Mobility Management Framework in Edge Computing Using Multi-Criteria Decision Making

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The urge for seamless and ubiquitous connectivity for heterogeneous devices and networks to deliver desired results has gathered a lot of attention of researchers, academicians and industry experts. To a large extent, this issue has been resolved by cloud computing through task offloading either partially or fully but sending so much data on cloud create overheads. So, a particular task has to be uploaded or not and handoff to be initiated or not is a major decision. Through this paper, an algorithm to take the decision for handoff and switching to the most lucrative network has been proposed. The scheme aims to preserve and provide the users with Quality of Service and Quality of Experience while keeping in mind the criteria of offloading traffic to another cell or network based on the number of mobile users, type of application being used on the mobile, available bandwidth, and network load. The proposed mobile edge architecture may improve the timely execution of the handover process, greatly reduces the ping-pong rate and terminal overhead.

Keywords: Edge Computing, Edge Intelligence, Cloud computing, Network Selection, Mobile Edge computing.

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1. Introduction

Cloud computing has experienced an explosion in the business and corporate world. Additionally, fueled by recent advancements in computing, communication, and storage, the emerging field of cloud computing known as edge computing and edge intelligence has significantly impacted a variety of industries, including healthcare, entertainment, augmented reality, and virtual reality, all of which require large amounts of data and data analysis[1]. The dependency on uninterrupted network with high speed has substantially hiked due to social media, Internet of Things, robots, artificial intelligence, 3D games, and many more intelligent applications. [2] Further, the development of smart mobile devices and the Internet has made these domains even more popular.
A new development in computing has been the role of clouds shifting more and more toward the network edges. [3] In the near future, tens of billions of Edge devices are anticipated to be deployed. At the edge of the mobile network, within the Radio Access Network (RAN), and close to mobile users, mobile edge computing offers an IT service environment with cloud computing capabilities. [4] Instead of allowing direct mobile traffic from the core network to the end user, EC links the user to the closest edge network with a cloud service enabled. [5]

2.Related Work

Increased production and usage of handheld devices with the enabled feature of Always Best Connectivity has paved a new path for cloud. Providing better connectivity is now a fundamental concern for all service providers. Many underlying algorithms [6] has contributed in providing seamless connectivity through optimal handoff procedures.

The new methodologies use evolutionary algorithms, artificial intelligence based algorithms[7] for network selection keeping in mind the various parameters like Bandwidth, Delay, Battery Power, Cost etc. Following is the summary of work done by other authors.

Reference	**Techniques/ Methods & Tools**	**Proposed scheme**	**Parameter**	**Features /Description.**
[8]	SAW/MATLAB	Vertical Handoff Decision Algorithm	Bandwidth & Delay	Selection of network based on context information e.g. quality-of-services parameters like Bandwidth and delay
[9]	MARKOV Decision Process/ MATLAB	multi objective optimization model for VHO NSGA-II	QoS & Bandwidth	• maximize the value of the network state and the user data receiving rate. • increases the system throughput and reduces the blocking rate
[10]	MATLAB	Semi-Distributed TOWCRM algorithm	Bandwidth, Power, U E preferences, input data size, number of path loss	• Optimize offloading tasks • Optimize the system utility under the constraints of computing resources
[11]	TOPSIS & FTOPSIS/ MATLAB	Multi-Criteria Based VHD (MCVHD)	RSSI, Time, Bandwidth, Power Consumption, Cost,	• suitable for an IoT environment • outperforms the conventional RSS Quality based VHD by minimizing handover failures, unnecessary handovers, handover time and cost of service

			Security	
[12]	MARKOV Decision Process/ Framework of the FP7 project TROPIC IST-318784 STP	Path Selection Algorithm	UEs energy consumption (both energy spent by data transmission and handover), handover delay, radio channel quality, and backhaul conditions.	• delivery of the offloaded tasks between the UE and the cloud-enhanced small cells • the UE to perform handover if it is efficient in terms of the overall transmission delay (considering radio and backhaul) and/or energy consumption of the UE. In order to find a trade-off between transmission delay and energy efficiency, weighting of both metrics is introduced
[13]	TROPIC & SESAME	Light weight algorithm	Task information, small base station information and the user mobility	• reducing the task execution delay by task scheduling in MENs
[14]	MEC & ML	DL handover decision algorithm	QoE nd QoS	• Handover decision algorithm that uses a look-up table (LUT) and is catered to key user quality of experience (QoE) and quality of service (QoS) requirements
[15]	Numerical experimentation	Recovery schemes for overloaded or broken MEC		• Neighboring recovery MECs in the cluster can mitigate the problem of overloaded MEC by workload offloading
[16]	Hierarchical Fuzzy System in Matlab	Handoff Initiation Scheme	RSSI, Bandwidth Packet Loss Network Load	• Reducing Ping-pong effect and unnecessary handoffs • Avoiding call dropping with initiating handoff as and when required.

3.Proposed Scheme

In order to produce effective outcomes, an effort has been undertaken to build an edge computing system that uses multi-criteria decision-making.

