Chapter 70
An Overview on Mobile Edge Cloud System

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Abstract A model that allows the clients or users to access a collection of resources used for computing such as storage, services provided by peer devices, server and applications which is available to all the mobile users as it presents at the edge of the wireless network is called as mobile edge cloud system. It provides wireless network information and local context awareness along with low latency and bandwidth conservation, so it is much better than traditional central cloud. This paper represents the characteristics, application, model services, architecture and open challenges of mobile edge cloud system; the application is also classified into different criteria. It also gives an idea of MEC for future research direction.

70.1 Introduction

The knowledge of combining both information technologies and communication helps in creating a network structure that helps to improve the user requirements and develop a large number of options for selecting new internet application. So, one among them is cloud computing. But the model of cloud computing which is based on centralized data centers comes with a number of limitations like:

- For real-time applications, it is very much difficult and also costly to move all the data from different edge nodes to the center cloud.
- It difficult to take care of the latency requirements of time-critical application.
- It difficult to adapt in traffic changes for applications that works on local network and user content using far away data centers.

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These limitations as lead to the development of an integrated model called mobile edge cloud system also known as edge cloud. These limitations are often addressed employing a new integrated model called mobile edge clouds (MEC) also called edge cloud. The system consists of base stations, access points, routers, switches and a collection of computation and storage resources which is used by the clients or users in mobile devices for performing a task [1–4]. Fog computing [5] provides a virtualized platform concept which is placed at the sting of wireless network that provides resources for computing, storage and networking services between the datacenter and different edge nodes. Mobile edge computing [6–9] is analogous to cloud computing that provides IT and cloud-computing services that is in the range of the radio access network which can be referred as RAN at a close range of mobile users. The mobile edge computing server can be placed at the base stations, radio network controller or at sites with different types of MultiTechology Aps. [10–12] proposed various segmentation techniques.

70.2 Characteristics and Applications of MEC

MEC has the subsequent characteristics [5, 6] (Fig. 70.1).

(1) *Status awareness for local network*: To access channel information and real-time network, MEC is established at the string.
(2) *Context awareness for local user*: The user location and contents are locally available to the application.
(3) *Distributed*: The MEC resources, service and application are distributed in nature placed at different locations, and the wireless access networks are

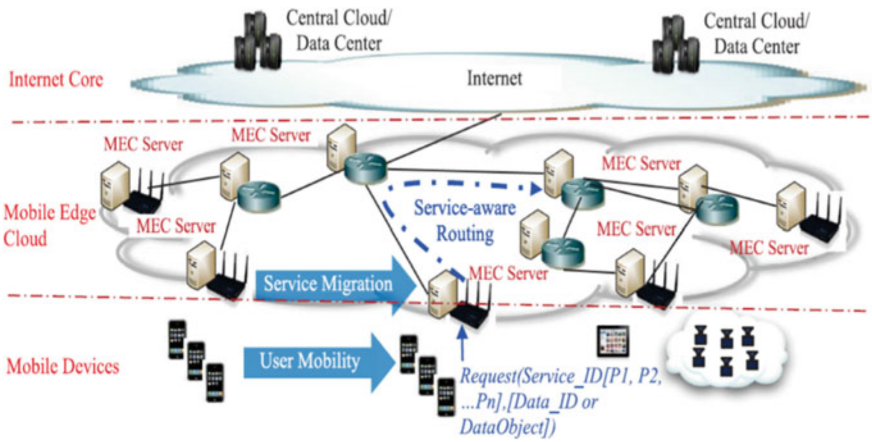

Fig. 70.1 The overview of mobile edge cloud system

arranged in a hierarchy order which are base stations, access points, switches, gateways and also end-point devices.

(4) *Multiformity*: The MEC nodes are heterogeneous in nature with different processing and storage capabilities with changing network bandwidth and connectivity.

(5) *Mobility and undependable access*: MEC services needs to be hosted in the mobile devices itself because the services might be accessed through unexpended wireless network or the point of connection to the network might change so mobility support is must.

(6) *Ultra-low latency*: To support tangible Internet applications which are robotics, virtual, AR and real-time application MEC must be able to perform in low-latency so that the application can overcome delay and end-end latency.

(7) *Interaction with mesial cloud*: MECs provide local processing of data along with low latency and content awareness, but there are clouds which provides global centralization which as advanced storage and processing capabilities, and it also provide support to the traditional central cloud.

Along with the properties, the applications of MEC are as follows (Fig. 70.2).

(1) Real time application like live gaming can reduce the experience of delay if the process is executed at the sting so that the data does not need to move between the end devices and other data centers.

