Mobility Management Based Mode Selection for the Next Generation Network

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Abstract. In this work, we proposed a modish approach to enhance Quality of Service (QoS) in the mobility management of cellular mobile communication using mode selection method. In this approach, mode selection method uses certain quality parameters such as delay, signal strength and throughput. Different mode selection scheme is proposed based on accessibility and decision making, i.e., either the User Equipment (UE) or the Cellular Mode (CM). During the exchange of the network from cellular mode to user mode, there is a need to maintain the acceptable quality of parameters. It is decided by mobility management model. The proposed method offers faster response (0.165 s lesser than the existing) and 1.64 Mbps throughput.

Keywords: Handover · LTE · Mobility management · Mode selection · Quality of Service (QoS) · Wireless network

1 Introduction

The demand of mobile data is increasing exponentially and in the fifth generation (5G) cellular mobile communication systems, the data speed is expected to reach up to 10 Gbps, around 20 fold increases from that of forth generation (4G) Long Term Evolution Advanced (LTE-A) [1]. The speedy growth in the usage of mobile communication has greatly necessitated the expansion of cellular mobile. At the same time, it is expected that the network to provide good Quality of Service (QoS). From Ericsson mobility report (June 2020), the average traffic for each smartphone is anticipated to increase nearly 25 Gb per month in 2025 [2]. Furthermore, near about 410 million smartphone users are anticipated in India by 2025, wherein global traffic rate would reach around more than 35 Eb per month by the end of 2020 [2]. More mobility support devices are used continuously by users. One of the Quality of Service (QoS) parameter is seamless

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connectivity, that is, mobility which can be addressed by mobility management [3]. Because of denser deployment, users require much frequent handover. The handover can be performed by User Equipment (UE) also called user mode or by base station, also called cellular mode. In addition, it is also possible to perform the function sometimes by cellular mode while sometimes, with user mode. Mobility management plays important role in the mode selection. However, frequent and inefficient process of mode selection between user mode to cellular mode especially when handover process initiates, degrades the network performance. UE system does not have the intelligence to select the best mode to enhance or maintain the Quality of Service (QoS).

In this paper, we present an enhanced QoS using mobility management to assist selection of modes like user or cellular for seamless connectivity. The switching of modes is enabled on the basis of Quality of Service (QoS) parameter like signal strength and delay of user mode or cellular mode. Enhance QoS Mobility Management (eQMM) is checked for heterogeneous networks. It selects the calls from user mode to cellular mode. It is based on network performance. During the selection of mode, mobility management will insist to choose for better performance so that QoS is maintained. And, according to the selection process, call will be transferred towards the best network. Our proposed work build up on customers QoS performance such as less communication delay and maximum throughput. We scrutinize these terms and formulate them with switching factors.

Rest of the contents of the paper is arranged as follows. In Sect. 2, mobility management in cellular network and, mobility management model is discussed, propose mode selection method is explained in Sect. 3. Section 4 presents results and discussion while conclusion is given in Sect. 5.

2 Mobility Management in Cellular Network

2.1 Relevant and Recent Work

In this section, we describe the overview of present state of art for mobility management in cellular network and consider LTE-A as recent technology.

In Fig. 1, basic cellular network is shown, where base station includes antenna, controller and number of receivers. Base Transceiver Station (BTS) is installed on upper side of the antenna. It is a mobile phone access point to the network. BTS communicate between network and mobile phone. While Mobile Telecommunication Switching Office (MSTO) connects calls between mobile units. It help to set up the calls and handle the call routing and call switching also. MSTO is also helpful for the handover. Mainly two types of channels are available between mobile unit and base station.

1. Control Channel: This is used for exchanging and maintaining the information.
2. Traffic Channel: This is use to carry the voice as well as data connection in between the clients or users.

