Identifying Factors Enabling the Enhancement of Service Migration of Multi-Access Edge Computing

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***Abstract*—Edge computing is a novel concept proposed to overcome the limitations of the prevailing cloud-based telecommunication networks. Various concepts have emerged with edge computing that requires proper investigation prior to deployment. Migration of services within the edge computing nodes/ base stations is an imminent aspect of the envisaged paradigm that has created a lot of attention. The selection of the optimum edge node to migrate the service is such an issue that restricts the advancement of edge paradigms. The sole focus of this research is to identify and validate the factors enabling the optimal migration decision considering the Multi-Access Edge Computing paradigm.**

I. Introduction

Multi-Access Edge Computing (MEC) is one of the leading edge computing paradigms introduced by ETSI for overcoming the limitations of cloud computing based network infrastructures; by placing the storage and processing infrastructure in proximity to the User Equipment (UE) [1]. Edge computing, evolving beyond cloud computing in terms of mobile network integration and heterogeneity support for Internet of Things (IoT) devices, enables the deployment of emerging 5G applications. Such stipulated use cases of 5G include: massive Machine Type Communication (mMTC), Autonomous Vehicle (AV) Driving, Unmanned Aerial Vehicles (UAV), and Ultra Reliable Low-Latency Communication (URLLC) [2]. But due to the architectural changes in the mobile network based storage and processing infrastructure, unprecedented challenges of service migration, mobile offloading, technological integration, communication, mobility management, security, and privacy are emerged.

Service migration is the process of transferring executable content incepting in an application or a service, among cloud and edge computing environments. These migrations are occurring either from cloud-to-edge or edge-to-another-edge environment. Typically, a particular Mobile Edge Service (MES) is not available at all the edge nodes due to the envisaged heterogeneity and scalability of IoT resembled services. Therefore, in a situation where a UE/ IoT device/ AV/ UAV is crossing over to a different coverage area from the serving edge node (referred as a handover), the serving MES should be migrated to the roaming edge node for mobility management and service continuity as depicted in Fig. 1. Thus, migration is opening novel avenues for researchers to investigate various aspects of managing migration channel capacity, edge resource utilization during migration, and security of the migration channel from the edge computing perspective; minimizing latency, migration down-time, and selecting the optimum edge node with MEC capabilities to migrate the service are aspects important for maintaining the Quality of Service (QoS) and Quality of Experience (QoE) standards from the MES perspective.

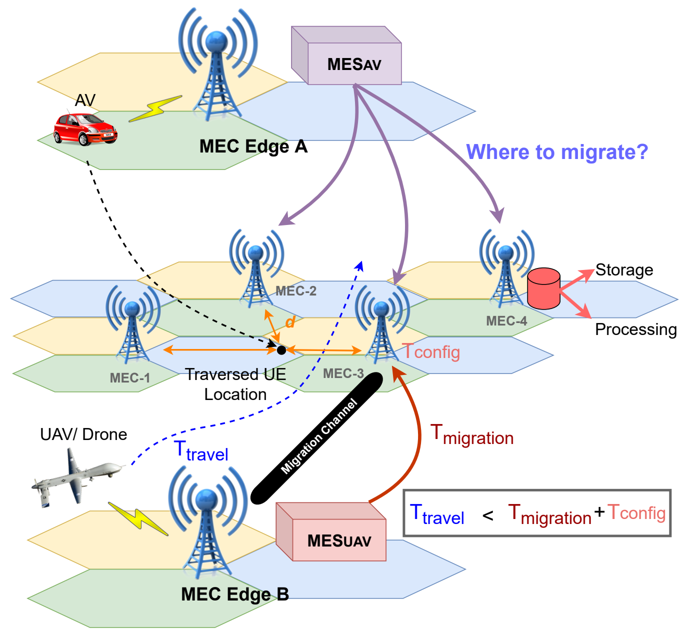

Fig. 1: Issues of MEC based service migration

Among the stated research directives of the service migration phenomenon, a strategy to select the optimum MEC enabled edge node to migrate (i.e. when there are multiple edge nodes in the proximity of the UE that possess different capabilities) is an aspect that lacks in the current research. Eventhough the closest edge node might grant the highest radio access capacity, its current resource utilization, status of the migration channel, and the availability of the considered MES are factoring in for the selection process. Thus, it is imperative to identify the factors that aids us to select the optimum edge node. In this research, our prime focus is to investigate such factors/ parameters that governs the service migration process in addition to guiding the optimum migration selection.

