SURVEY ON MOBILE EDGE COMPUTING TECHNIQUES

Mohanasathiya K.S
Ph.D Research Scholar (Part-Time),
Department of Computer Science, Nandha Arts & Science College, Erode, Tamil Nadu, India
E-mail ID: sathya_vinu87@yahoo.co.in
Dr.S.Prasath
Assistant Professor & Research Supervisor,
Department of Computer Science, Nandha Arts & Science College, Erode, Tamil Nadu, India
E-mail ID: softprasaths@gmail.com

Abstract- Mobile Edge Computing (MEC) is an growing design where cloud computing services are extended to the edge of networks mobile base stations. The challenging edge technology are applied to mobile, wireless and wire line development using software and hardware platforms, located at the network edge in the vicinity of end-users. MEC present faultless combination of various application service supplier and hawker towards mobile subscribers. The important component in 5G architecture which supports variety of new applications and services where especially little latency is required. In this paper intended to current a broad analysis of related technical improvement in area of MEC. It provides the definition of MEC, architectures and application in particular highlighted and future directions. It concluded with security and privacy issues related to existing are discussed.

Keywords: MEC, IOT, Fog Computing, Cloud Computing.

1. INTRODUCTION

Mobile Edge Computing (MEC) is a technology that brings the IT service environment and cloud computing capabilities into the Radio Access Network. The close proximity to mobile devices reduces latency and creates a better quality of experience for end users. MEC accelerates applications with real-time requirements which may improve effectiveness of radio resource usage. Connectivity management applications for mobile devices are good candidates for deployment onto a MEC platform.

Connectivity management is the ability to connect and manage mobile devices in Machine-to-Machine (M2M) communications. Resilient and scalable connectivity management is fundamental to M2M solutions. Connectivity management of mobile M2M devices is a complex task when dealing with various network protocols, physical or virtual interfaces.

2. RELATED WORKS

Internet of Things (IoT) established by AutoID labs [1] was initially used for radio frequency identification (RFID) tags system. Internet of things (IoT) refers to a global interconnection of objects (food, home appliance and vehicles) with unique identifiers such as Internet Protocol (IP) address with the ability to communicate, interact or react to given changes with each other [18].

Cloud computing method allows IoT devices to carry executions remotely with the Internet accessible computer (Cloud). This gives IoT devices virtually unlimited capabilities in terms of storage and processing power [2]. Cloud computing paradigm can hardly satisfy the requirements of high mobility support, location awareness and low latency. To concentrate on some of these edge computing are proposed.

Edge computing methodology shifted computation from remote cloud to the computational devices that are closer to the front-end IoT devices within edge networks [12]. The closeness of edge devices has improved the efficiency IoT devices as it enables them to do real-time operations with less latency limitation.

Mist Computing an immerging methodology goes further beyond Edge computing as it pushes the computation to the sensors and actuators. Hence, this even saves more power since communication from a node to Edge nodes takes more power than computation at the nodes [14].

Chen et al. [4] designed an efficient computation offloading model using a game theoretic approach in a distributed manner. Game theory is a persuasive tool that helps simultaneously connected users to make the correct decision when connecting a wireless channel based on the strategic interactions. If all user devices offload computation activities using the same wireless channel, it might cause signal interference with each other and wireless quality reduction. Specifically, the game theory targets the NP-hard problem of computation offloading incurred by multi-user computation offloading and provides a solution by attaining Nash equilibrium of multi-user computation offloading game.

Wei Gao [7] proposed a opportunistic peer-to peer mobile cloud computing framework. The probabilistic framework is comprised of peer mobile devices that are connected via their short-range radios. These mobile devices are enabled to share both the energy and computational resources depending on their available capacity. He proposed the probabilistic method to estimate the opportunistic network transmission status and ensure the resultant computation is timely delivered to its initiator. The purpose of the proposed framework is to facilitate war fighters at the tactical edge in a war zone. This framework is beneficial for situation awareness or surrounded ground environment understanding, with the help of data processed by in-situ (on site) sensors. The preamble novel framework thus efficiently shares computational tasks by migrating workloads among war fighters mobile hand held devices, perhaps taking an account of timeliness of computational workload for successive resultant migration.

Cloud computing methodology usage in past decade in IoT networks has provided on-demand access to shared computing resources pool (storage, applications, services and software) that are hosted in the cloud. These are easily provisioned when needed by any authorised device in need of them with minimal vendor interaction [16, 11].