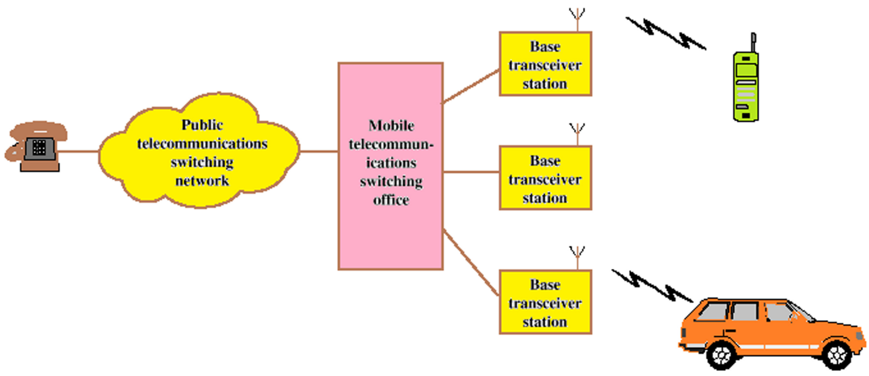

Fig. 1. Basic cellular network

In the past years many research works addressed the challenging issue of mobility management in cellular network to improve the Quality of Service (QoS) with respect to parameters such as delay, jitter, interactive traffic and low Bit Error Rate (BER). Authors in [4], designed the mobility prediction coupled with the various protocol which was used to improve QoS for mobile devices and explained the traffic load distribution in Wi-Fi network without disturbing. In [5], authors developed an enhanced mobility management and Vertical Handover (VHO) algorithm which was used during Device to Device (D2D) communication for maximizing the throughput. However, the scheme is for precise borders of different regions with less time. Authors in [6] addressed a device centric communication for networks. [12] designed Location Management (LM) system for the personal communication system. This method proposed for mode writing in device to the network. But in this work, movement of user in mobile management is not investigated and discussed. In some research [6], user centric mesh is used to determine the dynamic femto access node group for 5G mesh but again node mobility is not addressed. In this paper, we present an enhancing Quality of Service (QoS) mobility management using mode selection algorithm.

2.2 Mobility Management Model and Architecture

Figure 2 shows the mobility management architecture. This model includes two parts. One is handover unit for controlling the handover and Context Aware Module (CAM) for generating trigger event for handover. Handover unit examines the better selection of network and grant the decision towards Cellular Mode (CM) or User Mode (UM) and stores the remaining information in data storage unit. Figure 3 shows handover stages in mobility management module. Handover procedure depends on three major actions,

1. One is collecting the information in which it checks the availability for network and also find the user requirement.

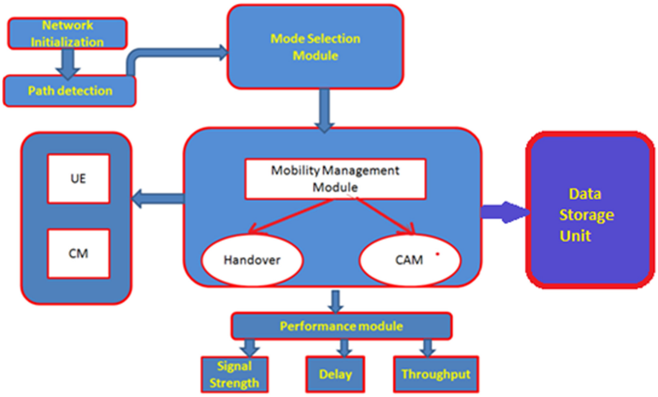

Fig. 2. Proposed mobility management model using mode selection method

2. Decision takes place using resources of availability and from the decision algorithm handover decision takes place. In final stage handover execution occurs.

3 Proposed Mode Selection Method

This is a mode selection method where mesh changes towards user centric transmission. This method is independent on mesh infrastructure wherein system to system communication is not depended on enhance Node Base Station (eNB). The proposed work has outcome based mode selection using mobility management. Figure 3 shows proposed mode selection method.

