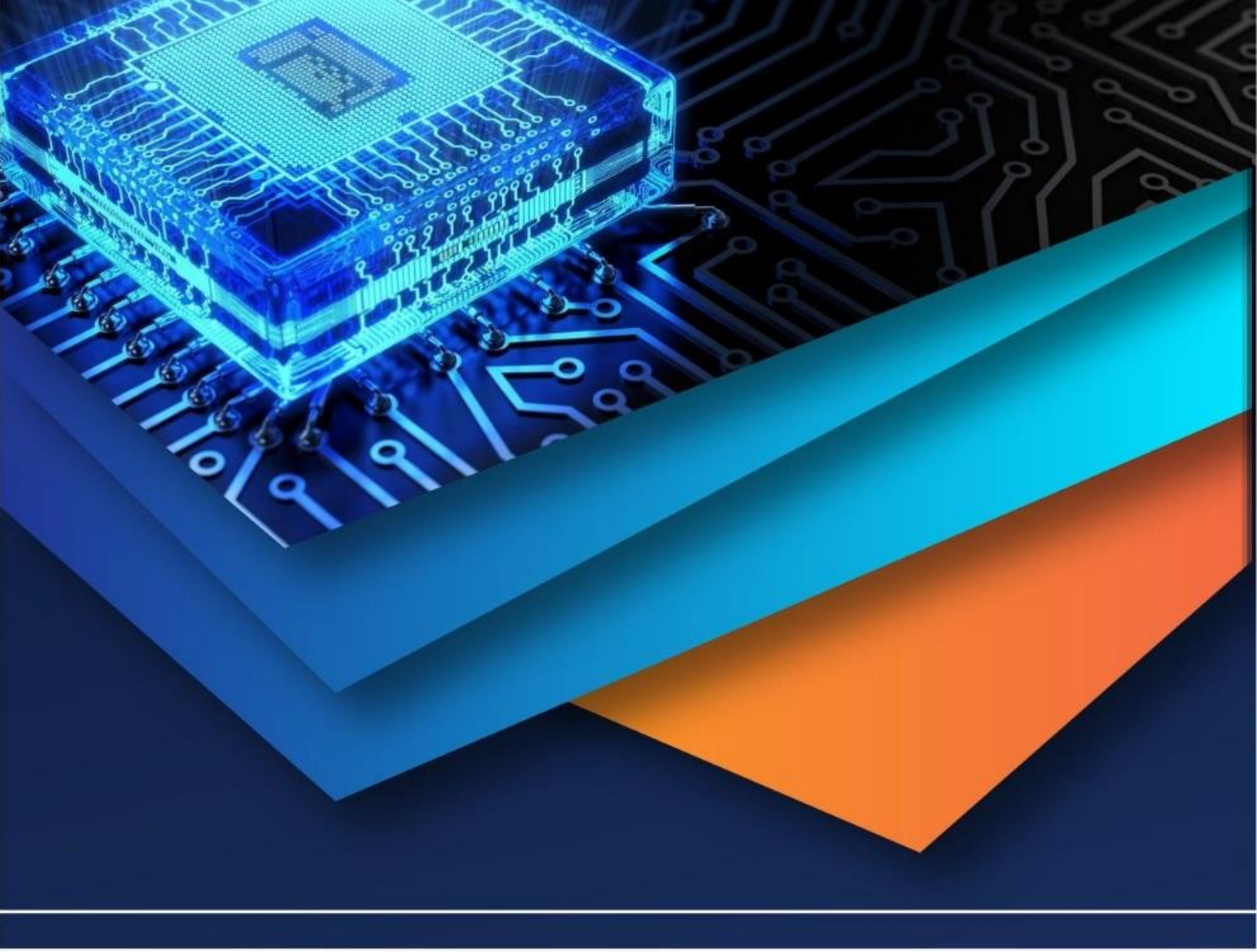

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