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A Study of Potent 5G Technologies with Mobile Edge Computing

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Abstract - *Mobile Edge Computing (MEC) is a concept which emphasizes on distributed computing by bringing the processing closer to the edge of the network. MEC is recognized as a prime contributor to the features of 5G technology which includes reduced latency, bandwidth reduction and increased scalability. MEC does so, by bringing storage and computations closer to the users, at base stations of cellular networks. However, speed required for 5G technology appears challenging to obtain. Hence, integration of various other techniques with MEC, like Device-to-Device(D2D), Network Function Virtualization (NFV), Software Defined Networking (SDN) to help achieve the objectives of 5G has been in research. Related works concentrate mostly on any of the specific technologies to be used in the advent of 5G. This paper provides a study of some of the technologies which are estimated to be effective for 5G along with the MEC by aggregating and comparing various technologies together.*

Key Words: MEC, 5G, D2D, SDN, NFV, Mobile Edge Computing

1.INTRODUCTION

With increased use of cellular technology, rapid collection of data by sensors in fields like Internet of Things (IoT), 4G technology is estimated to be soon incapable in catering the needs of all the user. 5G technology promises increased accessibility in scarcely populated areas, reducing the communication delay by increasing the speed of network transmission.

The main features for 5G technology estimated today are:

1. Decreased latency
2. Reduced Bandwidth requirements
3. Ensuring security and privacy of user data
4. Enabling new kind of applications
5. Better scalability

Mobile Edge computing works as a promising solution to cater the requirements of 5G. Many other concepts are being integrated to MEC in order to further satisfy the needs of 5G.

The paper is organized as follows. In section 2, the overview of various technologies potential for 5G is described. In section 3, the current work and discussion on the technologies are carried out. Section 4 of the paper is the conclusion of the study. Section 5 lists the references used for this study.

2. OVERVIEW OF DIFFERENT TECHNOLOGIES POTENT FOR 5G

2.1 Mobile Edge Computing

MEC deals with bringing computation and storage closer the location of users in cellular base stations. It is seen as the prominent concept for obtaining faster response, reducing network delays. It promotes the environment of distributed computing by maximizing localizing the computations to nearby locations. The computations which are not possible in edge servers are redirected to the cloud servers. This also ensures privacy and security as all data need not be stored in cloud technologies. It also allows advent of new kinds of applications. Various applications of MEC includes Augmented and Virtual reality, IoT technology, Connected Cars, Intelligent Video Acceleration.

2.2 Software Defined Networking

Software-defined networking is a concept which emphasizes on dynamic network management which is programmatically optimized in order to facilitate monitoring and high performance of network in order to make making it similar to cloud computing than traditional network management. Software Defined device networking provides various advantages which includes automatic load balancing, on-demand provisioning, simplified physical infrastructure and the ability to lock up network resources with application and data requirements.

2.3 Network Function Virtualization

Virtualization of the network function is a term for network architecture that uses IT virtualization technologies in order to virtualize whole groups of node functions of the network to building blocks which can link together to build communication, Network Function virtualization depends on the conventional virtualization of the server methods , which are used in IT enterprise, but varies from those. A virtualized network function can contain more than one virtual machine that runs various software and also uses high volume servers, storage devices and switches for processing or even cloud computing setup or infrastructure instead of having hardware appliances for each network function.

2.4 Device to Device Communication

Device to device communication is a concept where multiple devices communicate directly with each other instead of

going through the cloud every time. These communications including Bluetooth and Wi-fi Direct are known to be dependent on proximity of devices. It will promote interoperability between vital networks of public safety and all-round commercial networks. Taking advantage of direct communication between neighbouring mobile devices would, in theory, increase spectrum consumption, total performance, and energy efficiency, allowing working of new peer-to-peer apps and services based on location.

3. STUDY OF PROSPECTIVE TECHNOLOGIES FOR 5G

3.1 Mobile Edge Computing in 5G

The In [1], authors have presented a study on MEC. They state that Mobile Edge Computing brings benefits with better offloading techniques which helps in obtaining less communication delay and increased bandwidth network. They listed MEC architecture and explained cloudlet concepts (Mobile concept). The paper also highlights the various advantages and issues including the security and privacy issues of MEC. The authors have also listed the various application areas of MEC including healthcare, connected cars and video processing.