Initially, the network is established and searches a path for further communication. Once the path is detected, the path detection performs the input function for Mode Selection Module (MSM). In wireless networks, the selection of best

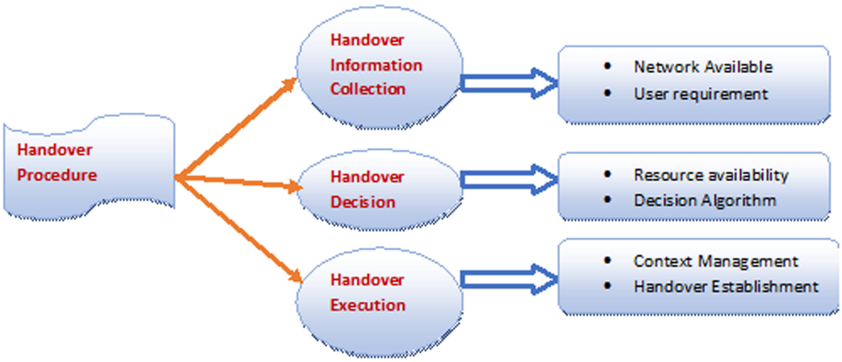

Fig. 3. Handover stages in mobility management module

network is challenging process. For seamless mobility there is no single factor that can provide a clear data of which term to select. The following performance parameters like signal strength, user satisfaction, delay, maximum throughput are used for decisions. However, all methods do not satisfy users requirements. In this current proposal, by minimizing delay and latency user satisfaction Quality of Service (QoS) is fulfilled.

4 Mode Selection Algorithm

Figure 4 shows the mode selection algorithm which explained the process of selection. Let $s(g)$ represents signal strength and $b(w)$ represents bandwidth. These operations will record the Quality of Service (QoS) specifications such as UE and Correspondent Node (CN) to calculate the signal strength between UE to eNB and Correspondent Node (CN) to eNB. And the network for UE and CN is denoted by $N(w)$. Also, consider performance of energy for the signal is denoted as $e(n)$ and time delay to reach eNB is denoted as t(d). If signal is maximum from threshold value (Δ) then call will move towards UM. We used threshold values same as LTE network. P_r is indicates for the performance parameters. And the e(n) used for energy while t(d) is denotes for time delay.

4.1 Model Formulation with Mobility Management

Consider client motion probability is MB, a cell phone client walk in limited service zone D. Starting position of the client is assumed as $U_1(a_1b_1c_1)$ and actual location is $U_2(a_2b_2c_2)$, the $distance = |U1U2| = \sqrt{(}a_2 - a_1)^2(b_2 - b_1)^2(c_2 - c_1)^2$. For each movement of the user will change the results.

4.2 Delay

In the proposed method, the eNB will select the mode of communication on the basis of network performance. So $delay = Time1{+}Time2$. Due to free user movement, the mobility and hopping affect this delay. In between the communication user is selecting the mode. Delay in cellular mode is,

$$t(d)_{CM} = Ug_e \left(\prod_{k}^{i} \sum_{e=1}^{\gamma} \sum_{j=0}^{\partial J} \rho + \pi_i^k \sum_{j=0}^{\partial J} \rho \right) \tag{1}$$

Where, U indicate movement factor, and ρ denotes transmission delay. g_e represents probabilities devised on the basis of call arrival and departure, i represents index of position, k denote call departure states, J represents per hop link utilization, $\prod$ represents state change, j represents signifies movement direction and γ indicates hop count.

Mode Selection Algorithm

Data: s(g) → UE, s(g) → CN, b(w) → UE, b(w) → CN

Device mode selection

Calculate: P(r)[UE, eNB], P(r)[CN, eNB]

While P(r) [UE, eNB], P(r)[CE, eNB] = Threshold(?)

User -Mode();

End

Cellular- Mode();

Data N(w) → UE , N(w) → CN

Performance $P_{r(\alpha)}$

Calculate e(n) → [UE, eNB], t(d) [UE, eNB]

t(d) [CN, eNB], b(w) (β)

If e(n) → [UE, eNB] && e(n) [CN, eNB]

&& t(d) [UE, eNB] &&

t(d) [CN, eNB] && b(w) = Threshold(?)