The architecture of cloud computing model. The threat of insecurity of data transmitted between devices, service instability, and latency are major drawbacks of Cloud computing [Wb10]. As Cloud computing participant's machines, may be many hops away from each other, some data packets can be lost or man in middle attacks can be done on the transmitted data. To reduce on the drawbacks of far way cloud, usage of cloudlets was proposed as it brought, a limited local Cloud nearby [17].

Fog computing pushes closer Cloud computing paradigm down to the edge network by processing data at fog nodes or IoT gateway. This has solved some of Cloud computing challenges such as high latency and failure ensure total location awareness [6,19]. These fog nodes can be deployed at factories, parks, health care units, transport stations [3].

Edge computing brings, even more, closer the intelligence and application logic past the fog nodes, as it directly does these computations at devices programmable automation controllers that are in the edge networks [Pt04]. This increases the infrastructure efficiency as it provides intermediate layers of computation, networking and storage closer to IoT devices [10].

Niroshinie et al [5] describe Mobile Cloud computing. MCC gives applications ability to be run on remote machines in the cloud so that they can be accessed by client mobile devices that use resources being served over an internet connection. MCC clusters resources in a peer network among mobile devices. This forms a local cloud of mobile devices in the vicinity that provides different services to each other. Mobile cloud computing enables mobile devices to use cloudlet computers with in the proximity, to carry out executions that would have been carried out in the cloud. Even though Mobile cloud computing reduces high latency and bandwidth usage when compared to Cloud computing though itself also has some drawbacks such as low reliability and privacy related issues [8].

Pahl et al [21] review about the impact container virtualization on edge devices when being placed into clusters. It focus on how Edge clouds could go tough computation to scattered lightweight assets close to users. They used containerization technology to build clusters that consisted of customized platforms of SBCs nodes, running different containers with orchestration services that enabled the communication of these SBCs nodes in the clusters.

Riccardo et al [13] proposes the designing of gateways used in Cloud of Things which distributes a collection of resources, enabled in a horizontal integration with various IoT platforms and applications. These gateways oversee, manage data from IoT devices and act as endpoint for communication between cloud data-centers and local devices. The proposed gateways in their study used container based virtualization which gave an improvement of 2.67%, 6.04% and 10% in CPU, memory performance and Disk I/O.

Ramalho et al [15] study evaluates the performance difference between containerized based and the hypervisor-based virtualization at the network edge. The use of hypervisor-based virtualization had good results in regards of isolation in the last decade but containerization abilities such fast to boot up, fast migration and easy to maintain have taken virtualization to next level.

Mist Computing (Mist) represents a paradigm in which edge network devices, that have predictable accessibility, provide their computational and communicative resources as services to their vicinity via Device-to-Device communication protocols. Requesters in Mist can distribute software processes to Mist service providers for execution [9].

Takahashi et al. [20] proposed Edge Accelerated web Browsing (EAB) prototype designed for web application execution using a better offloading technique. The purpose of EAB is to improve user experience by pushing application offloading to the edge server which is implemented within the RAN. EAB-frontend at the client-side retrieves the rendered web content which is processed in the EAB server, whereas, audio and video streams travel through the EAB-backend and are decoded depending on the capabilities of the client hardware.

Sardellitti et al. [21] proposed an algorithm-based design, called Successive Convex Approximation (SCA). This algorithm optimizes computational offloading across densely deployed multiple radio access points. The authors considered the MIMO multicell communication system where several mobile users request for their computational tasks to be carried at the central cloud server. They first tested a single user offloading computational task on the cloud server which resulted in the non-convex optimization problem. In the multiuser scenario, the SCA-based algorithm attained local optimal solution of the original non-convex problem. According to the formulation results, authors claimed their algorithms to be surpassed disjoint optimization schemes. Moreover, they stated that the proposed SCA design is more suitable for applications acquiring high computational tasks and minimizes energy consumption.

Zhang et al. [22] proposed the contract-based computation resource allocation scheme. This scheme improves the utility of vehicular terminals which intelligently utilize services offered by MEC service providers under low computational conditions. The MEC provider receives the payment from vehicles on the basis of the computation task they offloaded to the MEC servers. Using a wireless communication service, information of the contract and payment information is broadcasted to the vehicles on the road.

Habak et al. [23] proposed the FemtoCloud system which forms a cloud of orchestrated co-located mobile devices that are self-configurable into a correlative mobile cloud system. A FemtoCloud client computing service is installed on each mobile device to calculate device computing capability and capacity for sharing with other mobile devices, and energy information. Mobile properties are built and maintained inside a user profile that is shared in a mobile cluster connected to a cloudlet or a control device that is available in a WiFi network. Intensive computational tasks in the form of codes are sent to cloudlets to leverage the computational capacity of other connected mobile devices. The FemtoCloud model is designed to reduce the computational load from the centralized location and bring it to the edge of the mobile network.