(2) The application needs to adjust with the local network because there will be situation where the network degenerate or load in the traffic increases. One of

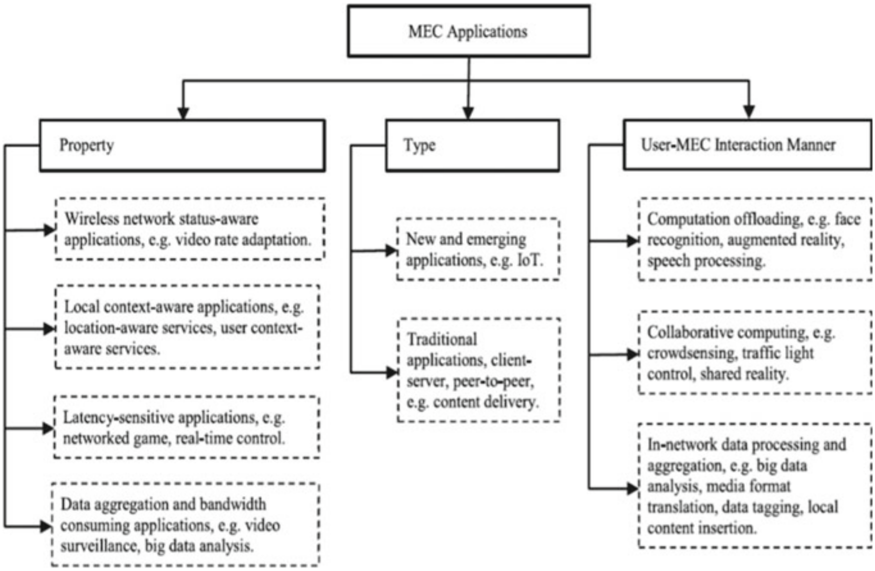

Fig. 70.2 The different methods of MEC applications

the solutions is reducing the video data rate which is suitable for the required bandwidth.

(3) The application which are local in nature process and compute the information on smaller dataset locally and maintains location privacy of the user by not sharing with any kinds of network. The application involves insertion, sharing, crowd sensing of local data or content.

(4) Huge amount of data like large data analysis, surveillance monitoring is processed and aggregated at the sting in order to reduce the bandwidth and cloud storage of the mesial cloud.

MEC can provide three levels of services to its customers:

- Infrastructure as a service (IaaS)
- Software as a service (SaaS)
- Platform as a service (PaaS).

The characteristics difference between traditional cloud and MEC is listed in Table 70.1.

For MEC SaaS, mobile users do not need to think about the problems that involves system configuration like application that is within the data center, take on cloud computing. MEC application services can be of any kind of service such as requested or transparent service and these are provided by the service providers, when the data from the client passes through mobile network, i.e., content optimization of radio-aware shown in Fig. 70.3.

Several use cases of MEC platform services are:

(1) To serve applications to mobile end-users, third-party service provider charter a share of the platform. (2) Similar to crowd sensing, MECs allow the mobile end user to release their own application in the platform. (3) In normal cloud architecture, wireless access network contains different levels which contains resources without

Table 70.1 Characteristics difference between traditional cloud and MEC

	Traditional cloud	MEC
Service location and resource	The data are sent to dedicated data centers over the Internet	Present at base stations (BS), access point (AP), gateways, switches and mobile devices
Awareness of service content	Application report provides user content and location	Aware of user content and status of local radio network
Heterogeneity of resource	The devices and network are well-planned in the machine room	Distribution and heterogeneity depend on variation in process and storage resources and network connectivity
Latency	High latency	Low latency
Resource capabilities	Limited resources	More powerful compared to traditional cloud

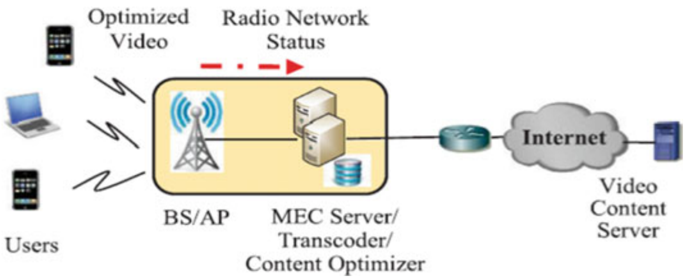

Fig. 70.3 Content optimization of radio-aware

any planned connection, but in MEC infrastructure, the user can send the code for execution in the platform service automatically.

70.3 Architecture of MEC

Fig. 70.2 illustrates the components like access point (AP), base station (BS), switches, router and aggregation for cell which makes up the MEC server [6] which provides the client to access network data and radio data, resources for computing and storage.

70.3.1 Server

Fig. 70.4 shows the architecture and interfaces of MEC server. The server consists of two parts: one is hosting infrastructure and other is virtualized application platform (VAP). The VAP provides a virtualization manger which provides a sharing environment that is used for deploying and running application that ranges from network operator to third party application and also services to host the different applications such as platforms.