User Mode();

Data: D(S) for UE, CN

If Ds = Threshold(?)

Calculate N(w) → UE, N(w) → CN

The Enb calculates

S(g),t(d),e(n).

P(R)[γ] == S(g) && t(d) && e(n) = Threshold(?) User Mode (UM)();

Otherwise Cellular mode(UM)

Γ--- Metric between source node to target node.

Fig. 4. Algorithm for mode selection

This delay in UM is expressed by,

$$t(d)_{UM} = Ug_e \left(\prod_{k}^{i} \sum_{e=1}^{\psi} \sum_{j=0}^{\partial J} \rho + \pi_i^k \sum_{j=0}^{\partial J} \rho \right) \tag{2}$$

4.3 Energy

The usage of energy is based on network energy. Which is dependent on mobility factor. Energy usage in CM describe as,

$$e(n)_{CM} = \prod_{k}^{i} \sum_{e=1}^{\gamma} \sum_{h=1}^{U} (\alpha + \beta + x) + \prod_{k}^{i} \sum_{e=1}^{\gamma} \sum_{h=1}^{U} x \quad (3)$$

where, α denotes group energy, γ represents hopping, U denotes signifies user mobility factor such that $1 \leq h \leq U$, β indicates network update energy and x is signaling cost. The energy usage in UM is expressed as,

$$e(n)_{UM} = \prod_{k}^{i} \sum_{e=1}^{\gamma} \sum_{h=1}^{U} (\alpha + \beta + x) + \prod_{k}^{i} \sum_{h=1}^{U} x \quad (4)$$

5 Simulation Setup

The performance result of the proposed method is done in MATLAB R18a using PC with Windows 10 Operating System, 2 GB RAM, and Intel i5 core processor. Parameters such as utilizing delay, power and throughput are evaluated. We used 110 nodes and simulation time is 500 s. Following Fig. 5 shows output graphs for the delay and Fig. 6 shows comparison for throughput. Figure 7 shows output graphs for power.

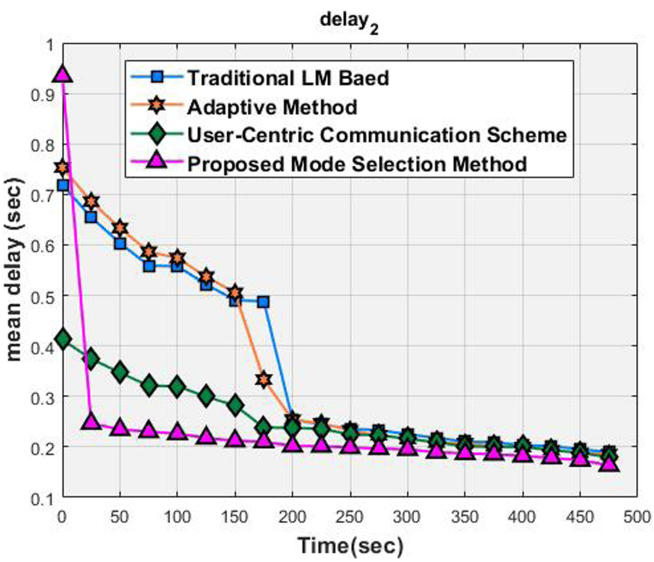

Fig. 5. Delay in proposed method

Table 1. Results

Metrics	Traditional location based method	Adaptive scheme	User-centric communication method	Proposed mode selection method
Delay (s)	0.195	0.188	0.180	0.165
Power	28.448	33.810	36.768	58.785
Throughput (bps)	1138543	1550007	836393	1641723.5