Abdelwahab et al. [24] proposed REPLISOM which is a edge cloud architecture and LTE enhanced memory replication protocol to avoid latency issues. LTE bottleneck occurs due to allocating memory to a large number of IoT devices in the backend cloud servers. These devices offload computational tasks by replicating and transmitting tiny memory objects to a central cloud which makes IoT to be scalable and elastic. The LTE-integrated edge cloud provides its compute and storage resources at the edge to resource intensive services. Thus, the proposed REPLISOM reduces the stress of LTE by intelligently scheduling memory replication events at the LTE-edge to resolve any conflicts during the memory replication process for the radio resources.

Nunna et al. [25] proposed a real-time contextaware collaboration system by combining MEC with 5G networks. By integrating MEC and 5G, it empowers realtime collaboration systems utilizing context-aware application platforms. These systems require context information combined with geographical information and low latency communication. The 4G network might not be capable to fulfill such requirements, instead 5G networks and MEC are proficient to utilize contextual information to provide real-time collaboration. The above suggested model is beneficial for scenarios such as life Remote Robotic Tele-surgery and Road Accident that demand high bandwidth and ultra low latency.

Kumar et al. [26] proposed a vehicular delaytolerant network-based smart grid data management scheme. The authors investigated the use of Vehicular Delay-Tolerant Networks (VDTNs) to transmit data to multiple smart grid devices exploring the MEC environment. With the use of a store-and-carry forward mechanism for message transmission, the possible network bottleneck and data latency is avoided. Due to the high mobility of vehicles, a smart grid environment supported by MEC is used to monitor large data sets transmitted by several smart devices. According to the data movement, these devices make computation charging and discharging decisions with respect to message transmission delay, response time and high network throughput for movable vehicles.

Beck et al. [27] proposed ME-VoLTE which is an architecture that integrates MEC to voice over LTE. The encoding of video calls is offloaded to the MEC server located at the base station (eNodeB). The offloading of video encoding through external services helps escalating battery lifetime of the user equipment. Encoding is high computational-intensive
and hence is very power consuming. In the proposed system, encoding techniques are wisely used to stream video on the MEC server. MEC transcodes video by using a special codec program before responding to the user device request. This phenomenon significantly increases data transmission and enhances power management.

Jalali et al. [28] proposed a flow-based and time based energy consumption model. They conducted number of experiments for efficient energy consumption using centralized nano Data Centers (nDCs) in a cloud computing environment. The authors claim that nDCs energy consumption is not yet been investigated. Therefore, several models were presented to perform energy consumption tests on both shared and unshared network equipment. In the paper, it concludes that nDCs may lead to energy savings if the applications, especially IoT
applications generate and process data within user premises.

Jararweh et al. [29] proposed a Software Defined system for Mobile Edge Computing (SDMEC). The proposed framework connects software defined system components to MEC to further extend MCC capabilities. The components jointly work cohesively to enhance MCC into the MEC services. Working with Software Defined Networking (SDN), Software Defined Compute (SDCompute), Software Defined Storage (SDStorage), and Software Defined Security (SDSec) are the prime focus of the proposed framework which enables applications requiring compute and storage resources. Applications like traffic monitoring, content sharing and mobile gaming will benefit from SDMEC.

El-Barbary et al. [30] proposed DroidCloudlet which is based on commodity mobile devices. DroidCloudlet is legitimized with resource-rich mobile devices that take the load of resource-constraint mobile devices. The purpose of the proposed architecture is to enhance mobile battery lifetime by migrating data-intensive and compute-intensive tasks to richmedia. DroidCloulet works as a client device or as a server device running an application that supplements resource-poor devices by offering their available resources. One of the devices takes the role of an agent which is responsible for coordinating resources with other groups of devices.

3. CONCLUSION

Mobile edge computing processing has a brilliant ability to be the future facet innovation supplying statistics switch ability, battery life and capacity to the asset requirement cell phones. This paper surveys and the research efforts made on the mobile edge network, which is a paradigm integrating computing, caching and communication resources. The related problems of processing, storing and interchanges are tested respectively. Then the advances of communication techniques and the synergy with computing and caching are discussed. The novel applications and use cases are the driven force of the mobile edge network architecture. The applications and uses cases that mobile edge networks can fully enable. This new paradigm faces many challenges and opportunities.

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