Middleware services like communication, registry and traffic offload function (TOF) are provided by the application platform to the application. The registry stores information about the services that is present in the server that helps to get services to the application at different end points. One more middleware service is radio network information service (RNIS) which provides application to know about its services and also to tell other applications.

The TOF contains policy that routes the client's data between different applications and also set priority to the traffic.

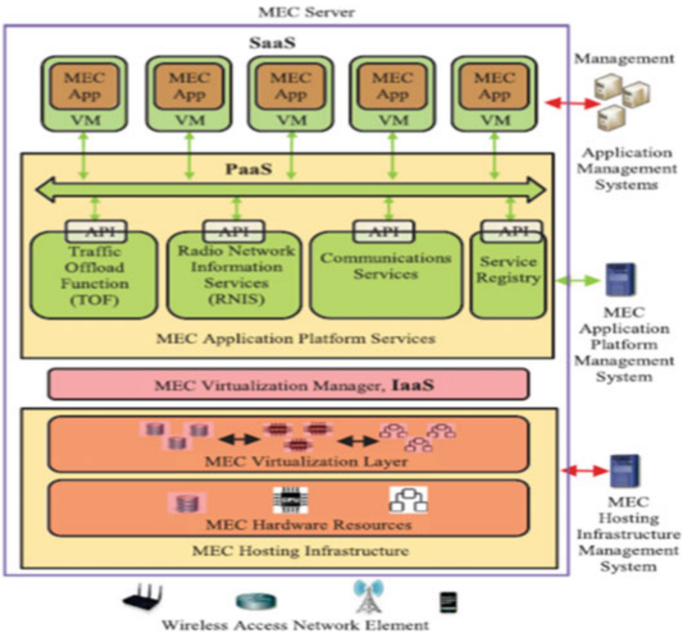

Fig. 70.4 Overview of server platform

70.3.2 Specification of Server

The wireless access network is arranged in a hierarchical level and are placed at different locations and each server host different type of application.

Services such as Web services, TCP/IP protocol and other services which contains structure of traditional IP network can be provided by the MEC server [9, 13]. Three of the programming frameworks, i.e., cloudlet, MAUI, and clone cloud and comparison between them is shown in Table 70.2.

Table 70.2 Programming frameworks of offloading

	Approaches of offloading	Remote execution of unit
Cloudlet	To create a user-defined environment for execution, the dynamic VM synthesis by the base VM and VM overlay from mobile devices	Virtual machines
MAUI	Partitions the application program and offloads certain methods to the cloud	Method
Clone Cloud	Partitions the application program and certain threads are migrated to cloud using application-level VM	Thread

70.4 Research Challenges of MEC

The major challenges faced in MEC are (Table 70.3).

70.4.1 *Proper Platform with APIs*

Network algorithm and control protocol are importantly needed to build a good MEC system, or else it leads to problems in planning. The main problems include: (1) to route quickly and efficiently the traffic to the simplest service case within the network. (2) An adaptive allocation for moving users for allocating function and the required data which will handle user mobility and the required services. (3) To maintain session state while migrating a service from one virtual network to another virtual network without causing any interruption in service.

70.4.2 *Management of Resource and Computation Balance*

Networks usually contains highly dynamic and complete resources of varies dimension which are placed at geo-spatial points and follows multiple levels of hierarchal network. Further, in unreliable wireless network the changing of mobile device points brings problems in allocation of resources and scheduling algorithm. So, strategies need to be developed to overcome this problem. So, for that, new mechanisms are required to virtualize the complex network and provide resources which are required to the distributed environment.

Table 70.3 Overview of MEC system architecture

MEC architecture	Service model	Targeted layer	Service naming	Service discovery and routing
Application based on TCP/IP	SaaS	Application layer	URI	Based on IP routing and dynamic DNS
Mobility first	SaaS	Transport and network layer	Based on flat service ID	Distributed name resolution servers are used to resolve service ID to network address
Cloud edge	SaaS	Application, network and transport layer	Based on flat service ID	The data plan is programmed with central controller
NFN	SaaS	Network layer	Based on λ calculus expression	The service name prefix diffusion

70.4.3 Interaction with Mobile Devices and Traditional Cloud

The execution of application requires the task to jump from one end mobile node to another, i.e., MEC network nodes and distant central clouds. And it may also involve several stages of computation especially in pipelined fashion where data flow from one stage to another. So, it is important that innovative runtime management schemes needs to be developed for effectively executing the distributed jobs and tasks which as real-time constraints.

70.5 Conclusion

The paper describes about the different MEC systems, their architecture, challenges and models. At first, the paper briefs the characteristics and also explored the applications of MEC based on criteria. Service models are also discussed. Different types of architecture are explained and also the challenges faced by them. As future work, problems faced by MEC in security can be explored and studied.

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