Various components of this framework are Nodes, Base Station, Edge Devices & Cloud. Nodes are the User Equipments which are moving from one location to another. Base station(s) are access points of available networks to which user can connect. An edge device provides an entry point into a cloud to offload the services according to the traffic classes such as voice, video and best effort. Cloud and Cloud layer act as an intermediate between cloud and the mobile device.

This plan consists of two phases:

a. **Handoff Initiation Phase:** During this phase, all the necessary information regarding the various selected parameters will be collected like RSSI, Bandwidth, Packet Loss, Network Load from the mobile node and its connected base and mobile station. Based on this information, certain rules will be framed and data is being analyzed and a conclusion is being derived that whether a handoff is required or not. This step is being introduced to avoid the problem of unnecessary handoffs and yet reducing the ping pong effect. This will definitely reduce the load on network. This algorithm will move to second phase if handoff is required.

b. **Decision Making Phase:** Once the decision of handoff has been made, then the decision pertaining to switching to the most appropriate network has been done. Selection of network also involves the gathering of data of related parameters of all given networks so that the best alternative is chosen. Once the decision is made for the requirement of a handoff, then the neighboring available networks are being scanned and on the basis of certain set of key indicators, the candidate network is selected. This process must be executed at the backend with least delay possible to avoid call blocking, forced termination and call failure probability.

- **Non fuzzy method**: VIKOR
- **Fuzzy method:** FVIKOR

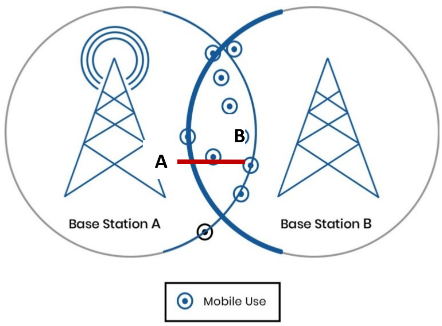

Fig. 1: Switching of the MN near the edges

As you can see from Figure 1, mobile nodes are visible moving along the edge, and the dim lines portray the edge line from both connected endpoints. The process of decision making is important on the grounds of unnecessary & untimely decisions that could prompt futile handovers which will waste network resources and reduce channel utilization.

Therefore, this algorithm utilizes better handover edge computing methods and is more centered around this edge region while settling on network determination choices. Around the portable hub, there are various available network options. At the point when initially found, the MN is arranged in Base Station A and is gradually moving to one side and drawing closer to location B, which is near Base station B. The inclusion of the adjoining edge server will change while this pushing ahead happens. At the point when there is an over-the-top distance between the MN and the edge server, both the QoS and the client experience begin to endure.

The continuous call, errand, or administration on the MN should accordingly be moved to the new edge server for execution. Hence, in this present circumstance, the decision of regardless of whether to offload should be made by consolidating MADM strategy with prescient examination.

If offloading is done and mobile node is moving from position A to B, then to provide the optimal QoS and QoE to user, connection is rebuilt to the new Base Station i.e. B. The decision will be correct if the user continuous to move towards Base Station B. But the decision has to be reverted if before station A which again initiates the process of handoff which results in loss of bandwidth and incurs twice a delay as compared to the previous case. Hence, our proposed work provides a solution to this problem through an edge based framework which is elaborated in Figure 2.

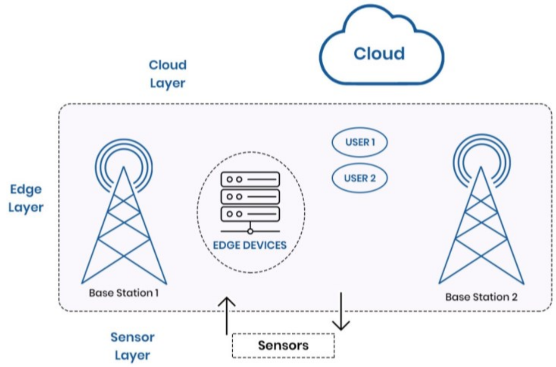

Fig. 2: Edge computing framework for handover process

4. **Challenges of Proposed Algorithm**

The proposed system will generate lesser number of handoffs or predict and decide handoff only when it is required thus reducing the network load and bandwidth. It may have few challenges also. Due to the uncertain and dynamic behavior of the network and random fluctuation in the connectivity available [17], it might be a case that we are not able to predict the handoff in a more accurate manner. These outcomes will increase the quantity of handovers which even probably won't be needed. To resolve this issue, there is a requirement for an instrument to foresee the traffic observing around the reach and afterward anticipating it through the available data sets.[18]

Secondly, it is great challenge to define an edge of a cell when there is a collision two or more different networks. This zone should be treated as a genuine dynamic region for which different arrangement of measurements can be considered and applied for.

5.Conclusion

This paper suggests and recommends a smart task offloading algorithm in edge computing environment by marking a particular cell zone area for handoff decision making. In order to provide QoS and QoE to the user in terms of call and session continuity without any interruption, a predictive network selection decision making algorithm has been worked upon. In existing work, the researchers have employed many techniques such as context aware, genetic algorithm, RSSI based methods, queuing algorithms, neural networks for decision making but to cater to the existing challenges, future work will incorporate the usage and study of data sets and then predicting that whether handover is required or not.

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