In [2], the authors have listed the market drivers for MEC which emphasizes on the advantages of having novel applications, offloading. They also briefed on various Mobile Edge Computing technologies including Virtual Reality, Intelligent Video Acceleration, Connected Vehicles, Stuff Gateway Internet. They also concluded that MEC is a crucial technology of the 5G age to come.

In [3], authors have explained about MEC's topology. They stated that there are four MEC stakeholders, namely mobile end users using User Equipment (UE), network operators owning base stations, Internet infrastructure providers maintaining Internet routers and application service provider. They have also addressed the RACS architecture which represents concrete MEC server incarnations. The paper also addresses the six classes of applications, namely offloading, web scaling, local networking, edge service delivery, enhancement and aggregation, and measures the classes using few metrics. The paper also addresses the advantages of mobile edge computing depending on the classes of applications.

In [4], authors have reported that MEC not only meets more consumer needs and increases the Quality of Service of MU (Mobile Users), but also provides consumer benefits to service providers. They conducted a detailed survey of MEC from a service acceptance and provision perspective. MEC is composed of two components namely mobile user and edge server. The paper studies the service adoption of both the components.

3.2 Integration of MEC and D2D for 5G

In [5], authors propose and explore a novel concept and architecture of Mobile Edge Computing along with descriptions of the proposed solutions. They propose a novel Mobile Edge Fog Computing architecture with 3 major components – core network, mobile users and relay gateways. The relay gateways are connected to both mobile users and core network. Multiple relay gateways are equipped to have D2D communication in between them. This platform facilitates high bandwidth and give way to new business opportunities.

In [6], the authors have stated that the keyway to tackle power, storage and latency challenges is by using Device to Device Communication (D2D) and MEC. They also suggested a specification for the 5G cellular network which can be used as a foundation. The paper presents an architecture with multiple levels of cloud tier employing D2D communications, namely, cloudlet tier, micro cloud tier, mini cloud tier and main cloud tier. The architecture provides promising results when D2D communication is employed in all 4 levels

3.3 Integration of MEC with NFV and SDN for 5G

In [7], authors have given summary of duties expected to be taken care by stakeholders, because it is necessary for the success of upcoming communication technology requirements. The paper talks about integration of all three above mentioned technologies. It proposes an architecture which converges these technologies to ensure isolation, efficient utilization and exploitation of resources and to ensure rapid deployment of novel services. The paper shows many cases of usage, scenarios and emerging vertical markets which are considered to be prominent in the 5G ecosystem. It also defines device specifications and outlines key design principles.

[8] proposes a platform integrating all three technologies namely, MEC, NFV, SDN. It tries to address the management problems of mobile edge computing like application provisioning and effective management of network traffic. It does so in two steps:

- The Mobile Edge applications are maintained as Virtual Network Functions upon the underlying virtual network.
- The management of network traffic is taken care by SDN controllers

The above platform is evaluated to know that it gives better Quality of Experience by reducing the congestion delay.

There are present day requirements to change the network infrastructure into a distributed platform, where all the nodes are built using commodity hardware. But, these MEC nodes are incapable of executing all the virtualization technologies for large data. NFV and SDN are used to make the management of network resources easier in distributed

environments. The limited availability of resources in the edge of the network needs to make use of light weight components, such as containers. The paper [9] makes use of Open Baton framework which makes it possible to achieve the objective.

In [10], the authors make use of the novel improvements of SDN, NFV and MEC to propose a prototype architecture for the 5G network. The architecture makes a proposal to avoid the tunnelling protocols like 3GPP, by replacing the tunnel setup to SDN based forwarding to reduce the latency by 50% further. High reliability and low latency are obtained through this particular setup according to the paper.

4. CONCLUSIONS

The ever-increasing usage of network and data creates a need for improved technology like 5G which promises reduced latency, higher bandwidth and scalability. The paper provides a study of the potent novel technologies which can be used in order to satiate the requirements of 5G. MEC is considered a primary technology for advent of 5G bringing the computations close to the consumers to reduce network delays. Device to Device communication, when employed reduces the amount of data which needs to be stored or processed in the cloud, thus further reducing the latency and improving performance. NFV and SDN technologies concentrate on virtualizing the network and dynamically routing traffic inside the network. This helps support a distributed computing environment like MEC. In conclusion, all the above technologies when used accordingly promises to meet the expected features of 5G.

FUTURE WORK

Most of the researches combine MEC separately with D2D and NFV/SDN. Our future goal is to combine all four technologies together and propose an architecture for 5G.

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