II. MEC-based Enabling Factors to Enhance Service Migration

The factors or parameters enabling the governance of service migration phenomenon can be specified from communication and operational capability of the edge node, and backhaul capacity of the migration channel.

1) Communication and Operational Capability of the MEC Edge Node

Communication Capability : Signal-to-Interference-Noise-Ratio (SINR) measurement of a radio channel gives a good perception on the Received Signal Strength (RSS), that corresponds to the communication capacity of the migrating MEC node. The aerial distances derived from geo-locations (assuming obstacle-less line-of-sight radio links) can be employed to determine the SINR, where data rates in bps can be computed. A permissible communication range (R - minimum data rate, SINR level [3], or number of edge nodes) should be established to conduct the selection process.

Operational Capability : the operational capability of the considered MEC edge node can be determined by the consuming computing (C) and storage (S) capacities at the considered instance. The factors of latency, jitter, and priority level of the MES are contributing to the C and S parameters. QoS Class Identifier (QCI) standards and specifications are aiding to model these two factors in line with the emerging applications and services [4].

2) Backhaul Capacity of the Migrating Channel

The edge-to-edge Bandwidth (BW) of the backhaul link is critical for modelling the service migration process. The existing backhaul links are typically employed for signaling purposes with limited capacity. Though, novel services tend to utilize these links for improving QoE aspects with embedded intelligence. As migrations are less-occurring events, there is no guarantee that available backhaul capacity would be sufficient for migration initiation. For the MEC node selection model, migration time (computed from available link capacity and size of the migrating content) for a specific MES can be considered as a viable input parameter.

III. Validating the Proposed Enabling Factors

Two scenarios can be considered to validate the proposed factors. In the legacy scenario MEC edge node is selected based only on the communication capability (i.e. data rate) as presented in [3]. The proposed scenario considers communication, operational, and backhaul capabilities for the selection process. A simulation was carried out considering 25 edge nodes located at Dublin city, Ireland (i.e. longitude $53.3243282° \sim 53.3654212°$, and latitude $-6.2956804° \sim -6.2071241°$), with their actual geo-locations and BWs extracted from [5]. We assumed that all the nodes were MEC enabled. Further, MESs were incepted based on the QCI levels 1,2,3,4,5,6,7,8,9,70,80,84 to randomize the C and S consumption. The 3GPP propagation model in [6] was followed to compute the data rates. In addition, parameters in TABLE I were considered to perform the simulation, where R was considered as 10.

The simulation was carried out for continuous 500 trials where the UE location was randomized withing the grid to determine the success of launching the migrated services at the roamed MEC edge node based on its resource availability. It is observed from Fig. 2, the success rates of both legacy and proposed scenarios are 33.4% and 98.8% respectively. Thus, the proposed enabling factors are suitable for selecting the optimum MEC edge node for migration.

TABLE I: General Simulation Parameters

Parameter	Values
Number of eNBs	25
Average eNB BW	15 MHz
Maximum transmission power of a eNB	46 dBm
Average resultant antenna gain at eNBs	5 dBm
Average resultant noise power	-92 dBm
Number of MESs Normalized μ / σ	100/ 90
Maximum eNB computing capacity	100 GHz [7]
Maximum eNB storage capacity	100 TB [7]
Maximum computing capacity of a MEC App	60 MHz
Maximum storage capacity of a MEC App	100 GB

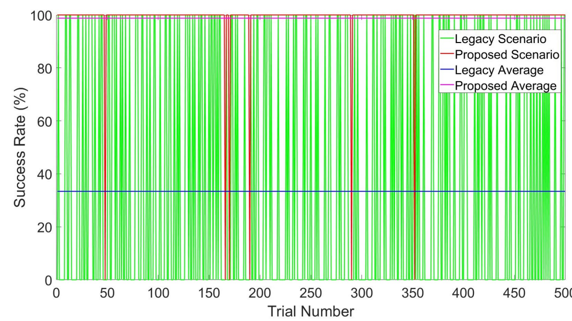

Fig. 2: Simulation results on the success of launching the migrated services.

IV. Conclusion

This study was conducted to identify the enabling parameters that govern the service migration process of MEC. The presented validation proves the effectiveness of the identified parameters defined in terms of communication, operational capability of edge nodes, and backhaul capacity of the migrating channels. These factors will provide a baseline for formulating solutions to current issues of service migration: security, latency, mobility and handover management.

Acknowledgment

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