6 Result

The methods used for the comparative analysis are traditional Location Management (LM) method, adaptive method and user centric communication method. The comparison analysis for traditional method and proposed method with delay parameter is shown in Fig. 5. When simulation time is 470 s, the delay values calculated by the Location Management (LM) method, adaptive method, user centric communication scheme, and proposed mode switching methods are 0.195 s, 0.188 s, 0.180 s, 0.165 s. The analysis method for calculating throughput is shown in Fig. 6. When simulation time is 470 s, throughput values computed by traditional Location Management (LM) based is 1138543, adaptive method is 155007, user centric communication method is 836393 and in proposed mode selection method throughput is maximum value as 1641723. The analysis of methods using the power parameter is considered in Fig. 7, when simulation time is 470 s, the power values computed by the Location Management (LM) scheme, Adaptive scheme, User centric communication scheme, and proposed mode switching method are 28.448, 33.810, 36.768,58.785 (Table 1).

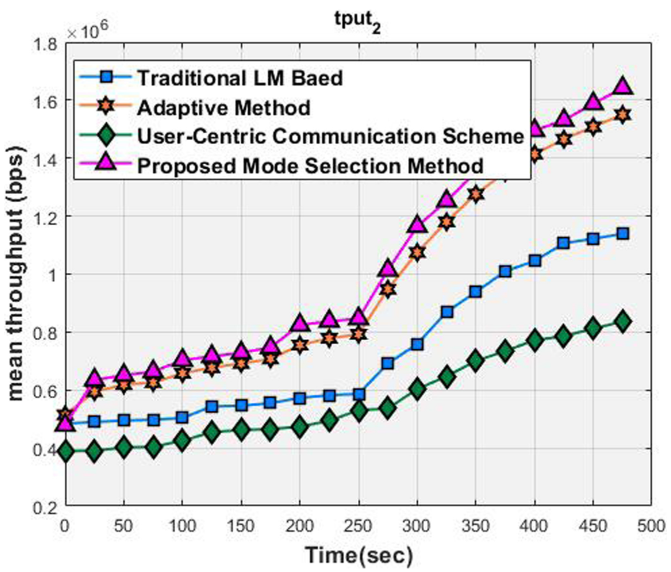

Fig. 6. Throughput in proposed method

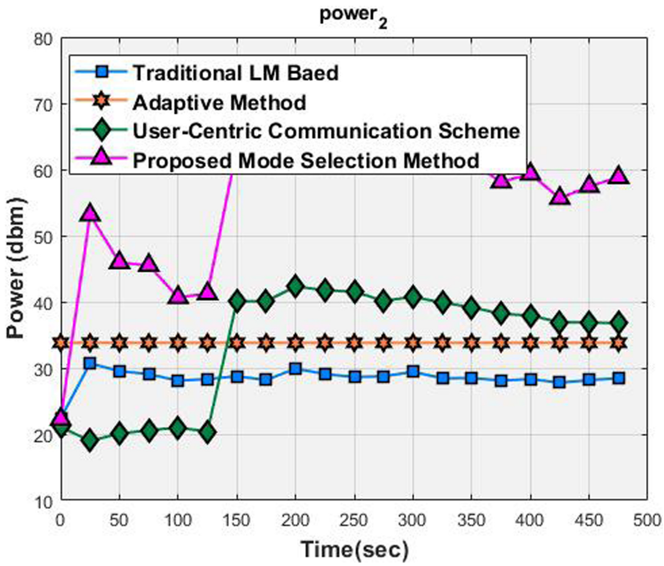

Fig. 7. Power in proposed method

7 Conclusion

A new mode selection scheme in cellular networks for mobility management is developed. At this point, in the system design the selecting factors, which includes secure execution based specifications, like delay, energy usage, and signal strength for available user. The enhancing Quality of Service (QoS) in mobility management using mode selection method as well as client mode selection also done. In between the procedure, it select user mode or cellular mode. For increasing the quality of service, client motion can be anywhere. The planned work of mode selection method gives the minimum delay of 0.165 s, power of 58.785, and obtained throughput is 1641723.5.

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